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THE ROTIFERA;

OR

WHEEL-ANIMALCULES.

BY

C. T. HUDSON, LL.D. CANTAB.

ASSISTED BY

P. H. GOSSE, F.R.S.

WITH ILLUSTRATIONS.

IN TWO VOLUMES.

TEXT.

LONDON:
LONGMANS, GREEN, AND CO.
1886.

14

Cæcam mihi in cunctis fidem haberii haud postulo; id tantum optans, ut continua indagatione ac studio mea aliquando confirmentur, aut me a vero aberrasse demonstretur. Perscrutatoris vel exactissimi, et quamvis summam adhibeat, attentionem fugere aliquando quædam possunt; et casus nonnunquam fortuito nobis offert, quæ intensissima sæpe cura frustra quæsivimus.—J. Baster.

C'est dans les livres de la Nature, qu'on doit lire, quand on veut travailler sur l'Histoire Naturelle; mais on ne peut pas y lire, quand on veut. Il faut des lieux, des saisons et des circonstances favorables pour faire des observations nécessaires. Quelques fois à la vérité on peut aider à faire naître des circonstances heureuses, mais plus souvent il faut que le hazard nous serve.—Réamur.

THE ROTIFERA.

VOLUME I.

PRINTED BY
SPOTTISWOODE AND CO., NEW-STREET SQUARE
LONDON

THE ROTIFERA;

OR

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BOTH BRITISH AND FOREIGN.

BY

C. T. HUDSON, LL.D. CANTAB., F.R.S.

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IN TWO VOLUMES, WITH SUPPLEMENT.

VOLUME I.

WITH ILLUSTRATIONS.

LONDON:
LONGMANS, GREEN, AND CO.
AND NEW YORK: 15 EAST 16th STREET.
1889.

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PREFACE.

Nearly fifty years have passed, since Ehrenberg's successful invasion of the unseen world was made known by the publication of his noble work, *Die Infusionsthierchen*; and twenty-five since Dr. Arlidge's edition of Pritchard's excellent *History of Infusoria* brought together, in a convenient form, the results of the long and patient observation of many investigators.

Meanwhile memoirs on various species of Rotifera, as well as the number of species themselves, kept slowly increasing; and, what is of greater moment, the prolonged study of these interesting atoms, by several acute observers, has made clear some of the perplexing difficulties in their structure, and swept away many mistakes both of observation and inference.

Under these circumstances the authors of this work believed that such a book as the present was much wanted; and they hoped that their prolonged study of the Rotifera (continued, in the case of each author, almost daily, for upwards of thirty years), as well as their invariable habit of drawing from life all that they had observed, would enable them, by means of their long accumulated stores of drawings and notes, to meet this want.

They venture to think, from the manner in which, so far, the book has been received, that this belief and hope have both been justified; and in confirmation of the favourable opinions of it that have already been expressed, would point out (they trust with pardonable pride) that this work contains more than 120 species which were unrecognized when Dr. Arlidge wrote; that nearly the whole of these have been added to science by the authors themselves; that about eighty of these new species, chiefly among the *Ploïma*, have been found by one of the authors during the last fifteen months; and that the other by the discovery, among other remarkable forms, of *Pedalion mirum*, has put beyond question the fact that the Rotifera, in one point at least, are closely linked to the Arthropoda.

The thirty coloured plates have been divided nearly equally between the two colleagues; the small uncoloured plates A, B, C are by Dr. Hudson. The figures in plate D are taken from various sources; but in every case, both here and in the coloured plates, the original authority has been indicated; the initials G or H being attached to those figures which have been drawn from the life by Mr. Gosse or Dr. Hudson. Mr. Gosse's independent portions of the text are always inclosed in square brackets [ ], and marked at the end with his initials, P.H.G.: the portions not so marked are by Dr. Hudson, including the first four chapters.

Throughout the whole of the work Dr. Hudson has had the invaluable assistance of Mr. Gosse's MS. notes, and of his close and constant revision of the proofs.

The hearty thanks of the authors are due to Mr. Frank Crisp, one of the secretaries of the Royal Microscopical Society, and editor of its Journal, for the great service that he has rendered them by forwarding early notices of all the pamphlets and papers published on the subject: anyone who is, or has been, engaged in a task similar to this will know what time and labour have thus been spared, by his thoughtful kindness.

They are, too, greatly indebted to numerous kind correspondents for living specimens, often obtained with no little expenditure of time and trouble, and for the records of their observations on them; as well as for valuable preparations of rare species, which could not be sent alive: to these correspondents the authors tender their grateful thanks. In each case where the specimen was new or rare the name of the place in which it was found, and (when permitted) the name also of the finder, has been added to the description. They wish, however, to make special mention of how much they owe to Miss Saunders of Cheltenham, Miss Davies of Woolston, Dr. F. Collins, and Mr. John Hood of Dundee, for their constant kindness in sending a profuse number of specimens of many species, some of which were of unusual interest.

It is so natural to recommend one's own favourite pursuit that the recommendation often carries but little weight; and yet there is much to be said in favour of the study of the Rotifera, that cannot be gainsaid. They are to be found almost everywhere; they cost nothing; they require neither expensive lenses nor an elaborate apparatus; they tempt us to explore the country, and to take pleasant walks; they are beautiful themselves; and they suggest all kinds of difficult questions on life and being. Moreover there is happily still a great store of scientific ignorance concerning them, thus leaving an ample field for fresh discoveries.

Nor is this all. The study of these animated specks (in which teeth, stomach, muscles, and even a brain lie hidden in the compass of an invisible mote) irresistibly leads the mind to the contemplation of Him, whose almighty hand is as visible in an atom of this animated dust, as it is in the myriad sparkles of the starlit heavens.

C. T. H.

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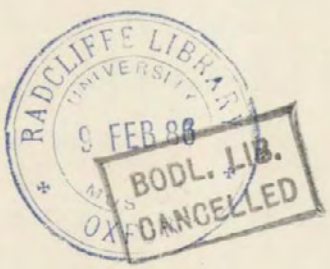
OF

THE FIRST VOLUME.

THE ROTIFERA.

CHAPTER I.

INTRODUCTION.



Contemplatio Naturæ prægustus est voluptatis cælestis, constans animi gaudium, perfectique ejus solatii initium, summusque felicitatis humanæ apex. Cum Anima hujus particeps fuerit, ex gravi quasi sopore excitata, in luce ambulat, sui ipsius obliviscens, in cælesti, ut ita dicam, terra, inque terrestri cœlo.—J. Baster.

Inest in explicatione Naturæ, insatiabilis quædam e cognoscendis rebus Voluptas, in qua una, confectis rebus necessariis, vacui negotiis, honeste ac liberaliter possumus vivere.—Cicero, *De Finibus*, lib. iv. cap. 5.

CHAPTER I.

INTRODUCTION.

On the Somersetshire side of the Avon, and not far from Clifton, is a little combe, at the bottom of which lies an old fish-pond.

Its slopes are covered with plantations of beech and fir, so as to shelter the pond on three sides, and yet leave it open to the soft south-western breezes, and to the afternoon sun. At the head of the combe wells up a clear spring, which sends a thread of water, trickling through a bed of osiers, into the upper end of the pond. A stout stone wall has been drawn across the combe from side to side, so as to dam up the stream; and there is a gap in one corner, through which the overflow finds its way, in a miniature cascade, down into the lower plantation.

The pond's smooth surface is prettily diapered with the green leaves of many a water-plant, and with the sharp images of three famous beeches growing close to its edge: but to a naturalist's eye the old wall is the more charming object. Time has crumbled away the mortar near the water's edge, and made a thousand nooks and crannies; which, densely clothed with algæ, are the haunts of myriads of living creatures.

If we approach the pond by the gamekeeper's path from the cottage above, we shall pass through the plantation, and come unseen right on to the corner of the wall; so that one quiet step will enable us to see at a glance its whole surface, without disturbing any living thing that may be there.

Far off at the upper end a water hen is leading her little brood among the willows; on the fallen trunk of an old beech, lying half-way across the pond, a vole is sitting erect, rubbing his right ear; and the splash of a beech husk just at our feet tells of a squirrel, who is dining somewhere in the leafy crown above us.

But see! the water rat has spied us out, and is making straight for his hole in the bank, while the ripple above him is the only thing that tells of his silent flight. The water hen has long ago got under cover, and the squirrel drops no more husks. It is a true 'Silent Pool,' and without a sign of life.

But if, retaining sense and sight, we could shrink into living atoms and plunge under the water, of what a world of wonders should we then form part! We should find this fairy kingdom peopled with the strangest creatures:—creatures that swim with their hair, that have ruby eyes blazing deep in their necks, with telescopic limbs that now are withdrawn wholly within their bodies and now stretched out to many times their own length. Here are some riding at anchor, moored by delicate threads spun out from their toes; and there are others flashing by in glass armour, bristling with sharp spikes or ornamented with bosses and flowing curves; while, fastened to a green stem, is an animal convolvulus that by some invisible power draws a never-ceasing stream of victims into its gaping cup, and tears them to death with hooked jaws deep down within its body.

Close by it, on the same stem, is something that looks like a filmy heart's-ease. A curious wheelwork runs round its four outspread petals; and a chain of minute things, living and dead, is winding in and out of their curves into a gulf at the back of the

flower. What happens to them there we cannot see; for round the stem is raised a tube of golden-brown balls, all regularly piled on each other. Some creature dashes by, and like a flash the flower vanishes within its tube.

We sink still lower, and now see on the bottom slow-gliding lumps of jelly that thrust a shapeless arm out where they will, and, grasping their prey with these chance limbs, wrap themselves round their food to get a meal; for they creep without feet, seize without hands, eat without mouths, and digest without stomachs.

Time and space, however, would fail me to tell of all the marvels of the world beneath the waters. They would sound like the wild fancies of a child's fairy tale, and yet they are all literally true; and, moreover, nearly all of them are true of that rotiferous world which it is my purpose to describe.

But it will be naturally asked by those of my readers to whom the subject is new, "What *is* a Rotiferon?" and no doubt one would say that a book about Rotifera ought to begin at the beginning, and define precisely what a Rotiferon is.

Precise definition is, however, in such a case, quite out of the question; for, though it is easy enough to define the typical form of a natural group of animals, or even to include in the definition forms that must be placed not far off from the central one, yet in the ambitious attempt to frame a definition that shall include many families, we find (as we get farther away from the typical form) that one by one all the positive statements are disappearing from our definition; and at last we have nothing left but the mere shell of a proposition, with everything worth the stating struck out of it.

The Rotifera, then, are small aquatic animals varying from $\frac{1}{8}$ to $\frac{1}{500}$ of an inch in length, and deriving their name from a wheel-like appearance produced by fine circlets of hairs seated on the front of their heads. A few species are marine; but the great majority known to us belong to fresh water, and are to be found in ditches, ponds, reservoirs, lakes, and slowly running streams, sometimes attached to the leaves and stems of water plants, sometimes creeping on the algæ, sometimes swimming freely through the water. Although the greater number of the genera resemble each other in the chief features of their internal organization, so as to form a very natural group of animals, yet there are several aberrant forms which would render it a difficult matter to include them all in one precise definition.

This indeed could be done only by introducing so many qualifications and exceptions to every statement, that the portrait would be rendered too vague for any reader but one already familiar with the whole subject.

Of the greater number, however, it is enough to say:

(1) That they swim by means of hairs on the front of their heads.

(2) That they possess a simple stomach and intestine; and peculiar jaws.

(3) That they have muscles which are sometimes striated, and which often pass freely through the cavity of the body.

(4) That they have a well-developed vascular system.

(5) That their nervous system consists of one ganglion, with nerve threads radiating to their organs of sense.

(6) That they are dicœcious; have ova of two kinds; and do not pass through any distinct metamorphosis.

Though the above six statements are precise enough, and in the main true, yet it will be as well for those, who are not versed in the subject, to pass them over for the present, and first to master the structure of some one typical Rotiferon; as, when this has been done, the general conception of a Rotiferon will be easily grasped, and the variations from the type readily followed and understood.

For this purpose I have selected *Brachionus rubens*, whose figure is given much magnified in Pl. A, fig. 1. The genus *Brachionus* is to be met with almost everywhere. It is hardly possible in summer to take a dip of water from a garden-pond, or to gather the algæ from its walls, without bringing up some specimen of the genus. *Brachionus rubens* is a fairly common species. It is comparatively a large handsome

animal, very suitable for the purpose of description, and one which bears the temporary captivity of a compressorium remarkably well.

The Female.

Fig. 1, Pl. A, represents the dorsal aspect of the female of this *Brachionus*, and fig. 2 the upper part of the ventral aspect. The drawings are from life; but the outlines of the various organs have been made unnaturally sharp and distinct, for the sake of clearness. The dorsal and ventral surfaces may be distinguished from each other in the great majority of the Rotifera by the following considerations:

First, as to the dorsal surface:

(1) It is arched (fig. 5).

(2) The stomach (fig. 1, *s*) passes down it; between it and the ovary (fig. 1, *oy*).

(3) The cloaca (fig. 1, *cl*) is on it; in the median line.

(4) There is almost invariably one antenna (fig. 1, *a*) (or a coalesced pair) on it; placed anteriorly on the median line.

(5) The eye or eyes (fig. 1, *e*) are towards the dorsal surface.

(6) In swimming over objects the Rotiferon keeps the dorsal side upwards.

Secondly, as to the ventral surface (fig. 2):

(1) It is comparatively flat.

(2) The entrance to the mouth lies on it (figs. 2, 5, *bf*).

(3) The ovary is placed close to it (fig. 2, 5, *oy*).

In the case of those Rotifera whose dorsal and ventral surfaces have much the same contour, the above considerations present points of difference enough to decide between the two.[1]

B. rubens is inclosed in a case or *lorica* (figs. 3, 4, 5) which is both hard and transparent. The internal structure can be readily seen through it; and, by suffering the animal to dry on a glass slip, and then dropping on it a solution of caustic potash, the softer portions of the body may be dissolved away, and the lorica left unharmed.

It will then be seen to be closed above and below, with an opening at each end, like the shell of a tortoise. From the front opening the head is protruded, and from the hind the *pseudopodium* or *foot* (fig. 1, *f*).

The lorica has a glassy shining surface, and is armed with six short sharp spines in front, of which the central pair is the longest. Four of them are distinctly on the dorsal surface; but the outmost pair belongs as it were to both surfaces, being on the edge where they meet.

The front edge of the ventral surface (the *mental* edge as it is sometimes termed)[2] is hollowed out symmetrically into graceful curves (fig. 4).

The lorica widens from the front backwards, till, at about two-thirds of its length, it reaches its maximum breadth; and is then rounded off by two ogee curves that are separated, by a square notch on the dorsal surface, but by a nearly circular one on the ventral. In consequence, it is often said that the lorica has two blunt spines behind on the dorsal surface; but this is somewhat misleading, as these so-called spines are merely the sides of the excavation. Strong ridges from each of the four central front spines run down about one-third of the dorsal surface (fig. 3), and still longer ridges mark the ventral surface with sweeping curves (fig. 4).

The median portion of the lorica is by far the deepest, and in it the internal organs mainly lie. The dorsal surface of the lorica slopes upwards from the head to its line of greatest width (fig. 5), and then abruptly falls to meet the under surface; the whole lorica thinning off there into closely approaching plates, through the excavation in which the foot can pass. Each side, too, of the median portion of the lorica thins off in a similar manner; so that the dorsal and ventral surfaces meet everywhere (except at the head) in a sharp edge.

[1] *Cf.* Dr. Moxon, *Trans. Linn. Soc.* vol. xxiv. 1864, p. 455.

[2] From *mentum*, the chin.

The head is shaped somewhat like a truncated cone, with the larger end forward; posteriorly it is studded with several small rounded lobes; while from its anterior surface rise three fleshy protuberances, crowned with stout vibrating hairs called *styles*.

Each side of the front of the head, or *corona*,[1] is rounded into a nearly circular lobe, and along the rim of each lobe runs an unbroken row of smaller vibrating hairs, called *cilia*, which are continued so as to meet each other on the dorsal surface. It is by means of this apparatus that *Brachionus* both swims and procures its food.

As the head is seldom withdrawn into the lorica for more than a moment or two, and as the cilia begin to play the instant it is protruded, *Brachionus* would have been condemned to almost perpetual motion if it had not been for the foot. This organ is provided at its extremity with two pincer-like processes, or *toes* (fig. 1, *t*); which, however, do not pinch, but which can adhere even to glass by means of a viscid secretion that flows through their tips.

The *foot-glands* (fig. 1, *fg*), which secrete this substance, are two club-shaped organs running down the whole length of the foot. They are to be met with in nearly all the Rotifera.

The cilia, which are set closely round the edge of the corona, lash the water with such fury that it is impossible usually to follow the action of any individual cilium; but, by selecting an animal whose corona is close to the covering glass of the live box, some spot can often be found where the action of the cilia is checked by their striking against the glass; and, under these circumstances, it is easy to understand their action. Each cilium lashes sharply downwards (like a whip) on the corona, and then rises gradually into its place again, to repeat the action continuously, so long as the corona is expanded. As, however, the cilia do not do this simultaneously, but in turn, one after the other, in very rapid succession, those that can be seen together at any given moment are in every phase, from complete extension to complete depression; thus giving rise to various wave-like illusory appearances, according to the illumination, and also to the plane on which the objective is brought to focus. One of the most common of these appearances is that of a toothed wheel, which is so well imitated by the *Philodinadæ*, that early observers thought such wheels existed, and drew them like the escapement-wheel of a watch.[2]

If a little carmine be mixed with the water, two beautiful coloured spirals will be produced by the action of the ciliary wreaths, one on each side of the head leading down to the buccal funnel. The orifice of the buccal funnel, or, as it will be termed, the *buccal orifice*, lies in a niche on the ventral surface; it is fringed by the ciliary wreath, which here dips down on either side of the corona, and passes round the V-shaped opening of the *buccal funnel* (fig. 2, *bf*)—that is, of the passage leading from the niche to the mastax. The atoms brought by the ciliary currents pass down the buccal funnel, which itself is lined with cilia; and, if uninterrupted, enter the *mastax* (figs. 1, 2, *mx*), a muscular bulb containing the *trophi* (fig. 1, *ti*) or teeth. But it is not every atom whirled down the buccal funnel that is suffered to reach the mastax; for there are two lip-like processes (fig. 2, *lp*) rising from the mastax, which can be seen every now and then thrust up and down the buccal funnel; and which by closing prevent the passage of morsels that are not to the Rotiferon's taste. The sudden check, produced by the lips on the inflowing current, always sweeps out of the buccal funnel whatever the animal desires to reject; and a constant stream of rejected particles may be seen issuing from the buccal funnel midway between the spirals caused by the corona.

The Mastax.

The *mastax* (figs. 1, 2, *mx*; fig. 6) is the muscular covering of the jaws or *trophi*. It has thick walls, and is slightly three-lobed, each lobe investing one of the three principal parts of which the trophi consist. There is an opening in front towards the ventral surface at the bottom of the buccal funnel, whose walls here merge into those of

[1] A name suggested by Mr. Cubitt in lieu of *trochal disk*.

[2] *Baker on the Microscope*, vol. i. Plate VIII. fig. 6, 1785.

the mastax; and there is a posterior opening towards the dorsal surface, just above the œsophagus.

The contained hard parts, or *trophi*, consist of two hammer-like bodies, the *mallei* (fig. 6, *ms*; fig. 9), and of a third anvil-piece called the *incus* (fig. 6, *is*). Each malleus has for its head or *uncus* (figs. 6, 7, 9, *us*) a piece which, when spread out by pressure, is like a comb with five unequal teeth (fig. 8, *us*), but which, under ordinary circumstances, is much curved, so as to bring the teeth close together.

The handle of each of these hammers is a single stout piece called the *manubrium* (figs. 6, 7, 8, 9, *mm*). The anvil or *incus* roughly resembles a triangular prism, of which one end (the dorsal one) has been tapered to a point (fig. 10). It is divided into two equal pieces, the *rami* (figs. 6, 7, *rs*), by a cut from the dorsal to the ventral surface, so as to leave them just attached to each other at the bottom of the broader end. The two rami rest there on what looks like a stem, the *fulcrum* (figs. 6, 7, *fm*), but which viewed laterally is seen to be a slender plate (fig. 10, *fm*).

Muscles, springing from the walls of the mastax, are attached to various parts of the mallei and rami, and act so as to cause the unci to approach and recede from each other. But each uncus is fastened to the corresponding ramus; and, in consequence, as the mallei recede the rami are opened, and when the mallei approach each other the rami are closed.[1]

From these arrangements it results that all the food which falls from the buccal funnel into the mastax, is first torn by the sharp points of the unci and then crushed between the opposing surfaces of the rami. On passing the rami, the food enters at once into the œsophagus.

The Œsophagus.

The *œsophagus* (fig. 2, *œ*) is a short tube, with thick walls, connecting the mastax with the stomach. The thickness of the walls may be readily seen by feeding *Brachionus* with carmine, and watching the stream of coloured particles trickle through the œsophagus into the stomach. Their course, in a narrow central line, shows clearly the small dimensions of the passage.

There is always an appearance of water flowing through the œsophagus, even when the animal has withdrawn its head into the lorica, and when of course the action of the ciliary wreath has ceased. This appearance seems to be due to minute cilia lining the œsophagus, which by their joint rhythmical action give rise to illusory waves much larger than any real waves could be. That this explanation is not a mere guess will be shown farther on in the case of the Floscules.

The Glands.

Seated near the top of the mastax, and on either side of the buccal funnel, are two clear vesicular organs; which are possibly *salivary glands* (fig. 2, *sg*), and are unusually large in *Brachionus*. They consist of two or three lobes on either side, and are best seen from the ventral side, as the buccal funnel enters the mastax, a little below the summit, on that side.

There is a pair of glands called the *gastric glands* (figs. 1, 2, *gg*) placed at the anterior end of the stomach, and on either side of it. They exhibit cells with central nuclei imbedded in a granular substance. Each has a long, wide, nucleated duct connecting it with the upper end of the stomach. They probably perform the function of a rudimentary liver, and possibly cause, by their secretion, the peculiar yellow-brown colour which is so frequently met with in the stomach. The *foot-glands* have already been described in p. 6.

The Stomach and Intestine.

The stomach (figs. 1, 2, *s*) is a simple sack, with thick cellular walls, which are frequently

[1] For a full description of the complex action of the trophi see Mr. Gosse's paper "On the Structure, Functions, and Homologies of the Manducatory Organs in the class Rotifera," *Phil. Trans.* 1856, p. 419.

studded with what appear to be bright yellow oil-globules. It is divided by an invagination at its lower third into an upper portion, the true stomach, and a lower which may be considered to be a short intestine (fig. 1, *i*). This lower portion frequently lies transversely to the longer axis of the stomach. Both are thickly ciliated on the inner surface, but the cilia of the intestine are larger, and more readily seen.

When a portion of digested food has been transferred from the stomach to the intestine, it is kept slowly revolving by the cilia, till it is suddenly expelled through the cloaca (fig. 1, *cl*). The intestine is connected with the cloaca by a short and very dilatable tube or *rectum* (fig. 1, *r*), and ends (as has been already said) on the dorsal surface, in the median line, just at the commencement of the foot. The rectum also is ciliated, so that the whole of the alimentary tract from the top of the buccal funnel down to the cloaca, with the exception perhaps of the passage through the mastax, is lined with cilia.

The Vascular System.

At the right of the intestine (viewed dorsally), and just under the line of the lorica's greatest width, lies the *contractile vesicle* (fig. 1, *cv*). This is a delicate bladder which alternately dilates and contracts, and with some regularity.

The contraction is produced by fine muscular threads, which ramify in its walls, and cause it to empty its contents through a duct into the cloaca. Its distension is most probably due to the fluid poured into it by two looped and twisted tubes (fig. 1, *lc*), which may be seen passing to it, one on each side of the body down from the head.

This is, however, a much disputed question, which will be discussed fully in another place, along with the probable function of the whole apparatus.

The tubes appear to be surrounded with a granular floccose material, which here and there dilates into irregular masses. Attached to the tubes on each side, at tolerably regular intervals, are five little tag-like bodies (fig. 1, *vt*), in which a flickering motion may be constantly seen, sometimes presenting the appearance of a waving cilium. There is much difference of opinion about the true structure of these tags—the *vibratile tags*, as they are termed—but it is probable that their office is to direct the perivisceral fluid into the tubes, and along them into the contractile vesicle, whence it is driven at intervals through the cloaca.

The Muscles.

The dorsal muscles are shown in fig. 3, and the ventral in fig. 4. From the posterior dorsal surface of the head, on each side of the cephalic ganglion, and close to it, a stout muscle (fig. 3, 1, 1) slopes backward towards the dorsal surface, and is attached by a broad base to the lining membrane of the lorica. Outside this pair is a second (fig. 3, 2, 2), similarly attached, and running rather obliquely underneath the first pair, but not quite so stout. A similar pair (fig. 4, 4, 4) is attached to the posterior ventral surface of the head, and to the lining of the ventral surface of the lorica. The united action of these three pairs of muscles withdraws the head into the lorica.

When it is so withdrawn, a pair of diverging muscular threads (not given in the figure) can be seen fixed to the lorica, just below its central notch, with their other ends fastened to the head. These evidently oppose the action of the three other pairs (figs. 3, 1, 1, 2, 2; 4, 4, 4) and help to draw out the head again. They are assisted in this by a further pair of muscles (also omitted from figs. 3 and 4), each of which is fastened at one end to the base of one of the outermost anterior spines, and at the other to a side lobe of the head.

But the principal part in driving out both the head and the foot is borne by transverse muscles, which are attached to the lorica at the side, and are closely applied throughout their length to the soft organs of the body. Their sudden contraction compresses the perivisceral fluid, and so forces out the retracted head or foot. Nothing could be

more effective than this hydrostatic pressure; and under it the retracted foot darts out of the lorica with amazing swiftness.

When the head is protruded, and the cilia are all in full play, *Brachionus* may often be seen to move its head, without withdrawing it, first to one side and then to the other, depressing the side lobes alternately. This action is effected by two pairs of short muscles (figs. 3, 4, 3, 3), one on each side, attached to the lorica at about one-third of its length from the front, and at their anterior ends inserted into the side lobes.

Just as the muscles attached to the dorsal surface control the action of the head, so do the majority of those of the ventral surface give its various motions to the foot. They are six in all. First, two central muscles, closely parallel (fig. 4, 5, 5), and each divided into two branches at its upper end, run from nearly the middle of the lorica down to the bottom of the foot, where they appear to be attached each to one of the toes. Next, two slighter ones (fig. 4, 6, 6), which pass up from the base of the toes, one on each side of the foot, and then diverge right and left from the central pair to points on the lorica about half-way between the median line and its edge. Besides these, there is, attached to the upper end of the foot and on each side of it, a muscle (fig. 4, 7, 7) which diverges still farther from the median line, and is fastened not far from the margin. All these six can act together, so as to draw the foot suddenly within the lorica; while, by contracting some and relaxing others, the animal can whisk the foot about, or, if the toes be adherent to any substance, can shake its whole body vigorously from side to side—a favourite action.

The Nervous System and Organs of Sense.

The nervous system is represented by a bean-shaped cephalic ganglion (figs. 11, 1, *gn*) seated within the head on its dorsal side. Its substance is marked with what appear to be the hexagonal boundaries of cells. It is two-lobed posteriorly, and on the niche between the lobes lies the crimson eye (fig. 11, *e*).

The pigment is distinctly curved round both sides of the niche so as to lie on each lobe, and to give rise to the notion that the eye may really represent a pair fused into one. I have not detected in this Rotiferon the clear spherical lens which is so plainly visible in some of the others.[1] Attached to the upper portion of the cephalic ganglion on the dorsal side is a conical and very flexible tube (fig. 1, *a*), whose broad base rests on the ganglion, and whose free end passes through the sinus in the lorica between the two longest spines. This is the dorsal *antenna*. A bulb armed with motionless setæ completely closes the orifice of the tube; and is so attached to its rim, that when this bulb is withdrawn by the contraction of a muscular thread fastened to its base, the tube is drawn down also by being infolded like the finger of a glove (fig. 15).

There are two other setigerous bodies, close to the dorsal surface of the lorica, and with the setæ protruding through the surface. They are near the margin on each side, a little above the line of greatest breadth (fig. 1, *a'*). They are rocket-shaped structures, the cylindrical heads carrying on their blunt, rounded, outer ends, radiating setæ; and giving off, from their inner and pointed ends, cords which can be traced but a little way below the surface.

But the list of the tactile organs of *Brachionus* is not yet exhausted. From the two spaces on the dorsal side of the corona lying between the three large setigerous prominences (fig. 1, *sp*) rise two papillæ, each bearing a long and very flexible style (fig. 1, *ts*). A similar style (fig. 2, *t's'*) is placed on the ventral side, just within the rim of each ciliary circlet; and another pair on the top of the central prominence. The whole six are very mobile; and, from the way in which they seem to be used to explore in all directions, there is little doubt that they are organs of touch.

[1] As in *Pedalion*, *Conochilus*, &c.

The Reproductive System.

The reproductive system of the female is only too conspicuous; as the presence of a large ovary (figs. 1, 2, *oy*), and of one or two opaque ova in different stages of growth, frequently obscures the sight of the other organs.

The ovary is studded with large and rather irregularly shaped germs (figs. 1, 2, *g*); and the ova (fig. 1, *om*), so long as they are within the body, are dark, granular, and homogeneous. The ovary opens doubtless by an oviduct into the cloaca, but this I have not been able to see. This is the arrangement that exists in other cases wherever I have seen the oviduct. The mature ovum is expelled very quickly; and the egg often remains attached to the animal by a thread till the young escapes by rupturing the shell (if it may be so termed) in which it is inclosed. If, however, a *Brachionus*, with two or three eggs attached, be held in the compressorium, it will frequently free itself by pushing with its foot against the eggs, and so breaking the threads.

The Egg.

Of the eggs and their development it is unnecessary here to say more than that *B. rubens* has two kinds of female eggs, nearly of the same size; of which the one has a smooth, transparent, membranous covering or shell, while the other has a thick opaque shell, ornamented with hemispherical knobs. The former is the ordinary "summer" egg, and the latter the so-called "lasting," "winter," or "ephippial"[1] egg. In shape, too, the ephippial egg differs from the ordinary female one. It is much bigger at one end than the other, and at the smaller end there is a projecting neck and cover (fig. 16).

The male eggs are smooth and semi-transparent like the ordinary female egg; but are somewhat rounder in shape, and barely half the size. They occur, too, in larger clusters; for while it is usual to see only two or three smooth female eggs, or one ephippial egg, attached to the mother, no fewer than eight or ten male eggs may be seen carried about together.

The Male.

The young female *Brachionus* when hatched resembles its mother; but the young male is a widely different animal (figs. 13, 14). It is about one-third of the length of the adult female's lorica, and it has neither lorica, mastax, jaws, nor stomach.

The head bears a simple circle of long cilia, and there is a red eye on a cephalic ganglion placed just as it is in the female. The vascular system, with its tortuous canals, vibratile tags, and contractile vesicle, is also present; and the foot is furnished with the usual pair of glands; but of a nutritive system there is not the slightest vestige.

Nearly half the body is occupied by a great *sperm-sack* (figs. 13, 14, *ss*), in which under favourable circumstances the spermatozoa themselves may be seen in motion. The sperm-sack ends in a short protrusile tube, the *penis* (figs. 13, 14, *p*), ciliated at the end, and placed just above the foot.

In the larger and more transparent males of other genera—notably in that of *Asplanchna Ebbesbornii*—there are special muscles for drawing back the protruded penis; and, though I have failed to see these in the male of *B. rubens*, it probably possesses a similar structure.

This strangely unfurnished creature leads a brief life of restless energy, now darting from place to place, so swiftly that the eye can scarcely follow it, and now whirling round as if anchored by its curved foot and penis.

It often circles round the female, attaching itself now here, now there, and forcing its companion to waltz round and round with it, from the top of the phial to the bottom. With animals so active and so small it is difficult to be certain of having seen actual

[1] So named by Prof. Huxley from the resemblance to the lasting-eggs of the Daphniæ. These latter were called "ephippial" by Müller from their shape, which is that of an *ephippium*, or saddle.

coitus, but Mr. Gosse had this good fortune in the case of a closely allied species, *B. pala*. He says:

"I collected about a dozen females, half-grown and adult, and placed with them two lively males that had been hatched during the night. I directed my attention principally to one of these, as I could not watch them both. It soon came near one of the females, when it seemed to become animated by a sort of frenzy; describing with excessive rapidity a circle, of which its head formed the circumference and its foot the centre. The extremities were incurved in the direction of its circular movement. After a while it left off, and began to play about the body of a female, moving over and round the lorica, while she whisked about the foot, as if to lay hold of him; at length she drew in her foot, and that of the male appeared to adhere to it; and I distinctly saw the thick penis presented to the cloaca, and for a moment inserted about half its own length; then it was instantly drawn out, and the male began his frenzied gyrations again." [1]

It is obvious, even from the brief account here given, that several highly interesting questions arise concerning the reproductive system of the Rotifera. For instance, in what respects, besides outward form and covering, do the ephippial eggs differ from the smooth female eggs? and what leads to their production?

What part, if any, does the male play in these differences? and how is it that one female produces none but male, while another has none but female eggs?

Again, why are the males of so strange a structure? and why do they appear only for a short time during the year? and is their appearance due to external causes, or are they the inevitable completion of a cycle of reproductive changes?

Unfortunately it is much easier to ask these questions than to answer them. The observations that have been made on these points are but scanty; and, to some extent, contradictory; and the difficulties in the way of persistent investigation are by no means slight.

[1] "On the Diœcious Character of the Rotifera." *Phil. Trans.* 1857, ¶ 19.

CHAPTER II.

THE HISTORY OF THE LITERATURE CONCERNING THE ROTIFERA.

Multum egerunt, qui ante nos fuerunt, sed non peregerunt. Multum adhuc restat operis, multumque restabit; nec ulli, nato post mille secula, præcludetur occasio aliquid adhuc adjiciendi.—Seneca, *Epist.* lxiv.

Cæterum nullius in verba jurans, aliorum inventa consarcinare haud institui; quæ ipse quæsivi, reperi, debitaque attentione et patientia repetitis vicibus, diversoque tempore annorum serie observavi, propono.—O. F. Müller, *Verm. Terrest. et Fluv.* præf.

CHAPTER II.

THE HISTORY OF THE LITERATURE CONCERNING THE ROTIFERA.

It is nearly 200 years since Mr. **JOHN HARRIS**, F.R.S., Rector of Winchelsea, published in the "Philosophical Transactions"[1] the following "Microscopical Observations" on a drop of some rain water which "had stood in a gallipot in his window" for about two months:

"I saw here an animal like a large maggot, which could contract itself up into a spherical figure, and then stretch itself out again; the end of its tail appeared with a forceps like that of an earwig; I could plainly see it open and shut its mouth, from whence air-bubbles would be frequently discharged. Of them I could number about four or five, and they seemed to be busy with their mouths as if in feeding."

This description is but vague; and yet it is very probable that the animal which the rector found in his gallipot was a *Rotifer*: and if so, this is the earliest notice that we have of the class.

A few years later, in 1703, **LEUWENHOEK** published, in the same "Transactions,"[2] an account of some animalcules, living in sheaths, that he had found at Delft, on green weed brought by the flooding of the Maes from Delft Haven. These little creatures were almost certainly *Limnias ceratophylli*. Leuwenhoek gives figures of one, and notices its bearing "two wheels thick set with teeth as the wheel of a watch." In a later paper[3] in the "Philosophical Transactions" he gives a much better account of *Limnias*, with greatly improved figures. He states that when the two wheels are viewed frontally they are seen to be continuous and to form but one; and he adds a figure (Pl. B, 4) of the corona so seen, and notices that the ciliary waves run right round the whole wreath in the same direction.

Leuwenhoek next describes an animal "that has a receptacle or little house composed of round bubbles," and furnished with "surprising wheelwork" of four parts, three of which only were shown in his figure, "the fourth being almost hid from sight." One glance at the figure of the animal (Pl. B, 1), and at its corona (Pl. B, 2), shows us that he has had *Melicerta ringens* under his microscope.

His next paper[4] on the same Rotiferon is pleasant reading; for it vividly recalls the shock of delighted surprise with which every naturalist first enters into the enchanted world beneath the waters.

"I took notice," he says, "of the surprising figure of an animalculum, fixed in a little scabbard or sheath, fastened to some of the small green weeds found in ditches of water. And, as often as I viewed these animalcula and showed them to others, we could not satisfy ourselves with looking on such surprising objects; and the more because we could not conceive how so strange a motion, as they all had, could be performed; as also what should be the use of such a motion." Leuwenhoek also relates how *Melicerta* makes its tube pellet by pellet; and this is his account of it. "I viewed one of these animalcula a good while together; and observed, several times, one after another, that when the animalculum thrusts its body out of the sheath or case, and that the

[1] *Phil. Trans.* vol. xix. 1696.
[2] *Phil. Trans.* No. 283, 1703.
[3] *Phil. Trans.* No. 295, 1705.
[4] *Phil. Trans.* No. 337, vol. xxviii. 1713.

wheel-like or indented particles moved in a circle, at the same time out of a clear and transparent place a little round particle appeared, which, without nicely viewing, could hardly be perceived; which particle growing larger, moved with great swiftness as it were about its own axis, and continued without any alteration in its place, till the animalculum had drawn part of its body back into its sheath; in doing which it placed the said round particle on the edge of its sheath, which thus became augmented with a round globule; and whereas the animalculum had placed the said globule on the east part of its sheath, another time it fixed it on the south or north side; by which means the sheath was regularly increased on all sides."

Of course this is but a rough sketch of the machinery and actions of the famous tube-maker; but it is a vigorous one, and true to the life as far as it goes.

With equal truth and vigour does Leuwenhoek describe, in the same paper, the transformations of *Philodina roscola*;—that creature, whose powers of lying dormant for rotiferous ages, and of then coming to life again, have made it as famous as the "Seven Sleepers."

To anyone with a sense of humour it must be delightful to read the following paragraphs of Leuwenhoek's paper; and then to reflect how his discoveries have been repeatedly re-discovered; and how again and again they have been challenged, confirmed, forgotten, and once more discovered. In fact, the Philodine has been the cause of a dispute which has all the marvellous properties of the Rotiferon itself. For it periodically goes to sleep and revives again, just as *P. roscola* does; but with a difference. The Rotiferon, when it awakes after its long sleep, takes up its life at the point where it left it off; and ultimately "gives up its murmuring breath" after an existence of three or four years; but the dispute concerning it invariably begins again both *de novo* and *de ovo*; and having already lasted, with periodical intermissions, for nearly 200 years, evidently bids fair to last for 200 years more; as it has only a short time ago awakened once more, as fresh and as vigorous as ever, and found its way into our daily papers.

"I discovered," says Leuwenhoek, "several animalcula that protruded two wheels out of the fore-part of their body as they swim, or go on the sides of the glass. . . . This sort I found, in great numbers, in the gutter water which had stagnated some days in the small pits or cavities of the lead. . . . In October 1702, I caused the dirt of the gutters, when quite dry, to be gathered together, and taking a small quantity of it, I put it into a paper on my desk; since which time I have often taken a little of it, and poured on it boiled water after it had stood still till it was cold, that I might obviate any objection that should be made, as if there were living creatures in that water. These animalcula, when the water runs off or dries away, contract their bodies into a globular or oval figure. . . . In the month of September I put a great many of the last-mentioned animalcula into a wide glass tube, which presently placed themselves on the sides of the glass; whereupon, pouring off the water, I then observed that several of the animalcula, to the number of eighteen or nineteen, lay by each other in a space of coarse sand; all of which, when there remained no more water, closed themselves up in a globular figure. Some of these animalcula were so strongly dried up that one could see the wrinkles in them, and they were of a reddish colour; a few others were so transparent, as if they had been little glass balls, that, if you held them up between your eye and the light, you might move your fingers behind them, and see the motion through their bodies. After these animalcula had lain thus dried up a day or two, in an oval or globular form, I poured some water into the glass tube; whereupon they presently sank to the bottom, and after the space of about half an hour began to open and extend their bodies, and, getting clear of the glass, to swim about the water. . . . In the month of October, before the dirt of the leaden gutter was quite dried up, I took a handful of it, and laid it on a glazed earthen dish in order to preserve it. . . . Upwards of twenty-one months after, I took some of this dry stuff and infused it, both in cold water that had been boiled, and in rain water newly fallen; whereupon the animals began to show themselves in great numbers."

The only points of this much vexed question that Leuwenhoek passes over are:

(i) how the Rotiferon, when drawn up into a ball, resists the persistent baking of a summer's sun on the housetop, or the long drought of twenty-one months on the naturalist's desk, without parting with its own internal moisture; and (ii) why only eighteen or nineteen of his Rotifera (those near the coarse sand) succeeded in rolling themselves up and surviving, while the rest perished.[1]

The investigations thus worthily begun by Leuwenhoek were carried on with much spirit by many other observers; and, during the hundred and thirty-five years that elapsed before the publication of Ehrenberg's famous work, "Die Infusionsthierchen," no fewer than sixty of Ehrenberg's species, contained in thirty of his genera, were entered on the list of known Rotifera.

I have arranged the more striking forms of these in the following table, which classifies them under the heads of some of the families into which I have divided the Rotifera;[2] and I have added the names and dates of their discoverers; it will be thus seen how wide a ground had been covered by the early naturalists, since more than half the families have representatives in the table.

A List of some of the Rotifera discovered before 1838.

Flosculariadæ	Stephanoceros Eichhornii	Eichhorn, 1761
	Floscularia ornata	Eichhorn, 1767
Melicertadæ	Melicerta ringens	Leuwenhoek, 1703
	Limnias ceratophylli	Leuwenhoek, 1703
	Lacinularia socialis	Brady, 1755
	Megalotrocha alboflavicans	Rösel, 1755
Philodinadæ	Rotifer macrurus	Baker, 1753
	Philodina roseola	Leuwenhoek, 1702
Hydatinadæ	Hydatina senta	Müller, 1773
Synchætadæ	Synchæta Baltica	Baster, 1759
Notommatadæ	Notommata tigris	Müller, 1786
Triarthradæ	Triarthra longiseta	Eichhorn, 1775
Brachionidæ	Brachionus pala	Joblot, 1718
	Brachionus urceolaris	Hill, 1751
	Anuræa striata	Müller, 1776
Pterodinadæ	Pterodina patina	Eichhorn, 1775
Euchlanidæ	Euchlanis dilatata	Eichhorn, 1775
Rattulidæ	Mastigocerca carinata	Müller, 1786
Dinocharidæ	Dinocharis pocillum	Müller, 1776
	Stephanops lamellaris	Müller, 1786

It will be seen that the names of Eichhorn and Müller occur much more frequently than that of any other observer in this list, and their works on the Rotifera deserve, I think, a special notice.

JOHANN CONRAD EICHHORN was the pastor of St. Catharine's church at Danzig, and his book on the "Natural History of the Smallest Aquatic Animals"[3] was published in 1781. Though small, it is a most interesting work. He gives figures and descriptions of about a dozen Rotifera that can be identified, including *Stephanoceros*, *Floscularia*, *Melicerta*, *Triarthra*, *Dinocharis*, *Actinurus*, *Euchlanis*, and *Pterodina*; and of most of his species he was the discoverer.

His enthusiasm is delightful. "I have devoted myself," he says, "to this invisible world, which yields itself to our ken only under the magnifying glass; and I have, for eleven years, spent my leisure moments on it, so far as my professional duties would permit, in order to know God in His smallest and invisible works; and I have found Him very great therein. Not the great works only, those vast heavenly bodies—

[1] The question will be found fully discussed farther on in the general account of the family Philodinadæ.

[2] See chap. III. On the Classification of the Rotifera.

[3] *Beiträge zur Naturgeschichte der kleinsten Wasserthiere.*

not those huge animals, on earth as well as in sea, who can scarcely drag the weight of their frames—not these alone declare the glory of the Almighty. No! the smallest also show, just as distinctly, the perfections of their Creator. Yea! one may say, these even more than those! A great church clock is certainly a wonderful machine, but a pocket watch—a watch in a ring—is yet more so, and conduces to the greater fame and glory of its maker."

His description of his chief discovery, that of his Crown Polyp (*Stephanoceros Eichhornii*) is very amusing. "I found," he says, "this extraordinary and marvellously formed animal first in 1761, on July 20, on a water plant, which had been standing some weeks in water. I saw that there was something on the plant which was quite unknown to me. I moved the glass, in order to see if it was something alive, and if it would draw itself together, which happened, to my delight; therefore I examined it through a lens, but it appeared to me, through this, just like an orange flower which was not yet closed, but which now drew itself together, and now outspread itself. All this stirred up in me a great desire to see this new animal under the glass, but that required skill to get it out, as the glass vessel in which it was, was nearly an ell high, and this animal was right at the bottom. I tried first with the quill of a feather to bring it to the top, but it was continually lost to the eye by shutting itself up. At last I succeeded with a little wire hook in drawing out the plant on which it obviously was, and as soon as I could reach it with the scissors I snipped off a tiny stem, and that brought me out the whole animal unharmed. I placed it at once under the magnifying glass, and saw this matchless creature as it is shown in the engraving."[1] What a pleasant picture this is of the grave pastor fishing away with a quill pen to fetch up *Stephanoceros* from the bottom of a glass beaker a yard and a quarter high!

About the same time as Eichhorn, flourished the great Danish naturalist, **OTHO FREDERIC MÜLLER.** He was an excellent botanist and zoologist, and published works on many subjects. He wrote on the Flora and Fauna of Denmark, on Fungi, on the Hydrachnæ, and on Fresh-water and Marine Worms; but his chief delight was in the Infusoria, and his posthumous work, "Animalcula Infusoria Fluviatilia et Marina, &c." 1786, was the first that brought this new kingdom to the knowledge of the naturalist.

The "Animalcula Infusoria" contains the descriptions and figures of about fifty Rotifera, among which are *Lacinularia*, *Hydatina*, *Scaridium*, *Triarthra*, *Brachionus*, *Anuræa*, *Pterodina*, *Euchlanis*, *Dinocharis*, *Stephanops*, and *Mastigocerca*. More than half of Müller's species were new when published; and his figures, taken from life, are beautifully drawn on copper by himself. Of course there is a great lack of detail in the drawings of the internal structure of the animals, but they are an immense advance on those of Eichhorn, the outlines being usually both spirited and faithful.

Müller's text, too, is as good as his figures. It is the work not only of a naturalist, but of a thoughtful and learned man; and both the "Animalcula Infusoria" and his previous work, "Vermium Terrestrium et Fluviatilium," abound with admirable and striking passages. In the latter, he thus begins his dissertation on the Infusoria: "The world of the invisible, a world shut to our ancestors, was first entered about a hundred years ago. It breeds monsters of unheard-of form and manner of life, it abounds in miracles as much as do the remote Indies; but is explored with lesser peril, for it lies everywhere at our very feet, and is not sought out for gold.

"Each was explored with great slaughter of its inhabitants; the one often resisted by wasting the lives of its aggressors, the other had no defence but patience.

"*This* we owe to the needle, which joined two hemispheres together; *that* to the lens, which images alike the solar spots and the infusoria, the widest apart of all things.

"In this interval what indeed is great, what little? Man: for he thinks and suffers."

L. JOBLOT styles himself, "Professeur Royal en Mathématiques, de l'Académie Royale de Peinture et Sculpture, demeurant sur le Quay de l'Horloge du Palais, au gros Raisin."

[1] See Pl. B, fig. 14.

His book, published in 1718, consists of two parts. In the first he describes various forms of microscope, and the best way of using them; in the second he details, from his diary, the results of a series of experiments made with infusions of various plants and substances. The list of his infusions is long and curious. He tried pepper, roses, rhubarb and senna, maize, violets, mushrooms, hay, raspberry stalks, celery, knapweed, fennel, straw, marigolds, melons, tea, oak bark, &c. &c., and even found an animalcule that,—

> for saving charges,
> A peeled sliced onion eats, and tipples verjuice.

He scoffs at the notion that living animals could be produced by the putrefaction of anything, and is confident that the infusion of each substance produces its own peculiar animals. He supposes that eggs are laid on these substances "by a countless number of very little animals that fly or swim in the air close to the ground," and who "let fall their eggs and little ones as they course backwards and forwards in the air," particularly in the spots where they were stopped by the vapours escaping from their favourite plants.

He was the first to discover the genus *Brachionus* (*B. pala* and *B. amphiceros*), and he found in his infusions various species of the genus *Rotifer* (probably *R. vulgaris* and *R. citrinus*) as well as, possibly, a *Lepadella* and a *Monostyla*.

His figures are grotesque enough; and he damaged his reputation as a sober naturalist by sketching a six-legged creature with "tout le dessus de son corps couvert d'un beau masque bien formé, de figure humaine, parfaitement bien fait." A fierce moustachioed face it is, and, as Joblot adds, "couronné d'une coëffure singulière." His names for the animals are as odd as his figures: he has "top-knots," "bagpipes," "dandies," "tortoises," "kidneys," and even "crowned and bearded pomegranates"—the last strange title being given to his new discoveries, the *Brachioni*.

In spite of all these absurdities his written descriptions are often vivid and accurate, and he is a shrewd observer. For instance, he notices how cleverly the Rotifera swim without jostling each other; and he concludes that "though we cannot see them, they must have eyes, and those very good ones." He describes the restless movement of *Brachionus* swaying from side to side as it thrusts about its long foot, and observes that "there are some females who carry only one egg, some that carry two, and some as many as six, which, however, is not common; and when there are so many eggs they are smaller in size than they are when they are fewer."

It is thus clear, both from his description and his figure, that this first discoverer of *Brachionus pala* had already lighted on a female carrying a cluster of male eggs. Again, he discerns the difference, in size and colour, between *Rotifer vulgaris* and *R. citrinus*; and describes their leech-like movements, their telescopic joints, and their constantly moving jaws. I need hardly add that he considers the latter to be the heart.

His comments on his discoveries are as characteristic as his figures and theories. We have seen the Danish naturalist exulting in the human intellect which, armed with one simple weapon, attacks alike the distant planets and the invisible infusoria; and finding even greater reason for his pride in the very weakness and ills that flesh is heir to. The Prussian pastor, too, is as enthusiastic after eleven years' study as he was when he first began; and, as if he would add another verse to the Benedicite, cries to all the creatures of the invisible world, "Bless ye the Lord; praise Him and magnify Him for ever." And Professor Joblot is also enthusiastic, but his strain is pitched in a different key. He says of one of his infusions that "it gives rise to a most delightful spectacle, so curious to see and watch that I do not think that the diversion of the play, of the opera with all its magnificence, of rope-dancing, tumbling, or of the animal-combats which we see in this superb city, ought to be preferred before them."

It would be unfair to M. Joblot not to add that he is capable of better things, as the following extract shows:

"There is nothing despicable in nature; and all the works of God are worthy of our

respect and admiration, especially if we take heed to the simplicity of the means by which God has made and preserved them. The smallest gnats are as perfect as the largest animals, the proportions of their limbs are equally just, and it seems as if God had even wished to give them more ornaments than He has to the greater creatures, in order to make up to them for the smallness of their bodies. They have crowns, tufts, and other adornments on their heads, which surpass all that female luxury has invented; and we may say that those who have looked only with unaided eyes have seen nothing so beautiful, so fitting, nor even so magnificent, in the palaces of the greatest princes, as that which the microscope shows on the head and body of a simple fly."

About forty years after Joblot, **HENRY BAKER**, F.R.S., published a somewhat similar work. The first volume, "The Microscope made Easy," treats of the instrument itself; while the second volume, "Employment for the Microscope," describes the various things that may be seen with it.

In the second volume he gives an elaborate account, with figures, of what I believe to be *Philodina roseola*; as well as descriptions and drawings of *Rotifer macrurus*, *Brachionus pala*, *B. urceolaris*, *B. Bakeri*, and probably also of *Euchlanis triquetra*; and of these six species the second and last had not been described before.

His drawings are vastly superior to those of Joblot, especially his figures of the *Brachioni*. He notices and introduces into his figure the long vibrating styles which crown the head of *B. pala*, as well as its winter eggs. He failed, indeed, to understand the lorica of *Euchlanis*; but that is no wonder, for he has had many to bear him company.

It is unnecessary for me to say more of a book that is still within everyone's reach; but there is one admirable passage in his preface that I must give myself the pleasure of quoting.

"That man is certainly the happiest who is able to find out the greatest number of reasonable and useful amusements, easily attainable and within his power; and, if so, he that is delighted with the works of nature, and makes them his study, must undoubtedly be happy; since every animal, flower, fruit, or insect, nay, almost every particle of matter, affords him an entertainment. Such a man never can feel his time hang heavy on his hands, or be weary of himself, for want of knowing how to employ his thoughts; each garden or field is to him a cabinet of curiosities, every one of which he longs to examine fully; and he considers the whole universe as a magazine of wonders, which infinite ages are scarce sufficient to contemplate and admire enough."

In Plate B, I have given copies of some of the old figures drawn by these authors, and if the reader will compare them with **EHRENBERG's** drawings of the same animals, he will see at a glance why the Prussian naturalist's work [1] swallowed up as it were the very memory of all his predecessors. Instead of feeble, inaccurate drawings, in which the internal structure was represented by mere blots and patches, Ehrenberg gave excellently drawn figures full of accurate details; and at the same time described the animals themselves with wonderful exactness, considering the very great number that he studied unaided.

Nor was this all: he had such a grasp of the whole subject, such a minute personal knowledge of the living animals themselves, that he invented a system of classification which has held its own for nearly fifty years.

In addition to its other merits, Ehrenberg's splendid work added more than a hundred new species to those already known, containing among them such remarkable forms as *Conochilus volvox*, *Notommata clavulata*, *N. copeus*, *N. centrura*, *Diglena grandis*, *Polyarthra platyptera*, *Noteus quadricornis*, *Microcodon clavus*, *Œcistes crystallinus*, &c.

Three years after the publication of "Die Infusionsthierchen," **DUJARDIN** published his "Infusoires" as one of the volumes of the Histoire Naturelle des Zoophytes in the "Suites à Buffon." The last part of this volume, being one-sixth of the whole, is devoted to the "Systolides" or Rotifera. His book is mainly critical, and, so far as I can find, contains little on the Rotifera that was new, except his observations on *Albertia* and *Lindia*.

[1] *Die Infusionsthierchen*; Leipzig, 1838.

His criticisms are shrewd and often just; he points out that Ehrenberg's respiratory tube is probably an antenna; suggests that the convoluted tubes, flickering tags, and contractile vesicle of the vascular system have a respiratory function; calls attention to the varying forms of the mastax and trophi as good characters for classification; and conjectures that the perivisceral fluid is the true analogue of the blood.

On the other hand, he could not see *Floscularia's* tube; could not make out the striated muscles in any Rotiferon, even in *Pterodina patina*, of which he gives a figure; could see indeed no difference between the muscles and the nerves; doubted the existence, as specialised structure, of either the one or the other; and from want of personal acquaintance with them, affirmed the identity of many of Ehrenberg's species, which are undoubtedly distinct.

But although he has small claim to be considered either an original or an accurate observer of the Rotifera, he made one happy hit in his attempted classification, which will be detailed elsewhere.

Since Dujardin's time the more noteworthy essays that have been published on various portions of our present subject are by Mr. P. H. Gosse, F.R.S.; Dr. F. Leydig; Professor T. H. Huxley; Herr C. Vogt; Dr. F. Cohn; Dr. W. Moxon, F.L.S.; Dr. W. Salensky; Dr. S. Bartsch; and Herr Karl Eckstein.

Mr. **GOSSE**, in his paper, "On the Anatomy of *Notommata aurita*,"[1] described with minuteness the organization of this common species, so that the essay became, as it were, a key to the structure of the majority of free-swimming Rotifers. His next treatise, "On the Structure, Functions, and Homologies of the Manducatory Organs in the Class Rotifera,"[2] is illustrated with a great many drawings of the mastax and trophi of various species; and discusses the changes that they undergo, in passing from the typical to the most aberrant forms. It is in this treatise that Mr. Gosse contends that the dental organs of the Rotifera are true mandibulæ and maxillæ; and that the mastax is a mouth; and assigns to the Class a position among the *Articulata*. In a subsequent paper, "On the Diœcious Character of the Rotifera,"[3] Mr. Gosse extended this character from a single genus, *Asplanchna*, to five others; and trebled the number of the known diœcious species. Some years later, Mr. Gosse began, in "Contributions to the History of the Rotifera,"[4] a general account of the whole class, arranged according to a classification of his own, and continued it so far as the *Floscularidæ*, *Melicertadæ*, and *Notommatina*, illustrating each family with descriptions and figures of certain selected species. This work, however, owing to the cessation of the periodical, was never completed.

Dr. **F. LEYDIG**, in "Ueber den Bau und die systematische Stellung der Räderthiere,"[5] after a full description, accompanied with figures, of many species, three of which are new, proceeds to deal with the structure of the Rotifera as a class, and to arrange them in a system of his own. He further discusses their true position in the animal kingdom, and assigns them a place among the *Crustacea*.

Professor **HUXLEY**, in his paper, "On *Lacinularia socialis*; a Contribution to the Anatomy and Physiology of the Rotifera,"[6] takes this Rotiferon as his text, and, while minutely describing its structure, discusses various questions concerning that of the whole class. He enters into the general relations of the Rotifera to other animals, and arrives at the conclusion that they are permanent forms of Echinoderm larvæ.

Herr **C. VOGT**, in his treatise, "Einige Worte über die systematische Stellung der Räderthierchen,"[7] combats Leydig's reasonings and conclusion on the position of the Rotifera, and affirms that they must be classed among the *Vermes*.

In Dr. **F. COHN's** essay, "Ueber die Fortpflanzung der Räderthiere,"[8] the males and females of three species are minutely described, especially with reference to their reproductive organs; and the general question of the reproductive system of the whole class is also discussed.

Dr. **W. MOXON's** 'Notes on some Points in the Anatomy of the Rotatoria'[9] call

[1] *Trans. Micr. Soc.* 1852.
[2] *Phil. Trans.* 1856.
[3] *Phil. Trans.* 1857.
[4] *Popular Sci. Rev.* 1862 and 1863.
[5] Leipzig, 1854.
[6] *Trans. Micr. Soc.* 1853.
[7] *Sieb. u. Köll. Zeits.* 1855.
[8] *Sieb. u. Köll. Zeits.* 1856.
[9] *Trans. Linn. Soc.* 1864.

attention to the right use of the terms "dorsal" and "ventral" as applied to the Rotifera; to the existence, in many species, of three antennæ, holding definite positions with respect to the dorsal and ventral surfaces; to the true nature of the entrance to the crop of *Floscularia*; and to the structure and function of the vibratile tags.

Dr. **W. SALENSKY**'s paper, "Beiträge zur Entwicklungsgeschichte der *Brachionus urceolaris*,"[1] traces the gradual changes in the ovum, from its first division into two unequal spheres, through its complete segmentation, to the formation of the germinal layers, and the evolution of the various organs of the completed embryo. Although the paper deals with only a single species, it is our principal contribution to the Embryology of the Rotifera.

Dr. **S. BARTSCH**, in "Rotatoria Hungariæ," 1877, and Herr **KARL ECKSTEIN**, in "Die Rotatorien der Umgegend von Giessen,"[2] have published treatises containing descriptions and figures of local Rotifera (forty in Hungary and fifty at Giessen), including two or three new species; as well as new classifications of the whole class ROTIFERA.

Of Dr. **BARTSCH**'s work I can say but little, as it is written unfortunately in Hungarian. His figures, though somewhat archaic, are well worth the studying; and he gives drawings and descriptions (happily this time in Latin) of six new species, of which two had been recorded in England some years before.

Herr **ECKSTEIN** also gives many interesting details of his local species, of which two are new; and adds a general discussion of the structure, development, affinities, and classification of the whole class. His treatise also contains useful lists of synonyms, as well as a good bibliography of the subject.

The last edition (1861) of **PRITCHARD**'s "History of Infusoria," by Dr. Arlidge and others, is a work differing in character from any of the above. About one-sixth of it is devoted to the Rotifera, and contains descriptions of the whole of the then known species, illustrated by a great many figures. Both the descriptions and the figures have been mainly taken from Ehrenberg's work, which is closely followed throughout; but they have been supplemented by others taken from the various treatises mentioned above.

As a compilation, it is not only the best, but almost the only, English work on the subject. It contains, moreover, an admirable and exhaustive treatise on "The General History of the Rotifera" as a class, dealing minutely with their structure, reproduction, development, systematic position, and classification.

This original and most valuable essay may be said to be indispensable to all students of the Rotifera, bringing together, as it does, into one point of view, the opinions of all the best observers, on the many vexed questions that these little creatures have given rise to, not only as to their organization and development, but as to their relations to the rest of the animal kingdom.

A full list of works on the Rotifera, including numerous papers that have been published in various scientific periodicals, will be found at the end of this work.

[1] *Sieb. u. Köll. Zeits.* 1872.

[2] *Sieb. u. Köll. Zeits.* 1883.

CHAPTER III.

ON THE CLASSIFICATION OF THE ROTIFERA.

Omnis enim systematica divisio claudicat lacunisque laborat; optima est, quæ paucioribus horret, documentum satis splendidum, mortales non e vero visionis puncto Naturam contemplari.—O. F. Müller.

Tous les ordres des êtres naturels ne forment qu'une seule chaîne, dans laquelle les différentes classes, comme autant d'anneaux, tiennent si étroitement les unes aux autres, qu'il est impossible aux sens, et à l'imagination même, de fixer précisément le point, où quelqu'une commence ou finit.—Leibnitz.

Dum inter ea, quæ determinatis characteribus discreta, et certis quasi limitibus inclusa sunt, semper intermediæ quædam species reperiuntur, quæ, utriusque proxime accedentis speciei, aliquid possideant, et ita copulationem quasi duarum diversarum specierum constituant; colorum ad instar, qui ita commiscentur et quasi confluunt, ut nemo veros cujusque fines determinare possit.—J. Baster.

CHAPTER III.

ON THE CLASSIFICATION OF THE ROTIFERA.

Four attempts have been made to improve upon Ehrenberg's classification: viz. that of Dujardin in 1841, of Leydig in 1854, of Dr. S. Bartsch in 1877, and of Herr K. Eckstein in 1883. I do not intend to discuss here the various merits and faults of these five systems; it is enough to say that they all seem to have the fault of needlessly bringing together animals that are different in structure, while separating others that closely resemble each other; I say "needlessly" because perfect classification appears to be an impossibility, except at that fleeting stage of our knowledge when none but the commoner genera are known to us. These usually differ from each other in a marked fashion, the very fact of their wide-spread co-existence being perhaps due to their differing so as not to interfere with each other.

When, however, continued search has brought to light the rarer forms, these usually prove to be links between the more common ones; and then the troubles of the classifier begin. For these strange forms, which are the delight of the naturalist, are the classifier's despair. Do what he will, no system that he can devise will put into Nature those sharp divisions and well-marked gaps that are so dear to him, but of which she knows nothing.

Nature has but one law, that of infinite variety; and the utmost that the classifier can do is to group his animals as well as he can round certain typical forms, content to have the symmetry of his plans and the sharpness of his definitions marred by forms that perversely bear the characteristics of two or three of his types, in nearly equal proportions.

He may take comfort, nevertheless; for, even if he had been able to invent a thoroughly satisfactory classification, it is from the nature of the case written in sand. He can never say as he throws down his pen:

Exegi monumentum ære perennius;

for it is almost certain that the fresh discoveries of the next ten years will require his work to be re-cast; and no higher praise could be given to Ehrenberg's system than that, in spite of new discoveries and its own obvious faults, it has reigned alone for nearly five times the usual period.

The Rotifera may first be divided into four natural orders, according to their modes of locomotion, and the structure of the foot. The first of these ideas appears in Dujardin's classification, and the second in Leydig's, and they are both excellent; for there are Rotifera that swim by means of their ciliary wreath, and skip by the help of their arthropodous limbs; Rotifera that swim only with their wreath; others that swim and creep like a leech; and lastly, some that, when adult, are stationary. Moreover, in three of these four orders there is only one form of foot in each order, and that form is unlike those of the other two; and although in one order there are more forms of the foot than one, still they are all unlike the forms of the other three.

Nor is this all. The natural character of these four orders is further shown by there being other important points of structure, in which the animals comprised in each order at the same time resemble each other and differ from those of the other orders.

I have named these orders as follows:

I. RHIZOTA (the rooted). Fixed when adult.
II. BDELLOIDA (the leech-like). That swim with their ciliary wreath, and creep like a leech.
III. PLOÏMA (the sea-worthy). That only swim with their ciliary wreath.
IV. SCIRTOPODA (the skippers). That swim with their ciliary wreath, and skip with Arthropodous limbs.

Now, the creatures contained in these orders, with a few exceptions, differ from each other, first in their habits, and secondly in the following points:

I. In the structure of the foot.
II. In the arrangement of the ciliary wreath.
III. In the form of the trophi.

I. In the structure of the foot.

(1) The *Rhizotic* foot is transversely wrinkled, and ends in a sort of sucking disk (fig. 16) or cup (fig. 17). It is not retractile within the body, it never has telescopic joints, nor is it ever furcate.

Fig. 16.—Rhizotic foot. (*Floscularia campanulata*)

Fig. 17.—Rhizotic foot. (*Melicerta ringens*)

Fig. 18.—Bdelloidic foot. (*Rotifer citrinus*)

Fig. 19.—Scirtopodic foot. (*Pedalion mirum*)

(2) The *Bdelloidic* foot (fig. 18), on the contrary, is telescopic, retractile, furcate, and is never transversely wrinkled, nor terminated by a sucking disk.

(3) The *Scirtopodic* foot (fig. 19) is unique; it is divided into two unconnected, smooth, jointless styles, each ending in a ciliated expansion.

(4) The *Ploïmic* foot is various in shape, but is always unlike that of any other order; for—

(*a*) if transversely wrinkled, it is yet retractile within the body, and almost invariably furcate;
(*b*) if jointed and furcate, it is not also telescopic;
(*c*) occasionally it is absent altogether.

II. In the arrangement of the ciliary wreath.[1]

(1) The *Rhizotic* ciliary wreath is of two forms:

(*a*) The first encircles the body twice, by bending on itself; thus inclosing the mouth, and having a dorsal gap between the points of flexure, figs. 20, 21.

Fig. 20.—Rhizotic wreath (*a*), front view. (*Melicerta ringens*)

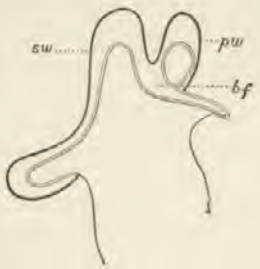


Fig. 21.—Rhizotic wreath (*a*), side view. (*Melicerta ringens*)

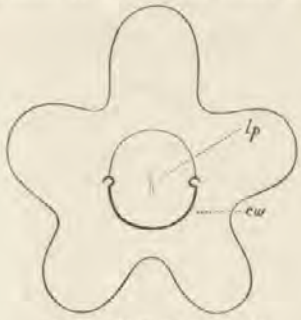


Fig. 22.—Rhizotic wreath (*b*), seen from above. (*Floscularia campanulata*)

[1] In figs. 20 to 25, *cw* is the ciliary wreath; *pw* is the principal wreath; *sw* is the secondary wreath; *bf* the buccal funnel; *lp* the lips.

(*b*) The second form is a simple segment of a circle, placed on the ventral side above the mouth, fig. 22.

(2) The *Bdelloidic* wreath is also of two forms:

(*c*) The first, like the *Rhizotic* wreath (*a*), is a double wreath surrounding the body twice, and inclosing the mouth; but, unlike the *Rhizotic*, it has two gaps instead of one, viz. a dorsal gap between the points of flexure, and a ventral gap in the upper wreath opposite to the mouth.

(*d*) The second form of Bdelloidic wreath is a mere furring of the corona on its ventral surface, as shown in fig. 25.

(3) The *Ploïmic* wreath is very various in shape, but is never *Rhizotic*, while it is *Bdelloidic* only in one genus.[1]

Fig. 23.—Bdelloidic wreath (*c*), from above.
(*Rotifer citrinus*)

Fig. 24.—Bdelloidic wreath (*c*), side view.
(*Rotifer citrinus*)

Fig. 25.—Bdelloidic wreath (*d*).
(*Adineta vaga*)

(4) The *Scirtopodic* wreath is of *Bdelloidic* type.

III. In the form of the trophi.

If we disregard two genera[2] of the *Ploïma* (not one-fifteenth of the whole number of Ploïmic genera), we can then say that the first three orders differ also in the forms of their trophi. For—

(1) The *Rhizotic* trophi are either *malleo-ramate*,[3] fig. 26, or *uncinate*,[3] fig. 27.

(2) The *Bdelloidic* trophi are always *ramate*,[3] fig. 28.

(3) The *Ploïmic* trophi are of various forms; but are never *Bdelloidic*, and are *Rhizotic* only in two genera.[2]

(4) The *Scirtopodic* trophi are of a Rhizotic type, being *malleo-ramate*, fig. 26.

Fig. 26.—Malleo-ramate.
(*Melicerta ringens*)

Fig. 27.—Uncinate.
(*Stephanoceros Eichhornii*)

Fig. 28.—Ramate.
(*Rotifer citrinus*)

Now, in reviewing the points of agreement and of difference in the four orders, we may at once set aside the fourth order, the *Scirtopoda*, as unmistakably separated from the others.

This order contains but one family, which has only one genus, and that genus itself consists of only one species.[4] In fact, it has been formed to contain that remarkable creature *Pedalion mirum*, which I discovered at Clifton in 1871. This

[1] *Pterodina*. [2] *Triarthra* and *Pterodina*.

[3] For the explanations of these technical terms, see p. 29.

[4] I pass over for the present Dr. Schmarda's *Hexarthra polyptera*, and will discuss it under the *Pedalionidæ*.

Rotiferon has six hollow limbs continuous, in true Arthropodous fashion, with the body-cavity, and worked by opposing muscles passing down them, and is thus plainly linked to the Crustacea and Insecta. *Pedalion*, in fact, is a Nauplius larva, and is yet a Rotiferon.

Order IV., then, is sufficiently separated from the rest by its Arthropodous limbs, and by the use made of them; and of the other three orders, it has been shown above that, if we disregard some points of only two genera, we may say of orders I. II. III. that they differ *inter se* in their habits, and in the structure of their feet, trophi, and ciliary wreaths.

This seems a satisfactory first step towards classification; but it is only fair to the reader to warn him that it has been gained by omitting some parasitic Rotifera, as well as a few very troublesome forms, such as *Trochosphæra*, *Apsilus*, *Microcodon*, &c.

I have dwelt on the differences in structure, as well as in habits, between the four orders, in order to show that these four groups are natural; but I do not propose to use as ordinal characteristics any others than the mode of locomotion and the structure of the foot; and for this reason, that each of the first three orders has more than one form of the trophi, or of the ciliary wreath, or of both.

The *Rhizota*, for instance, have two forms of the trophi, and two of the ciliary wreath. The *Bdelloida* have two forms of wreath, and the *Ploima* have many different forms of both wreath and trophi.

Before I proceed to divide these four orders into families, I must, however, digress a little to explain and name the various types of trophi, as the classification partly depends upon them.

Mr. Gosse's treatise on "The Manducatory Organs in the Class Rotifera" essays to show that these organs present seven principal types of structure, distinguished from each other by the prominence of some particular part.

To make this clear, it may be as well to re-state that, in the mastax of a *Brachionus*, there are two hammer-like bodies or *mallei* (fig. 29, *ms*), which work on a kind of split anvil or *incus* (fig. 29, *is*), and that each *malleus* consists of an upper part, the head or *uncus* (fig. 29, *us*), and of a lower part or handle, the *manubrium* (fig. 29, *mm*); while the *incus* consists also of two parts, the upper divided into two symmetrical halves, the *rami* (fig. 29, *rs*), which are supported on the lower piece or *fulcrum* (fig. 29, *fm*).

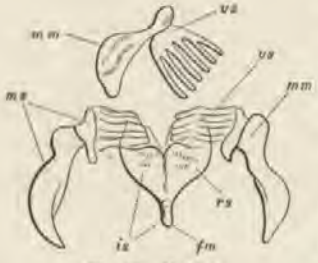


Fig. 29.—Malleate.

Now, in *Brachionus* all the trophi are well developed, but the other typical manducatory organs may be arranged in a series in which the *mallei* are successively degraded, while continually greater prominence is given to the *incus*; at least in all but three types; and in two of these the *rami* and *unci* are the prominent parts, while the third is distinguished by the close connection of the *mallei* and the *rami*.

The typical trophi may, then, be named as follows:

1. *Malleate* (fig. 29).

Mallei stout; manubria and unci of nearly equal length; unci 5- to 7-toothed; fulcrum short; as in *Brachionus urceolaris*.

2. *Sub-malleate* (fig. 30).

Mallei slender; manubria about twice as long as the unci; unci 3- to 5-toothed; as in *Euchlanis deflexa*.

3. *Forcipate*[1] (fig. 31).

Mallei rod-like; manubria and fulcrum long; unci pointed or evanescent; rami much developed and used as a forceps; as in *Diglena forcipata*.

[1] In *Furcularia*, and in a few other genera, the rami as well as the mallei are rod-like; and the

4. *Incudate* (fig. 32).

Mallei evanescent; rami highly developed into a curved forceps; fulcrum stout; as in *Asplanchna Ebbesbornii*.

5. *Uncinate* (fig. 27).

Unci 2-toothed; manubria evanescent; incus slender; as in *Stephanoceros Eichhornii*.

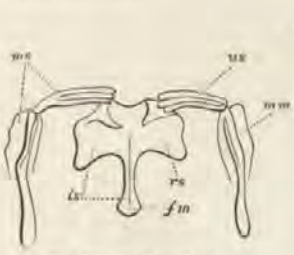


Fig. 30.—Sub-malleate.

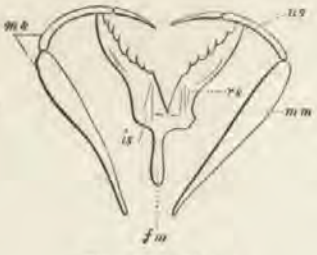


Fig. 31.—Forcipate.

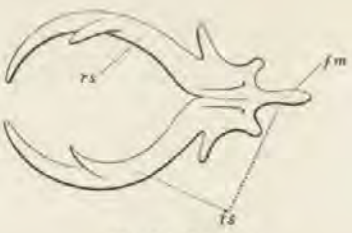


Fig. 32.—Incudate.

6. *Ramate* (fig. 28).

Rami sub-quadrantic, each crossed by two or three teeth; manubria evanescent; fulcrum rudimentary; as in *Philodina roseola*.

7. *Malleo-ramate* (fig. 26).

Mallei fastened by unci to rami; manubria 8 loops soldered to the unci; unci 3-toothed; rami large, with many striæ parallel to the teeth; fulcrum slender; as in *Melicerta ringens*.

Now, the seven Rotifera, made use of above to yield examples of typical trophi, are very distinct from each other, and show that the form of the trophi is one good characteristic for separating the families. But a difference in the shape and disposition of the corona, and of its ciliary wreath, generally accompanies a difference in the manducatory organs; and the three together will serve as good guides to a division of the four orders into families.

In one of the sub-divisions of the *Ploïma*, however, the corona, ciliary wreath, and trophi are often difficult of determination; but just where these guides desert us, a new character, viz. the lorica, comes to our aid, and shows such well-marked differences in shape and structure, as to enable us to divide this sub-order (the *Loricata*) into fairly natural groups. The *Loricata* are so called from the integument of the body; which, from the distribution of chitine throughout the tissue, is hardened into a stiffened coat or shell (*lorica*, a coat of mail) inclosing, more or less completely, the internal organs. In the *Il-loricata* the integument is soft and flexible; but there is, unfortunately, no very sharp division between the two sub-orders in this respect; as every variety of integument exists, from the hard, dense coat of *Dinocharis*, to the tough yet flexible covering of *Rattulus*, and the perfectly soft cuticle of *Albertia*.

The following scheme, then, is an attempt to divide the four orders of Rotifera into families, by means of the various characters which I have just detailed: of course, there are some genera which do not readily fall into the arrangement; but this is only what is certain to happen to every possible scheme of classification.

Such difficulties must attend every attempt to marshal Nature's endless varieties into

whole apparatus looks like one forceps within another. To this variety of the *forcipate* trophi the term *virgate* will be applied.

well-marked battalions. Nature knows no hard lines of separation; and the best of classifications can be only that which contains the fewest faults: as Müller has forcibly said, 'Optima est, quæ paucioribus horret.'

Order I. Rhizota.

Fixed when adult; foot *transversely wrinkled, not retractile within the body, ending in a sucking disk or cup.*

Fam. 1. *Flosculariadæ* (Pl. C, fig. 1).

Corona produced longitudinally into setigerous lobes; *buccal orifice* central; *ciliary wreath* a single half-circle above the buccal orifice; *trophi* uncinate.[1]

Fam. 2. *Melicertadæ* (Pl. C, fig. 2).

Corona not produced into setigerous lobes; *buccal orifice* lateral; *ciliary wreath* a marginal continuous curve, bent on itself at the dorsal surface, so as to encircle the corona twice, with the buccal orifice between its upper and lower curves, and having also a dorsal gap between its points of flexure; *trophi* malleo-ramate.[1]

Order II. Bdelloida.

That swim with their ciliary wreath, and creep like a leech; foot *wholly retractile within the body, telescopic, furcate.*

Fam. 3. *Philodinadæ* (Pl. C, fig. 3).

Corona two transverse circular lobes; *ciliary wreath* a marginal continuous curve bent on itself at the dorsal surface, so as to encircle the *corona* twice, with the *buccal orifice* between its upper and lower curves, and having also two gaps, the one dorsal between its points of flexure, and the other a ventral gap in the upper curve opposite to the *buccal orifice*: *trophi* ramate.[1]

Fam. 4. *Adinetadæ* (Pl. C, fig. 4).

Corona a flat ventrally placed surface; *ciliary wreath* the furred ventral surface of the corona; *trophi* ramate.[1]

Order III. Ploïma.

That swim with their ciliary wreath, and (in some cases) creep with their toes.

Sub-order. Il-loricata.

Foot, *when present, almost invariably furcate; but not transversely wrinkled; rarely more than feebly telescopic, and partially retractile.*

Fam. 5. *Microcodidæ.*

Corona obliquely transverse, flat, circular; *buccal orifice* central; *ciliary wreath* a marginal continuous curve encircling the corona, and two curves of larger cilia, one on each side of the buccal orifice; *trophi* forcipate[1]; *foot* stylate.

Fam. 6. *Asplanchnadæ* (Pl. C. fig. 7).

Corona two transverse, flattened, confluent cones, with their summits distinct; *ciliary wreath* single, marginal; *trophi* incudate[1]; *intestine, cloaca,* and *foot,* absent.

[1] For description of these technical terms, see pp. 28, 29.

Fam. 7. *Synchætadæ* (Pl. C. fig. 6).

Corona a transverse spheroidal segment, sometimes much flattened, with styligerous prominences; *ciliary wreath* a single interrupted marginal curve, encircling the corona; *trophi* forcipate [1]; *foot* minute, furcate, or absent.

Fam. 8. *Triarthradæ*.

Corona transverse; *ciliary wreath* single, marginal, fringing the buccal orifice; *trophi* malleo-ramate [1]; *foot* absent.

Fam. 9. *Hydatinadæ* (Pl. C, fig. 5).

Corona truncate, with styligerous or ciliated prominences; *ciliary wreath* two parallel curves, the one marginal fringing the corona and buccal orifice, the other lying within the first, the styligerous prominences being between the two; *trophi* malleate [1]; *foot* furcate.

Fam. 10. *Notommatadæ*.

Corona obliquely transverse; *ciliary wreath* one of interrupted curves and clusters, usually with a marginal wreath surrounding the buccal orifice; *trophi* forcipate [1]; *foot* furcate.

Sub-order. Loricata.

Corona and *ciliary wreath* various in shape, but never Rhizotic, and Bdelloidic only in the *Pterodinadæ*: *trophi* of different types, but never Bdelloidic, and Rhizotic only in the *Pterodinadæ*.

Division I.

Foot jointed, stylate or furcate; not transversely wrinkled, nor wholly retractile.

Fam. 11. *Rattulidæ*.

Lorica entire, cylindrical, without angles; *trophi* asymmetrical.

Fam. 12. *Dinocharidæ*.

Lorica entire, vase-shaped, sometimes facetted; head distinct, with a chitinous covering; *trophi* symmetrical.

Fam. 13. *Salpinadæ*.

Lorica compressed, cleft down the back, the two halves united by a membrane, so as to form a dorsal furrow.

Fam. 14. *Euchlanidæ* (Pl. C. fig. 10).

Lorica depressed, of two dissimilar plates, one dorsal and one ventral, united by a membrane so as to form a lateral furrow.

Fam. 15. *Lepadelladæ*.

Lorica depressed, broad, closed beneath; head distinct, surmounted by a retractile, arched, chitinous plate.

Fam. 16. *Coluridæ*.

Lorica compressed, open beneath; head distinct, surmounted by a retractile, arched, chitinous plate.

[1] For description of these technical terms, see pp. 28, 29.

Division II.

Foot transversely wrinkled, wholly retractile, furcate or ending in a ciliated cup; sometimes absent.

Fam. 17. *Pterodinadæ* (Pl. C. fig. 9).

Lorica greatly depressed, entire, of two nearly equal plates, soldered together at the edges; *corona* and *ciliary wreath* those of the *Philodinadæ*; *trophi* malleo-ramate [1]; *foot* ending in a ciliated cup.

Fam. 18. *Brachionidæ* (Pl. C. fig. 8).

Lorica depressed, entire, dorsally arched, generally armed with anterior and posterior spines; *corona* transverse with styligerous prominences; *ciliary wreath* single, marginal, fringing the buccal orifice; *trophi* malleate [1]; *foot* furcate, or absent.

Order IV. Scirtopoda.

That swim with their ciliary wreath, and skip with Arthropodous limbs; foot *replaced by two dorsal, stylate, unconnected appendages, ending in ciliated expansions.*

Fam. 19. *Pedalionidæ* (Pl. C. fig. 11).

Corona truncate; *ciliary wreath* a marginal continuous curve, bent on itself at the dorsal surface, so as to encircle the corona twice, with the buccal orifice between its upper and lower curves; having also two gaps, the one dorsal between its points of flexure, and the other a ventral gap in the upper curve opposite to the buccal orifice; *trophi* malleo-ramate.[1]

The further subdivision of each family into genera will be given with the description of that family.

[1] For description of these technical terms, see pp. 28, 29.

CHAPTER IV.

ON THE HAUNTS AND HABITS OF THE ROTIFERA.

Nonne vides, quæcunque mora fluidoque calore
Corpora tabuerint, in parva animalia verti?

Ovid, *Metam.* xv. 362.

Equidem tum Naturæ rerum gratias ago, cum illam non ab hac parte video, quæ publica est, sed cum secretiora ejus intravi.

Curiosus spectator excutit singula et quærit. Quidni quærat? Scit illa ad se pertinere. Quantum enim est, quod *ante pedes* jacet.

Seneca, *Nat. Quæst.* præf. (adapted by O. F. Müller).

'T is born with all: the love of Nature's works
Is an ingredient in the compound man,
Infused at the creation of the kind. . . .
It is a flame that dies not even there
Where nothing feeds it: neither business, crowds,
Nor habits of luxurious city life,
Whatever else they smother of true worth
In human bosoms, quench it or abate.

Cowper, *The Task.*

CHAPTER IV.

ON THE HAUNTS AND HABITS OF THE ROTIFERA.

That the first thing to be done is to catch your game, is a maxim as applicable to Rotifera as to hares; and it is no less true of these that to hunt for them successfully requires some knowledge of their haunts and habits. To carry away from a pond's side a bottle of dirty water full of slimy weed, is by no means a good plan for catching these animals, even the commonest and coarsest. It is true that there are some fine forms which may be found in very dirty ponds, or even in dirtier puddles: for instance, there can hardly be too dark a farmyard puddle for *Hydatina senta*, which rejoices in the drainings of a manure-heap, even when the water is of so deep a colour that it is impossible to see the animals in it when you have got them. *Triarthra*, too, and the beautiful *Notops*[1] *clavulata* are to be met with in cattle ponds, where the water is like pea-soup; and *Brachioni* of all kinds rejoice in such places, especially when green with *Euglenæ* and alive with the motile seeds of algæ. Indeed, there is one *Brachionus*, *B. angularis*, whose presence in a pond bids us put up our bottles and go elsewhere, as it likes water that will support hardly any Rotiferon but itself.

Floscularia, *Stephanoceros*, *Melicerta*, *Limnias*, and *Œcistes* are, of course, to be found only in such places as pond weeds will grow in healthily. Old ponds that have been left long undisturbed are their favourite haunts. *Floscularia* is a very wide-spread genus, at least so far as one or two species are concerned; and these may be looked for with every prospect of success in any such pond. Most of the finer and rarer kinds have been found in the Scotch lakes by Mr. Hood, who during the last four years has doubled the number of recorded species by his discoveries in the lochs round Dundee.

Stephanoceros, though by no means a rare Rotiferon, is more partially distributed; it is found often enough in ponds near London and Birmingham; but I have not heard that a single specimen has ever been met with in the neighbourhood of Clifton.

It appears also to be rare in Scotland; as Mr. Hood has found it only once or twice, in marsh-pools in Perthshire.

Melicerta ringens is to be found almost everywhere. It has even been seen swarming in one of the aquaria in the parrot-house in the Clifton Zoological Gardens. The roots of duckweed, the fibres of algæ, the leaves of *Myriophyllum*, and of all sorts of water plants, bear this very common species, as they do also the tubes of *Limnias* and *Œcistes*. *Lacinularia* and *Megalotrocha* have similar tastes, but are less frequently met with, especially the latter. This must be a comparatively rare genus, as it has been sent to me but three or four times in many years. *Cephalosiphon* is also rare. I once found a large colony of it, on a water weed at Nailsea in the big pond near the railway station, and it has been sent to me from Cheltenham and London;[2] but I never met with it again.

Conochilus is a lover of clear water. I have found it in Loch Lomond, and Dr. Imhoff has obtained it, in abundance, in the middle of Lake Zug. It is common enough

[1] *Notommata clavulata*; Ehr.

[2] Miss Saunders, to whom I am indebted for the specimens, says: "It is curious I never before came across this tube-dweller in the hundreds of pools I have searched."

in clean ponds round about London, and Mr. Hood has met with it in the Perthshire lochs.

The *Notommatadæ* and *Philodinadæ* have a very wide range. The algæ of ponds always hold many species, and many haunt the sediment that lies on the mud of the bottom. Some of the latter are to be found in gutters of houses, in water-butts, on the blades of wet grass, anywhere indeed where dust can fall and moisture can follow. For the eggs of the Rotifera are blown away by the wind from dried-up puddles, and are scattered broadcast through the air; and some of the creatures they give birth to can exist apparently under almost any kind of moist conditions.

The *Asplanchnadæ* fortunately are as indifferent to their quarters as they are large and handsome. I have found them in roadside ditches thickly covered with *Lemna*, in farmyard ponds, in the clear water of a miniature lake, and in a foul yellow-green duck puddle in which the fluid (it could not be called water) was so thick that it had to be diluted with five or six times its own bulk, before anything could be seen in it. An *Asplanchna* is the very beau-ideal of a Rotiferon for a beginner. It is very large and transparent; it swims slowly; and it generally occurs in great numbers. Moreover, its male is even more transparent than the female; a mere living bubble, thinner and clearer than the finest blown glass. Unhappily, they are as capricious as they are charming; for a pool may be full of them to-day and deserted to-morrow; and, so far as my own experience goes, they do not occur in the same spot year after year as many Rotifera do.

The *Pterodinadæ* and *Euchlanidæ* are dwellers in clear ponds, and rather solitary in their habits. On a warm sunny day the latter may be captured by skimming off the *Lemnæ*, and floating bits of leaves and stems, that are driven to the leeward corner of a pool. If the bottle be then allowed to stand a few minutes till the water is clear, a *Euchlanis* will often be found slowly gliding up the glass with its long toes pressed against it. It is always worth while to capture it at once with a pipette, and put it into a small tube along with any others of the same kind, as a live *Euchlanis*, properly exhibited under dark-field illumination, is one of the choicest treats that the Rotifera afford.

The *Pterodinadæ* are almost always creeping about the algæ on the sides of the pond. I never but once have seen any other than solitary specimens, but that exception was a notable one. I then found swarms of them in the small space in which the sluice gate of a pond worked. It was not more than a foot square by about four feet deep, and was mantled over by duckweed. Out of this unlikely spot they were dipped by hundreds, while not one could be found in the pond itself. Of course the duckweed came up with the *Pterodinæ*, though as little as possible was taken, on account of the disagreeable way in which it clings to every pipette put into the bottle. On this occasion, however, I found it of great service; for, on inspecting the catch at home with a hand-lens, I noticed that the Rotifera were attached in clusters to some of the roots of the duckweed. Watching for a favourable opportunity, I whipped one of the *Lemnæ* out of the water so suddenly, that the creatures had not time to let go their hold. Then cutting off the green head, I coiled the stem into a circle on a glass slip, and covered it with thin glass. It was impossible to conceive a more beautiful sight than this natural cage now afforded me. Thirty or forty shields of living glass were flashing across the field of view in every direction; some were adhering to the stem, swaying backwards and forwards so as to present themselves in every point of view, while others were moored to the glass cover, thus giving an admirable opportunity of making out their structure.

It was a memorable occasion, but I never had such a chance again.

I have yet to speak of the *Synchætadæ* among the free-swimmers. Both the genera included in this family are to be found in open water; and both alike shun dirty ponds; though in different degrees, for *Synchæta* is absolutely intolerant of them; while I have dipped up *Polyarthra* from the hollows of a muddy bottom where once a pond had been.

Both genera are tolerably common, and are often to be caught in considerable numbers. The habits of the two chief species of *Synchæta*, viz. *S. mordax* and *S.*

tremula, are very different. The former is the swiftest and most restless of the Rotifera; it is the very swallow of the waters, ever whirling round and round in endless spirals, and never still for a single instant from its birth till its death; but the latter may be constantly seen drifting along in some gentle current, while twisting round at the end of a long thread spun from its toes, and fastened to some floating object.

Of course, creatures with habits like these can be captured only by making random dips in the water, now at the surface, now deeper down—here in the sunshine, and there in the shade; for even Rotifera have their fancies, and are sometimes swarming in one particular spot, while all the rest of the pond is deserted by them.

I have, however, noticed that they specially affect the neighbourhood of a forest of weeds growing up from the bottom; waltzing up and down outside of them in myriads, like gnats under the trees in summer.

There is yet another free swimmer that avoids the shore, and sails out into the open sea; viz. *Anuræa longispina*. This curious creature has a lorica like a Greenlander's canoe, or a University eight, and it keeps off from the weeds and algæ, as if fearing lest it should be entangled for life if it once got among them. It was discovered by Professor D. S. Kellicott in Niagara water at Buffalo, U.S., in 1879, and was found almost immediately afterwards in the Olton Reservoir, near Birmingham and since then in Lake Zug in Switzerland. It appears to be a rare species, though its rarity may be due partly to the fact that it often requires a boat to catch it; and an ordinary Rotifer hunter can hardly be expected to add this to his apparatus.

The known habitats of the *Pedalionidæ* are at present very few. I had the good fortune to be the first to light on *Pedalion mirum*. It was in July 1871 that I found it in a small roadside pool at the top of Nightingale Valley, close to Clifton. Soon afterwards I dipped it from a fine old pond at Abbot's Leigh, about two miles distant from Nightingale Valley. It reappeared in this pond in the following year, but since then it has not revisited the neighbourhood. It has been met with several times near Chester and Birmingham, and on one occasion it was tolerably abundant in the warm water-lily tank in the Duke of Westminster's gardens at Eaton.[1]

Dr. L. K. Schmarda discovered in Egypt, in 1853, in some brackish pools near El-Kab, a six-limbed Rotiferon, *Hexarthra polyptera*, which evidently belongs to the same family, though it must be placed in a different genus. He says that there were great swarms of them distinctly visible to the naked eye, in a pool of very transparent, colourless water, of a strong brackish taste.

Now, a Rotiferon that is equally at home in dirty puddles, clear ponds, warm-water tanks, and brackish pools, ought not to be a rare one: and yet *Pedalion is* rare.

Possibly its apparent rarity is due to its being constantly mistaken for an Entomostracous larva. I was on the point of throwing the water away, when I first dipped *Pedalion* out of the pool in Nightingale Valley. Its skipping movement is so precisely that of the young of a *Cyclops*, that I thought I had caught nothing more valuable than these ever-present nuisances. Fortunately I noticed that, unlike them, my captives seemed to glide along after every skip, instead of stopping stock-still to gather breath for a fresh jump; and so, thinking that they might possibly be some large sort of *Polyarthra*, took them home for further investigation. But it is very probable that *Pedalion* has been thrown away hundreds of times, and will be so again, as this happened to me after nearly twenty years' experience in catching Rotifera.[2]

Rotifera may often be seen perched just under the plumed heads of one of the fresh-

[1] M. J. Barrois described, in the *Revue Scientifique*, No. 13, 1877, p. 303, a marine Rotiferon under the name *Pedalion*, and gave an account of its embryology. His description, however, shows that the animal was of the genus *Synchæta*.

[2] It is a pity that *Pedalion* is not more frequently met with, as there are some points in its structure that yet remain to be cleared up; and as it is such a striking link between the *Rotifera* and the *Arthropoda*. Mr. T. Bolton, of Birmingham, has, however, succeeded in preserving specimens as microscopic objects, and they can generally be obtained from him.

water zoophytes, wisely making use of the stronger currents produced by the ciliated tentacles of their hosts, in order to bring grist more easily to their own mills. I have had sometimes quite "a happy family" of them in the field of view at once; a *Brachionus*, a *Philodina* or two, and a *Melicerta*, all attached to the neck of a *Plumatella*, and all eagerly whirling their wheels in order to divert to their own throats a portion of the currents that swept down to them from above. Nor was this all; for the *Melicerta* in its turn had the top of its tube turned to the same use, and bore, as closely under its wheels as possible, the tiny case of one of its own offspring.

Limnias ceratophylli and *Melicerta ringens* carry this semi-parasitical habit to a great extent. Clusters of two or three generations all attached to one tube are not at all uncommon in the former species; and I once found in Nailsea pond a large *Limnias* bearing up no fewer than fourteen of its own descendants. *Melicerta ringens*, too, in America,[1] is frequently met with in large adhering clusters, but in England it is usually a solitary species. However, this is not invariably the case; for not long ago I had the pleasure of seeing as many as thirty-four live *Melicertæ* attached to one another.[2] They were of all ages and sizes, and were grouped round one large tube, so as to form a striking example of a natural co-operative society. Nor is this the only way in which the Rotifera show their capacity for fighting the battle of life. Every animal is limited by its own powers to a certain space, beyond which its excursions cannot possibly extend. Its food and its mate must be found within these limits; and when these two imperious wants are satisfied, there is but little time or strength left for travelling. But it would be an obvious advantage to many creatures if they could be carried about from one spot to another without tiring their own muscles—ready to slip off, at any favourable opportunity, "to fresh woods and pastures new." Now this is precisely what some of the *Brachioni* and *Philodinæ* contrive to do; for they may be seen riding in clusters on the backs and sides of the Entomostraca, or thickly fringing the legs and side plates of the water wood-louse.[3]

Whenever I have caught a water-flea[4] so encumbered, and have placed it in a live box to see the Rotifera it carried, they have soon deserted their captive steed, and have swum off as if to search for a more serviceable one.

There are, too, some Rotifera whose structure has been adapted to give them a good grasp of their host, or even to enable them to pierce its skin, and so suck its juices for their own support.

Balatro calvus, for example, has been found[5] in the Seine (Canton de Genève) creeping on the bodies of small water-worms which it habitually infests, and having two greatly enlarged foot-processes, which probably enable it to take a firm hold.

Another Rotiferon, *Callidina parasitica*, is always found attached to the thoracic or abdominal appendages of the fresh-water shrimp[6] and water wood-louse, and limits its journeyings to creeping about on the body of its host; while the strange creature *Drilophaga Bucephalus* holds on by its altered jaws to the hind segments of a fresh-water worm, *Lumbriculus variegatus*, and sucks the animal it clings to.

This parasitic Rotiferon was discovered in North Bohemia in the great pond at Hirseberg, in the banks of which the *Lumbriculus* is found in immense numbers. The worm buries the fore part of its body in the mud, and moves its naked hinder segments like a pendulum in the water. But no such gentle motion will unfasten the grip of the *Drilophaga*, which is so firmly attached to the worm's skin that it can be dislodged only by using considerable force.

[1] I am indebted to Mr. Galloway C. Morris, of Philadelphia, U.S., for this information. A cluster of tubes that he sent to me contains twenty-eight specimens of various sizes adhering together.

[2] It was found near Clifton by Mr. E. C. Bousfield, and is drawn in Pl. V. fig. 1, *a*.

[3] *Asellus vulgaris*.

[4] *Daphnia pulex*.

[5] By M. Ed. Claparède. See *Ann. Sci. Nat. Zool.* 5 Ser. vol. viii. 1867.

[6] *Gammarus pulex*. Mr. H. Giglioli, who discovered this species, says that he has never found it anywhere else; and that out of 700 *Gammari* from different localities, not one was free from the parasite. *Quart. J. Micr. Sci.* N. Ser. vol. iii. 1863, p. 237

If the Rotifer hunter can rise to a pitch of enthusiasm, which I confess I have never been able to attain to, he may follow Dujardin's example, and, by making incisions [1] in the sides of earth-worms and slugs, obtain from the expressed fluids the entozoic *Albertia vermiculus*. The same creature has been seen inside *Nais proboscidea*,[2] and an allied species (*Albertia crystallina*) in the viscera of *Nais littoralis*,[3] while the *Synaptæ* of the Channel Islands have been found [4] to carry within their body-cavity a minute Rotiferon only $\frac{1}{500}$ of an inch in length.

But I have not yet exhausted the list of these strange dwelling-places. A pretty little Rotiferon, *Notommata parasita*, may be found swimming about within the beautiful spheres of *Volvox globator*, or lodged within the embryo globes when almost ready to escape from the parent sphere. "On examining several specimens of *Volvox* with a pocket lens we may frequently detect such as are thus tenanted, by perceiving a spot differing from the young clusters in form and colour. These spots are found to be the *Notommata*, snugly ensconced within the globe, in the spacious area of which it lives at ease, and swims to and fro like a gold fish in a glass vase. We see it for the most part, however, clinging to the inner surface of the circumference, engaged in devouring the green monads with which the gelatinous surface is studded, or else eating away the embryo clusters." [5] *Volvox globator* is common enough in most neighbourhoods, and may be met with it even in clear rain puddles in quarries and plantations; while in two or three ponds near Clifton it is sometimes so abundant as to give a green hue to the water; and yet I have never seen its guest here, nor do I know anyone in the neighbourhood who has; so it can scarcely be a common species.

The reproductive cells of *Vaucheria*—a thread-like alga which grows on pond walls and in many moist places—are the homes of another *Notommata*, *N. Werneckii*. This parasitic Rotiferon passes a small portion of its youth in the open water; but it soon returns to a lifelong imprisonment in the green cells in which it was hatched, and where it undergoes very singular changes of form. Its presence in the *Vaucheria* may be detected by the unusual size and shape of the reproductive cells, and by their containing a black spot which is the animal's stomach.[6]

Some further means of obtaining Rotifera have yet to be mentioned.

If a little of the mud or rotten leaves at the bottom of a dried-up pool, in which Rotifera have been observed, is brought home and allowed to lie in a vessel of water, the chances are in favour of there being in the mud some of their eggs, and of their ultimately hatching. I have often adopted this plan with success, especially when some rare species has been discovered in a little pool due only to the rain, and drying up after two or three days' fine weather. Unluckily the mud too frequently harbours an abundance of small worms also; and these are disagreeable to see and troublesome to deal with, for they are liable to starve, die, and taint the water.

Rotifera also may be produced at home by placing infusions of hay, leaves, &c. in some vessel out of doors. No very great variety is to be obtained by such methods; but it is always as well to try it, and to have a good-sized pan in the garden, full of soft water, into which rubbish from pond-gatherings may occasionally be thrown. These, and the chance droppings from the air into the pan, will sometimes give the student, at his own door, species which he would otherwise have to travel far to find.

Many of the Rotifera may be kept indoors in vessels in which there is a healthy growth of *Myriophyllum*, *Anacharis*, or other water-weed. Mr. Gosse has tried this plan with

[1] *Ann. Sci. Nat. Zool.* 2 Ser. vol. x. 1838, p. 176.

[2] By Mr. P. H. Gosse, in water from a pond at Walthamstow.

[3] By M. Max Schulze.

[4] By Professor Ray Lankester, *Quart. J. Micr. Sci.* N. Ser. vol. viii. 1868, p. 54.

[5] Mr. P. H. Gosse, *Trans. Micr. Soc.* vol. iii. 1852, p. 143.

[6] Prof. Balbiani, *Ann. Sci. Nat. Zool.* 6 Ser. vol. vii. 1878. I am not aware that *Notommata Werneckii* has been found in England. Probably it would be, were it deliberately searched for. Mr. F. W. Roper, of Eastbourne, has found a similar species tightly rolled up in a ball inside the leaves of one of the liver-worts, *Lejeunia minutissima*.

success, and has lately had thousands of *Stephanoceros*, *Melicerta*, *Pterodina*, &c., thriving in tanks and jars in his study. Mr. J. Hood has been equally successful with *Floscularia* and *Limnias*; and I know of other instances in which a literally constant stock of the tube-making Rotifera has been maintained in these home preserves.

Indeed, if nothing more is desired than to watch the growth of a couple of generations or so, an ordinary zoophyte trough is aquarium enough. All that is necessary is, (1) to take great care that there are not many animals of any kind in it, (2) to keep it in a subdued light, (3) and at a moderate temperature, (4) and especially to provide the Rotifera with plenty of their natural food. For, in the great majority of cases, Rotifera die, when in captivity, of starvation: one moment's examination of their stomachs will make that point clear.

Of course, what is their natural food must first be observed under the microscope, and then it must be provided to them every day by dropping a fresh supply of water containing it into the trough. It will, therefore, always be necessary to bring away from the pond, where they were found, a good supply of pond water free from all other kinds of animals.

Sometimes, however, it is well to make an overfed Rotiferon starve a little, in order to see its internal structure. *Hydatina senta*, for instance, is frequently so gorged with dark green food, that little else can be seen but its distended stomach; the organization of *Pedalion mirum*, too, is often a hopeless riddle, owing to its greedy habits; but drop either of these creatures into a tube of clear soft water for an hour or so, and it may be fetched out again in delightful condition for microscopic investigation, and yet perfectly healthy.

Summing up the various habitats that I have just recorded, we see that Rotifera may be found in rivers, lakes, reservoirs, ponds, ditches, puddles, gutters, and water-butts; in the mud of dried ponds, in the dust of dried house-gutters, on wet moss and grass; in the rolled-up leaves of liver-worts, in the cells of *Volvox globator* and of *Vaucheria*, in vegetable infusions; on the backs of *Entomostraca*, and of fresh-water fleas, wood-lice, shrimps, and worms; in the viscera of slugs, earth-worms, and *Naiades*, and in the body-cavities of *Synaptæ*. Nor have I yet completed the list; for several species have been found in the sea. Mr. Gosse says,[1] "*Synchæta Baltica* swims at large through the water, never resting; it is self-luminous, and is one of the causes of the phosphorence of the sea. *Brachionus Mülleri* and *Pterodina clypeata* occur in brackish water at the mouths of rivers; and other marine species may often be detected by searching with a pocket-lens the glass sides of a well-stocked aquarium."

Since then these creatures have so wide a range of habitats, it is hardly possible for anyone, who will take the trouble, not to find some of them near his own home.

To obtain some particular Rotiferon, at a particular given time, is often difficult enough, if not impossible; but for one who is content to study these beautiful creatures as he finds them, there is always a never-ending supply of delightful amusement.

[1] *Marine Zoology*, part i. 1855, p. 107. See also *Tenby*, 1856, p. 274.

CHAPTER V.

FLOSCULARIADÆ.

Difficultates, quibus laborat investigatio animalculorum microscopicorum, innumeræ; eorundemque certa et distincta determinatio tantum temporis, tantum oculorum judiciique acumen, tantamque animi compositi et patientissimi præsentiam requirunt, ut vix aliud supra. Nihil facilius quam animalcula videre, eorumque motu et ludo delectari; differentias vero in bestiolis simplicissimis, mobilissimis, mutabilibus, in area minimi campi conspectum omni momento effugientibus, percipere, perceptas variosque cujusvis motus verbis significantibus exprimere, hic labor, hoc opus.

Hinc sæpe post lucubrationem plurium horarum, cum videre et mirari lassus essem, defectu tamen verborum insolitos motus et imagines exprimentium, metuque, ne quæ ipse quidem oculo et mente percepi lectori obscura manerent, chartæ nihil commisi.—O. F. Müller.

CHAPTER V.

Order I. **RHIZOTA.**

Fixed when adult, usually inhabiting a gelatinous tube excreted from the skin; foot *transversely wrinkled, not retractile within the body, ending in an adhesive disk or cup.*

Family I. FLOSCULARIADÆ.

Corona *produced longitudinally into setigerous lobes;* **buccal orifice** *central;* **ciliary wreath** *a single half circle above the buccal orifice;* **trophi** *uncinate.*

This family, like the one that follows it, contains some of the largest, handsomest, and most attractive of the Rotifera. It consists of only two genera, *Floscularia*, and *Stephanoceros*, which closely resemble each other in their habits and internal structure, but differ considerably in outward form. The latter genus, which is represented by only a single species, has its frontal lobes produced into long arms, having setæ set round them in whorls; while the former, which contains no fewer than sixteen species, has the lobes comparatively short and expanded, with the setæ radiating from their summits, and frequently edging the whole rim of the corona. The two genera differ also in the kind of tubes that they secrete. The majority of the Floscules have somewhat irregular tubes of slight consistency; but *Stephanoceros* has a thicker tube, more regular in shape, and apparently of greater density.

Both genera are to be found adhering to the common water-plants, frequently in the axils of the leaves; though some species prefer more exposed positions on the stems, or on the leaves themselves. The *Floscullariadæ* bear captivity fairly well, and may be easily bred, provided that they have a good-sized trough and a plentiful supply of food; for they are greedy feeders. They live mainly on *Monads*, ciliated *Protozoa*, &c.; but occasionally capture and swallow comparatively large animals, such as *Stentors*, or even free swimming *Rotifera*. In one respect, however, captivity often tells on them; for the home-bred specimens, though healthy enough, and breeding freely, are frequently much inferior in size to those that are brought fresh from their native haunts.

Genus FLOSCULARIA, *Oken.*

Generic Characters.—**Frontal lobes** *short, expanded, or wholly wanting;* **setæ** *very long and radiating, or short and cilia-like;* **foot** *terminated by a non-retractile peduncle, ending in an adhesive disk.*

Neither pen nor pencil can do justice to the beauty of these animated flowers. It can only be properly appreciated when they are seen by dark-field illumination under the microscope. Then the eye is at once delighted with the filmy transparency of the petaloid head, with the flowing curves of the lobes, and with the pencils of delicate setæ radiating from their summits in all directions, and often passing altogether out of the field of view. Should, moreover, the species under observation happen to be a social one, such as *F. campanulata*, four or five specimens may often be found with their

tubes in juxtaposition, and the whole group can then be well shown under a low power; the animals, in various positions and under different aspects, forming, with their delicate cases and interlacing setæ, a picture that can be hardly rivalled.

F. campanulata, when fully expanded, has been compared to "a long tubular flower with a five-angled petal, the tube swollen, contracted below the lip, and seated on the end of a long stalk."[1] This description applies very well in most respects to the other species, except that the number of petals is not always five; for, owing to late discoveries, there is now a regular series of Floscules with seven, five, three, and two lobes; and one species in which the corona is not divided into lobes at all.

The setæ also, which crown the lobes, and are so highly characteristic of the better-known forms, vary quite as much in the newer species as do the coronæ; in some exceeding the Rotiferon's utmost length, and in others diminishing almost to the size of ordinary cilia. Indeed, if the strange genus *Acyclus*—which must be very closely allied to the Floscules—be also taken into account, as well as the equally curious genus *Apsilus*, there is a tolerably complete series of forms showing a gradual change from a Floscule, with seven lobes, and long radiating setæ, to a Floscule-like Rotiferon in which the setæ have entirely vanished, the corona has degenerated into a very delicate protrusile cup, and even the foot itself has shrunk into a mere sucking disk.

The **Tube.**—The Floscules inhabit a semi-transparent gelatinous tube, into which the animal when alarmed can contract itself with great swiftness. It is secreted by the creature itself, and moulded on its own body by its sudden contractions, and slow expansions. When free from diatoms and extraneous particles (which is seldom the case), it is difficult to be seen, especially by transmitted light: under the dark-field illumination, not only can its outline be seen, but the substance of which it is composed can be traced from the outer surface, far in towards the Rotiferon itself. The tube becomes thinner towards the top, and it is often difficult to trace it there; but it will generally be found to close in neatly a little under the neck.[2]

A Floscule, emerging from its tube, after one of its contractions, presents the appearance of a pear-shaped body on a transversely wrinkled stalk, with a pencil of long parallel hairs rising from the puckered centre of the rounded upper end. It slowly stretches itself till the wrinkles of the foot have nearly disappeared; and then, after a delay, sometimes provokingly long, the puckers round the setæ relax, and the whole pencil is thrust forward, by the unfolding of the lobes of the corona; which, as they rise, show that they had been drawn down into the body by inversion, as the tip of the finger of a glove may be drawn into it, by pulling it from within. After a little further hesitation, the lobes unfold, and expand into a wide cup, while "the setæ seem to fall round it on all sides in a graceful shower." The now fully expanded Floscule consists of five well-marked portions; the corona, the vestibule, the crop, the trunk (including the viscera), and the foot.

The **corona** is a delicate nearly hemispherical cup, whose free edge is cut into lobes varying much in size, shape, and number. There are two main varieties of lobe; in the one they are narrow, pointed, and ending in a spherical knob; in the other they are broad, bounded by low convex curves, and knobless. In almost all, the dorsal lobe is conspicuous by its greater size, or peculiar appendages. The corona is furled by the action of delicate muscular threads imbedded in its surface, and expanded by the upward rush of fluid between its outer and inner integuments, due to the contraction of the transverse muscles of the trunk.

The **setæ** are set either on the knobs that crown the summits of the lobes, or on a thick rim running round them; and they sometimes form a continuous fringe on the

[1] Gosse, *Popular Sci. Rev.* vol. i. 1862, p. 160.

[2] Though the tube is of the flimsiest material, and lighter than water, it certainly protects the animal from its enemies. I have watched a sharp-jawed larva trying to bite through a Floscule's tube, and it was as completely foiled by its swaying about from side to side at every touch, as a boy at Hallow E'en is baffled by a floating apple, when trying to seize it with his teeth.

rim of the corona. Owing to their great delicacy, and to their lying in different planes, it is impossible to see nearly all of them at once. They vary greatly in size, position and arrangement; but their varieties, with those of the forms of the lobes, will be described in the account of each species.

Volvocina, small *Infusoria*, and floating particles may constantly be seen to enter the bell-shaped corona, and to pass thence down towards the buccal orifice. The setæ take no part in this process, beyond that of preventing the return of the captured prey, by interlacing in a close network over the top of the cup, or by individually lashing at a returning object, so as to throw it back again into the gulf. The interlacing of the setæ is accomplished by the heads of the lobes approaching each other, and, should the prey be large and vigorous, the lobes are pressed tightly together, so as to completely bar all chance of escape. In most of the species, the motion of the setæ appears due to the fitful action of the cuticle, on which they are placed; but in *F. trilobata*, *F. Hoodii*, and notably in *F. mutabilis*, a regular cilia-like motion occurs in the setæ; while in *F. mira* there is a still wider departure from the ordinary type; since in this Floscule each seta has a constant, slow, independent, amœboid motion.

The **Vestibule.**—At the bottom of the corona is a second chamber (the vestibule), bounded above by a highly contractile collar, below by a diaphragm with a slit in its centre (the buccal orifice), and on the sides by thick walls. On the upper margin of the collar, and running half round it on the ventral side, is a horse-shoe-shaped ciliated rim, ending in two knobs, bearing long, slowly moving cilia; and this rim is so set, that it slopes downwards from the dorsal side to the ventral. This true rotatory apparatus may be easily seen in the large Floscules *F. Hoodii* and *F. trilobata*.[1]

A current, due to the action of these cilia, sets down the coronal cup, in a plane at right angles to its base, and carries the food, past the collar, into the vestibule. When once an organism has reached the vestibule, there is no return for it to the upper world. The Floscule often suffers two or three small *Infusoria* &c. to wander about round the walls of the vestibule; but at any attempt to pass the collar, that at once contracts on itself, and closes the passage. In the diaphragm, which is the base of the vestibule, there is a long slit, the **buccal orifice**, bounded by two chitinous **lips** (Pl. I. fig. 1*d*, *lp*), from which there hangs into the next chamber, called the "crop," an elastic tube (Pl. II. fig. 4, *t*), which may be seen always undulating above the mastax. When there are victims enough collected in the vestibule to make it worth while to swallow them, the collar contracts violently, the lips dart forward with a sort of snap, and the prey is forced down the tube into the crop. It is evident that this hanging tube is an admirable contrivance for admitting fresh prey into the crop, while at the same time preventing the return of that previously captured. Naturalists plagiarise from the Floscules, when they drop their live specimens through a quill stuck into the cork of a bottle; only the rigid quill is far inferior to the flexible and ever-moving tube.

The **crop** (Pl. II. fig. 4, *cp*) is a rounded chamber just under the diaphragm at the base of the vestibule. It has very thick walls, which are strengthened externally by two granular spots one on either side of the Floscule's shoulders (Pl. I. figs. 4, 8*a*). Viewed as opaque objects they are white, like the similar oval knobs on *Megalotrocha alboflavicans*.

Under the action of small muscular fibres, the sides of the crop contract alternately, and throw the contained food from side to side; by which means every part of it in turn is subjected to the action of the jaws (Pl. II. fig. 4, *ti*). These lie at the bottom of the

[1] Dr. Dobie described the two ciliated knobs in *F. campanulata*, *Ann. Nat. Hist.* 1849. Mr. Gosse inferred the existence and position of the true rotatory organ from the motion of particles in the coronal cup (*Tenby*, p. 307). Dr. Moxon says that "the alimentary canal above the gizzard is divided by a highly irritable cilium-clothed sphincter of irregular outline" (*Trans. Linn. Soc.* vol. xxiv. 1864, p. 457). In 1867 I published a full description of the rotatory organ of *F. campanulata* in the *Trans. Bristol Micr. Soc.* In 1869 Mr. Cubitt did the same for *Stephanoceros* and *F. coronetta* (*Mon. Micr. J.* vol. ii. 1869, p. 133).

crop, attached to the walls of the stomach; and to reach the latter everything must pass between them. The Floscules are great feeders, and sometimes the crop becomes so distended with food, that the animal, unable to force it past the jaws quickly enough, seeks relief by expelling the contents of the crop right through the inverted tube. The lobes of the corona are folded back on the body, the diaphragm is pushed upwards and the tube is thrust inside out through the slit in the diaphragm; while through it pours the unmanageable food. Dr. Moxon (*loc. cit.*) has seen this take place on two separate occasions, and I have seen it once: in each case the animal was *F. campanulata*.[1] The appearances due to the tube have been variously described as caused by moving filaments, laminæ, vibratile cilia, and a waving membrane; but these observations of Dr. Moxon, confirmed by my own, put the matter beyond doubt.

The **Trunk**.—The outer wall of the trunk is a tough, elastic, and often shining cuticle, which has an inner and softer layer of varying thickness. This double covering interferes greatly with a clear view of the viscera, especially as it has intercommunicating cavities and channels containing fluid, which is driven upwards and downwards by the contraction of the muscles, and by the various motions of the body. Nor is this all; for the fluid itself is often rendered semiopaque by granules floating in it. It is doubtless by means of this fluid that the lobes of the furled corona are pushed forward and expanded, the transverse muscles of the trunk forcing it into definite channels, which are thus rendered tight and stiff, like the ribs of an umbrella. Mr. Gosse[2] has described and figured these in the case of *F. ornata*; and has noticed how the granules flow from the trunk over the neck into the various channels of the coronal cup. Mr. Hood, too, has watched a steady stream of granules passing down from the trunk into the foot, and returning again from a point about half way from its extremity. The granules may be frequently seen, in some degree, in specimens of almost every species, but occasionally they are in such abundance as to render the animal quite opaque; and, by reflected light, of a dead white.

The **foot** is very long and flexible, and is capable of great expansion and contraction, but cannot be drawn into the trunk. It consists of little else but muscles. The great longitudinal muscles pass down its whole length, and numerous fine muscular fibres encircle it everywhere, covering it with transverse rings of very variable thickness, from its junction with the trunk to its extremity. This latter contracts to an inextensible, and usually short cord or peduncle, which itself terminates in a sort of disk. In the foot are also the two club-shaped glands (so common in other genera) which probably secrete a viscous fluid for fastening the disk to some extraneous object.

The **Nutritive System**.—The food is feebly pecked at by the jaws, while it is in the crop, but it evidently undergoes there some process of digestion. I once saw a Floscule bolt a small *Salpina*. When inside the crop it was still alive, and it charged from side to side, in the vain hope of escape. The sharp points of its lorica ought to have made its captor uncomfortable; but the only result was, that its outline gradually grew dim, and that before long the whole animal faded into a shapeless mass.

Mr. Gosse[3] notices the absence of the mastax, and says of the **trophi** that "the jaws consist of a pair of curved unjointed but free mallei, with a membranous process beneath each. Each malleus (Pl. I. figs. 9*a*, 9*b*) is an uncus of two slender arched divergent fingers, united by a subtle web; the back of each curves downwards, where, expanding and becoming membranous, it is connected with some delicate but definite processes with rounded outlines, which I should have supposed to be muscular bulbs, but that they remain after treatment with potash."

After passing between the jaws the food enters the stomach (Pl. II. fig. 4, *s*) apparently directly, as no œsophagus is visible. The alimentary canal is divided into stomach (*s*) intestine (*i*), and rectum (*r*), which latter is bent on itself, and ascends to the cloaca (*cl*)

[1] Fig. 1, Pl. D, is a copy of Dr. Moxon's drawing, showing the tube turned inside out and protruded through the slit in the diaphragm: the lobes (*l*) are shown drawn down close to the body.

[2] *Popular Sci. Rev.* vol. i. 1862, p. 160, pl. ix.

[3] *Phil. Trans.* 1856, p. 419.

on the dorsal surface. A partial separation (probably due to a sphincter muscle) is usually visible between the stomach and intestine, and the distinction is often made more obvious by the different colour of the contained food. The whole alimentary tract is richly ciliated; and so is the tube (*t*) that hangs down into the crop. The cilia can be easily seen in the intestine, when it is partially empty; and on the tube, when it is everted by the Floscule's disgorging its crop.

Secreting System.—In the great majority of Rotifera there are two **gastric glands**, seated on the top of the stomach. I have, however, never been able to detect them in any Floscule, neither has anyone recorded their existence except Ehrenberg and Grenacher. The latter describes and figures them of unusual length in *F. campanulata*,[1] but it is probable that in this matter he is mistaken. He also describes two club-shaped glands in the foot.

Vascular System.—It is very difficult to trace this in most of the Floscules, owing to the optical difficulties due to their skins. But in 1864 Dr. Moxon (*loc. cit.*) published a complete account of it in *F. campanulata*. His figure of the contractile vesicle (Pl. II. fig. 3, *cv*), the lateral canals (*lc*), and of four of the vibratile tags (*vt*), is so clear as to render any verbal description unnecessary. A fifth vibratile tag was discovered by Grenacher in *F. campanulata* (*loc. cit.*), in the side of the coronal cup, near the spot where Dr. Moxon (*loc. cit.*) had anticipated that it would, some day, be found. Parts of this system have been seen in several other species, and doubtless it exists in all.[2]

The **muscles** consist of non-striated fibres. Below the bottom of each depression, between the lobes, a muscle runs downwards in the substance of the coronal cup and vestibule, and is lost on the surface of the body, to reappear again, as it nears and passes down the foot. The anterior portions of these muscles end in two or more branches which diverge to the thickened rim of the coronal cup, and often interlace, as seen in *F. coronetta* (Pl. II. fig. 2), and in *F. trilobata* (Pl. II. fig. 6), where they may be seen reaching the summit of the dorsal lobe. There are some half-dozen transverse muscles imbedded in the integument of the trunk; and the walls of the vestibule, with its upper ciliated rim, are all highly contractile.

The Nervous System.—Dr. Moxon (*loc. cit.*) has described and figured the nervous ganglion in *F. campanulata*, and I have seen it in *F. Hoodii*. It is in nearly the same position as it is in *Stephanoceros*, namely, on the dorsal side of the vestibule; and is, as usual, close to the organ of taste, and not far from the eyes and dorsal antenna; to all of which doubtless it sends out nervous threads. Dr. Moxon has seen and figured such threads in *F. campanulata* (Pl. II. fig. 3, *n*.)

In the great majority of the Rotifera the mastax is also not far from the nervous ganglion; but in the *Floscullariadæ* the mastax almost vanishes, while the jaws and ganglion are far apart.

Organs of Sense.—Two red eye-spots lie usually above the ganglion; but, as in the adults they are deeply imbedded in the integument, they are not easily seen. In fact the ordinary way of attempting to see them, by transmitted light, will scarcely ever be successful; but by treating the Rotiferon as an opaque object, and concentrating a strong light on it, the eyes may often be seen glowing like rubies when all else is invisible.[3] The **eyes** are conspicuous in the half-grown animals, and in the young within

[1] *Sieb. u. Köll. Zeits.* Bd. xix. 1869, p. 483.

[2] Dr. Leydig saw the contractile vesicle in *F. cornuta*; *Ueb. d. Bau d. Räderth.* 1854. Dr. Bartsch has seen the contractile vesicle, lateral canals, and vibratile tags in his *F. longilobata* (*F. coronetta*) *Rot. Hungariæ*, 1877.

[3] Mr. Gosse (*Popular Sci. Rev.* vol. i. 1862, p. 166) observed one eye at a time in *F. cornuta*. Mr. Cubitt (*Mon. Micr. J.* vol. iii. 1870, p. 245) saw the eyes in *F. coronetta*; and I have recorded (*J. Roy. Micr. Soc.* 2 Ser. vol. iii. 1883, p. 163) my having observed them in *F. Hoodii* and *F. regalis*. Herr K. Eckstein (*Sieb. u. Köll. Zeits.* Bd. xxxix. 1883, p. 347), unaware of the above observations, says "the Floscules have been hitherto regarded as eyeless," and records his having seen the eyes in *F. cornuta*.

the egg. There are three **antennæ** in *F. campanulata*, *F. coronetta*, and *F. Hoodii*; and no doubt the same three may with care be found in the other species. There is one on each side of the neck, and one on the median line near the middle of the dorsal lobe. The two lateral antennæ are very short tube-like prominences each carrying a brush of divergent setæ; they are very apparent in *F. coronetta* (Pl. II. fig. 2): the dorsal antenna is a mere setigerous pimple.[1] The **setæ** on the lobes act also as organs of touch, warning the creature of the approach of anything detrimental to its delicate cup; and whipping back into it any animalcule that endeavours to escape from it.

On the middle of the contractile collar, which is above the vestibule, and on the dorsal side of it, there is a round projection facing the concavity of the ciliary wreath. It can be easily seen in *F. coronetta* and *F. Hoodii*, and is probably an organ of taste, as it is constantly thrust forward to meet any particle which is passing into the vestibule. A very obvious and tongue-like organ holds a similar position, and acts in a similar way, in *Stephanoceros*.

The **Reproductive System.**—The ovary, with its clear spherical germs, and frequently with an opaque egg in it, can be seen filling the greater part of the space between the stomach and the ventral surface. No other portion of the apparatus has been made out, owing no doubt to a habit that the Floscules have of contracting themselves sharply into their tube when about to lay an egg. When laid, the eggs are ranged above one another, between the foot and the tube. The ordinary number of female eggs is from two to five; though as many as eight or ten have been seen at once. The male eggs, which are smaller, rounder, and more numerous, than the female, frequently amount to as many as nine or ten, and have occasionally been seen in a cluster of eighteen or twenty in the same tube. Both are inclosed in a delicate shell, which is left behind in the tube, when the young Floscule is hatched. Dr. Weisse and Mr. Hood agree in assigning six or seven days as the time from the extrusion of the egg to the birth of the young animal.

The **Young Female.**—"The infant female Floscule is a white cylindrical maggot (Pl. I. fig. 9*c*), blunt at the front end, with a central orifice, whence protrudes a short brush of cilia; but the margins are capable of unfolding, when the cilia are seen to form a whorl around the truncate summit, swiftly rotating. The margin soon begins to bud forth the little knobs around which the cilia are gathered (Pl. I. fig. 9*d*); these quickly increase in length, and the angular flower-like corona gradually forms. Meanwhile the little creature, which was at first free, attaches itself by its hinder end, and assumes the condition as well as the form of the parent."[2]

Mr. Hood has observed in *F. calva*, that the young animal fixes itself two or three hours after it has burst its shell, and soon begins to form its tube, which at first rises barely to half the height of the foot. By the time it is three days old (Pl. III. fig. 8*a*) the tube has attained fair proportions.

The same observer noticed that the lobes of the young *F. ambigua* began to develop from a collar under the ciliary wreath, and were at first merely a dorsal and ventral lobe; the latter with a small notch. In three or four days the notch deepened and widened so that there were three lobes; but it was not till the fifth or sixth day that the rudiments of the small side lobes (the fourth and fifth) made their appearance. The young Floscule arrived at maturity at the twenty-fourth or twenty-sixth day, but continued to increase in size after it had deposited eggs: in fact, did not cease to grow till shortly before its death. The whole lifetime, in a trough, was from forty to forty-six days.

Captivity, however, affected the growth of the animals, even when carefully attended to, and plentifully supplied with food. On one occasion, for instance, a large *F. campanulata* $\frac{1}{18}$ inch long, from one of the Scotch lochs, was placed in a tank; and

[1] Dr. Moxon (*loc. cit.*) first called attention to their existence in the Floscules. Herr Grenacher (*loc. cit.*) mentions his having discovered the median antenna in *F. proboscidea* (*F. campanulata*); but was unaware that Dr. Moxon had seen and described all three, five years before.

[2] Mr. Gosse on *F. campanulata*. *Popular Sci. Rev.* vol. i. 1862, p. 166.

the young reared from its eggs, though perfectly healthy and breeding freely, never exceeded $\frac{1}{3}\frac{1}{0}$ inch in length: their eggs, too, were half the size of those of their parent.

In *F. trilobata*, occasionally, the egg produces the living young in the body of the parent. Mr. Hood has seen the embryo alive in the egg, within the Floscule, and has witnessed its birth: yet Dr. Collins has seen the same Rotiferon deposit the usual eggs in its tube.

The **Male.**—Until 1874 no male had been discovered among the *Rhizota*;[1] and indeed some observers supposed this group to be monœcious; but in that year I had the good fortune to find the male of *Lacinularia socialis*, and to study it thoroughly.[2] Soon afterwards I found that of *Floscularia campanulata* (Pl. I. fig. 1*c*) and I have since seen what I believe to be the male of *F. mutabilis* (Pl. III. fig. 2*c*). Mr. Hood has observed and figured the male of *F. calva* (Pl. III. fig. 3*b*), and has seen that of *F. ambigua* actually hatched. The structure of the male Floscule has not yet been thoroughly investigated; but, so far as it has been studied, it has been found to agree with that of other male Rotifera. The **corona** is an imperforate many-lobed cushion, surrounded by a simple circlet of long cilia. The **nutritive system** is wholly absent. Two red **eyes** are visible just under the surface of the corona; and the longitudinal **muscles**, for withdrawing the head, are generally obvious. Nearly the whole of the body-cavity is filled with a large **sperm-sac** (Pl. I. fig. 1*c*, and Pl. III. fig. 3*b*; *ss*) from which the **penis** (*p*), a ciliated protrusile tube, proceeds to the dorsal surface, at the junction of the trunk and foot.

The **vascular system**, **ganglion**, and **antennæ** have not yet been seen; but no doubt they are present, as in the males of other Rotifera.

F. REGALIS, *Hudson*.

(Pl. I. fig. 8.)

Floscularia regalis . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. iii. 1883, p. 166, pl. iv. fig. 3.

SP. CH. **Lobes** *seven, knobbed.*

The **corona** is a deep cup with a nearly circular rim, from which project four knobbed triangular processes on the ventral side, dividing that half of the rim into three equal spaces. The processes curve slightly outwards; and, at the rim, their bases unite, so as to give that edge of the cup a semi-hexagonal appearance. In the middle of the dorsal side of the rim rises a large triangular knobbed lobe, bearing on each side a short recurved knobbed process. All seven knobs carry pencils of long radiating setæ. A true **ciliary wreath** at the bottom of the trochal cup, and two red **eyes**, can be easily seen. This remarkable Rotiferon, the only seven-lobed species, was found by Mr. Thos. Bolton in September 1882, near Birmingham.

Length, $\frac{1}{8}\frac{1}{0}$ to $\frac{1}{3}\frac{1}{0}$ inch.[3] **Habitat.** Lakes and clear ponds. Birmingham (T.B.[4]); Perth (J.H.,[4] and W. Dingwall): not common.

F. CORONETTA, *Cubitt*.

(Pl. I. fig. 5; Pl. II. fig. 2.)

Floscularia coronetta . . . Cubitt, *Mon. Micr. J.* vol. ii. 1869, p. 133, pl. xxv.
Stephanoceros Horatii . . . Cubitt, *Mon. Micr. J.* vol. vi. 1871, p. 166.
Floscularia longilobata . . . Bartsch, *Rot. Hungariæ*, 1877, p. 24, ii. Tab. fig. 14.

[1] Mr. Gosse (*loc. cit.* p. 487) described some probably male eggs in *M. ringens*.

[2] *Mon. Micr. J.* vol. xiii. 1875, p. 45.

[3] As the Rotifera vary from $\frac{1}{2}$ to $\frac{1}{500}$ inch, no attempt has been made to draw them to a fixed scale. The actual length of each species will be given at the end of its description.

[4] Throughout the work the following initials will be used in the Habitat:—J. H. = Mr. John Hood; T. B. = Mr. Thos. Bolton; P. H. G. = Mr. Gosse; C. T. H. = Dr. Hudson.

SP. CH. **Lobes** *five, linear, knobbed;* **setæ**, *non-extensile.*

The **corona** has five long narrow knobbed lobes, nearly all of equal length, separated by deep depressions, and forming a miniature coronet. The dorsal lobe is slightly the longest, and the lobes are so set on the front of the body that a plane touching the knobs would be oblique to its longitudinal axis; the dorsal lobe being the furthest forward. All the knobs carry long radiating setæ, and the setæ are continued all along the edge of the trochal cup (Pl. II. fig. 2). The true **ciliary wreath** and the **eyes** have been seen in the adult by Cubitt (*loc. cit.*); but the former with difficulty. The lateral **antennæ** can be readily seen when the animal is favourably placed, as well as the delicate muscular threads by which the longitudinal **muscles** act on the corona (Pl. II. fig. 2). As many as seven **male** eggs have been seen in one tube.

Length, $\frac{1}{25}$ inch. **Habitat.** In ponds and marsh pools; rare. Wandsworth Common (Cubitt); Forfar, Fife (J.H.).

F. MIRA, *Hudson.*

(Pl. III. fig. 1.)

Floscularia mira . . . . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. v. 1885, p. 609.

SP. CH. **Lobes** *five, linear, knobbed;* **setæ** *extensile.*

The **corona** is very like that of *F. ornata*, which species the Rotiferon closely resembles in every respect but two. First, the **tube** is much more like that of a *Stephanoceros* than that of an ordinary Floscule. I have seen only one specimen, but Mr. Cocks (its discoverer) tells me that the tubes of the half-dozen specimens which he has seen were all of the same sort. Secondly, in its **setæ** *F. mira* is not only unlike all other Floscules, but is unique among the Rotifera: for each seta is in constant independent motion, slowly extending or contracting like the pseudopodium of an Amœba. When the retracted seta begins to extend again, it is often bent into a whip-like shape, a wave of motion overtaking, as it were, the resting anterior portion, and finally driving out the latter with a characteristic flourish of its tip. The setæ are of amazing length and abundance, exceeding the total length of the Rotiferon. This very rare and wonderful creature was discovered by Mr. W. G. Cocks in June 1884.

Length, $\frac{1}{50}$ inch. **Habitat.** Unknown; found in an aquarium, in water that probably came from Epping Forest or Walton-on-Thames (W. G. Cocks).

F. ORNATA, *Ehrenberg.*

(Pl. I. fig. 9.)

Floscularia ornata.—Ehrenberg, *Die Infus.* 1838, p. 408, Taf. xlvi. fig. 2.
" " Peltier, *Ann. Sci. Nat. Zool.* 2 Sér. t. x. 1838, p. 41, pl. iv.
" " Dujardin, *Hist. Nat. Zooph.* 1841, p. 610, pl. xix. fig. 7.
" " Gosse, *Tenby*, 1856, p. 307, pl. xx.
" " " *Popular Sci. Rev.* vol. i. 1862, p. 160, pl. ix. figs. 1–3.
" " Pritchard, *Infusoria*, 1861, p. 675, pl. xxxii. figs. 384, 385, and xl. figs. 25, 26.
" " Weisse, *Sieb. u. Köll. Zeits.* Bd. xiv. 1864, p. 107, Taf. xiv. figs. 1–5.
" " Bartsch, *Die Räderth. b. Tübingen*, 1870, p. 24.

SP. CH. **Lobes** *five, triangular, knobbed;* **dorsal lobe** *without any process.*

The **corona** has five knobbed lobes of moderate length separated by broad depressions, the dorsal lobe being distinctly the longest and broadest, and the knobs crowned with long radiating setæ. Ehrenberg describes *F. ornata* as having usually six lobes, but sometimes five, and draws an example of each case. No doubt it must have been a difficult matter for one of the old observers with only a monocular microscope, and that a poor one, to make out the shape of a delicately transparent and scolloped cup, pre-

sented to him so that its upper and under surfaces were projected on each other. With a modern binocular and dark-field illumination, no tyro would fail to describe correctly the cup with its five knobbed lobes. Ehrenberg credits this species with two "clear spaces" that he considers to be **gastric glands**. I have made frequent search for such glands, but cannot find them; Ehrenberg's "clear spaces" are probably the small bulbs, the rudiments of a mastax, in which the jaws are inserted.

It is most probably Eichhorn's "Der Fänger" (Pl. B, figs. 15, 16), and, if so, it is the earliest known Floscule, having been discovered as long ago as 1767. Unluckily, Eichhorn has given two other drawings of it, one with nine, and one with ten knobbed lobes; but, as he complains of the difficulty of rightly understanding and drawing it, it is possible that these numerous lobes represent only the puckers of the half-expanded corona. This is a very pretty species, and, as Eichhorn well says, "no lightning can dart out of the clouds through the air more swiftly" than this little animal can contract upon its prey. Owing to its small size, however, and its lack of transparency, it is not well adapted for the investigation of the internal organs of the Floscules.

Length. From $\frac{1}{60}$ to $\frac{1}{30}$ inch; average $\frac{1}{50}$. **Habitat.** Fresh waters everywhere

F. CORNUTA, *Dobie*.

(Pl. I. fig. 7.)

Floscularia cornuta . . .	Dobie, *Ann. Nat. Hist.* 2 Ser. vol. iv. 1849, p. 233, with pl.
" " . . .	Gosse, *Popular Sci. Rev.* vol. i. 1862, p. 168, pl. ix. fig. 6.
" " . . .	d'Udekem, *L'Institut*, t. xix. 1851, p. 222.
Floscularia appendiculata . .	Leydig, *Ueb. d. Bau d. Räderth.* 1854, p. 3, Taf. i. fig. 6.
Floscularia cornuta . . .	Pritchard, *Infusoria*, 1861, p. 676, with fig.
" " . . .	Cubitt, *Mon. Micr. J.* vol. v. 1871, p. 170, pl. lxxxi. fig. 7.
Floscularia appendiculata . .	Bartsch, *Rot. Hungaricæ*, 1877, p. 24, Tab. ii. fig. 19.
" " . .	Eckstein, *Sieb. u. Köll. Zeits.* Bd. xxxix. 1883, p. 344, Taf. xxiii. figs. 1–4.

SP. CH. **Lobes** *five, triangular knobbed;* **dorsal lobe** *with flexible process.*

This species was first described by Dr. Dobie (*loc. cit.*) and was afterwards re-named as a new species by Dr. Leydig (*loc. cit.*). It is like *F. ornata*, but possesses at the back of the dorsal lobe a curious flexible **process**, which is probably an organ of touch, though it does not appear to bear setæ, or to have any opening. It rises from a swollen base just below the knob, and is suddenly bent over the latter, and then turned up again so as to point forwards and clear the knob. It occasionally moves a little, and slowly alters its shape, taking often an undulating form; but it is not moved about like the antenna of *Cephalosiphon* or of *Rotifer macroceros*: it reminds one rather of the slow bendings of the dorsal appendages of *F. Hoodii*. The **eyes** cannot be easily seen in the adult, but I have succeeded in exhibiting both together by condensing a strong lamp-light on the dorsal surface.

Leydig (*loc. cit.*) describes and figures the **contractile vesicle** but places it away from the intestine on the ventral side.

Length, cir. $\frac{1}{80}$ inch; Scotch specimens up to $\frac{1}{40}$ inch. **Habitat.** Widely distributed.

F. CYCLOPS, *Cubitt*.

(Pl. I. fig. 6, and Pl. D. fig. 2.)

Floscularia cyclops . . .	Cubitt, *Mon. Micr. J.* vol. vi. 1871, p. 83, pl. xciii. figs. 1, 3.

SP. CH. **Lobes** *five, knobbed, very short, variable in length, but sometimes with the knobs almost seated on the rim of the coronal cup;* **the dorsal lobe** *rather the longest and stoutest;* **setæ** *radiating from the knobs.*

This Floscule greatly resembles *F. ornata*, but it is distinguished by its height,[1] the length of its foot, and the shortness of its lobes. The fully extended **foot** is frequently thrice as long as the body. The **tube** is much wider than usual in proportion to the animal's size, and often symmetrical in shape, like that of *F. longicaudata*. Two **eyes** are visible in the adult. This species is prolific and has often many eggs in its tube. As many as twelve female eggs have been counted in the same tube; and eighteen male eggs in another. Found by Mr. C. Cubitt in 1871.

Length, $\frac{1}{72}$ inch. **Habitat.** North Brook, Kent (Cubitt); ponds and marsh pools, Forfar, Fife (J.H.): rare.

F. CAMPANULATA, *Dobie*.

(Pl. I. Fig. 1.)

Floscularia proboscidea . . .	Ehrenberg, *Die Infus.* 1838, p. 408, Taf. xlvi. fig. 1.
" " . . .	Dujardin, *Hist. Nat. Zooph.* 1841, p. 610.
Floscularia campanulata . .	Dobie, *Ann. Nat. Hist.* 2 Ser. vol. iv. 1849, p. 233, with pl.
" " . . .	Gosse, *Popular Sci. Rev.* vol. i. 1862, p. 167, pl. ix. figs. 4, 5.
" " . . .	Pritchard, *Infusoria*, 1861, p. 675, with fig.
" " . . .	Hudson, *Trans. Bristol Micr. Soc.* 1867, 2 pls.
Floscularia proboscidea . .	Grenacher, *Sieb. u. Köll. Zeits.* Bd. xix. 1869, p. 483, with fig.
Floscularia campanulata . .	Cubitt, *Mon. Micr. J.* vol. viii. 1872, p. 5, pl. xxiv. fig. 1.

SP. CH. **Lobes** *five, broad, without knobs, separated by distinct depressions;* **peduncle** *short;* **setæ** *radiating from the summits of the lobes, and fringing the whole edge of the coronal cup.*

I think that Grenacher (*loc. cit.*) is right in supposing that Dr. Dobie's *F. campanulata* is really Ehrenberg's *F. proboscidea*. Ehrenberg describes the latter as having six lobes, and also a snout-like organ, of cylindrical form, beset with setæ like those on the lobes, and rising from the depths of the coronal cup above its rim. Grenacher suggests, as Dujardin had done before him, that this snout-like organ is only the dorsal lobe seen before the corona is fully expanded. I have thought it best, however, to retain Dr. Dobie's name, as *F. campanulata* has certainly neither a proboscis nor six lobes: I confess, however, that I have little expectation of anyone's ever finding a Floscule with either the one or the other.

The **setæ** often appear to be confined to the thickened summits of the lobes, forming simply a tuft on each. They really, however, fringe the whole circumference of the corona, sloping further away from it as they approach the bottoms of the depressions between the lobes, and even at last pointing backwards towards the foot. The **vascular system** has been described above, p. 47, and is shown Pl. II. fig. 3. Only four vibratile tags are given in Dr. Moxon's figure; but Grenacher has seen a fifth, whose position is shown in Pl. II. fig. 4. A **nervous ganglion** has been seen by Dr. Moxon. It is situated dorsally on the neck (Pl. II. figs. 3 and 4, *gn*). Nerve threads are drawn by Dr. Moxon, as passing from the ganglion to the three antennæ. There is one dorsal antenna, half-way up the coronal cup, and one on each side of the cup close to its junction with the body (Pl. II. fig. 3, *a*). They are little more than setigerous pimples. When the coronal cup is furled, the dorsal antenna may be seen on the summit of the contracted Floscule's pear-shaped body. The discovery of the **male** has been mentioned above, p. 49. Its sperm-sac (*s*) and penis (*p*) are indistinctly shown in Pl. I. fig. 1, *c*; but the dead specimen from which I drew the figure was so lately hatched that its cuticle was more than usually opaque. As many as twenty male eggs have been

[1] To obtain a correct notion of the completely expanded animal, the foot and case in Pl. I. fig. 6, should be supposed to be continued quite two inches below the bottom edge of the page on which the figure is drawn. A small, correctly proportioned figure, is given in Pl. D, fig. 2.

counted[1] in one tube. This beautiful Rotiferon is by no means shy, but often attaches itself in closely-packed clusters, of a dozen or more, to the stems or ends of the leaves of water-plants.

Length. Average about $\frac{1}{45}$ inch; but Mr. Hood has found in the Scotch lochs specimens no less than $\frac{1}{18}$ inch long. **Habitat.** Clear ponds and lakes: common.

F. LONGICAUDATA, *Hudson.*

(Pl. I. fig. 4.)

Floscularia longicaudata . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. iii. 1883, p. 165, pl. iv. fig. 2.

SP. CH. **Lobes** *five, rather pointed, without knobs, the dorsal lobe the largest, the two ventral ones next in size, and the two lateral ones much the smallest;* **peduncle** *very long;* **setæ** *as in F. campanulata.*

This Floscule resembles both *F. campanulata* and *F. ambigua* but is distinguished from them by its pointed lobes, very long peduncle, and comparative smallness of its body. The lateral **lobes** vary in size in different specimens, and even in the same animal at different times, and are occasionally as minute as they always are in *F. ambigua*. The **peduncle** (*pd*) is often $\frac{1}{3}$rd of the length of the extended foot, while in other Floscules it varies from $\frac{1}{15}$th to $\frac{1}{20}$th of that length. It is a thin, transparent, non-retractile thread, and is generally thrown into graceful curves and coils. The **tubes** of all the specimens which I have seen were remarkably compact and symmetrical.

This is a social Rotiferon, and is to be found sometimes in clusters of a dozen or more, of various ages and sizes. It selects exposed situations, perching itself on the edge or point of a leaf, and preferring the convex side to the concave. It is a great feeder, swallowing small live *Infusoria* greedily; and, though not so hardy as *F. ambigua*, yet it will bear being kept in a trough for a fortnight.

F. longicaudata was first discovered by Mr. J. Hood in 1881, on a leaf of *Sphagnum* in a pool on Tent's Muir; and again in Loch Rea, Blairgowrie, in July and August of the same year.

Length. From $\frac{1}{25}$ to $\frac{1}{35}$ inch. **Habitat.** Lochs and marsh pools; Forfar, Fife, Perth (J.H.): rare.

F. AMBIGUA, *Hudson.*

(Pl. I. fig. 2.)

Floscularia ambigua . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. iii. 1883, p. 163, pl. iv. fig. 1.

SP. CH. **Lobes** *apparently three; viz. one large broad dorsal lobe, and two much smaller ventral ones; a pair of minute lateral lobes lie between the dorsal and ventral lobes;* **setæ**, *as in F. campanulata.*

This broad stumpy Rotiferon connects the five-lobed with the three-lobed Floscules; for though, at first sight, it seems to have but three lobes, there is also a minute lateral pair. These lateral lobes are frequently reduced to mere thickenings of the rim of the cup, but can always be detected by the setæ radiating from them. From some points of view *F. ambigua* closely resembles *F. campanulata*; and, indeed, I think that Dr. Moxon (Pl. II. fig. 3) may have mistaken the one for the other.

From the body up to the dorsal lobe, as in *F. Hoodii*, run two ridges of semi-transparent tissue, which look like buttresses to the coronal cup; and form, with it and the dorsal surface, a deep hollow, at the bottom of which lies the neck.

The animal has a habit of so contracting itself as to throw its cuticle into deep folds, especially at the neck, and at the base of the body. There often appears also to be a

[1] By Mr. W. Dingwall, of Dundee.

well-marked separation between the body and foot, the latter looking as if it possessed only half the width of the body, at the line of junction.

F. ambigua was discovered by Mr. J. Hood in May 1881 on a leaf of *Sphagnum*, in a mossy pool on Tent's Muir, Fife. Its habits are the reverse of those of *F. longicaudata*. It selects for its post the axil of a plant, or the under surface of a leaf, especially of a well-curled one; so that it is difficult to find a specimen that can be easily studied from various points of view. Thus placed as it were in ambush, the burly Floscule draws, with its powerful ciliary wreath, all kinds of organisms into its coronal cup. Nothing seems to come amiss to it, and its appetite never fails. Mr Hood has seen it devour the young of *Œcistes pilula*, and of *Œ. umbella*; as well as other free swimming Rotifera, along with all kinds of *Infusoria*; so that, to use his own vigorous language, "it would eat its own weight in three hours." The same observer has twice seen the **male** hatched from the egg laid in the tube; and noticed the motion of its spermatozoa in the sperm-sac.

Length. From $\frac{1}{30}$ to $\frac{1}{40}$ inch. **Habitat.** Lochs and marsh pools; Forfar, Fife, Perth (J.H.); near Birmingham (T.B.); Woolston pond (P.H.G.): sometimes abundant.

F. ALGICOLA, *Hudson*, sp. nov.

(Pl. I. fig. 3; Pl. II. fig. 1.)

SP. CH. *Very small;* **corona** *precisely that of F. ambigua, but ornamented with dots arranged in symmetrical patterns;* **tube**, *if present, undistinguishable.*

This pretty little Rotiferon is very like *F. ambigua*, differing but little from it except in its ornamented corona, small size, and strange dwelling-place. Its coronal cup is ornamented on the outside with minute dots, arranged in a symmetrical pattern, as shown in Pl. II. figs. 1*a*, 1*b*. It makes its home in a parasitic growth (*Gloiotrichia pisum*[1]) on the stems of water plants. Possibly it may in this way avoid the necessity of making a tube, as the parasitical sphere that it lives in seems to consist chiefly of a kind of grey mucus; but I could not be certain whether it had a tube or not: Mr. Gosse searched with great care, but could see none.

This Rotiferon was found first by Mr. J. Hood in 1882, at Rosemont Loch, Blairgowrie. It was then very abundant.

Length, $\frac{1}{65}$ inch. **Habitat.** Lochs, Perth (J.H.): not common.

F. TRILOBATA, *Collins*.

(Pl. II. fig. 6.)

Floscularia trilobata . . . Collins, *Science Gossip*, Jan. 1872, p. 9, with fig.
Floscularia trifolium . . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. i. 1881, p. 4, pl. ii.

SP. CH. **Lobes** *three, large, broadly curved, separated by very deep and similarly curved depressions:* **dorsal lobe** *rather the largest;* **setæ** *forming a continuous double fringe round the entire circumference of the corona; the outer row arranged like those of F. campanulata; the inner row short, slightly curved, and arranged like cilia.*

This large and elegant Floscule was discovered by Dr. F. Collins in 1865, in a small pool near Sandhurst, Berks; and he published a short account of it, with a figure (*loc. cit.*) in 1872. It was afterwards found by Mr. J. Hood, in Loch Lundie, near Dundee, in 1880; and I published a description of it (*loc. cit.*) naming it *F. trifolium*, as I had considerable doubt of its really being Dr. Collins' species. I have since seen the description and figures which Dr. Collins sent, with some live specimens, to Mr. Gosse in 1865; and I have now no doubt that *F. trifolium* and *F. trilobata* are the same.

[1] Kindly identified by Dr. Cooke in a letter to Mr. Gosse.

The peculiarity of a second fringe of setæ lying within the principal fringe is shared with it by *F. Hoodii* alone. Unlike the ordinary setæ, these smaller secondary setæ possess a kind of joint action; for when any captive creature tries to escape from the coronal cup, and to pass the setæ, those of the outer row either lash separately at it, or are drawn together over it by the converging lobes; while a wave of motion, like a ciliary wave, runs once or twice round the inner row. The true **ciliary wreath** can be easily seen at the bottom of the coronal cup, owing to this Floscule's great size and transparency. I saw a small **contractile vesicle**, but I had no opportunity of tracing the rest of the **vascular system.** The two lateral **antennæ** were also obvious.

The first thing that strikes the observer, on watching the protrusion of the furled head, is the great size of the Floscule, and the curiously shrivelled appearance that the lobes of the coronal cup present, as they emerge from the opening head. They look exactly as if the animal were sickly or injured. In a few seconds, however, they gently swell out, the many folds and creases disappear, till at last the eye is gratified with the sight of a lovely transparent tulip, of three petals, their edges all fringed with delicate and motionless hairs. It is a creature of exquisite beauty; from every point of view the flowing curves of the cup are charming, and its great transparency permits the whole of the outline of the rim to be seen at once. The dorsal lobe is rather larger than the other two, and is curved forward over the cup. Across each lobe run delicate muscular threads for furling it, which are specially visible on the back of the dorsal lobe (Pl. II. fig. 6).

Dr. Collins saw **eggs**, laid by his specimens, remaining attached to them within the tube; but Mr. Hood observed that some specimens, which he reared in a trough, hatched the ova in the ovary, and then gave birth to the living young.

They are voracious feeders on *Infusoria* and small animalcules, and are fond of stationing themselves in the axils of water plants.

Length, $\frac{1}{18}$ to $\frac{1}{15}$ inch. **Habitat.** Lochs, marsh and boggy pools; Sandhurst (Dr. Collins and P.H.G.); Woolston, Hants (P.H.G.); Fife, Forfar, Perth (J.H.): not common in England, abundant in Perthshire.

F. Hoodii, *Hudson.*

(Pl. II. fig. 5.)

Floscularia Hoodii . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. iii. 1883, p. 161, pl. iii. figs. 1, 2.

SP. CH. **Lobes** *three;* **dorsal lobe** *much the largest, and carrying two, large, sleeve-like, flexible processes;* **setæ**, *short, cilia-like, in two parallel rows, fringing the entire circumference of the coronal cup.*

This is one of the largest of all the Rotifera; adult specimens being quite $\frac{1}{10}$ inch from the top of the dorsal lobe to the extremity of the peduncle. Its great size, and its curiously shaped three-lobed corona make it sufficiently remarkable; but, in addition to these peculiarities, it has two extraordinary processes, perched one on each side of the back of the dorsal lobe. They appear to be hollow, and to communicate with two lenticular spaces lying between the two surfaces of the dorsal lobe. Fine muscular threads pass along and across them (Pl. II. 5*b*), and the animal can contract and expand each independently of the other; and throw them into all kinds of positions. The upper end of each seems to be separated from the lower portion by a constriction, from which a muscular thread runs down to the base. Each of these processes slowly and independently changes its shape and position, now sinking down on the dorsal lobe so as to be invisible, or again bending its free end at right-angles to the lower portion. I have never seen anything like them on any other Rotiferon: they may possibly be organs of touch, but I could detect no trace of setæ on them. Mr. Hood tells me that both in young and adult specimens he has seen brown granular matter discharged from their free ends. The thickened rim of the three lobes carries its double fringe of setæ

set just as they are in *F. trilobata*, the larger row stretching outwards, and the smaller inwards; and the same rapid flicker may be seen on occasions to run all round the edge of the coronal cup. The orifice of the coronal cup alters constantly, now opening in the characteristic way shown in Pl. II. fig. 5*a*, and now reduced to a slit; or even closed in puckers. Two dorsal ridges, as in *F. ambigua*, run like buttresses from the body to the back of the dorsal lobe, and in the lowest portion of the deep hollow between these lie the two pale pink **eyes**; both in the neck, and one close to each buttress. The true **ciliary wreath** is distinctly visible throughout its whole length. It is a long horse-shoe-shaped and ciliated ridge, sloping sharply down from the bottom of the coronal cup into the vestibule. The **contractile vesicle** is unusually large and distinct; close to it, and apparently situated in it, is a cluster of yellow globules, which look black by transmitted light.

This strange and beautiful Floscule was discovered by Mr. J. Hood in December 1882, in a ditch on Tent's Muir, Fifeshire.

Length, $\frac{1}{110}$ inch. **Habitat.** Marsh pools; Fife (J.H.): rare.

F. CALVA, *Hudson.*

(Pl. III. fig. 3.)

Floscularia calva . . . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. v. 1885, p. 610.

SP. CH. **Lobes** *two, short;* **dorsal lobe** *the larger;* **setæ** *very short, radiating from the thickened summits of the lobes, incapable of cilia-like action;* **body** *unusually long and narrow, its outline confluent with that of the coronal cup, so that there is no neck;* **eyes** *cervical.*

Mr. J. Hood discovered this species in 1884 on a *Sphagnum* leaf, in a mossy pool on Tent's Muir, only twelve inches deep, and on another occasion found it in Loch Lundie at a depth of ten feet. I have seen only two specimens of it, and those under disadvantageous circumstances; as each had dropped from the plant on which it was found, and was lying in the sediment at the bottom of the tube. The creature appears to attach itself rather to its tube than to the stem of the plant which bears the tube, and so to be easily detached. I am indebted to Mr. Hood for drawings of the young male and female (Pl. III. figs. 3*a*, 3*b*), each of which he saw hatched from eggs laid in the tube. The **male** is about $\frac{1}{210}$ inch in length, and resembles that of *F. campanulata*.

Length, $\frac{1}{65}$ to $\frac{1}{50}$ inch. **Habitat.** Lochs and marsh pools, on *Myriophyllum* and *Sphagnum*; Forfar, Fife (J.H.): rare.

F. MUTABILIS, *Bolton.*

(Pl. III. fig. 2.)

Floscularia mutabilis . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. v. 1885, p. 609, pl. xii. figs. 1–3.

SP. CH. **Lobes** *two, well developed;* **dorsal lobe** *decidedly the larger;* **setæ** *rather short, set round the whole circumference of the disk, and capable of cilia-like motion;* **eyes** *near the summit of the dorsal lobe.*

F. mutabilis somewhat resembles *F. calva*, but is at once distinguished by its larger lobes, moveable setæ, and by its unique habit of swimming. The animal has not as yet been found attached to any water plant. It looks, when resting in its case at the bottom of a live cell, just like an ordinary Floscule that had been knocked off its perch, as the setæ are straight and motionless. After a short rest it pulls down the two lobes to a level with the bottom of the depressions between them, and so alters the **corona**

that it looks like that of an *Œcistes*; at the same instant the setæ[1] set up a vigorous cilia-like action; and the animal, case and all, sails slowly, stern foremost, through the water. Two red **eyes** are very conspicuous in a most unusual position; namely, near the top of the dorsal lobe. I have seen what I believe to to be the **male** (Pl. III. fig. 2*c*), but I failed to isolate it so as to make out its internal organs. Its length was about $\frac{1}{180}$ inch. It appeared to have, in addition to the usual ciliary wreath, setæ pointing backwards to the foot.

Mr. T. Bolton discovered *F. mutabilis* in a pond of Sutton Park, near Birmingham, in May 1884. He described, named and figured it, soon afterwards, in one of the fly-leaves sent out with his specimen tubes.

Length. About $\frac{1}{80}$ inch. **Habitat.** A pond in Sutton Park, Birmingham (T.B.): rare.

F. EDENTATA, *Collins*.

(Pl. III. fig. 4.)

Floscularia edentata . . . Collins, *Science Gossip*, Jan. 1872, p. 9, with fig.
" " . . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. v. 1885, p. 611.

Corona *lobeless, transversely truncate;* **setæ** *very short, chiefly on the ventral and dorsal portions of the rim;* **body** *large and stout in proportion to the animal's total length, and nearly as long as the foot.*

Dr. Collins first discovered this ugly Floscule near Sandhurst in 1867. He says (*loc. cit.*) that it has no masticating organs, and that the food passes directly into a capacious stomach. As his specimen was a female (for it laid an egg while in captivity) this is very unlikely. My specimens were so gorged with food that no internal organs could be seen, except the stomach and a portion of the ovary. One of them was literally crammed full of specimens of *Cocconema*, which not only distended the real stomach and the crop, but even protruded above the rim of the coronal cup. How the animal contrived, with its feeble cilia, so to pack itself with these unmanageable diatoms, I cannot imagine.

Length. My specimens, $\frac{1}{15}$ inch; Dr. Collins', $\frac{1}{80}$ inch. **Habitat.** Sandhurst, Berks (Dr. Collins); Woolston, Hants (P.H.G.); Blair Athol (W. Dingwall): rare.

Genus ACYCLUS, *Leidy*.

GEN. CH. *One dorsal, frontal* **lobe**; **setæ** *absent, the coronal cup edged with a delicate festooned membrane; termination of* **foot** *truncate.*

*ACYCLUS INQUIETUS, *Leidy*.[2]

(Pl. D. fig. 3.)

Acyclus inquietus . . Leidy, *Proc. Acad. Nat. Sci. Pa.* 1882, p. 243, pl. ii. figs. 1–6.

The structure of this species has been only imperfectly made out; but, so far as it has been, the animal appears to be closely allied to the *Flosculariæ*; and so also do the next two species, *Apsilus lentiformis*, and *Apsilus bipera*. The characters of *Acyclus inquietus* given by Prof. Leidy are as follows:—

"*Body fusiform, tapering behind into a long narrow tail-like appendage, by which it is attached, not distinctly annulated, but becoming transversely wrinkled in con-*

[1] It is possible that there may be (as Mr. Bolton says) a row of short cilia round the coronal cup, as well as the larger setæ; but my impression is that there is not: I altered my opinion more than once, while watching the creature, but came at last to the conclusion that it swam by means of its setæ, and not by a subsidiary row of cilia.

[2] Throughout the work the species which are not known to be British will be marked with an asterisk.

traction. A non-ciliated cup-like head prolonged into an incurved digitiform appendage (as a substitute for the usual trochal disc), contractile and retractile."

The Professor found eight specimens of this strange creature, each surrounded by a group of *Megalotrocha alboflavicans*, and all attached to the tubes of *Plumatella diffusa*, in the Schuylkill river, U. S. It is considerably larger than *M. alboflavicans*, and can be readily distinguished with the naked eye, towering above the surrounding cluster of *Megalotrochæ* "like a giant in a crowd." It is a very difficult animal to observe, as it bends abruptly in different directions; suddenly contracting and slowly elongating, and scarcely ever for a moment remaining erect. It is translucent, whitish, with the thicker portion of the body of a yellow or brown hue, due to the colour of the alimentary canal. The **corona** is a cup prolonged on the dorsal side into an incurved lobe (Pl. D, fig. 3). It is capable of being expanded or contracted, protruded or retracted; and when expanded, the dorsal lobe is also extended, but remains somewhat incurved. There are no **cilia** or **setæ** on the edge of the cup or lobe, but both of them are bordered by a delicate festooned membrane. When contracted, the lobe is rolled up spirally (Pl. D, fig. 3*b*). A narrow, transversely wrinkled neck lies between the cup and the body. No **ciliary wreath** has been noticed within the cup. There is generally no **tube** present; but in two instances the animal has been seen in a "copious colourless gelatinous sheath." The cup converges into a pouch (the **vestibule**) occupying the neck, which is seen to expand and contract from time to time. Longitudinal **muscles** extend from the neck to the membrane surrounding the coronal cup, passing along its walls. Retractor muscles stretch from the body down the length of the foot. The **secreting, vascular,** and **nervous systems** have not been observed; neither have any **eyes** or **antennæ** in the adult female. The **ovary** is in the usual ventral position, and the ova are large, and unsegmented when extruded.

Length, $\frac{1}{31}$ to $\frac{1}{17}$ inch. **Habitat.** Schuylkill river, U. S. (Prof. Leidy): rare.

Genus APSILUS, *Metschnikoff.*

GEN. CH. **Coronal cup** *wholly membranous;* **setæ** *and* **foot** *absent.*

*APSILUS LENTIFORMIS, *Metschnikoff.*

(Pl. D, fig. 4.)

Dictyophora vorax (?) . . .	Leidy, *Proc. Acad. Nat. Sci. Pa.* 1857, p. 204, and 1882, p. 248, pl. ii. fig. 7.
Apsilus lentiformis	Metschnikoff, *Sieb. u. Köll. Zeits.* Bd. xvi. 1866, p. 346, with figs.
Cupelopagus bucinedax (?) . .	Forbes, *Amer. Mon. Micr. J.* 1882, pp. 102, 151, with fig.
Apsilus vorax	Foulke, *Proc. Acad. Nat. Sci. Pa.* 1884, p. 37 pl. i. figs. 2, 5.
Apsilus lentiformis	Leidy, *Proc. Acad. Nat. Sci. Pa.* 1884, p. 50.

Herr E. Metschnikoff found many specimens of this Rotiferon at Giessen in 1866, on the under side of the leaves of the yellow water-lily, to which they were attached by a chitinous ring on the ventral surface; both in the young and adult female the foot was absent. The **coronal cup** is wholly membranous, and destitute of either **cilia** or **setæ**. It is capable of having its edge all drawn close together into a point (Pl. D, fig. 4*a*), and of being wholly withdrawn within the body, so that it acts as a net, closing over any prey that voluntarily enters it, and forcing it down into the chamber below it, which in the Floscules would be called the **crop** (fig. 4*a*, *cp*). At the bottom of the crop is a very peculiar set of **trophi** (fig. 4*c*). A broad **stomach** has a cœcal appendage on each side, and a cloacal orifice on what appears to be the ventral side, but is really a portion of the dorsal, having been drawn round by the animal's curving its body when attached to the leaf. There are two pear-shaped **glands** attached by their narrow ends to the crop. There is a **contractile vesicle** opening into the cloaca, and from it, above, issues a

duct which divides into two **lateral canals**. Each canal runs slantingly up to a coil at the side of the body below the cup, and thence sends a branch into the dorsal surface of the cup, anastomosing with its fellow above and below the nervous ganglion (Pl. D, fig. 4*b*), and bearing two **vibratile tags** on each side of it. The **nervous ganglion** is a four-side organ in the dorsal wall of the cup; it sends out a nerve thread at each corner, the lower pair passing to two lateral **antennæ**. No **eyes** are visible in the adult. The young **embryo** is developed in the egg in the body of the parent. When hatched, it is a free-swimming Rotiferon (Pl. D, fig. 4*d*), with a truncate, ciliated, anterior extremity, and with the cloaca, at the ciliated posterior extremity, surrounded by a membranous ring. There are two red **eyes**, but the characteristic coronal cup is as yet undeveloped. The **male**, which has a ciliated foot, is so like those already described, that Herr Metschnikoff's drawings supersede description (Pl. D, fig. 4*e*).

Prof. Leidy described in 1857 (*loc. cit.*) a new Rotiferon, "destitute of wheel-organs," which he named *Dictyophora vorax*. He obtained, however, some fresh specimens in 1884, and is now of opinion (*loc. cit.*) that the animal is identical with *Apsilus lentiformis*, and that the discrepancies between his account and Herr Metschnikoff's are due to the wrinkled condition of his first specimens, which had been forcibly removed from the glass sides of an aquarium.

Mr. S. A. Forbes also described (*loc. cit.*) a Rotiferon found in a neglected aquarium, and "wholly destitute of cilia or other vibratile structure." He called it *Cupelopagus bucinedax*, and gave a very characteristic figure of its side view. I have little doubt that this also is *Apsilus lentiformis*.

Length. Maximum about $\frac{1}{30}$ inch. **Habitat.** On water plants, Giessen (Metschnikoff); Fairmount Park, and Schuylkill river, U. S. (Leidy).

*Apsilus bipera, *Foulke*.

(Pl. D, fig. 5.)

Apsilus bipera	Foulke, *Proc. Acad. Nat. Sci. Pa.* 1884, pp. 37, 50, pl. i. figs. 4, 7.
Apsilus lentiformis . . .	Leidy, *Proc. Acad. Nat. Sci. Pa.* 1884, p. 50.

Miss S. G. Foulke, who discovered this Rotiferon, is of opinion that it differs from *Apsilus lentiformis* sufficiently to warrant its being regarded as a distinct species; the points of difference being the shape of the cup, the absence of ganglion, the presence of a "second stomach," and the ciliation of the cup.

If *A. bipera* really has two stomachs, one above the jaws and the other below them, and each a closed sac with walls distinct from those of the body-cavity, then it would not only be a new species, but also a perfectly unique one among the Rotifera. It is evident that further investigation is wanted on this and other points; especially as Prof. Leidy is of opinion that *Apsilus bipera*, *Dictyophora vorax*, and *Apsilus lentiformis* are all the same animal.

But whether Miss Foulke's species be a new one or not, to her is due the discovery of a true **ciliary wreath** within the coronal cup. It consists of two gradually narrowing ridges, fringed with long cilia, and running up the inside of the dorsal surface of the cup (fig. 5*a*). Short diagonal lines of finer cilia can be indistinctly seen between the larger set. This ciliary apparatus is quite unique in position; and, if *A. bipera* and *A. lentiformis* are the same, it is curious that Miss Foulke should have missed the nervous ganglion, and that Herr Metschnikoff should have missed the ciliary ridges.

Length. Up to $\frac{1}{50}$ inch. **Habitat.** Water-plants in Fairmount Park, U.S. (Miss Foulke).

Genus STEPHANOCEROS, *Ehrenberg*.

GEN. CH. **Lobes** *long, slender, erect, convergent;* **setæ** *set diagonally on the lobes in parallel bands;* **foot** *terminated by an adhesive cup.*

S. EICHHORNII, *Ehrenberg*.

(Pl. IV. fig. 1.)

Stephanoceros Eichhornii . .	Ehrenberg, *Die Infus.* 1838, p. 400, Taf. xlv. fig. 2.
,, ,, . . .	Dujardin, *Hist. Nat. Zooph.* 1841, p. 612, pl. xix. fig. 8.
,, ,, . . .	Gosse, *Popular Sci. Rev.* vol. i. 1862, p. 30, pl. iii. and iv.
Stephanoceros glacialis . . .	Perty, *Zur Kenntniss kleinst. Lebensf.* 1852, p. 47, Tab. i. fig. 1.
Stephanoceros Eichhornii . .	Leydig, *Ueb. d. Bau d. Räderth.* 1854, p. 5, Taf. i. figs. 1–4.
,, ,, . . .	Pritchard, *Infusoria*, 1861, p. 668, pl. xxxii. fig. 383, pl. xxxvii. figs. 1–4.
,, ,, . . .	Cubitt, *Mon. Micr. J.* vol. iii. 1870, p. 240, pl. lii.
,, ,, . . .	Newlin Peirce, *Proc. Acad. Nat. Sci. Pa.* 1875, p. 121.
,, ,, . . .	Rosseter, *J. Roy. Micr. Soc.* 2 Ser. vol. iv. 1884, p. 169, pl. v. figs. 1–3.

Anyone who has seen *Stephanoceros* favourably placed, and properly lighted, can well understand the enthusiasm with which Eichhorn relates its discovery[1]; for it is a lovely creature, and as strange as it is beautiful. A small pear-shaped body, whose rich green and brown hues glow beneath a glistening surface, is lightly perched on a tapering stalk, and crowned with a diadem of the daintiest plumes: while the whole is set in a clouded crystal vase of quaint shape and delicate texture. The **tube** is denser than it is in the Floscules, is more symmetrical in shape, and is continuous in substance from its outer surface almost to the creature's body. If an empty tube be examined, it will be found that it has a central hollow, which the body and foot will exactly fill.

Mr. Gosse and Dr. Mantell have each seen a young *Stephanoceros* bore its way through its parent's tube by means of its cilia; just as I have several times seen young Floscules do. The material, therefore, of which it is composed, must be of the flimsiest kind. The commencement of the formation of the tube has been described by Mr. Gosse (*loc. cit.*) as follows: "A specimen, which was hatched under my eye, swam for ten minutes, and then became permanently attached to the upper glass of the box, so that it was vertical in its position, with the foot next to the eye; a favourable aspect for observing the development of the case. It presently began to dilate its body; and, in about five minutes from its attachment, I perceived a distinct filmy ring around it, perfectly circular, whose diameter was about twice that of the body (Pl. IV. fig. 8). The little animal now began to lean over to one side, and the ring soon had another segment additional, leaning in the same direction (fig. 9). The case, for such it was, looked like two broad hoops of glass, each swollen in the middle and set one on the other but not quite concentrically, at least to the eye of the observer. It was manifest that it was produced from an excretion from the body, owing its form and size to the animal's moving round on the foot as on a pivot."

Ehrenberg's drawing of *Stephanoceros* has certainly been taken from a crushed or sickly specimen, and, indeed, in the majority of cases its portrait has been drawn too long after the creature had left its native haunts; for when freshly caught and in vigorous health it arches its five plumes so that its crown almost forms a sphere.[2] The

[1] P. 18, *supra*.

[2] Mr. Gosse has found that healthy specimens, removed from an aquarium and inspected at once, have their five arms more frequently produced into a cylindrical form, with their extremities incurved, than arched into a sphere.

setæ are far longer than they appear at first sight, and are not stiff bristles as Ehrenberg has drawn them, but are gracefully curved, and taper off into lines of exquisite fineness. Those of one arm interlace with those of the arms on either side of it, so as to form a living cage of the finest network, through which it is hardly possible for anything to pass without striking some part of the sensitive meshes. The instant this happens band after band of the setæ lashes at the runaway, a swift wave of motion runs along each band, and the captive is thrown back into the vortex produced by the wreath at the bottom of the coronal cup, the ciliary armature of which is precisely like that already described in *Floscularia*. I have also on more than one occasion detected a fitful ciliary wave running round the top of the coronal cup, just under the level of the lowest points of the depressions between its lobes. This has not hitherto been noticed, but I am certain of the fact: the motion was of the briefest duration.

There are considerable differences of opinion about the **muscular system**. Dr. Leydig (*loc. cit.*) says that there are four muscles which rise in the foot, and each of which divides into a pair, as it crosses the trunk, and then subdivides into smaller branches, as it passes over the coronal cup to the base of the lobes. Mr. Gosse makes them to be five pairs, and says that usually each pair runs up the trunk from the foot in a line with one of the arms; and then, before reaching it, divides into diverging branches which, at remote points, are united to a muscular collar close to the base of the arms. He notices, however, that he has seen cases where the muscles run down direct from the depressions between the lobes without uniting to form pairs.

My own opinion, after prolonged observation of many specimens, is that there are really six pairs of muscles, and that they are arranged in the following fashion. Each pair runs up the foot looking like a single muscle; and the reason why never more than four (pairs) are visible in the foot from any point of view, is that there is always a pair on each side of the animal (however viewed) which is there lost to sight. At the junction of the foot and trunk each pair begins to open a little; and by the time they have reached the bottom of the coronal cup the constituents of each pair diverge obviously from each other, and terminate usually at the base of some one of the depressions between the lobes: but in such a fashion that the constituents of the same pair never end in the same depression (Pl. IV. figs. 2, 3, 4, *lm*). There is, however, an exception to this in the case of the two pairs of dorsal muscles (Pl. IV. fig. 2, *lm*). Here it will be seen that while the outer muscles in each pair end in a depression between the lobes, the inner muscles curve over towards each other and meet so as to form a fine arch, some distance below the base of the dorsal lobe. There are, too, fine hexagonal markings visible on this side of the coronal cup, which are probably the boundaries of large cells: oval nucleated cells are also easily seen in the wall of the coronal cup, when the animal is viewed from either side (fig. 4).

The **nutritive and reproductive** systems are so similar to those of *Floscularia*, that they require no separate description. It is enough to call attention to Dr. Leydig's figure of the ovary treated with acetic acid (reproduced in fig. 7), and exhibiting the ova in various stages of growth, as well as its own delicate walls, and the oviduct (*ot*), which leads into the cloaca (*cl*).

The **Secreting System**.—Neither salivary, gastric, nor foot glands have been observed in *Stephanoceros*, but as the animal secretes a large and comparatively solid tube, it is clear that it must either have some organ for this purpose, or that the substance of which the tube is constructed oozes from the surface of the body.

The **vascular system** is much better seen in this genus than it is in the preceding. Fig. 4 shows *Stephanoceros* viewed a little obliquely from the side on the left of the dorsal surface. The left lateral canal (fig. 4, *lc*) can be seen winding to the left of the nervous ganglion (*gn*) and having two vibratile tags (vt_1, vt_2) attached to it close to where the left eye (*e*) is. The lateral canal then divides into two branches; the right branch curving upwards towards the dorsal surface to meet its fellow on the median dorsal line (see fig. 2), while the left branch passes along the side of the vestibule till it nearly

reaches the level of the knobbed ends of the ciliary wreath (*cw*). Here this left branch joins an offshoot of the right branch; the point of junction being marked by a third vibratile tag (vt_3). A fourth vibratile tag (vt_4) is attached to the right branch just where it gives off the connecting offshoot, and a fifth (vt_5) can be seen on the highest dorsal portion of the lateral canal. Fig. 2 shows the same right and left canals, as seen from the dorsal surface, with the same vibratile tags on either side. Each lateral canal winds down the side of the trunk and ends at last on the surface of the contractile vesicle. Leydig (*loc. cit.*) records his having distinctly seen this junction in young specimens, as well as a duct leading from the contractile vesicle into the cloaca (*cl*).

The **Nervous System.** What is probably the **nervous ganglion** is a peculiar organ (figs. 2, 4, 5, *gn*) consisting of large clear cells, lying at the back of the vestibule near the dorsal surface. Above it, and well under the dorsal surface, is a three-lobed, granular, semiopaque body (figs. 2, 5, *x*) with which the nervous ganglion is possibly connected. The nervous ganglion in many of the Rotifera, especially among the *Notommatadæ*, shows a marked cellular structure at the lower end which loses itself in a granular, semiopaque upper portion; but it must be admitted that if these peculiar bodies (*gn*, *x*) constitute the nervous ganglion of *Stephanoceros*, it is rather their position than their shape and structure that would lead us thus to interpret them. From the spot where it adheres to the wall of the vestibule, a sort of protrusile tongue or **taster** (fig. 4, *tr*) rises which can be pushed forward so as nearly to fill up the interval between the knobbed ciliated ends of the ciliary wreath. This tongue may be seen incessantly pressing backwards and forwards as the food passes into the vestibule, as if discriminating between the passing atoms, just as the two tasters do in *M. ringens*.[1] The **eyes** (fig. 2 *e*) lie on either side of the nervous ganglion; they may be seen by dark-field illumination, but as they are small, rather deep down under the surface, and often obscured by other parts, it is not easy to get both into view at once. Mr. Cubitt (*loc. cit.*) describes and figures them as clear globes resting on pigment spots, and with nerve threads attaching them to the nervous ganglion: this is a very probable structure, but I have failed to make it out. Two very short lateral **antennæ** (Figs. 2, 5, *a*) can be seen when *Stephanoceros* is viewed dorsally: they are mere setigerous pimples.

The **development of the young** is shown in Mr. Gosse's figures (Pl. IV. figs. 8 to 15), in which fig. 8 represents young *Stephanoceros* a few minutes after birth; figs. 9 and 10, a little later; and figs. 11 to 14 represent successive stages of growth of a specimen from three to eighteen hours old. Fig. 15 shows the perfectly developed young *Stephanoceros*, thirty-six hours old; it exhibits the bands of setæ, the principal viscera, the muscular collars, vestibule, crop, and jaws. Mr. Rosseter (*loc. cit.*) says that on one occasion he watched the development of a young *Stephanoceros* and noticed that the lobes of the corona "originate as buds and unroll like the fronds of ferns" (figs. 16, 17). These buds began to appear about eleven hours after the animal was hatched, and when they had risen to a small height gradually unfolded; they remained in a drooping state for two days, but on the third day took the arched form usual in the adult. Dr. Mantell observed a young specimen in which the lobes even after eighty hours from birth were mere rudimentary buds. Such discrepancies in the rate of development noticed by these three observers are common in all the Rotifera, and are doubtless partly due to the various degrees of development that the embryo attains in the ovum before its extrusion. In *Stephanoceros* (as in a few other Rotifera) the young (as Ehrenberg conjectured) is occasionally born alive. This has been seen by Mr. Rosseter and Dr. English,[2] and indeed is almost shown in Dr. Leydig's figure (Pl. IV. fig. 7), where the much advanced embryo (*y*) lying close to the oviduct (*ot*) already exhibits the eyes and frontal cilia.

[1] (Pl. V. fig. 2 *c*, *tr*).

[2] See Mr. Rosseter's paper (*loc. cit.* p. 171).

No **male** has as yet been recorded, but Leydig's fig. 3. Taf. i. (*loc. cit.*), of a young *Stephanoceros* forced out of the egg by pressure, has a very masculine look about it.

Disease.—Mr. Gosse ("Popular Sci. Rev." *loc. cit.*) has noticed that *Stephanoceros* will occasionally throw off portions of one or more of its lobes, which slough away so as to be reduced to mere stumps. As Mr. Gosse remarks, there is little doubt that Perty's *S. glacialis* (*loc. cit.*) is only such an unhealthy specimen of *S. Eichhornii*. I have seen the same thing; and I have noticed that, when a portion of the lobe sloughed off, the discarded piece would round itself into a globe, and float away urged by the fitful lashing of the setæ on it.[1]

Length, $\frac{1}{24}$ to $\frac{1}{15}$ inch. **Habitat.** On weeds in clear ponds in the neighbourhood of London (P.H.G.); of Birmingham (T.B.); in marsh pools on *Sphagnum*, Perthshire (J.H.). Very partially distributed; not uncommon about London and Birmingham, but rare in Scotland, and very rare apparently in America. Widely spread on the Continent.

[1] Mr. Newlin Peirce (*loc. cit.*) has written a strange account of a *Stephanoceros* that accumulated a mass of *débris* in the upper portion of its tube; and then, dividing itself transversely at the level of the *débris*, deserted its tube, carrying the accumulation with it, and attached itself to another stem of the plant to which it was originally fastened. Here it gradually became a perfect animal in a new tube; and it then repeated the process. The whole account is incomprehensible.

CHAPTER VI.

MELICERTADÆ.

Chaque genre de Vers, et j'ose presque dire chaque espèce, offre un objet tout à fait neuf, qui demande à lui seul presqu'autant de travail que les classes entières des grands animaux.—Geoffroy St. Hilaire.

What, dull! when you do not know what gives its loveliness of form to the lily, its depth of colour to the violet, its fragrance to the rose! when you do not know in what consists the venom of the adder, any more than you can imitate the glad movements of the dove! when, unlike the wisest of monarchs and of men, far from knowing the trees as he did, "from the cedar tree that is in Lebanon even unto the hyssop that springeth out of the wall," you do not know anything even of the two extremes of Solomon's great knowledge! What, dull! when earth, air, and water are all alike mysteries to you! and when, as you stretch out your hand, you do not touch anything the properties of which you have mastered! while, all the time, Nature is inviting you to talk earnestly with her, to understand her, to subdue her, and to be blessed by her! Go away, man; learn something, do something, understand something, and let me hear no more of your dulness.—Sir Arthur Helps.

CHAPTER VI.

Family II. MELICERTADÆ.

Corona *not produced into setigerous lobes;* **buccal orifice** *lateral;* **ciliary wreath** *a marginal continuous curve, bent on itself at the dorsal*[1] *surface, so as to encircle the corona twice, with the buccal orifice between its upper and lower curves, and having also a dorsal gap between its points of flexure;* **trophi** *malleo-ramate.*

The *Melicertadæ* are at once distinguished from the *Floscullariadæ* by the difference of the corona, and the unsymmetrical position of the buccal orifice. In all the genera the corona bears two parallel wreaths of cilia, the upper of which frequently presents the appearance of a revolving wheel. The family contains seven genera, which differ from each other mainly in their coronæ, tubes, and habits; their internal structure being so much alike, that it has been proposed, more than once to reduce the seven genera to two.

There is no more interesting family. It contains animals that build their own tubes, pellet by pellet; and that themselves form these pellets, either out of external materials, moulded in hollows of their own bodies, or out of their own fæces. All have social instincts: some rearing their tubes, to the fourth and fifth generation, on those of their ancestors, or forming dense clusters on the stems of water-plants; and others (fixed forms only in a sort of Parliamentary sense) adhering to each other by their posterior extremities, and forming spherical clusters that roll unceasingly through the waters of still lakes and ponds. Most of them are hardy, and luckily all are prolific; sometimes so amazingly that the water-weeds are literally covered with their tubes, and the fortunate finder can thus have in the small compass of a live box scores of animals of all ages, and in every stage of growth.

Genus MELICERTA.

GEN. CH. **Corona** *of four lobes;* **dorsal gap** *wide;* **dorsal antenna** *minute;* **ventral antennæ** *obvious.*

The **tube** varies in all the four species, and its structure and formation will be described under each. In all there is an inner gelatinous tube,[2] and in *M. ringens* and *M. conifera* there is also an outer tube, consisting of pellets of extraneous matter; while in *M. Janus* the pellets are fæcal. In *M. tubicolaria* the outer tube is entirely absent.

The **corona** seen dorsally looks somewhat like a heart's-ease, with its four petals lying in a plane; but a side view shows that the two lower lobes are bent upwards, so as to form an oblique angle with the upper lobes. A groove runs round the corona, on both sides, just under its edge; and on the ventral surface it is confluent with the buccal funnel. There is a gap in the groove on the dorsal surface, so that it does not entirely surround the corona. The edge of the corona is fringed with large cilia, and the edges of the groove and buccal funnel with much smaller ones; and they

[1] In one instance (that of *Conochilus volvox*) read ventral for dorsal.

[2] This inner tube can be seen in the young animal (Pl. V. fig. 1*d* and Pl. VI. fig. 1*g*) before the outer tube has been completed.

are all in constant motion. The action of the former, or principal, wreath (Pl. V. figs. 2*c*, 4, *pw*) draws the particles floating in the water into two spiral currents, which are tangential to the groove on either side of the disk. The action of the latter, or secondary wreath (Pl. V. figs. 2*c*, 4, *sw*) drags the particles, as in their spiral path they strike the groove, out of that path into the groove itself, and hurries them along its windings towards the buccal funnel. At the two points where the groove on each side joins the buccal funnel are two fleshy knobs (Pl. V. fig. 2*c*, *tr*), which can be seen in constant motion; either regulating the force of the current, examining the moving atoms, or possibly performing both offices at the same time. The ciliated edges and sides of the buccal funnel conduct a portion of the stream down to the mastax; while another, and apparently the larger portion, rushes over the ciliated chin.[1] If a little carmine be added to the water, it is a pretty sight to see the coloured spirals form on both sides of the corona, while two processions of crimson atoms wind in and out under the margin of the petals, one on the left hand, and one on the right; each starting from the dorsal gap, and dashing at last down the buccal funnel, or over the chin. (Pl. V. figs. 2*c*, 4, *ch*.) But the whole of the ciliary apparatus has not yet been noticed. Beneath the chin there is a hemispherical hollow (Pl. V. figs. 2*c*, 4,*cc*) which is furred with minute cilia. It is in this cup that *M. ringens* and *M. conifera* mould their pellets, as will be described further on[2]; it is present also in *M. tubicolaria* and *M. Janus*, but its function in these species is unknown.

The **Nutritive System.**—The buccal funnel (Pl. V. figs. 2*c*, 2*d*, 4, *bf*) slopes downwards, and somewhat dorsally, towards the mastax. It is ciliated throughout, and has a pair of chitinous lips (fig. 2*d*, *lp*) similar to those described at p. 6. These lips are in frequent motion, now opening and shutting, now moving up and down the funnel, evidently selecting and rejecting the food: if an objectionable morsel attempts to pass, "it is astonishing to see how the little quick jerk, which the lips give, tosses it up into the central stream of waste and drives it away."[3] Should this morsel be unusually large, the mastax itself aids the lips in their upward jerk. On each side of the buccal funnel and above the mastax is a clear organ (Pl. V. fig. 2*d*, *sg*) whose surface is spheroidal. The two have been described as salivary glands by some observers, and as mere stays to the mastax by others. They are obviously elastic, and move up and down with its every motion. The mastax (fig. 2*d*, *mx*) consists of three confluent lobes, presenting a trefoil outline in vertical section; each side-lobe contains a malleus, and the bottom-lobe grasps the incus. The malleo-ramate trophi (Pl. V. fig. 1*f*) are almost precisely similar to those already described.

The food flows between the lips, and after having been torn by the sharp teeth of the mallei, and crushed by the ridged inner surfaces of the rami, passes through a short ciliated œsophagus (fig. 4, *œ*), and so enters the stomach (fig. 4, *s*). This is a long cylindrical sac, with very thick walls of large cells, lined with cilia. A partial constriction usually separates it from the intestine (*i*). The walls of this latter are thinner and more transparent, and their cilia longer. The distinction between the stomach and intestine is obliterated when the stomach is much distended with food, but is usually present, and is often rendered obvious by the difference of colour in the contents of the two. Those of the intestine revolve under the action of its cilia; and when the pellet thus formed is ready for extrusion, the animal lifts its cloaca above the rim of its cup pushes up the pellet, bends downwards over it, and then dexterously shoots it across its shoulder into the current flowing from the chin. By this means the fæces are carried away out of the currents of the trochal disc.

The **Secreting System.**—The so-called salivary glands I have already noticed. There

[1] Judge Bedwell (*Mon. Micr. J.* vol. xviii. 1877, p. 216) describes in *M. ringens* a hemispherical cushion, placed at an angle on that side of the buccal funnel which is opposite to the chin. He thinks that it is a highly sensitive organ, which, by altering its facial configuration, directs the streams that go down the buccal funnel and over the chin, and drives suitable particles in appropriate directions. I have not, however, been able to confirm those observations.

[2] Pp. 70, 71.

[3] Judge Bedwell (*loc. cit.*).

are two moderate-sized gastric glands (Pl. V. fig. 2*d*, *gg*) in the usual position at the top of the stomach; and Mr. Gosse describes in *M. ringens* "near the tip of the foot on its ventral side, a little granular body connected with the tip by a point, and enlarging at the upper end where it is connected with a small globular vesicle."[1] He suggests that this is a foot-gland similar to that in so many other Rotifera.

The **Vascular System.**—The contractile vesicle is very small, and is generally hidden by the viscera; it lies close to the rectum. When the animal is viewed sidewise, the lateral canals can be traced from a knot of twisted tubes in the shoulder to a similar knot in the corona. Two vibratile tags can be seen at each knot. The lateral canals lie close to the surface, and can be best found by slowly focussing upwards from any point near the shoulder, and just under the cuticle. It is possible to trace them down from the shoulder to the contractile vesicle; but it is not often that the viscera lying beneath permit this to be done.

The **Reproductive System.**—The ovary is similar in structure to those already described; it is somewhat oblong in shape, and extends between the stomach and ventral surface, over nearly the whole of the latter. The oviduct passes beneath the intestine, and in *M. ringens* "enters the cloaca near the point where the lower stomach [intestine] opens into the excretory canal."[2]

The **Nervous System and Organs of Sense.**—The nervous ganglion has as yet only been made out in *M. ringens*. M. Joliet (loc. cit. *M. ringens*) describes it as a group of big cells of a very characteristic form, and provided with a large nucleus. Many similar cells are placed beside the first, and stretch in different directions. It is not large, and is situated on the dorsal face of the pharynx. The two ventral **antennæ** (figs. 2*c* and 4, *a*) are very obvious. Between them lies the buccal funnel, as well as the tract which, in *M. ringens* and *M. conifera*, is engaged in forming and depositing the pellets; and which contains the chin (*ch*), the ciliated cup (*cc*), and a prominent knob lying just under it. The antennæ are tubes, with a short transverse plug in them, carrying a pencil of delicate setæ. This plug can be withdrawn into the tube at will, by a muscular thread; the top of the tube itself following the plug, just as in a snail's horn. They are so situated that, when *Melicerta* furls its corona, they stand on the top of the round closed head (fig. 1*c*, *a*). Immediately opposite to them, in *M. ringens* and *M. conifera*, there are two curved sharp hooks (*h*), which look like weapons of defence; and between them lies the third antenna, the dorsal one, which is nothing but a setigerous pimple. Two red **eyes** are visible in the young, but none as yet have been seen in the adult.

The **Muscular System.**—The longitudinal muscles, as in the *Flosculariadæ*, run up the foot to its junction with the trunk, where they are fastened. They then cross the trunk till they reach the neck, where they are again fastened; and as they reach the head they divide into branches, which cross the lobes of the corona, and, by their contraction, furl it. Transverse muscles, imbedded in the integuments, encircle the trunk; and, by the compression of the body-fluids, drive out and unfurl the corona, just as in *Floscularia*. In *M. conifera* I have observed a set of longitudinal branching muscles, which are inserted in the neck, just under the ciliated cup, and the prominent knob beneath it (Pl. V. fig. 2*c*, *lm*). It is by their varied action that *Melicerta* is able to curve and twist its neck, and clinch its pellet on to the top of the tube, by the opposing pressures of the knob and chin.

The **male** has not yet been certainly recognised. I have seen what is probably the male of *M. tubicolaria*,[3] and Judge Bedwell gives a graphic description of the probable male of *M. ringens*,[4] and of its coquetting with the female; Mr. Gosse has also seen what there is little doubt was the male of *M. conifera*.[5]

[1] *Quart. J. Micr. Sci.* vol. i. 1853, p. 71, pl. ii. fig. 22.
[2] Professor Williamson, *Quart. J. Micr. Sci.* vol. i. 1853, p. 1.
[3] See p. 73 and Pl. V. fig. 3*c*.
[4] *Midland Naturalist*, vol. i. 1878, p. 245; see also p. 71.
[5] See p. 72.

M. RINGENS, *Schrank*.

(Pl. V. fig. 1.)

Melicerta ringens . . . . . Ehrenberg, *Die Infus.* 1838, p. 405, Taf. xlvi. fig. 3.
" " . . . . . Gosse, *Trans. Micr. Soc.* vol. iii. 1852, p. 58, pl. xii. figs. 1–4.
" " . . . . . " *Quart. J. Micr. Sci.* vol. i. 1853, p. 71, pl. ii. figs. 12–27.
" " . . . . . " *Popular Sci. Rev.* vol. i. 1862, p. 474, pl. xxvi. figs. *a*, *b*.
" " . . . . . Pritchard, *Infusoria*, 1861, p. 672, pls. xxxii., xxxvi., xxxvii.
" " . . . . . Williamson, *Quart. J. Micr. Sci.* vol. i. 1853, p. 1, pl. i. figs. 14–34.
" " . . . . . Leydig, *Ueb. d. Bau. d. Räderth.* 1854, p. 17.
" " . . . . . Claparede, *Ann. Sci. Nat. Zool.* 5 Sér. t. viii. 1867, pl. iii. figs. 1, 2.
" " . . . . . Cubitt, *Mon. Micr. J.* vol. v. 1871, p. 205, pls. lxxxiii., lxxxiv.
" " . . . . . " *Mon. Micr. J.* vol. viii. 1872, p. 8, pl. xxiii. fig. 2.
" " . . . . . Bedwell, *Mon. Micr. J.* vol. xviii. 1877, p. 214, pls. cxcvii. and cxcviii.
" " . . . . . " *J. Roy. Micr. Soc.* vol. i. 1878, p. 176, pl. x.
" " . . . . . " *Mid. Nat.* vol. i. 1878, p. 245.
" " . . . . . Hudson, *J. Roy. Micr. Soc.* vol. ii. 1879, p. 6.
" " . . . . . Joliet, *Comptes Rendus*, t. 93, 1881, pp. 748, 856.

SP. CH. **Lobes** *when expanded, wider than the tube;* **chin** *short, extremity blunt;* **pellet** *nearly spherical.*

During the hundred and eighty years which have elapsed since Leuwenhoek discovered *M. ringens*, it has been a source of delight to a long succession of observers. It has had more than a dozen names given to it, and has been the subject of upwards of three times as many treatises; and no wonder, for the surprising spectacle of its whirling disk captivates even those who have seen it scores of times before.

Then the building of its **tube** appeals powerfully to the imagination. Here is a tiny creature which, when barely an hour old, and not $\frac{1}{100}$ of an inch in length, sweeps from the water its food and the materials for its dwelling; and which, at the same moment, and with faultless accuracy, sorts the one from the other, and both from the mere rubbish, drives away the waste, sends a stream of food down its throat, supplies selected atoms to a brick-making machine in its own body, mixes them with cement, moulds them into bricks, and finally (to crown the marvel) lays the bricks one by one around its body in regular order, so as to form a compact and effective dwelling.

Leuwenhoek saw, and clearly described, the laying of the pellets and the raising of the tube; but failed to see how the former were produced. Indeed, even what he did discover was forgotten, so that Mr. Gosse's paper "On the Architectural Instincts of *Melicerta ringens*" (in which the process of forming the pellets and tube was completely described) roused the greatest desire in all microscopists to see this marvel for themselves.

It is unnecessary for me to quote once more passages that are to be found in every text book, but I will continue the description (interrupted at p. 68) of the various streams that are set in motion by the ciliated borders of the corona, buccal funnel, and chin, and briefly tell how the pellets and tube are formed.

The main stream of waste, that rushes over the chin, has two feeble currents running under the somewhat incurved edges of the buccal funnel: at the side of its banks, if I may so say. Along these two currents float very minute atoms, at a comparatively gentle rate, while the larger particles dash along in the main stream. As the former glide along the banks of the buccal funnel they come to a notch on either side of the chin, over which they slip and are then drawn by the action of connecting lines of fine cilia into the ciliated cup, that lies close beneath the chin. This cup is nearly hemispherical in shape, and is furred with fine cilia. Soon after it has been emptied of one pellet, another begins to form in it, and a minute sphere of particles, generally of a yellowish-brown colour, is seen whirling in the centre of the cup. As this rapidly

grows in size from the addition of fresh matter, it is easy to see in what direction it rotates, by means of the darker specks on its surface. If these are watched, it will be found that every now and then the rotation is reversed, and that this happens many times before the pellet is completed. It is needless to credit *Melicerta* with the voluntary alteration of the motion, for it is obvious that a pellet, kept in the centre of a ciliated cup by the action of its cilia lashing up and down, must be in an unstable position; a very little alteration of its own figure, or of its centre of gravity, or of the relative power of the cilia in different parts of the cup, would be sure to drive it out of its central position to one side or the other. This done, the cilia on that side (say the lower one) would be checked, and those on the upper would have the predominance, and so force the pellet to rotate towards the upper side; which when it had slowly reached, the upper cilia would in their turn be checked, and the lower cilia would now have the predominance, and would again draw the pellet towards themselves, reversing the rotation —and so on. The particles in the cup are made to adhere by being mixed with the same glutinous secretion as that which forms the inner tube. This exudes either from the cup itself or (as I believe) from the surface of the large knob just beneath it (Pl. V. fig. 2*c*). In a minute or two, from the commencement of the process, the pellet is completed, and then the animal bends its neck swiftly over the edge of the cup, and clinches the pellet on to the top of the inner tube, by the opposing action of the chin and the knob beneath. It is obvious that it selects the place in which to deposit the pellet, and it is probably guided to the exact spot by its dorsal antenna, which is generally close to the spot the instant before the pellet is laid.[1] It is curious that Ehrenberg should have completely missed the way in which the pellets and tube are formed. He says that the former "are not foreign bodies (as in the tube of *Phryganea*) nor excrement; but a peculiar substance mixed with the latter, gummy, and hardening in water": and he further says that he distinctly saw the pellet discarded from the posterior intestinal opening, and fastened by it to the tube. Mr. Gosse, who calls attention to this discrepancy, suggests that there may possibly be "two species closely allied but differing in this part of their organisation and economy"; and the discovery of *M. Janus*, which has precisely the habit wrongly ascribed to *M. ringens*, shows how shrewd was Mr. Gosse's suggestion. The only difficulty about the matter is that Ehrenberg's drawings are certainly taken from *M. ringens*; while his description of the formation of the pellets and tube seems to be taken from *M. Janus*. Possibly he may have found first the one, and then the other, and not distinguished between them; though that seems hardly likely.

Melicerta ringens in England does not usually occur in clusters of adhering individuals, though occasionally one is seen with a young one or two attached to its tube. But in the United States (as I have already noticed) it frequently occurs in large clusters, and some of the tubes of these clusters greatly exceed in size the largest known English specimen. For instance, I possess a cluster in which the central tube is $\frac{1}{3}$ of an inch long, and of which therefore the tenant must have been upwards of $\frac{1}{4}$ of an inch in length, thus exceeding even the great length of *Floscularia Hoodii*. I found that this great tube contained upwards of six thousand pellets arranged in about two hundred and forty rows, one above another.

The **Male.**—Judge Bedwell in the "Midland Naturalist" (*loc. cit.*) describes a small free-swimming Rotiferon which he saw emerge from a tube of *Melicerta ringens*. It was not more than $\frac{1}{8}$ of the length of the tube, had a forked foot, and trophi somewhat like an inverted W, which were capable of protusion through the corona. Like the probable male of *M. conifera*,[2] "it began to woo and caress the lobes of the female in the most active and elegant manner, almost as if it were nibbling the main wreath of cilia. Now to anyone accustomed to watch *Melicerta*, it must always be a matter of astonishment to see such a timid, nervous rotifer allow another to touch the cilia with impunity; but in this instance the female never flinched in any way, but accepted the attentions of

[1] Judge Bedwell, *Mon. Micr. J.* (*loc. cit.*). The whole paper is most suggestive.

[2] See Mr. Gosse's description, p. 72.

the little visitor with perfect composure, and continued to feed as if quite undisturbed by its presence." The same observer broke up about fifty tubes of *M. ringens* in December, and procured ten specimens of the same small Rotiferon from them: in one case there were four males in a single tube.

In the above account, the presence of a forked foot, and of a mastax and trophi, and the fact that the latter were seen to be protruded from the corona, would naturally lead one to say that the Rotiferon recorded was rather some one of the *Notommatadæ* than a male *Melicerta*. On the other hand, its unresented action towards the female was precisely that noticed by Mr. Gosse in the case of *M. conifera*; and the latter observer has also seen trophi in a very similar creature with similar habits, which he believes to be the male of *Limnias ceratophylli*.[1]

Length. Varies greatly. Average length of an adult tube about $\frac{1}{30}$ inch. Specimens twice the size are common in Scotch lakes. Those in clusters, in Philadelphia, U.S., extend even to $\frac{1}{9}$ inch. **Habitat.** Very common on water plants, in standing or slowly running water.

M. CONIFERA, *Hudson*, sp. nov.

(Pl. V. fig. 2.)

SP. CH. **Lobes**, *when expanded, of the same width as the tube;* **chin** *long and pointed;* **pellet** *a pointed cylinder.*

This *Melicerta* is somewhat larger, and very much rarer, than *M. ringens*. It was discovered by Mr. J. Hood in 1876 in a pool on Tent's Muir. He found it again in profusion in the summer, autumn, and even in some of the winter months of 1879, the weed being quite matted with it. The points of difference between it and *M. ringens* are persistent, though slight; but the difference in their tubes is striking. This is due to the shape and quality of the pellets. They are much longer in proportion to their diameter than those of *M. ringens*, so as to resemble a conical rifle bullet; and they are more transparent, and of a clear golden yellow. In consequence of their length the tube is a stout one, and its thickness is shown by a stripe on each side of a different colour from the centre of the tube, and darker or lighter according to the illumination used.

The fully expanded lobes are almost exactly as wide as the top of the tube, but in *M. ringens* they exceed it in the proportion of ten to nine. The chin, too, differs from that of the common species; it is longer and more pointed.

The **Male.**—[In water from Epping Forest sent to me by Mr. Henry Davis, I found *Melicerta conifera*, projected and rotating. Emerging from the mouth of the tube, about three-fourths extruded, was a male (Pl. D. fig. 6) about as long as the diameter of the tube, playing, as it were, with the disk of the female. Two irregular shaped opaque masses were seen in it far apart from each other. I looked away for a minute to delineate what I had seen, and he was gone: but I presently found him slowly swimming around, which he continued to do, turning on his long axis as he went. There was now only one opaque mass, the hinder; and this was in contact (whether in connection I do not know) with a large ovate clear bladder, perhaps an air vesicle. The head is oblique, the face ciliated, the occiput, angled and projecting. The foot is a little knob of flesh. I could see no internal organs, nothing but the clear, colourless tissue, full of corrugations throughout. P.H.G.]

Length. About $\frac{1}{12}$ inch; tube, $\frac{1}{16}$ inch. **Habitat.** Marsh pools, Fife and Perth (J.H.); abundant in a pool at Snaresbrook (P.H.G.): rare.

M. TUBICOLARIA, *Ehrenberg*.

(Pl. V. fig. 3.)

Tubicolaria Naias . . . Ehrenberg, *Die Infus.* 1838, p. 399, Taf. xlv. fig. 1.
" " . . Leydig, *Ueb. d. Bau. d. Räderth.* 1854, p. 14, Taf. i. fig. 7.

[1] See p. 76.

Tubicolaria Naias	Pritchard, *Infusoria*, 1861, p. 668, pl. xxxii. figs. 379–382.
Melicerta tyro	Hudson, *Mon. Micr. J.* vol. xiv. 1875, p. 225, pl. cxix.
Tubicolaria Naias	Fullagar, *J. Quekett Micr. Club*, vol. iv. pp. 182, 202, pls. xvi.–xviii.

Lobes, *when expanded, more than three times the width of the body*; **antennæ** *very long*; **tube** *a gelatinous sheath without pellets.*

Three striking peculiarities at once catch the eye in this beautiful *Melicerta*, viz. (1) the great size of the trochal disk; (2) the wonderful length, backward setting, swollen bases, and great flexibility of the ventral antennæ; and (3) its semi-transparent tube, which, though resembling that of the Floscules, has yet a character of its own.

The **tube**, unlike those of all the other species, bears no pellets at any time. It is of a loose fluffy texture, and extends from the surface almost up to the Rotiferon itself. There is a central hollow, little wider than the creature's body, up and down which the animal moves. Horizontal layers of diatoms, and other foreign bodies, cross the tube at irregular intervals, and mark the height at which the tube then was, when they were entangled.

The **corona** is very large. It is more than three times the width of the body; thus considerably exceeding the proportions of *M. ringens* and *M. conifera*. Its four lobes are really all curved, just like those of *M. ringens*, and are often seen fully expanded and round; but the animal has a habit of bending the corners of the two upper lobes, so as to give the whole disk a butterfly shape.

There is a **ciliated cup** under the chin, just as in the two former species, but no pellets are formed in it. I examined it carefully several times, but I could find no lines of cilia between the chin and cup, such as Mr. Gosse observed in *M. ringens*; neither could I see the minute notches in the chin, through which, in that species, minute atoms slip from the buccal funnel, to be conducted by lines of fine cilia to the pellet cup.

The **muscular, nutritive, secreting,** and **reproductive systems,** are so similar to those of *M. ringens* as to call for no further remark.

Vascular System.—Leydig notices the absence of the **contractile vesicle**, and says that he traced the two **lateral canals** from the corona, where they originate in two coils, across the body, from the dorsal to the ventral surface, and so down to the cloaca. He says that, after repeated efforts, he at last saw the two **vibratile tags** in the corona. I was more fortunate, for I made out five vibratile tags on each side of the body, though I could not see exactly where the lateral canals ended. I could find no contractile vesicle, but on two occasions I noticed that the empty intestine became distended and very transparent, and then shot out its fluid contents through the cloaca. While this was going on, the passage from the stomach to the intestine was closed. It would thus appear as if the intestine itself was filled by the lateral canals, and discharged the office of the contractile vesicle. It will be seen subsequently that something similar takes place in other Rotifera.

Organs of Sense.—I have failed to discover any **eyes** in the adult, but they are very conspicuous in the young animal (Pl. V. fig. 3*b*). The **antennæ** are of great length, twice as long in proportion as those of *M. ringens*; and, as they are transparent, it is easy to see how the muscle that runs up the centre to the setigerous knob at the top can withdraw the knob, thus infolding the tube, till the knob comes right down to the base of the antenna. When the animal is contracted into its tube, the antennæ are closely pressed to its club-shaped body; and, as it rises, they, too, slowly rise from their recumbent position, while the perivisceral fluid, under the pressure of the transverse muscles, drives the knobs up the antennæ, and so completely extends them.

The **Male.**—I believe that the male Rotiferon drawn in Pl. V. fig. 3*c*, is the male of *M. tubicolaria*. I had a small piece of *Anacharis* with about a score of females attached to it, and while observing them I saw this young male circling round one of them. It

was about $\frac{1}{170}$ inch long; but, owing doubtless to its having just been hatched, the skin was so granular and corrugated that I could not make out its whole structure. The **nervous ganglion**, **sperm-sac** (*ss*), and **penis** (*p*), were plainly visible, and I could see the motion of the spermatozoa, though not the individual spermatozoa themselves: neither could I make out the muscles nor the water vascular system. I did not see this creature hatched; still, as there were no other Rotifera present but *M. ringens* and *M. tyro*, it was certainly the male of one or the other.

The Rotiferon, I have little doubt, is Ehrenberg's *Tubicolaria Naias*. He formed the genus to receive a Melicertan that was destitute of eyes at all periods of its life, and lived in a gelatinous tube. But Ehrenberg points out that he has not seen the young, and that therefore the absence of eyes cannot be depended upon as a characteristic. His other characters of the genus are, a four-lobed corona, two antennæ, and a gelatinous tube. Of these, the latter alone is peculiar to *Tubicolaria*, and as it is not sufficient to found a genus on, I have placed the animal among the *Melicertæ*.[1]

Length. Adults from about $\frac{1}{30}$ to $\frac{1}{16}$ inch; the maximum size given is that of Scotch specimens. **Habitat.** Ponds and ditches, Birmingham (C.T.H.); Chartham, Kent (Col. Horsley); Forfar (J.H.); Reading (Tatem): rare.

M. Janus, *Hudson*.

(Pl. VII. fig. 1.)

Œcistes Janus . . . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. i. 1881, p. 1, pl. i.

Upper lobes *deeply divided*, **lower** *nearly confluent*; **dorsal gap** *minute*; **antennæ** *short*; **chin** *two-pointed*; **pellets** *fæcal*.

This remarkable Rotiferon is one of those creatures whose form is as irritating to the classifier as it is delightful to the naturalist. For it possesses in almost equal proportions the characteristics of two genera, viz. of *Melicerta* and of *Œcistes*, and might, with nearly equal propriety, be placed in either genus. It was found first by Mr. J. Hood in Loch Lundie in 1880, and was most numerous, and in best condition, on weeds at a depth varying from six to ten feet.

When seen from the ventral surface, so that the lower lobes are partly hidden by its tube, no one would suppose it other than a *Melicerta*; but when it turns and exhibits its dorsal surface, it is seen that the lower portion of the **corona** resembles that of *Œcistes*, for, instead of there being a wide dorsal gap in the ciliary wreath, there is scarcely any at all (Pl. VII. fig. 1); and the subdivision of the lower portion of the corona is so slight that the outline of its two lobes is almost confluent: in fact, it might almost be said that this is a three-lobed Melicertan. As in *Œcistes*, thickenings (fig. 1*d*) cross the corona, which itself is so thin that it becomes nearly invisible under dark-field illumination, while the thicker portions stand out distinctly, especially when seen sidewise (fig. 1*b*). When the animal begins to open its corona, these portions are thrust forward in a squarish and very characteristic bundle, the thinner parts of the disk lying folded neatly between them. In this respect *M. Janus* closely resembles *Œcistes umbella*.

The cilia of the corona are unusually large, while the groove that lies between the principal and secondary wreaths is broad and deep. Should the larger cilia be checked by contact with the side of the cell in which the animal is placed, it is easy to count them, and their whip-like action becomes plainly visible. Individual cilia may now and then be seen even in the secondary wreath.

The chin (fig. 1*b*, *ch*) is also peculiar. It terminates, not in one point, but in two

[1] It must be admitted that Ehrenberg's figure is very unlike mine. The corona is barely the width of the body, and the antennæ are very short; but I think that both disk and antennæ are intended to be represented in a contracted state.

(fig. 1*e*); and below it, at right-angles to it, are two thin walls (fig. 1*a*) looking like the supports of a bracket, the chin being the bracket itself. These supports form, with the chin above, and the ventral surface between them, a cup or recess somewhat like the cup of *M. ringens*. I could not, however, detect any cilia in it. Below the cup is a large viscous knob, as in the other species, but differing from them in bearing on its upper surface two or more curved bristles (fig. 1*b*, *h*) pointing to the cup.

The **tube** is not nearly so compact as that of *M. ringens*, or even of *Limnias ceratophylli*. It is composed of large ovoid fæcal pellets, which are laid upon one another somewhat obliquely in rings, as shown in fig. 2*d*.

The pellet is formed in the intestine (figs. 1*b*, 1*c*, *i*), and when it is ready the animal bends down over the cloaca (*cl*), the rectum (*r*) is everted and pushed forward, and the pellet is shot over the shoulder so that it rubs against the viscous knob and is thus held, partly by the sticky surface of the knob, partly by the curved bristles already mentioned. When it has thus caught the pellet, the creature, with a swift twist backwards, pushes it on to the top of its tube. The **intestine** (*i*) is large and usually contains a fæcal pellet in the course of formation. These are not all appropriated to the construction of the tube, but are often suffered to float away. The **gastric glands** (*gg*) are conspicuous, and form an arch over the top of the stomach: they contain large nucleated cells. The two ventral **antennæ** (*a*) are short and are placed rather as they are in an *Œcistes* than in a *Melicerta*. Mr. Hood tells me that he has seen the **male**, and that it resembles that which I have figured as the male of *M. tubicolaria*. He further notices that the **young female** acquires its perfect form in four days after it has been hatched. Although *M. Janus* has so many points in common with the genus *Œcistes* that I originally placed it there, yet as it really has four lobes in its corona (however inconspicuous two of them may be) I have felt constrained to add it to the *Melicertæ*.

Length, $\frac{1}{16}$ of an inch. **Habitat.** Lochs only, Forfar, Perth, Ayr (J.H.): abundant.

Genus LIMNIAS, *Schrank*.

GEN. CH. **Corona** *distinctly of two lobes*; **dorsal gap** *wide*; **dorsal antenna** *minute*; **ventral antennæ** *obvious*; **tube** *without pellets*.

The genus *Limnias* differs from *Melicerta* in the shape of its lobes, and the structure of its tube. The **corona** is much broader than it is high, and consists of two nearly circular lobes connected on the ventral side by a hollow opposite to the buccal funnel, and separated on the dorsal side by a gap. The double **ciliary wreath**, buccal funnel, and chin are similar to those of *Melicerta*. There is no ciliated cup, though there is a hollow beneath the chin somewhat like one.

The **tube** is unlike that of *Melicerta* or *Œcistes*; it is really tubular in form, widening a little towards the top; it is often opaque, and is not composed of pellets; those of the different species are unlike each other.

The **internal structure** of the common species, *L. ceratophylli*, is almost precisely that of *Melicerta*: it is said by Ehrenberg, and often repeated, that it has no **vascular system**, but this is a mistake. I have seen, but have not had an opportunity of studying, the rare species *L. annulatus*; neither have I been able to find any account of its internal structure.

L. CERATOPHYLLI, *Schrank*.

(Pl. VI. fig. 1.)

Limnias ceratophylli . . .	Ehrenberg, *Die Infus.* 1838, p. 402, Taf. xlvi. fig. 4.
" " . . .	Gosse, *Evenings at the Microscope*, 1859, p. 302, with fig.
" " . . .	Pritchard, *Infusoria*, 1861, pl. xxxii. figs. 388–392, pl. xxxvi. fig. 2.
Melicerta ceratophylli . . .	Gosse, *Popular Sci. Rev.* vol. i. 1862, p. 481, pl. xxvi. fig. *c*.
Limnias ceratophylli . . .	Moxon, *Trans. Linn. Soc.* vol. xxiv. 1864, p. 458, pl. xlvii. fi 3.

Limnias ceratophylli . . .	Tatem, *J. Quekett Micr. Club*, vol. i. 1868, p. 124, pl. vi. figs. 1, 2.
Limnias socialis	Leidy, *Proc. Acad. Nat. Sci. Pa.* 1874, p. 140.
Limnias ceratophylli . . .	Bedwell, *Mon. Micr. J.* vol. xviii. 1877, p. 221, pl. cxcviii. figs. 7, 8.

SP. CH. *No horny* **processes** *on the dorsal surface below the corona;* **ventral antennæ** *very short;* **tube** *nearly cylindrical, smooth, often rendered opaque by extraneous materials, except at the posterior end.*

I have already related, in Chapter I., Leuwenhoek's discovery of this the earliest known tube-maker. It has not been much studied, as its tube is often quite opaque, and its own attractions have been eclipsed by those of *Melicerta*. The tube is of a yellow-brown tint and is generally coated over on the outside with waste matter that falls down on it from the coronal currents above, and with the particles that trickle over the chin, and adhere to the sticky surface beneath it. These latter are rubbed off from time to time on to the tube by the animal, as it bends its head over it. Doubtless this renders the tube smooth and compact. Judge Bedwell (*loc. cit.*) thinks that there is a chitinous shield below the dorsal gap, whose hard edge is shown at *xz*, fig. 1*d*. He points out that its position corresponds to those of the horny processes of *L. annulatus*, and the sharp hooks of *M. ringens*; and he suggests that the tube is smoothed with it "much as a bricklayer smooths over his stucco with his flat trowel." The tube is generally not coated towards its posterior extremity, and is very imperfectly covered in the young (fig. 1*g*). Occasionally adults are met with that have tolerably transparent tubes,[1] and even large adults have sometimes tubes of an opaque white (fig. 1*b*).

Ehrenberg recognises no **vascular system**,[2] but Dr. Moxon (*loc. cit.*) has observed part of it, and given a figure of the neck and expanded corona, with two **vibratile tags** on the same side. I have had no difficulty in seeing the **lateral canals**, and their accompanying tags, in the upper portion of their course, from a vascular plexus near the shoulder, up to a similar one in the corona (fig. 1*f*, *lc*, *vt*). The **contractile vesicle** (if there is one) has not yet been noticed.

Besides the two short ventral **antennæ** (Pl. VI. figs. 1*d*, 1*f*, *a*) Dr. Moxon (*loc. cit.*) has observed a minute dorsal one similarly situated to that in *M. ringens*.

Prof. Leidy (*loc. cit.*) says that in many localities of the Schuylkill, almost every stone exhibits multitudes of bunches of a *Limnias*, pendent from its sides, and under surface: as many as fifty tubes may be counted in a bunch. Prof. Leidy proposes to call this rotifer *L. socialis*, on account of its habit of growing in clusters; but as the animal itself is said to be like *L. ceratophylli* in other respects, and as *L. ceratophylli* in England has this habit of clustering to a considerable degree[3] it is unnecessary to make a new species of the American Rotiferon.

Male. [As a *Limnias* was slowly protruding from its tube, there swiftly pushed past it, out of the mouth of the tube, a young one, which I supposed from its general appearance, a male.[4] It was a simple cylinder of colourless flesh, slightly tapering behind to a blunt point, with no foot or tail apparent, of about one-third of the total length of the parent, filled with minute globules of oil or air. There was a simple crown of cilia around the truncate front, a well-sized and well-made mastax, an enormous blunt-pointed brain-sac reaching about two-thirds down its total length, and carrying, on its dorsal side, near its point, a small but clear round eye-spot of crimson hue. Its manners were those common to males, swimming swiftly around the parent, often coming close to her for a moment, and then darting finally off on a wide wild voyage. That this was truly a male individual of the species is highly probable, notwithstanding the presence of a mastax, of which there was no doubt, and of a long viscus below which appeared to be a stomach. P.H.G.]

Length. Maximum about $\frac{1}{25}$ inch. **Habitat**. On water plants: very common.

[1] Mr. Gosse (*loc. cit.*), p. 303.
[2] "Kiemen und Gefässe sind nicht erkannt."
[3] See p. 38; Pl. VI. fig. 1*c*.
[4] Pl. D. fig. 7.

Mr. Tatem (*loc. cit.*) described and figured a tube-making Rotiferon, somewhat resembling a *Limnias*, with long curved antennæ. If the bi-lobed condition of the trochal disk (as given in his figure) were permanent, and if there were also an obvious dorsal gap in the ciliary wreath, this would be a species of the genus. Unfortunately Mr. Tatem's description does not make this point clear, and in other respects the animal resembles *Œcistes longicornis*.

L. ANNULATUS, *Bailey*.

(Pl. VI. fig. 2.)

Limnias annulatus . . . . Cubitt, *Mon. Micr. J.* vol. vi. 1871, p. 165, pl. xcviii.

SP. CH. Five horny **processes** *on the dorsal surface below the corona*; **ventral antennæ** *moderately long*; **tube** *cylindrical, smooth, transparent, and crossed by transverse ridges, at regular intervals.*

I have met with this *Limnias* but once, and then had no time to study it. It appears to be rare in England, though Mr. Cubitt (from whose paper, cited above, the following particulars are taken) found it in abundance in a tributary of the Northbourne Brook, Kent.

Its **tube** is remarkable. In young adult specimens it is perfectly transparent, with a brilliant orange tint which at the sides becomes a deep carmine, owing to the greater thickness of tube which we there look through. Fine transverse ridges, one-ten-thousandth of an inch apart, surround the tube from top to bottom. These are possibly caused by the pressure against the case of two **horny processes** (figs 2*b*, 2*d*, *hp*) on the dorsal surface. These, under dark-field illumination, show a bright red spot at the top. Three less prominent processes lie in a line below the first two; the distance between the rings is precisely that between these two rows, so that possibly they may help to form and gauge them.

The **foot** is long, wrinkled, with distinct muscles. When the animal contracts itself into the case it folds the foot as shown in fig. 2*a*; a plan also adopted at times by *L. ceratophylli*.

Length, $\frac{1}{25}$ inch; Scotch specimens, $\frac{1}{18}$ inch. **Habitat.** Witlingham, Norwich (Brightwell); Kent (Cubitt); Forfar (J.H.): rare.

Genus CEPHALOSIPHON, *Ehrenberg*.

GEN. CH. **Corona** *nearly circular*; **dorsal gap** *distinct*; **dorsal antenna** *obvious*; **ventral antennæ** *absent*[1]; *two* **dorsal hooks** *enclosing the dorsal antenna.*

C. LIMNIAS, *Ehrenberg*.

(Pl. VI. fig. 3.)

Cephalosiphon Limnias . . .	Ehrenberg, *Verhandl. der Berlin Akad.* 1853, p. 193.
,, ,, . . .	Pritchard, *Infusoria*, 1861, p. 670.
Limnias ceratophylli . . .	Slack, *Marvels of Pond Life*, 1861, p. 149, with fig.
Cephalosiphon Limnias . . .	,, *Intellectual Observer*, vol. i. 1862, p. 53, figs. 1, 2.
,, ,, . . .	Gosse, *Intellectual Observer*, vol. i. 1862, p. 49, with plate.
Melicerta Cephalosiphon . . .	,, *Popular Sci. Rev.* vol. i. 1862, p. 490.
,, ,, . . .	Tatem, *J. Quekett Micr. Club*, vol. i. 1868, p. 124, pl. vi. figs. 6, 7.
,, ,, . . .	Cubitt, *Mon. Micr. J.* vol. v. 1871, p. 170, pl. lxxxi. figs. 1, 2.
,, ,, . . .	Hudson, *Mon. Micr. J.* vol. xiv. 1875, p. 165, pl. cxvii. fig. 1.

SP. CH. **Dorsal antenna** *very long*; **tube** *tapering to the foot, compact, strengthened with extraneous material.*

[1] I thought once that I caught sight of a minute setigerous ventrally placed pimple in *C. Limnias*; there may possibly be a pair of such ventral antennæ.

Ehrenberg formed the genus *Cephalosiphon* of his family of the *Floscularieæ* to receive a single species, *C. Limnias*, one specimen of which he found on *Ceratophyllum* at Berlin. His characters of the genus are as follows: "*Cephalosiphon*, E. Rotatory organ bi-lobed, eyes two, sheath or lorica single, two little frontal horns enclosing the siphon;" and those of the species are: "*C. Limnias*, E. Sheath membranaceous, ringed."

The characters of the genus and species were given in Pritchard's "Infusoria" (edition 1861), but no one after Ehrenberg seems to have actually seen the animal itself, till Mr. Slack found it in a pond in the neighbourhood of London in 1860 on *Anacharis alsinastrum*. Mr. Slack supposed it to be the young of *Limnias ceratophylli*, and gave a brief description of it under that name in 1861 in his "Marvels of Pond Life" (*loc. cit.*). He noticed the creature's bi-lobed corona, as well as the great length, flexibility, and peculiar action of the dorsal antenna "thrust on this side, and on that, as if to collect information for its proprietor." Mr. Gosse in the same year, in a paper entitled "A Rotifer new to Britain (*Cephalosiphon Limnias*)," gave a full description with a plate of three figures of the new Rotiferon, taken from some specimens sent to him by Mr. Slack. These specimens seem to have been injured by the journey, as they did not expand freely, and so led Mr. Gosse to draw the corona with a butterfly-shape, which healthy specimens do not possess. Mr. Gosse, however, fully worked out the Rotiferon's structure, with the exception of the secreting and vascular systems; and he described and figured the "frontal horns" or **hooks**, which are situated like the hooks of *Melicerta ringens*, one on each side of the dorsal antenna. This Rotiferon is very partially distributed. It was upwards of twenty years after I first began to search for Rotifera in the neighbourhood of Clifton, that I first lighted on it; and Miss Saunders has had a similar experience at Cheltenham. In 1875 I found a group of them on a leaf of a *Potamogeton* in a pond at Nailsea, near Bristol, and I made a careful drawing of the group (Pl. VI. fig. 3). The **tube** is horn-shaped tapering to the foot; generally neater and more compact than that of *Œcistes crystallinus*, but coated with much the same sort of yellow-brown material.

The **trunk** is small compared with the **foot**, which is long and slender. The animal arches its dorsal side (fig. 3), in a manner common among free-swimming Rotifera, but unique among the fixed ones, which, in all other instances, arch the ventral side, so as to bring the entrance to the buccal funnel uppermost. *C. Limnias* has that entrance almost hidden by the bending over of the corona. The arrangement of the double **ciliary wreath** is precisely that of the other *Melicertadæ*. The usual pair of clear vesicles (**salivary glands**?) rest on each side of the top surface of the mastax, which is high in the neck towards the dorsal side; and the ciliated buccal funnel slopes across to pass between them. There are a narrow œsophagus, two globular **gastric glands**, cylindrical **stomach**, short **intestine** with upturned **rectum**, ending in a **cloaca** rather low on the dorsal surface.

Of the **vascular system** nothing has been seen; but Mr. Gosse (*loc. cit.* "Intell. Obser.") describes the **nervous ganglion** as "a grey cloudy mass of irregularly-lobed form, immediately below the antenna, and behind the discal mammilla." I thought once or twice I caught sight of a ventral setigerous pimple just below the entrance to the buccal funnel, but I am not sure about it: there may be a pair of them there. The dorsal **antenna** is the striking feature in *C. Limnias*. When the animal has closed its corona and retired into its case, this slender transparent rod, with a brush of setæ at the top may be seen gently moving about to see if the coast is clear. When satisfied that it may come up safely, *Cephalosiphon* hitches its long antenna over the side of the tube, and hoists itself up by it into a great curve; it then straightens its body and unfurls its corona.

The long antenna is not always straight; it is occasionally bent into long curves like the process of *F. cornuta*, but its changes of form are slow. Its base is broadened out like that of a rose-thorn, as if to give it a good purchase. Two red **eyes** are conspicuous in the adult, a little below the dorsal surface, one on each side of the antenna, and close to the nervous ganglion.

The gradual changes of form in the **young** are shown in figs. 3, *x*, *y*, *z*, which are all taken from the same individual in different stages of growth. Fig. 3, *x*, shows it when only $\frac{1}{250}$ inch long, and with a sort of hump where the dorsal antenna is to be. Twenty-four hours after, the hump had become a short antenna (fig. 3, *y*); in four days the young animal had grown to $\frac{1}{80}$ inch, in six days to $\frac{1}{65}$ inch, and in twelve to $\frac{1}{55}$ inch, by which time, as shown in fig. 3, *z*, the characteristic antenna was well developed: at this stage of its growth I unfortunately lost it.

I have little doubt that M. du Trochet was the first discoverer of *C. Limnias*. In the "Annales du Muséum d'Histoire Naturelle," t. xix. 1812, p. 385, pl. 18, figs. 19 to 21, he describes and figures a tube-maker, *Rotifer cruciger*, with a fawn-coloured tube and a long dorsal antenna, and he noticed that the animal explores with it in all directions. It is true that he figures two eyes, "saillants et globulaires," near the summit of the dorsal antenna, one on each side of it; but these (if the animal were *C. Limnias*) must have been something extraneous, accidentally attached to the antenna; possibly two air-bubbles.

Length. About $\frac{1}{40}$ inch. **Habitat.** Neighbourhood of London (Mr. Slack); Sandhurst, Berks (Dr. Collins); Woolston, near Southampton (P. H. G.); Cheltenham (Miss Saunders); Lochs, Forfar (J. H.); Nailsea, near Bristol (C. T. H.): very partially distributed.

C. CANDIDUS, *Hudson*, sp. nov.

SP. CH. **Dorsal antenna** *very long;* **tube** *irregular, semitransparent, gelatinous.*

Mr. J. Hood found this very rare Rotiferon in Loch Lundie in October 1880, and again between September and December in the same loch next year. He found a few specimens in his aquarium, but evidently from eggs on weeds brought from the same spot.

Mr. Hood points out that it differs from *C. Limnias* not only in its **tube**, but also in its stout wrinkled **foot**, which is kept habitually in this condition. I have always noticed that the foot of *C. Limnias* (when in its tube) is delicate, tapering, and smooth; but Mr. Gosse found that, on his dislodging one from its tube, the foot became of nearly equal thickness throughout (as in *C. candidus*), and of about one-third the diameter of the body, from which it was abruptly separated. The whole length, too, was then studded with wrinkles, which at intervals took the form of great thickened rings. The foot terminated in a circular sucking disk. The two species are very much alike; but their tubes differ so much that I have thought it best to keep them apart.

Length, $\frac{1}{40}$ inch. **Habitat.** Loch Lundie (J.H.): very rare.

Genus ŒCISTES, *Ehrenberg*.

GEN. CH. **Corona** *a wide oval, indistinctly two-lobed;* **dorsal gap** *minute;* **dorsal antenna** *absent*[1]; **ventral antennæ** *obvious.*

In this genus the tube is extremely irregular and variable in shape; it is usually of a loose fluffy texture, and encumbered with extraneous matters of all kinds. In one species, however, it is compact, like that of *Limnias ceratophylli*; in another it is formed of fæcal pellets; and in a third it resembles that of *Melicerta tubicolaria*.

The **corona** is no longer distinctly lobed, and becomes nearly circular; it is hollowed a little on the ventral side opposite to the buccal funnel. The **ciliary wreath** is double, and is on precisely the same plan as that of the preceding genera; only the dorsal gap in it, though distinct, is so minute as easily to escape notice, unless the animal be in a favourable position. Ehrenberg failed to see either it or the secondary wreath; and,

[1] Probably a minute setigerous pimple, which has escaped observation.

in consequence, separated it from the *Melicertadæ*, and placed it in a family named after itself: an honour it did not deserve. The **antennæ** vary greatly in length in the different species: some are mere setigerous pimples, others the longest known among the Rotifera.

The **internal structure**, so far as it has been ascertained, is that of *Melicerta*. The parts not made out are the **vascular system** and the **nervous system**. The **male** also is unknown.

Œ. CRYSTALLINUS, *Ehrenberg*.

(Pl. VII. fig. 3.)

Œcistes crystallinus . . .	Ehrenberg, *Die Infus.* 1838, p. 392, Taf. xliii. fig. 7.
,, ,, . . .	Pritchard, *Infusoria*, 1861, p. 663, pl. xxv. figs. 361–364.
Melicerta crystallina . . .	Gosse, *Popular Sci. Rev.* vol. i. 1862, p. 490.

SP. CH. **Ventral antennæ** *extremely short, and set wide apart;* **tube** *most variable and irregular in shape, often beset with extraneous matter.*

I have frequently met with this Rotiferon in dense colonies, whose dirty-brown tubes gave quite a rusty look to the water plants which they infested. Though small, it is a very pretty object; and, with a little care, the **secondary wreath** of cilia, the two **antennæ** and the **dorsal gap** in the ciliary wreath can be distinctly made out. For this purpose the animal must be so placed that its long axis is nearly in the line of sight. From almost all other points of view the dorsal gap is invisible, and only one antenna can be seen at once, owing to the unusual width between the two. When the case is free from rubbish, it is not difficult to see that the animal's **internal structure** is very like that of *Melicerta*. The **vascular system** and the **nervous system** have not yet been observed. Two red **eyes** are visible in the half-grown young.

Length. About $\frac{1}{50}$ inch. **Habitat.** Ponds and ditches: very common.

Œ. INTERMEDIUS, *Davis*.

(Pl. VII. fig. 5.)

Œcistes intermedius . . .	Davis, *Trans. Roy. Micr. Soc.* vol. xv. 1867, p. 14, with fig.

SP. CH. **Antennæ** *short;* **dorsal gap** *unusually wide;* **tube** *opaque, tapering slightly from top to bottom.*

Mr. Davis found this species at Leytonstone, in company with the former. It differs from *Œ. crystallinus* in the width of the dorsal gap in the ciliary wreath, which almost approaches that of a *Limnias*, and in its neat tube, which exactly reproduces that of *L. ceratophylli*. In fact, had it not been for its distinctly oval corona, I should have said that it was a variety of the latter species. Mr. Hood, however, tells me that he has found it (sometimes in abundance) in Scotland and always with the oval disk; Mr. Gosse, too, has seen many Scotch specimens, and has no doubt that it is a true species.

[Two specimens, so young that no visible tube was begun, yet attached to a stem by the foot, showed, in the wall of the occiput just below the ciliary rota, two well-defined and conspicuous dark eyes, rather far apart.—P. H. G.]

Length. About $\frac{1}{75}$ inch. **Habitat.** Leytonstone, Essex (H. Davis); marsh pools, Fife and Perth (J.H.): not common.

Œ. SERPENTINUS, *Gosse*, sp. nov.

(Pl. IX. fig. 1.)

SP. CH. **Corona** *small, circular;* **foot** *fully thrice the length of the body, much wrinkled, extensile;* **ventral antenna** *a single, simple tubercle; a pair of dorsal* **hooks** *below the corona, adnate at the base;* **tube** *very short, or absent.*

[This very striking species I found on leaves of *Anacharis alsinastrum*, which had been growing for months in a glass jar in my study-window.

The **body** and corona do not vary much from those of other species. In the act of expanding, the summit of the head becomes sub-conical, and is seen to terminate in two small hooks having a common stem, which remind the observer of the protruding head of *Melicerta ringens* (fig. 1*b*). When unfolded, the **corona** does not much exceed the greatest diameter of the body: it appears to form a complete uninterrupted circle. A small round knob on a conical eminence constitutes a **ventral antenna**; a little below which is seen the mastax; and, about as much below this, but on the opposite side to the antenna (the dorsal side), the **cloaca** is bounded by a minute wart. The body is of the usual proportions, but the **foot** is of enormous length, being about thrice as long as the trunk and head. It is rather stout (about half the greatest diameter of the body), and of uniform thickness throughout; thrown for its entire length into transverse close-set wrinkles. These were not obliterated nor perceptibly diminished by the greatest extension that I witnessed; so that, if this corrugation is a provision for indefinite elongation at pleasure, as one must suppose, then the foot would seem capable of stretching to a length more than ten times as great as I have represented! Yet I have seen it on repeated occasions contracted in an instant to a condition in which it was not more than half the length of the body, or one-sixth of its former length.

The investing **tube** is reduced to extreme insignificance. The one that I saw would not hold half the body, even if it had no foot. It was invisible, save for a few irregular opaque masses here and there, and for two or three eggs adhering to the margin. As if indifferent to concealment, the foot was attached to a point not near the bottom of even this short dwelling.

The **trunk** is transparent, but tinged with umber-brown. Here and there, within, were multitudes of very small air- (or oil-) globules agglomerated into long masses, which looked like patches of blue-black hue, and had a curious appearance. When I first saw the specimen, two **eggs** were already laid, and presently a third was added, but not under my actual gaze. The eggs were all of a clear yellow, minutely granular.

The **manners** of this creature are as odd as its figure. It is not by any means intolerant of exposure: though sensitive, shutting up and violently contracting on a very slight shock or jar, yet in a moment it is again stretched to its length, and quickly has its corona expanded. The foot is endowed with an extreme flexibility and muscular power, for the animal is constantly (I will not say *swung*, but) shot, from side to side; just as the body of a snake or of a writhing worm is jerked about in tortuous evolutions.

While I was examining and delineating this example, another appeared, in all essential points agreeing with it, but quite destitute of any apology for a case, the foot being unattached to any object; the creature being loose in free water, but lying on the same leaf of *Anacharis*. The **male** has not yet been observed.—P.H.G.]

This species in many points resembles Ehrenberg's *Ptygura Melicerta*. The two agree in the small corona, cylindrical body, dorsal hooks, single ventral antenna, many-toothed jaws, and inconspicuous or absent tube. But the prodigious length and extensibility of the great ringed foot of *Œ. serpentinus*, and the animal's extraordinary actions, none of which are mentioned by Ehrenberg, show it to be a different creature. If Ehrenberg had seen only a solitary specimen for a few minutes, in a contracted state, the two might have been supposed to be the same; but he distinctly says that he had met with many examples. Besides, Herr Eckstein has also found *Ptygura Melicerta* more than once; and, although he has not seen the expanded corona, his description and figure in all other respects agree with Ehrenberg's.

From the descriptions given by Ehrenberg and Herr Eckstein I am inclined to think that *Ptygura* is an *Œcistes*; but it is impossible to determine this till the corona has been thoroughly studied.

Length. Not recorded. **Habitat.** On a leaf of *Anacharis alsinastrum* in a fresh-water aquarium (P.H.G.).

Œ. longicornis, *Davis*.

(Pl. VII. fig. 6.)

Œcistes longicornis . . . Davis, *Trans. Roy. Micr. Soc.* vol. xv. 1867, p. 13, with figs.

SP. CH. **Antennæ** *very long and recurved;* **tube** *floccose, irregular.*

Mr. H. Davis found this well-marked species, in abundance, in ponds at Leytonstone, Essex. It is the smallest of the tube-makers. The tube is very irregular and variable in shape; but, in most of the examples which I have met with, small and tubular at the bottom, while wide and unsymmetrical towards the top. On supplying it with carmine, Mr. Davis saw that the fine coloured particles accumulated in the hollow under the chin, and that they were then rubbed off by the Rotiferon, and left on the top of its case. He thus obtained tubes with crimson tops at least one-fourth of the length of the whole, showing how the structure was gradually formed. The long **antennæ**, curved back from the ventral surface, and set wide apart, give this *Œcistes* a very striking appearance.

Length. About $\frac{1}{70}$ inch. **Habitat.** Leytonstone, Essex (H. Davis); Abbot's Pond, Clifton (C.T.H.); Woolston, Cheltenham (P.H.G); marsh pools, Fife and Perth (J.H., P.H.G.): partially distributed.

Œ. pilula, *Wills*.

(Pl. VII. fig. 2.)

Melicerta, variety No. 2 . . . Tatem, *Jour. Quekett Micr. Club*, vol. i. 1868, p. 124, pl. vii. figs. 3, 4.
Melicerta socialis (?) . . . Collins, *Science Gossip*, No. 85, 1872, p. 9, with fig.
Melicerta pilula (?) . . . . Cubitt, *Mon. Micr. J.* vol. viii. 1872, p. 5, pl. xxiv. figs. 2–4.
Œcistes pilula . . . . Wills, *Midland Naturalist*, vol. i. 1878, pp. 302, 317, pl. v. figs. 3, 4.

SP. CH. **Antennæ** *long;* **tube** *formed of fæcal pellets.*

The first certain notice of this Rotifer is by Mr. Tatem (*loc. cit.*). He gave two excellent and characteristic drawings of it; saying merely that it was a two-lobed variety of *Melicerta ringens*, without a ciliated cup, and inhabiting a "gelatinous sheath" with adherent fæcal pellets. Its broadly oval[1] **corona**, however, and the minuteness of the **dorsal gap** in the ciliary wreath, clearly place it in the genus *Œcistes*.

As in *Melicerta Janus*, the **intestine** is large and densely ciliated; and nearly always contains an oval **pellet** in the course of construction. Mr. Wills (*loc. cit.*) describes how the animal deposits its completed pellet. He says that it is ejected between the body and the tube, and then caught by the lower margin of the corona. Here it is retained for a few seconds, as if the creature wished to make sure of a proper hold, and it is then, by a sudden retracting of the body, dabbed down on the margin of the tube. The pellets are deposited at irregular times, and the majority of them are so ejected as to be whirled quite away by the coronal currents. Those that form the tube are laid in transverse rings round the body so as to cut the ring obliquely (fig. 2*d*). The tubes are generally neat, gradually widening to the top, but I have met with some in which the pellets seemed to have been deposited in a most irregular fashion (fig. 2*a*). These tubes, however, had probably suffered from some accident. The **eyes** are visible in the half-grown animal.

Length. Scotch specimens up to $\frac{1}{75}$ inch. **Habitat.** Sandhurst, Berks (Collins); Sutton Park, Birmingham (A. W. Wills); Snaresbrook, the tube of unusually large pellets (P.H.G.): marsh-pools, Fife and Perth (J.H.): not common.

[1] Mr. Cubitt's and Dr. Collins's drawings make the corona so like that of a *Limnias* that I am by no means sure that they are describing *Œcistes pilula*.

Œ. BRACHIATUS, *Hudson*, sp. nov.

(Pl. IX. fig. 2.)

[SP. CH. **Corona** *distinctly two-lobed;* **ventral antennæ** *as long as the transverse diameter of the corona, mobile, non-retractile;* **tube** *gelatinous, quite transparent, but for adhering matters, subcylindrical.*

The front in retraction is rounded, ending in two geminate hooked points. The ventral **antennæ** rise from swollen bases wide apart, and diverge on each side nearly in the line of the body. They move independently of each other, often quickly, but not spasmodically. In each can be seen a globose corpuscle within the tip, bearing one seta, whence a double line (probably a tube or a nerve-cord of sensation) can be traced throughout. A **mastax** of normal form, a long œsophagus, an ample stomach, and a distinct intestine, are plain; from this last a long up-turned rectum leads to the cloaca, at half body-length. Laid eggs, of very long-ovate form, are usually seen, from one to four in number, in the middle part of the tube.

Below the viscera the body suddenly becomes hyaline, and gradually tapers to a slender **foot**, twice as long as the body, through which run many pairs of muscle-threads. At the bottom, already much attenuated, it *abruptly* contracts to an excessively fine thread, which adheres by a sucking disk to the base. The investing **tube** is wide and high, but is absolutely invisible; and can be inferred only from a crowd of minute diatoms (almost wholly of one slender kind) that are entangled in its substance. The cavity of the tube can be easily traced, of equal width throughout, a width determined by that of the body, which, however, rarely retracts sufficiently to enter it. The foot generally displays few transverse wrinkles.

It is not reluctant to display its discal beauties. The **corona** is that of a *Limnias*, composed clearly of two circles united; the dorsal gap wider than the ventral. Each half is conspicuously marked with a thick rib (muscle or vessel?) originating in the common centre, and divaricating, with many branches, nearly to the circumference. But, just within the margin, a concentric band connects these branches, forming a submarginal edge, thick and dark, which is constantly thrown into varying puckers by contraction; the whole contributing greatly to the beauty of the corona.

This species, which is among the finest of Rotifera, was discovered in 1882 by Mr. John Hood of Dundee, to whose successful researches this work bears grateful witness. He obtained it from several lochs around; and sent a specimen (which did not survive the journey) to Dr. Hudson, with many notes and sketches. Recently he has favoured me with many specimens, which have freely increased in captivity with me, even in very small phials, so as to be swarming, by scores, for months after their transmission. Thus I have had abundant facilities for study and delineation of the species. It has always occurred attached to filamentous weeds much crowded with impalpable algæ.

Length, $\frac{1}{40}$ inch to $\frac{1}{25}$ inch. **Habitat.** Weeds in Scottish lochs (J.H., P.H.G.): not rare.—P.H.G.]

Œ. (?) VELATUS, *Gosse*.

(Pl. D. fig. 8.)

Megalotrocha velata . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 198.
Melicerta ptygura (?) . . . ,, *Popular Sci. Rev.* vol. i. 1862, p. 490, pl. xxvi. fig. *d*.

[SP. CH. **Corona** *very large, circular, crossed by thick diverging ribs;* **teeth** *four in each ramus;* **eyes** *two, cervical, permanent;* **tube** *habitually wanting.*

This very beautiful form is aberrant, if indeed it is an *Œcistes*. My attempts to assign it, first to *Megalotrocha* and then to *Ptygura*, must both be given up. The

absence of frontal hooks, and the high position of the cloaca, forbid the latter identification. The form of the trophi; the *very distinct*, small, three-sided intestine (a mark by which the species may usually be identified at a glance), and the absence of any tube-proper, make its position in *Œcistes* doubtful. Dr. Collins, indeed, who has met with it often, and has sketched it in his Note Book, speaks of its occasionally throwing off irregular mucus; but this seems scarcely a tube. I have lately had many specimens, and have never seen an approach to a tube. The presence of two **eyes**, small but conspicuous, and apparently permanent, is noteworthy. They are situated in the neck, moderately wide apart. Dr. Collins, in one example, figures and describes them as rather close together and near the edge of the corona, which is unaccountable.

The **corona** is a hyaline disk, of beautiful rotundity and of great size, being twice as wide as the body when well expanded;—shallowly funnel-shaped, but sometimes taking the form of a lovely glass salver, with slightly raised edge, around which the great ciliary waves play nobly. Turbid matters are sometimes poured off through the minute dorsal notch.

The **rectum** may easily be traced, upward from the bottom of the intestine, to the cloaca far above its summit. I have seen an egg, and also fæces, discharged, after which the cloaca protrudes lip-like (8*d*). Around the outside of the corona, investing it to some height, is sometimes seen what seems a vascular tissue of granular yellowish hue (8*b*), apparently movable, whence the specific name. A very good view of the **mastax** enabled me to see that each hemispheric ramus is crossed by four teeth, nearly parallel, whose points project beyond the edge (8*e*, 8*f*).

I found this fine species near London in 1849, in two examples; but never saw it again for many years. Within a few months, however, Mr. Hood has sent me water from a pond near Dundee, very rich in forms of Rhizota, among which many specimens of *Œ. velatus* occur. I am tempted to give my ardent correspondent's experience in the procuring of these. It was in the very height of the great snow of early March, in the present year 1886. "I went to the pond to-day to search for *velatus*—a difficult and hazardous task. The pond is more than twelve feet deep, covered with thick ice and snow. As I knew the exact spot . . . I cleared away the snow, and bored a number of small holes in a circle of eighteen inches in diameter; then thrust down the central plate, which gave me a large hole. I put down my line with sinker and grapnel, but fished a long time with no result. At last a bit of the *Myriophyllum* came up, to which I hope you will find specimens attached;"—as, I am happy to add, I did.

Length, $\frac{1}{100}$ to $\frac{1}{75}$ inch. **Habitat.** The Black Sea, Wandsworth (P.H.G.); Sandhurst (Dr. Collins); Dundee (P.H.G.; J.H.): rare.—P.H.G.]

Œ. UMBELLA, *Hudson.*

(Pl. VII. fig. 4.)

Œcistes umbella	Hudson, *J. Roy. Micr. Soc.* (1878), vol. ii. 1879, p. 1, pl. i.
Œcistes longipes	Wills, *Midland Naturalist*, vol. i. 1878, p. 317, pl. v. figs. 1, 2.

SP. CH. **Corona** *large, nearly circular, crossed with thick ribs; ventral* **antennæ** *long;* **tube** *loose, very irregular, clay-coloured.*

Mr. F. Oxley sent me, in June 1878, several specimens of this large and handsome species, which he had just discovered in a pond at Snaresbrook, on the leaves and in the axils of a *Sphagnum*. Its **corona** is so strengthened by thick ribs as to look somewhat like an umbrella. Two of these ribs are very broad, and run across from the ventral to the dorsal side, and when the corona is viewed sideways are seen to project a little above its surface. There is also on either side a branched rib with a triangular space within it like a gusset. When the Rotiferon closes its corona it brings the ribs together, the thinner portions being olded up between them. The thus infolded corona

forms a rectangular bundle that is characteristic of the species. The **foot** is unusually long and slender. Two red **eyes** are distinctly visible in the adult, just below the surface of the corona.

Length, $\frac{1}{75}$ inch. **Habitat.** Ponds at Snaresbrook, Essex (F. Oxley); and Sutton Park, Birmingham (A. W. Wills); Woolston, Cheltenham (P.H.G.); marsh pools, Perth and Fife (J.H.): rare.

Œ. STYGIS, *Gosse*, sp. nov.

(Pl. IX. fig. 3.)

SP. CH. **Corona** *circular;* **dorsal gap** *not perceptible;* **ventral antennæ** *mere tubercules. Of large dimensions.*

[I found this fine species on September 18, 1885, among impalpable floccose vegetation sent me by Mr. Hood from the Black Loch, near Dundee; a habitat which has suggested a fanciful appellation, and which it shares with its neighbour and rival *Œ. brachiatus*. It equals that species in size, being about $\frac{1}{40}$ inch in height when expanded; its beautiful clear corona, of exquisite rotundity, being $\frac{1}{160}$ inch in diameter.

The **corona** is strengthened with thick divergent ribs, very visible when viewed obliquely or nearly laterally; but, in a direct front view, these disappear, and the hyaline disk looks like a circular plate of clear glass, marked by a few almost invisible curves. There are no **antennæ** proper; a pair of minute knobs marking their place. But for this, it might be mistaken for *Œ. umbella*. I saw no trace of **eyes**. The body, of the usual form, contracts to a long and slender **foot**; which, at its pedal extremity, dilates into a minute cubical knob, which adheres to a little heap of floccose. A **tube** of loose gelatinous matter, of brownish hue, surrounds the body, of such a thickness that its diameter is about twice that of the corona. It is undefined to the eye, but carries an agglomeration of extraneous matters entangled in its substance.—P.H.G.]

Length, $\frac{1}{40}$ inch. **Habitat.** Black Loch, Dundee (P.H.G.): rare.

Genus LACINULARIA, *Schweigger*.

GEN. CH. **Cluster** *fixed, of many individuals, with adhering gelatinous tubes;* **corona** *heart-shaped, oblique, with its longer axis placed dorso-ventrally, and a deep ventral sinus;* **dorsal gap** *in the ciliary wreath very minute;* **trunk** *without opaque warts;* **dorsal** *and* **ventral antennæ** *absent.*[1]

L. SOCIALIS, *Ehrenberg*.

(Pl. VIII. fig. 1.)

Lacinularia socialis . . .	Ehrenberg, *Die Infus.* 1838, p. 403, Taf. xliv. fig. 4.
,, ,, . . .	Leydig, *Sieb. u. Köll. Zeits.* Bd. iii. 1851, p. 452, Taf. xvii.
,, ,, . . .	Huxley, *Trans. Micr. Soc.* vol. i. N.S. 1853, p. 1, pl. i. pl. ii. figs. 20–25.
,, ,, . . .	Pritchard, *Infusoria*, 1861, p. 671, pl. xxxvii. figs. 19–25.
Megalotrocha socialis . . .	Gosse, *Popular Sci. Rev.* vol. i. 1862, p. 494.
Lacinularia socialis . . .	Cubitt, *Mon. Micr. J.* vol. viii. 1872, p. 9, pl. xxiii. figs. 3, 4.
,, ,, . . .	Hudson, *Mon. Micr. J.* vol. xiii. 1875, p. 45, pl. xci. fig. 8.
,, ,, . . .	Bartsch, *Rot. Hungariæ*, 1877, p. 19, Táb. i. fig. 1.

This common and very beautiful Rotiferon, the only known species of the genus, is found adhering in clusters, like little balls of grey jelly, to the stems and leaflets of pond-weeds.

[1] Possibly they may be very minute setigerous pimples, which have escaped observation.

The cluster is a lovely microscopic object for a low power with dark-field illumination, and can be easily placed in a live-trough without injury; so that during the hundred and thirty years which have elapsed since its discovery, it has naturally attracted the attention of many observers, and has been the subject of special essays by Professor Huxley and Dr. Leydig. It has, in consequence, been very thoroughly examined, and only a few points of its structure remain as yet doubtful. These, as might have been expected, are in the vascular and nervous systems; and these alone require notice, as the rest of its **internal organisation**, as well as the general plan of the **corona**, **ciliary wreath**, **chin** and **buccal funnel**, follows very closely that of *M. ringens*.

The **Vascular System.**—Professor Huxley describes the two lateral canals as arising from a common origin upon the dorsal side of the intestine (rectum), but Dr. Leydig says that the lateral canals start from a common branch opening into a contractile vesicle, which discharges itself into the cloaca: it will be seen that a similar doubt exists concerning the termination of the canals in *Conochilus volvox*, and further investigation is, I think, wanted to make the matter clear.

The **Nervous System.**—Professor Huxley (*loc. cit.*) describes and figures a ciliated cup beneath the chin, just as in *M. ringens*; and below this cup, underneath the surface, on the ventral side, a "bi-lobed homogeneous mass resembling in appearance the ganglion of *Brachionus*." This organ he supposes to be the true nervous ganglion. Dr. Leydig, on the other hand, points out two nucleated polar cells, giving off threads, just below the mastax, and two similar ones at the junction of the foot and trunk. These four are, in his opinion, the nerve centres of *L. socialis*. Now, each of these suppositions is liable to the same objection, viz. that it places the nervous ganglion in a unique position. All the known nervous ganglia in the Rotifera lie towards the dorsal surface, and the great majority are near the mastax, and not far from the eyes; there are no other examples of nervous ganglia on the ventral surface, or in the foot. Besides, in the only one of the *Melicertadæ* (viz. *Conochilus*) in which there is an obvious nervous ganglion, it lies in the normal position; and M. Joliet describes the nervous ganglion of *M. ringens* as being above the mastax towards the dorsal surface. No antennæ have as yet been observed, and the eyes are visible only in the young.

The **Male.**—I had the good fortune to discover and study the male in November 1874, and published (*loc. cit.*) an account of it, and several other males, soon afterwards. Fig. 1c gives a side view of it. It has a conical head fringed with a wreath of long cilia, a cylindrical soft trunk, and a short, pointed, ciliated foot. There are strong longitudinal **muscles** for withdrawing the corona into the trunk, and several transverse muscular bands in the integument. The **nutritive system** is wholly absent. Two secreting **foot glands** are present, as well as the **lateral canals** and their **vibratile tags**. I several times thought I caught sight of the edge of the **contractile vesicle** behind the upper part of the sperm-sac. There is a large **nervous ganglion** sending threads to a dorsal **antenna** and two red **eyes**. A large **sperm-sac** fills nearly the whole trunk, and ends in a broad tubular, ciliated, and protusile **penis**.

Length. About $\frac{1}{72}$ inch; diameter of large cluster, about $\frac{1}{8}$ inch. **Habitat.** On water-weeds: common.

Genus MEGALOTROCHA, *Ehrenberg*.

GEN. CH. **Cluster** *fixed, of many individuals without tubes;* **corona** *kidney-shaped, oblique, with its shorter axis placed dorso-ventrally, and with a deep ventral sinus;* **dorsal gap** *in the ciliary wreath very minute;* **trunk** *with four opaque warts in a row on the breast;* **dorsal and ventral antennæ** *absent.*[1]

[1] Possibly they may be very minute setigerous pimples, which have escaped observation.

M. ALBOFLAVICANS., *Ehrenberg.*

(Pl. VIII. fig. 2.)

Megalotrocha alboflavicans . .	Ehrenberg, *Die Infus.* 1838, p. 397, Taf. xliv. fig. 3.
„ „ . .	Pritchard, *Infusoria*, 1861, p. 665, pl. xxxii. figs. 374–378.
„ „ . .	Gosse, *Popular Sci. Rev.* vol. i. 1862, p. 491.
„ „ . .	Weisse, *L'Acad. Imp. St. Pétersb.* 7 Sér. t. iv. No. 8, 1862, p. 7, with figs.
Lacinularia alboflavicans . .	Cubitt, *Mon. Micr. J.* vol. viii. 1872, p. 9, pl. xxiii. fig. 5.

This is a comparatively rare animal, though it has been known for upwards of a century. Had it been common it would never have been supposed to be a *Lacinularia* without a tube, for only those who have never seen it could make such a mistake. It differs obviously from *L. socialis* in its shape and habits, as well as in its being ornamented with a necklace of four white opaque knobs, "like a row of pearls," stretching from shoulder to shoulder across the ventral surface. These are so placed, that when the animal furls its corona they border the edge of its then pear-shaped body.

The cluster radiates in all directions from a small space on the stem or leaf of a plant, and often consists of both adults and their young. Now and then a young brood will swarm out, as in *Conochilus volvox*; and, when swimming away, circling round each other in search of a resting-place, may easily be mistaken for a young cluster of that species. The ways of the animal are unlike those of *L. socialis*. It is a much more timid creature, and does not expand so freely. When a cluster is undisturbed, first one and then another will contract with a sudden twist, to expand in leisurely fashion at its own pleasure; but every now and then a panic seizes the whole cluster, and they all rush together into a contracted mass, with a curious circular sweep, as if some violent eddy had struck them.

The creature has a peculiar habit of swelling out at times the surface of the corona, so that it is curved up above the ciliary wreath; but in other respects the two ciliary wreaths, the chin, and the buccal funnel are similar in plan to those of *L. socialis*; and so is the whole alimentary tract. The two vesicles, which some take to be **salivary glands**, and others mere horny stays to the buccal funnel and mastax, are yellowish; and so are the **trophi**. The **gastric glands** are somewhat three-sided in outline when seen ventrally. The **lateral canals** and their vibratile tags are obvious (figs. 2 to 2*c*), but the **contractile vesicle** (if any) has not been seen; neither has it been determined how the lateral canals end posteriorly. No **nervous ganglion** or **antenna** has as yet been seen, and the two red **eyes** only in the egg and young.

[Mr. W. G. Cocks, of Dalston, has been very successful in keeping this and other fine Rhizota in a tank. He has favoured me with many valuable observations on the habits and development of this species; and I am indebted to him for a supply of specimens. I noticed that, in one case, when an egg was discharged in my sight, it separated and fell down among the crowded feet of the cluster; while, in another, it hung awhile to the cloaca after exclusion. Presently a young one was swimming free, probably hatched in the trough. It was colourless, very transparent; and swam smoothly, evenly, and swiftly, by the rotation of the cilia on its expanded corona. Then came shooting-by a slender creature (Pl. D. fig. 9*a*), about $\frac{1}{260}$ inch long, with truncate, apparently ciliate, front, tapering regularly to the hind extremity. In this, though full of a bright granulation, I could not detect any viscera, nor other organs. I conjecture this was the new-born **male** of the same; as fig. 9 is probably a new-born female.—P.H.G.]

In Dr. Weisse's figure (*loc. cit.*) of the female embryo leaving the egg, it will be noticed that the four opaque warts on the trunk, as well as the eyes and mastax, are already formed.

Length. About $\frac{1}{12}$ inch; diameter of large cluster, about $\frac{1}{5}$ inch. **Habitat.** On plants in gently running streams, Weybridge, Surrey (W. G. Cocks); Kent (Cubitt, Badcock): rare.

* Genus TROCHOSPHÆRA, *Semper*.

GEN. CH. *Solitary, free-swimming;* **body** *a perfect sphere;* **buccal orifice** *on the spherical surface;* **principal wreath** *dividing the sphere into two hemispheres, and passing above the buccal orifice;* **dorsal gap** *in the wreath at the pole opposite to buccal orifice;* **secondary wreath** *a fragment on the under edge of the buccal orifice;* **ventral antennæ** *extremely minute;* **tube** *absent.*

T. ÆQUATORIALIS, *Semper*.

(Pl. D. fig. 11.)

Trochosphæra æquatorialis . . Semper, *Sieb. u. Köll. Zeits.* Bd. xxii. 1872, p. 311, Taf. xxiv., translated in *Mon. Micr. J.* vol. xiv. 1875, p. 237, pls. cxx. to cxxii.

Who can complain here that a rough wrinkled skin, complicated external form, and huddled-up organs have rendered his utmost efforts almost fruitless? Here is a creature whose outer shape and texture have alike reached the very acme of simplicity; the one translucent as the clearest water, the other rounded into a perfect sphere: an animal created as it were for the study of its internal structure; its organs all symmetrically spread apart in due array, just as if a skilful demonstrator had teased them out with delicate needles; no one overlapping another, and all deftly hung to the walls of a hyaline globe which not only upholds them, but also displays them to the utmost possible advantage; for it has a band of cilia girdling its entire circumference, and rolling it through the water, so as to present it in every possible point of view.

Trochosphæra has a perfectly transparent spherical body with a principal ciliary wreath running round what may be called the equator, and marking the common boundary of what Prof. Semper calls the "oral" and "ab-oral" hemispheres. In the former lie nearly all the organs of the body; for only one nerve-thread and portions of a pair of muscular bands are to be found in the other. At one spot in the equatorial ring of cilia there is a break in the wreath, and at the opposite extremity of the diameter passing through this spot is the buccal orifice, which has a very small secondary wreath fringing its oral or lower side.

The various internal organs are so well displayed in Prof. Semper's figure, that only a few points require notice. The **trophi**, though of somewhat peculiar shape, are malleo-ramate. The **lateral canals** end in the cloaca, not in the contractile vesicle; and this latter, according to Prof. Semper, discharges itself into the intestine. The **nervous system** can be well made out. From the nervous ganglion (*ng*), which lies close to the mastax (*mx*), five pairs of nerves pass respectively to the ciliary wreath, buccal orifice, lateral antennæ (*a'*), lateral canals (*lc*), and eyes (*e*); while a single nerve thread (*n*) passes to the probable dorsal antenna (*a*).

The **male** is unknown.

It is obvious that if the aboral hemisphere were pressed flat, and the oral lengthened out into a cone, we should have, in the altered *Trochosphæra*, a Rotiferon somewhat resembling one of the *Melicertadæ*. For it would have a buccal orifice laterally placed; a principal ciliary wreath surrounding the body, with a gap in it on what would then be the dorsal side; a portion of a secondary wreath passing round the edge of the buccal orifice; trophi of a Melicertan type; two minute ventral antennæ, and a single dorsal one. On the other hand, the absence of an attached foot, and of a complete secondary wreath, and the difference of habit, make it no easy matter to say where *Trochosphæra* should be placed; on the whole, I think it should be put among the *Melicertadæ* near *Megalotrocha* and *Conochilus*.

Length. Diameter of sphere, $\frac{1}{36}$ inch. **Habitat.** Ditches in the rice fields of Zamboanga, in the Philippine Islands (Prof. Semper): rare.

Genus CONOCHILUS, *Ehrenberg*.

GEN. CH. **Cluster** *free-swimming, of several individuals, inhabiting coherent gelatinous tubes;* **corona** *horse-shoe-shaped, transverse;* **gap in the ciliary wreath** *ventral;* **buccal orifice** *on the corona, and towards its dorsal side;* **dorsal antennæ** *absent;*[1] **ventral antennæ** *obvious.*

Take a clay model of an *Œcistes*, and cut off the head by a transverse section through the neck. Lift up the head, and reverse its position, placing the surface of the **corona** on the decapitated trunk, so that the entrance to the buccal funnel may point towards the centre of the dorsal surface. There will thus be obtained a rough representation of the relative positions of the trunk, corona, and ciliary wreaths in *Conochilus*. Such a violent alteration in the general plan of the *Melicertadæ* might almost seem to entitle *Conochilus* to a family by itself, but its affinities are so clearly with this group that it may well remain here.

On the surface of the corona,[2] close within its edge, and parallel to it, runs a groove, which is broadest and deepest opposite to the dorsal surface, where it is confluent with the entrance to the buccal funnel. The groove grows both narrower and shallower on each side as it approaches the ventral surface, and ceases just before reaching a ventral gap in the corona.

The **buccal funnel**, except at its wide entrance, is covered by a sloping roof, formed of the uplifted corona, which here rises into a kind of pent-house, notched at its apex. The **principal wreath** runs round the outer edge of the groove, and is joined, at each side of the ventral gap, by the secondary wreath. This latter fringes the groove's inner edge; and on reaching the buccal funnel, bends sharply back, rising up each edge of its walls, till it has reached the notch described above; so that in *Conochilus*, as in other *Melicertadæ*, the entrance to the buccal orifice lies between the two wreaths, and is bordered by the secondary one.

The two known species differ considerably in their modes of clustering, and in their antennæ: they apparently closely resemble each other in other points, but only one has been really studied, viz. *C. volvox*.[3]

C. VOLVOX, *Ehrenberg*.

(Pl. VIII. fig. 8.)

Conochilus volvox	Ehrenberg, *Die Infus.* 1838, p. 393, Taf. xliii. fig. 8.
,, ,, ...	Eichwald, *Dritt. Nacht. z. Infus. Russlands*, 1852, p. 520.
,, ,, ...	Cohn, *Sieb. u. Köll. Zeits.* Bd. xii. 1863, p. 197, with figs.
,, ,, ...	Pritchard, *Infusoria*, 1861, p. 664, pl. xxv. 365-370.
Megalotrocha volvox . . .	Gosse, *Popular Sci. Rev.* vol. i. 1862, p. 491, pl. xxvi. figs. *e,f*.
Conochilus volvox	Davis, *Mon. Micr. J.* vol. xvi. 1876, p. 1, pl. cxliii.
,, ,, ...	Bedwell, *J. Roy. Micr. Soc.* vol. i. 1878, p. 176, pl. xi.
,, ,, ...	Hudson, *J. Roy. Micr. Soc.* vol. ii. 1879, p. 3, pl. ii.
,, ,, ...	Imhof, *Zool. Anz.* No. 147, 1883.

[1] Possibly very minute.

[2] Ehrenberg misunderstood the corona of *C. volvox*, and described it as surrounded with a single wreath of cilia and bearing four papillæ on its surface. He placed the buccal orifice on the ventral side, where the ventral gap is; and suggested that the four papillæ might be a sort of upper lip to the mouth, the edge of the disk itself being the lower one. Dr. Cohn, in his otherwise admirable paper (*loc. cit.*), draws the buccal orifice on the ventral side, and wrongly places the antennæ between it and the dorsal surface. His conical protuberance over the antennæ is also singularly out of shape and proportion. The corona and antennæ were first correctly described by Mr. Davis (*loc. cit.*), whose observations I have repeatedly verified.

[3] *Strophosphæra ismailoviensis* (Poggenpohl, *N. Mem. Mosc.* t. x. 1876) is, I think, a *Conochilus*; with two short separate antennæ lying between a pair of ventral hooks.

SP. CH. **Cluster** *spherical, consisting of many adults and their young;* **tubes** *so compressed together as to be indistinguishable from each other;* **ventral antennæ** *on the corona, between the buccal orifice and the ventral gap, adnate at the base.*

No microscopic object is more beautiful than this lovely globe of living creatures, each bearing its flashing crown of cilia, its ruby eyes and orange-tinted jaws. Fortunately it is as common as it is beautiful, and is equally at home in the Swiss Lakes, in the Scotch Lochs, and in the pools of Hampstead Heath.

The animals all radiate from a common centre (fig. 8*e*), the extremities of their feet being close together, though not in actual contact. The action of their ciliary wreaths imparts a slow motion to the globe, which rolls along, rising and falling, and often returning on its course, in a very aimless fashion. The globe is formed by the co-operation of its inmates, each contributing its secretion to the structure. The newly-hatched free-swimming young may be seen circling round each other, with their bodies curved, and the extremities of their feet directed towards a central spot in the group. In this way they will swim off in a swarm, not actually cohering, but keeping all close together. I have not been able to follow the process further; but, no doubt, all soon begin to form some sort of tube, and their united secretions fix the swarm together, and at last combine them into a small globe, to which fresh additions are constantly made. A young globe increases its size also, not only by the growth of the original company, but by the addition to it of its newly-hatched young; which, as they emerge from the egg, squeeze a place for themselves among their elders.

But the process has its limits. After a time the globe is too thickly packed, and a young swarm starts off as already described. The largest globes often separate into two portions, each of which soon rounds itself into a sphere; no doubt they are torn apart by the strain on them produced by the opposing action of the ciliary wreaths in opposite hemispheres.

The **internal structure** resembles that of *Melicerta*, but a few points require notice. The **trophi**[1] are tinted orange-red, and so is the lower end of the buccal funnel, where are the lips which form an entrance to the mastax: these latter resist the action of caustic potash. The **stomach** appears to be divided into two chambers, which lie symmetrically on the right and left sides of the body; while between and below them the intestine is curved abruptly back towards the dorsal surface; so that its long **rectum** ends in an unusually highly placed **cloaca.**[2] Indeed the whole of the viscera are, as it were, tucked high up into the trunk, leaving its lower end empty of all but the longitudinal **muscles.** Six of these run from the head over the trunk, down the broad, transparent, spindle-shaped foot. Five or six bands of transverse muscles cross the trunk, at somewhat regular intervals, from the neck to where it joins the foot. This latter is generally drawn up a little into the body, at its junction with it, so as to make there a conspicuous fold in the integument. The **vascular system** has no **contractile vesicle,**[3] but its function is performed by the cloaca; which I have often watched dilating and emptying at regular intervals. The **lateral canals** arise in a plexus on each side of the corona, slope downwards dorsally to a similar plexus in each shoulder, and throw out on their way branches, above and below the nervous ganglion, which appear to run into each other. From each shoulder-plexus the canal is continued, still near the dorsal

[1] Judge Bedwell (*loc. cit.*) gives a minute, careful, and original account of the structure and action of the trophi.

[2] Mr. Gosse (*loc. cit.*) described and figured the faecal pellets, which he supposed to be eggs. His account of them is as follows:—"Their form is very peculiar; it appears to be nearly circular, flattened on one side and convex on the other; there is considerable difference in their size; they are of a pale-yellow hue, marked with several blackish specks."

[3] Dr. Cohn (*loc. cit.*) says that each lateral canal ends in a dilated portion or small contractile bladder, which empties itself into the cloaca, and that the two act alternately. The arrangement, however, seemed to me to be that given in the text. I have drawn in Pl. VIII. fig. 3*i* what I saw. The figure shows a lateral canal (*lc*) ending in what I supposed to be the cloaca (*cl*), and which dilated and contracted regularly. Unfortunately, I have not been able to procure a specimen of *C. volvox* since I read Dr. Cohn's paper.

surface, down to the cloaca. The **vibratile tags** can be easily seen. There is a conspicuous **nervous ganglion** on the dorsal side, just above the neck, and below the two **eyes**. These latter are beautiful little hyaline spheres (fig. 3*h*) resting on patches of crimson pigment.[1] The two **antennæ** rise from the corona, on the sloping walls of the buccal funnel between it and the ventral gap (fig. 3*a*, *a*). They are adnate at the base, and each carries a bristle that can be withdrawn within a tubular sheath (fig. 3*g*), as in *Melicerta*. The **ovary** is frequently obscured by a large egg, lying across the body, in which the red eyes, moving cilia, and mastax of the young animal are distinctly visible. I have frequently noticed living **spermatozoa** attached to the outside of the ovary: how they can get there it is not easy to see, unless they can find their way from the cloaca, up the lateral canals, and out of the vibratile tags into the body-cavity.

I have watched the formation of an **ephippial egg** from the first enclosing of a considerable portion of the ovary, through the changes shown in figs. 3*k*, 3*l*, 3*m*, to the ultimate production of an egg (fig. 3*n*), covered with a deep layer of hexagonal cells, and bristling with spines, from each spot where the angles of the hexagons meet. As Mr. Davis has well observed, it is a misnomer to call these "winter" eggs, for they occur in all seasons of the year.

The **male** (Pl. VIII. 3*d* and 3*p*), as usual, consists of little else than a sperm-sac and penis. Its general appearance when swimming is shown by Mr. Davis (*loc. cit.*) and its internal structure has been worked out by Dr. Cohn, one of whose figures is reproduced in Pl. D. fig. 10. Dr. Cohn (*loc. cit.*) says that the nutritive system, from mouth to cloaca, is wholly wanting; that the vascular system is indistinct, though probably present; that the whole head is occupied by a great nervous ganglion; and that there are two eyes, which consist of refracting lenses set in pigment. He also describes, and figures, the spermatozoa (Pl. VIII. fig. 3*q*), which he saw under unusually favourable circumstances; and noticed their attachment to the outside of an ovum (fig. 3*r*).[2]

Length. Diameter of large cluster, about $\frac{1}{20}$ inch; length of individual, about $\frac{1}{40}$ inch. Mr. Gosse has counted as many as 70, and Mr. Davis 100, in a single cluster. **Habitat.** Lakes, clear ponds, and pools: common.

C. DOSSUARIUS, *Hudson*, sp. nov.

(Pl. VIII. fig. 4.)

Cephalosiphon dossuarius . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. v. 1885, p. 611, pl. xii. fig. 4.

SP. CH. **Cluster** *unsymmetrical, of one adult and a few of its young*; **tubes** *distinct*; **ventral antennæ** *below the corona, long, adnate for nearly their whole length.*

This rare species was discovered by Mr. Bolton in September 1884 near Birmingham. It is remarkable for the size, shape, and position of the **antennæ**, which stand on the arched ventral surface like a rifle-sight on the barrel. The specimens that Mr. Bolton sent me were all solitary, carrying with them, as they swam, their cases with the contained eggs; but Mr. Bolton tells me that the clusters which he usually met with consisted of one adult and a few young individuals of various sizes. On one occasion, too, he saw an adult with one large egg, and four much smaller eggs in its tube. If these latter were male eggs, and the former a female one, this observation would, I believe, be unique.

I had no opportunity of studying the internal structure of this Rotiferon closely; but I detected no difference in this respect between this species and *C. volvox*.

Length. My solitary specimen was $\frac{1}{50}$ inch. **Habitat.** Near Birmingham (T.B.).

[1] Dr. Imhoff says (*loc. cit.*) that in the specimens in Lake Zug the pigment is black, and Dr. v. Eichwald (*loc. cit.*) found specimens, in ditch-water at Hapsal, in which the eyes were invisible.

[2] The Rev. Lord S. G. Osborne has described (in a letter to the 'English Mechanic,' March 1, 1878), clusters of *Conochilus volvox* which bear at their centres bundles of fine stick-like diatoms. I am indebted to his Lordship for a cluster, mounted by himself, and containing these needle-shaped bodies. They appear to be of three kinds; they are colourless, and their distinctive markings (if any) are so obscured by the rotiferous jelly, that it is very difficult to say whether they are diatoms or desmids. Lord Osborne's explanation of their presence in the cluster is no doubt the true one: namely, that they are drawn in point-downwards, bit-by-bit, at each sharp contraction of *Conochilus* into its ball.

CHAPTER VII.

BDELLOIDA.

Si quæ de animalculis infusoriis dici possunt enarrentur, verbaque et oculorum acies sufficerent, dicendi nullus finis esset. Paucissima magnificentiæ et splendoris Numinis optimi maximi documenta prodere mens humana valet; in plurimis stupet et obmutescit.—O. F. Müller.

He, who feels contempt
For any living thing, hath faculties
Which he has never used;
. . . thought with him
Is in its infancy.

Wordsworth.

CHAPTER VII.

Order II. BDELLOIDA.

Swimming[1] *with their ciliary wreath, and creeping like a leech;* **foot** *wholly retractile within the body, telescopic, ending almost invariably in three toes.*[2]

The Leech-like Creepers form so natural a group of animals that all the classifiers of the Rotifera have placed them by themselves. Ehrenberg, Dr. S. Bartsch, Herr K. Eckstein, have arranged them in the family *Philodinæa*; Dujardin, in the order of the *Rotifères*; and Dr. Leydig, in his un-named second family of Rotifera "with a long, jointed, telescopic, retractile foot." This extremely characteristic foot is to be found only in the two families of this order, the *Philodinadæ* and *Adinetadæ*. The longitudinal muscles, which pass down the foot, end at intervals below each other, so that their contraction draws the lowest part of the foot into that just above it, and this in its turn is drawn into the part above, and so on; until the whole foot can be shut up like a telescope, and withdrawn completely into the trunk.

A special interest attaches to the *BDELLOIDA*. Specimens of various species in both the families have been dried, suffered to lie in that condition for three or four years, and then brought to active life again by being placed in water.[3] I have no space to give the history of this question, and of the controversies that have arisen about it, some of which, indeed, are still as lively as ever; I shall therefore confine myself simply to a relation of facts whose reality may be easily tested, and of the satisfactory explanation of them given by Mr. Davis.[4] If specimens of *Philodina roseola* be placed with a little clear water on a slip of clean glass, and the water be quickly dried up, they will all be killed; no watering will revive them. I have tried this scores of times and never met with a case of recovery. But if the rotifers be placed in a cell that contains a little sand, or moss, then the cell may be dried even *in vacuo* over sulphuric acid; and yet, when water is again added to it, in the majority of cases, some of the Rotifera will be found to be still alive: or the cell with the water, sand &c., and the animals may be gradually heated up to 200° Fahr., and yet some of the creatures will probably recover if, when the cell is cool, fresh water be added: or once more, the cell may be laid aside for several years in utter dustiness, and still, on the addition of a few drops of water, the chances are that, in the course of an hour, a few of the animals will revive. Now the real point is obviously this. If a Philodine can be revivified after having been dried in

[1] [The swimming faculty in this order is very subordinate. We never see a *Philodina* or a *Rotifer* sailing smoothly hither and thither, turning waywardly on its course, and roving about with no apparent aim, like a *Microcodon* or a *Euchlanis*. It will bore through a mass of vegetation, and, on coming to its margin, shoot straight away on a voyage of discovery. But the very first new bit of sediment that it meets arrests it; it instantly creeps into this, and makes this its home for a while: as if its natatory powers were used merely for change of place, as distinguished from actual enjoyment in swimming.—P.H.G.]

[2] All the known British species have three toes. Dr. L. K. Schmarda has described some foreign species with only two toes; but I think it probable that he is mistaken.

[3] Mr. Jabez Hogg (*English Mechanic*, Jan. 16, 1885) says that he has seen rotifers revive "after fifteen years' careful seclusion."

[4] *Mon. Micr. J.* vol. ix. 1873, p. 206.

sand over sulphuric acid, or gradually heated to 200° Fahr., or left to the neglected dust of years, why will it not recover from the effects of quick evaporation, without sand, on a glass slip, in the comparatively moist air of a sitting-room? It has been suggested that, by burying itself in the sand, the animal obtains a covering to protect its internal fluids. But this explanation does not meet the case of Rotifera heated in sand up to 200° Fahr. Surely hot sand at this temperature would be a poor protection for the natural juices of a soft-bodied Rotiferon. On taking some earth or sand containing dried-up Philodines, we shall see them dotted here and there, adhering to the earth's particles, and looking like little red, orange, or white balls. If one of them be picked out, and a drop of water placed on it, after a quarter of an hour or so, a part of the infolded foot will usually shoot out with a jerk, and the foot itself will then gradually lengthen joint by joint. Often, at this stage, the jaws will be seen to be at work, and the head will be driven out with its corona and wreaths still furled: at last these in their turn open, and the recovered animal begins to roam about, or to work for food. Now if, before we moisten the rotiferous earth, a bright light be thrown down on the ball-like Rotifera, it will be seen that each globe has a nearly smooth glittering surface, as if it were coated with a gelatine that filled up the hollows between the stout ridges which run from head to foot. This is the key to the puzzle; for Mr. Davis suggests that the Philodine survives the air pump, oven, and sun-baked gutter, by drawing-in its head and foot into a ball, and then secreting round itself a gelatinous coating which hardens in air and effectually preserves its internal fluids from evaporation. That the gelatinous coat does preserve these fluids Mr. Davis proved by crushing the little balls and finding them all moist within.

But why can the creature do this when sand or moss is present, but fail to do it under much less severe trials in their absence? Here, too, Mr. Davis's explanation is complete. The water dries more slowly when there is sand or moss in it.[1] The Philodines (who are gutter-lovers) are trained in being dried up under these conditions. They naturally creep to the little heaps of sand &c., where the water lingers longest, and, finding it going, contract themselves into a ball, pour out a viscid secretion over their bodies, and prepare for the worst. But all this takes time, and, on the clean glass slip, not only does the water evaporate too quickly, but the animal is too restless in the unusual conditions in which it finds itself to attempt its ordinary defence. As I have often seen, they roam about, vainly seeking shelter, till it is too late; they are overtaken by the rapidity of the evaporation, and dry up never to recover.

[1] It has been questioned whether the presence of sand in a cell, or in a gutter, does retard the evaporation of the water. An experiment or two would soon satisfy a doubter; and a little consideration will show the cause of the retardation. When a drop of water is enclosed by three or four morsels of silex, nearly in contact, it is protected by the silex from evaporation everywhere except at the surface. In fact it is in a similar condition to water in an uncorked bottle. Of course the water will dry up in such a bottle at last, but it will evaporate very much more slowly than it would do were it poured out on a marble slab.

If Philodines be left in a zoophyte trough, they will often be found dried up in one of its corners, for the water lingers longest in the angle formed by the bottom and sides. Their instinct leads them too, when other defences fail, to gather together in clusters so as to protect the evaporating water by their own nearly-touching bodies. The Rev. E. J. Holloway, taking advantage of this habit, has succeeded in drying up groups of *P. roscola*, on slips of clean paper, quite free from sand or rubbish of any kind. He kindly sent me two or three of these slips; and an inspection of them under the microscope confirmed the correctness of Mr. Davis's theory. The fibres of the paper had evidently delayed the evaporation long enough to enable the rotifers to resort to their customary defence. Each Philodine is the centre of a patch of glutinous secretion, which meets the similar patches, surrounding its neighbours, in a succession of straight lines; so that the whole group has quite a tesselated appearance. Here and there, where fibres pass over or through a group, long tongues of the secretion stretch from the animals to the fibres; and, in one case, a rotifer, that had tried to squeeze itself under some interlacing fibres, had been caught; and, so held, had been moored to half-a-dozen others by radiating viscous cords. The efficiency of the protection was at once shown by dipping one of the slips into water, and watching the Philodines revive as the secretion dissolved.

All the Rotifera seem to possess the power of secreting a viscous fluid, which they put to various uses. The *Rhizota* form their cases of it; the *Ploïma* and *Scirtopoda* draw it out in long threads from spots to which they have adhered, and thus moor themselves to external bodies; while the *Bdelloida*, by coating themselves all over with it, not only resist the extremities of heat and drought, but set at defiance Old Time himself.

Family III. PHILODINADÆ.

Corona *a pair of circular lobes transversely placed;* **ciliary wreath** *a marginal continuous curve, bent on itself at the dorsal surface so as to encircle the corona twice, with the buccal orifice between its upper and lower curves, and having also two gaps, the one dorsal between its points of flexure, and the other ventral in the upper curve opposite to the buccal orifice;* **trophi** *ramate.*

The genera of this family resemble each other so closely that it has often been suggested that they should be reduced to one. They differ from each other chiefly in the number and position of their eyes. One genus has them at the free end of the cylindrical frontal column which forms the anterior portion of the head; and within which, through a fold on its ventral side, the rotatory apparatus can be withdrawn. In another genus they are placed within the neck; while in a third they are entirely wanting. Now, strong objections have been made, by Dujardin and others, to Ehrenberg's use of coloured spots for the purposes of classification; mainly on the ground that it is not certain that they are really organs of sight: and it is true that, in many cases, there is little else to be seen in these so-called eyes but an irregular spot of pigment. On the other hand, some of the Rotifera have unmistakable eyes, consisting of a spherical lens seated on a sort of red, black, or purple cushion. Nerve-threads too, in some species, can be traced from the ganglion to the eyes; and by this means the general positions and appearance of coloured spots, that really are eyes, have been established. Moreover (as might have been expected), the undoubted eyes prove to be in these cases good generic characters. When, therefore, pigment spots are visible in positions that the undoubted eyes usually hold, it is reasonable to consider them to be organs of vision however humble, and to make use of them with other characters in classification. In the genus *Rotifer*, nerve-threads may be seen passing from the ganglion to the eyes in the frontal column; and in *Rotifer vulgaris* Dr. Otto Zacharias has observed "that each of the two carmine-red eye-spots is furnished with a crystalline body." Again, in the genus *Philodina* the position of the red spots with respect to the nervous ganglion is precisely that which is held by such unmistakeable eyes as those of *Conochilus volvox*. I have decided, therefore, to retain the old genera with only a few alterations.

Genus PHILODINA, *Ehrenberg.*

GEN. CH. **Eyes** *two, cervical.*

The Rotifera comprised in the genus *Philodina*, though technically separated from the rest of the family by their having two eyes in the neck, can be generally recognized at a glance by their greater stoutness of build, by their larger heads, by their more powerful wreaths, and by their habit of so contracting the foot as to form an abrupt division from the trunk. The **corona** and ciliary wreath would closely resemble those of *Limnias*, were it not for the break in the latter just opposite to the buccal orifice, by which the upper wreath is converted into two segments of circles. The animal, too, holds itself differently from the *Rhizota* while it is feeding; for it slightly arches the dorsal surface so as to throw forward its dorsal antenna; while the *Rhizota* (with the exception of *Cephalosiphon*) reverse this, and arch the ventral surface so as to throw forward the two ventral antennæ. A *Philodina* or *Rotifer*, when creeping, shows no

external sign of **corona**: the animal tapers to a point in front as well as in rear. It attaches itself by the tip of its head, and then, releasing and shortening its telescopic foot, takes a fresh hold and arches its body like a leech or geometric caterpillar: it then releases the head in its turn, extends its body, and takes hold again. When it wishes to swim, or to feed, the front of the head is arched backwards; and, by the action of the transverse muscles diminishing the visceral cavity and so driving forward the body fluids, the infolded corona is forced out of a puckered slit on the ventral surface, just where the head joins the trunk. As the corona is pushed out, each disk begins to unfold, and its cilia to act; while at the same time the tapering forepart of the head, or **column**, is thrown backward, falling on the neck, between the lobes of the corona, much as the hood of a cloak falls upon a lady's shoulders, when it has been dropped from her head. The **trunk** is frequently marked with longitudinal furrows, which make it difficult to observe the viscera; and in some species it is tinged with reddish yellow, or brown; while the extremities are usually free from colour. The penultimate joint of the telescopic **foot**, in every species but one, carries a pair of soft tapering processes, called **spurs**, which appear to be useful in giving the Rotiferon a firm hold. The method of attaching itself is this: the three soft toes, rendered sticky by a secretion that exudes from them, are first fastened to the object; then by the contraction of the longitudinal muscles the last joint is drawn over the toes, and the penultimate joint over the last; till the penultimate touches all round the object to which the animal is attached, and the spurs also are brought into contact with it. By this means the Philodine is securely fastened so as to be able to resist the action of its ciliary wreaths, or to dart back without letting go.

There are a few points in the internal structure that call for notice. The **mastax** contains two stout rami, whose appearance is best described by Pl. C. III. fig. *ti*. They are crossed by two or three principal teeth, with sharp points projecting beyond the interval ridges of the rami, and by a multitude of minute ridges parallel to the teeth. There are also faint indications of the three chitinous loops, attached to each ramus, which are conspicuous in the malleo-ramate type.

The **stomach**, intestine and rectum (unlike those of *Rhizota*) are nearly in a straight line, and the cloaca is situated below the junction of the foot and trunk. The walls of the stomach are unusually thick and absorbent; and become tinged with coloured food almost immediately after it is eaten. The stomach, when empty, is reduced to a tube of narrow bore, whose end dilates into a globular intestine: there appears to be a sphincter muscle separating the two.

Gastric glands, though small in size, are usually visible; and foot glands constantly.

The **contractile vesicle** can be readily seen symmetrically placed in front of the intestine, and though it is difficult to make out the lateral canals, it is generally easy to see some of the vibratile tags. A large triangular **nervous ganglion** lies in the neck, its apex pointing forward, and with a red eye on either side of the apex. The dorsal antenna[1] is long, tubular, and setigerous; its terminal part can be withdrawn within the basal, in the same telescopic fashion as that in which the foot is shortened. No ventral antennæ have been recorded.

The **reproductive system** has been but imperfectly made out. The ovary, with its contained germs, is distinctly visible on either side of the stomach, but no oviduct has as yet been detected.

When a germ becomes developed into an ovum, it is seen, as it grows, to be gradually separated by a constriction from the rest of the ovary, and at last appears to drop off into the body-cavity, in which the young is sometimes completely hatched.

Both the living **young** and the egg have been seen to issue from the cloaca, but it

[1] [The occipital **antenna** is normally three-jointed, but in some species the third joint is habitually concealed, in others protruded. Yet this, though characteristic, is not invariable. The terminal joint is three-lobed, each lobe carrying a projecting seta.—P. H. G.]

is difficult to suggest how this is managed, as there appears to be no communication between the body-cavity and the cloaca.[1]

No **male** has as yet been observed among any of the *Philodinadæ*.

P. ERYTHROPHTHALMA, *Ehrenberg*.

Philodina erythrophthalma . . Ehrenberg, *Die Infus.* 1838, p. 499, Taf. lxi. fig. 4.
" " . . Pritchard, *Infusoria*, 1861, p. 705, pl. xxxviii. fig. 4.

[SP. CH. **Body** *smooth with a thick bulging collar;* **corona** *ample with a broad shallow sulcus;* **frontal column** *having no proboscis;* **antenna** *decurved, three-jointed;* **eyes** *conspicuous rond-ovate;* **teeth** *two;* **foot** *stout gradual. Animal hyaline, colourless.*

The characters assigned to this and the following species must not, I confess, be pressed with minute exactitude; nor are they all of equal value. Some of the species do not differ very obviously *inter se*. Still, I think, all *are* specifically distinct; and the cumulate character, which, with some thought and care, I have assigned to each, may aid the scient in discriminating forms too easily confounded.

This first species of the genus is one of the most difficult to be diagnosed with precision; though it is of conspicuous size, and of so common occurrence as to fall very early under the notice of the student. It was almost the first of the Rotifera[2] which I essayed to describe and delineate, nearly seven-and-thirty years ago, from specimens obtained in the north suburbs of London.

The most readily observable feature is, that below the **corona**, itself of ample dimensions, there is a thick prominent neck, bounded by sensible constrictions. Thus it seems inseparable from Professor Ehrenberg's *P. collaris*; and, indeed, I shrewdly suspect these to be but one and the same species, in different stages of growth. The gradual, instead of sudden, transition of the trunk into the stout **foot**, is another character easily noticed. The **proboscis**, which in this family is general at the tip of the frontal column, seems, here, wholly wanting; the truncate tip having only a slight transverse depression. But the point is peculiarly difficult of determination in this species.

The specific name, besides being repulsive from its uncouth aggregation of unpronounceable consonants, is unsuitable, because undistinctive. The possession of red eyes is common, not only to all *Philodinæ*, but almost to all Rotifera.

Length, $\frac{1}{100}$ inch to $\frac{1}{60}$ inch. **Habitat**, weedy pools, widely distributed: common.—P.H.G.]

P. ROSEOLA, *Ehrenberg*.

(Pl. IX. fig. 4.)

Philodina roseola . . . . Ehrenberg, *Die Infus.* 1838, p. 499, Taf. lxi. fig. 5.
" " . . . . Pritchard, *Infusoria*, 1861, p. 705, pl. xxxv., fig. 490.

[SP. CH. **Body** *smooth, with no constriction nor swelling at the neck;* **corona** *moderate, with a deep square sulcus;* **antenna** *two-jointed, nearly horizontal;* **eyes** *small, oblong, oblique;* **teeth** *two*[3]*;* **foot** *stout, gradual. Translucent, ruddy in hue.*—P.H.G.]

No doubt it was this common and hardy species which Leuwenhoek discovered in

[1] See footnote, p. 103, for a suggested explanation of the difficulty.

[2] [It was the second. *Euchlanis dilatata* was the very first.—P.H.G.]

[3] Lord Osborne kindly sent me many beautiful specimens of the trophi of *P. roseola*, which he had mounted both plain and tinted with carmine. They were in every possible position, so as to admit of a thorough study of the jaws. Among these I found several with two teeth only in each ramus, and a few with two in the one and three in the other. I am aware that, when not accurately focussed, this appearance will be sometimes improperly obtained; but I took care, by delicate focussing, to be able to count the pointed ends of the teeth in each case. Dr. Oskar Schmidt has noticed the same thing in *Rotifer vulgaris* (*Archiv f. Naturgeschichte*, xii. Jahrg., 1 Bd. 1846, p. 69, Taf. iii. fig. 4).—C. T. H.

the form of little pink balls in the dried-up dirt of a house-gutter; and whose revivification he describes. It is very common in ponds, water-butts, and housetops; and will bear to be dried up and reanimated, again and again, without injury. It is, too, most prolific in situations that suit it; and these are sometimes odd enough. Lord S. G. Osborne, for instance, found that the dust of two stone vases in his grounds at Blandford was thick with the little pink spheres of *P. roseola*, and with the white ones of *Adineta vaga* (*Callidina vaga*, Davis); and he supplied his microscopic friends for years with this rotiferous dust.

[The **body** is sometimes of a delicate flesh tint, often deepening to full rich red in the cellular walls of the ample stomach, but fainter at the head and foot; it is evident that the tint does not depend on the nature of the Rotiferon's food, and it is quite as glowing in the half-grown animal.

The **corona** is large, with a deeply cleft sinus, and the two wheels of the ciliary wreath are remarkably fine. The **frontal column** is large, cylindrical, truncate, and strongly ciliated. The proboscis has a soft decurved hook on its very front (fig. 4*b*), which is probably a tactile organ of great sensibility. I believe that I have seen it used for grasping the slender stems and filaments, laying hold of one between the hook and the face. In progress through clear water the creature often makes a perceptible snatch forward, as if it caught prey with the organ, though none was visible. Only in accurate profile, and full extension can this be seen. The broad head of the **stomach** embraces the base of the mastax; and, when the animal is extended, this viscus is so stretched that the middle portions are drawn thin, while the ends are dilated. There is a short round distinct **intestine**; and the **cloaca** is at the base of the first joint of the foot. Two earlike triangular **gastric glands** are visible, one on either side of the mastax; and there is a small **contractile vesicle** which contracts about every thirteen seconds: but the colour of the body and its longitudinal folds interfere greatly with the sight of the internal organs. The **eyes** are of a beautiful pale red; but are invisible by reflected light. Under pressure eight transverse **muscles** have been distinctly seen, as shown in fig. 4*d*.—P.H.G.]

Length. When extended, about $\frac{1}{50}$; in a dried condition they are globes of $\frac{1}{400}$ to $\frac{1}{200}$ inch in diameter. **Habitat.** Ponds, water-butts, house-gutters: common.

P. CITRINA, *Ehrenberg*.

(Pl. IX. fig 6.)

Philodina citrina	Ehrenberg, *Die Infus.* 1838, p. 501, Taf. lxi. fig. 8.
" "	Gosse, *Tenby*, 1856, p. 299, pl. xix.
" "	Pritchard, *Infusoria*, 1861, p. 705.
" "	Eckstein, *Sieb. u. Köll. Zeits.* Bd. xxxix. 1883, p. 353, Taf. xxiv. fig. 14.

[SP. CH. **Body** *smooth with a distinct constriction below the swelling disk, but no collar;* **corona** *wide, with a deep square sulcus;* **antenna** *nearly horizontal;* **eyes** *minute, oblong, oblique;* **teeth** *two;* **foot** *moderately slender, abrupt. Transparent, yellow.*

There is great resemblance of form between this and the preceding; but the differences enumerated above, though mostly minute, help to distinguish it. The **colour**, however, is the main peculiarity. This is normally a rich clear yellow, like a topaz; yet specimens occur in which the hue is much paler and duller: and the extremities are always colourless. Under reflected light the creature is an object of great beauty. The citron hue becomes positive, and brilliant, separated abruptly from the hyaline extremities; while the whole animal assumes a sparkling, glittering appearance, reflecting the rays of light from various points, as if it were carved out of a precious stone.

Though there is no turgid neck, as in *P. erythrophthalma*, there is a more marked constriction than in *P. roseola*, the hemisphere which carries the **corona** being more

ventricose, and marked more distinctly with oblique ridges. The period of the **contractile vesicle** is about sixteen seconds.

It is lively and sprightly. It breeds freely in captivity; in a phial it congregates at the very margin of the water; if they are numerous, a glance along the water line with a lens gives a pleasing sight; it reveals a whole array of the tiny creatures hanging head-downward, in the ridge of water produced by the attraction of cohesion, their amber-like bodies of various sizes, and their broad white crown-wheels all in full play. They do certainly appear to have the instinct of companionship, as Ehrenberg has observed of another species.

Length, $\frac{1}{100}$ inch to $\frac{1}{50}$ inch. **Habitat.** Widely scattered, but by no means common. Near London; Widcombe Pond, Bath; Tenby (P.H.G.).—P.H.G.]

P. MEGALOTROCHA, *Ehrenberg*.

(Pl. IX. fig. 7.)

Philodina megalotrocha . . Ehrenberg, *Die Infus.* 1838, p. 501, Taf. lxi. fig. 10.
" " . . Pritchard, *Infusoria*, 1861, p. 705.

[SP. CH. **Body** *smooth, with no constriction nor swelling at the neck;* **corona** *very wide, with no conspicuous sulcus;* **antenna** *three-jointed, unisetate, decurved;* **eyes** *large, roundish;* **teeth** *two;* **foot** *slender, abrupt. Hyaline.*

The great width of the expanded **corona**, and the size of the frontal column and antenna, are very noticeable in this species; as also the plumpness of the body, and its sudden attenuation to form the foot, whence its appearance is somewhat like that of *Rotifer macrurus*. The spurs are small and the toes short, thick, and truncately conical. The **mastax** is set more transversely than usual, so as not to be made out in a longitudinal aspect. Two teeth cross each ramus. In certain lights there seem to be three; but a true adjustment with a power of 300 reveals the projecting points, and shows them to be distinctly two. There is a wide sub-cylindrical **stomach** with a tubular passage, followed by a short and somewhat transverse intestine. This latter discharges, through a narrow but distinct rectum, beneath the second telescopic joint of the foot. Traces of small globose **gastric glands** are seen beneath the mastax. A small **contractile vesicle** lies in front of the rectum. No other portion of the **vascular system** has been recorded. The **ovary** is large with many clear nuclei. The **antenna** appears to have only one terminal seta.

Length. About $\frac{1}{100}$ inch. **Habitat.** Ponds, ditches, &c.: not uncommon.—P.H.G.]

P. ACULEATA, *Ehrenberg*.

(Pl. IX. fig. 5.)

Philodina aculeata . . . Ehrenberg, *Die Infus.* 1838, p. 501, Taf. lxi. fig. 9.
" " . . . Dujardin, *Hist. Nat. Zooph.* 1841, p. 660.
" " . . . Eckstein, *Sieb. u. Köll. Zeits.* Bd. xxxix. 1883, p. 352, Taf. xxiv. fig. 15.

[SP. CH. **Body** *beset with spines, having no constriction nor swelling at the neck;* **corona** *not so wide as the body;* **antenna** *two, long-jointed, mobile;* **eyes** *large, nearly round;* **teeth** *three;* **foot** *thick, gradual. Dark brown.*

This species is easily recognised by the **spines** which have given it a name; but I cannot find these appendages nearly so numerous as in Ehrenberg's figures.[1] Nor are they scattered irregularly over the body, but are arranged in rows on the dorsal aspect. The first row consists of three spines; the next two rows have two each, and are placed

[1] Ehrenberg draws as many as twenty-seven spines, irregularly placed, on the dorsal surface. Dujardin (apparently following Ehrenberg's description) says that the body is 'tout hérissé d'épines molles.' Herr Eckstein's description and figure, however, exactly tally with those of Mr. Gosse, only the two spines, which in Mr. Gosse's figures (*5b*, *5d*) of the contracted animal point forwards, are drawn pointing backwards in Herr Eckstein's figure of the uncontracted animal. Very likely the direction of the spines is liable to be reversed by the creature's contortions.—C. T. H.

near together about the middle of the back, and the fourth has also two at the bottom of a strong constriction where the body begins to be attenuated: this pair appears to terminate the body (fig. 5*b*) when contracted, the posterior segment being bent up and forward. The upright spines shown in Ehrenberg's figure I have represented in fig. 5*b*. They are situated one on each side, level with the second pair of dorsal spines. Under pressure, and when seen dorsally, the body assumed the appearance of fig. 5*d*; by which the relative positions of the spines is better shown. The **frontal column** is large and cylindrical, resembling that of *R. macrurus*; the tip, which is truncate, but furnished with a little protrusile proboscis, is ciliated, and capable of a rotating vibration. The **wheels** are large, and the sulcus at the chin is deep.

The **antenna** is large and prominent; it is capable of being erected, of projecting horizontally, or of hanging downward. It consists of two joints, the first tapering to the articulation, which is telescopic, the second dilating to the tip, which is distinctly three-lobed. The deep yellowish umber hue of the body, and its close-set longitudinal furrows, effectually impede the discernment of the internal organs; but I could see that there is a capacious **digestive canal**, which attenuates near the fourth row of spines, and terminates in a **cloaca** at the end of the next segment. Near this point is a small **contractile vesicle**. A large oval transparent **ovum** was seen in the ventral region of the trunk. As it showed the jaws perfectly developed, I presume the species to be viviparous. This species very seldom expands its corona while stationary; it is impatient, restless, perpetually crawling, or pushing about its closed fore-parts in all directions, while attached by the foot. Generally the expansion of the corona is instantly followed by the detachment of the foot, and away the creature shoots head-foremost, and glides rapidly about the live-box until it is suddenly arrested by coming into contact with some object.—P.H.G.]

Length. When extended, about $\frac{1}{50}$ inch. **Habitat.** Ponds near North London, (P.H.G.): rare.

P. TUBERCULATA, *Gosse*, sp. nov.

[SP. CH. *Scarcely distinguishable from* P. aculeata, *but the surface beset with rough tubercles, instead of spines.* **Body** *much fluted longitudinally;* **antenna** *with a small three-lobed, club-shaped, terminal joint;* **eyes** *very small;* **teeth** *three, thick;* **spurs** *long, slender, slighly sigmoid, acute. Dark brown.*

A species in most particulars resembling *P. aculeata*, with like club-shaped **antenna**, much corrugated and plicated, and of a pronounced **wood-brown** hue, but having the recurved spines replaced by rough irregular **tubercles**, has occurred in water sent by Mr. Bolton, Birmingham, from Sutton Park. The sediment of this water, of rich golden brown hue, largely consisting of floccose fæcal deposits, as I suppose, full of great Desmids and other algæ, has proved usually rich in Rotifera. Among them, grubbing sluggishly, was this uncouth *Philodina*; the whole body clogged with sediment. For some time I supposed that it might be *P. aculeata*, the spines modified into tubercles; but I have found *P. aculeata* repeatedly since, with the spines clear and sharp, exactly as I had drawn them from life thirty-five years ago. And I have also since found numerous examples of this tubercled form, from other waters, in no respect differing from the first; so that I have no doubt of its being an undescribed species. It has very close resemblance to *Rotifer tardus*, except that the two eyes are not in the frontal column, but on the level of the mastax. It has also the manners of that species, slothful, wallowing in the gelatinous floccose, reluctant to move, but ready to rotate.

The **frontal column**, when extruded to the utmost, is tipped with vibratile cilia, amidst which a minute proboscis projects, which is double, consisting of two obtuse blade-like clear laminæ, side by side, and slightly divergent.

Length, $\frac{1}{50}$ inch. **Habitat.** Sutton Park, Birmingham (P.H.G.): rare.—P.H.G.]

Genus ROTIFER, *Schrank*.

GEN. CH. **Eyes** *two, within the frontal column.*

At first sight it seems strange that so humble a form as that of *Rotifer* should have succeeded, not only in attracting universal attention, but also in giving its name to the whole class of animals to which it belongs. But there are good reasons for its having done so. The genus is most widely distributed; it has been found in almost every quarter of the globe: apparently, indeed, wherever it has been looked for. It haunts alike the damp moss on the Great Sidelhorn at a height of 8,000 feet, and the swamps and sea-weeds of the Finnish coast; and seems equally at home under the ice in moor-pools on St. Gotthard, and in the irrigating ditches of the gardens at Cairo. It is, too, as prolific as it is common, and breeds in captivity as freely as when at liberty. Moreover, the genus *Rotifer* exhibits the wonder of ciliary rotation in its most effective form; for its wreath when in full action looks precisely like a pair of escapement-wheels of a watch, whirling round at great speed, the cogs looking "sometimes like the ancient battlements of a round tower; at others ending in sharp points, and forming a kind of Gothic crown; now bent all the same way like so many hooks, and now with their ends clubbed like a number of little mallets." How a living creature could possess or use such a contrivance was a hopeless riddle to the early observers; though even some of the earliest expressed the opinion that the appearance was an optical illusion.

But the marvels of the genus did not end here. It had been asserted by Leuwenhoek that the creatures might be dried up for months, and yet be restored to life again. This was enough to fire the dullest imagination; and as also a brisk controversy sprang up about the accuracy of this assertion, the charms of a dispute were added to those of a *Rotifer*, and it was no wonder that the genus secured all its honours; and, like the bramble, was raised by circumstances to a position which it little deserved.

The whole structure of the genus is so nearly that of *Philodina*, that it requires but little notice. The **eyes** are placed close together within the column, generally near the extremity, instead of in the neck, as in the case of *Philodina*. Nerve-threads have been traced to them and light-refracting bodies seen in them, in the case of *Rotifer vulgaris*, by Dr. Zacharias. The only portion of the internal organization that has not been satisfactorily made out is the **reproductive system**. Just as in *Philodina*, no oviduct has as yet been discovered; and no one has explained how it is that the living young pass from their apparently free position in the body-cavity into the cloaca, through which they have been seen to issue.[1]

The **male**, too, is equally unknown; a strange fact, when one considers first that the structure of the female reproductive organs, so far as it has been studied, is that of a typical Rotiferon; and secondly, that thousands of specimens of this genus must have been watched by many practised observers, during the century and a half which have elapsed since the animals were discovered.

[1] It is possible that the long thread, which is often seen to pass from the posterior end of the ovary towards the cloaca, may really be, not a muscle, as is usually supposed, but the collapsed oviduct terminating in the cloaca. Should this be the case, then the ovum, when it drops from the ovary, does not fall into the body-cavity, as has been supposed, but simply stretches out over itself that portion of the delicate investing membrane, which had up to that moment been shrivelled into a mere cord. As the membrane investing the ovary is of extreme tenuity, it is just possible that it has escaped observation when extended, not only over the ovary, but even over the developed young. If this explanation prove correct, there is nothing abnormal in the reproductive system of *Rotifer*. Mr. Gosse quite concurs with me in taking this view of the case: a view which had occurred to him before he read my note.

R. VULGARIS, *Schrank*.

(Pl. X. fig. 2.)

Rotifer vulgaris	Ehrenberg, *Die Infus.* 1838, p. 484, Taf. lx. fig. 4.
" "	Pritchard, *Infusoria*, 1861, p. 703, pl. xxxv. fig. 476–480.
" "	Claparède, *Ann. Sci. Nat. Zool.* 5 Sér. t. 8, 1867, p. 11, pl. iii. figs. 6, 7, pl. iv. fig. 1.
" "	Cox, *Mon. Micr. J.* vol. xvii. 1877, p. 301.
" "	Eckstein, *Sieb. u. Köll. Zeits.* Bd. xxxix. 1883, p. 355, Taf. xxiii. figs. 6–12.
" "	Zacharias, *Ann. Nat. Hist.* Ser. 5, vol. xv. 1885, p. 125, pl. v. figs. 1–8.

SP. CH. **Body** *white, smooth, gradually tapering to the foot;* **spurs and dorsal antenna** *of moderate length;* **eyes** *round, small;* **teeth** *two.*[1]

The **nutritive system** of this very common species differs in no way from that of *Philodina*. The walls of the stomach are thick and absorbent, and become tinged at once after the reception of coloured food. The **foot gland** and nucleated **gastric glands** are obvious, and the latter, according to Dr. O. Zacharias (*loc. cit.*), are three-lobed on the ventral surface, but confluent on the dorsal. The same observer gives the following account of the **vascular system**. The **contractile vesicle** opens into the dorsally placed cloaca, and a lateral canal with five vibratile tags can be traced, on each side, down to it from the head. "Each tag has the form of a cylindrical beaker seated by its tapering extremity on the excretory vessel. The beaker is open above, and a broad cilium inserted at its bottom projects a little beyond the aperture. . . Under a power of 1,500 diameters the oscillation of the cilia was so violent that the beakers surrounding them were kept in constant tremulous movement." Of the **nervous system** Dr. Zacharias says: "When examined from the dorsal surface, the anterior portion of the body shows a triangular ganglion placed immediately in front of the mastax. . . The anterior angle of the triangle emits two hardly visible branches towards the eye-spots." Dr. Zacharias thinks that nerve-threads also pass to the extremity of the frontal column and to the antenna; the former of which bears two long tactile setæ as well as a circlet of small cilia, and the latter a tuft of setæ.

In the same interesting paper, from which I have so freely quoted, there is an account of an oval **parasite**, *Trypanococcus rotiferorum*, which Prof. von Stein discovered, and which Dr. O. Zacharias was at first inclined to consider as a peculiar kind of ovum produced by germination from the inner surface of the cuticle. These parasites were attached to the body-wall at either end of the *Rotifer*. Each was an oval hyaline vesicle, at the free pole of which was a globular finely granulated structure capable of amœboid movements. Where the parasite was attached was a small aperture in the body-wall; and near this, inside the parasite, a clear ciliated cavity. From this cavity an œsophagus is said by Prof. von Stein to go to the opening in the *Rotifer's* body-wall. Dr. O. Zacharias does not seem entirely satisfied that these egg-like structures were specimens of *Trypanococcus rotiferorum*, but as he found them in abundance it is to be hoped that before long the matter will be cleared up.

The **male** of *R. vulgaris*, as of every other species, is unknown.

Length. When extended, about $\frac{1}{50}$ inch. **Habitat.** Most widely distributed in fresh water: sea-water, Tay Estuary (P.H.G.): very common.

[1] [Since the diagnosis of all the Bdelloida *inter se* is somewhat indistinct at best, every distinction is valuable. And it may be added to that of *this* familiar species (*R. vulg.*) that it is so strongly, closely, and evenly fluted, as to resemble the *Callidinæ*; that its length and slenderness, in proportion to its thickness, are peculiar; and that in crawling it often elongates the foot to such an extent as to recall (without any exact resemblance) *R. macrurus*.—P.H.G.]

R. TARDUS, *Ehrenberg*.

(Pl. X. fig. 1.)

Rotifer tardus	Ehrenberg, *Die Infus.* 1838, p. 490, Taf. lx. fig. 8.
" "	Pritchard, *Infusoria*, 1861, p. 704.
" "	Eckstein, *Sieb. u. Koll. Zeits.* Bd. xxxix. 1883, p. 358, pl. xxiii. fig. 13.

[SP. CH. **Trunk** *dull brown, viscous, with foreign bodies attached, corrugated longitudinally and transversely;* **extremities** *colourless;* **dorsal antenna** *swollen at the top, large;* **spurs** *long;* **eyes** *shaped like long drops, usually broken;* **teeth** *two.*

This is a large sluggish *Rotifer* of clumsy build, fond of groping among floccose sediment, or of getting within the hollow bracts of a moss and of remaining snugly ensconced there for some time. It frequently appears contracted, the constrictions alternating with prominent swellings, like a sack tied in many places, while the body is fluted almost as regularly as an Ionic column; and its whole surface is covered with a viscous secretion to which floccose matter, small Diatoms, &c. attach themselves; sometimes a long stream of the mucus is dragged behind, with extraneous substances adhering. The colour appears to be wholly external, and to depend, in some degree, on the extraneous matters lodged in the viscous coating; for those portions that are constantly introverted are free from surface-colour, though the viscera have still a slight yellow tint. The **corona** is large and powerful, and the **frontal column** is cylindrical, truncate with a minute proboscis at the tip, which does not seem sensibly hooked, or even lengthened, and which projects between and over two small disks each carrying a wreath of vibrating cilia. Within the column, and at some distance from its tip, are the **eyes**,[1] which are usually long and drop-like in shape, and often broken [2]—one eye often more than the other. The **body** tapers gradually to the **foot**, the last joint of which ends in the usual three toes, of which the hindmost is the shortest; all these are curved and claw-like, but truncate. The penultimate spurs are much developed. The dark colour of the trunk, and its close-set corrugations, nearly destroy its transparency, so as to make it very difficult to demonstrate the viscera. By pressure, however, on one occasion, the **intestinal canal** was forced out, attached to the mastax, the ligaments of the anal extremity having given way; it appeared then as at fig. 1*d*; a slender tube, permeating a thick cellular mass, forming the stomach. The mastax has two distinctly separated teeth in each ramus. I cannot but think that *R. citrinus* and *R. tardus* of Ehrenberg are one and the same species.

Length. When fully extended, up to $\frac{1}{72}$ inch. **Habitat.** Near London; Snaresbrook; Birmingham; Woolston; Dundee (P.H.G.): not uncommon. P.H.G.].

R. MACROCEROS, *Gosse*.

(Pl. X. fig. 5.)

Rotifer macroceros	Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 202.
Rotifer Motacilla	Bartsch, *Die Rüderth. b. Tubingen*, 1870, p. 48.
" "	" *Rot. Hungariæ*, 1877, p. 27, iv. Táb. 34 ábra.

[SP. CH. **Body** *hyaline with longitudinal folds;* **corona** *large;* **spurs** *short, stout;* **dorsal antenna** *very long and mobile;* **eyes** *small, round;* **teeth** *two.*

This form, which I discovered in 1850, and described in "Ann. Nat. Hist." September 1851, is indubitably a good distinct species. It has occurred repeatedly of late. The great length of the **antenna**, being not less than fully one-third of the whole

[1] If, as I suspect, the Rotifer which Dr. Leydig describes as *Rotifer citrinus* is really *R. tardus*, then each of the eyes of the latter Rotifer (according to Dr. Leydig) has a crystalline light-refracting body imbedded in the pigment.—P. H. G.

[2] Herr Eckstein (*loc. cit.* Taf. xxiii. fig. 12) has noticed a similar anomaly in *Rotifer vulgaris*, and Ehrenberg has seen another case in *R. macrurus* (*loc. cit.* Taf. lx. fig. 7$_4$).

animal when rotating, is very observable, as are also its stiffness, and yet great mobility, as well as its unusual number of joints. Nor are the actions of this organ less peculiar, for, in a manner of which I have met with no other example in the class, the animal, in the act of protruding, jerks the antenna from side to side as if feeling with it, wags it about rapidly but not vibratingly, and often taps the water, as it were, with it. As soon as the wheels are quite expanded the antenna becomes still. The organ is very slightly fusiform, quite transparent, and has either a tube or a band running throughout its middle, connected apparently with three very short bristles which project from the somewhat enlarged truncate extremity. Perhaps these are very sensitive, and the band may be a nervous thread which conveys impressions to the brain. Indeed, by careful focusing with a high power, the medial bristle (viewed dorsally) is seen to have a sensible diameter, and to be the continuation of the permeating band projected. Within the first joint, about one-third from the base, the part exterior to it can be retracted. There is not the least bending *at these joints*; the wagging is *solely from the base*. Two small pale-crimson **eyes** are low down in the column, which is normal in form. An ovate body may sometimes be seen so large as almost wholly to occupy the greater moiety of the abdominal cavity, quite transparent and colourless, in the midst of which is a great mastax, not to be distinguished, *even in dimensions*, from that one which is proper to the animal, but motionless.[1] This of course indicates an unborn **young**, and proves this species to be viviparous. Alongside of this embryo lies a large sac, doubtless the stomach, throughout which the action of vibratile cilia lining the interior is clearly visible. The **foot**, spurs, and toes are of the usual form. These lowest joints are usually shortened; the animal habitually sitting, when at rest as well as when rotating, in a squat position, so that they are almost, if not quite, concealed, the long antenna always projected. Generally, save when distended either by digesting food or by an advanced embryo, the whole body is marked with lines, which are longitudinal folds of the skin, not greatly interfering with vision. The **corona** is unusually large and the wheels more than usually circular; the latter are separated dorsally by a wide sulcus, the lower edge of which is a straight horizontal line. The **mallei** are evidently two-toothed.—P.H.G.]

Dr. Bartsch found this species in the Weilheimer pool, near Tübingen, in company with *Floscularia* and *Melicerta*, and published an account of it (*loc. cit.*) in 1870. He describes the great length of the antenna and the creature's curious actions, "stretching its long antenna far forward and moving it up and down as the water-wagtail does its tail"; and, under the impression that it was a new species, named it *R. Motacilla*. I have met with this species several times in the clear water of Abbot's pond near Clifton. It was always snugly ensconced in a floccose heap on a stem of alga, or in the axil of a water plant; and its presence was usually first betrayed by its long antenna, which could be seen waggling about some time before the animal itself appeared.

Dr. Bartsch in "Rot. Hungariæ" (*loc. cit.*) figures the gastric glands, stomach, ovary, and contractile vesicle.

Length, $\frac{1}{100}$ inch (P.H.G.) **Habitat**. Near London; Woolston, near Birmingham; Stormont Loch (P.H.G.); Clifton (C.T.H.): not common.

R. HAPTICUS, *Gosse*, sp. nov.

(Pl. X. fig. 3.)

[SP. CH. **Body** *clear, brown-stained, not strongly plicate, not enveloped in mucus*; **antenna** *long, stout, motionless when extended*; **corona** *small*.

[1] I believe that I have seen the distinction between the stomach and the intestine; and also another great viscus, which must be the ovary. The œsophagus is wide and short. After some hours, the mastax of the embryo worked; but not rapidly, and only at intervals.—P.H.G.

This species I have met with on several occasions in the water from Woolston Pond, though it cannot be considered other than rare. It is one of the larger species, being equal to *R. tardus* in size, with which from its form and colour it may readily be confounded. The colour, however, is a clearer amber, and the comparative absence of the deep longitudinal folds of the skin gives to this species a bright translucency like that of stained glass. It readily expands its **wheels**, which are normal but small. The **antenna**, however, is of unusual dimensions both in thickness and length, equalling *R. macroceros* in this respect. The organ, however, does not wag to and fro, in the curious manner characteristic of that species; nor does the animal squat down on its hinder parts, concealing its foot. The antenna is fusiform, and carries a distinct joint at its extremity, which is, I think, retractile; but not tipped with setæ that I could perceive. The thick truncate frontal column bears, near its tip, two large, conspicuous dark-red **eyes**, showing the animal to be a true *Rotifer*. The specific name (from ἅπτομαι, to touch or test) alludes to the presumed function of the prominent antenna.

Length. About $\frac{1}{50}$ inch. **Habitat.** Woolston Pond (P.H.G.): rare.—P.H.G.]

R. MACRURUS, *Schrank.*

(Pl. X. fig. 4.)

Rotifer macrurus . . . Ehrenberg, *Die Infus.* 1838, p. 490, Taf. lx. fig. 7.
" " . . . Pritchard, *Infusoria*, 1861, p. 704.

[SP. CH. **Body** *white, hyaline at the ends, plump, suddenly attenuated to a slender and very long foot;* **corona** *large;* **spurs** *small;* **frontal column** *long, cylindrical, truncate;* **dorsal antenna** *of moderate length;* **eyes** *usually small and round;* **teeth** *two.*

This is a large and well-marked species, imposing and attractive. Its stout corona, large wheels, and plump body are much like those of a *Philodina*; it can be generally recognized by the sudden break in outline between the trunk and the foot, by the great length of the latter, and by the long stout column, which stands well up above the expanded wheels. The **spurs** are unusually short for so large a *Rotifer*, being of about the same length as the three toes. The foot consists apparently of eight joints, almost all of unusual length. There is a short, but bulging neck. The distinction between the **stomach** and intestine is often visible, and the rectum extends through (what appears to be) the whole basal joint of the foot. There are two oval **gastric glands**, as well as a pair of club-shaped glands in the foot. A small **contractile vesicle** can be readily seen, and so, with some little difficulty, can the lateral canals and vibratile tags. Dr. Leydig failed to make out these last, but both Dr. Bartsch (*loc. cit.* Tübingen) and myself have seen three tags on each side. The **nervous ganglion** has not been noticed. The shape of the **eyes** appears to be variable. Dr. Leydig says that he met with some specimens in which the pigment spots were hemispheres much cut out in front, and in others were lengthened out into a row of points lying behind one another. The former had light-refracting bodies seated on them, which the latter lacked. A pair of **muscles**, inserted into the neck, pass to the great constriction behind; another pair, inserted in the shoulders, pass down into the first joint of the foot; and a third pair start from near the same point as these last, and pass to points where the first pair end. Each joint of the foot has at least two longitudinal muscles on each side, which pass into the joints above them. Under strong pressure the whole foot is seen to be crossed with transverse muscles of which at least twenty can be counted. High pressure shows numerous muscles in the trunk also. These are in the form of broad bands alternating with spaces of equal width. I saw the birth of a **young one** twenty-four hours after it had (apparently) escaped from an oval membrane into the body-cavity. It passed head-first through the cloaca in a few seconds. It was

compressed during the passage, and the parent's cloaca was but little disturbed. This young one extended, before its birth, from the base of its parent's foot to the base of the column; and, when born, was $\frac{1}{50}$ of an inch long, or about two thirds of its parent's length.

Length. When extended, about $\frac{1}{33}$ inch. **Habitat.** Widely distributed: common.—P.H.G.]

Genus ACTINURUS, *Ehrenberg*.

[GEN. CH. *The whole animal excessively long and slender;* **eyes** *two, frontal;* **teeth** *two, converging.*

Technically, there is little but its extreme length and tenuity to distinguish this genus from *Rotifer;* the only difference that Ehrenberg gives (viz. the number of the toes) being founded on error, since all the *Rotifers* have three, and not, as he assigns to them, two. Yet he has done well to separate the present form. The diminution of thickness, and the great development of length, impart a peculiar *facies*, which at once precludes the possibility of mistaking it for any species of *Rotifer*, as soon as seen. Even in contraction the trunk is not sensibly thickened, never swelling in the middle as in the other genera of the family it does.—P.H.G.]

A. NEPTUNIUS, *Ehrenberg*.

(Pl. X. fig. 6.)

Actinurus Neptunius . . .	Ehrenberg, *Die Infus.* 1838, p. 496, Taf. lxi. fig. 1.
,, ,, . . .	Pritchard, *Infusoria*, 1861, p. 704, pl. xxxv. figs. 481–4.
,, ,, . . .	Eckstein, *Sieb. u. Köll. Zeits.* Bd. xxxix. 1883, p. 359, Taf. xxiv. fig. 17.

[SP. CH. **Frontal column** *short, carrying the eyes near its base;* **corona** *small;* **trunk** *long, slender, cylindrical;* **foot** *protrusile to twice the length of the trunk;* **spurs** *small, two-jointed;* **toes** *very long, recurved.*

From its excessive length and tenuity the appearance of the creature is very remarkable. It may be likened to a cylindrical tube out of which protrude a great number of draw tubes from both extremities, principally the posterior one. The head is peculiar, when viewed laterally; ovate in form, the frontal column very short, and the eyes being oval, dark and large, with the antennal tube projecting obliquely backwards, it presents a ludicrously strong resemblance to the head of a rabbit. The **rotatory organs** are small and seldom unfolded; the **eyes** of an intense red, almost black. The eight or nine joints which constitute the **foot** are of extreme slenderness, and its **spurs** consist each of two joints; the first club-shaped, the second very slender and acute. The three long, slender, cylindrical, diverging toes, are flexible, and commonly bent outward. Owing to the slenderness of the body the viscera are greatly elongated. The **mastax** is at a considerable distance from the corona, and is reached by a long buccal funnel. Each **ramus** bears two inwardly-converging teeth. The digestive canal is apparently undivided, and originates directly from the mastax: with, I think, two small **gastric glands**. I think I detected a **contractile vesicle**. The viscera, however, can be demonstrated with difficulty, partly owing to the strong longitudinal corrugations in the dorsal region of the trunk, and partly to the creature's incessant contractions and elongations. The ovary is obvious, and the appearance of the eggs suggests that the animal is viviparous. This singular creature is lively in its motions; and it is a curious sight to see the immense length of foot suddenly thrust forth from the body, in which it had been completely hidden, the starting out of the horizontal processes, and the diverging of the long toes, as these are successively uncovered.

Length. Fully extended, $\frac{1}{12}$ inch: closed, $\frac{1}{70}$ inch. **Habitat.** North London; Leamington; Caversham: rather rare (P.H.G.).—P.H.G.]

Genus CALLIDINA, *Ehrenberg*.

GEN. CH. **Eyes** *absent*.

Although this genus differs technically in so slight a degree from those which we have considered, yet it can be generally recognized by its slender, pointed shape, its smaller size, and the abundant corrugations of its skin. Its internal organization, with the exception of the eyes, is so precisely that of *Rotifer*, that it requires no special description. One of the species (Mr. Gosse's *C. bihamata*) possesses a very obvious pair of those dorsal hooks which are so characteristic of the nearly related *Melicertadæ*, and which are to be found also in the still humbler and more closely connected genus *Adineta*.

C. ELEGANS, *Ehrenberg*.

Callidina elegans	Ehrenberg, *Die Infus.* 1838, p. 482, Taf. lx. fig. 1.
" "	Perty, *Zur Kenntniss kleinst. Lebensf.* 1852, p. 43.
" "	Pritchard, *Infusoria*, 1861, p. 702, pl. xxxiv. figs. 470-3.

[SP. CH. **Body** *fusiform, abruptly enlarged centrally, strongly fluted, collared;* **frontal column** *thick, truncate, ciliate, with a decurved proboscis;* **jaws** *with no prominent teeth;* **foot** *thick;* **spurs** *moderate.*

This species, the only one of the genus known to Ehrenberg, I find not uncommon in various waters: but it is only by careful observation that it can be distinguished from its congeners. The **corona** is scarcely wider than the body, the double disk being very little more than a full circle, or two circles *very* slightly separated, when seen quite vertically. The **column** is short, unusually thick, with a minute acute proboscis overarching the dorsal edge of its tip. The **antenna** longer than width of corona, slender, subequal throughout, flexible, truncate, carrying (apparently) a short terminal brush of fine setæ. A swelling collar above the antenna. The **trunk**, bounded above and below by a strong transverse fold, is abruptly swollen, impressed with strong longitudinal plaits, frequently visible as the animal turns. The **foot** is thick; the penultimate spurs middling; the three toes well developed. The outline is very variable. The trunk is tinged with clear yellow-umber, which is abruptly defined at both ends; the extremities being colourless, and very hyaline when stretched in extension.

The **trophi**, when viewed quite dorsally, have much of the form seen in the *Rhizota*, as figured (for *Limnias*) in my mem. "On Mand. Org." fig. 71: the rami being long and pointed, and having a projecting handle-like knob. After keen scrutiny, I cannot discover any teeth crossing them, or anything to break the uniformity. I hence conclude that there are only the very close minute lineations, which Ehrenberg describes. A vanishing shadow of a curved line on each side may represent the mallei, but quite undefined. The restlessness of the animal precludes fine definition. It is most impatient, incessantly moving, not still for an instant. It rarely swims, but perpetually crawls by alternate elongation and shortening, in a course excessively devious.

Length, $\frac{1}{130}$ to $\frac{1}{75}$ inch. **Habitat**. Sutton Park Ditch; Woolston Pond: rather common (P.H.G.).—P.H.G.].

C. BIDENS, *Gosse*.

(Pl. X. fig. 8.)

Callidina bidens	Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 202.

[SP. CH. **Surface** *closely corrugated;* **spurs** *minute, conical, pointed;* **teeth** *two.*

I obtained this species at Messrs. Smith and Beck's in 1849, from a nearly putrescent infusion of hay, in which it was swarming almost to the exclusion of everything else. Its manners differ much from those of other *Philodinadæ*. It is, if I may use

the term, very wild, shooting about with swiftness in an impatient manner, with a peculiar mingling of swimming and creeping; proceeding in this way all about the live-box by the hour together, so rapidly and irregularly that the motion of the stage can scarcely keep it in the field. It is much bolder than the other members of the family, keeping its wheels in rotation all the time it is attached; and though a sudden jar, or the impact of another animal, will cause it to close them, it is but for an instant. I have never seen it contract on alarm into a short round bulb; far less remain quiescent in such a condition for hours, as *Rotifer* and *Philodina* do. It is spindle-shaped, the central region of the body always having an angular prominence; but this varies its situation, sometimes the upper part, sometimes the middle, sometimes the posterior of the abdomen, projecting, according to the position of the viscera at the moment; the creature thus assumes various candelabra-like forms, as shown in figs. 8, 8*a*. The head, when extended, terminates in a thick rounded **column** which is ciliated; when the wheels are expanded, the column appears small, square, and truncate, fits in below the wheels, and does not project beyond their surface. The **foot** is moderate in length; the **spurs** of the penultimate joint are very minute cones, and the last joint has one small stiff point behind, and two soft cylindrical protrusile lateral toes, truncate at their extremities. The whole surface of the body is covered with minute irregular and close-set corrugations. The buccal funnel is very long, and the **rami**, which are very small, are each crossed with two teeth. A scarcely appreciable œsophagus leads to an enormous and very mobile **stomach**: in one specimen this organ appeared to be composed of a number of spherical cells; in others of a minutely granulated texture: it ends in a short rectum.

There are two corrugated **glands** in the foot, and a **contractile vesicle** (whose period is forty seconds) with the usual lateral canals. A long **ovary** with double rows of rudimentary ova occupies each side of the stomach, and two large eggs are commonly seen, of a bright pellucid appearance, but sometimes dark and granulate. The whole animal is crystalline, and usually colourless, but I have seen a specimen in which the wheels were of a delicate pale citron-colour, and another in which the intestine was of nearly the same cinnabar hue as in *Philodina roseola*, though not so brilliant. It is noteworthy, seeing that the creature is eyeless, that the specimens which I first possessed had been kept in the dark; expressly because "it was found speedily to die, if kept in the light." With the phial of water I obtained, I impregnated two vessels, one of which I placed in a window, the other in a dark corner. Five months elapsed, when, on examination, the species was abundant in the darkened phial: but in that in the window I could not find a single specimen.

Length. About $\frac{1}{15}$ inch. **Habitat.** Pools on Hampstead Heath; lake in Kew Gardens (P.H.G.).—P.H.G.]

C. PARASITICA, *Giglioli*.

(Pl. X. fig. 9.)

Callidina parasitica . . . Giglioli, *Quart. J. Micr. Sci.* N. Ser. vol. iii. 1863, p. 237, pl. xi.

SP. CH. **Spurs** *stout, conical, as long as width of the contracted joint;* **teeth** *two. Parasitic on the limbs of crustacea.*

This species was discovered by Mr. H. Giglioli as an epizoic parasite on the thoracic and abdominal appendages of *Gammarus pulex* and *Asellus vulgaris*; and was figured and elaborately described by him *loc. cit.* According to Mr. Giglioli the body is very transparent and colourless, fusiform in shape, and without the angular prominence at its central region which is so distinct in *C. bidens*. The **corona** consists of two small circlets of short cilia, and is rarely expanded; the animal usually contenting itself with crawling like a leech over its host. There is a distinct **alimentary canal** surrounded by

a yellowish-green cellular mass, a broad pyriform ciliated stomach, narrowing gradually to a bent intestine, and again widening into a broad and richly ciliated cloaca. No **salivary** or **gastric glands** have been seen. There is a large irregular **contractile vesicle**, with a period of about thirty seconds, and two very small lateral canals; the vibratile tags, however, have not been made out. The **dorsal antenna** is large, and divided into three lobes at its tip, but no setæ were visible. No **eyes** have been seen either in the adult or young. [I found several examples in June 1885, on the thoracic limbs of *Gammarus pulex*. To Mr. Giglioli's interesting details I have little to add. He says that out of 700 or 800 *Gammari*, he had not found one free from these *Callidinæ*. My experience is not quite confirmatory of this constancy. Out of four *Gammari*, I found *Callidinæ* on only one. They adhered to its limbs merely as other Bdelloids do to any surface. The "suckers," mentioned by Mr. Giglioli, are no organs of special function, connected with parasitism, but are the three truncate toes common to the whole order.

My examples, four in number, crawled off their nurse presently, on the subjection of the latter to pressure in the live-box, and moved actively about in the free water; contracting, and elongating, and readily swimming. Their hue was a pale straw-yellow, becoming clear ochre-yellow in contraction, which deepened to umber in the middle of the alimentary canal, and in the maturing ovum: but of a glassy translucency. The pair of **spurs** at the bottom of the penultimate joint of the telescopic foot, are stout, thick, long and pointed. It is difficult with creatures so extremely variable in outline to give any measurements which are not too vague to be distinctive: yet, as compared with these organs in *C. bidens*, I may say that in *C. parasitica* they are as long as the diameter of the penultimate joint itself, when thickened to its utmost by retraction; whereas in *C. bidens* their length does not equal half the width of the joint in the same condition. Their bases are separated by a horizontal space equal to their own breadth (fig. 9*d*). The joint itself is closely and minutely fluted.—P.H.G.].

Length. Up to $\frac{1}{50}$ inch. **Habitat.** Parasitic on *Gammarus pulex* and *Asellus vulgaris* (Mr. H. Giglioli; P.H.G.).

C. BIHAMATA, *Gosse*, sp. nov.

(Pl. X. fig. 7.)

[SP. CH. **Frontal column** *bearing two hooks, mutually crossed.*

This species I found in the sediment of a phial of water that had been standing on my study table for more than a month, originally sent to me by Mr. H. Davis, dipped by him from a pool near Snaresbrook in June 1885.

It has not any obvious peculiarity to distinguish it from its congeners, except that the **column** is terminated by a pair of acute hooks, set on the same plane, and crossing each other transversely, like the blades of a pair of shears. These at first sight suggested the *C. vaga* of the friend to whose kindness I had been indebted for this stranger. A moment's observation showed that it was not that species, now elevated by Dr. Hudson to the rank of a genus, *Adineta*. Yet the peculiar structure in question may well be considered as a marked approach to it. Minute hooks, terminating the column, are, indeed, common to all the species of the *Bdelloida*, but usually soft, obtuse, decurved, and single. The whole **trunk**, somewhat swollen, is strongly scored with longitudinal folds of the skin; a dozen or more in number. The double **corona** was readily expanded, and the animal glided freely and swiftly through the free water. It is small, as in *Callidina* generally: the column with its terminal hooks was projected (or rather not retracted) during the coronal rotation. The **dorsal antenna** is placed unusually far back (see fig. 7*a*); it is small, obtuse, oblique, connected with a dorsal tubercle; not seated on it, but, so to speak, leaning on its front slope. It is scarcely in advance of the mastax, when this is in its normal position. I did not see on it either cilia or setæ.

Length. Estimated at about $\frac{1}{70}$ inch. **Habitat.** Pool near Snaresbrook (P.H.G.).—P.H.G.]

Family IV. ADINETADÆ.

Corona *a flat, prone surface;* **ciliary wreath** *the furred ventral surface of the corona;* **trophi** *ramate;* **frontal column** *soldered to dorsal surface, and ending in two hooks.*

The family *Adinetadæ* has been formed to receive one genus, which itself contains at present only one species. It has been separated from the *Philodinadæ* on account of its lacking the usual corona of two circlets, and of its having in lieu of it a mere furring of a flattened, ventrally placed, portion of the head, which in some degree resembles the face of the genus *Proales*. In other respects the organization is that of the *Callidinæ*, except that the frontal column, which is so striking a feature in the other *Philodinadæ*, and which is tossed aside like a hood when the coronal wheels are expanded, is here soldered as it were to the dorsal surface, and projects slightly beyond it, bearing two curved hooks.

Genus ADINETA, *Hudson.*

GEN. CH. **Eyes** *absent.*

A. VAGA, *Davis.*

(Pl. X. fig. 10.)

Callidina vaga . . . . Davis, *Mon. Micr. J.* vol. ix. 1873, p. 201, pl. xiv.

SP. CH. **Body** *smooth, colourless, with longitudinal corrugations;* **spurs** *short, finely pointed;* **teeth** *two.*

This species was discovered by Mr. H. Davis in 1867, along with abundant specimens of *P. roseola*, in a parcel of pink dust sent to him by the Rev. Lord S. G. Osborne, and found in some open stone vases in Lord Osborne's grounds at Blandford. These vases, at times, become partly filled with rain, and the wind drives into them dead leaves and other matters, which by their decomposition seem to afford suitable food.

The front of the **head** is somewhat like a thumb in outline, and on its dorsal surface is what appears to be the trace of a **column** soldered to the head, projecting slightly beyond it, and bearing two transverse hooks. The **corona**, though nothing but the flat ventral surface of the head, yet shows a sort of division into two parts, owing to the absence of cilia on a broad median line leading to the buccal funnel: the rest of the surface is densely furred with minute cilia. The base of the corona, just at the animal's neck, rises on either side above its general plane, and forms a well-marked ridge. Mr. Davis says that each ridge is strongly serrated, and draws them with teeth pointing forwards. I could see no such serrations, though the strong cilia, that here lead to the entrance of the buccal funnel, frequently produced a fleeting appearance of serration: but all my specimens were small and young, and possibly the serrations were not yet developed. The pathway (if it may be so termed), through the coronal cilia, leads straight to a long buccal funnel imbedded in a thick fleshy mass, and ending at the mastax, each ramus of which bears two main teeth and a multitude of fine parallel striæ.[1] When *Adineta* is feeding, it curves the flat corona so as to bring its two furred halves opposite to each other, and at the same time draws together the transverse ridges at its base. In this way a ciliated semi-cylinder is formed as a prolongation of the buccal funnel, and minute atoms may be seen rapidly streaming down the tract clear of cilia, into the funnel's entrance. The **stomachs** of my specimens were all filled with clear yellowish particles, but of what substance I could not make out. I could see no **salivary** or **gastric glands**, but the **foot-glands** were conspicuous. The **contractile**

[1] Mr. Davis measured these, and found there were from thirty to forty thousand in the inch; in my specimens the striæ were about fifty thousand to the inch.

vesicle was also plainly visible: Mr. Davis says that its period is about twenty seconds in the young, and from two minutes to five minutes in the adult. By compression I obtained an unusually distinct view of the lateral canals (fig. 10*b*), which showed clear against the grey ground of the ovary. Mr. Davis has seen five vibratile tags on each side, but not the lateral canals; and I succeeded in finding two pairs of tags attached to the canals: one pair just below the transverse ridges of the corona's base, and another mid-way between this point and the contractile vesicle. There is a **dorsal** antenna; but no **eyes**: the **nervous ganglion** has not been made out.

A. vaga may be recognised at once by its peculiar movements, which are unlike those of any other Rotiferon I am acquainted with, and are also extremely embarrassing to the observer. It fastens itself by its foot, extends its body to its full length, and then swiftly contracts itself. Nor is this all; for, instantly extending itself again, it alters its direction, as well as its distance from the surface to which it is attached. In this way it will work around its toes, as around a pivot, compelling the observer to make incessant alterations of the stage and focus. In fact very little is to be learned of its structure, while it is permitted to go free. When imprisoned in a very closely flattened drop of water, it is a little more manageable, for it ceases then to dart backwards and forwards; but on the other hand it makes up for this by constantly gliding about at a very fair pace. It is quite incapable of swimming in the open, and may now and then be seen rolling ignominiously from the top of the glass cell to the bottom; but it glides with ease over the surfaces of stems, plants, or glass, by the reaction of those surfaces on the ciliated head. It is, if possible, a hardier creature even than *Philodina roseola*; for Lord Osborne tells me that he has repeatedly found that, in a mixed gathering of the two, *A. vaga* will survive successive dryings and moistenings which have proved fatal to all the former.[1]

Length. From $\frac{1}{36}$ to $\frac{1}{30}$ inch. **Habitat.** In some stone garden-vases at Blandford (Lord S. G. Osborne); in a mill-pond at Petit Bot, Guernsey (C.T.H.); frequently in dried gatherings of *Philodina roseola*.

[1] Mr. Davis's experiments (*loc. cit.*) show that this is not always the case.

CHAPTER VIII.

PLOÏMA

(IL-LORICATA).

Curiosum nobis ingenium Natura dedit, et artis sibi ac pulchritudinis suæ conscia spectatores nos tantis rerum spectaculis genuit; perditura fructum sui, si tam magna, tam clara, tam subtiliter ducta, tam nitida, et non uno genere formata solitudini ostenderet.—SENECA.

For Beauty, Good, and Knowledge are three sisters
That doat upon each other, friends to man,
Living together under the same roof,
And never can be sundered without tears.

TENNYSON.

CHAPTER VIII.

Order III. PLOÏMA.

Swimming with their ciliary wreath, and (in some cases) creeping with their toes.

It has been already seen [1] that our typical Rotiferon was drawn from the ranks of the *PLOÏMA;* and rightly so, for the number of its genera, the abundance of its species, the restless energy, perfection of structure, and superior intelligence of its members, clearly entitle the third order to be considered the typical one. It is true that *Pedalion* makes a still nearer approach to the *Arthropoda* in its structure than does any species of the *PLOÏMA*, and must be ranked above them in the scale of the animal kingdom; but it is almost (if not quite) the only representative of its order, and therefore unfitted to be taken as a type of the class.

In the Free-Swimmers the mastax reaches its highest development, and is often used like the mandibles of an insect. Mr. Gosse and I, as well as other observers, have seen these active creatures seize their prey with their jaws, and watched them nibbling the floccose sediment on the stems of water-plants, or slitting up the cells of algæ and the skins of infusoria in order to extract their contents. Indeed, the snapping of the protruded jaws among some of the *Notommatadæ* is so vigorous that it is difficult to see it and not to fancy that we hear the snap; and on one occasion, even, the fierce atom has been seen to give itself a fatal lock-jaw by its outrageous snatch.

In this order, too, as might have been expected from their habits, the nervous system is conspicuous, the ganglion being large, and the nervous threads from it to the various organs of sense more easily traced than in the first and second orders. The eyes, too, have often obvious lenses, and the tactile organs are numerous and well-developed. The vascular system, whose probable respiratory functions must be of the utmost importance to these restless animals, is unusually well developed. It spreads a network of coiling tubes close under the cuticle, and not unfrequently ends in a contractile vesicle so large as to fill, when distended, an important portion of the body-cavity.

In fact, the whole structure of the order shows its members to be well equipped for the energetic life which observation proves them to pursue. They haunt the algæ on pond walls, coast along the water-line among decayed leaves and floating *débris*, dive down to the bottom to explore the muddy sediment, or boldly put off from shore, and sail out even into the middle of such a lake as that of Zurich. No doubt the marvellous coronæ of the *Rhizota* and *Bdelloïda* will always continue to attract the expert and amateur alike; but to obtain an adequate notion of the structure of the Rotifera, and of what may fairly be termed their mental capacities, the inquirer must turn to the study of the *PLOÏMA*.

Sub-Order Il-loricata.

Integument *flexible, not stiffened to an inclosing shell;* **foot**, *when present, almost invariably furcate, but not transversely wrinkled; rarely more than feebly telescopic, and partially retractile.*

[1] P. 4.

Family V. MICROCODIDÆ.

Corona *obliquely transverse, flat, circular;* **buccal orifice** *central;* **ciliary wreath** *a marginal continuous curve encircling the corona, and two curves of larger cilia, one on each side of the buccal orifice;* **trophi** *forcipate;* **foot** *stylate.*

Genus MICROCODON, *Ehrenberg.*

GEN. CH. **Eye** *single, centrally placed, just below the corona.*

M. CLAVUS, *Ehrenberg.*

(Pl. XI. fig. 1.)

Microcodon clavus . . Ehrenberg, *Die Infus.* 1838, p. 395, Taf. xliv. fig. 1.
" " . . Pritchard, *Infusoria*, 1861, p. 665, pl. xxxii. figs. 371-2.
" " . . Grenacher, *Sieb. u. Köll. Zeits.* Bd. xix. 1869, p. 487, Taf. xxxvii. fig. 2.

This curious Rotiferon, for which, though the only species of the genus, it has been found necessary to make a new family, was discovered by Ehrenberg in 1830. It has since been described by Dr. Max Perty and Dr. H. Grenacher (*loc. cit.*), and has been found in England several times by Dr. Collins, at Sandhurst, and lately by Miss Davies, at Woolston. It has, however, escaped the notice of the majority of observers during the last fifty years, in some measure no doubt owing to its small size; for though its whole length is $\frac{1}{125}$ inch, more than one-half of this is taken up by a long narrow foot, so that the actual body of the animal does not much exceed $\frac{1}{300}$ inch. Ehrenberg placed it in his family *Megalotrochæa;* but neither in its ciliary wreath, its trophi, nor its foot, does it resemble the *Rhizota.* The **corona** is a flat circular disk, set obliquely on the trunk, and with its dorsal edge pointing forwards.[1] A complete ring of minute cilia edges the disk, and these perform the office of driving the food to the buccal funnel. The entrance to this latter is near the centre of the corona, a little towards the ventral surface. It lies between two curves of large unequal cilia, of such lengths and so arranged that they form on each side an oval border to the buccal orifice. Usually these large cilia are at rest; and *Microcodon*, under the action of the smaller cilia, either glides along swiftly or oscillates gently to and fro over the same spot, as if it were moored by a thread from its single toe. It is possible that this curious hovering over one place may be due to the mutually opposing action of the minute cilia of the two halves of the corona, but it always gave me the impression that the animal was at these times moored by a viscous thread to some spot on the glass. Every now and then, whether gliding along or hovering, the creature darts suddenly forward with the utmost swiftness, accomplishing this by vigorous strokes from the two rows of larger cilia. It would seem that it has unusual control over this apparatus, for Dr. Grenacher has seen, in an injured specimen, these inner cilia lifted and depressed one by one; and has traced to them what he supposes to be nerve-threads arising from the depth of the corona. A further peculiarity noticed by this observer is that the corona remains expanded, no matter how the animal be treated.

The **trophi** (fig. 1*c*) consist mainly of two ribbed rami, attached to a long narrow plate (the fulcrum), which is seen edgewise in the figure. I think, too, that I detected delicate pointed unci on each side of the incus. The whole are included in a long conical mastax, closely resembling that of *Polyarthra*, and pointing downwards towards the

[1] Ehrenberg says that its shape is that of a transverse figure 8; but Dr. Grenacher, Dr. Collins, Mr. Gosse, and myself all agree that it is circular. Mr. Gosse, however, points out that, when the corona is inclined to the line of sight, it does look somewhat like that of a *Limnias*.

ventral surface. Dr. Grenacher says that there is no separation between the **stomach** and intestine, but this Mr. Gosse has distinctly seen. The latter says: "When I first detected the animal, the intestine occupying the gibbous swelling of the hind abdomen was clear, save for a considerable well-defined mass of orange-red; but, on resuming my observations on it an hour or so later, the intestine was not distinguishable from the stomach, the whole being of a deep rich sienna-brown, with oil-globules of various sizes scattered throughout it." The **ovary** appears to be divided into two distinct portions, and a clear reddish spot, somewhat like an oil-globule, but of unknown function, lies between the stomach and ovary. A **contractile vesicle** is conspicuous above the foot, and Dr. Grenacher notices his having seen indistinctly the lateral canals, but not any vibratile tags. There are two spherical **gastric glands**, and just above these, at the head of the mastax, is a round **nervous ganglion**, on which is seated a splendid **eye**. It is a purple ball, resting on purple plates curving round the ganglion, so as to give the whole a curious likeness to a jockey's cap (fig. 1*b*). Two of these stripes appeared to have been displaced in my specimen, but I cannot tell if this was an accident or if their position is normal. I could only make out these details by flooding the animal with transmitted light. There are a dorsal and two lateral antennæ, all mere setigerous warts; and the foot bears just above the toe on the dorsal side three bristles, which Dr. Grenacher says are erectile. The same observer has noticed that the longitudinal muscles which move the foot, and are continued down into it from the body, are all striated. The foot is divided into three joints, of which the first and last are small, and it ends in a single toe. It is freely moved from one side to the other, round its basal joint, and is sometimes laid flat to the ventral surface.

The **Male.**—[A female had been playing in my live-box within an area formed by bounding filaments of *Myriophyllum*. Presently I saw a slender worm, about as long as this charming subject itself, of almost aerial transparency, very slender, darting about the same limited area. It was a nearly perfect cylinder, but gradually tapering to an acute extremity, which may possibly have been a minute conical toe. The front, slightly bent downward, was transversely truncate; its circular margin carrying a wreath of locomotive cilia, by whose vibrations it shot vigorously and rapidly about. The whole body was refractive of light, but one vesicle, situate about two-thirds from the front was more intensely refractive. This I suspect to have been the sperm-sac. I could detect no other organ or viscus in the animal, but the entire length and breadth was full of minute granules. My grounds for suggesting that this was the male *Microcodon* are but inferential. First, the motions were exactly imitative of those which I had just been watching in the female—swift glidings hither and thither, occasionally varied with moments of sudden pausing, and again with still more sudden and invisibly rapid starts and springs to a distance. Secondly, its appearance at the same time, in the same dip, and in the same limited area with the female, which itself is a rarely occurring species with me: and thirdly, the apparent attentions which the supposed male paid to the female, every now and then coming close to her in his devious travels, though only to shoot by her. The area was quite open at one end; yet for a long time, and not till after many sailings to and fro, did he assert his freedom, when she presently followed.—P.H.G.]

Length. From $\frac{1}{125}$ to $\frac{1}{150}$ inch, of which the foot is more than half. **Habitat.** Sandhurst (Dr. Collins, P.H.G.); Woolston Pond, Hants (Miss Davies, P.H.G.).

Family VI. ASPLANCHNADÆ.

Corona *sub-conical, with one or two apices;* **ciliary wreath** *single, edging the corona;* **intestine and cloaca** *absent.*

The *Asplanchnadæ*, though singularly beautiful Rotifera, are yet of a low type of structure, for their stomach is a blind sac, and they reject all fæcal matter through

the mouth. The family contains the genera *Asplanchna* and *Sacculus*, which, while separated from all other Rotifera by the absence of intestine and cloaca, differ also from each other in several important points. The incudate trophi of *Asplanchna* are massive forceps quite free from an inclosing mastax, and capable in consequence of even plunging down into the œsophagus; but the forcipate trophi of *Sacculus* are feeble hooks and blades, inclosed in a grape-shaped mastax, and admitting of only a slight protrusion from the mouth. The stomachs also of the two genera are widely different: that of *Asplanchna*, a spheroidal bag of moderate dimensions; that of *Sacculus*, a large sac with six great cæcal appendages nearly filling up the whole of the body-cavity: and, further, *Sacculus* carries its eggs attached by a thread to a hollow of the posterior surface, while *Asplanchna* produces its young alive.

Genus ASPLANCHNA, *Gosse*.

GEN. CH. **Corona** *with two apices;* **trophi** *incudate, not inclosed within a mastax;* **stomach** *of moderate size, spheroidal. Viviparous.*

The various species of this genus differ from each other mainly in the presence or absence of the foot, in the shape of the trophi, in the number and colour of the eyes, in the size and arrangement of the vascular system, and in the external shape and appendages of the male.

It was in this genus that the first male Rotiferon was discovered; and, indeed, the great size and transparency of the female, and its habit of producing its young alive, give unusual facilities for the study of the males. Many of the Rotifera deposit their eggs here and there on the stems and leaves of algæ &c., so that it is impossible to identify the males when hatched; but in the genus *Asplanchna* the male may be readily seen alive in its mother's ovary. It is a creature of the greatest delicacy, like a bubble of the clearest glass; and yet the various species can be easily distinguished by the differences of figure. In one the male is a mere reproduction of its parent on a reduced scale; in another it bears two sleeve-like processes on its sides; in a third, four such processes; while one has its ventral surface prolonged into a sheath for the penis.

A. EBBESBORNII, *Hudson*.

(Pl. XI. fig. 3.)

Asplanchna Ebbesbornii. . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. iii. 1883, p. 621, pls. ix. x.

Female *with one dorsal, one ventral, and two lateral* **humps; eye** *single;* **rami** *with singly pointed ends, not serrated;* **contractile vesicle** *expanding to more than half the body-cavity;* **vibratile tags** *often forty on each side, and arranged in straight lines;* **ovary** *horseshoe-shaped;* **male** *with two additional, lateral, humps, below the neck.*

This fine and rare Rotiferon was discovered by Mrs. Tupper Carey in 1880, in a duck-pond in the vicarage of Ebbesborne Wake; and, strange to say, this, at present, is its only known habitat. It differs from all other species of the genus in its outline, which is not bell-shaped, and in its possession of four sleeve-like prolongations of the cuticle; one on the dorsal surface, one at the hind end of the ventral, and one on each side of the body below the head. All these appendages are empty of organs, and somewhat flaccid when the animal is swimming quietly; but, when it draws in its head, they are driven out stiffly from the general surface. Fine muscular threads tie their extremities to various parts of the body, and serve to shorten the processes when the head is again protruded: the two side appendages have their tips connected by a fibre passing straight through the body from the one to the other. The **head** is conical with two apices; and in the hollow between them, a little towards the ventral surface, lies the buccal orifice, with two small style-bearing prominences on either side of it. The **ciliary wreath** is a simple ring of cilia surrounding the coronal cone, and bent down

inwards at the ventral surface, to the buccal orifice. This latter opens directly on the jaws, which are two stout hooked rami with their fulcrum plate imbedded in a horseshoe-shaped cushion: doubtless, as Mr. Gosse suggests, the third lobe of the mastax; there are no other lobes, so the jaws are practically free. The muscular bands which open and shut these formidable nippers are shown in fig. 3*e*, and can be seen with ease. Immediately below the horseshoe-shaped ring, and partly embraced by it, is a chamber or **pharynx** formed by a delicate membrane strained over four curved rods, which hang downwards, and are joined together at the bottom by cross pieces. This curious contrivance resembles somewhat in shape the silk well of a lady's work-table. By suddenly pulling the four rods apart at the top, the animal causes a partial vacuum, and any prey near the buccal orifice is instantly engulfed. I have seen this happen often, even to Rotifera of considerable size; for *A. Ebbesbornii*, like all the *Asplanchnæ*, is an indiscriminate feeder, and will swallow even such awkward mouthfuls as *Triarthra longiseta* and *Brachionus Bakeri*; the latter of which I have seen with its posterior spines actually piercing the stomach and body walls of the *Asplanchna*, while the former I saw head-downwards in the œsophagus, with its long propellers stretching right up almost to the buccal orifice. From the pharynx, on its ventral side, stretches a very long transparent and extensile œsophagus, down which run ribbon-like muscular threads. Not unfrequently it is loaded with food, so that the creature seems then to have a stomach of twice the usual size. The **gastric glands** (figs. 3*c*, 3*d*) have each a large duct leading to the stomach, and the cells imbedded in them lie together in clusters of four and five. The spherical **stomach** has thick cellular walls with a clear round nucleus in each cell; it is often divided for a time into two unequal portions by a deep muscular constriction, as in fig. 3*a*. There is not a trace of intestine or cloaca: the hind end of the stomach is merely attached to the body by two fine threads. The fæcal matter is rejected through the mouth; it is slowly driven up by successive contractions of the stomach and œsophagus, till it reaches the pharynx, where it is grasped by the jaws and tossed out through the buccal orifice. There is a rectangular **nervous ganglion** just under the corona, touching the buccal orifice on its dorsal side, and carrying a crimson eye. A nerve-thread passes from each of the four corners to one of the antennæ. Two of these latter are on the dorsal side of the body about half-way down, and two others are on the coronal apices. There is yet another pair on the corona just above the buccal orifice, and to these branch nerves are sent from those of the second pair. The **ovary** is horseshoe-shaped, flattened at the ends, and studded with germs which are often clusters of cells (fig. 3*h*). The ova are always developed at the hind-surface of the middle of the ovary: and, when they attain some size, they drop off into the ovisac, a funnel-shaped pocket with its broad base attached to the contractile vesicle. The ovisac ends in an oviduct, which opens on the ventral surface in a transverse slit. Occasionally I have met with specimens that had as many as three or four **ephippial eggs** in the ovisac at once; but generally there is only one maturing ovum, or a young animal lying across the parent with its head presented to the opening of the oviduct. The birth of the **young** is almost instantaneous; and I have seen it expelled with such force that its stomach was driven right through its mouth, so that it was born with its ciliary wreath half-way down its body. The ephippial eggs[1] are circular, corrugated, and often tinged yellow; as is sometimes the ovary itself.

The **male** (fig. 3*i*) is rather more than half the size of the female, and bears two small additional appendages below the neck. As usual, the entire digestive tract is absent. There are, however, some rounded masses adhering to the dorsal surface, just below the hump. Possibly these may be a kind of stored-up material to compensate for the male's inability to take nourishment.

The **sperm-sac** with its enclosed spermatozoa, and the penis, are shown in fig. 3*j*. The penis is a tube with delicate longitudinal furrows sheathed in soft granular masses,

[1] Two ephippial eggs are shown in fig. 3.

and having a ciliated opening. It can be drawn back by two pairs of muscles attached to the dorsal surface. Short muscular threads help to draw and direct it forward; but its vigorous outward movement is mainly due to the compression of the body-fluids by transverse muscles. The spermatozoa can be distinctly seen in motion in the sperm-sac, and they are of the two forms drawn in fig. 3*k*. The **vascular system** (fig. 3*f*) is alike in both sexes, but is much better seen in the male. The flocculent ribbons which support the lateral canals are unusually large and long, and are looped up here and there by threads, and also tied in the same way to the body-walls. They appear, themselves, to be tubes of a loose granular stuff, with clear cells (fig. 3*g*) imbedded in their walls. Possibly it is through these cells that the perivisceral fluid finds its way into the tubes and thence into the lateral canals. These latter are much smaller tubes, connected with the first, but meandering along their edge; and they have attached to them an amazing number of vibratile tags; often more than forty on either side. The contractile vesicle, to which the flocculent ribbons and lateral canals are obviously attached, swells out in the female, at times, so as to occupy nearly two-thirds of the body. In the male it is smaller, but in both sexes it is covered with a fine muscular network, which is constantly compressing it into ever-varying and graceful shapes. The **muscular system** is best seen in the male, owing to the absence of digestive organs, but is so plainly shown in the drawings that it requires no further explanation.

Length. Nearly $\frac{1}{20}$ inch. **Habitat.** Ebbesborne Wake, Wiltshire (Mrs. Tupper Carey): very rare.

A. Brightwellii, *Gosse*.

(Pl. XII. fig. 1.)

A dioecious rotifer allied to the genus Notommata . .	Brightwell, *Ann. Nat. Hist.* 2 Ser. vol. ii. 1848, p. 153, pl. vi.
An infusory animalcule allied to the genus Notommata .	Dalrymple, *Phil. Trans.* 1849, p. 331, pls. xxxiii. xxxiv.
Asplanchna Brightwellii and A. Bowesii	Gosse, *Ann. Nat. Hist.* 2 Ser. vol. vi. 1850, p. 23.
Ascomorpha Anglica	Perty, *Zur Kenntniss kleinst. Lebensf.* 1852, p. 39.

SP. CH. **Female** *without humps;* **eye** *single;* **rami** *with doubly pointed ends, not serrated;* **contractile vesicle** *expanding to about one-fourth of body-cavity;* **vibratile tags** *on each side varying from about ten to twenty, and arranged in a straight line;* **ovary** *horseshoe-shaped;* **male** *without humps.*

Mr. Brightwell discovered this species in a small pond immediately without the city of Norwich in 1841. Both sexes were in abundance, so that he was able not only to make out the structure of the male, but also to witness several acts of copulation; thus, for the first time, establishing beyond all question the dioecious character of at least one species of the Rotifera. The **female** differs from that of *A. Ebbesbornii* in the following points. It is bell-shaped, possessing none of those **humps** which are so striking a feature in the former species. The **jaws** (fig. 1*b*) differ slightly in their proportions and shape, and Mr. Dalrymple (*loc. cit.*) detected on either side of the stout rami delicate curved rods, which no doubt are the unci. The **gastric glands** are kidney-shaped, the **contractile vesicle** somewhat smaller. The **ephippial egg** of this species is also circular, but it has on its outer covering a beautiful pattern of concentric circles of overlapping scales. The **male** (fig. 1*c*) is also humpless, but it is a little squarer in outline behind than the female, from the ventral surface having been produced into a sheath for the penis.[1]

Length. Female, $\frac{1}{2\frac{1}{3}}$ inch; male, $\frac{1}{4\frac{1}{8}}$ inch. **Habitat.** Ponds and ditches in many parts of England: not uncommon.

[1] In 1874 I found an *Asplanchna* apparently not distinguishable from *A. Brightwellii*, and whose male (*Mon. Micr. J.* pl. xci.) had only two lateral humps. Mr. T. Bolton has lately found both sexes near Birmingham. I have named it provisionally *A. intermedia*.

A. PRIODONTA, *Gosse.*

(Pl. XII. fig. 2.)

Asplanchna priodonta[1] . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. vi. 1850, p. 18, pls. i. ii.

SP. CH. **Female** *without humps;* **eyes** *three;* **rami** *broadening to the free ends, their inner edges serrated;* **contractile vesicle** *about equal to the two gastric glands together;* **vibratile tags** *four on each side, attached to a single coil of tubes;* **ovary** *roundish;* **male** *without humps.*

Mr. Dalrymple's exhaustive memoir on *A. Brightwellii* was followed soon afterwards by a similar paper of Mr. Gosse's on his new species, *A. priodonta*, in which its structure is described with the greatest minuteness and care. *A. priodonta* was discovered by Mr. Gosse in the Serpentine, in Hyde Park, in 1850. It is much smaller than *A. Brightwellii*, its outline more oval, its head more conical. The **jaws** are broader: and instead of a projecting tooth on the inner side, they have this edge minutely serrated, with the tip forming two curved long teeth (figs. 2*f*, 2*g*). Each carries a spine proceeding from its back and curving round nearly parallel to its extremity. The **gastric glands** are situated on the œsophagus itself, a little above the stomach, not on it. But the chief differences lie in the **vascular** and **reproductive systems**. The contractile vesicle, when full, is globular and small, being scarcely, if at all, bigger than the two gastric glands together. The flocculent ribbons that support the lateral canals have their middle parts wrinkled into a large coil of four or five pairs of doublings, and on this coil are placed four vibratile tags; so that there are only eight tags in all. The **ovary** is roundish and very small; it is shown in fig. 2*a* with its germs, and the ovisac wrinkled up close to it. In fig. 2 it is behind and above the ovisac, which contains a developing ovum with salmon-coloured oil-globules in it. There are three crimson **eyes** (fig. 2*b*), one under the centre of the corona and one on each side of it; each resting on a **nervous ganglion**.

The **male** (fig. 2*c*) differs hardly at all in its internal structure from that of *A. Ebbesbornii*, though very different in shape. Its **sperm-sac** is supported by a strip of tissue that hangs from the head, and resembles in shape and position the alimentary canal of the female. It is, however, imperforate and structureless, and seems to have no other office than to support the sperm-sac and penis. The **nervous ganglion** (fig. 2*d*) is unusually conspicuous. Two of its four diverging threads pass downwards to the dorso-lateral rocket-headed antennæ (figs. 2*c*, 2*e*), and two pass upwards to similar antennæ on the two apices of the corona.

By slightly compressing a male, I put beyond question the fact that the contractile vesicle empties itself *outward* through the cloaca; for under slight pressure the vesicle contracted slowly, by stages as it were, collapsing partially in separate efforts instead of closing at once. As it did so, I distinctly saw, at each effort, the gradual passage of a plug of fluid down the cloaca, dilating its walls as it went.

Length. Female, $\frac{1}{48}$ inch; male, $\frac{1}{75}$ inch. **Habitat.** Kensington Gardens, Serpentine (P.H.G.); ponds and ditches round Clifton and Birmingham (C.T.H.; T.B.): not uncommon.

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[1] Ehrenberg's *Notommata syrinx* is wonderfully like *A. priodonta*, but is said to have a cloaca, and a minute foot and toes. His *N. myrmeleo* is unknown in England, but Leydig has made it clear (*Ueb. d. Bau. d. Räderth.* p. 20, Taf. iv. fig. 36) that in this instance Ehrenberg has made a mistake, and that the Rotiferon has not got the cloaca which Ehrenberg describes. It is therefore an *Asplanchna* with a foot; one much resembling that of *Notops clavulata*. Its jaws, ovary, vascular system and eye resemble those of *A. Brightwellii*.

Leydig (*loc. cit.*) has described another *Notommata*, *N. Sieboldii*, which is a true *Asplanchna*. The female closely resembles *A. Brightwellii*; but the male, which is conical in shape, has four humps, two lateral ones and two on the neck, just like those of the male of *A. Ebbesbornii*.

Genus SACCULUS, *Gosse*.

GEN. CH. **Corona** *with one apex;* **trophi** *inclosed in a mastax, virgate, with unequal mallei, very evanescent;* **alimentary canal** *very large, having eight cæca;* **eggs** *attached after deposition.*

S. VIRIDIS, *Gosse*.

(Pl. XI. fig. 2.)

Sacculus viridis . . .	Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 198.
Ascomorpha helvetica . .	Perty, *Zur Kenntniss kleinst. Lebensf.* 1852, p. 39.
Ascomorpha germanica (?) .	Leydig, *Ueb. d. Bau. d. Rädderth.* 1854, p. 44, Taf. iii. fig. 34.
Sacculus viridis . . .	Gosse, *Phil. Trans.* 1857, p. 320, pl. xv. figs. 24–26.
Ascomorpha saltans (?) . .	Bartsch, *Rot. Hungariæ*, 1877, appendix, Tab. ii. fig. 17.

This beautiful "little green sac" was first discovered by Mr. Gosse, in the summer of 1850, in a small pool on Hampstead Heath, and was described by him in the "Annals of Natural History" in 1851. It haunts the bottoms of small pools on heaths and in plantations, and I have occasionally found it roaming over the vegetable sediment at the shallow ends of cattle-ponds. It is not a common creature, and it is an extremely difficult one to study, for its skin is thick and rough, and its huge stomach hides almost all the other organs.

The **ciliary wreath** is a simple ring of cilia with three or four large styles set in it at intervals. Just below the wreath, on the dorsal side, is a comparatively clear space of external surface (figs. 2, 2*b*), which is shagreened, as it were, with diamond-shaped clusters of granules. Through this can be seen the **nervous ganglion**, bearing a crimson eye, and (I think) the front portions of two spherical **gastric glands**. The ovoid **mastax** can be readily seen in the side view; it contains delicate triangular rami on a long slender fulcrum and two rod-like mallei, which Mr. Gosse thinks are of unequal length. The shape of the **stomach** is very unusual. Seen dorsally it appears to consist of two cylindrical sacs, one on each side, tapering in front, curved towards each other behind, and connected by a broad cross sac, so as to have a rude resemblance to a letter H. A lateral view shows four short, equal sacs hanging down from the long side sacs; two on each. The whole of this strange stomach is stuffed full of beautiful green oval bodies, which are probably the zoospores of algæ. At each of the four junctions of the short sacs with the long ones there is a dark-brown spot, which seems to consist of decomposing food. No observer has seen any fæcal discharge, or detected a cloaca; and although I made several specimens fast for some hours in clear water I failed to obtain one with a comparatively empty stomach. The **ovary** lies between the four short cæcal prolongations of the stomach, and the **contractile vesicle** lies deep down below the connecting cross sac. The animal carries its **eggs** attached to its hind extremity; bearing sometimes one or two female eggs, or occasionally a whole cluster of small male eggs.

[From one of the eggs, which, before maturity, are much clouded and spotted with granules and globules, a young one was produced in my live-box, which was, I doubt not, a **male** (fig. 2*c*). I could not detect any **eye** (though this organ is conspicuous in the parent) nor any internal organisation; nothing but a confused assemblage of granules and globules; even the ordinary opaque masses were not present. The form somewhat resembled that of an amphora with a short wide neck; the frontal cilia were very large, but the motion was not rapid, nor was the animal wild, as male Rotifera usually are.—P.H.G. ("Phil. Trans." *loc. cit.*).]

Length. Female, $\frac{1}{150}$ inch; male, $\frac{1}{270}$ inch. **Habitat.** Hampstead Heath (P.H.G.); Clifton (C.T.H.).

Family VII. SYNCHÆTADÆ.

Corona *a transverse spheroidal segment, sometimes much flattened, with styligerous prominences;* **ciliary wreath** *a single interrupted or continuous marginal curve, encircling the corona;* **mastax** *very large, pear-shaped;* **trophi** *forcipate;* **foot** *minute, furcate.*

Genus SYNCHÆTA.

GEN. CH. **Form** *usually that of a long cone whose apex is the foot; front furnished with two ciliated* **auricles**; **ciliary wreath** *of interrupted curves;* **foot** *minute, furcate.*

Though this genus consists of only a few species yet it is alike interesting in its structure and its habits. The various species differ from each other chiefly in the shape of the body and of the coronal head, as well as in the number and position of the tactile organs. There is, too, at least one species which is marine, and which has been said by its presence to render sea-water luminous.

In all the species the striking characters are the swift and varied motions, the ciliated auricles, the huge mastax, and the long delicate œsophagus closely resembling that of *Asplanchna*.

S. PECTINATA, *Ehrenberg*.

(Pl. XIII. fig. 3.)

Synchæta pectinata . .	Ehrenberg, *Die Infus.* 1838, p. 437, Taf. liii. fig. 4.
Synchæta mordax . . .	Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 200.
Synchæta pectinata . .	Leydig, *Ueb. d. Bau d. Räderth.* 1854, p. 41.
Synchæta mordax . . .	Pritchard, *Infusoria*, 1861, p. 686, pl. xxxiii. fig. 422.
" " . . .	Hudson, *Mon. Micr. J.* vol. iv. 1870, p. 26, pl. lvi.

SP. CH. **Body** *a swollen cone;* **auricles** *very long, pointed, usually pendent;* **coronal head** *very large and convex; two club-shaped* **prominences** *in front, each crowned with a wide brush of setæ; four* **styles**, *the outer pair sometimes compound.*

This is the finest and most vigorous of the *Synchætæ*. No one can watch it swimming in ample space, without marvelling at the energy of this living speck, and admiring the grace and ease of its varied motions. No swift is more untiring in its flight. Now it sweeps along in spiral turns from the surface to the bottom, and now it darts through the green branches of the water crow-foot to hang motionless over a leaf like a hovering fly in summer; motionless, and yet with its front all ringed with the halo of its furiously lashing cilia. The **auricles**, which seem mere rudimentary stumps, are really most effective organs of locomotion. They are tongue-shaped fleshy protuberances, edged with powerful cilia; and, as they can be set by special muscles at various angles to the body, the creature can dart, wheel, and stop, with the greatest ease. The **trunk**, seen ventrally, appears to be a cone tapering to a small foot divided into two minute toes, but the side view shows the dorsal surface rising behind the head into a distinct hump. The **coronal head** is nearly half a spheroid. Round its base on the dorsal side are four semicircular curves of small cilia, and two similar curves edge cup-like protuberances on the ventral side. These cups can be lowered or raised a little at will, and their contour altered so as to enable their fringe of cilia to sweep the food effectively between the two into the **buccal orifice**. This lies near the top of the coronal head towards the ventral side. It can be seen only by looking directly at the top of the head; no dorsal or side view will show it, and, unluckily, these are the only views that a compressorium will yield. I have, however, on one or two occasions found a *Synchæta*, left in an open cell, swimming feebly in an upright position just before it died; and I have thus caught sight of the buccal orifice. It is an oval opening between the ventral cups, and overshadowed by two projections each bearing a fan of styles. As the atoms of food are swept towards the orifice, the fans are bent over it, and the styles lash the water to drive downwards any escaping prey. Many Rotifera have a similar contrivance, notably the *Brachioni*, whose coronal styles form quite a dome over the buccal orifice. The corona bears also four **tactile organs**, two towards the dorsal, and two towards the ventral side; and each consisting of one or more styles issuing from a small prominence, and set in a short cylinder. To the end of the cylinder a muscle is attached, so that by this means the styles it carries can be withdrawn nearly below the surface. There is yet another organ of touch. At the summit of the dorsal hump meet two rocket-headed **antennæ**, each bearing a tuft of setæ; and the two tufts issue together from the

same opening. A nerve-thread passes from each rocket-head to a **nervous ganglion** in the head, on which is seated a bluish-purple eye-spot[1] bearing a refractive body, shaped somewhat like a truncated cone.

The great **mastax** is a pear-shaped body placed so close to the buccal orifice that there is no room for a buccal funnel. The forcipate trophi are driven snapping through the buccal orifice by the great striated muscles shown in fig. 3. A V-shaped one embraces the end of the fulcrum, and one on each side acts on each malleus. The **œsophagus** closely resembles that of *Asplanchna*, and like that is often used as a supplementary stomach. Indeed, I have seen it so full that, for a moment, I did not recognize *Synchæta*, and thought that I had found a new Rotiferon. The **gastric glands** are small and round; the foot glands obvious. The **stomach** is usually yellow, but sometimes brown; more rarely, pink. It is round, with thick walls formed of very large cells. Sometimes these are studded all over with oil-globules, as in fig. 3. The **lateral canals** with their vibratile tags can be plainly seen in the lower half of the trunk, but do not appear to run up to the head in the usual fashion. There is a small round contractile vesicle just above the foot. The longitudinal and transverse **muscles**, as well as those that work the auricles, can be seen in fig. 3, and need no further description.

The **male** is as yet unknown.

Length, $\frac{1}{70}$ inch. **Habitat.** Clear ponds and reservoirs: common.

Synchæta Baltica, *Ehrenberg*.

(Pl. XIII. fig. 1.)

Synchæta baltica . . . . . Ehrenberg, *Die Infus.* p. 437, Taf. liii. fig. 5.
" " . . . . . Gosse, *Tenby*, p. 274, pl. xiv.

[SP. CH. **Body** *cylindric, becoming conical behind, or bell-shaped: gibbous dorsally;* **rotatory clusters** *four;* **styles** *four;* **crest** *single, sessile. Luminous. Marine.*

The **form** is usually that of a bell, or a long cone, viewed dorsally; but much arched, viewed laterally. The **auricular lobes** are very small: two equidistant setæ radiate from the occiput. There are two ciliated eminences besides the auricles, and a medial crest, smooth-edged. The front is rather wider than the body, whose hinder part tapers to a well-jointed foot, and two very minute conical **toes**. Conspicuous pear-shaped **mucus-glands** from these run up through the foot.

A large **red eye** is seated at the end of a cylindrical **brain-sac**: below which is the vast **mastax** of normal structure. We see, now and then, a momentary snatching action with this organ, of which I have not been able to define the actual seat. A sudden trembling also occasionally passes through the whole fore parts. A long œsophagus leads to a small sacculate yellow **stomach**, on which are seated ample **gastric glands**. A small intestine opens into the cloaca, above which projects a wart, which is a true tail. A band-like **ovary**, of horseshoe form, the ends forward, lies in the lower belly; and behind this a small **contractile bladder**, whose period is $2\frac{1}{2}$ times a minute. The **muscular system** is very distinct: a cord from the frontal region is inserted in the skin of the back, thrown into sigmoid curves during contraction; other cords proceed from the hind-head to various points near the middle of the trunk; one (pair?) proceeds from the mid-back to the side; five or six bands run transversely across the back. There are, moreover, long diagonal bands down the sides.

The brilliant translucency of this animal makes it a very charming object, particularly when well illuminated on a dark ground, when the eye shines out like a ruby, and the whole body resembles a sparkling diamond. Its movements are vivacious and elegant. It shoots rapidly along, or circles about in giddy dance, in company with its fellows, sometimes near the surface, sometimes just over the bottom of its prison. Occasionally the foot and tiny toes are drawn up into the body, and then suddenly thrust down, and bent up from side to side, as a dog wags his tail. Sometimes the two ear-

[1] Crimson by lamp-light and dark-field illumination.

lobes are brought forward, and then spasmodically spring back to their ordinary position, when the creature shoots forward with redoubled energy. All its actions display vigour and precision; and convey the impression of intelligence and will.

The most interesting fact connected with its history is that it seems to be one of the sources of the phosphoric light which often pervades the waves of the sea. In July, 1854, at Tenby, I saw the water within the harbour splendidly luminous. No trace of light, indeed, appeared on the smooth surface, but when this was agitated it blazed. The finest effect was produced by dashing a large stone down from the quay: every spray that splashed up was luminous; and thus a momentary star of many irregular rays of light was made, some of the lines reaching to fifteen or twenty feet. At the same moment a great circular wave was raised, which took the appearance of a bank, or annular agger, most intensely lustrous, but so transient that the progression of the wave could not be traced; the light sank into darkness in an instant. The Bristol steamer was just leaving the wharf, and an impatient stroke or two from her paddles illuminated the dark water under her quarter, and the lowest step of the quay stairs was every instant covered with sparks, like diamond dust, by the tiny wavelets that washed over it. On examination, I found specimens of *S. Baltica* in it; associated, however, with other animalcules, both larger and smaller, which were indubitably luminous, as *Noctiluca* and *Ceratium*.

I first met with this species in July, 1850, in water from the mouth of the Naze, in Essex. Mr. Hood has lately found it in the estuary of the Tay, in Scotland, with many other marine Rotifera; and has communicated living specimens to me, one of which has contributed to the present description.—P.H.G.]

Length, $\frac{1}{170}$ to $\frac{1}{125}$ inch; width, $\frac{1}{433}$ to $\frac{1}{350}$ inch. **Habitat.** Sea-water; coasts of England, Wales, and Scotland (P.H.G.; J.H.).

8. OBLONGA ?, *Ehrenberg*.

(Pl. XIII. fig. 4.)

Synchæta oblonga (?) . . . . Ehrenberg, *Die Infus.* 1838, p. 438, Taf. liii. fig. 6.

[SP. CH. **Body** *ovate or pyriform;* **head** *very large;* **auricles** *wide;* "**rotatory clusters** *six;* **styles** *four;* **crest** *single, sessile*"; **toe** *single, minute, without foot. Lacustrine.*

A species which I met with in the Watering Pond on Hampstead Heath in 1850, I concluded to be *S. oblonga* of Ehrenberg, though I could not identify all the characters. But a single specimen occurred, and I have never seen it since, till in November 1885, in a tube dipped from Keeper's Pond, Birmingham, and sent to me by Mr. Bolton, I met with a second example, recently dead, but in fair preservation.

The **front** has two minute ridges, each with an edging of short comb-like spines; outside these are the two knobbed **antennæ**, on which I did not detect any brushes of divergent setæ. A good deal lower, on the slope of the auricle, on one side, was a long stiff bristle, doubtless one of a pair. The **auricles** are very large, and each is pervaded by a chain of globose bodies, possibly ganglia, which, having passed around the swollen extremity, turns back at least as far as the base of the bristle. A vast **mastax** exists, whose chief visible feature is a stout incus, whose wide rami appear as diverging lines. A very long, delicate, corrugated œsophagus leads to a small, globose, sacculate **stomach** (which recalls the structure common in the *Asplanchnæ*) filled with green food; thence a thick, much-wrinkled intestine passes straight to the extremity, where is a very minute, conical **toe**, which I could not by any effort divide. A glandular thread runs from the tip to a minute globose vacuole (?) at its base. Three great **ova**, colourless but turbid, were in the body-cavity, from the appearance of which I should conjecture the animal to be viviparous. Various muscles and nervous (?) threads are shown in the figure.—P.H.G.]

Length, $\frac{1}{75}$ inch; greatest width, $\frac{1}{110}$ inch. **Habitat.** Hampstead; Birmingham (P.H.G): rare.

S. TREMULA.

(Pl. XIII. fig. 2.)

Synchæta tremula . . .	Ehrenberg, *Die Infus.* 1838, p. 438, Taf. liii. fig. 7.
„ „ . . .	Leydig, *Ueb. d. Bau d. Räderth.* 1854, p. 41.
„ „ . . .	Pritchard, *Infusoria*, 1861, p. 686.

SP. CH. **Body** *a slender cone;* **coronal head** *nearly truncate;* **auricles** *scarcely protuberant;* **setæ** *four; no club-shaped* **prominences**; *a sudden diminution in girth below the cloaca.*

S. tremula is rather smaller than *S. pectinata*, and its habits are different. It loves to twirl round its own longer axis at the end of a thread stretching from its toes; and, so twisting, to drift lazily along with the current which bears the object to which it is attached. Its **coronal head** is almost flat, and the side auricles are nearly in the same plane with it. This makes the animal strikingly unlike *S. pectinata* in outline. It has no crests on its corona; only four long curved styles, similar to those of *S. pectinata*. Its **stomach** is generally full of a rich brown food, and I have sometimes captured specimens with the œsophagus at the same time stuffed with some pinkish substance. Its **eye** is an intensely dark-red, and Mr. Gosse has detected a refractive body imbedded in the pigment.[1] There is a rocket-shaped **antenna** (fig. 2*b*) on each side of the trunk just above the foot: organs that I have failed to detect in *S. pectinata*. In all other respects the structure of the two species is almost identical.

[In one of the shallow evaporating tanks in my orchid house, I found (at the end of May) this pretty species swarming. It plays, by myriads, just above the dull-green floccose sediment that settles on the bottom. I learn, from this colony, a habit which I think has not been recognised as proper to this genus—viz. that, like the *Brachioni* and *Anureæ*, and one or two other genera, *Synchæta* retains its **egg** after discharge, attached to its own body, just behind the foot. The egg, which I saw, was nearly globular, of a pale yellow hue, granular by the process of segmentation.—P.H.G.]

I found the **male** (fig. 2*c*) in the winter of 1870. It is much smaller than the female, narrower for its length, but otherwise much like her in shape, and with the same four styles on the coronal head. I distinctly noticed in it the entire absence of the nutritive system; but its irrepressible energy prevented me from obtaining more than a fleeting view of the sperm-sac and penis.

Length, $\frac{1}{110}$ inch. **Habitat.** Clear ponds: common.

[1] [On the occipital aspect of the brain-mass is seated an eye-spot, always conspicuous both from its great size and from its intense colour, a red so deep as to be practically black. Its outline varies much; but normally it is a hemisphere, or rounded cone: often it seems homogeneous, but occasionally we see that it is composed of a multitude of pigment cells agglomerated together and inclosed within a transparent capsule, whose walls I have frequently detected of a thickness greater than that of one of the pigment cells. But more than this: I have seen, so often as to have no doubt of its presence, an ovate transparent cell, let-in, as it were, into the coloured body of the eye, the dark pigment rising on each side so as to embrace the base of it. I venture to think this a crystalline lens.—P.H.G.]

THE ROTIFERA.

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THE ROTIFERA;

OR

WHEEL-ANIMALCULES

BOTH BRITISH AND FOREIGN.

BY

C. T. HUDSON, LL.D. CANTAB., F.R.S.

ASSISTED BY

P. H. GOSSE, F.R.S.

IN TWO VOLUMES, WITH SUPPLEMENT.

VOLUME II.

WITH ILLUSTRATIONS.

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1889.

Those viewless beings,
Whose mansion is the smallest particle
Of the impassive atmosphere,
Enjoy and live like man:
And the minutest throb,
That through their frame diffuses
The slightest, faintest motion,
Is fixed, and indispensable,
As the majestic laws
That rule yon rolling orbs.

SHELLEY.

Qui curiosus postulat totum suæ
Patere menti, ferre qui non sufficit
Mediocritatis conscientiam suæ,
Judex iniquus, æstimator est malus
Suique naturæque; nam rerum parens,
Libanda tantum quæ venit mortalibus,
Nos scire pauca, multa mirari jubet.

GROTIUS.

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OF

THE SECOND VOLUME.

CHAPTER IX.

PLOÏMA

IL-LORICATA—continued.)

Les actions des bêtes sont peut-être un des plus profonds abîmes su quoi notre raison se puisse exercer; et je suis surpris que si peu de gens s'en aperçoivent.—Bayle.

Their good is good entire, unmixed, unmarred;
They find a paradise in every field,
On boughs forbidden where no curses hang:
Their ill, no more than strikes the sense, unstretched
By previous dread, or murmur in the rear;
When the worst comes, it comes unfeared; one stroke
Begins and ends their woe.—Young.

CHAPTER IX.

Family VIII. TRIARTHRADÆ.

Body *furnished with skipping appendages;* **corona** *transverse;* **ciliary wreath** *single, marginal;* **foot** *absent.*

The four genera which form this family resemble each other in one striking particular. Each bears spines, or moveable appendages, by means of which the creature can leap through the water. These spines have no connection with the body-cavity, though they are moved indirectly by the usual longitudinal muscles; which, in sharply withdrawing the head, throw the spines forward. In one genus, *Pteroessa*, which is known only by its lorica, the spines are very numerous, and are of two distinct patterns; in another, *Polyarthra*, they are clusters of blades borne upon the shoulders; in the remaining two, *Triarthra* and *Pedetes*, there is only one simple spine on each shoulder, but *Triarthra* carries also a similar spine on the posterior ventral surface. All the genera are more or less loricated. In *Pedetes* the skin bears hard knobs for the attachment of the spines, while *Triarthra* has it stiffened chiefly round the edge below the neck. *Polyarthra* is semi-loricated; the dorsal surface is very tough and there is a still harder shield on each side between the dorsal and ventral surfaces. The ventral surface, however, is soft and membranous. In all, the longitudinal muscles are highly developed, and coarsely striated.

The genera differ in their trophi. *Triarthra* has the malleo-ramate trophi of *Melicerta ringens*; in *Pedetes* the trophi have not been clearly defined; while *Polyarthra*, widely unlike either, has a mastax and trophi closely resembling those of *Synchæta*. *Polyarthra*, moreover, is still further separated from *Pedetes* and *Triarthra* by having one occipital eye, instead of two frontal.

Genus POLYARTHRA, *Ehrenberg*.

GEN. CH. **Spines** *in clusters on the shoulders;* **eye** *single, occipital;* **mastax** *very large and pear-shaped;* **trophi** *forcipate.*

It is not easy to decide in which family the genus *Polyarthra* should be placed. Its mastax and trophi are almost exactly those of *Synchæta*; its corona bears styligerous prominences similar to those of *S. pectinata*; its ciliary wreath is marginal and single, though not broken up into curves; and, like *Synchæta*, it possesses but one occipital eye. On the other hand its skipping spines naturally place it with *Triarthra* and *Pedetes*, which genera it further resembles by its lack of foot, by its habit of carrying its eggs, and by the partial stiffening of its skin into an imperfect lorica.

P. PLATYPTERA, *Ehrenberg*.

(Pl. XIII. fig. 5.)

Polyarthra platyptera[1]	. .	Ehrenberg, *Die Infus.* 1838, p. 441, Taf. liv. fig. 8.
,, ,,	. .	Leydig, *Ueb. d. Bau d. Räderth.* 1854, p. 42, Taf. i. fig. 10.
,, ,,	. .	Gosse, *Phil. Trans.* 1856, p. 435, pl. xvii. figs. 44–49.
,, ,,	. .	,, ,, ,, 1857, p. 320, pl. xv. figs. 27–29.
,, ,,	. .	Plate, *Jenaisch. Zeits. f. Natur.* 1885, p. 16, Taf. i. fig. 4.

[1] Ehrenberg's *P. trigla* is possibly *P. platyptera* with the blades seen edgewise.

SP. CH. **Spines** *twelve broad blades with serrate edges.*

When gliding along under the action of its ciliary wreath *Polyarthra* seems to have a triangular outline; for the **body**, though itself truncated both in front and rear, carries four clusters of serrated blades fastened to the shoulders; and these trail behind so as nearly to meet in a point, at some distance from the animal's body. Every now and then the blades are jerked vigorously forward, and the creature is tossed out of its path, several times its own length. The **trunk** is partially loricated. There is a kind of chitinous shield running down each side of the body, pointed at its hinder end, and bent at the sides so as to encroach a little on the tough dorsal and membranous ventral surfaces. The edge of the dorsal lorica (if it may be so termed) is plainly visible running across from one cluster of blades to the other. A pair of powerful striated **muscles**, forming a letter V, is fastened to the lower pointed end of the shield, and to the inner surface of the soft tissues, to which, at the upper end on each side, six of the blades are attached. The contraction of these V-shaped muscles drags the soft tissues sharply down over the hard edge of the shield, and makes the blades fly out with great swiftness. The **blades** are curiously like a bird's feather in general outline (fig. 5*d*), having a midrib (fig. 5*e*) and being distinctly serrated on both edges. The **corona** is slightly convex and bears, towards the dorsal surface, two **prominences** like those of *Synchæta pectinata*, each carrying a brush of styles. There are also two long styles facing these, and springing from the corona towards the ventral surface. Mr. Gosse has, moreover, noticed, besides these tactile organs, a small occipital pimple armed with bristles. The very large mastax points obliquely downward to the ventral surface. Both it, and its trophi, closely resemble those of *Synchæta pectinata*. The contractile vesicle can be easily seen, but neither lateral canal nor vibratile tags have been recorded. Nothing else in its internal structure requires notice.[1] The animal carries the great female egg singly, and transversely, between the points of the two side shields; but the small male eggs in clusters of half-a-dozen or more at a time (fig. 5*b*). The male was discovered by Mr. Gosse in 1850, and described and figured by him in the "Phil. Trans." for 1856. [Its length is only $\frac{1}{250}$ inch. The head is very large (fig. 5*h*) and the body tapers quickly to the posterior part, but both extremities are truncate. The front bears two warts between which the rotatory cilia are placed, but the cilia are longer (perhaps setæ) on the warts. The hinder part is bifid, the smaller division being the caudal extremity or toe-less foot, and the latter a protrusile truncate penis ciliated at the tip. No internal organization was discoverable.—P.H.G.] Dr. Plate's figure (*loc. cit.*) shows the sperm-sac.

Length. Female's body, $\frac{1}{100}$ inch. **Habitat.** Pools and ponds: common.

Genus PTEROESSA, *Gosse*.

[GEN. CH. **Lorica** *entire, save for a large oval opening behind; beset with articulate pinnate* **styles**, *and simple* **setæ**: **foot** *wanting.*

P. SURDA, *Gosse*, sp. nov.

(Pl. XIII. fig. 9.)

SP. CH. *The only known species. Horny yellow;* **pinnæ** *twenty-four, in six longitudinal rows.*

The form of this remarkable species is that of an ancient amphora; a long oval tapering to an obtuse point, with no foot, forming a constricted neck, in front, and thence

[1] An observation of Mr. Gosse's leads him to think that the rectum is turned far forward as in the *Rhizota*; and that it is capable of considerable protrusion, though ordinarily invisible.

expanding to a broad truncate margin. Behind there is a great ovate opening, as if a slice had been cut off the entire breadth from the middle to the extreme point. Doubtless this, in life, is covered with membrane, and its edge is thickened. From the upper margin rise two short **setæ**, jointed to knobs; while from the breast, exactly opposite, there issues another, similarly jointed but of great length, descending far behind the extremity of the body.

But the chief peculiarity of the creature is that four-and-twenty **styles**, regularly arranged, are affixed to the lorica, giving a most unique aspect to it. For every one is a feather in appearance; the shaft, moderately long and stout, being beset, on its two opposite sides, with regular pinnules like those of a fern (*Polypodium*, for instance), in considerable number, length, and regularity (fig. 9*c*). These pinnæ are arranged in six longitudinal rows, three on each side, on the ventral aspect, the middle pair of rows consisting of six each, the next pair four, and the outmost two, each. The shaft of each is evidently articulated on a knob of chitine, which is itself a tubercle on a somewhat larger round knob, set in a commensurate orifice in the lorica,—apparently moving freely in it, a true "ball and socket" joint, worked doubtless by proper muscles within. Thus, adding the three simple styles, which are similarly based, we have here a wonderful array of exterior articulate members, which well illustrate the claim of the ROTIFERA to a place among the ARTHROPODA. The pinnules vary much in their number, their length, and the angle of their expansion. The body ends in a blunt point, with no foot, nor other appendage. The anterior extremity, beyond the marked neck, is short, somewhat inclined toward the back, truncate, with an orifice as wide as the widest part of the trunk. Through this, of course, the head is protruded during life; but of this, and of the whole internal organization, I can give no information. The specimen which came under my observation was an empty lorica, in good preservation, as if recently dead, which I was enabled to revolve under the microscope, and so to examine in several aspects. The whole lorica was of a dark yellow-brown hue, with a dull translucency like that of a smoky horn lantern: but whether this is specific, or only accidental, I cannot tell.

This most curious form occurred in the sediment of a bottle of water, examined on October 20, 1885, but which had been standing on my table since September 23, when I had received it from Mr. Hood with a colony of *Scaridium cudactylotum*. From the condition of the lorica I have little doubt that it had come to me alive; but being occupied with the new *Scaridium* I did not search closely.—P.H.G.]

Length. Of lorica, $\frac{1}{116}$ inch; to tips of pinnæ, $\frac{1}{93}$ inch; from brow of lorica to tip of ventral seta, $\frac{1}{74}$ inch. **Habitat.** Loch near Dundee (P.H.G.).

Genus TRIARTHRA, *Ehrenberg*.

GEN. CH. **Spines** *single, two lateral, one ventral;* **eyes** *two frontal;* **mastax** *of moderate size;* **trophi** *malleo-ramate.*

There are three known species of this genus, and they resemble each other very closely; the main points of difference being the length of the leaping-spines, the distance between the eyes, and the length of the œsophagus. The first of these characters is one that cannot be much relied on except in the case of *T. breviseta*; for the length of the spines varies very much in the same species. Ehrenberg makes a further point of difference, in the presence or absence of any well marked separation between the stomach and intestine, asserting that *T. longiseta* possesses this separation and that *T. mystacina* lacks it. This, however, is a character of small value, for the same animal will show at one time an undivided alimentary canal; and, at another, one sharply divided into intestine and stomach.

T. LONGISETA, *Ehrenberg*.

(Pl. XIII. fig. 6.)

Triarthra longiseta . . . Ehrenberg, *Die Infus.* 1838, p. 447, Taf. lv. fig. 7.
" " . . . Hudson, *Mon. Micr. J.* vol. i. 1869, p. 176, pl. vi.
" " . . . Grenacher, *Sieb. u. Köll. Zeits.* Bd. xix. 1869, p. 491, Taf. xxxvii. fig. 3.

SP. CH. **Body** *oval;* **buccal orifice** *prominent but not beaked, cup-shaped;* **spines** *more than twice the length of the body;* **eyes** *wide apart;* **œsophagus** *long.*

The habit of this interesting creature is to swim slowly forward while turning round its longer axis, and every now and then to dart out of its course by jerking forwards the three long spines which usually trail behind it. The **corona** is oval, and bears in its centre one broad, low prominence, with a smaller one on either side of it; and just within each of these latter is placed a red eye. The buccal orifice is cup-shaped and has its inner surface lined with cilia. The **buccal funnel** slopes backwards and upwards towards the dorsal surface to meet the mastax, whose trophi are almost identical with those of *Melicerta ringens*. The œsophagus is long and narrow, and the stomach and intestine are usually separated by a deep constriction. The **gastric glands** (fig. 6*a*) are curiously shaped, and frequently studded with what appear to be oil-globules. The **vascular system** is delicately transparent, and difficult to be seen. I have traced the lateral canals on each side, for some distance down the trunk, from a plexus of tubes in the neck, and have detected just there a vibratile tag. I failed to discover the contractile vesicle, but Dr. Grenacher (*loc. cit.*) has seen it, in its usual position, close to the cloaca. There is a large **ovary**; and the newly laid eggs remain attached to the parent by a thread for some time after their exclusion. The ephippial eggs (fig. 6*f*) are as curious in shape as the gastric glands, and are protected by a thick layer of yellowish transparent cells. By bringing into focus the central inner portion of the head, seen sidewise, a bluish and roughly rhomboidal mass may be observed; this is the **nervous ganglion**, and above it are the eyes, and from it threads extend to a setigerous fossa in the neck, as well as to rocket-headed antennæ, one on each side (fig. 6*e*) just under the surface. Each **eye** (fig. 6*b*) is a clear, colourless, refracting sphere $\frac{1}{8000}$ inch in diameter, resting on, and partly imbedded in, a flat plate of red pigment. The longitudinal **muscles** are very powerful, and are strongly striated; the striæ not being straight transverse lines, but irregular obliquely transverse curves (fig. 6*c*). Indeed they appeared to me to alter both in direction and in size as I looked at them, giving me the impression that I was looking at illusory striæ, produced possibly by looking through separated sheets of striated fibre, lying over each other. There is an unusually powerful muscular collar running round the neck. The **spines** are stiff quill-like appendages, broadest at their attached bases, and tapering at their free ends. The bases (fig. 6*d*) are like quills that have been obliquely cut across, and it is by these cut surfaces that they are attached, one on each side of the corona, just above the neck; and one on the ventral surface, at the spot from which the foot springs, in those Rotifera that possess one. The spines are notched here and there (fig. 6*d*), and finely imbricated towards their tips. On looking at fig. 6, it will be evident that if the muscular collar round the neck be suddenly contracted, and the head withdrawn, the spines will be first dragged across the stiff edge of the trunk, below the collar, and then jerked forward by the downward pull of the head.

How the third spine is moved is not so clear. Dr. Grenacher suggests that it is dragged forward by the other two, which are often crossed beneath it; but adds that this is a forced explanation. It is probable, I think, that this spine is driven forward by the sudden jerk downwards on its base, when the longitudinal muscles sharply compress the stiff ventral cuticle. Fine muscular fibres surround the trunk at regular

intervals, and unite with the broad band round the neck in driving out the retracted head, and restoring the spines to their usual position.

Length. Without the spines, $\frac{1}{150}$ inch. **Habitat.** Fresh-water ponds and ditches: common.

T. MYSTACINA, *Ehrenberg.*

(Pl. XIII. fig. 8.)

Triarthra mystacina . . . Ehrenberg, *Die Infus.* 1838, p. 447, Taf. lv. fig. 8.

[SP. CH. **Body** *oval;* **buccal orifice** *taking the form of a beak projecting from the face;* **spines** *not twice the length of the body;* **eyes** *approximate;* **œsophagus** *invisible.*

In July 1849, from the ditch at Dalston Causeway, near London, I took several of the Whiskered Three-beard. The moderate length of the leaping spines, the approximate eyes, and the absence of any manifest œsophagus—the stomach coming into contact with the mastax—marked the species as Ehrenberg's *mystacina*. The absence of the œsophagus is doubtless only apparent, this duct, as is the case with *Polyarthra* (see Pl. XIII. 5*c*) and many other Rotifera, issuing from behind the mastax, near its summit. One adult had an egg attached to the hind extremity, which somewhat retarded its motions, as compared with those of its fellows. After a while the spontaneous movement of the embryo became more and more vigorous, and the ciliary rotation energetic; and a clear globule, as of air, was seen within, while yet the egg remained adherent.

The front is formed of a ring of six or seven sub-globose masses, in mutual contact, each of which is crowned by a cluster of divergent cilia. The **chin** descends in a prominent hook, like a parrot's beak, which appears stiff, and projects between the bases of the two pectoral spines. The two **eyes** are nearly frontal, small, bright red, and approximate. The **mastax** appears formed on the plan seen in the Bdelloida. The stomach is large and saccate, and is supplemented by a distinct intestine. The animals are very subject to be infested by two species of *Colacium*, which are seen in fig. 8. They cling to its spines as well as its trunk, and appear to give it uneasiness. I have counted sixty-five of these parasites on one individual, and nearly fifty on another.

The animal seems to have no power of affixing itself, or of resting. It swims constantly; interrupted only by its spasmodic jerks or leaps, performed by the sudden throwing out of the elastic spines, chiefly, I think, the pectoral pair. These are articulated to shelly knobs, which imply a solidifying of the integument around their bases, to supply the necessary resistance. In the act of springing, these two are often shot forward so forcibly as to be projected in front, reminding us of the anal bristles in *Podura*. This is done with a rapidity that the eye cannot follow; and this, through so dense a fluid as water, requires the exertion of great muscular power.—P.H.G.]

Length. To tips of setæ, $\frac{1}{80}$ inch. **Habitat.** Around London: ditches and ornamental waters (P.H.G.).

T. BREVISETA, *Gosse.*

Triarthra breviseta . . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 200.

[SP. CH. **Body** *cylindrical;* **breast** *projecting, but not beaked;* **spines** *not one-fourth as long as the body.*

This species is more regularly cylindrical than the others; it is diminished toward the front, which is truncate; the hinder end is ventricose, and extends much beyond the base of its spine; the belly is deeply sulcate, with thick collops of the skin between; the breast forms a great rounded projection, but not a beak. Just beneath this is a constriction, where the very short spines are set, each not more than half the body's width in length, very slender. The whole head can be retracted as far as this, by which involution of the skin the spines point straight forward, reverting to their normal direc-

tion as the head emerges. The animal has no power of springing by means of the spines, or of using them in any appreciable manner. The hind spine is similar, and similarly set in a deep sulcus of the lower belly. All are dilated at their bases.

At the very front are two minute but distinct red **eyes**, side by side, seated on a small brain-mass, which tapers into a thread that passes to the occiput, probably to an antenna, not detected. The **mastax** was obscure, but seemed of the Bdelloid pattern. A very slender but long **œsophagus** leads to a vast sacculate alimentary canal, and this to a cloaca at the very point of the body, behind the spine; which hence, Herr Grenacher's judgment notwithstanding, I conclude to represent the foot. A momentary action, like that of a **contractile vesicle**, I perceived, but could not define one; and lateral canals run down each side. Several **muscles** are discernible.

The animal is vivacious, swimming freely and swiftly; I did not see it attempt to spring, nor to crawl; the foot-spine was not whisked about. I first met with the species in a pond in Holly Walk, Leamington, in July 1850; and again lately in water from Keeper's Pool, Birmingham, sent me by Mr. Bolton.—P.H.G.]

Length, $\frac{1}{102}$ to $\frac{1}{135}$ inch. **Habitat.** Warwickshire pools: rare (P.H.G.).

Genus PEDETES, *Gosse*.

[GEN. CH. **Body** *ovate, tailed;* **toes** *absent;* **eyes** *two frontal; two leaping* **styles** *articulated to the breast.*

P. SALTATOR, *Gosse*, sp. nov.

(Pl. XIII. fig. 10.)

SP. CH. *Leaping* **styles** *thrice the length of the body.*

This genus has a very close relation to *Triarthra*. It may, indeed, be described as a *Triarthra* with the posterior style wanting. The **body**, though apparently soft and flexible, must be considered as enveloped in a lorica, since the knobs to which the styles are articulated, are hard, immoveable, and doubtless chitinous. Its form, viewed dorsally, is ovate, obtusely pointed behind and broadly truncate in front. Viewed laterally (fig. 10*a*), it is flat on the ventral, and strongly arched on the dorsal surface. The dorsum rises to a marked conical elevation which is a true tail, for the cloaca opens between it and the **foot**. The latter (or what represents it) is a small ovate terminal member, within which, close to the tip, is a minute vesicle, possibly the contractile bladder. The rotatory cilia are seated on a number of small projecting eminences, with which the front is beset. On each side of what for convenience sake we call the breast, but rather high up, is a large round shelly knob, apparently hard and immoveable. Dr. Hudson ("M. M. J.") long ago explained the action of the pectoral **styles** in the parallel case of *Triarthra* (see *T. longiseta*, p. 6). We may conclude the mechanism to be the same in both cases; but I am inclined certainly to see more than mere mechanical action in these shelly knobs, viz. special muscles for the forcible and definite motion of the styles, by means of a true (perhaps *ball* and *socket*) joint. Each style is a highly elastic rod, thick at its origin and for a considerable distance, then gradually tapering to a great attenuation, about thrice as long as the body. On the tips of these, which must therefore possess remarkable firmness, the animal, now and then, suddenly jerks itself away, as on a leaping-pole, with great force; so that they are in an instant seen stretching out at a right angle, or even more, forward. These leaping-poles are composed of transparent refractive material (chitine), resembling glass in appearance. The **brain** has not been defined; but two **eyes**, of a translucent red hue, near together, are conspicuous at the very front. The **mastax**, far down in the body, with vigorously working mallei, was visible near the middle; and below this a great globose, sac-like alimentary canal, without visible division. The only specimen I have seen occurred in

a tube, rich in Rotifera, sent me by Mr. Bolton in the autumn of 1884. It had become, in the live-box, accidentally entangled in a small mass of tenacious mucus, which evidently annoyed it, and from which it made vigorous but ineffectual efforts to become free. I have never met with the form since.—P.H.G.]

Length of body (without styles), about $\frac{1}{170}$ inch. **Habitat.** A pool near Birmingham (P.H.G.).

Family IX. HYDATINADÆ.

Corona *truncate with styligerous prominences;* **ciliary wreath** *two parallel curves, the one marginal fringing the corona and buccal orifice, and the other lying within the first, the styligerous prominences being between the two;* **trophi** *malleate;* **foot** *furcate.*

Ehrenberg's very extensive family of the *Hydatinæa*, under the name of *Hydatinadæ*, is here restricted to three genera, viz. *Hydatina*, *Notops*, and *Rhinops*. They are all alike in their corona, ciliary wreaths, and trophi, but differ from each other in their shape, eyes, and foot.

The **head** is truncate with a deep cup-like cavity as it were scooped out of it. This cavity lies more towards the ventral surface than the dorsal, so that a transverse slice would be horseshoe-shaped, the bend of the horseshoe being to the dorsal surface. The **principal wreath** fringes the outer edge of the cup's wall, and the secondary wreath borders the inner; both wreaths are continued down into the buccal orifice, which lies just within a deep notch in the wall of the cup on the ventral surface.

Styligerous prominences rise in the space between the two wreaths, except in the case of *Rhinops*; and in this genus the dorsal side of the corona bears a thick proboscis, around the edges of which the principal wreath is continued.

In their habits they in the main resemble each other; for all but *Rhinops* tolerate even very dirty water, provided that it contains an abundance of the minute organisms on which they feed.

Genus HYDATINA, *Ehrenberg.*

GEN. CH. **Body** *conical, tapering towards the foot;* **foot** *short, and confluent with the trunk;* **eye** *absent.*

H. SENTA, *Ehrenberg.*

(Pl. XIV. fig. 1.)

Hydatina senta	Ehrenberg, *Die Infus.* 1838, p. 413, Taf. xlvii. fig. 2.
" "	Cohn, *Sieb. u. Köll. Zeits.* Bd. vii. 1856, p. 436, Taf. xxiii.
" "	Leydig, *Müller's Archiv*, 1857, p. 404, Taf. xvi.
" "	Hudson, *Mon. Micr. J.* vol. ii. 1869, p. 22, pl. xix.

H. senta is one of the largest of the Rotifera, and its flashing styles, ruddy teeth, and yellow stomach, often stuffed with brilliantly green *Euglenæ*, make it a charming object for dark-field illumination. Its **shape** is conical, the corona being the base, and the toes the apex. When seen, however, from the side (fig. 1*b*), especially if a little arched, the separation of the head and foot from the trunk is distinctly visible. The **styligerous prominences** are semi-globular cushions crowned with long and rapidly vibrating styles, set fan-fashion. It is difficult to say how many cushions there are, owing to *Hydatina's* incessant restlessness; but there are probably ten or eleven. Two are on the median line; one on the dorsal edge, and one between the first and the cavity of the head. The rest are arranged round the cavity in a sort of quincunx fashion; mainly on the dorsal half of the corona. The great hollow in the corona is not only ciliated on its edge but

also on its whole surface, and may fairly be considered to be the buccal funnel. At its base, close to the ventral surface, lies the **mastax**, containing malleate reddish trophi with unci of four arrow-like teeth (fig. 1*e*). I have often seen these hand-like unci protruded into the funnel to grasp some desired morsel. The thick cellular walls of the **stomach** are well seen in the young specimen (fig. 1*a*), in which a thin line of green food marks the hollow of the nearly empty stomach. The **secreting** and **vascular** systems are obvious and normal. A rectangular **nervous ganglion** (fig. 1) below the corona, and just under the dorsal surface, sends off a pair of nerve-threads at each corner. The upper pairs possibly ramify to the styligerous prominences which are very sensitive; and which Mr. Gosse has seen individually depressed below their usual position by muscular threads rising up to them from the depth of the head. One of the lower pairs supplies the two lateral **antennæ** (fig. 1*a*, 1*b*), and the other two nerve-threads pass to the dorsal antenna (fig. 1*b*). The **ovary** in the half-grown animal (fig. 1*a*) is very transparent, and the oviduct is then conspicuous; as are also the fibres that tie the ovary to the body-walls.

The **male** was described by Ehrenberg under the name *Enteroplœa hydatina*, as he was not aware of its sex. It is often to be met with among the swarms of females that haunt dirty farmyard ponds and neglected water-butts. Its general appearance is that of a young female, but it can be recognised at a glance by the absence of the mastax. Its internal structure is precisely like that of the male of *Asplanchna priodonta*, and is sufficiently shown in fig. 1*n*.

Disease.—I once found a few specimens of *H. senta* (fig. 1*m*) with what appeared to be the mycelium of a fungus growing in the perivisceral fluid, and loosely surrounding the various organs. The infected creatures, however, seemed as vigorous as the healthy ones. *H. senta*, too, suffers from an internal parasite. It is of a narrow oval form, about $\frac{1}{300}$ inch in length, and swims up and down its host's stomach by jerking the contents of its body constantly backwards and forwards (figs. 1*h*, 1*k*). There are curious bodies inside the parasite itself something like the globe of a lamp in shape (fig. 1*l*).

Length. From $\frac{1}{10}$ inch to $\frac{1}{5}$ inch. **Habitat.** In water swarming with *Euglenæ*, &c.: common.

Genus RHINOPS, *Hudson.*

GEN. CH. **Body** *conical, tapering to the foot; a long dorsal* **proboscis** *on the corona;* **foot** *short, and confluent with the trunk, with two minute* **toes** *closely pressed together;* **eyes** *two, at the end of the proboscis.*

R. VITREA, *Hudson.*

(Pl. XIV. fig. 2.)

Rhinops vitrea . . . . . Hudson, *Ann. Nat. Hist.* 4 Ser. vol. iii. 1869, p. 27, pl. ii.
" " . . . . . Plate, *Jenaisch. Zeits. f. Natur.* Bd. xix. 1885, p. 46.

Rhinops vitrea appears to have escaped notice till 1869, when I found it in a pond in Losely Park, near Guildford; so I suppose it must be rare: and yet I have often taken it in the neighbourhood of Clifton, and at times even in abundance. Though not a large Rotiferon, it is easily recognized with a hand-lens by its slow, deliberate way of swimming; a peculiarity which first attracted my attention to it. Its **shape** is striking. It is a *Hydatina* without any styligerous lobes on the **corona**; but bearing, in lieu of them, a unique prolongation of the dorsal surface into a sort of proboscis. Two splendid ruby **eyes** are placed on the extremity of this proboscis, and its under surface is furred with cilia like the prone face of *Adineta*. The outer **ciliary wreath** is carried up each side of the proboscis; but the tip between the eyes is free from cilia, and seems to act

as an organ of touch. The inner ciliary wreath consists of larger cilia which are sometimes held erect. The **œsophagus** is long and narrow, and the **gastric glands** so irregularly conical, that they generally appear unlike; probably owing to their being seldom presented to the eye from similar points of view. The **nervous ganglion** has an unusual position. It lies near the end of the proboscis, and gives off, above, four parallel nerve-threads; the two outer of which pass to the eyes, and the two inner to the sensitive bare spot on the tip of the proboscis (fig. 2*c*). The rest of the internal structure is both obvious and normal. The **young animal** quits the egg while yet in the body of the parent, and may often be seen filling up a large portion of the body-cavity. The **ephippial eggs** closely resemble those of *Conochilus volvox*.

Rhinops vitrea usually swims at a moderate pace, rolling gently round its longer axis as it goes, and every now and then bending back its proboscis, or turning somersaults as *Synchæta pectinata* does, only in a much more leisurely manner. Occasionally it darts forward; and, at each time that it has done so, I fancied I could see the atom which it wished to secure. Then it glides over the stems of *Algæ*, using its long proboscis just as *Adineta vaga* does its ciliated face; and, when a larger atom than usual has been drawn into the coronal cavity, it compresses the broad flaps of the corona, and rounds the whole front of the body into a long ciliated tube.[1]

Length, $\frac{1}{80}$ inch. **Habitat.** Clifton (C.T.H.): not common.

Genus NOTOPS, *Hudson*.

GEN. CH. **Body** *not conical;* **foot** *long and symmetrically placed with respect to the trunk, or short and wholly retractile within the ventral surface;* **eye** *single, occipital.*

Of the three remarkable species contained in this genus, two, *N. Brachionus* and *N. clavulatus*, are strikingly alike each other, especially in the head and its ciliated protuberances, and also in the trophi. They are, however, curiously unlike in their outline, and in the relative length of the foot. The third species, *N. hyptopus*, resembles *N. clavulatus* in the short foot, and in the odd position in which it is placed; but differs widely from all the *Hydatinadæ* in the corona and trophi. Feeble, however, as are its affinities with the two other species of the genus, they are stronger than those it has with any other; so it has been placed here as the best makeshift that could be devised.

N. BRACHIONUS, *Ehrenberg*.

(Pl. XV. fig. 1.)

Notommata brachionus . . . Ehrenberg, *Die Infus.* 1838, p. 433, Taf. l. fig. 3.
" " . . . Leydig, *Ueb. d. Bau d. Räderth.*, 1854, p. 99.
" " . . . Hudson, *Mon. Micr. J.* vol. xiii. 1875, p. 46, pl. xci. figs. 1–4.

SP. CH. **Trunk** *square;* **foot** *one-third of total length, placed in continuation of the body's longer axis, not wholly retractile;* **trophi** *malleate.*

I found this handsome creature in a small rain-pool in Leigh woods. The summer heat frequently dried the pool up, but a heavy shower or two soon filled it again; and, two or three days after the downfall, I always found *N. brachionus* there in abundance: no doubt hatched out from eggs deposited on the rotting leaves which formed the bottom of the pool. These strange habitats of the Rotifera are probably due to their eggs being wafted by winds, or carried by birds; so that it is no wonder that this species should have been captured by Schmarda in a spring near the top of Adam's Peak in

[1] Dr. Plate (*loc. cit.*) says that *R. vitrea* has but one toe. I thought so myself, till I saw the creature, of its own accord, separate the apparently single toe into two.

Ceylon. It is a remarkable Rotiferon, surpassing almost every other in the number and variety of its styles, setæ, and cilia. In general shape it is something like a *Brachionus*, but its head is that of a *Hydatina*. There are only three styligerous prominences in the **corona** between the two usual wreaths, and these bear styles arranged fan-fashion and thickened at the base, as if each style passed through a short sheath; a form of style strikingly visible in the young animal, when the styles are short. The whole of the cavity leading to the buccal funnel is ciliated, and at its base is a ring of large curved styles, pointing upwards. On each side of the wedge-shaped opening, at the entrance to the buccal funnel, are large setæ set horizontally above one another in short sheaths, and fringed at their bases with minute vertical setæ (fig. 1*c*). The **trophi** are malleate, and Mr. Gosse says that they are the exact repetition of those of *N. clavulatus* (*Notommata clavulata*) as figured by him in "Phil. Trans." 1856, Pl. xvi. fig. 23. The rest of the **nutritive system**, as well as of the **secreting** and **vascular systems**, is obvious and normal. The **ovary** is horseshoe-shaped, with its germs set in a single line. There is a **nervous ganglion** just below the dorsal surface of the head, somewhat rectangular in outline like that of *Hydatina senta*; and, like it, giving off nerve-threads at its corners, two of which doubtless pass to the large dorso-lateral **antennæ** shown at the lower corners of the trunk in fig. 1. Mr. Gosse, in a side view, has seen that the nervous ganglion is a truncated pyramid, bearing the **red eye** on its summit.

The **Male.**—*N. brachionus* carries its egg for some time after exclusion, so that it is possible to identify the male with certainty. The male is very unlike its mother in shape and size, and a side view (fig. 1*b*) shows that the head slopes back to a hump, on the apex of which is a bunch of **tactile setæ**. A nerve-thread from the **nervous ganglion** passes to these, and lies between two fine muscular fibres. A moderately sized **spermsac** ends in a ciliated **penis** just above the foot, which contains two large club-shaped **glands.** Close to the sac is a small **contractile vesicle**, the lateral canals of which can be readily traced on either side of the ventral surface.[1]

Length, $\frac{1}{80}$ inch. **Habitat.** Ponds and pools; Clifton (C.T.H.); Kingswood (P.H.G., T.B.): not common.

N. CLAVULATUS, *Ehrenberg.*

(Pl. XV. fig. 3.)

Notommata clavulata . . . Ehrenberg, *Die Infus.* 1838, p. 432, Taf. l. fig. 5.

SP. CH. **Body** *sac-shaped;* **foot** *one-ninth of total length, wholly retractile within the ventral surface;* **trophi** *malleate.*

At the first glance one would say that this animal was an *Asplanchna*, which genus it greatly resembles in general shape, in brilliant transparency, and in the comparative emptiness of the trunk. But a little examination shows that the two are widely unlike in corona, trophi, and alimentary canal. On comparing, however, the apparently dissimilar creatures *N. brachionus* and *N. clavulatus*, it will be found that they are, in many important points of their structure, exact counterparts of each other. The **coronæ**, for instance, are closely alike, although *N. clavulatus* has a greater number of styligerous lobes, and lacks the ring of curved styles that lie round the base of the cavity of the corona in *N. brachionus* (fig. 1). The **trophi** are identical. The **muscular** and **vascular systems** are much alike; the latter, indeed, curiously so, for the sharp bend at right angles in the lateral canals, which is rendered necessary by the shape of *N. brachionus*, is repeated (needlessly, as it were) by *N. clavulatus*. The **contractile vesicle** in the latter, however, has much thicker walls, and is sluggish in action. The **eye** is seated on the

[1] Ehrenberg found a female with a cluster of male eggs; and, misled by their size and number, supposed that the issuing young were those of a *Notommata* which he named *N. granularis*, and which he credited with laying its eggs on the backs of *Brachionus pala* and *Notops brachionus*. Leydig explained the error (*loc. cit.*).

ventral side of the nervous ganglion in *N. clavulatus*, and on the dorsal side in *N. brachionus*; but in other respects the **nervous systems** are alike; the side view (fig. 3*a*) of the female of the former showing precisely the same nerve-threads to a dorsal antenna which are exhibited by the male of the latter (fig. 1*b*). The **ovaries** in both species are flat horseshoe-shaped ribbons bearing a single row of germs. The chief points in which *N. clavulatus* differs from *N. brachionus*, besides those of the general shape, and of the size and position of the foot, are as follows. The **gastric glands** are long and cylindrical, and below them there are two pairs of short cæca attached to the dorsal surface of the stomach. The **stomach** often appears as a long conical tube tapering to a cloaca above the foot, colourless when empty, or tinged above with a faint yellow tint when filling with food. Frequently, however, there is a deep constriction above its lower portion, thus forming an **intestine**; and on one occasion I saw this constriction suddenly disappear, and the contents of the intestine at the same time drawn up into the stomach. Mr. Gosse noticed that the body had its surface marked with minute oblong points, which were scarcely visible except at the edge. He observed also that the discharged **egg** was carried behind the cloaca, and that its development was extremely slow; no sensible maturation having appeared even several days after its exclusion. The **male** is unknown.

Length, $\frac{1}{35}$ inch. **Habitat.** Hampstead (P.H.G.); Clifton (C.T.H.): not common.

N. HYPTOPUS, *Ehrenberg*.

(Pl. XV. fig. 2.)

Notommata hyptopus . . . Ehrenberg, *Die Infus.* 1838, p. 426, Taf. l. fig. 6.

SP. CH. **Corona** *without setigerous prominences;* **ciliary wreath** *single;* **foot** *about one-fifth of the total length, arising from the ventral surface and capable of being wholly withdrawn within it;* **trophi** *forcipate. Partially loricated.*

This must be a rare animal; for, since Ehrenberg found two specimens in 1835, no one but Dujardin and Perty records having seen it. I have myself only seen it twice; but on one of these occasions I fortunately had many specimens, and so I was able to add something to Ehrenberg's rather meagre details. The first thing that strikes the observer is the creature's odd, wabbling way of swimming. This is due, no doubt, to its unusual shape; for it is greatly compressed, having a narrow dorsal surface, but a broad lateral one. The skin can hardly be termed a **lorica**, yet there are several places where it is much stiffened. The two curved edges down the dorsal surface (figs. 2, 2*a*), the undulating edge of the trunk beneath the neck, and the rim of the aperture into which the foot can be withdrawn, are all thick and unyielding. The **corona** is truncate, but bulges forward towards the centre. The marginal **ciliary wreath** is interrupted on each side by a long vibratile style. A grape-shaped **mastax**, with feeble forcipate trophi, lies close to the buccal orifice. Ehrenberg says that there is neither **œsophagus** nor intestine; and if his two specimens had their alimentary canals much distended with food, these organs would have appeared to be wanting. But in front of the true stomach, with thick cellular walls, there is a very thin transparent chamber (fig. 2*a*) often empty, and constantly puffed in and out, in ever-varying shapes.

This, I think, is an œsophagus similar to those in *Asplanchna* and *Synchæta*; and, like them, capable of being distended with food, so as to be confluent with the stomach, or of collapsing to form a narrow tube. The apparent absence of intestine is also a temporary condition of the alimentary canal: my specimens had all a most well-marked intestine. The **gastric glands** are large and plainly nucleated; and the walls of the **stomach** are studded with unusually large oil-globules. The **contractile vesicle** is high on the ventral surface owing to the whole animal being tucked up, as it were, towards that surface. The lateral canals are unusually large and distinct; and lie, with their floccose ribbons, close to the skin: they are well shown in fig. 2*b*. The same figure

shows the chief longitudinal **muscles**. The **ovary** (fig. 2*a*) is very large, and has large germs: a maturing ovum is visible in fig. 2. A large **nervous ganglion** of Notommatan type stretches back from the corona to the dorsal surface and bears a large red **eye**. I failed to find any **antennæ**. The **male** is unknown.

Length, $\frac{1}{70}$ inch. **Habitat.** Near Birmingham (T.B.): rare.

Family X. NOTOMMATADÆ.

[**Corona** *obliquely transverse;* **ciliary wreath** *of interrupted curves and clusters, usually with a marginal wreath surrounding the buccal orifice;* **trophi** *forcipate;* **foot** *furcate.*

The Rotifera associated in this family may be considered the most typical representatives of the whole class. They are permanently free, never affixed to other objects, never to each other in clusters. Their bodies are not inclosed in tubes; their integument is more or less flexible, never hardened into a shelly mail. The body is generally cylindrical, with a length twice or thrice the diameter: the front does not expand into a flower-like disk, but is usually convex, often with a flat versatile face, inclined downwards (supposing the animal to be crawling), beset with strong vibrating cilia, so arranged that their combined action produces two vortices, one on each side of the head. The posterior extremity bears a foot of several diminishing joints, capable, in a slight degree, of telescopic inversion; and the last of these bears two diverging toes, chitinous in structure, used for support and locomotion.

The trophi are well developed, all the seven constituent elements—the *labrum*, the two *mallei*, the two *incus-rami*, the *fulcrum* and the *labium*—corresponding homologically to the *labrum*, the *mandibles*, the *maxillæ* and the *labium*, of insects,[1] being present, in relative proportions. The mastax is so placed that the jaws can be freely protruded from the buccal orifice, as has been seen in most of the genera, and used, forceps-like, to slit the cells of Algæ, to nibble the flocculent matter which grows on vegetable stems, or to seize, retain, and devour active animalcules.

Some of the genera possess a singular apparatus for suddenly augmenting locomotion, in the form of a pair of organs (*auricles*), ordinarily concealed, which can be thrust out in an instant, by eversion of the skin. The surface which is then external is clothed with cilia, dense, vigorous, and capable of producing ample vortices in the water.

The *Notommatadæ* are the most highly organised of all Rotifera; the most sudden, varied, and energetic in their motions; most highly endowed with external sense-organs; most predatory; most nearly approaching to the Articulate classes, not only in their manducatory organs, but also in their skin usually firm, elastic, capable of being thrown into transverse folds, or sub-articulations, more or less permanent. If not the most beautiful, they may claim to be the most interesting; best repaying investigation, while they present the greatest difficulties to the student. As this must be considered the central or typical family, without adopting all the fancies of the Circular theories, we may suggest that the relation between the genus *Furcularia* and the *Loricata*, through *Diaschiza*, is very close: that *Proales*, with its long prone face, leads to the *Bdelloida* through *Adineta*: that the skipping species of *Furcularia*, as *longiseta* and *æqualis*, look towards the *Scirtopoda*: and that in the mucous investiture common in the genus *Copeus*, we perceive a reflection of the excreted tubes of the *Rhizota*.—P.H.G.]

[1] See my mem. "On Mand. Organs," *Phil. Trans.* 1855 p. 449.

Genus ALBERTIA, *Dujardin*.

[GEN. CH. **Body** *vermiform, lengthened; ciliated* **face** *sub-prone;* **eyes** *wanting;* **jaws** *minute, forcipate;* **foot** *small, one-toed. Entozoically parasitic in Annellida.*—P.H.G.]

A. INTRUSOR, *Gosse*, sp. nov.

(Pl. XVII. fig. 13.)

[SP. CH. **Body** *greatly lengthened, nearly cylindric, but swollen behind;* **foot** *of one joint, besides the toe, which is a small cone;* **viscera** *divided by annular constrictions, within the straight (unconstricted) integument.*

This species seems distinct from the *A. vermiculus* of M. Dujardin, if I may judge from his figures (Infus. Pl. 22. 1 A, B). The general form of *that* is uniformly cylindrical, slightly tapering to a great conical foot; of *this*, cylindrical, gradually swelling to the ventricose hind parts, where a very minute conical toe terminates a small one-jointed foot. The mastax and jaws of *that* species are moderately large; of *this*, excessively minute. *That* species is parasitic within earthworms and slugs; *this*, within water-worms (*Naïs*). The discovery of the following species makes it almost certain that these differences are specific.

The **body** is greatly elongated, slender in front, thickening behind the middle, so that the diameter of the hind part is just double that of the fore. As, however, a great ovate egg was mature in the ovary, at the very extremity of the visceral cavity, of the specimen figured, the body may have been more than usually swollen. The **ciliated face** is broad and oblique; the **mastax** minute, displaying a forcipate incus, with broad blades, resembling those of *Diglena*, to which are attached slender simple mallei, with long straight arms inflexed at their extremities. All the trophi are frequently protruded fully half-way from the ciliated front, and vigorously snapped. A very slender **œsophagus** leads to a long alimentary canal, which is constricted at short intervals throughout, but appears to be simple. No **gastric**, or biliary (?) glands were seen. The **ovary** is long, and occupies the greater part of the abdomen. In all the specimens that I examined, there were seven or eight amorphous nuclei, and one large well-matured ovum filling up the posterior end; its substance minutely granular, with a vitelline globule near the anterior end. Between this ovum and the intestine was a small **contractile vesicle**. A minute point projects from the front, which may possibly be a sense-organ, but I perceived no setæ on it. A long pointed **occipital sac** descends far below the mastax, but is destitute of any eye-speck. The whole animal is slightly tinged with yellow; and this is the only trace of colour in it, as the abdomen contains no coloured food, owing to its peculiar economy. For the animal lives as a parasite in the visceral cavity of *Naïs proboscidea*. I was examining a specimen of this aquatic worm (in October 1854), when a slight pressure of the compressorium caused it to separate into two parts. I had looked over it with a lens, but had no suspicion that my *Naïs* was any other than a single integer, and unfortunately it was not in focus when the separation took place, so that I did not actually watch the process. The next moment, however, I found that I had two perfect *Naïdes*; the one which had been the tail differing only by being a little smaller, but with a head, eyes, and proboscis, as perfect as the other. The one which must be called the parent had the hind extremity less distinct than the daughter, and there was a slight trace of jaggedness visible. But my attention was arrested by a vermiform animal shooting swiftly through the water; and presently another. They were evidently Rotiferous, and as I was sure that they had not been in the live-box before, I conjectured that they had been discharged from the body of the *Naïs*, at the moment of division. This was immediately confirmed: for, on examining the *Naïs*, I found, within the alimentary canal of the parent, near the dividing point, three or more of the parasites snugly nestled, and actively writhing about. All the

specimens agreed accurately with each other, as described above. In the open water they swam swiftly; and it was difficult to confine them even with the compressor; for they soon managed, by contraction and elongation, to wriggle themselves out of the field of view. The *Naïs* was from a pool at Walthamstow. Examining another *Naïs* from the same phial, I found a single *Albertia* in the intestine; in another, an egg of the parasite was within the intestine, attached to a pellet of fæcal matter, which pushed it along. The opacity of the bowel prevented my seeing whether any matured parasites were present or not in this case.—P.H.G.]

Length, $\frac{1}{100}$ inch; diameter, $\frac{1}{300}$ to $\frac{1}{1000}$ inch. **Habitat**, Walthamstow (P.H.G.): entozoic.

A. NAÏDIS, *Bousfield*, sp. nov.

(Pl. XVII. fig. 14.)

[SP. CH. **Body** *moderately long, the cervical and pectoral parts the thickest, diminishing to the hind part;* **toe** *minute, soft, papilliform;* **integument** *slightly constricted in the hinder half.*

This species was discovered by Mr. Edward C. Bousfield, who has kindly communicated to me his own careful drawings and descriptive MS. notes. He has "several times observed it *in situ*, in *Naïs barbata*, living free within the cavity of the stomach of its host."

"**Body** cylindrical, soft, hyaline, vermicular, extremely flexible and telescopic, especially the hinder part. Anterior extremity truncate. **Trochal disc** small, oblique, *on dorsal aspect* of body. [One drawing shows that it is invertile, the cilia being depicted far down the buccal funnel.—P.H.G.] **Jaws** very minute, protrusile, snapping. **Alimentary canal** conical, extending through the body, opening at the junction of the last two segments. **Gastric gland** semi-ovoid. **Ovary** straight, slender, cylindro-conical; the ova developed serially. A minute **contractile vesicle**.

"Caudal appendage [= **foot**, P.H.G.] papilliform, composed of two joints [of which the terminal is] soft, resembling in its action the finger of an elephant's trunk."

"**Habitat**. Vicinity of London. Anterior portion of stomach of *Naïs*, in which it moves freely. Egg about one-third of length of parent's body. **Length**, $\frac{1}{270}$ inch."[1] —P.H.G.]

Genus TAPHROCAMPA, *Gosse*.

[GEN. CH. **Body** *fusiform or cylindrical, annulose, furnished with two furcate toes;* **trophi** *forcipate; rotatory* **cilia** *wanting or very limited.*

T. ANNULOSA, *Gosse*.

(Pl. XVII. fig. 12.)

Taphrocampa annulosa . . . Gosse, *Ann. Nat. Hist.* 2 Ser. 1851, p. 199.

SP. CH. **Body** *cylindrical, short and thick, marked throughout with distinct articulations;* **brain** *opaque;* **alimentary canal** *simple, wide, cylindrical;* **terminal fork** *thick, conical, acute.*

This animal is very larva-like; the **body** consists of many well-marked rings or segments which are set within the clear cylindrical integument, apparently touching this only at the points. Each of these, if viewed through the longitudinal line, would be of a sub-square outline, with four projecting angles, as seen at fig. 12*b*. In general no vortices are seen, nor any trace of vibratile **cilia**, so that I long concluded

[1] Thus the three recorded species differ notably in their respective dimensions:—*A. vermiculus* being $\frac{1}{50}$ inch to $\frac{1}{30}$ inch (Duj.); *A. intrusor*, $\frac{1}{100}$ in. (P.H.G.); *A. naïdis*, $\frac{1}{270}$ in. (Bousfield).

rotatory organs to be wanting. Yet, lately I saw one on whose front a strong ciliary action was conspicuous: it seemed as if the ciliate surface were on the prone side of the front. The species, moreover, is furnished with protrusile auricles for augmented locomotion, like *Notommata* proper. I have not myself seen these, indeed; but the fact rests on ample evidence. Dr. Hudson was assured by Mr. Brayley, the Secretary of the Bristol Microscopical Society, that he had seen a *Taphrocampa* "put out very small auricles from the head, and swim with a slight vermiform movement." He had made a pen-and-ink sketch of the creature in both conditions; which sketch is in my possession, and represents indubitably *T. annulosa*. Miss Saunders, too, a careful observer, writes me under date of June 10: "Watching your *Taphrocampa annulosa* a long time, I saw it thrust out an ear-like lobe on each side, and swim frantically about in a most headlong fashion; but only one of three did this. The processes were not very prominent, but were quite distinct." This fact affords an interesting link with the present family.

The form of the mastax and **trophi**, too, though not yet quite satisfactorily defined, is evidently *Notommatous*, and seems to resemble the pattern seen in some of the *Furculariæ*, and some of the *Rattulidæ* also, 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 very front, and nibbles floccose matters with them. An **alimentary canal**, broad and straight, with no accessory **glands**, and with no constriction, runs through the cavity to the cloaca close to the forked toes. It is usually empty and colourless. At the occiput, behind the mastax, and almost invariably sharing its motions in contraction and elongation, is a moderate-sized mass of opaque matter, white by reflected light, and probably chalky. Like a similar mass in many *Notommatæ*, with which it is another link, it lies at the bottom of a wide and deep sac. I had vainly searched for any trace of red pigment in this mass which might indicate an **eye**. On one occasion recently, however, I was examining a specimen under direct sun-light, when there suddenly flashed out from the opaque mass a spark of radiance, as if from an eye-lens, though I could not discern any red hue. What represents the ordinary **foot** and toes is peculiar. It would seem rather to be a forked tail; for I have seen, now and then, projecting beneath this, a very delicate rounded lobe, which is possibly the foot, the cloaca opening between these. Or, rather, it is the optical expression of the lower half of the cylindrical rectum, of which the middle of the crescentic fork forms the upper part or ceiling. The intestine can be traced down to this orifice beneath the fork. The fork, or, if this explanation is correct, the *tail*, is formed of two incurved taper, chitinous, clear, sharp spines, together making a semicircle; but not separated into toes, nor articulated with the segment that carries them, and so having no power of motion independent of one another, or of their segment. True toes would have both.

The animal contracts strongly and continually, like a *Notommata*; but the sphere of the contraction is the space occupied by the alimentary canal, the parts both before and behind this viscus remaining unaffected, while the parts included contract forcibly, and both ways, but chiefly from behind forward. In most of its movements it resembles *Chætonotus*, crawling sluggishly about the glass, and the masses of sediment.[1]—P.H.G.]

Length. About $\frac{1}{150}$ inch. **Habitat.** Pools and ditches: common (P.H.G.).

[1] There are two very distinct varieties of the above, well-marked and constant; yet with hardly sufficient dissimilarity to warrant our separating them as species. The one smaller, with the articulation strong, the lateral projections of dark tissue into each segment clearly seen, the caudal points short, stout, and *straight*. This was the form first recognized, is the form above described, and is by far the more common. The other much larger, the articulation and the interior projections both indistinct, often imperceptible; the caudal points long, slender, crescentic, wider at their bases, and making together a regular semicircle. In this variety, an excellent observation which I obtained showed the *mastax*, *mallei*, and *incus*, almost exactly of the same familiar pattern as in *Notommata aurita* (*Phil. Trans.* 1856, pl. xvi. figs. 16–21).

T. Saundersiæ, *Gosse*, sp. nov.

(Pl. XVII. fig. 11.)

Taphrocampa Saundersiæ . . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. v. 1885, p. 614, pl. xii.

[SP. CH. **Body** *lengthened, fusiform, annulate;* **brain** *clear; a decurved frontal* **hood**; *two* **eyes** (?); *a distinct* **tail**; **foot** *and furcate* **toes** *of normal form.*

Many examples of this form occurred to my observation in the floccose sediment of water, very rich in Rotiferous life, which was sent me by Miss Saunders of Cheltenham, in May 1885, dipped from a tank which she had used as a preserve of living *Rotifera*. But Dr. Hudson had observed the same species in water from Birmingham, in July 1884; and had prepared a notice of it for the "Journ. Roy. Mic. Soc." The publication was delayed, however, through press of matter, till the following spring. It is a very distinct species, less abnormal than *T. annulosa*, more manifestly Notommatous in its affinities.

The **body** is divided into well-marked rings, about seven or eight, not so numerous as in *annulosa*; each of which rises to what seems a sharp edge; but momentary glimpses, which one has as it turns around the weeds, show a number (not only four) of conical points (perhaps about eight in the dorsal half) in the transverse section (as at fig. 11*b*), the expression of as many series of conical elevations running down the whole (possibly dorsal and lateral) surface. The head is rather large, and sub-globose (fig. 11), and seems permanent in outline; as the restless animal twists and turns itself about constantly, causing much change of diameter, the head remaining undiminished, the neck (so to speak) becomes conspicuously slender, to be filled up by the next contraction, in an instant. Very frequent retractation of the hind parts towards the head occurs. There is a marked diminution in these parts, the ultimate segment bearing two moderately short diverging toes; the penult or antepenult segment sending forth a distinct conical projection, which follows the general direction of the body, and may be called a tail, with more breadth than depth, much as in *Notomm. tripus*, *N. pilarius*, and others (fig. 11*a*). The front of the head bears a projection, which, on a lateral view (fig. 11*a*), looks like a proboscis, and often like a sharp hook, bent forward and downward; yet I think it has considerable width, and Dr. Hudson has found it to be a broad arched hood. Just behind this organ, and so on the very front of the globose head, are a pair of minute colourless globules, quite conspicuous in all aspects, which may be **eye-spots.** The **mastax** consists of two stout, curved, pointed teeth, capable of being widely expanded and closed, like the blades of scissors (fig. 11); these appear based on an oblong transparent body, probably the muscular bulb requisite for motion. The points can be brought to the edge of the front.[1] The **front** is oblique; it is composed of several fleshy eminences, each bearing a crown of cilia, whose vibrations I have distinctly seen, though they do not appear to constitute a disk or *rota*. The animal's motion in the free water, a smooth and rather swift gliding, is doubtless produced by these frontal cilia. Accurate observation, with the high powers required by its minuteness, is very difficult from its incessant restlessness; as it glides through the open, it is constantly contracting and extending the body; at the nearest atom of sediment it pauses, but instantly throws itself into rapid contortions. A long **stomach**, capable of much width where it proceeds from the mastax, reaches to the cloaca under the tail, while a large **ovary** occupies the ventral region. The body is transparent, more or less tinged with yellow. The stomach usually contains particles of dark food, sufficient sometimes to impart a blackish hue to the body; while the entire venter may be filled with a dark egg.

I have honoured this species with the name of Miss Saunders of Cheltenham—from

[1] These seem to be the blades of an incus (of the pattern Fig. 21 of my memoir in *Phil. Trans.* 1856, pl. xvi.); the mallei apparently quite aborted.

whom I have received many specimens—a lady, who, for many years, has given intelligent attention to this class of animals, and who has aided me very effectively in my researches.—P.H.G.][1]

Length, $\frac{1}{150}$ to $\frac{1}{170}$ inch. **Habitat.** Pools near Birmingham (C.T.H.); Cheltenham (P.H.G.): not rare.

Genus PLEUROTROCHA, *Ehrenberg*.

GEN. CH. "*No* **eyes**; **mallei** *one-toothed*; **foot** *furcate*" (*Ehr.*).

[There seems nothing very obvious to distinguish this genus from *Notommata*, but the lack of eyes, both cervical and frontal; and characters that are merely negative are always somewhat unsatisfactory. The form seems scarcely to have attracted attention in Britain. In the close, almost daily, study of the class, which I pursued some thirty years ago, it never occurred to my notice; no example of it appears in Dr. Collins's richly-stored book of drawings; Dr. Hudson has no record of it; and in my recent resumption of the study, extending over the last year and more, I have met with but three examples; which, with more or less certainty, I identify with the three recorded species of Prof. Ehrenberg. Doubtless, by us all, it may possibly have been confounded with the obscurer species of *Notommatadæ*, and have been overlooked. But yet the common difficulty of discerning the eye in a restless animalcule is more likely to cause a *Notommata* to be taken for a *Pleurotrocha*, than a *Pleurotrocha* for a *Notommata*.—P.H.G.]

P. CONSTRICTA, (?) *Ehrenberg*.

(Pl. XVIII. fig. 3.)

[SP. CH. **Toes** *moderately long, acute, straight.*

If this is identical with *P. constricta*, the singular and almost unprecedented illustration which Prof. Ehrenberg has given us on the testimony of his own eyes, of its predatory instincts, I may cite as adding to it the greatest interest. He has figured the apparently weak and unarmed *Pleurotrocha* as watching a specimen of the swift and vigorous *Notommata lacinulata*; then, as having seized it; then, as sucking out its juices; and then, as having dropped away the now empty skin. Well may he give it the secondary title of The Robber.

I have seen nothing of this in the little delicate creature which I here represent. It occurred to me in the spring of 1885, and then for so brief a period that I had but just time to make a drawing of it, which is here reproduced. It is indubitably rare. Ehrenberg appears to have seen but two examples, one of which was the above warrior of now historic renown. I had no time for measuring mine, but his length of $\frac{1}{114}$ inch would well enough agree with my estimate. But, a few months later, I met with a specimen in water from Dundee represented in fig. 3, which I conclude to be specifically identical with the above, though there are some slight differences. The front is broader; and, though I could not say that auricles were actually protruded, their presence seemed indicated. (I incline to think the existence of these aids to locomotion more usual in the class than is generally accredited.) The toes also are more slender and more acute. It was active and moderately swift, gliding through the clear water; now and then suddenly darting a little right or left of its course, and apparently seizing some invisible prey. The manner of the action could not be mistaken; it was manifestly predatory.

The **mastax** was large and conspicuous; but I could not obtain a look at it sufficiently steady to define it. The intestinal canal was ample and filled with dark bistre-

[1] In one specimen I observed, on a side view, a long egg-shaped contractile vesicle lying between the hind end of the stomach and the ventral surface, and terminating in a delicate tube entering the cloaca. The vesicle filled and emptied every 2½ seconds.—C.T.H.

brown granular food. The **toes** are usually held close appressed when the animal is gliding; but often expanded. It was lost before I could complete my observation.

This individual was found in Monk Mire Loch near Dundee, in August 1885, among slender filamentous weed crowded with minute diatoms, making dense masses of impalpable floccose. The former was from Woolston Pond, Hants.—P.H.G.]

Length, $\frac{1}{144}$ inch (?). **Habitat.** Woolston; Birmingham; Dundee (P.H.G.).

P. LEPTURA (?), *Ehrenberg*.

(Pl. XVIII. fig. 4.)

[SP. CH. **Toes** *moderately long, slender, acute, slightly decurved;* **face** *oblique.*

This species is of equal rarity, in my experience, with its two congeners; a single solitary example alone having occurred to me, and that at about the same time.

The ciliated **front** is much more prone than I observed in the others, and the mastax was at one time so thrust forward that the **trophi** were brought to the very face, as we see with many of the *Notommatæ*. The outline is gracefully swelling, and tapering behind; and the form and curve of the slender toes are elegant.—P.H.G.]

Length. About $\frac{1}{150}$ inch. **Habitat.** Woolston Pond (P.H.G.).

P. GIBBA (?), *Ehrenberg*.

(Pl. XVIII. fig. 5.)

[SP. CH. *Short and thick in proportion to its length;* **toes** *moderately long and broad, nearly straight.*

It is with great hesitation that I attach Ehrenberg's name of *gibba* to this little species. The general shortness and stoutness of form agree, and, though the lumbar parts of the body want the plumpness whence he has selected an appellation, this may be a variable character dependent on repletion of the alimentary canal. My figure was drawn from life; but the example was lost before I had completed my observations. It was in the early spring of 1885; but I made no record of the source whence it was obtained.—P.H.G.]

Length. About $\frac{1}{325}$ inch: whereas Ehrenberg gives $\frac{1}{216}$ inch as the average of his.

Genus NOTOMMATA, *Gosse* (*nec Ehr.*).

[GEN. CH. **Body** *not annulose, cylindrical, furnished behind with a projecting tail; special organs* (**auricles**) *on the head for locomotion, evertile and protrusile;* **brain** *large, containing opaque chalk-masses;* **trophi** *virgate. There are species in which one or more of these characters may not be found.*

The genus *Notommata* of Ehrenberg, even as it left his pen, was a heterogenous mass of dissimilar species. Many naturalists have indicated the need of dividing and redistributing the unwieldy group; but none have yet ventured upon the task. I propose to break it up into three distinct genera. The family *Asplanchnadæ* having been already formed, some species of large size, sacciform body, and hyaline transparency, migrate thither; while others of similar appearance may be associated with the *Hydatinadæ*. These being eliminated, there comes the curious species *N. copeus*, which Ehrenberg distinguished by large dimensions, a fusiform body, a distinct tail, and organs of special sense, projecting from the lumbar regions, as well as from the head. As a number of others, allied to this form, have been discovered, I form them into a separate group with the generic appellation of *Copeus*. Then there is a group of conspicuous species, marked by auricles, by a more or less distinct tail, and by the brain being unusually

developed, and opaque with chalk deposits. This genus may retain the name of *Notommata*. There still remain a multitude of species, mostly of small, none of large, size, with characters mainly negative, yet having much in common with each other, a community more easily recognized than described; but having the ciliate face more or less obliquely prone. These make the genus *Proales*. The second of these three is characterized above, and shall still prolong the time-honoured title. It is even now a populous tribe, as usual with typical groups: yet not unnaturally associated. Its constituent species are easy of recognition, by three prominent characters, all fairly constant—1, the tail; 2, the auricles; 3, the opaque brain. The first is moderately conspicuous, and readily distinguished by being always on the dorsal side of the cloaca, while the foot and toes are always on the ventral. The second is not always available, being often inactive and invisible; but if seen, seen without doubt. The third is the best mark: the opaque brain-mass, like a vast well-defined black cloud, striking the eye at the first glance, unmistakably.

The genus is widely distributed in our fresh waters.—P.H.G.]

N. AURITA, *Ehrenberg*.

(Pl. XVII. fig. 6.)

Notommata aurita . . . . Ehrenberg, *Die Infus.* 1838, p. 430, Taf. liii. fig. iii.
„ „ . . . . . Gosse, *Trans. Micr. Soc. Lond.* 1852, p. 93, pls. xii. xv.

[SP. CH. **Body** *sub-cylindric, ventricose;* **brain** *opaque; head wide, furnished with evertile* **auricles**; **tail** *minute.*

Of this moderately large species, of elaborate organization, and of frequent occurrence, the anatomy has been given with so much detail, by myself (*loc. cit. supra*), that only a very succinct account is needful here. Its opaque **brain-mass**, looking like a great black ball in the neck, connected by a tube with the front, renders it conspicuous as soon as it is seen; and when it glides through the clear water, the sudden quickening of its speed, as it everts the great ciliate hemispheres from its two cheeks is hardly less notable.[1] The **foot** consists of two very short and small joints, telescopically infolded; bearing two furcate toes, acute cones, also short and small.—P.H.G.]

Length, $\frac{1}{70}$ to $\frac{1}{100}$ inch. **Habitat.** Fresh waters. Common everywhere (P.H.G.).

N. ANSATA, *Ehrenberg*.

(Pl. XVII. fig. 3.)

[SP. CH. *Closely resembling* N. aurita *in form and structure, but smaller; the* **brain** *not opaque*; *the* **toes** *long.*

The examples of this species that I have observed I could distinguish from the preceding only by the points mentioned above. Perhaps it is slightly more slender, more cylindrical. Ehrenberg gives no appreciable diagnosis between the two forms; nor can his figures be distinguished, save by the lack of opacity on the brain of *ansata*. The length of the toes is, however, a good mark, and readily observed.

A few specimens have occurred to me in water sent me by Dr. Collins from Berkshire, containing aquatic moss. They moved in the clear, with great impetuosity, driving round and round, and turning on their course, with no apparent aim. One made its way just within the edge of a moss-leaf, where it worked for itself a little hollow, in which it remained several hours, incessantly turning round and round, or to and fro, as fast as it could move, without a moment's intermission. In this example the **alimen-**

[1] Herr Eckstein (*Sieb. u. Köll. Zeits.* 1883, p. 361) describes in this, as in many other Rotifera, specks of crimson pigment near the front, each in connection with a setigerous sense-organ. He concludes these to be secondary eyes. I have myself never detected them; neither has Dr. Hudson, nor Dr. Plate.

tary canal was large, not visibly separated, and filled with food of a rich dark-brown hue. The **toes** are long, slender, acute, and slightly decurved. The **auricles**, which were freely protruded, are rather small.—P.H.G.]

Length, $\frac{1}{260}$ inch. **Habitat.** Sandhurst, Berks; Epping Forest; Woolston, Hants (P.H.G.); pools: rare.

N. CYRTOPUS, *Gosse*, sp. nov.

(Pl. XVII. fig. 7.)

[SP. CH. *In* **form** *resembling* N. aurita, *but very much smaller, and more slender in proportion;* **brain** *intensely opaque; no visible* **auricles**; **toes** *long, decurved.*

This little species I had known from a single specimen just dead, in August 1851, which I found in water from Widcombe Pond, Bath. I had never met with it again till June 1885, when I found a second in water from Woolston, and subsequently many, from many localities. It much resembles *N. aurita*; but is smaller; and the **toes** are slender and decurved. A pair of colourless specks, like air-globules, are in its front, which may be **eyes**, and a large **brain**, which carries at its hinder end an aggregation of opaque matter forming a collection of round cells. This, by refracted light, is intensely black, as in *aurita*, and renders the species very conspicuous, reaching far down into the body-cavity. The **mastax** is normal; the **alimentary canal** also large, not visibly divided; **ovary** and **contractile vesicle** as ordinary.

In manners it is particularly sluggish, scarcely changing its place, though in constant motion. It roots and nibbles among the floccose sediment, and affects concealment, seeking the shelter of the thin integument of decaying *Nitella*, and such-like plants, under which it hides; and, if it creep out for an instant, presently betaking itself to its refuge again, where it twists and turns restlessly on its centre.—P.H.G.]

Length. About $\frac{1}{160}$ inch. **Habitat.** Bath; Woolston; Sandhurst, Berks; Epping Forest; Cheltenham (P.H.G.); pools: not common.

N. TRIPUS, *Ehrenberg (nec Leydig.)*

(Pl. XVII. fig. 4.)

[SP. CH. **Body** *thick, arched dorsally, diminished behind to a conspicuous tail, and furcate toes;* **tail** *equal in length to the toes;* **brain** *opaque;* **auricles** *small, slender.*

I know this animal by a single specimen, which I found among *Myriophyllum* in a tank in my own garden, near London, in 1854. It has never occurred to me again; and I do not feel quite certain that it is the *tripus* of Ehrenberg. The **body** is marked by several strong folds of the skin. Viewed from the side it is arched, and the ventral outline is concave; but the ovary was undeveloped, which fact might modify the form. The **frontal cilia** are set on a large ovate area looking ventrally (fig. 4), so that ordinarily the front appears rounded and free from cilia. Occasionally, however, the front is elevated and expanded somewhat angularly, and an **auricle** is thrust out on each side, of somewhat serpentine outline, set on its anterior edge with vibratile cilia, whose effect is manifest in accelerated motion. The **brain** runs down to a long obtuse point in the occiput, whose extremity, in my example, was occupied (fig. 4*a*) with some irregular granules of opaque matter; seated on the end of which was a large pear-shaped red **eye**. The posterior extremity of the trunk runs out into a prominent **tail**, a tapering cone, with alternate constrictions and swellings. Beneath this are the furcate **toes**; and as the tail is of the same length as these, and diverges at a like angle, forming three angles of a triangle, the animal well deserves its specific name.—P.H.G.]

Length, $\frac{1}{115}$ inch. **Habitat.** A garden pan, near London (P.H.G.).

N. PILARIUS, *Gosse*, sp. nov.

(Pl. XVII. fig. 5.)

Notommata tripus . . . . Leydig, *Ueb. d. Bau d. Räderth.* p. 37. Taf. iii. fig. 28.

[SP. CH. **Body** *(viewed dorsally) rhomboidal in outline, sub-truncate at both ends;* **head** *broad, with great globose* **auricles**; **brain** *pointed, filled to a greater or less extent with opaque matter;* **tail** *and* **toes** *as in* N. tripus.

This little creature has much likeness to the preceding, from which, however, it sufficiently differs in the trapeziform **outline**, tapering from the middle to the foot; in the size and form of the **auricles**, which are very large, hyaline, and round, more than a semi-globe being exposed; in the conspicuous **eye**; in the singular overarching of the edges of the dorsal region, like the carapace of an *Oniscus*. Mr. Perty mentions this peculiarity in his *N. onisciformis*; yet a glance at his figure proves that the two species are not identical. The singular effect produced when the little creature suddenly pushes out, and as suddenly withdraws, its frontal balls of glass, reminded me of the ancient *pilarii*, or jugglers with balls, and suggested a specific name.

The great transverse diameter of the body is remarkable. The rhomboidal outline has much of the appearance of a lorica; for it is constant, and the viscera within take the form of great sacculate lobes, varying, and more or less receding, from this outline. The **brain** is a large, perfectly defined opaque mass stretching almost wholly across the head.[1] There seems to be a very minute crimson **eye-speck** in the centre of the front, discernible with difficulty. The **contractile vesicle** is very large; its period of discharge was just two minutes. The globular **auricles** are exserted only at uncertain intervals, as when the animal wishes to swim swiftly. We may watch one by the hour, creeping up and down the stems, nibbling ever as it goes, or even now and then slowly gliding through the clear water; yet not once see the crystal balls thrust out by the little juggler. Yet is he unmistakable, in whatever condition, when once familiarly known; and a very pretty, attractive little fellow he is.

I first became cognizant of it in February 1855, when examining a tangle of conferva and *Nitella* in one of my window-reservoirs at Torquay. But I have since met with it on many occasions and in many waters. It is moderately lively, actively grubbing about the vegetation and sediment, now and then swimming across the open spaces, generally with little speed or energy, till the great glassy globes are set to work. The interior structure calls for no special notice.—P.H.G.]

Length, $\frac{1}{200}$ inch; breadth, $\frac{1}{400}$ inch. **Habitat.** Woolston Pond: common (P.H.G.).

N. FORCIPATA, *Ehrenberg.*

(Pl. XVIII. fig. 1.)

Notommata forcipata . . . Ehrenberg, *Die Infus.* 1838, p. 428, Taf. li. fig. 5.

[SP. CH. **Form** *lengthened, saccate, large in front, tapering to a small* **foot**, *and very minute furcate* **toes**; *occipital end of* **brain** *semi-opaque, a small inverted pyramid;* **eye** *a broad transverse lens.*

This is an active, graceful, attractive animal, somewhat sack- or purse-like, slender behind, but enlarged towards the head, which is in constant contraction. The front is obtuse in the dorsal and lateral aspects; the **face** is slightly prone. Behind a large **mastax** of normal jaws, very protrusile, an ample **brain** descends into the occiput, whose pyramidal tip, for a small space, is occupied by a well-defined granulation of clear brown tissue, *not white* by reflected light, and so not cretaceous; on the frontal end of which is seated a broad, somewhat square **eye** of pigment darkly red. Two small ciliate

[1] From this transverse development of the opaque chalk-masses, I infer that Dr. Leydig's *tripus* is this species.

auricles can, at will, be protruded from the head, and I believe there is a small appressed **antenna**. The cloaca is very manifest, overhung by a minute wart-like projection. Then the **foot** tapers rapidly, ending in small, sometimes very minute, furcate toes, which about mid-length lessen abruptly, leaving a marked shoulder (fig. 1*b*).

I am indebted to Mr. Bolton for many specimens on repeated occasions.—P.H.G.]

Length, $\frac{1}{96}$ inch. **Habitat**. A ditch in Sutton Park, Birmingham (P.H.G.).

N. BRACHYOTA, *Ehrenberg*.

(Pl. XVII. fig. 1.)

Notommata brachyota . . . Ehrenberg, *Die Infus.* 1838, p. 435, Taf. li. fig. 3.

[SP. CH. **Brain** *clear*; **body** *fusiform*; **auricles** *small*; **foot** *invisible*; **toes** *minute*; *no* **tail**.

Outline rounded and plump, stout in the middle, tapering to each end. The **face** is obliquely prone; a pair of very small **auricles** are thrust out from the sides of the head, occasionally, when pushing between stalks of *Nitella*, and not only when swimming. Fore and hind extremities hyaline, but corrugated longitudinally. **Mastax** large and round; mallei strong, of several teeth, on a long-stalked incus, much on the pattern seen in *N. aurita*, which worked vigorously and perseveringly, boring its way into a *Nitella* stalk, and nibbling till it had cleared a great space of its green pulp-cells. The **eye-spot** is moderately large, of full crimson. This, in an instant's good view, I discerned to be a regular globe, of which only the hinder half was red, the anterior half being quite colourless; the two halves being distinctly divided by a clean line (fig. 1*b*). The clear half was doubtless a crystalline lens of very perfect form and of powerful magnification. This eye is seated near the end of a long occipital **brain**. I could detect no dark spot, on each side of the eye, as figured by Ehrenberg; but have little doubt of the species. A great sacculate **stomach** comes up, as a brown granular mass, to the mastax, furnished with the usual pair of ear-like **gastric glands**. It reaches, without any manifest division, nearly to the clear space around the base of the foot; a **contractile vesicle** intervening. The **foot** is scarcely distinguishable, the pair of very minute conical toes apparently emerging from the rounded end of the body. No projection could be called a tail. It was not till I had watched the creature a considerable time, actively engaged, that I suspected the head to be other than simple in outline. Then, as it was swimming smoothly, I noticed its motion suddenly augmented; and at the same instant I saw that two minute clear semi-globes were extruded, but only for a few moments; then withdrawn, and no trace left. The absence of these organs, therefore, must not confidently be inferred from the non-observation of them, particularly in species inadequately observed. The plump body seems very soft, compressible, and flexible; the integument thin, elastic, and yielding. The animal is eager, impatient, persevering, pushing everywhere. It really seemed to have some sense of locality, which its perfectly-formed eye might assist. For though it often strayed to a considerable distance, beyond many stalks, it invariably returned, and sought out its feeding-ground within the *Nitella*. I was called away; but, after nearly two hours, there he was, pegging away at the very same hole!—P.H.G.]

Length, $\frac{1}{130}$ inch. **Habitat**. Woolston Pond: rare (P.H.G.).

N. SACCIGERA, *Ehrenberg*.

(Pl. XVII. fig. 2.)

Notommata saccigera . . . Ehrenberg, *Die Infus.* 1838, p. 434, Taf. l. fig. 8.

[SP. CH. *Slender, obtusely pointed at both ends*; **face** *prone, greatly lengthened, ending with a prominent chin*; **foot** *and* **toes** *small*.

The form is unusually thin from side to side, compared with the length, widening

sensibly at three-fourths from the head, and thence, more or less abruptly, diminishing. It is rather deeper (viewed laterally, fig. 2*a*), the dorsal outline rising to about the middle, thence falling to the tail. The ventral line is nearly straight, only that the ciliated face, almost quite prone, extends fully one-third of the length, and there forms a sort of projecting chin. The outline of this part is, however, very flexible and versatile. The dorsum terminates in a minute conical tubercle, beneath which the cloaca opens; so that it is a true **tail**. Below this is a very short and inconspicuous **foot**, and two minute furcate conical toes. The front is rounded, and can evolve two small hemispherical **auricles**, very observable, because they are freely protruded, even when the animal is not swimming, but pushing its way among the tangled algæ. The **mastax** is ample, and the trophi of the normal pattern; behind, the **brain** descends low into the occiput, and carries a dark red **eye** near the middle of the sac. I have not seen this sac so pyriform as Prof. Ehrenberg has figured it. It is, in general, turbid toward the lower part, and sometimes quite opaque with angular chalk-masses. A large **stomach** and intestine, with **gastric glands**; a wide ovary; indications of a **vascular** or **branchial** system, and a small **contractile vesicle**, are all normal, and require no remark. The animal is usually tinged with an olive-brown hue, especially in the abdominal viscera.

Both the form and manners of this species strike the observer, at once, as unusual. It swims almost constantly; and affects the surface when in freedom. It makes a smooth rapid course, devious, and apparently objectless; probably, however, governed by aims which we cannot appreciate. For it frequently makes little darts and jumps as it goes, with a sensible snap of the jaws, as if it took invisible prey. A number of examples occurred in water collected by Mr. Bolton from a ditch in Sutton Park, Birmingham, and specially marked "surface."

I presume this to be the *N. saccigera* of Ehrenberg, from the general form, the long pointed head, the long prone ciliated face, the short toes and shorter foot. Yet he has not noticed the auricles, nor the opacity of the brain. The former, however, are retractile; and the latter varies much.—P.H.G.]

Length, $\frac{1}{150}$ to $\frac{1}{105}$ inch. **Habitat.** Birmingham (P.H.G.).

N. NAIAS, *Ehrenberg*.

(Pl. XVIII. fig. 2.)

Notommata najas . . . . Ehrenberg, *Die Infus.* p. 429, Taf. lii. fig. 2.

[SP. CH. *Of large size, fusiform;* **brain** *clear;* **head** *broad, obscurely* **auricled**; **foot** *long;* **toes** *short, pointed.*

This is a large and imposing form, evidently approaching the genus *Copeus*, yet showing no visible sense-organs projecting from the trunk. Its claim to a place in the present genus is slight, for the brain has no opacity, there is no tail, and the auricles, if present, are small, and appear to be permanent, as globose ciliated knobs, not evertile. Yet there is no prone face, and the general appearance and structure show affinity with these higher forms. The **body** is nearly cylindric, somewhat ventricose; the head nearly of the same width, divided into several broad but shallow lobes, the cilia on which make independent whorls. The **mastax** is ample, the jaws of the normal pattern. A **brain** descending into the occiput, and carrying a transversely ovate dark-red **eye** near its middle,[1] is flanked by a shorter sac on each side;—another point of resemblance to *Copeus*. A small **antenna** projects from the occiput. Several annular folds of the skin —false joints—encircle the body, three in the anterior half, and one distinguishing the trunk from the **foot**. The latter consists of three well-marked joints rapidly diminishing, terminated by two forked acute toes which are rather short. Two pyriform **mucus-glands** run through the foot from the toes. The **branchial system** is well displayed:

[1] Eckstein figures two tentacular brushes of setæ on the front, with a crimson eye-speck at the base of each.

a rather thick ribbon, slack, but scarcely convolute, passes down each side, apparently lost in (perhaps beneath) the lateral brain-sac, bearing sundry vibratile tags, and merging into a small **contractile vesicle**. The **alimentary canal** and the **ovary** were both amply sacculate in such specimens as I have examined.

I first met with this fine species on the dichotomous leaves of the Water Crowfoot, growing in a sunken pan in my own garden near London, in the summer of 1849. It was vigorous and active, swimming rapidly through the water, with a headlong, pushing violence, or fixing itself slightly by its toes, and thrusting about its head in all directions. It seemed fierce and voracious; for, though I did not actually see it swallow food, it several times munched with apparent greediness the side of a large *Rotifer*, returning to the attack, and seeming to bite ferociously. The *Rotifer*, if not materially injured, was thoroughly alarmed. I have since met with the species, but very rarely.—P.H.G.]

Length, $\frac{1}{50}$ inch. **Habitat**. Near London (P.H.G.); Sandhurst, Berks (Dr. Collins).

N. TUBA, *Ehrenberg*.

(Pl. XVII. fig. 8.)

Notommata tuba . . . . Ehrenberg, *Die Infus.* 1838, p. 433, Taf. xlix. fig. 3.

[SP. CH. **Body** *trumpet-shaped;* **brain** *clear; a cervical* **eye**; **toes** *furcate, conical, minute.*

My right to mention this species rests on a pencil-sketch which I made from life, many years ago, and which I still possess, but without sufficient detail to warrant description, and of which I have preserved no accompanying notes. In Dr. Collins's Note-book, which is kindly entrusted to me, there is a pencil-drawing to which he has attached this name; but this also is unaccompanied by any note, except the date 1866.

From Ehrenberg's figs. I conjecture that its affinities are with *Hydatina*, the cervical eye notwithstanding.—P.H.G.]

N. LACINULATA, *Ehrenberg*.

(Pl. XVII. fig. 9.)

Notommata lacinulata . . . Ehrenberg, *Die Infus.* p. 428, Taf. li. fig. 4.

[SP. CH. *Small;* **body** *cylindrical, thick, broadly truncate;* **brain** *clear;* **foot** *short;* **toes** *long;* **trophi** *forcipate;* **incus** *much developed, hemispheric;* **mallei** *very small.*

This tiny, sprightly atom is of pleasing **form**; vertically viewed, it is a very regular oval in outline, the head dilated, archedly truncate, and of a width, when the hemispheric auricles are out, equal to that of the body; while at the other end the acute divergent toes, set on a very short foot, make an elegant finish to the form. Laterally viewed, the diameter is nearly the same, the fore and hind extremities nearly perpendicular and nearly equal, the dorsal line arched, the ventral straight, the foot and toes set-on at the end of the latter.

The **mastax** is very large and the trophi peculiar. The incus is remarkably developed, the fulcrum stout and long, the rami forming, when closed, a transparent hemisphere, "so as to resemble, when viewed obliquely from above, a globe of glass standing on a pedestal." (See my mem. "On Manduc. Org." in "Phil. Trans." 1855, p. 432, pl. xvii. figs. 32–34.) The tips of the rami are habitually projected in greater or less degree from the front, so that there is no buccal funnel proper. Behind the mastax there is a large dilated pale-red **eye**, seated near the middle of a moderate **brain**, which carries no opaque chalk-granules.[1] The **alimentary canal** is ample, usually filled with food of a rich yellow-brown hue, which adds much to the attractiveness of the animal.

[1] Eckstein finds his usual two red specks at the ciliate front, in addition to the large red eye at the bottom of the brain; but he does not associate them here with tentacular *setæ*.

I first found this species in various waters around London in 1849; and have been familiar with it ever since. Wherever filamentous sub-aquatic vegetation grows, it is sure to be abundant. A restless little creature, it ranges among the leaves with incessant activity, now pushing its way through some narrow aperture, using its toes as points of resistance; now pausing to nibble among the decaying algæ; now scuttling off, by means of its ciliary paddles, to another quarter. The **toes**, when used as a rest, are often stretched asunder as wide as they will bear. In general a free rover through its tiny ocean, it yet occasionally, though rarely, anchors by the mucous excretion from its toes.[1] These moorings it cannot always loosen when it wishes again to leave port. I have been amused to see one swiftly pursuing its course, dragging after it, at some half dozen times its own length, a bit of floccose sediment attached by an invisible thread. It seemed as it were pursued by an eager persevering enemy through all its windings, which enemy at length proved to be nothing but a bit of inanimate dirt.—P.H.G.]

Length, $\frac{1}{250}$ inch; of toes alone, $\frac{1}{1200}$ inch; of egg, $\frac{1}{700}$ inch. **Habitat**. Everywhere in still fresh waters of aquatic vegetation: abundant (P.H.G.; C.T.H.).

N. COLLARIS (?), *Ehrenberg*.

(Pl. XVI. fig. 6.)

Notommata collaris . . . Ehrenberg, *Die Infus.* 1838, p. 428, Taf. lii. fig. 1.

SP. CH. **Body** *cylindrical, tapering to both extremities;* **ciliated face** *very long and oblique, projecting far out from the ventral surface just below the mastax; head with small evertile* **auricles**; **neck** *large and swollen;* **nervous ganglion** *tri-partite, semi-opaque at the free border;* **tail** *distinct;* **toes** *minute.*

This *Rotiferon* (probably Ehrenberg's *N. collaris*) resembles *Copeus Cerberus*; and, like it, might almost be placed either in the genus *Copeus* or *Notommata*. I have only seen one specimen, which from its size (two-thirds of that given by Ehrenberg) was, I think, a young one. It can at once be distinguished from *Copeus Cerberus* by its singular **ciliated face** (which, on a side view [fig. 6*a*], gives the head quite a triangular outline), and by its **swollen neck**. My impression, when I drew fig. 6, was that this swollen condition of the neck was due to the presence of two unusually large and clear **gastric glands**, which inclosed the mastax between them, on one side, and pushed out the surface of the body on the other. But on referring to Ehrenberg's figure (*loc. cit.*), I found that he had drawn the gastric glands as small round bodies, decidedly below the neck. Unfortunately I lost my specimen before I had an opportunity of revising my sketch. The front of the head carries two low ciliated projections, one above each auricle; the **auricles** themselves are decidedly larger than those of *Copeus Cerberus*.

The **nervous ganglion** consists of three distinct parts: a broad upper portion filling up the head; a narrower truncate part, projecting downwards to the top of the mastax; and a long flask-shaped body, the lower end of which, at times, reaches almost to the bottom of the mastax. There is a splendid crimson **eye**, and a very well developed **vascular system**. The rest of the internal structure requires no notice.

It is a sluggish creature, loving to creep among the algæ; but at times it will protrude its auricles and swim off into the open, giving one, as it turns, a good view of the peaked gutter, in which the ciliated face projects in front of the mastax, just as in *Copeus spicatus* and *C. labiatus*. Although mine was but a young specimen, still it was a handsome Rotiferon; and a full-grown one of $\frac{1}{45}$ inch (Ehr. *loc. cit.*) would certainly be one of the largest and most striking of the *Notommatæ*. I am indebted to Mr. Thomas Bolton for this rare animal.

Length. My specimen, $\frac{1}{70}$ inch (Ehrenberg's, $\frac{1}{45}$ inch). **Habitat**. In water from Sutton Park (T.B.): rare.

[1] I once saw half a dozen of these lively creatures, all in a row, attached by their toes to a delicate green filament, and whirling round it like gymnasts on the horizontal bar.—C.T.H.

Genus COPEUS, *Gosse*.

[GEN. CH. *Usually of large size, ventricose behind the middle, furnished with organs of sense*[1] *in the lumbar regions;* **brain** *usually threefold; body tailed.*

The type of this natural group is, as already observed, *Notommata copeus*, of Prof. Ehrenberg, which I propose to honour with his own name, *Copeus Ehrenbergii*. As I have myself found several other species closely allied to this, yet quite distinct, in a very brief period, and in one locality, it is probable that future research may considerably augment their number.

The feature which peculiarly marks the genus is the existence of organs, doubtless of some unknown sense, not only in the vicinity of the great brain (where their presence is quite normal), but in the lumbar region of the trunk, far from the brain, where it seems strange to find them, and where the form and conditions of the surrounding parts seem to preclude their advantageous exercise. This, however, is but the expression of our ignorance.

In many cases there is some extraordinary development of the ciliary system, in the shape of wide expansions of the face, or remarkable forms of the auricles, lately described; and sometimes the tail takes unusual shape and size. The skin, in several cases, has the power of secreting a dense mucus, insoluble in water, so as to constitute a thick coherent mantle for the animal, in which extraneous matters are entangled; and the production and retention of this seem to be subject to the animal's will.

It is perhaps in harmony with this specialty of sense-development that the brain itself is generally of great size, and of complex form; for there is often, in addition to the central sac, which is sometimes pyriform with a tubular stalk, a secondary sac on each side.

The species are for the most part of large dimensions, heavy and unwieldy in motion, and vegetable feeders.—P.H.G.]

C. LABIATUS, *Gosse*, sp. nov.

(Pl. XVI. fig. 1.)

Notommata centrura . . . Leydig, *Ueb. d. Bau d. Rädertk.* p. 33. Taf. iii. fig. 21.

[SP. CH. *Lumbar regions furnished on each side with a stout* **seta** *(apparently single) projecting horizontally;* **tail** *pointed;* **chin** *projected into a long, horizontal, channelled, ciliated process, very versatile;* **brain** *threefold.*

This noble species I at first thought to be the *N. copeus* of Ehrenberg. Yet the dissimilar structure of the head presently showed that it is quite distinct.[2] There is no trace of the great lateral telegraph-like arms which project from the head in *C. Ehrenbergii*; what answer to the **auricles** being small ciliate channels, bent-over at their ends, into which the front is produced on each side. These cilia are continued along the frontal margin; while from the lower part of the **face** projects horizontally forward a very moveable **lip** in the form of a great fold of transparent flesh, of which the two sides, sloping outward, make a channel as long as the width of the head, deep at the base, but coming to a point, its edges, which fold over toward the hollow (see fig. 1*a*), being fringed with locomotive cilia. From the occiput projects, pointing outward and forward, a stout **antenna**, of outline swelling to about seven-eighths of its height, then diminishing with an angle, to a truncate end, whence issues a brush of divergent setæ, evidently connected by internal nerve-threads with the brain beneath. The ciliation of the face reaches far below the lip on the ventral surface. The longitudinal **muscles** are very numerous and conspicuous. Immediately behind the front is a row of (at least) *four* oval translucent masses, which may be compared with the globose masses in the head of *Hydatina*

[1] An account of these "sense-organs," "antennæ," or "tentacles," in the whole Class, will be given at the end of Part VI.—C.T.H.

[2] Dr. Leydig, who (*loc. cit.*) has well described and figured this species, assumes that it is the *N. centrura* of Ehrenberg. But so practised an observer could not have overlooked the great lip, if *labiatus* had indeed been before him.

senta and *Euchlanis deflexa*; these appear to be quite independent of the great **brain** proper. This is here triple; the middle lobe is pear-shaped, depending considerably below the mastax, with a long slender neck, quite pellucid, having a great red **eye** seated near its mid-length; on each side is a similar but shorter lobe. The **trophi** are of the pattern in *N. aurita*: each uncus is somewhat slender, and *seems* to comprise but two fingers; but, from the opacity of the parts, I am not certain. Under pressure, there seemed to be five, blade-shaped, and closely parallel. A very long **œsophagus** leads to a wide and ample alimentary canal, divided by a sensible constriction into stomach and intestine, even when there is no diminution in their common outline. But this condition I saw rather suddenly much altered; so that the constriction was made as manifest as if a cord had been drawn tightly round. Both stomach and intestine were, in all specimens that I have seen, moderately full of dark yellow-brown granular food, interspersed with orange-coloured oil-globules, brilliantly refractive, most thickly at the pyloric end. The alimentary canal, when moderately filled with food, has a very peculiar appearance, as if divided by constrictions, both transverse and longitudinal, into squares. This is not accidental, but characteristic, being seen in every example that has occurred to me, and distinguishing the species from all its congeners. A pair of ovate, colourless **gastric glands** are seated on the two shoulders of the stomach. The **contractile vesicle** is large; the branchiæ take the form of two very long, and very slender bags, transparent, but much corrugated, rather than of convoluted cords. I counted three vibratile tags, which happened to be all on the same side: one level with the eye, one with the lumbar seta, and one intermediate. The **ovary** appeared normal. The fusiform body ends in a well-marked **tail**, stiff, transparent, tapering to a point, but diminishing abruptly in the middle, forming a distinct shoulder there. Through it runs a pair of chain-like glands, resembling those in the toes, supposed to be mucous. A **foot** of two joints carries a pair of straight, short, conical acute toes.

The manners of this striking creature were rather sluggish, though it moved and turned and twisted about restlessly. I did not see it swim. I had an interesting observation of the character of its food, and of its mode of feeding. The water was much stocked with the finer desmids and diatoms,—great Closteriums, Euastrums, Cosmariums, and the like. I caught my *Copeus* eating a great *Epithemia turgida*. He had evidently only just seized it with his protruded jaws, and had drawn one end of the desmid into his mouth, and was vigorously biting it. After a while, the frustule was pierced, as was seen by the cloud of dark granules that rushed down the mastax. All the contents were quickly sucked-in, till the shell was as empty and clear as a glass vessel; to the manifest increase of the dark contents of the alimentary canal. Then it was contemptuously thrown away. Another had partly gnawed through a slender filament of conferva, and had extracted, and was still extracting, the green granules from its interior, *just at that part*. Afterward I saw it devouring a small crescentic *Closterium*. This it ate up bodily; and it occupied considerable time, even after the desmid was within the buccal funnel, and the end within its jaws. Thus it appears that this large species is a true vegetarian in diet. I have seen several more, all from a ditch in Sutton Park, Birmingham. All agree in these characteristic details. Each one has been quite clean, and totally devoid of any gelatinous covering.—P.H.G.]

Length, $\frac{1}{40}$ inch; width, $\frac{1}{175}$ inch. **Habitat**. Birmingham (T.B.).

C. SPICATUS, *Hudson*.

(Pl. XVI. fig. 2.)

Notommata spicata . Hudson, *J. Roy. Micr. Soc.* 2 Ser. vol. v. 1885, p. 612, pl. xii. fig. 5.

[SP. CH. *Lumbar regions furnished with tubules, setigerous at their extremities; two occipital* **antennæ**; **brain** *threefold*; **tail** *saccate*.

In this species we see two pairs of what we may call **tentacles**, of consimilar

structure: the one pair (the ordinary *antennæ*) seated on the occiput, the other on the hinder part of the trunk, one on each side. Each tentacle consists of a tubular column, which has a thickened extremity, whence issues, in the anterior pair, a brush of divergent setæ; in the posterior, a single seta; all of great length and tenuity. The lumbar tubules are much more slender than the occipital, but are twice as long; and the increase to the terminal knob is much more gradual.

The general **form** is sub-cylindrical, becoming more ventricose at the hinder part, then abruptly diminishing. But this form is subject to constant alteration, as the animal is ever lengthening or shortening, swelling one point, and contracting another. A very curious appearance is presented by the two sides at intervals. There is, near the middle of each side, a portion of the outline, which is now and then thrown into folds,—not constrictions of a rounded saccate body, as usual, but presenting the exact appearance of a single thin tissue, the edge of which is thrown into sharp, minute, and close-set wrinkles, like those of a frill of crimped muslin. The appearance is very frequent, seldom lasting more than a minute or two: not peculiar to one individual, but common and characteristic. I cannot explain it. The body is contracted into a true **tail**, which is of a thick sub-cubical form, corrugated with strong folds of the skin, like that of *C. pachyurus*, presently to be described, but smaller. Below this is a small **foot**, bearing a pair of furcate toes, short, taper, and drawn out to excessively slender points, often slightly incurved, the flexure varying in different examples. The frontal cilia appear to be seated on slight eminences. The **face** projects into a channelled protrusile lip, whose edges are ciliated; agreeing both in shape and structure with the like organ in *C. labiatus*, but not nearly so large (figs. 2*a*, 2*b*). The **brain** is 3-lobed, composed of three pyriform ovate sacs; the outer two clear, the middle one shorter, and turbid or almost opaque, with a broad red **eye** lying transversely across its upper part, in shape like a shallow lens. The **trophi** are large and distinct, of the form seen in *Notommata aurita*. A long **œsophagus** leads to an ample alimentary canal, on which are seated a pair of kidney-shaped **gastric glands**. In the specimen which I have delineated (and I have observed it in others), the alimentary canal formed a great bag, one side of which was smooth and expanded, a most delicate transparent tissue, enclosing many small diatoms and other algæ; while the other half was thrown into close longitudinal wrinkles. Within it were four or five oil-globules of brilliant orange-hue, varying in size, the light refracted through which made very attractively beautiful objects, as the focus was ever and anon changed. The **ovary** takes the form of a long and slender band, full of clear embryonic vesicles, passing in a sigmoid curve from near the gastric glands to the bottom of the cavity. At its hinder extremity was an ephippial **egg**, covered with transparent spines, broad-based, much curved, much like the prickles of a rose, of whose development Dr. Hudson has given an interesting account (*loc. cit.*). Just above this was another smaller egg, maturing and already opaque. The undeveloped portion of the ovary is speckled all over with minute light-refracting dots. The **branchiæ** take the ordinary form of slender, somewhat twisted cords, probably tubular throughout, beginning apparently at the front face, by many attenuate ramified channels, with doubtless open ends, to receive the influent water for respiration; and terminating each on one side of a large **contractile vesicle**, occupying the hinder end of the visceral cavity. Each branchia has attached to it by a slender stem a pear-shaped bag, which hangs free in the cavity, at about mid-body; and, a little below this, an ovate enlargement, which is sessile by its whole side. The contractile vesicle takes a globose form when full; when it is seen to have a number of very minute clear glands (?) scattered over its surface. I found the period of filling, between one contraction and the next, to be just three minutes. At the point where the pear-shaped bag is given off, each branchial cord adheres firmly to the epithelial lining of the skin; but is free above and below that point. I searched carefully, but vainly, for any vibratile tags in the course of either branchia. But, in one I saw, in a very slender offshoot, close to the attachment of the pear-shaped bag, which yet was not a "tag," a vibration exactly similar to that of a

"tag." From each **toe** runs up a thread, which in the foot dilates into an ovate **gland**, studded with minute vacuoles. Probably these are mucous glands: but no mucus-strings were visible from the foot, nor any gelatinous envelope of the body, in all the specimens (nearly a score) that I have examined. The brush of each occipital **tentacle** (*antenna*) consists apparently of three, or at most four, setæ; each lumbar tentacle carries but a single seta. Through all, lines are seen running down from the setæ to the base. From the base of each lumbar tentacle the thread which descends from the seta is distinctly seen to pass for some distance up the visceral cavity toward the brain, till it can be no longer distinguished among the multitude of lines. On the other hand, the thread issuing from the base of each antenna may be traced to the very summit of the brain.

This is, perhaps, the largest of all known *Rotifera*. Some among the *Rhizota* may exceed it in length, a great part of which is occupied by the foot of almost linear tenuity. But, bulk for bulk, *Copeus spicatus* far exceeds them all. It is a noble, as well as a very interesting, member of its class. Viewed on the stage of the microscope, we forget that we are contemplating a speck, such as a lady's cambric needle might prick in a sheet of paper, and are struck with what we are ready to call its gigantic dimensions. For, with a half-inch objective, it almost crosses the round field of view, and with a quarter, such as is needful to interpret the organization of the Rotifera, we are obliged to examine it piecemeal; for a large portion of the creature is necessarily beyond our vision. Its great size, slow movement, and brilliant transparency make it a subject very favourable for observation. Perhaps this is the finest addition made to our knowledge of the Rotifera since Ehrenberg's *magnum opus*. And we owe our acquaintance with it to Dr. Hudson, who named, described, and figured it in the "Journ. Roy. Micr. Soc." for May 1885. It was discovered by Mr. Bolton, who sent him specimens, as he has lately sent to me also, obtained from Sutton Park, Birmingham.—P.H.G.][1]

Length (moderately extended), $\frac{1}{2}\frac{1}{0}$ inch; width, $\frac{1}{1}\frac{1}{3}\frac{1}{0}$ inch. **Habitat.** Birmingham: Coleshill (T.B.); Sandhurst (Dr. Collins).

C. PACHYURUS, *Gosse*, sp. nov.

(Pl. XVI. fig. 4.)

[SP. CH. *Front furnished with a pair of long and thick* **auricles** *projectile and retractile; lumbar regions with tubules, destitute of setæ;* **tail** *saccate.*

The general accuracy of Prof. Ehrenberg's details, where he gives them, makes me distinguish this species from his *N. copeus*; though it comes very close to that fine species, perhaps even closer than does Dr. Hudson's *N. spicata*, or any other. It is, indeed, less than half the size of *Copeus* (= *Ehrenbergii*), my specimen measuring $\frac{1}{7}\frac{1}{5}$ inch in length, when moderately extended; I could not be sure that the **brain** had more than one lobe; the lumbar **tentacles** are placed far back, as in *spicatus*, and differ in apparent structure from those of either; and finally the **tail** is neither a minute conical tubercle nor a long stiff point, but a wide sub-globose sac (as in *spicatus*, but far larger), whose walls are thrown into stiff sharp folds, as if composed of a firm leathery skin.

Yet the general aspect is that of *Ehrenbergii*; the **auricles** have the same form and direction, and the same comparatively large dimensions. Ordinarily they are quite un-

[1] A side view of this fine Rotiferon has been accidentally omitted from pl. xvi.; but will be given in pl. xxx. It shows that the two occipital antennæ are connected by a transverse ridge crossing from the base of the one, to that of the other. My solitary specimen had a semi-transparent gelatinous covering, out of which peeped the ends of the four tentacles. The ephippial egg, when I first saw it, was quite smooth, and separated by a clear space from its outmost covering. I saw its prickles begin to grow, and watched them slowly stretching across to the outer shell. Two hours elapsed before they had accomplished the distance.—C.T.H.

suspected, being absolutely concealed within the rounded outline of the head; but, at the will of the animal, are suddenly pushed out horizontally, by eversion of the skin, to a length more than half the diameter of the head. They then form oblique cones, which are truncate at their tips; but the skin there, which seems in some sort double, is at every instant drawn in a little, as if very sensitive. The outer upper corner of each is richly ciliated; and the ciliary action, at this point of each, makes a strong vortex, into which floating atoms are drawn, and whirled round as in those of the *Bdelloids*. The auricles are often extruded when the animal is not swimming, but grubbing among the sediment; and they do not sensibly augment the speed, then; but if extruded during the swimming, they do so notably. Each can be thrust out in varying degrees; and very often one is out while the other remains concealed: they are manifestly very flexible. No **antenna** from the occiput is visible; and the tentacles on the lumbar regions are very minute tubules projecting through the internal skin, and connected with a visible basal area on the exterior of a vascular membrane which surrounds the abdominal viscera. I can discern, even with a high power, no setæ at the tips of these tubules: but possibly these may be retractile. Indeed, the tubes themselves are not always apparent. After death, the ventral surface being in view, a thread was distinctly seen on each side proceeding from the base of the lumbar tentacle, dividing into two branches at about mid-length, and going up to the sides of the brain. Each thread, both before and after the division, had a sensible diameter, and showed a double outline. No under lip breaks the uniform rotundity of the frontal outline. But, in a ventral view, when it was still and contracted in dying, I have observed an ovate line, as of a minute orifice, just within the edge (fig. 4*b*), which may possibly have marked the place where a lip had protruded.

The general figure of the animal much resembles that of *N. aurita*; but is more variable, as if the integument were softer and more flexible. A momentary glance while it was turning left the impression that a segment would be as at fig. 4*a*; as if the ventral surface were dilated and flat. The skin was free from gelatinous envelope.

A stout **foot** of three joints carries two toes of the blade-form, stout, of uniform width, somewhat long, *straight*, and pointed. Behind them, separated from them by the cloaca, and from the gibbosity of the trunk by a strong constriction, there is a large bladder-like inflation of the skin, thrown into strong folds or creases, which must be taken to represent the tail. It is colourless, and appears quite empty; it is constantly changing its outline, but ever falls into the same folds. It is slightly bilobed, and seems somewhat dilatable. This great fat ventricose tail is a conspicuous character, by which this species may in a moment be recognised. The internal economy is, in most examples, sufficiently clear. A three-fold **brain** is seen: the mid-lobe pear-shaped with a long slender neck, the bulb reaching far below the mastax; the side-lobes comparatively short. I have seen the mid-lobe filled with granular matter, not quite opaque, but darkly turbid. A deep-red **eye**, large, oblong-square or ovate, is seated on the neck of the mid-lobe. An ample **mastax**, with normal trophi, nearly fills the breadth of the pectoral region; followed by a vast stomach, in most examples, densely filled with dark-brown conglobate rolls of food; sometimes with no **glands** visible, at others with two small glands, dark, with a large oil-globule within each, of deep orange hue, whose rich refraction of light has a very striking effect, like a pair of coloured carriage-lamps. The **ovary** often has a great egg, nearly mature. **Lateral canals**, one on each side, are more or less clearly discerned, on one of which I have seen one vibratile tag; but I have not been able to detect a contractile vesicle.

In manner of life this, like its congeners, is dull and slothful, rolling stupidly and aimlessly about, and ever altering its form, but not much given to locomotion. Now and then, however, it seeks a new locality; and then it shoots away in a straight line, with considerable swiftness and grace, cleaving its path, with dilated front, through the water. I was so fortunate as to be present at the dinner of this species, as I had been at that of *C. labiatus*. Several large algæ were strewn around, among them a *Closterium*,

dark green, very slender, nearly straight, and longer than the *Copeus* (perhaps *C. lineatum*). The animal attacked two of these in succession, taking hold transversely, yet not attempting access there. But feeling its way, it worked, very cleverly, and with manifest intelligence, till its jaws reached the tip. At this, then, they worked eagerly, drawing it in, so that it stretched out lengthwise from the head. No impression, however, was made on the flinty frustule, and it was presently relinquished, to attack another, equally in vain. After some hours, I perceived that it was essaying food again; and again one of the same long *Closteriums*, which now was drawn far down the buccal funnel; while the mastax in its usual position had already eaten a good deal of the desmid, chewing it away, as one would eat a radish. The great **auricles** (in this very example) were reluctantly and charily put out. They would not be suspected at other times. During several hours' observation I saw them extruded only on one occasion, when the creature was gliding through clear water. And then, it thrust out first one and then the other, timidly and tentatively, as it were, and drawing each back before it was nearly out; then again protruding it; till, by this time, some impediment was reached, and I saw neither any more. Such was very much my experience of others also. The first specimen that I saw occurred in water sent me, in June, by Dr. Collins from his "happy hunting-ground" at Sandhurst. But more recently Mr. Bolton has sent me examples from the prolific ditch in Sutton Park, near Birmingham, where it revels in company with *labiatus* and *spicatus*.—P.H.G.]

Length, $\frac{1}{78}$ inch. **Habitat.** Pools and ditches where the larger *Diatomaceæ* abound. Sandhurst; Birmingham (P.H.G.).

C. CAUDATUS, *Collins.*

(Pl. XVI. fig. 5.)

[SP. CH. **Form** *slender, swelling in the middle;* **auricles** *wanting; one occipital antenna, and one lumbar* **tentacle**; **tail** *minute.*

In "Science Gossip" for 1872, Dr. Collins described and figured this *Notommata* of singular facies. I had long desired to examine it, having had my curiosity excited, not only by the brief diagnosis of its discoverer, but by numerous pencilled sketches in his well-filled note-books, committed to me from time to time by his courtesy. At length, by his kindness in sending me samples of water from the original habitat, I have been gratified by the sight of several specimens in healthy activity. It is a species much more abnormal in appearance than in structure: an appearance which depends on the seeming severance of the head from the body by a long interval. The **head** is large, somewhat square in outline, and, owing to the definition of the brain with its eye, and of the mastax, it catches the observation in a moment. Then follows a neck of unusual length; and though its thickness is scarcely less than usual, its extreme transparency and colourlessness render it hardly visible till focussed; and it contains no organs, save on each side the twisted **lateral canals**, of such filmy mistiness as scarcely to be perceptible when searched for; and so there seems nothing at all, save the œsophagus, a tube of great subtleness and slenderness running through the middle of its entire length. We seem to see an oval abdomen filled with viscera, and a head tied to it at the end of a long string. The head carries at each frontal corner a small globe refractive of light, which I take to be an **auricle**, though I have not seen them retracted or protruded, nor are they manifestly ancillary to speed, being visible uniformly in the animal's twinings and crawlings. The frontal surface between these auricles bears vibratile setæ, as well as ordinary locomotive cilia. A large well-developed **brain** occupies the whole width, and descends, sack-shaped, far down the occiput, bearing on its facial side a brilliant crimson globular **eye**, and in its rear, supplying a nerve-thread to the sensitive seta which runs through an antennal tubule, projecting from the back of the head (figs. 5*c*, *d*). A **mastax** of ordinary form in the family has the bent mallei of some thickness. It is figured at 5*b* from some very good observations, though, from difficulties inseparable

from the circumstances, I dare not vouch for the minute details, particularly of the *incus-rami*. The **respiratory organs**, in the form of slender cords, loosely twisted together, but, as I presume, tubular, can be traced to the very front of the head; at least to the point on each side where the proximity of the brain to the integument allows them to be no longer discerned; and thence backward without interruption, till their ends ramify and are lost on the walls of the ample contractile vesicle that occupies the termination of the abdominal cavity. It was an operation of much delicacy, but with a $\frac{1}{4}$-in. obj. I think I satisfactorily followed the entire course described. In the ample abdomen the viscera are large. The **alimentary canal** is clearly separated into a stomach and an intestine. In all the individuals examined, neither of these held any visible food, but both were tinged with pale umber-brown. An **ovary** of embryonic vesicles, and a great dark ripening ovum, were conspicuous in one. At the expansion of the long œsophagus into the stomach are the pair of ovate colourless **glands**, which possibly are biliary, and may impart the prevalent yellow-brown tinge to the digestive canal. The dorsum, just before the point where it contracts into the foot, rises into an angular prominence; which must be regarded as a true **tail**, because beneath and behind it is the common excrementary outlet, whether for matters urinary or fæcal—the *cloaca*. The anterior side of the orifice is crowned with a bristled tubercle (fig. 5*d*), very closely resembling that projecting from the hind head. It seems a tubular wart with a thickened rim, bearing a rather short seta on the summit. From the base of this are discerned, clearly running down through the transparent tube, two fine lines, which probably are the optical expression of a nervous cord, bending forward to some sensible distance up the body, till lost behind the viscera. I searched (vainly) for some ganglion in the vicinity, with which this thread may communicate. But I rather presume that it runs through the body, and communicates with the great brain at the very front. It seemed to me that each of these tentacular warts, both that on the head and that on the tail, is susceptible of sensible elongation, and of occasional withdrawal, partial or perfect. The **foot** is slender and colourless, like the anterior parts, and is terminated by two minute and delicate toes; from which two long, club-shaped muscles pass forward nearly to the cloaca.

The species was discovered by Dr. Collins in 1865, in a small pool near Sandhurst Military College, whence he has recently sent me a supply. There seemed here the exercise of a sense of companionship, at least in captivity. After some days this species became rather numerous in the bottle of water-moss, and I have had, perhaps, a dozen in my live-box at once, of various ages. I noticed, much too often to be merely fortuitous, that they were in the habit of associating in couples, two being generally in close contiguity, and now and then coming into actual contact; the one crawling, in their lithe embracing manner, over the foreparts of the other; separating, however, immediately after. It was not sexual. In young individuals, not more than half as long as the adult, all the characters are developed; except the great length and almost invisibility of the neck, which are not so manifest.—P.H.G.]

Length, $\frac{1}{150}$ inch. **Habitat.** Sandhurst, Berks (Collins); Dundee (P.H.G.).

C. Cerberus, *Gosse*, sp. nov.

(Pl. XVI. fig. 3.)

Notommata centrura . Gosse (nec Ehr.), *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 200.

[SP. CH. **Tentacles** *wholly wanting (or unobserved)*; **auricles** *small*; **brain** *three-lobed*; **tail** *a minute tubercle.*

This species approaches the ordinary *Notommatæ*, in form and in the absence of those projected organs of sense which characterise the other species of this genus. Yet the general aspect, the sluggish manners, and the three-lobed brain, seem to war-

rant me in placing it in this genus. Indeed, when, five-and-thirty years ago, I first met with it, I concluded that it was identical with Ehrenberg's *N. centrura*. But I have lately seen several more examples, which have convinced me that it is still an undescribed species.

The **form** is rudely cylindrical, with many irregular constrictions, and the abdominal regions somewhat swollen. The front is rondo-truncate, with a minute **auricle** on each side. These seem scarcely protrusile, though the oval space in which ciliary action is seen appears in each. The ciliated **face** is prone, and reaches far down; no lip appears. At the hinder extremity there is a distinct **tail**, small, saccate, almost amorphous, beneath which the cloaca opens, as I saw by the actual emptying of the rectum. A very short **foot** carries two minute, conical, pointed toes. The **brain** consists of three sacs, of which the central hangs low, being seen behind the mastax, and as usual forms a long tube at the origin, in which is the **eye** of lenticular form, and brilliant crimson hue. The lateral sacs are moderately short. All three are more or less occupied with opaque granular matter; but in the central sac this is *generally* (not always) so much diluted as to be pellucid. The central sac, too, is occasionally seen truncate at its lower end, exhibiting very distinctly at its margin the separate cells of which it is composed. The **trophi** are normal: the mallei apparently four-fingered. The **alimentary canal** is large, saccate, furnished above with small globose **gastric glands**, and not sensibly divided; its central longitudinal cavity may usually be traced, full of digesting food of a dark umber-hue, while the thick surrounding walls are tinged with the same. The voluminous **ovary**, forming a wide horseshoe across the ventral region, its horns directed backwards, is full of clear embryonic vesicles, and often carries a dark maturing egg which I have seen discharged. The **branchial system** has the usual form of a rather thick cord (probably tubular), not twisted, but hanging so loose as to be thrown into many curves, with at least three vibratile tags on each, and the usual **contractile vesicle** of moderate size occupying the hind mid-ventral region. **Muscles**, both longitudinal and transverse, agree with those that I long ago demonstrated in *Not. aurita*.[1] The whole head is usually tinted with buff, and the mastax-front with red-brown.

My first example of this species was found in June 1850, in a phial dipped on Hampstead Heath three weeks before. The more recent were in the sediment of a phial sent me by the kindness of Dr. Collins, from the historic pool in Sandhurst Wood. The creature, like its congeners, is slow and deliberate in manners, burrowing and rooting in its floccose surroundings. Its motions are much like those of the water-bears; indeed, on first catching a glimpse of my subject among the half-hiding sediment, I have repeatedly been doubtful whether I was looking at a Tardigrade or one of these massive *Notommatadæ*.—P.H.G.]

A specimen of Mr. Gosse's *Copeus Cerberus*, which I found in some water from Sutton Park, Birmingham, enabled me on one occasion to obtain an excellent view of the mastax and trophi; for it every now and then slowly turned its head back, so as to bring its ciliated face up to the cover-glass, and thus to rotate the mastax, for me, with all its parts in their natural position. I could distinctly see the massive malleate trophi unusually thick and broad; the short, wide, yet graduated teeth of each uncus opposing each other at the top of the mastax, like the fingers of the two hands brought just to touch at their tips. Immediately above them were two very prominent lips, like a parrot's beak, and evidently of a much harder substance than the rest of the mastax: they were seated upon it, on each side of the opening between the buccal funnel and the teeth. These I saw repeatedly open and shut as food passed down the funnel to the trophi.

Length, $\frac{1}{25}$ inch. **Habitat.** Hampstead Heath; Sandhurst, Berks (P.H.G.).

[1] *Trans. Micr. Soc. Lond.* vol. iii. p. 101, pl. xv.

Genus PROALES, *Gosse*.

GEN. CH. *Of moderate or small size;* **body** *generally cylindric, or larviform; ciliated* **face** *more or less prone;* **brain** *clear;* **auricles** *and* **tail** *wanting.*

This again is an extensive group, containing many species, some of them of familiar occurrence, often obscure, of indefinite character, and hard to be distinguished. Some are entozoically parasitic on other creatures. The vibratile cilia are disposed on a face, along that side of the head which is more or less in the ventral plane. Their bodies are usually lithe, soft, and versatile; their motions rapid and various.

P. DECIPIENS, *Ehrenberg*.

(Pl. XVIII. fig. 6.)

Notommata decipiens . . . Ehrenberg, *Die Infus.* 1838, p. 431, Taf. lii. fig. 6.
„ *vermicularis* . . Dujardin, *Hist. Nat. Zooph.* p. 648, pl. xxi. fig. 7.

[SP. CH. **Body** *cylindric, slender, worm-like;* **foot** *undeveloped;* **toes** *minute.*

This much resembles a dipterous larva; having a soft, flexuose, slender body, with a rounded front, and two minute, conical toes, without any sensible foot. A large, occipital **brain** carries a red **eye**, distinct, though small; a crystalline lens is conspicuous, seated on, and partly imbedded in, the pigment-globule; the latter much the larger. (See Duj. *loc. cit.*) Near the front are two clear colourless granules, usually distinct in the many examples that I have met with. These may be readily mistaken for eyes when the animal is in motion. A **mastax** with trophi of normal form leads by a very long and slender œsophagus to a cylindric alimentary canal, with usual accompaniments.

I first found this in 1849, in waters near London both north and south. Since then it has occurred repeatedly in various localities. When I saw my first example, it was spinning round on its long axis. After a while it became less impatient, but still very lively. It frequently bent itself up double, in the manner of a caterpillar, and occasionally shrank up into a wrinkled, shapeless ball, remaining thus awhile quiet. Gliding through the water by means of its rotatory cilia, its motion was not particularly rapid. Though I have called the trophi normal, there is, in the form of the rami, a manifest approach to these organs in *Diglena*.—P.H.G.]

Length, $\frac{1}{100}$ to $\frac{1}{145}$ inch. **Habitat.** Near London; Epping Forest; Birmingham; Stapleton Park, Yorkshire; Dundee (P.H.G.): pools: not common.

P. FELIS, *Ehrenberg*.

(Pl. XVIII. fig. 17.)

Notommata felis . . . . Ehrenberg, *Die Infus.* p. 431, Taf. lii. fig. 7.

[SP. CH. **Body** *cylindric, slender; a large decurved fleshy* **proboscis**; **eye** *very large;* **trophi** *Diglenoid;* **foot** *stout;* **toes** *slender, pointed.*

Of this little species, the slender **trunk** is strongly fluted longitudinally. The curious projection which Ehrenberg calls a horn, is a thick soft lobe of translucent flesh, which curves down before the head, perhaps a tentative organ, and recals what we see in some of the *Diglenæ*. So also do the pincer-shaped **rami**; and, as in that genus, they are capable of being rapidly and forcibly thrust forth, with a snapping action. The **brain** is broad, and descends far; it bears on its round extremity an **eye** so large that it occupies fully half the diameter of the body. Yet it is seldom seen; being a lens seated transversely, and edgewise to the observer. The **stomach** too, with high lateral shoulders, usually densely filled, hinders the observation, not only of the eye, but of all

the viscera.[1] Its manners are lively and restless; rarely swimming, but incessantly boring and pushing through the yellow sediment in which it chooses to dwell; and that so pertinaciously, that when it comes to the edge of a mass, it will not (or very rarely) go on into the clear, but turns back, and bores its path anew. If it does sail out for an instant, it presently stops short, turns tail, and hurries back to its cover. I have seen the pincer-jaws rapidly protruded almost to their full length. I have seen many specimens, in water and sediment from the ditch in Sutton Park, Birmingham, which Mr. Bolton has so successfully explored.

The new Rotifera *Pleurotrocha mustela* lately described and figured by Mr. W. Milne ("Trans. Phil. Soc. Glasgow," 1885), is very like the present species. He has represented the male, which closely resembles the female, but is smaller, and devoid of digestive system. The memoir is of high value.—P.H.G.]

Length. About $\frac{1}{175}$ inch. **Habitat.** A ditch near Birmingham (P.H.G.); Glasgow (Mr. Milne).

P. GIBBA, *Ehrenberg*.

(Pl. XVIII. fig. 8.)

Notommata gibba . . . . Ehrenberg, *Die Infus.* 1838, p. 430, Taf. lii. fig. 4.

[SP. CH. **Body** *compressed; back much arched, deeply incised above the stout foot;* **toes** *slender, pointed, slightly decurved.*

The fore parts are separated from the trunk by a marked infolding, as well as the foot; this latter constriction, when viewed sidewise, forms a deep sinus. The first example that I met with was in November 1849, in a pond at Battersea Rise. I afterwards found other specimens. The **front** is prominent and round; over it projects a semi-ovate plate apparently slightly bent downward, on each side of which is a fine seta. Perhaps the more natural place of this species would be in the (restricted) genus *Notommata*, near *lacinulata*. But the ciliated face is prone. The **brain** descends bag-like, into the occiput, and bears a wart-shaped red **eye** on its very end. The taper rectum terminates in a cloaca, in the deep posterior infolding. A minute **contractile vesicle** is in almost incessant contraction. The **foot**, with its curved toes, is often thrown forcibly back, in the manner of *Rattulus*.

The animal is lively, actively swimming, and contracting strongly as it goes, and throwing the toes backward and forward.—P.H.G.]

Length, $\frac{1}{300}$ to $\frac{1}{200}$ inch. **Habitat.** Battersea; Stapleton, Yorkshire; my domestic aquarium (P.H.G.): rare.

P. SORDIDA, *Gosse*, sp. nov.

(Pl. XVIII. fig. 7.)

[SP. CH. **Body** *nearly cylindrical;* **head** *broad, truncate;* **foot** *very broad, with a depression through the median line;* **toes** *minute, conical.*

This is a somewhat clumsy, ungraceful, unattractive species. The whole integument is flexible, and thrown into transverse folds, though seemingly stiff. The **corona** is broadly truncate, formed by numerous ill-defined globose masses, on which the cilia are grouped. The whole front is capable of little expansion or change, and the motion consequent, not very swift. The **mastax** is ample, of the *Notommatous* pattern; behind which a **brain**, moderately developed, carries a red **eye**, on its side. The eye is often invisible; then suddenly appears as a minute speck (or, as I once saw, two red specks, apparently in contact), or, often, as a well-defined considerable mass of rich colour. I

[1] Herr Eckstein (*Sieb. u. Köll. Zeits.* 1883, p. 363, fig. 29) describes and figures a pair of minute dark-red points one on each side of the front, whence a brush of setæ springs. These I have not seen, but cannot doubt that they are of the nature of antennæ, and that the red speck is imaginary. He describes the proper eye besides, and notices the distinct refracting lens, by which it is embraced.

have seen the saccate brain at its hinder end, densely opaque in a great ball, just as in *N. aurita*, while all the remainder was clear. In every other respect the specimen was a normal *sordida*. The most observable characteristic of this species, by which it may without fail be identified (for it is quite constant), is the condition of the **foot**. The hinder half of the trunk, viewed dorsally, insensibly diminishes to a width about one-third that of the widest part, where it is abruptly truncate; the hind half of this is separated by a slight fold, and appears to constitute the foot-proper. Yet there are no visible joints in it, and its outline, as I have said, simply continues the gradual tapering. Down the middle of this foot there runs what seems a shallow depression, crossed by two similarly depressed transverse lines, and the whole ends in two small conical toes. When once this peculiarity has been noticed, there is no mistaking it.

I first found the species in a tube sent me by Mr. Hood from Dundee, and since then in water from Miss Saunders of Cheltenham, and abundantly from Woolston, sent by Miss Davies. Some of these last were hyaline, and more active.—P.H.G.]

Length, $\frac{1}{110}$ to $\frac{1}{130}$ inch. **Habitat.** Many localities in England and Scotland: common in pools (P.H.G.).

P. TIGRIDIA, *Gosse*, sp. nov.

(Pl. XVIII. fig. 10.)

[SP. CH. **Body** *cylindric or fusiform, curved in the manner of* Rattulus; **foot** *and* **toes** *both long, and bent in a sigmoid curve.*

This animal, I do not doubt, has been confounded by observers, as it was by myself, with the *N. tigris* of Ehrenberg, but this latter I now relegate to another genus, in the Sub-order LORICATA. The present is certainly il-loricate, and its long ciliate **face**, almost absolutely prone, shows its affinities to be here, though it is certainly osculant with *Rattulus*. Its **trophi**, too, are symmetrical, and of the *Notommatous* pattern. The cilia of the face seem set on minute eminences; and there are longer setæ among them. The belly line bends upward and then downward to include the base of the deep **foot**, which again bends upward (*i.e.* backward) to the toes, and these bend downward at their tips. So that the whole line from the face to the toe-tips forms a double sigmoid curve of much elegance. In June 1885 I first became cognizant of this interesting form. It was haunting the decaying whorls of *Nitella*, in water from Woolston Pond, sent me by the kind courtesy of Miss Saunders. It has occurred also in other waters.

It is an energetic animal, given to sudden and rapid changes of motion, shooting through the free water with great celerity, the toes stretching behind straight and parallel; now abruptly turning on itself to pursue another course, now arrested by a cloud of floccose, to dig into the decaying vegetation with apparent determination and vigorous perseverance. The **digestive canal** is almost invariably dark with granular food, of a deep rich-brown hue. A **contractile vesicle** is usually conspicuous.—P.H.G.]

Length, $\frac{1}{170}$ inch. **Habitat.** South and Midland England; pools (P.H.G.): rare.

P. PETROMYZON, *Ehrenberg*.

(Pl. XVIII. fig. 9.)

Notommata petromyzon . . . . . Ehrenberg, *Die Infus.* p. 427, Taf. l. fig. 7.

[SP. CH. **Body** *ovate;* **foot** *long, stout, and very distinct;* **toes** *minute.*

The **form** is gibbous-ovate, truncate at each extremity, when contracted; the head is rounded, protrusile; the **foot** apparently of one joint, very large and long, but abruptly less in width than the truncate body whence it issues; the two toes are very minute cones. The character of the foot makes the species particularly easy of recognition.

The simplicity of the **trophi** makes them very instructive. The *incus-fulcrum* is

thin and blade-like, straight but slightly incurved at the free end, deeply truncate above where the rami are jointed, which are long triangular blades arching backwards. The *mallei* are slender rods, each with a process, and an *uncus* of two fingers.[1]

Ehrenberg describes the species as parasitic on the branching Bell-vorticels *Epistylis* and *Carchesium*, among whose twigs it lays its eggs; and also in *Volvox*. I have seen it always free, though repeatedly in close association with both these Infusoria. I have been acquainted with it from many localities since 1850. It is lively in its motions; yet frequently adhering to the glass, and moving by a feeble crawling; it can, however, swim rapidly. Its contractions are almost perpetual, and very vigorous.—P.H.G.]

Length, when extended, $\frac{1}{70}$ inch. **Habitat.** Around London; Walthamstow; Leamington Canal; Cheltenham; Woolston; Birmingham: pools and garden reservoirs (P.H.G.).

P. PARASITA, *Ehrenberg.*

(Pl. XVIII. fig. 11.)

Notommata parasita . . . Ehrenberg, *Die Infus.* 1838, p. 426, Taf. l. fig. 1.
Hertwigia volvocicola . . . Plate, *Jenaisch. Zeits. f. Natur.* 1885, p. 26, figs. 7, 8.

[SP. CH. **Body** *cylindric or gibbous, rounded at each end;* **foot** *and* **toes** *wanting. Parasitic in* Volvox.

To the characters just given may be added that the **jaws** are long, slender, protrusile, and asymmetric: the mallei being dissimilar in length and curvature; thus recalling the *Rattulidæ*. A brilliant crimson **eye**, wart-shaped, sits on the dorsal corner of a large occipital **brain**; from the front of which projects a club-shaped **antenna**, sometimes drooping, sometimes erect. The prominent round head is clothed with fine cilia, and surrounded by a wreath of stronger vibration; when this is retracted the margin is thrown into puckers.

The habits of this inconspicuous species are curious; for it is parasitic within the spheres of *Volvox globator*. Examining this elegant creature, we may, even with a pocket-lens, discern which are tenanted, by a spot differing from the young clusters in form and colour. Such a spot proves to be the *Proales*, snugly ensconced within the globe, in whose spacious area it lives at ease, and swims to and fro like a goldfish in a glass vase. For the most part it affects the inner surface, engaged in devouring the green Monads that stud the gelatinous expanse, or else eating away the embryo clusters. Sometimes laid eggs are present, with the *Proales*; sometimes eggs alone. The young seems always hatched in a *Volvox*, and, entering an embryo cluster, is expelled with it. Often they eat their way out, and swim at freedom. Observing in a globe one large egg, I opened the globe with a needle, and freed the *Proales*, placing it in water, and adding several *Volvoces*, all untenanted. But it did not enter one, during several hours' observation. During this period it discharged, loose in the water, an ephippial egg, covered with prickles. I have seen a prickly egg and a smooth one, transparent, with eye and jaws visible, in the same sphere. One of the latter I saw hatched, the young just like the adult. The *Volvox* appears to suffer little from the depredations of its ungrateful guest. The *Proales* is lively and energetic in freedom. It glides wildly about, often in a zigzag course, turning from side to side, as it dashes rapidly along. Sometimes it rotates on its axis as it goes; or, becoming stationary, it turns on its blunt extremity, as on a pivot. It is perpetually contracting and elongating, and throwing itself into angular folds and contortions.—P.H.G.]

This is one of the partially loricated Rotifera. The soft front of the head, seen dorsally, is truncate, and much like that of *Notops hyptopus*. The edge of the trunk, within which the head can be withdrawn, is chitinous, and scolloped in regular curves, just like the edge of a lorica. At the hind end of the trunk, and on the median line of the dorsal

[1] See *Phil. Trans.* 1855, p. 432, pl. xvii. figs. 27–31.

surface, is a forked projecting pucker of the hardened skin, so greatly resembling the notch in the lorica of a *Brachionus*, that I thought at first that the structures were identical. Ehrenberg (*loc. cit.*) says that the creature has a minute, and slightly projecting foot; which, as Mr. Gosse has stated above, it certainly has not: but it is clear, from Ehrenberg's description and figure, that he has mistaken the forked pucker which I have just described for a pair of small toes; a mistake easily made when the dorsal surface is presented to the line of sight from a certain point of view. The animal's dorsal outline reminds one of *Notops hyptopus*; which Rotiferon is also partially loricated.

I have often seen one of these little creatures ineffectively nibbling at the gonidia of the *Volvox* which it inhabited; but once I watched one bite its way into what was, I suppose, a softer place than usual; and a moment after I saw a long stream of bright green globules course swiftly through the mastax, down the œsophagus, and into the stomach.[1]

Length, $\frac{1}{215}$ to $\frac{1}{160}$ inch. **Habitat.** Wherever *Volvox* is numerous: London, Birmingham, Leamington, Dundee (P.H.G.); Clifton (C.T.H.).

Genus FURCULARIA, *Ehrenberg*.

[GEN. CH. **Body** *generally larviform, cylindrical, with a tendency to enlargement in the lumbar region; usually compressed;* **front** *conical, broad, and deep;* **eye** *single, frontal, sometimes wanting;* **incus** *forcipate, much developed, protrusile;* **toes** *two furcate, usually conspicuous.*

It is not easy to attach to this genus such a definite character as shall be really useful to the student for identification and diagnosis. Ehrenberg is very vague. He gives but two distinctive points,—the frontal eye, and the forked toes. The latter is worthless, as being indistinctive; and the former is unfortunately not constant, or not always available. Eckstein's character for the genus is really but the character of one species, inapplicable to others. Yet it is a good genus (as used by Ehrenberg, not by Dujardin), and easily recognized in almost all its members, by one who is personally familiar with them. Possessing much resemblance to the species of the extensive genus *Proales*, the *Furculariæ* have an aspect, as well as habits, of their own. Both aspect and habits are more easily detected than described. The front, more or less a low cone of wide base, in vertical aspect, with a minute but usually conspicuous crimson eye set at the very point, with no lateral developments—this is doubtless highly characteristic. So also are the toes, in general strongly marked, very active, and often thrown spasmodically backward, above the body-plane. There is one feature in their habits which is markedly prevalent: the predilection which many of them show for darkling retreats, and the tenacity with which they cling to them. No hare flees to cover more eagerly. Examples will be given in detail presently.

The species are vivacious, energetic, restless, eager, predatory. The strongly developed *rami* of the powerful *incus*, moved by proper muscles, are capable of protrusion from the face of the front, with a fierce snapping action, in which, however, they are rivalled by other kindred genera, such as *Diglena* and *Distemma* in particular. The recognized species are not numerous. Ehrenberg admitted four. To these I have added five others, including the *F. marina* of M. Dujardin (if, indeed, mine is identical with his); but one of Prof. Ehrenberg's has not been yet met with in Britain. They are wide-spread, and are not very uncommon, in the sediment of pools and ditches. Two species which Ehrenberg placed in his great genus *Notommata*, I prefer to place here.—P.H.G.]

[1] Dr. Plate (*loc. cit.*) has described *P. parasita* (*Notommata parasita*, Ehr.), male and female, as a new species under the name *Hertwigia volvocicola*, on account of its having no toes. Dr. Cohn gave an excellent figure of the male in *Sieb. u. Köll. Zeits.* 1858, but drew the female with two minute toes.

F. FORFICULA, *Ehrenberg*.

(Pl. XX. fig. 1.)

Furcularia forficula	. . .	Ehrenberg, *Die Infus.* 1838, p. 421, Taf. xlviii. fig. 5.
"	" . . .	Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 199.
"	" . . .	Lord, *Micr. News*, 1884, p. 235, fig. 27.

[SP. CH. **Body** *stout, straight, nearly cylindrical; broadest at the head, which comes to a frontal point, where is a single red* **eye** *;* **toes** *two, furcate, blade-shaped, acute, decurved, the ventral edge of each notched with two strong teeth.*

The deep sickle-shaped **toes**, having their under-edges notched near the base, readily identify this.[1] Its **form** is nearly cylindrical, slightly thicker in front; the back is sometimes gibbous, viewed laterally. The head forms a short regular cone, whose base is the width of the head, at the apex of which is placed the small but distinct red **eye**. The whole front appears set with cilia, which cause two vortices: a turbid occipital **brain** is visible, carrying the eye at its anterior extremity. In contact with this as usual, is an ample sub-globose **mastax**, with characteristic trophi. A long **œsophagus** leads to the alimentary canal, which has thick granular walls, and bears two large **gastric glands**. At times the dorsal portion of the stomach is inflated into a large clear bladder, which displaces the granular walls around it. As this often appears and vanishes rather suddenly, it has a singular effect. Towards the hinder part the granulation becomes less opaque; but whether there is any division between stomach and intestine has not been clearly seen. A small **contractile vesicle** lies around the base of the foot, and I have sometimes been able to trace the lateral canals and vibratile tags. A small oblong or cord-like **ovary** generally occupies the venter, sometimes dilated into a maturing granulate ovum. Many longitudinal **muscles** are visible, but the contractions and contortions of the animal are so incessant as to render it almost impossible to define them. By these contortions the firm skin is thrown into various irregular angular folds. The **foot** seems composed of two joints, of which the basal is by much the stouter, each enclosing a **gland**. The curved broad blade-like **toes** bend downward at their sharp points; each is cut into a strong projecting sharp tooth at its base, and its foot joint immediately preceding has two teeth exactly similar.

Ehrenberg alludes to this animal as very rare. I have been familiar with it for more than five-and-thirty years, and I consider it by no means uncommon. I used to meet with it in the waters around London, and have since found it in very many localities, often among conferva, and in the floccose sediment of ditches. In confinement it is often most restless, constantly swimming about with a swift gliding shooting motion, and throwing itself into frequent folds and twistings. The body is nearly colourless, but for the opacity of the granulate viscera, which appear white by reflected light.

On repeated occasions I have observed, in this species, the curious habits already referred to of inhabiting tubes, for some unimaginable purpose, of its own ingenious manufacture. I cite the following note from my Journal, jotted down while under my eye. "A fine specimen I found tenanting a long curved passage, in the yellow-brown floccose from the ditch in Sutton Park. This was just wide enough to allow it to move freely, and to turn its soft flexible body, when needed. It was about twenty times the animal's length, outwardly undefined, being but a cavity formed in the irregular mass of accumulated floccose. Within this, semi-transparent in parts, the *Furcularia* was diligently pushing its way from end to end, turning back on itself the instant the end was reached, not showing its nose out in the clear for a moment, and returning on its course; moving with considerable rapidity, never deviating and never resting. But after doing this a long while, perhaps an hour or two, it began to pause here and there, and to move

[1] Ehrenberg describes and figures a species, *Distemma forficula*, of which I know nothing more, with toes closely resembling the above. Only, to judge from his figs., the toes are *recurved* instead of *decurved*, and the notching is on the *dorsal* instead of the ventral edge.

more slowly. I at last picked the sheltering material to pieces with needles in order to be quite sure of the species: for I had not yet had one satisfactory view of it at this time. Yet even then it kept obstinately under the floccose, refusing to come out into the open, even when its tube was torn up." On another occasion, lately, a striking illustration of the fierce appetite of this carnivorous creature occurred to me. One in the live-box was driving to and fro in its eager headlong way, when its course was suddenly arrested. A *Naïs* worm had been wounded, probably by the pliers in taking up the milfoil from the phial, and a cloud of the pale flesh-granules had oozed, and was still oozing, out of its side. The *Furcularia*, aimlessly swimming, had come to the outside of this cloud, and its whole manner was changed instantly. It darted at the mass, snapped and snapped again, turning hither and thither, but not leaving the vicinity. The sharp rapid momentary projections of the head and of the jaws showed how heartily it was enjoying its unexpected meal. This went on for some time; but I was called away, and was compelled to leave my hungry little friend at his dinner.—P.H.G.]

Length, $\frac{1}{85}$ inch to $\frac{1}{100}$ inch. **Habitat.** Around London, Dundee, Birmingham, Hants, Devonshire, and elsewhere (P.H.G): by no means rare.

F. GRACILIS, *Ehrenberg.*

(Pl. XIX. fig. 14.)

Furcularia gracilis . . . . . Ehrenberg, *Die Infus.* 1838, p. 421, Taf. xlviii. fig. 6.

[SP. CH. **Body** *slender, compressed, the ventral line making a prominent angle;* **front** *rounded;* **face** *oblique;* **toes** *slender, straight, acute.*

This well-marked little species is of slender **form**, as its name imports, nearly equal-sided, somewhat compressed, occasionally gibbous at the hind-back, the outline of the belly concave, with a salient angle about two-thirds from the head, whence it abruptly recedes to the short conical foot. The front is rather small, rounded; the face obliquely prone, ample, clothed throughout with cilia. The joints of the **foot** are not readily separable; the toes, furcate, slender, acute rods, almost straight, are about one-fourth as long as the body, and are usually carried parallel. The **eye** is small, but conspicuous, of a vivid crimson, situate as usual in the middle of the very front, at the anterior extremity of the brain. A little wart-like projection is seen on the occiput, which is probably an **antenna**. The **mastax** is long and pear-shaped, containing a strongly forcipate incus, of which the fulcrum is evanescent, with a pair of long incurved mallei. The *rami* seem to reach over in a long descending pair of points, probably accessory to, but distinct from, the glassy *rami* themselves. The latter are frequently protruded from the oblique face, to bite the flocculent matter, adhering to the moss, and to seize atoms with a short snapping action.

I obtained this species in some abundance, near London, in my early researches, among the stems and bracts of a submerged moss. Since that time, it has occurred in widely separated localities, never with any notable variation. Its manners are active, writhing nimbly along with the toes stretched out behind, but now and then, for an instant, widely expanded.—P.H.G.]

Length, $\frac{1}{200}$ inch to $\frac{1}{175}$ inch. **Habitat.** Pools, wide-spread; London; Stapleton Park, Yorkshire; Woolston; Caversham; Cheltenham; Dundee; Oban (P.H.G.).

F. CÆCA, *Gosse.*

(Pl. XX. fig. 4.)

Furcularia cæca . . . . . Gosse, *Ann. Nat. Hist.* vol. viii. 1851.

[SP. CH. **Body** *cylindrical, the ventral line straight;* **front** *round;* **head** *separated by a strong constriction;* **eye** *wanting or invisible;* **toes** *slender, slightly recurved, obtuse.*

This species is much like the preceding: yet it seems sufficiently distinct. The figure is truly cylindrical, with a hemispherical head, and a short conical foot, each divided-off by a strong fold. Both the folds are bounded body-wards by a distinct thickened ring, the anterior by far the stronger; there is a third fainter transverse fold just behind the mastax. The **face** is prone; but its plane is curved, not flat as in *gracilis*. The great obtuse cone which forms the **foot** has but two separable joints, of which the hinder is notched behind, and carries two furcate slender rod-shaped toes, one-third the length of the body, very slightly recurved at the tips, which are rounded. This last character, which may seem unimportant, is, I think, constant.

The whole visible head, in vertical aspect a perfect hemisphere, appears clothed with short cilia, which extend also over the prone face, as far as the great constriction. No **eye** was discernible. The toes are commonly held in mutual contact, the tips often slightly crossed.

The manners were much like those of the other smaller *Furculariæ*; it both crawled and swam, but not swiftly. It was found in July 1850, in the sediment of a phial which had been dipped five days before, from Oldham's Pond, Leamington. A few weeks afterward, I met with another in the same phial, which well sustained my judgment of the distinctness of the species; while it gave me a few additional details. It had an occipital **brain**, but again no trace of eye. The alimentary canal has a pair of minute **gastric glands**; it was traced clearly to the cloaca, which appeared on the dorsal surface of the foot as a minute notch. The œsophagus, a long slender and somewhat sinuous duct, leads from the *back* of the mastax to the stomach. These two examples have furnished all the information that I possess of it.[1]—P.H.G.]

Length of body, $\frac{1}{178}$ inch; of toes, $\frac{1}{858}$ inch; total, extended, $\frac{1}{135}$ inch. **Habitat.** Leamington (P.H.G.); Sandhurst (?) (Dr. Collins).

F. GIBBA, *Ehrenberg*.

(Pl. XIX. fig. 13.)

Furcularia gibba . . . . . Ehrenberg, *Die Infus.* 1838, p. 420, Taf. xlviii. fig. 3.

[SP. CH. **Body** *oblong, slightly compressed, convex on the back, flat on the belly; the gibbosity of the back abruptly falling off steep to the foot;* **toes** *furcate, style-shaped, straight acute, nearly half the body-length.*

For more than thirty years I had assumed that this species was well known to me; when at length I discovered that what I had supposed *F. gibba* was really a loricate form, with a cleft dorsum, presently to be introduced under the name of *Diaschiza semiaperta*. Lately, however, I have met with an animal precisely agreeing with Ehrenberg's description and figure. Yet I judge it highly probable that other observers have, like myself, confounded the common *Diaschiza* with the rare *Furcularia*.

As I have seen but a single example of the real *Simon Pure*, I can add nothing to the published descriptions, except what may be gathered from the figure.—P.H.G.]

F. ENSIFERA, *Gosse*, sp. nov.

(Pl. XX. fig. 3.)

[SP. CH. **Body** *gibbous;* **toes** *simple, blade-shaped, wider vertically than laterally;* **foot-joints** *wanting;* **eye** *wanting.*

I first observed this rather attractive species in July 1885, in water taken from one of my window jars, where aquatic mosses had been growing for several months. The

[1] Except that Dr. Collins, in his Note-book kindly communicated to me, has pencil sketches of what he supposes to be this species, taken at Sandhurst, Berks. Its form, however, is much more gibbous behind than that of mine.

mosses originally came from one of the Scottish lochs, and the ancestors of these Rotifera may have been then introduced. But I constantly rinse out my live-boxes, after an examination, in one or other of my reservoirs; and as I have received samples of water, animals and plants, from many kind friends in various parts, it is impossible to trace the original habitat of any species which either of them may now contain.

In form the present species much resembles *cæca* or *gracilis*; it is, however, larger than either, nearly, if not quite, equalling *forficula* in dimensions. The gibbosity of the back, its abrupt descent to the cloaca, and the peculiar mode of carrying the toes behind, more easily seen than described, are all characteristically Furcularian.

A remarkable peculiarity, that strikes the eye at the first glance in the vertical aspect, is that the **toes** seem to be articulated direct to the trunk, without the intervention of the usual foot-joints. This is not an accidental malformation, but is evidently proper to the species, all the specimens being alike. The toes, too, are wide apart at their bases, the interval being sometimes straight, sometimes running up into an angle (fig. 3). They are in general carried nearly parallel; but they are often stretched so wide apart as to be horizontal, or, on the other hand, crossed. I could detect no eye, nor any brain, nor even turbidity, though I sought diligently. All the examples were brilliantly transparent, but most were tinged with a very delicate shade of canary-yellow, the stomach and intestine usually gorged with food of a warmer hue. The front and face are of a pale orange-tint.

The manners of this species are exactly those of its fellows. In the live-box half-a-dozen congregated under a single leaf of the moss, neglecting other leaves, though there were plenty more, apparently as eligible; and there they kept restlessly moving to and fro, twining and twisting on themselves, *suo more*, beneath the translucent green leaf. The freedom and facility with which they turn round within their own length and breadth is remarkable. It is effected with marvellous rapidity, and with no change of place, but only of *position*. You are looking with a high power at the head or mastax—a twinkle, a dimness—and in an instant you see the toes in the very spot! The creature has turned itself quite round, and is off on its steps.—P.H.G.]

Length, $\frac{1}{150}$ inch; of which the toes make about one-fourth. **Habitat.** The leaves of aquatic moss in a tank (P.H.G.).

F. MARINA, *Dujardin*.

(Pl. XIX. fig. 15.)

Furcularia marina . . . Dujardin, *Hist. Nat. Zooph.* 1841, p. 649, pl. 22, fig. 4.

[SP. CH. **Body** *long, cylindrical;* **toes** *blade-shaped, simple, decurved, pointed, minute;* **eye** *wanting. Marine.*

The great length and uniform thickness of this species, truncate at each end, obliquely in front, transversely behind, distinguish it readily from its fellows. There is a lobulate, pointed glandular **brain** in the occipital region, on which no eye-speck can be detected by either transmitted or reflected light. Behind this are some minute, seemingly isolated bodies, which may be connected with the branchial system. The points of the jaws are frequently pushed out from the oblique front to a considerable distance (fig. 15*a*), and retracted rapidly and repeatedly, with a snapping action. A minute protrusile **antenna** (?), ciliated at the tip, is seen behind the buccal funnel (fig. 15*a*).

It was in August 1854 that I became acquainted with this interesting species, already made known by M. Dujardin in 1841. I had been keeping a small marine aquarium ever since February; but during a two months' absence from home in the summer, most of the creatures had died, and were decomposed on my return. The water, however, remained fairly pure; and I therefore merely removed a good deal of the decayed matter from the bottom, and restocked it, mainly with *Actiniæ*. On the sides of the tank, and in the sea-water, I found this pretty *Furcularia* by thousands, associated with

a species of *Euplotes*, and a few of a *Colurus*. I have since found it repeatedly in sea-water from the Tay Estuary. It is active and sprightly in its manners, browsing among the floccose; frequently elongating and contracting its body, and occasionally swimming in the open water.—P.H.G.]

Length, $\frac{1}{220}$ to $\frac{1}{175}$ inch. **Habitat.** A marine aquarium; tide-pools in the Firth of Tay (P.H.G.).

F. Boltoni, *Gosse*, sp. nov.

(Pl. XX. fig. 2.)

[SP. CH. **Front** *rondo-truncate;* **body** *fusiform;* **foot-joints** *small;* **toes** *conical, about half as long as the foot;* **eye** *small. Lacustrine.*

This species I at first supposed to be Ehrenberg's *F. Reinhardti*, which has not yet occurred to British research; but, on mature consideration, there seem important differences, which warrant my raising this to specific rank. *Reinhardti* is stated to be $\frac{1}{120}$ inch in length, which is not so large as *F. forficula* and *F. gibba*; whereas this is $\frac{1}{62}$ inch in length, and so is a very giant among *Furculariæ*. Then the foot in *Reinhardti* is half the length of the body: in *Boltoni* about one-fourth; the toes in the former are minute, one-fifth to one-sixth the length of the foot: in the latter rather long and slender, full half the length of the whole foot and toes. Ehrenberg speaks of "the great eye" as an attractive feature in his species; but in this, the eye is, as usual, minute and inconspicuous. Lastly, his species is marine, living parasitically on the branching stems of the well-known polype, *Laomedia geniculata;* whereas mine occurred in a pool in the heart of England. Thus I venture to pronounce it new; and honour it with the name of that energetic microscopist, Mr. Thomas Bolton, who sent it to me. It has evidently very close relation with *F. Reinhardti*, as is shown by the general form, and especially the spindle-shaped trunk, and abruptly tapered foot. It is a true *Furcularia*, as to its **trophi**, of which I had a very favourable observation; the *mallei* being slight and feeble, while the *incus* is strongly developed with wide, glassy, arched *rami*, produced into long decurved points.

The **front**, in life, is probably conical, as usual; but in the condition in which alone I have seen the species, the cone was so low that its outline was nearly straight, with a minute but clear red **eye-speck** occupying the very centre of its edge. The mastax is of the usual large dimensions, followed by a slender œsophagus, an ample **stomach** with small oval **glands**, a separate intestine full of dark granulate food, an **ovary** with a great opaque maturing egg, and what I took for a **contractile vesicle**. The trunk is thickest at the lumbar region, and that whether viewed laterally or dorsally. Thence it diminishes rapidly to a width less than that of the head, and carries a **foot** of three joints, of which the first is contained within the trunk-walls, and the others are very small and slender, followed by a pair of furcate toes, which are of a long conical shape, acute, and nearly as long as the three foot-joints together. The whole foot is sometimes thrown up towards the belly.

I first became cognizant of this species in October 1885, a specimen having occurred in sediment collected from a ditch in Sutton Park (a locality most prolific in rotiferous and other microscopic life) by Mr. Bolton and sent to me. The animal was dead, but recently; so that the form was little altered, and the organs were all *in situ*, and readily identified. I subsequently found a second rather smaller example in the same tube of water, also dead; which afforded me the advantage, always to be prized, of an additional study. A sight of the living animal is still a desideratum.—P.H.G.]

Length, $\frac{1}{62}$ inch to $\frac{1}{80}$ inch. **Habitat.** A ditch near Birmingham (T.B.).

F. MICROPUS, *Gosse*, sp. nov.

(Pl. XIX. fig. 12.)

[SP. CH. **Foot** *inconspicuous;* **toes** *minute, conical. No* **eye** *visible.*

This small species, known only by a single example, is much like *F. forficula* in form, but the toes are very small in proportion, being cones whose length little exceeds the breadth of their base. The animal is clear and colourless; very soft and flexible; constantly contracting and lengthening. The anterior parts are somewhat thick, gradually attenuating to the foot, where the width, both transverse and vertical, is less than half that of the head. An occasional glimpse of the side (fig. 12*a*) showed that the **face** was truncate, and obliquely prone; whereas the front viewed dorsally was obtusely conical in outline. But the extreme changeability of form, especially in the fore parts, and the flexibility, were notable. No **brain** could be defined, nor any trace of an eye. Though, according to Ehrenberg's arrangement, this should be a *Pleurotrocha*, if the eye is really wanting, yet the whole habit and form of this creature showed its affinities to be with *Furcularia*. I found the specimen described in water sent me by Mr. Bolton in December 1884, obtained from a boggy ditch in Sutton Park.—P.H.G.]

Length, $\frac{1}{250}$ inch. **Habitat.** A ditch near Birmingham (P.H.G.).

F. LONGISETA, *Ehrenberg.*

(Pl. XVIII. fig. 16.)

Notommata longiseta . . . Ehrenberg, *Die Infus.* 1838, p. 432, Taf. liii. fig. 2.

[SP. CH. **Body** *cylindric, round at each end;* **foot** *thick, one-jointed;* **toes** *twice as long as the body, unequal.*

The cylindric **body** is slightly arched, but retains an uniform thickness. The whole rounded front is ciliate, with a semi-prone face. The **toes**, jointed on a thick cylindric foot, seem made of spun glass, thick at the base, but tapering to great tenuity, though not very acute. The right is about one-fourth longer than the left. The **mastax** and its trophi, *in situ*, closely resemble those of *Furcularia gracilis*; but I have not resolved them satisfactorily. A great **brain** carries an opaque terminal mass at its point. The front, viewed dorsally, has the outline of a low cone, with a single minute red eye at the very point; and now and then I have seen pushed out what seemed minute lateral auricles; yet with no perceptible acceleration of motion. The **contractile vesicle** is very large. There is a prominent angle on the occiput, which may indicate a protrusile **antenna**; but I have not seen it exserted.

I had this pleasing species in 1851, from a dyke near Stratford, and presently afterward from Maidenhead. Recently it has occurred in water from Snaresbrook sent me by Mr. H. Davis, and from Woolston, by Miss Davies. It swims slowly, often turning to one side; occasionally throwing apart the long toes, and springing when alarmed, so as to fling the body more than its own length in an uncertain direction, *the sound* made by the toes striking the glass on such occasions *being distinctly audible.*—P.H.G.]

Length, to tips of toes, $\frac{1}{76}$ to $\frac{1}{150}$ inch. **Habitat.** Pools in the southern half of England (P.H.G.).

F. ÆQUALIS, *Ehrenberg.*

(Pl. XVIII. fig. 15.)

Notommata æqualis . . . Ehrenberg, *Die Infus.* 1838, p. 432, Taf. liii. fig. 3.

[SP. CH. *Indistinguishable from the preceding, save that the* **toes** *are equal.*

Though the resemblance between these two species is very close, Ehrenberg was

certainly right in distinguishing them. Quite accidentally I have had the two in sight at once, side by side, yet without the slightest mutual recognition, and thus had facilities for comparison. *Æqualis* has the body longer and slenderer, more taper, where *longiseta* is gibbous, less divided into apparent joints by constriction, especially at the foot, besides the co-equality of the toes in this. Yet, on the other hand, the gibbosity of the former nearly disappears when extended in swimming, and then they are much alike.

I first saw this species together with *F. longiseta*, and both in some plenty, in water from Woolston, in September 1885. Though the species showed no association, their manners were exactly the same. The springs made by both and by *Scaridium*, with which they have apparent affinity, depend, doubtless, on the length and elasticity of the toes: and suggest a certain relation to the *Triarthradæ*, and even to the order SCIRTOPODA, in which, toes being wholly wanting, the same function is performed by special limbs, long, taper, and elastic.—P.H.G.]

Total length, about $\frac{1}{130}$ inch. **Habitat.** Woolston (P.H.G.).

Genus EOSPHORA, *Ehrenberg*.

[GEN. CH. **Body** *oblong;* **head** *dilated and furnished with protrusile* **auricles**; **foot** *very distinct, with telescopic joints, and furcate* **toes**; **eyes** *three, viz. one large, cervical, two minute, frontal.*

Of the four species which Ehrenberg includes under this genus I know but the one which he has not catalogued in its proper place, but which he subsequently mentioned under the head of *Diglena aurita*. His words are: "Dr. Werneck sent me a drawing of a new *Eosphora*, very like the *Diglena* of Berlin. I found, soon after, in the Berlin animal, a pale red point on the opaque sac in the neck, which makes this an *Eosphora*, if it prove to be an eye" ("Die Inf." p. 444).

Judging by this species, there is little to distinguish *Eosphora* from *Notommata* (proper), except the two minute frontal eyes;[1] and this distinction is evanescent, when we remember in how many species of *Notommata* Herr Eckstein has seen frontal pigment-specks. Yet, looking at the form of the trophi, I consider it intermediate between *Notommata* and *Diglena*.—P.H.G.]

E. AURITA, *Ehrenberg*.

(Pl. XVII. fig. 14.)

Diglena aurita . . .	Ehrenberg, *Die Infus.* 1838, p. 444, Taf. lv. fig. 2.
Eosphora aurita . . .	
" " . . .	Gosse, *Pop. Sci. Rev.* 1863, vol. ii. p. 475, pl. xx.

[SP. CH. **Body** *cylindric;* **head** *separated by a neck;* **front** *slightly convex;* **brain** *an opaque globe at the end of a long slender tube;* **trophi** *forcipate;* **foot** *slender, cylindric;* **toes** *slender, acute, furcate.*

This is an attractive species: its **form** is elegant and symmetrical, particularly when the auricles are everted above the neck; the slender foot and toes well finish the body behind; and the prevalent depletion of the viscera with bright pellucid green food, add brilliancy of colour to the clear glassy vase. To the naturalist, too, it is specially interesting. Far down in the body is a transparent ball, filled with opaque matter, whence a slender tube extends right up the very front: this tube is more or less turbid with like matter. On the ball just where it contracts to the tube is a broad and thick

[1] The frontal specks Dr. Leydig denies to be eyes, in the species *aurita*; but I have no hesitation in pronouncing them to be strictly analogous with what we call eyes throughout the class.

lens of crimson pigment, and at the frontal end of the tube, one on each side of it, are two small crimson globules.[1] All three are beautifully rich and distinct, even by transmitted light. It is indubitably Werneck's *Eosphora aurita*. The **jaws** are quite of the *Diglena* type, but the mallei are stouter, as in *Notommata*: the points are often protruded. A curious feature is that the capacious stomach juts up in two long horns, as high as the top of the mastax, distinct from the **gastric glands**. An **ovary** and a **contractile bladder**, both ample, help to fill the cavity; and the body terminates dorsally in a broad triangular tail, which projects far above the foot, with the cloaca between. On the occipital edge is a minute **antennal tube** and a bristled wart on each side of it. This triple arrangement is peculiar. The manners are usually sluggish.[2]—P.H.G.]

Length, $\frac{1}{125}$ to $\frac{1}{100}$ inch. **Habitat**. Greenwich Park; Hampstead Heath; Birmingham: pools; not rare (P.H.G.).

Genus DIGLENA, *Ehrenberg*.

[GEN. CH. **Body** *sub-cylindric, but very versatile in outline, often swelling behind and tapering to the head;* **eyes** *two, minute, situated near the edge of the front;* **foot** *furcate;* **trophi** *forcipate, generally very protrusile.*

This genus, while Notommatoid in form, has a certain aspect of vigour and intensity of function peculiar to it. Though one or two assigned species are massive, the majority are slender, lithe and energetic; the taper and elongate anterior parts habitually thrown above the general line of progression, in the manner of some lepidopterous and dipterous larvæ, as if eagerly exploring. The form of the trophi, though on the Notommatous pattern, is very predaceous; and the sharp, formidably-armed *rami* of the *incus* can be, and frequently are, thrust far beyond the limits of the head, and forcibly snapped. The front, in most of the species, is furnished with a hooked proboscis. The furcate toes are, in general, long and sharp, sometimes sickle-shaped.

Of the eight species included in the genus by Prof. Ehrenberg, *lacustris*, *conura*, and *capitata* have not been recognised in Britain; *aurita* is an *Eosphora*, and has been just described. To the remaining four, seven species are now added.—P.H.G.]

D. GRANDIS, *Ehrenberg*.

(Pl. XIX. fig. 6.)

[SP. CH. **Body** *massive, sub-cylindric;* **head** *rounded, with a frontal proboscis;* **face** *nearly prone; a tuberculiform tail;* **foot** *large, bulbous;* **toes** *straight, parallel-edged, abruptly pointed.*

Of this imposing species my knowledge for many years was limited to a specimen which I found in September 1851, already dead, in a dyke at Maidenhead. The **trophi** were beautifully distinct. Their structure was nearly the same as in *D. forcipata*, but the bristle-like teeth that line each side of the incus were much more conspicuous, and apparently larger; arranged in double rows. In August 1885, examining an aquatic moss growing in a glass reservoir in my study, I found, first one, and then another, of the same species, alive and active. The agreement in detail with my dead original was exact. Two very minute **eyes**, nearly close together, are at the front, whence projects a small hooked **proboscis**; and below this the ciliate **face** is very prone. The

[1] Eckstein says that these are connected with the great cervical eye by nerve-threads.

[2] Eyferth (*On the Lowest Forms of Life*, 1878) says that *Triophthalmus* of Ehrenberg is but the young condition of *Eosphora*; and that, even in the egg, are seen two dark specks, near the eye, which subsequently disappear. But Eckstein (*Sieb. u. Köll.* 1883) holds this conclusion doubtful, till the entire development from the egg has been watched. He confronts the points of consimilarity with those of dissimilarity in two instructive tables.

brain has a turbid yellowish appearance, at times clearly defined. The **alimentary canal** is very large, darkly granulate, composed of many sacs; and a slender rectum clearly opens into a cloaca below the tubercular tail. Convoluted **lateral canals** run down each side; but no contractile vesicle could be discerned.

The manners are sluggish; it twists and wriggles much, with little change of place. It is a fine large species, not devoid of elegance when extended; but it often contracts into very uncouth shapes.—P.H.G.]

Length, $\frac{1}{35}$ inch. **Habitat.** Maidenhead; an aquarium at Torquay (P.H.G.): rare.

D. GIBBER, *Gosse*, sp. nov.

(Pl. XIX. fig. 7.)

[SP. CH. **Body** *encased in a transparent leathery sheath, hunch-backed;* **face** *prone; frontal* **proboscis** *small;* **toes** *long, decurved.*

In sediment from one of my window-reservoirs, I found this large *Diglena*. About the size of *D. grandis*, it much resembles that fine species in general appearance. Its **form** is that of a cylinder, flattened along the belly; the entire soft parts are encased in what we might call a *lorica*, only that it is manifestly flexible: a difference, perhaps, merely in degree. This sheath, of a glassy transparency, is almost unchangeable in shape; yet it has marked creases here and there, which are permanent, serving for needful flexibility. At what might be called the shoulders, it rises to a conspicuous conical hump, diminishing thence by a gradual slope to the hinder parts. The internal organs do not rise above the cylindrical body-wall, leaving thus an ample cavity within the sheath all down the back; quite empty, save that a very delicate conglobate gland, attached by a thread to the hinder extremity, works up and down within it, by the contractions and contortions of the animal. What seemed the trochal front was, through the inclination of the head, nearly on the level of, and continuous with, the ventral surface, and was covered with vibratile cilia. Behind, the body-sheath is cut off obliquely, with a well-marked edge, for the emission of a stout **foot**, which carries two long curved blade-like toes, often thrown widely apart. On each toe, at about one-fourth of its length, there is an abrupt decrease of diameter on its superior edge, with the appearance of a joint; and a delicate line crosses each near its point.

This individual appears to have been subjected to the remarkable accident of the protrusion of the entire mastax, with all its accessories, from the frontal face, so that it was totally unable to retract it. Whether this was the result of over-eagerness in feeding, producing unguarded muscular exertion, or of violence from some of its predatory foes, I cannot guess. I could discern no mark of any pinch on the body. But there was a great extruded mass of flesh, amorphous and motionless, yet bearing a manifest resemblance in outline to a mastax: while in an occasional glance that I could get at its front, I saw what looked exceedingly like a long incus and a hooked malleus on each side, though only the bottoms of these organs could be shaped, and that very vaguely. Besides, there was not a trace of mastax to be seen within the head, for I searched carefully for it; the protruded mass was just where it would be, if such a misfortune had occurred; there was a conspicuous constriction behind the mass, evidently preventing retraction; while the mass was apparently of definite and unyielding shape, containing hard and lengthened organs. The frontal disk, both above the mass and also to a small extent below it, was covered with cilia in rapid, but feeble vibration; no whorls were produced in the surrounding floccose; no swimming or crawling progress was made by the animal; though it constantly contorted its body, and threw about its toes. Its vital power was manifestly stricken, and even the movements gradually grew feebler and feebler. I had not detected the slightest motion within the (supposed) mastax; its nerves had been probably paralysed at once. But fragments of the floccose sediment kept on adhering to the exposed parts, as if these were glutinous; and this was more manifest at first than after some time. From the summit of the front a minute finger-like proboscis descends.—P.H.G.]

Length. Of head and body, $\frac{1}{100}$ inch; of toes, $\frac{1}{250}$ inch; total length, about $\frac{1}{72}$ inch; vertical height at hunch, about $\frac{1}{250}$ inch. **Habitat.** An aquarium (P.H.G.).

D. FORCIPATA, *Ehrenberg*.

(Pl. XIX. fig. 2.)

Diglena forcipata . . . Ehrenberg, *Die Infus.* 1838, p. 443, Taf. lv. fig. 1.

[SP. CH. **Body** *cylindric, rather stout, obtuse at each end;* **face** *long, prone;* **trophi** *typically forcipate;* **toes** *scythe-shaped.*

This is one of the imposing species; stout, though more larva-like than either of the foregoing. The integument is again firm and thick, and forms tranverse folds, which are constant. The bluntly-tapered **head** carries the usual decurved fleshy proboscis, whence the ciliated **face** descends in the ventral plane to a length about one-third that of the body. A turbid **brain** descends far down the occiput, and bears two minute **eyes** on the very frontal edge. The **mastax** and jaws show a fine development of the form normal in this genus,[1] and perhaps they could nowhere be studied with greater advantage. The digestive apparatus differs little from that of *D. grandis*, or other species, but there is here no projection above the cloaca. The **foot** is large and bulbous, severed from the body by one of the strong folds; it bears two toes, which are stout, shaped like the blade of a pocket-knife or scythe. A large **contractile vesicle** occupies the lower abdomen, which appeared strangely divided into two by a strong constriction. Small vibratile tags were seen on attenuate threads running down each side.

I made acquaintance with this species, crowding the edges of a jar of water dipped from the "Black Sea" at Wandsworth, in January 1850. It was active, but little given to locomotion. Its numerous cilia are in constant agitation, and appear pale blue by reflected light; while the minute ruby-like eyes sparkle on the colourless body, the turbid parts of which are like whitish clouds. What I have called the proboscis may possibly be a broad lip, for it is visible only from the side. The wide spread of the toes is characteristic.[2]—P.H.G.]

Length, $\frac{1}{85}$ to $\frac{1}{72}$ inch. **Habitat.** Domestic aquaria near London, and Torquay (P.H.G.); Sandhurst, Berks (Collins).

D. CIRCINATOR, *Gosse*, sp. nov.

(Pl. XIX. fig. 4.)

[SP. CH. **Body** *slender at each end, gibbous in the middle;* **proboscis** *acute;* **mastax** *moderate;* **toes** *slender, strongly incurved.*

The fore parts are slender and nearly cylindrical (but flattened on the oral surface), swelling somewhat suddenly to a great ovate body, gibbous on the back, but flat on the belly; and as suddenly diminishing behind to a rather thick and short **foot**, which carries a pair of toes, each one a very regular quadrant of a circle in outline, broad at the base, running off to a very fine point. These toes are decurved, and also incurved towards each other, like the legs of a pair of calliper-compasses; and often thrown widely apart. The skin is very flexible, and, as the animal is every moment lengthening and contracting, and throwing itself into the most varied contortions, makes many irregular folds; yet the form delineated always recurs, and is evidently characteristic. The under surface has a remarkable projection (fig. 4*a*), pointing obliquely backward, more or less conspicuous, visible sometimes on each side in the dorsal aspect (fig. 4). This seems the limit of the ciliated face. The very front is furnished with a hook, which is capable of being thrown forward, as if hinged or jointed; and apparently sidewise also, for it is occasionally glimpsed for an instant, at either side of the head. This process is not a bent finger, but a regularly curved hook, hard and sharp-pointed. After a while

[1] They are described and figured in my Mem. "On the Mand. Org." (*Phil. Tr.* 1856) 435, figs. 50, 51.

[2] The animal described and figured by Mr. J. E. Lord (*Microsc. News*, 1884, p. 146, figs. 23*a*, *b*, *c*) is, I have little doubt, the present species.

the slender fore parts were retracted, and then from the gibbous body was seen projecting a curious little puckered bundle of transparent flesh and skin, as shown at fig. 4*b*.

This species I first found in the sediment of one of my indoor tanks among decaying conferva and milfoil: this was in June 1885. Afterwards it occurred again in a tube sent from Dundee by Mr. Hood. All the features were exactly the same as before; but this was more impatiently restless. I *thought* I saw a pair of frontal **eyes**, but I could not be quite positive. In a brief quiescence I made a careful study of the trophi, whose points are in contact with the very skin of the front.—P.H.G.]

Length, $\frac{1}{130}$ inch. **Habitat.** An aquarium at Torquay; Dundee (P.H.G.).

D. GIRAFFA, *Gosse*, sp. nov.

(Pl. XIX. fig. 9.)

[SP. CH. **Body** *slender, necked;* **eyes** *distinct, frontal, protuberant;* **toes** *slender, straight.*

This form, having some resemblance to *D. circinator*, differs from it, not only in the more marked neck, but in the toes being quite straight instead of circularly curved. For, though this may seem an unimportant character, I think the form of the toes will be found to present remarkable constancy in the same species. In *circinator* I could not be certain of **eyes**, but in this species they are well-marked, though minute, of dark hue, situate on the very front of the head, so close to the skin as to be prominent as tiny black warts on the surface. The **head** is small, and its connection with the body is by a sort of neck which can be greatly lengthened and attenuated, as the animal makes its frequent explorations through the free water in all directions, feeling about, very much as an earthworm does in the air. For this the skin is very flexible and versatile. The **abdomen** is tumid; but not so abruptly gibbous as in *circinator*. The **foot** is taper, and the toes moderately long, straight in every direction, not blade-shaped, but regularly diminished to great slenderness, and very fine points. There is no tail. Beneath the eyes the front forms a well-marked **proboscis**, which takes the shape of a decurved hook. At times this appears of equal thickness throughout, and blunt, or even truncate; then it is distinctly seen in the same individual much lengthened, and tapering to a fine point. Can the terminal part be protrusile? The ciliated **face** is quite prone, and appears to run far back on the ventral surface, where a chin-like prominence indicates the end of a ciliated furrow. (See *Diglena forcipata*, fig. 2*a*.) The skin, though flexible, seems very strong; it is continually thrown into folds by the unceasing contortions and contractions of the animal; it looks leathery, but is perfectly colourless and brilliantly transparent. It is a lively, vigorous, attractive creature; pushing among the sediment, occasionally swimming with a smooth gliding motion.

I found another specimen in the same water, exactly agreeing with the above. It had the odd habit of forcibly contracting the foot, and throwing back the toes, as far as the tapering outline of the body would allow; and then protruding the foot with a jerk, bringing the toes at the instant to a right-angle with each other, and therefore horizontal; immediately repeating the curious action; and so for fifty times together. When swimming glidingly, it will suddenly quicken its pace an instant, and make a sensible snap, as if it seized something; and this again and again; though my eye could detect no atom in the clear water.—P.H.G.]

Length, $\frac{1}{100}$ inch. **Habitat.** Woolston (P.H.G.): rare.

D. CAUDATA, *Ehrenberg*.

(Pl. XIX. fig. 8.)

Diglena caudata . . . Ehrenberg, *Die Infus.* p. 445, Taf. lv. fig. 6.

[SP. CH. **Body** *cylindric, long, slender;* **front** *broadly truncate, with two frontal colourless* **eyes**; **foot** *short, very thick, with two long straight slender toes.*

It is excessively versatile and variable in form, constantly contracting into inde-

scribable shapes (of which fig. 8*b* may serve as an example), with various sharp folds and angles. Yet it may be said to have a characteristic form, which is sub-parallel-sided viewed dorsally; but which, viewed laterally, is narrow for the anterior third, where it rises abruptly to nearly double the height. This is generally maintained to the end of the trunk, where it descends with even a sharper angle to give emission to a thick foot, carrying two long, straight, slender, acute toes. The **front** is unusually wide and truncate, viewed dorsally; but laterally, it is seen to project into the usual fleshy hook, which is probably sensitive, and used to collect and test food. The ciliated **face** is almost prone; behind this is an ample mastax with jaws of the normal pincer-form. The viscera present nothing noteworthy. The whole animal is of crystalline clearness; and is devoid of colour, so far as I have seen. The **eyes**, too, if eyes they are, are two colourless globules of considerable size and of somewhat irregular outline, placed wider apart than in Ehrenberg's figure, at the very front. The **toes** are long, tapering regularly to produced acute points, but slender throughout and quite straight, whereby they differ from those of *clastopis*. They are frequently thrown forward suddenly to more than a right-angle. (See fig. 8 and Ehrenberg's fig. 4.) The lumbar fold of skin is often strong and sharp; but there is no projection really answering to a tail; and the specific name is a misnomer. I examined two specimens in September 1885, from water which had stood on my table about four weeks, originally from Woolston Pond.—P.H.G.]

Length. About $\frac{1}{17\frac{1}{2}}$ inch. **Habitat.** Woolston (P.H.G.); Sandhurst (Collins).

D. PERMOLLIS, *Gosse*, sp. nov.

(Pl. XIX. fig. 11.)

[SP. CH. **Body** *extremely soft and versatile in form, swollen in the middle, broad and truncate in front, tapering behind to a thick and long foot;* **toes** *two furcate, slender, acute.*

I am conscious that the above is an unsatisfactory diagnosis of what I am sure is a distinct form. In a tube dipped from a fresh-water loch by Mr. Hood, containing a few leaves of milfoil thickly studded with *Rhizota*, I found a Notommatoid creature, certainly new to me, and apparently undescribed. Its most salient character was its excessive softness, as if it had no skin at all, but were a lump of mere jelly, yet intensely active and restless, swelling and contracting, lengthening and shortening, twisting and infolding, without the slightest intermission, for more than two days while under observation. All this made it quite unlike any other Rotiferon I had ever met with. The slender **toes**, at the end of a rather large foot, are very mobile, ever thrown about to their utmost, or suddenly brought point to point with a snap; in this specimen they had the remarkable peculiarity of what looked like a minute terminal joint, like a separate claw, which, however, was not apparent in other examples. The **front** is widely truncate, composed of many globose transparent cells; from the midst of which projects the usual soft triangular **proboscis**. The ciliated **face** below this is prone, whence frequently the trophi,—an incus with circularly forcipate rami, worked by long mallei,—are protruded with energetic snaps and snatches. Below the mastax is a vast **alimentary canal**, consisting of nucleate cells; an **ovary** of embryonic vesicles occupying the venter. I could not detect any **eye-spots**; but a rather short **brain** filled the occiput.

I subsequently obtained other examples from the same quarter. In one was a large **contractile vesicle** which I saw discharged, but I could not time its period. The corners of the front, when rotating, have almost the appearance of auricles.—P.H.G.]

Length. About $\frac{1}{130}$ inch. **Habitat.** A pool near Dundee (P.H.G.)

D. CLASTOPIS, *Gosse*, sp. nov.

(Pl. XIX. fig. 5.)

[SP. CH. **Body** *cylindric, long, slender;* **front** *rounded, without visible hook;* **foot** *long, slender, with two long decurved toes.*

I am not quite clear whether I ought to name this form. But, assuming that the cluster of unequal-sized and irregular-shaped red specks, resembling the fragments of crushed rubies, at the very front of the head, represents two frontal **eyes**, I place it in this genus, especially as the trophi appear to agree with those of the slenderer *Diglenæ*, and there is much similarity to them in general contour and conformation.

Its **shape** is long, thin, and nearly parallel-sided, viewed dorsally (fig. 5), abruptly narrowed to a very slender foot, and long, thin, acute, decurved toes. Laterally (fig. 5*a*), the lumbar region is gibbous without any marked fold. The eyes, resembling broken fragments, as said, are placed at the very front; and are conspicuous, even in the swift shootings of the animal. The front descends to a blunt angle, which may be the anterior point of a prone ciliated face. I could discern no fleshy hook. I did not detect the **brain**; but behind the mastax were two opaque globules, which seemed not to be eyes, but were possibly chalk-masses, smaller, and more shapely, than usual. A very long **alimentary canal** reached far down the cavity, well filled with food of various tints, accumulated in many dark nodules, which imparted to the animal in its movements a very peculiar spotted appearance. Most of the internal structure is as yet undefined.

This is one sample of the very rich harvest of species that I reaped out of a small bottle procured for me from Sandhurst Wood pool, by Dr. Collins, in June 1855. Though I had the specimen under my eye for an hour or more, I could scarcely, in all that time, find it still long enough to permit me to turn to the paper, in order to delineate it; and if I did, I was almost sure to lose it out of the field, to find it again with difficulty. It is swift and headlong in its course, shooting through the free water rather than swimming, and only now and then entering a cloud of floccose sediment, to push, with persevering violence, a way through it.

Only this single example has been subjected to examination.—P.H.G.]

Length, $\frac{1}{175}$ inch. **Habitat.** Sandhurst, Berks (P.H.G.).

D. CATELLINA, *Ehrenberg*.

(Pl. XIX. fig. 10.)

Diglena catellina . . . Ehrenberg, *Die Infus.* 1838, p. 444, Taf. lv. fig. 3.

[SP. CH. **Body** *cylindric, short, abruptly truncate at each end*; **toes** *short, straight acute, projected from the ventral side, at a right-angle to the body-axis.*

This plump, sturdy little creature occurred among my earliest researches in the summer of 1849. It is a true *Diglena*, yet is very dissimilar to its fellows, replacing their long, lithe slenderness by a short thick body, having strong skin-folds, often quite abruptly truncate before and behind. Now and then, indeed, a bluff rounded head is pushed out, carrying two **eye-points** at its front, and a ciliated face, hardly prone. From the broad square stern, a small **foot** projects at the lower margin, and two small, slender, acute toes, pointing downward, serve the creature for support and for locomotion. The internal organs are little noteworthy. There is a large **occipital brain**, and an enormous mastax, of which the jaws are normal.

Ehrenberg describes this tiny species as both marine and lacustrine. I have found many specimens from tide-pools in the Tay estuary, collected by Mr. Hood.—P.H.G.]

Length, $\frac{1}{250}$ to $\frac{1}{175}$ inch. **Habitat.** A garden near London; a pond at Snaresbrook (P.H.G.); Sandhurst (Dr. Collins); marine tide-pools in the Firth of Tay (P.H.G.).

DIGLENA (?) BIRAPHIS, *Gosse*.

(Pl. XIX. fig. 3.)

Diglena (?) biraphis . . . Gosse, *Ann. Nat. Hist.* vol. viii. 1851, p. 200.

[SP. CH. **Body** *oblong, the head and abdomen gently swelling*; **toes** *long, slender, straight, and perfectly even in thickness*; **eyes** *placed close together frontally*; **jaws**

protrusile; **alimentary canal** *very large, projected behind and above the mastax, always filled with green matter.*

This is an animal of no inconsiderable size, which has the technical characters of *Diglena*, but has little affinity with that genus, in structure or manners. My first acquaintance with it was in October 1849. A filamentous plant, growing in a pan sunk in my own garden, was thickly covered with a floccose matter, inhabited by numbers of *Stentor polymorphus*. Among them were specimens of this *Diglena* (?). In January 1851, I again found it in the same water, and on a subsequent occasion; but I have never met with it since.

The **form** is gracefully swelling and vase-like, not at all resembling a *Diglena* in appearance; it has much the aspect of being loricate, but it is not. Two **eyes** are placed at the extreme front; small, so close together as to be readily mistaken for one, brilliantly crimson. The transparent **mastax**, *in situ*, shows a pair of incurved strong pincers, whose approaching tips are two-toothed. These can be extended from the front for half their length, and seem to be a formidable instrument for seizing prey. These are, no doubt, the *rami* of an *incus*. What appears remarkable is that a great saccular lobe of the stomach runs up behind the mastax into the occiput, and divides into two lobules. The whole alimentary canal, with these lobes, was, in every example, uniformly filled with round green granules, the exact similarity of which to the component granules of the *Stentors* and the *Loxodes*, which abounded in the same water (together with various species of *Euglena*), suggested that the normal food of the Rotiferon may consist of the juices of these Polygastrica, especially as its formidable forceps seems to indicate carnivorous propensities. The long straight rod-like **toes** are now and then turned up, so as to incline over the back; occasionally their tips are crossed.—P.H.G.]

Length, $\frac{1}{100}$ inch. **Habitat.** A garden-pan near London (P.H.G.): rare.

Genus DISTEMMA, *Ehrenberg.*

[GEN. CH. **Body** *more or less cylindric, long, slender before, swol'en behind, versatile; two cervical* **eyes**; **front** *furnished with a fleshy* **proboscis**; **toes** *two, furcate.*

This somewhat obscure genus Ehrenberg constitutes on four species. These, however, must be reduced to two: for *D. setigerum* clearly belongs to the family *Rattulidæ*; and *D. marinum* is one of the *Loricata*. The others I have not met with. But I enumerate three species, apparently undescribed, which seem to come into the genus.

In aspect and manners they closely resemble *Diglena*, especially in their long, lithe, versatile forms, generally swollen behind; in the presence of soft tentacular appendages to the front; in the forcipate form and protrusile character of their trophi; and in their fierce raptorial habits. The species inhabit the sea and fresh waters.—P.H.G.]

D. RAPTOR, *Gosse*, sp. nov.

(Pl. XIX. fig. 1.)

[SP. CH. **Body** *long, gibbous behind, very changeable*; **front** *with a long projectile* **lip**; **foot** *short*; **toes** *small, slender, decurved. Marine.*

The lithe flexible **form** is usually lengthened, slender in the middle, becoming high behind, its outline descending in an abrupt curve to the very small **foot.** This is armed with two toes, whose thickness tapers abruptly at the middle (fig. 1*c*). It is near *D. forcipatum*, but is distinguished by this peculiarity of the toes, and by their curvature. And it is marine. The head is rounded, the front produced into three fleshy ciliate points, and a conical projection on each side. The central point is probably the tip of a curious fleshy process, which is now and then rapidly pushed out and in (figs. 1, 1*a*), quite straight, thus differing from the proboscis of *Diglena*. The lateral projections, when this

lip is retracted, close against each other, as in *Dinocharis*. The median line of the dorsum makes a sharp roof-like angle, especially at the lumbar part, but does not rise to a ridge. **Eyes** are sometimes clear and distinct, one on each side of the mastax, wide apart, highly refractile, very pale red, but well defined; but in some specimens they are quite invisible. The **trophi** consist of an *incus*, with *rami* broad and circularly forcipate, on which work slender bowed *mallei* (fig. 1*b*). The mastax is often retracted below the middle of the body; then the animal will suddenly elongate, and the mastax will be driven forward and backward, rapidly and far, the rami snapping fiercely. This snapping snatching action is very observable. Sometimes the mastax is, fully half or more, protruded from the front, and this again and again in rapid succession, the jaws giving a short snap at each time. It is incessantly restless, sudden and rapid in its contractions and turnings, yet not very locomotive, remaining long anchored to the glass by the toe-tips, swaying to and fro, much like a *Monostyla*, often stretching the toes apart.

I owe my acquaintance with this interesting form to Mr. John Hood, of Dundee, who, lately, at my request, searched for marine Rotifera. He presently sent me contributions of sea-water, from the estuary of the Tay, in which I found many species. Among the stems of a conferva this new *Distemma* was pushing and snatching.

It seems tenacious of life. The individual first observed lived in a live-box, containing a thin pellicle of water, for parts of three days, during which other Rotifera, its associates, had one by one succumbed. Perhaps from hunger, this specimen roamed incessantly through the clear water, snapping at every atom, now and then seizing a small diatom, and drawing it into the buccal funnel, to reject it instantly. The jaws were protruded and retracted every moment with lightning-like rapidity. Now and then a tiny cloud of floccose would be dragged in and chewed eagerly, then forcibly ejected. The force and energy displayed by so small an atom was remarkable. The sight seems to have a very small range. This one seized and devoured many Monads and even large Protozoa; but it seemed to have no power of discerning them till they were close to its head; then the action was prompt enough.

The highest expression of animal life that I have observed among Rotifera is this little obscure *Distemma*. As a fowl picks up minute atoms of food from the earth and pebbles and rubbish with which it is mingled, showing sight, observation, discrimination, selection, will, so does this *Distemma* manifestly snap up its food-atoms, often invisible to our eyes, selecting them[1] with rapid precision from other surrounding atoms. The jaws are thrust out and withdrawn, as I have said, with a quickness which we cannot follow, and with stroke succeeding stroke, quite as rapidly as a hen's beak picks its morsels, and evidently takes something at each. The way in which it pounces upon animacules that we *can* discern, and the energetic vigour with which it seizes them, are admirable, and quite unparalleled among Rotifera, so far as my experience goes; and there is hardly a species described in this work that has not come under my observation. If we could descend to his level, and form a personal acquaintance with him, I am sure we should find this *Distemma* a person of great decision of character.—P.H.G.].

Length, (as in figs 1, 1*a*) $\frac{1}{130}$ inch. **Habitat.** Tay-mouth: tide-pools (J.H.).

D. COLLINSII, *Gosse*, sp. nov.

(Pl. XVIII. fig. 13.)

[SP. CH. **Body** *cylindric, long*; **head** *large*; **foot** *stout*; **toes** *two, furcate, long, slender, unnotched, acute. Lacustrine.*

This species is known to me only by a drawing in Dr. Collins's Note-book. It is represented with a long body, a head of increased diameter, a stout foot, and two toes,

[1] "The power of choice is the distinctive peculiarity of a *mental* being." "All activities that are indicative of choice [except reflex actions] are indicative of consciousness. Wherever we see a living organism apparently exerting intentional choice, we may infer that it is conscious choice; and therefore that the organism has a mind."—Romanes, *Ment. Evol. in Anim.* pp. 47, 17.

which are thick, decurved at the tips, and of a length *equal to one third of the whole animal* when extended. The pencil-sketch has not many details of organisation.

The only note which the observer has added is the following :—" It has the power of drawing-in the first joint of the foot into the interior of the body ; and has a peculiar manner of separating the pair of curved toes."—P.H.G.]

Length. Unrecorded. **Habitat.** Sandhurst, Berks (Dr. Collins).

D. (?) LABIATUM, *Gosse*, sp. nov.

(Pl. XVIII. fig. 12.)

[SP. CH. *Slender, long, gibbous ;* **front** *furnished with a protrusile* **lip** ; **foot** *long, with two minute furcate, virgate* **toes.**

Beyond what the mere outline suggests, as conveyed in the figures, I can give little information concerning this species. With much doubt I place it in the present genus ; and that only on the possibility that two obscure spots, dimly seen in the neck, may have been **eyes.** They may have represented the **trophi.** In fact my knowledge of this form rests on a single brief observation. I was examining an aquatic moss, which Dr. Collins procured for me in June 1885, when this little creature glided out. I saw in a moment it was new to me, but my attention was already occupied. There were in that live-box, at that instant, three or four Rotifera unknown to me ; as many papers were before me, on which I was labouring to reproduce the portrait of each, feature by feature, as I could catch it. Here was one more. It was a complete *embarras des richesses.* What could I do ? I hastily threw in the outlines here given, careful to secure correctness in what was produced, but deferring minute examination in the hope of seeing it again ; while I pursued the study of those already in hand. The present subject, however, found speedy concealment among the moss, and I could find it no more ; nor has it ever reappeared. The **form,** particularly in the lateral aspect, recalls the *outré* shape of *Notommata caudata,* with its long neck, elevated back, and slender foot ; but the resemblance is only superficial. Its chief peculiarities are—(1) a slender parallel-sided, squarely-truncate **proboscis** or lip, projecting medially from the front, which is seen in the side view to be somewhat low in position ; it seemed retractile to some extent ; (2) a long, slender, and tapering **foot-joint,** furnished with a furcate pair of toes, very minute, *of equal thickness* throughout, obtuse ; like tiny pegs.

I can find nothing in Ehrenberg with which satisfactorily to identify it.—P.H.G.]

Length. About $\frac{1}{150}$ inch. **Habitat.** Sandhurst, Berks (P.H.G.).

[N.B.—In Dr. Collins's Note-book are pencil-sketches of an evidently large animal, which may possibly be the *Triophthalmus dorsualis* of Ehrenberg. I have carefully copied the sketches (Pl. xviii. figs. 14, 14*a*) ; but the details are not sufficient for diagnosis ; and there are no descriptive notes. I have not myself met with anything like it. —P.H.G.]

CHAPTER X.

PLOÏMA

(LORICATA).

How much weariness has there been in the human race during the last fifty years, because the human race cannot stop politically where it was, and, finding no rest, is pushed to a strange future that the wisest look forward to gravely, as certainly very dark, and probably very dangerous! Meanwhile have the bees suffered any political uneasiness? have they doubted the use of royalty, or begrudged the cost of their Queen? Have those industrious republicans, the ants, gone about uneasily seeking after a sovereign? Has the eagle grown weary of his isolation, and sought strength in the practice of socialism? Has the dog become too enlightened to endure any longer his position as man's humble friend, and contemplated a canine union for mutual protection against masters? No! the great principles of these existences are superior to change; and that which man is perpetually seeking, a political order in perfect harmony with his condition, the brute has inherited with his instincts.

P. G. Hamerton. *Chapters on Animals.*

Presumption is our natural and original disease. Man withdraws and separates himself from the crowd of other creatures; cuts out the shares of the animals, his fellows and companions; and distributes to them portions of faculties and force, as himself thinks fit. How does *he* know, by the strength of his understanding, the secret and internal motions of animals?—Montaigne.

CHAPTER X.

Sub-Order LORICATA.

Integument *stiffened to a wholly, or partially, inclosing shell;* **foot** *various.*

Family XI. RATTULIDÆ.

[**Body** *cylindric or fusiform, smooth, without plicæ or angles; contained in a* **lorica** *closed all round, but open at each end, often ridged;* **trophi** *long, asymmetric;* **eye** *single, cervical. Generally subject to abnormal conditions.*

This family comes first in the Loricate sub-order, because the loricate structure is in varied condition; for, whereas in some species it is indubitable, in others, which yet cannot be severed from these, the integument is still thin, flexible, and membranous. Ehrenberg, indeed, while he assigned *M. carinata* to the Loricata, removed his genus *Monocerca* far away to Il-loricata. Yet that *carinata* and *rattus* are congeneric cannot be doubted by anyone who knows both; *bicornis* certainly goes with the latter. The sausage-shaped species have many family affinities with these; though subdivisible *inter se*. The peculiar form of trophi represented in figs. 60–62 of my Memoir "On the Manduc. Organs" runs with little variation through all.

The most curious peculiarity in the family is its tendency to asymmetry, which appears in many organs. In the mastax the right malleus always differs from the left; when there is an elevated ridge on the dorsum, it is apt to be bent over on one side, and, instead of running straight down the middle, to pass slantwise from right to left; when two antennæ are present they are unequal. The toes, sometimes normal, are often reduced to a single style, with minute sub-styles grouped around its base. In other cases they are modified in a most unprecedented manner, described under the genus *Cœlopus*. On the whole, it is a group of very peculiar interest, both to the scient and to the intelligent seeker for amusement.—P.H.G.]

Genus MASTIGOCERCA, *Ehrenberg*.

[GEN. CH. **Body** *fusiform or irregularly thick, not lunate;* **toe** *a single style, with accessory stylets at its base;* **lorica** *often furnished with a thin dorsal ridge.*

The terminal style is by no means a tail, but a true **toe**, however modified. The homology of the sub-styles is not clear. The surface of the body is usually smooth and polished, often elegantly tapered; nor does the thin elevated carina of the dorsum materially interfere with this elegance, which the long taper toe admirably finishes. This organ, though inflexible throughout, is capable of rapid and sudden motions, being bent right and left, and whisked to and fro with great agility. The **mastax** is usually pear-shaped and very long, but the œsophagus, a sinuate duct, leads from it almost at its very summit occipitally, just where the mallei work upon the incus. Thus the great length of the mastax does not intrench on the needful length of the stomach, since this viscus begins far forward. The **muscles**, in many species, especially the transverse series, have been well resolved. Muciparous **glands** are richly supplied. Surprise is often felt that Rotifera with but a single style should be able to maintain so firm a hold upon

glass as to resist the force with which the surrounding water is carried up into a pipette by the pressure of the atmosphere. It is doubtless by the adhesive power of the clear glue secreted and poured out by the oblong foot-glands. In *Mastigocerca* this may often be seen running down the outside of the toe, its production seemingly subject to the animal's will. When first put into the live-box, it is commonly poured forth abundantly, so as to accumulate around the point, and to drag in a thick glairy stream behind it. I have seen it surround the terminal half of the spine to a thickness four times as great as that of the spine itself. Or it will run from the base downward, like a thick spiral cord. Sometimes it is not perceptible. The **male** has not been detected in the family. —P.H.G.]

M. CARINATA, *Ehrenberg*.

(Pl. XX. fig. 7.)

Mastigocerca carinata . . . Ehrenberg, *Die Infus.* 1838, p. 460, Taf. lvii. fig. 7.

[SP. CH. **Body** *long-oval;* **lorica** *ridged;* **ridge** *high, arched, reaching to middle of body;* **toe** *straight, equal in length to body-and-head;* **sub-styles** *very minute.*

The height of the dorsal **ridge** is very characteristic in this familiar species, rising, in the midst of its length, to fully half of the vertical thickness (*i.e.* from back to breast) of the body. Its cessation, too, just beyond the middle of the back, gives a peculiar humped outline to the forepart, viewed laterally. The belly-line is about equally curved with that of the back. The ridge, as already observed, is not set-on straight down the dorsal centre, but on a line that slants considerably to the left, while in its elevation it leans over to the right. It is manifestly hollow along its base, for the viscera may often be seen extending into it for a little way. It is marked on its basal part, through its length, with close-set corrugations. The front is rounded, with many minute eminences, on which the cilia, which make two distinct vortices, are set; they increase in size and height to the occiput, where an **antenna** projects, capable of being erected or inclined. A long occipital **brain** carries a rather large bright-red **eye**, set like a wart at its interior lower angle. The **mastax**, a pear-shaped bag, is enormous, reaching, from the front, half the body-length. It contains an incus with a slender straight fulcrum, the rami of which are obsolescent and the alulæ very large, and two bent mallei, unequal in size and form. There is a very small **contractile vesicle**, whose period is shorter than I have observed in any other Rotiferon, twenty-five times a minute. The distension of the viscera conceals the branchial vessels, but I have seen one **vibratile tag**.

The **foot** consists of an ovate bulb, to which is jointed the toe as a slender spine in the midst of two or three bract-like accessory styles, one of which is slightly longer than the others, distinctly moveable. The toe moves in all directions except backwards.—P.H.G.]

Length. Of lorica, $\frac{1}{150}$ inch; of toe, $\frac{1}{150}$ inch; depth to summit of ridge, $\frac{1}{250}$ inch.
Habitat. Pools; generally distributed: common.

M. LOPHOESSA, *Gosse*, sp. nov.

(Pl. XX. fig. 10.)

[SP. CH. **Body** *long-oval; dorsal* **ridge** *reaching to the foot, nearly uniform in height;* **toe** *straight, two-thirds as long as body;* **sub-styles** *one-third of toe-length.*

This I think a well-defined species. The **ridge** attains nearly to as great a height as in *carinata*, and is continued to the base of the foot. Its outline runs in several arches, and descends rather abruptly at the end. It is marked with faint radiating corrugations. The principal **toe** is a straight slender style, gradually tapering to a fine point, as in *carinata*, but not quite so long in proportion; and the accessory styles, of which I could discern two, are of unequal length, the longer equalling fully one-third of the principal; whereas in *carinata* it is not more than about one-eighth, by very careful micrometric measurement. The **mastax** and jaws seemed much shorter than usual, but of the common

form. I did not discern any eye, but do not doubt its presence in life. None of the viscera showed any peculiarity.

This species I met with at the beginning of October 1885, among sediment furnished me by Mr. Bolton. It was just dead; but afforded me a good observation. A week or two later, the empty lorica of another example occurred from the same ditch; and, a little afterwards, in water from Bracebridge Pool, still from Mr. Bolton, I found it yet again. And since, from Mr. Hood. The characters were constant in all.—P.H.G.]

Length, $\frac{1}{60}$ to $\frac{1}{80}$ inch; lorica, $\frac{1}{145}$ inch; depth at middle of ridge, $\frac{1}{385}$ inch. **Habitat.** Birmingham; Dundee. Pools: rare (P.H.G.).

M. SCIPIO, *Gosse*, sp. nov.

(Pl. XX. fig. 11.)

[SP. CH. **Body** *sub-cylindrical, slightly larger in front, thick and round behind; the front of the* **lorica** *set with three spines; a long low* **ridge** *considerably on the right side;* **toe** *half the length of the lorica;* **sub-styles** *one-fourth the length of the toe. Greatest width about one-eighth of total length.*

This and the following two species have much in common; yet are distinguished by details of form and structure. The general outline differs in each, as shown in the figures. The particulars detailed in the technical *Spec. char.* of each, though minute, seem trustworthy. What appears distinctive of the present is that the front edge of the **lorica**, otherwise smoothly truncate, carries three projecting spines, one occipital and two lateral, each of which runs down the outside of the lorica for a short distance as a sharp ridge. There is thus a certain resemblance to *M. bicornis*.

The general outline is that of a stout straight stick, thickened slightly near the head, with both ends rounded abruptly. At the extremity a very low **ridge** is seen, which runs up, considerably to the right of the medial dorsal line, almost imperceptibly at length, to the very front. The **foot**, which is short and bulbous, is contained within the rounded end of the trunk, but carries, attached to it by a very facile joint, a toe in the form of a slender spine, about two-fifths as long as the lorica. The spine, as in *carinata*, is not quite straight; it bears at its base a short supplementary style on each side, which moves on the basal joint with its own motions. Each is about one-fourth as long as the toe. The **mastax** is of immense size, occupying much more than half the body-length; the trophi are often pushed to the very front. Vibrating cilia are disposed on minute eminences, of which the central one is continually lengthened and shortened. An ample **brain** runs down the occipital region, bearing a conspicuous crimson **eye** *on its extreme point.* I saw no protruded **antenna**. Very characteristic (in all the specimens observed) was a long clear blank space, wide at the foot-point, and tapering to near the mid-venter: probably a **contractile vesicle**; only that I could never see it contract. The whole animal is transparent and colourless.

I first saw this species in the summer of 1885, on an aquatic moss, growing in one of my window tanks. I subsequently saw other specimens; one in particular, glued fast to a filament by the toe, illustrating the abundance and tenacity of this excretion, which, evidently, is not always under the control of the animal, so that, if usually it is a convenience, it may become a snare. This individual was not quite dead, yet the turbid matter of the head was already forced out, together with many oil-globules.—P.H.G.].

Length. With the toe, $\frac{1}{100}$ inch. **Habitat.** On water-moss in pools (P.H.G.).

M. MACERA, *Gosse*, sp. nov.

(Pl. XX. fig. 12.)

[SP. CH. **Body** *fusiform, thickest behind the middle;* **lorica** *smooth-edged in front; without visible* **ridge**; **toe** *half the length of the lorica;* **sub-styles** *one-fourth the length of the toe.*

I can give little information about this species, which yet seems distinct. I have seen but a single example, and that was moribund, if not actually dead. I met with it in June 1885, in water from Woolston Pond, Hants, courteously supplied by Miss Davies. Spontaneous motion had not ceased, particularly in the toe-spines, and the structure of the abdominal viscera was still perfect; yet all the foreparts were one mass of dissolving flesh and air-bubbles, protruding from the front and spreading around. An **eye**-spot could be detected in the mass; but of the **trophi** not a trace.

The form recalls *M. rattus*; but greatly produced in length, and without discernible carina. I hesitate whether it should not be placed in the genus *Cœlopus*; for it appears to have two unequal **toe-spines**, the smaller fitting beneath the other, and about one-fourth of its length. But the longer is straight, the shorter curved. So that, in defect of fuller observation, I assume that the shorter is but one of the supplementary styles common in this family; though I could detect other minuter spinelets at the base.

The specimen I unfortunately neglected to measure; but the total length to the toe-point was, approximately, $\frac{1}{100}$ inch.—P.H.G.] **Habitat.** Woolston (P.H.G.).

M. ELONGATA, *Gosse*, sp. nov.

(Pl. XX. fig. 8.)

[SP. CH. **Body** *nearly cylindric, slightly larger before than behind;* **lorica** *smooth-edged in front;* **ridge** *long, low, medial;* **toe** *as long as the lorica;* **sub-styles** *one-twentieth the length of the toe.*

This seems a very distinct species. Its smooth, hyaline, arched **lorica**, with a widely truncate front edge, quite smooth, but tapering in a graceful curve to the hinder end, where a small tubular orifice, also abruptly truncate, allows emission of the foot; is very distinctive from the preceding two species, to which, however, its remarkable length allies it. It is nearer to *M. carinata* than they; yet sufficiently remote from this by conspicuous characters; in particular, by the dorsal **ridge**, which is low throughout, and, as I believe, medial. The greatest depth of the lorica (viz. just behind the front edge) is just one-fourth of its length. This front edge, destitute of points, is apparently attenuated to thin membrane, thrown into minute transverse folds, inverted and everted with the motions of the head-mass. The **foot** is of one minute joint, exterior to the lorica. It bears one toe, a spine of great length and slenderness, almost quite straight, nearly uniform in thickness to the fine point. Its length *about equals that of the lorica.* Two accessory styles, very minute, are appressed to its base. The **mastax** is ample, and, as in *M. carinata*, having two mallei, unequal and dissimilar.

I owe my acquaintance with this charming species to Mr. Hood of Dundee, whose keen eye had already detected its specific distinctness. He sent me, in November 1885, water from one of the pools near Dundee, containing a number of living specimens. They are sprightly and active, swimming elegantly through the clear water, with a smooth but swift gliding movement.—P.H.G.]

Length. Total, $\frac{1}{82}$ inch; of toe, $\frac{1}{116}$ inch; of sub-styles, $\frac{1}{1700}$ inch; depth of lorica, $\frac{1}{370}$ inch. **Habitat.** Loch near Dundee (J.H.); Birmingham (P.H.G.): not rare.

M. RATTUS, *Ehrenberg.*

(Pl. XX. fig. 9.)

Monocerca rattus . . . Ehrenberg, *Die Infus.* 1838, p. 422, Taf. xlviii. fig. 7.

[SP. CH. **Body** *ovate, truncate in front, pointed behind;* **ridge** *reaching to two-thirds, evenly arched;* **toe** *longer than body-and-head together;* **sub-styles**, *very minute.*

The **lorica** is elegantly ovate, subtruncate before, where a thick head protrudes, with a rounded front, on which numerous pimples are beset with bristle-like cilia, making

a single vortex. Behind the head is a strong transverse fold, seen in retraction, but obliterated in extension; close to which projects horizontally backward a long **antenna**. The whole structure bears a very close resemblance to that of *M. carinata*, from which, however, it is distinguishable at a glance. The **mastax** and trophi are on the same pattern; but the right malleus is even still further reduced, only a slight vestige of it remaining. The dorsal **ridge** is evident but very low, with an outline regularly and elegantly curved. The **foot** is small and short; the toe nearly straight, long, slender, acute, closely embraced at its very base by several very short sub-styles. A copious secretion of mucus is often seen running down like a cord, from the base, whose viscosity is attested by the force with which the tip is moored to the glass.

This very elegant and sprightly animal is well named, for its resemblance to a rat is at once manifest, both in form and movement. It moves nimbly about among the vegetation, now nibbling, now turning short, now scudding hither and thither by little starts, whisking its long tail (toe) about in all directions. It swims gracefully and rapidly, revolving often on its axis. The periodic evacuations of its small **contractile vesicle** are thirteen in a minute. The species is often found in company of the finer *Desmideæ*, and from the alimentary canal being commonly distended with matter of a rich golden-brown hue, I conjecture that some of these may form its ordinary food. In the discharge of fæces, I have noticed such a quick closing contraction of the rectum at the point where the intestine merges into it (yet *without constriction* of the whole tube) as suggests a sphincter there: and the distinction between the coloured contents of the intestine and the perfect clearness of the rectum is well defined.—P.H.G.]

Length. Of body and head, $\frac{1}{160}$ inch; of toe, $\frac{1}{135}$ inch; total, $\frac{1}{73}$. **Habitat.** Pools, widely dispersed, not uncommon (P.H.G.).

M. BICORNIS, *Ehrenberg*.

(Pl. XX. fig. 5.)

Monocerca bicornis . . . Ehrenberg, *Die Infus.* 1838, p. 423, Taf. xlviii. fig. 8.

[SP. CH. **Body** *fusiform-ovate, with long thick head armed with two projecting unequal spines;* **lorica** *not ridged;* **toe** *two-thirds as long as body and head, with a bulbous base, and no sub-styles.*

The integument is truly a **lorica**, though more flexible than usual. It is truncate at the neck, whence a thick cylindrical head protrudes, the anterior half of which can contract by bringing the sides together in strong puckers. With much resemblance to both *rattus* and *carinata*, there is a marked difference in aspect, from the greater development of this head, and from the unequal spines which project over it; of which the left is medial, much the longer, and decurved. The absence, too, of any dorsal **ridge** is noteworthy. The **toe** is slightly swollen at its base, but I cannot detect any **sub-styles**, though Ehrenberg speaks of them; it is slightly recurved. The right **malleus** has here quite disappeared. The **brain** is of unusual length, even descending below the long mastax, and the **eye**, of moderate size and a pale-red hue, is seated *near its middle*. There are small **gastric glands** at the base of the stomach, and *two similar vesicles* attached to the *rectal end* of the intestine. The **contractile vesicle's** periods are three in a minute. In other points there seems little to distinguish the species from its fellows. There are, however, two **antennæ**, also unequal, which project, side by side, beneath the chief frontal spine. I have seen an ogg matured in the ovary, remarkable for its small size: perhaps male. (Cf. *Monoc. valga*, Ehr.)

In ponds and lakes around London, I met with this species and the preceding, six-and-thirty years ago; I have occasionally found both since, the present the rarer. Yet I have had this multiply in a phial; so numerous and so large, as to be visible to the naked eye. They glide slowly about, sometimes hanging to the glass, or playing around

the floccose attached to growing *Nitella*. It forms a charming object under reflected sunlight. The body is colourless, and sparkling as a vase of glass, as are some of the viscera. An advanced egg is conspicuously white; and so is the head of the mastax; the eye comes out like a ruby; the stomach, full of food, is richly brown, or perhaps grass-green; and the rotating front is enveloped in a cloud of pale cobalt blue. Like its neighbours, it is lively in movement.—P.H.G.]

Length. Of body, $\frac{1}{10}$ inch; of toe, $\frac{1}{100}$ inch; total, $\frac{1}{55}$ inch. **Habitat.** Pools near London; Birmingham (P.H.G.).

M. STYLATA, *Gosse*.

(Pl. XX. fig. 6.)

Monocerca stylata . . . Gosse, *Ann. and Mag. Nat. Hist.* Sept. 1851, p. 199.

[SP. CH. **Body** *irregularly oval;* **head** *short;* **lorica** *flexible, puckered in contraction, not ridged;* **toe** *less than half as long as body-and-head, simple, with no* **sub-styles.**

In several respects this nimble little species resembles the preceding; the lorica (even more flexible and skin-like) opens wide in front to emit the head, and closes with many folds or puckers, converging to a blunt point. The form is more irregular than in any other species, being plump and gibbous; the skin, which is so flexible as scarcely to be called a **lorica**, is often drawn in, or protruded in angles, which vary the shape. The **foot-bulb** is enormous, usually inclosed within the body; to this is jointed the toe, a taper acute spine, nearly straight, without a swollen base, and without sub-styles.

The **brain** is thick and moderately long, carrying a large **eye** on the middle of its dorsal surface, protuberant as a wart. No **antenna** has been observed. The protruded head is short, set with cilia, strong and bristle-like, around the margin. The **jaws** have the asymmetric character already noticed; the one malleus is very long and simply bowed. As in *bicornis*, there is a long distinct rectum, to which are attached two globular cæca, larger than the **gastric glands** above. There is a small **contractile vesicle**. The cloaca is marked by a depression.

Under strong lateral pressure, a very complicated system of muscular bands is seen (6*b*), mostly transverse, but many irregularly diagonal. I copied them with great care.

I first obtained this species from a garden reservoir near London, in 1850. Its minuteness and its figure, its short foot and great red eye, may cause it to be mistaken for an *Anuræa*, which it resembles in its swift, headlong, obliquely-revolving motion. Specimens in a phial may be detected with a pocket lens, rapidly urging their way, generally in a perpendicular direction, upwards or downwards, always with this revolving action. When alarmed, they suddenly increase their speed, shooting across the field of view with such a fleetness that it is difficult to keep them in sight.—P.H.G.]

Length. Of body, $\frac{1}{250}$ inch; including toe, $\frac{1}{170}$ inch. **Habitat.** South London; Hampstead Heath; Stapleton Park, Yorkshire; Birmingham (P.H.G.).

Genus RATTULUS, *Ehrenberg*.

[GEN. CH. **Body** *cylindric, curved;* **lorica** *smooth, (usually) without a* **ridge**; **toes** *two, decurved, symmetric.*

The *Notommata tigris* of Ehrenberg, with its rounded body, thickest before, its general curvature, and its two coequal toes, continuing the curve of the body, may be considered the type of this genus, which manifestly, however, forms a connecting link with the *Notommatadæ*, through *Proales tigridia*. The genus is a very natural one, inseparable, notwithstanding some diversities, with a common facies readily apparent to the skilled observer.—P.H.G.]

R. TIGRIS, *Müller*.

(Pl. XX. fig. 13.)

Notommata tigris . . . Ehrenberg, *Die Infus.* 1838, p. 431, pl. liii. fig. 1.

[SP. CH. **Body** *subcylindric, largest in front;* **foot** *thick;* **toes** *two, stylate, long;* **sub-styles** *two pairs, very short;* **brain** *clear.*

The **lorica**, though subcylindric, a tube open at both ends, and bent, is wider in front, where a great thick head is protruded, which is invested in an inflexible shelly coat, running off both frontally and mentally into hard sharp points. The face between bears rotatory cilia set on minute eminences. Ehrenberg says "the outer skin appears somewhat firm"; and I have met with the empty dead shell, as evidently chitinous as that of an *Euchlanis*. The whole animal is rounded, not only as a tube is round, but the outline of the back is the segment of a circle, a form which is unchanged with all the animal's motions. The **foot** appears to consist of one or two thick joints, and carries, besides the two toes, which are long taper styles, evenly decurved, sub-styles one on each side of each toe (fig. 13*b*), usually close appressed and minute. In death the toes are bent up under the belly; but in life they are usually carried straight behind, quite parallel, or often thrown upward, without, however, changing the downward curvature of their points. The ample **mastax** (fig. 13*a*) is pear-shaped: the mallei straight, unequally developed. The large **brain** carries a clear pale-red wart-like **eye**, on its point. The stomach is usually full of dark-brown food, coarsely granular.

Some points in Herr Eckstein's description of *Diurella tigris* make me doubtful whether his species and mine are identical. Mine I have had repeated opportunities of studying, both alive and dead.—P.H.G.]

Length, $\frac{1}{12\,0}$ inch, of which the toes are $\frac{1}{30\,0}$ inch. **Habitat.** Sandhurst, Berks; Woolston, Hants: rare (P.H.G.).

R. HELMINTHODES, *Gosse*, sp. nov.

(Pl. XX. fig. 17.)

[SP. CH. **Body** *very slender, especially in front, the width less than one-fifth of the length;* **toes** *without accessory* **styles** *at the base;* **brain** *clear.*

This obscure species approaches near to *R. tigris* in form, and also in the slenderness and comparative length of the toes. It is, however, much more elongated (even when all allowance is made for the protrusion of the parts in death); and the anterior half is the slenderer, whereas in *tigris* it is the thicker. The **lorica**, if I am not mistaken, has a long low dorsal **ridge**, beginning insensibly near the mid-length, and ending abruptly in an oblique angle (fig. 17) just above the foot. The short, stout, bulbous **foot** carries two long furcate toes, which are simple styles, very slender, tapering to fine points, decurved, closely resembling those of *R. tigris*. Yet I was not able to separate any accessory styles at the base of each, such as are seen in that species. Something was there; if styles, very short and close appressed, but it seemed rather a swelling of the basal part of each toe. It was only a dead lorica that came under my observation; from which the head-mass was extruded by decomposition, as an amorphous turbid cloud. Yet the **mastax** and its jaws of the normal form were still distinct, and the stomach and ovary were scarcely changed. I could not satisfactorily define a **contractile vesicle**, nor branchial tubes. The toes were turned up close to the belly.

The lorica occurred in a tube sent me at the beginning of November 1885, by Mr. Bolton, of water from Blackroot Pool, near Birmingham, in which *Asplancha priodonta* had swarmed, all now dead.—P.H.G.]

Length. To tips of toes, $\frac{1}{10\,0}$ inch; of toes, $\frac{1}{37\,5}$ inch; width (and depth) of body, $\frac{1}{32\,5}$ inch. **Habitat.** A pool near Birmingham (P.H.G.).

R. CIMOLIUS, *Gosse*, sp. nov.

(Pl. XX. fig. 14.)

[SP. CH. **Body** *arched, parallel-sided; skin flexible;* **brain** *opaque;* **toes** *short, blade-like, decurved; no* **sub-styles.**

The **brain**, descending far into the occiput, is furnished at the end with a large and opaque chalk-mass. This I have signified in the specific name, from κιμωλία = chalk. Its component cells are very distinct at the lower margin, which is sub-truncate. When the fore-parts are retracted forcibly, as is frequently the case, the conspicuous chalk-mass will sometimes reach to two-thirds of the entire length, displacing the viscera. A pair of small auricles are occasionally thrust out (fig. 14), without any sensible augmentation of speed, while the animal pushes through sediment. I have looked in vain for an **eye**, though it may have been concealed by the opaque cells. The trophi (figs. 14*b*, *c*) exhibit the virgate pattern common in the family. The **toes** are short compared with those of *tigris*, decurved; set side by side, and widely expanded (fig. 14).

This seems a quite distinct little species, there being no other with which it can be confounded, on examination. The specimen described was in the bottle with which Dr. Collins favoured me in June 1885. Its movements were by no means rapid, but persevering, forcing its way incessantly through the leaves of water-moss and sedimentary floccose. I have lately found a second in water from Mr Bolton.—P.H.G.]

Length, $\frac{1}{200}$ inch. **Habitat.** Sandhurst, Berks; Kingswood Pool, Birmingham (P.H.G.).

R. CALYPTUS, *Gosse*, sp. nov.

(Pl. XX. fig. 16.)

[SP. CH. **Body** *and* **toes** *as in* cimolius; **brain** *clear;* **face** *furnished with pendent veil-like lobes of flesh. Marine.*

This has much resemblance to *R. cimolius*, but it is larger, and the **brain**-sac is clear, not opaque. No **eye** has been visible: the **toes** are of like dimensions, pattern, and decurvation. A remarkable peculiarity is that in the front a thick and broad veil of transparent flesh hangs down, apparently bilobed, meeting another great lobe of like appearance from below. The function of these lobes I do not know. The body is cylindric, with no visible dorsal **ridge**. The **mastax** and trophi conspicuous, but ill-defined. An ample brain descends with a point into the occiput, with neither chalk-deposits, nor eye. A long and slender œsophagus leads to an ample **alimentary canal**. The **ovary** occupies the ventral region of the cavity; and a moderate **contractile vesicle** is behind all.

A single example of this charming little *Rattulus* I found in October 1885, with many other species of Rotifera, in sea-water, procured for me by Mr. Hood from the tide-pools of the Firth of Tay. In manners it was sluggish, contracting and lengthening itself with uniform persistence without changing its place. It was of hyaline transparency and colourlessness.—P.H.G.]

Length, $\frac{1}{130}$ inch. **Habitat.** Tide-pools on the Scottish coast (P.H.G.).

R. SEJUNCTIPES, *Gosse*, sp. nov.

(Pl. XX. fig. 15.)

[SP. CH. **Body** *projecting much above and behind the foot;* **toes** *two, coequal, slender, decurved, set side by side, wide apart.*

Of this remarkable species Dr. F. Collins has made several graphic sketches in his Note-book. It is of the *lunaris* form, stout, plump, and curved; the **foot** consists of a great basal bulb, wholly internal, and a second joint, thick and short, to which are articulated two toes; these are acute slender styles, so curved as to continue the outline of the body, mutually equal, set on the same plane, but (which is most unusual) *wide apart.*

The hinder body is ventricose, greatly overhanging the foot. There is a great aggregation of minute air-(or oil-)globules in the dorsal cavity. The **trophi** I supply conjecturally.

Dr. Collins has added to his figures the following note: "Head very large; rotatory organ compound; a large eye; peculiar ganglionic mass or brain lying on dorsal surface. Two toes, which it sometimes crosses; peculiar from being very wide apart, and decurved, as the toe of *Rattulus lunaris*. Found in a pool near Wellington Military College, Berks."—P.H.G.]

Length. Unrecorded. **Habitat.** As above.

Genus CŒLOPUS, *Gosse*.

[GEN. CH. **Body** *cylindrical, curved;* **foot** *bulbous, inclosed;* **toes**, *one broad plate with another laid upon it, in a different plane.*

A very remarkable deviation from normal structure is found in the species thus associated. Instead of two toes, consimilar and coequal, placed side by side right and left, like the legs of a man; here are two toes very unequal, hollow triangular plates of like shape, but of diverse dimensions, the smaller lying within the hollow of the larger. To use a homely comparison, let us suppose the bowl of a tablespoon, broadly truncate at the top and drawn out to a long point; then the bowl of a teaspoon of exactly the same shape, laid smoothly in its hollow; the two separately articulated to the foot-bulb, so as to be capable of independent motion to a slight extent.

These organs are so anomalous that it is hard to describe them as "toes." If it could be proved that the cloaca opens between them, we might say without hesitation that the larger and upper represents a true *tail*, the smaller and lower a stylate toe. But I have no knowledge on this point; which could be settled only by a rare accident,—the observing of the act of evacuation at the moment when the animal was viewed laterally.

In general figure and organization, there is so close an agreement with the former two genera, that the family affinity is indubitable. Several species I am able to associate as manifesting this structure: and, what is very curious, I have found it exhibited by a member of a remote genus,—one of the *Coluri* (*q. v. infra*).

It is possible that Ehrenberg's *Rattulus lunaris* may represent my *C. porcellus*. But the absence of any detailed diagnosis, in his text, leaves it doubtful; while his assigning of two eyes to his species is against the identification. The *Diurella rattulus*, Eyf., described and figured by Herr Eckstein, may possibly be the same thing. The delicate lines that are drawn through the middle of the toe, in his engraving, may be either the inner edges of two normal toes, or the outer edges of a single superposed toe; and the closest examination does not determine this. If the former, it is a species of my genus *Rattulus*; if the latter, a *Cœlopus*. His text also is ambiguous. "Two toes, long, much bent bellyward, and slender," seem to point to *Rattulus*; while "at their base they do not stand close side by side, but lie with their points one on the other," appear to indicate the peculiarity of *Cœlopus*, ill-understood.—P.H.G.]

C. PORCELLUS, *Gosse*.

(Pl. XX. fig. 18.)

Monocerca porcellus . . . . Gosse, *Ann. and Mag. Nat. Hist.* Sept. 1851.

[SP. CH. **Body** *cylindric, short and plump;* **lorica** *ridged;* **head** *with two projecting spines; the longer* **toe** *equal in length to the depth of the body.*

This neat, plump little creature always reminds me of a fat young pig. The general form may be compared to that of a well-filled sausage, a little bent, as sausages often are, and the varying shades of brown colour produced by the distended stomach and

ovary, add to the resemblance. The large head is bent downward; the brow and the chin project each in a sharp spine, between which the front is capable of a slight protrusion, ciliated, and furnished with a tubular antenna. Viewed dorsally, the front is ever and anon closed by the rapid approach of two triangular pieces from the sides, which recede immediately (cf. *Dinocharis*, &c.). The movement has no connection with the mastax. When the animal is confined by pressure, not sufficient to hurt it, it protrudes the jaws; and besides this a sort of veil is thrust forward, very thin and membranous, seemingly stretched between the frontal and mental points, and from an intermediate point (fig. 18*b*). The action, though frequent, is momentary, and the withdrawal is complete. The **lorica** terminates anteriorly by a strong transverse fold, at its full width, whence the mobile head is emitted, of much less apparent diameter. The difference, however, is mainly owing to a rather high dorsal **ridge**, which rises abruptly from the fold, and continues nearly equal in height to three-fourths of the body's length; or even, in some cases, to the whole.[1] The basal joint of the **foot** is a round transparent bulb of great size, almost wholly enclosed within the body-walls. It must not be confounded with the **contractile vesicle**, which is much smaller, and lies upon it. To this foot-bulb is so articulated as to allow very free vertical motion the remarkable form of toe which has been just described. It is usually bent forward toward the belly, but can be thrown out behind, particularly in swimming. The trophi resemble those of *Mastigocerca*: the fulcrum of the incus a long slender rod with the back elevated into a thin ridge; no trace of rami can be discerned, but their pendent divergent alulæ, which are unequal. The whole **mastax** is covered with fine transverse lines. A wide and long **brain**, of the normal form and position, carries near its middle a great deep crimson **eye**. On killing one by sudden pressure, the branchial vessels were severed from their connection with the **contractile vesicle**, and forced out, displaying some details of their structure. They appeared as a single tubule on each side, striate in parts with cross lines; towards their hinder parts are seen a number of transverse branchlets, whose ends have been torn off, suggesting not one but *many communications* with the **contractile vesicle**. There are also very minute structures attached at intervals to them, one near the head, resembling a twig of several leaves. These I cannot explain.

With this very attractive little creature I have been familiar since October 1849, when I met with it at Clapton, near London. It has occurred in many localities since. Its manners are sprightly and elegant. It is perpetually in motion, threading its way through the tangled conferva wires, and swimming across the open spaces, with a rapid gliding movement, turning on its long axis as it goes. The clear viscera, resembling bladders of various shapes and sizes, some filled with richly-coloured food or fæces, others granulate, or occupied with embryonic globules, all interspersed with orange-coloured fat-bubbles, and all seen through the transparent skin, have a most charming effect, as the animal thus revolves. It frequently arrests its roving course to examine the plants, and now and then to nibble at them, when the mastax is brought to the very front, and the jaws themselves are seen projecting from the head, and eagerly biting. Sometimes it swims round and round, in a circle of which the curved outline of the back forms an arc.—P.H.G.]

Length, $\frac{1}{110}$ inch, of which the double toe forms about one-fifth. **Habitat.** Pools and lakes: widespread through Middle and South England (P.H.G.).

C. TENUIOR, *Gosse*, sp. nov.

(Pl. XX. fig. 19.)

[SP. CH. **Body** *cylindric, decurved, slender;* **lorica** *without sensible ridge;* **head** *defended by two or three projecting points;* **toe** *with two* **sub-styles.**

[1] I am almost sure that the ridge is inclined; its edge bending over towards the right. I have seen it distinctly wrinkled along the base, as seen in *M. carinata*.—P.H.G.

This species has manifest affinity with *porcellus*; but it is much slenderer, and its proportions are different. The width of the body to its length (exclusive of the foot) is as 1 : 4; whereas in *porcellus* it is as 1 : $2\frac{1}{2}$. The **toe** is here beset with a short sub-style on each side (as in *Mastigocerca*); whereas in *porcellus* I can see no trace of these. The **lorica**, moreover, is not elevated into any sensible dorsal **ridge**. In all other respects it appears to agree with the preceding, except in being somewhat longer.

The species first occurred to my notice in water from Woolston Pond, sent me in September by the courtesy of Miss Davies. Several examples occurred, but all dead. A few days later I found it alive in water sent by Mr. Bolton from Birmingham, as well as another dead.—P.H.G.]

Length, $\frac{1}{110}$ to $\frac{1}{124}$ inch; depth, $\frac{1}{300}$ to $\frac{1}{330}$ inch. **Habitat.** Weedy pools. Woolston: Sutton Park and Coleshill, Birmingham (P.H.G.).

C. BRACHYURUS, *Gosse*.

(Pl. XX. fig. 21.)

Monocerca brachyura . . . Gosse, *Ann. and Mag. Nat. Hist.* Sept. 1851.

[SP. CH. **Body** *cylindric, short, plump, decurved;* **lorica** *not ridged;* **head** *without spines;* **toe-length** *less than the depth of the body.*

This species I described in 1851 from a single example taken on Hampstead Heath. It died before I had completed my observations; but I have since seen it on repeated occasions, from various localities, though always scarce. With much resemblance to *C. porcellus*, it is notably smaller; there is no trace of **ridge**; the twofold **toe**, though exactly similar, is proportionally shorter; the front is obtusely truncate, seen dorsally and laterally, and is destitute of projecting spines. When viewed endwise (as on many occasions), the transverse outline appears quite circular, so far as the back and sides are concerned. A long depending **brain** carries a great red **eye** at its tip. The singular appearance of a second eye *in the breast*, mentioned in my original diagnosis, occurred in no other specimen; it must have been illusory, though unaccountable. The viscera agree with those of *porcellus*; the **contractile vesicle** very large. The **toes** are almost always thrust up under the belly.

In manners this varies much from its lively predecessor, for though constantly in motion it is singularly slow and sluggish, creeping to and fro on the leaves of the milfoil, nibbling ever as it goes.—P.H.G.]

Length (without toe), $\frac{1}{175}$ inch; toe, $\frac{1}{350}$ inch; total, $\frac{1}{135}$ inch. **Habitat.** Hampstead Heath; Sandhurst; Woolston; Caversham (P.H.G.): pools: rare.

C. CAVIA, *Gosse*, sp. nov.

(Pl. XX. fig. 22.)

[SP. CH. **Body** *elevated and globose, very protuberant behind the foot;* **lorica** *without ridge or frontal spines.*

In the summer of 1885 Mr. Henry Davis kindly collected water for me near Snaresbrook in Epping Forest. Among other treasures found therein I met with this pretty little creature, which at first I was inclined to identify with *C. brachyurus*. It differs from it in form, however; the great elevation of its hinder quarters, and particularly the development of its buttock into a great plump breech, gives it the aspect of a squatting mouse or guinea-pig, and makes the double curved **toe** proceed (in appearance) from a notch in the belly, far forward. The **mastax** agrees with that of its congeners, of moderate size; but the **brain** is very large, and so is the **eye** at its point. The **stomach** was ample, filled with yellow food. Face truncate, slightly prone. The little thing was rather swift at first, but not wild.—P.H.G.]

Length (without toe), $\frac{1}{350}$ inch. **Habitat.** Epping Forest (P.H.G.).

[I suspect the *Distemma setigerum* of Ehrenberg to belong to this genus. He himself alludes to the liability of confounding it with *Rattulus*, as well as to the difficulty of resolving the very slender toe, which, at first sight, seems single; and to his inability to see any proper foot-joint. Yet he assigns to the species two eyes; which does not accord with any true species of *Cœlopus* known to me.—P.H.G.]

Cœlopus (?) minutus, *Gosse*, sp. nov.

(Pl. XX. fig. 20.)

[SP. CH. *Two* **eyes**, *wide apart;* **mastax** *and rotating* **cilia** (*apparently*) *wanting;* **body** *rotund, minute.*

Little as I know of this tiny animal, enough is manifest to show that it is one of much physiological interest. Though for convenience of reference, and because of certain conspicuous resemblances, I place it with the *Cœlopods*, it must be considered a species *incertæ sedis*. The general figure, plump and round, recalls *C. porcellus* and *cavia*, and so do the short, curved **foot**, thick at its base and tapering to a sharp point, and its manner of articulation. Yet, whether the structure of this member is that peculiar to *Cœlopus*,—a secondary spine lodged within the inferior concavity of the principal,—I cannot certainly affirm. I strove hard to determine this point, but could not obtain absolute certitude. It *appeared* single and indivisible.

But it is at the anterior extremity that the chief anomalies of the little creature are found. Two cervical **eyes** are seen, tiny globelets, brilliant and distinct, set wide apart, close within the outline on either side, in a dorsal aspect (fig. 20). I could find no trace of **mastax** or trophi, in general so largely developed and so conspicuous in this family; but instead of it what seemed a simple slender duct or tube, formed by the union of two short branches which communicate with the front, and open into a great sacculate **stomach**; as if the œsophagus had been continued upward,—the mastax being atrophied,—to the very front, or rather merged into the buccal funnel. Again, with the closest scrutiny I could detect no **cilia** nor any ciliary action.

Only a solitary example has occurred to my observation, from the Black Loch, near Dundee. It was alive but inert, and to a certain extent glued fast to the glass by an excretion from the foot.—P.H.G.]

Length, $\frac{1}{500}$ inch. **Habitat.** Black Loch, near Dundee (P.H.G).

Family XII. DINOCHARIDÆ.

Lorica *entire, vase-shaped, or depressed; sometimes facetted, often spinous;* **head** *distinct, with a chitinous covering;* **foot** *and* **toes** *often greatly developed;* **trophi** *symmetrical.*

Of the three genera, which together form the *Dinocharidæ*, two, viz. *Dinocharis* and *Scaridium*, resemble each other in the great length of the **foot** and **toes**, and in their conspicuous **condyles**. Both these genera are also completely **loricated**; but whereas in *Scaridium* the chitinous cuticle is thin, somewhat flexible, smooth, and transparent, in *Dinocharis* it attains a greater development than in any other genus of the Rotifera. For, not only is the trunk completely enclosed in a dense lorica shagreened with little knobs, ornamented with ridged facets, or bristling with spines, but the head and foot also are similarly protected, and the lorica stretches down even to the base of the toes. The third genus, *Stephanops*, resembles the first two in having a chitinous covering for the head, and in bearing stiff spines, which are not organs of locomotion, on various parts of the trunk; but its skin can hardly be termed a lorica, and its foot, though well-jointed and often spinous, is never immoderately long. The **head-gear** in the

three genera is also very different, and *Stephanops* has two **eyes** remote from the mastax, while *Dinocharis* and *Scaridium* have but one, closely applied to it. In all, however, the **trophi** are symmetrical, the family differing widely in this respect from the *Rattulidæ*.

Genus DINOCHARIS, *Ehrenberg*.

GEN. CH. **Lorica** *vase-shaped, dense, shagreened; facetted, and with projecting plates, or armed dorsally with spines;* **head** *retractile within a chitinous cap;* **eye** *single, apparently attached to the mastax;* **foot** *and* **toes** *very long, the former bearing spines.*

Two of the species of this genus, viz. *D. pocillum* and *D. tetractis*, resemble each other very closely; the main difference being that the former has, on the last joint of the **foot**, a small spine between the two toes. But the third species, *D. Collinsii*, is strikingly unlike the other two, in several respects. Their **loricæ** are vase-shaped, facetted and spineless; whereas its lorica is quadrangular, much depressed, free from facets, but notched round its edge and bearing long dorsal spines. The **head-coverings** are also unlike. Those of the first two species consist each of quadrantal pieces that can be brought close together so as to enclose completely the withdrawn corona; but in the latter species the head is protected on the dorsal surface by a notched shelly hood, and is uncovered on the ventral surface.

D. POCILLUM, *Ehrenberg*.

(Pl. XXI. fig. 1.)

Dinocharis pocillum . . . Ehrenberg, *Die Infus.*, 1838, p. 472, Taf. lix. fig. 1.
„ „ . . . Grenacher, *Sieb. u. Köll. Zeits.* Bd. xix. 1869, p. 497.

SP. CH. **Lorica** *vase-shaped, sub-cylindrical, facetted, without spines;* **foot** *and* **toes** *very long, and together nearly twice the length of the trunk;* **spurs** *curved; a short* **spine** *between the toes.*

The vase-shaped **lorica** of this species has a flat portion with scalloped edges down the centre of its dorsal surface; and a similar, but somewhat protuberant, portion on the ventral surface. These two plates are connected by stippled concave surfaces, which pass from a dorsal scallop to a ventral one and meet each other in stout transverse ridges, which are very prominent in a side view; and, when the creature is viewed directly in front, so as to obtain transverse views of the trunk, it is evident that the lorica, as shown in the elegant figure 1c, is produced on either side into delicate wing-like plates at right-angles to its surface. The **head** is protected by a complete cap, consisting of two pieces, which can fit together closely so as to conceal the corona, or fall back on each side into a fold in the neck in order to permit the head to protrude. The loricated **foot**, which is as long as the trunk, has three joints; on the last of which are two slender toes, decurved, bent outwards, and as long as the foot itself. Between the toes is a short chitinous **spine**. The first joint bears two stout **spurs**, usually about as long as the joint that bears them, but occasionally more than double the length. The front is rounded and set with small cilia: it is difficult to say what is the exact structure of the **corona**, or the arrangement of the ciliary wreath. There are a large **mastax** with sub-malleate trophi; two conical **gastric glands**; a broad cylindrical stomach; short intestine; moderate **ovary**; and very large **contractile vesicle**. This latter lies athwart the body when distended, and in that condition fills up more than one-third of the body-cavity: its time is four minutes. The **lateral canals** can be readily seen on the ventral surface, but I detected only one vibratile tag. There is a large crimson **eye** on the under surface of the **nervous ganglion**, which overlies the mastax so that the eye seems attached to this latter. Dr. Grenacher (*loc. cit.*) has seen two lateral rocket-headed **antennæ** on each side of the lower third of the dorsal surface.

This is an elegant and curious creature. With its toes well apart like a pair of com

passes, and its foot either thrown into one long curve or oddly bent zigzag fashion, it grubs among the sediment of the live-box; and sometimes it glides gently away by the action of the coronal wreath, with its long toes trailing gracefully behind it, just like *Scaridium eudactylotum*.

Length, $\frac{1}{80}$ inch. **Habitat.** Clear ponds and ditches, Hampstead Heath; Kew Gardens; Woolston (P.H.G.); Clifton, Birmingham (C.T.H.): not very common.

D. TETRACTIS, *Ehrenberg*.

(Pl. XXI. fig. 2.)

Dinocharis tetractis . . . Ehrenberg, *Die Infus.* 1838, p. 473, Taf. lix. fig. 2.

SP. CH. **Lorica** *vase-shaped, narrowing to the hind extremity, facetted, without spines;* **foot** *and* **toes** *very long, together more than twice the length of the trunk;* **spurs** *curved; no* **spine** *between the toes.*

This species is extremely like *D. pocillum*, differing from it chiefly in having no **spine** between the toes on the last joint of the foot. The **trunk** viewed dorsally has a somewhat triangular outline, the apex of the triangle being towards the foot, and is shorter in proportion to the foot and toes than it is in the former species. Mr. Gosse has observed in this species that the lorica runs off at the hind end into three, thin, transparent, and radiating plates, of which one is dorsal; and that this latter is not continued so far forward as the lateral plates, so that a transverse section shows no trace of the dorsal radiating one, but rather a slight depression between two gibbous swellings. This is well shown in fig. 1*c*, a transverse section through *D. pocillum*. Mr. Gosse has also seen many specimens of *D. tetractis*, in which the spurs on the penultimate joint were more or less deteriorated; so that in some they were reduced to short tubercles, or even effaced altogether. These latter specimens were precisely Ehrenberg's *D. pauper*, which can no longer, therefore, be entitled to rank as a species.

Length. Up to $\frac{1}{65}$ inch (P.H.G.). **Habitat** Clear ponds and ditches throughout England and Scotland (P.H.G.; C.T.H.): common.

D. COLLINSII, *Gosse*.

(Pl. XXI. fig. 3.)

Polychætus subquadratus (?) . . . Perty, *Z. Kenntn. kl. Leb.* 1852, p. 45. Taf. l. fig. 6*a*.
Dinocharis Collinsii . . . . . Gosse, *Intell. Observer*, vol. x. 1866, p. 269.
Polychætus spinulosus . . . . Archer, *Quart. J. Micr. Sci.* vol. viii. 1868, p. 72.

SP. CH. **Lorica** *depressed, sub-quadrangular, with serrated edges and eight dorsal* **spines**; **spurs** *straight;* **foot** *and* **toes** *short, together as long as the trunk.*

Though this Rotiferon is clearly a *Dinocharis*, it is a very singular one. The **foot** is short, the toes small, the **lorica** depressed, and a chitinous dorsal hood protects the head. The lorica is somewhat rectangular in shape, but broader in front than behind, with its fore corners rounded off, and its lateral edges serrated. At each hind corner a sharp **spine** projects, while six others rise from the dorsal surface. There is an outer pair attached to the shoulders, pointing down the back; and an inner pair, slightly decurved at the tips, rising from the central highest point of the lorica, and pointing diagonally outwards and upwards. A third pair, sharp and straight, rises from the hind end of the lorica, one on each side of the foot, and pointing outwards and upwards; while the first joint of the foot itself carries a pair of sharp chitinous **spurs**. The lorica is closed, much arched dorsally, highest in front, and flat on the ventral surface. The dense lorica, which is stippled in the central region, makes it difficult to define the internal structure; but Mr. Gosse, from whose Memoir (*loc. cit.*) this account is taken, succeeded in observing a globose **mastax**, ample **alimentary canal**, and rich ruby **eye**.

This *Dinocharis* was discovered by Dr. F. Collins in 1866, in a small pool in a wood near Sandhurst. Dr. Collins sent it to Mr. Gosse, who figured and described it (*loc. cit.*) in 1867. Dr. Max. Perty's *Polychætus subquadratus* may possibly, but not probably, be the same creature; if so, it is most inaccurately drawn and described. Mr. Archer's *Polychætus spinulosus* is undoubtedly *D. Collinsii*.

Mr. Gosse says of its habits that "it is rarely still, rooting among the sediment or swimming with a smooth gliding motion of no great speed. If I may judge of its behaviour in freedom from what is seen while under our notice, it seems to be a specially bottom-frequenting form."

Length, $\frac{1}{125}$ inch. **Habitat**. Sandhurst, Berks (Dr. F. Collins); Clifton (Mr. Brayley); Carrig and Callery districts, Ireland (Mr. T. Archer); Dundee (P.H.G.): rare.

Genus SCARIDIUM, *Ehrenberg*.

GEN. CH. **Lorica** *vase-shaped and compressed; or pear-shaped and depressed in front; very thin, transparent, smooth, without spines or projecting plates;* **head** *with a chitinous cuticle, except in front;* **eye** *single, really or apparently attached to the mastax;* **foot** *without spurs;* **toes** *very long.*

In the genus *Scaridium* the **foot** and **toes** (especially the latter) are remarkable for their great length, for the distinct **condyles**, which give them such free action, and for the powerful striated **muscles**, which enable the animal to jerk its long toes widely apart, and to strike the water violently with its foot, so as to make it an effective organ of locomotion. In both species the **lorica** is a transparent, thin, stiff skin, which appears to be continued over the foot; but its shape in the two species is very different: for, while the lorica of *S. longicaudum* recalls that of *Dinocharis pocillum*, the lorica of *S. eudactylotum* somewhat resembles in general outline that of a *Brachionus*. In each species the **eye** appears to be attached to the mastax, instead of to the nervous ganglion; this would be a very unusual arrangement, but it is possible that the appearance is due to the nervous ganglion's being closely applied to the mastax, and more than usually transparent.[1] The habits of the two creatures are similar. They swim quietly for a time, trailing the foot and toes behind them in an elegant curve; and then, with a sudden leap, they dart off into a new course.

S. LONGICAUDUM, *Ehrenberg*.

(Pl. XXI. fig. 5.)

Scaridium longicaudum . . . Ehrenberg, *Die Infus.* 1838, p. 440, Taf. liv. fig. 1.
" " . . . . Gosse, *Phil. Trans.* 1856, pl. xvii. figs. 64, 65.

[SP. CH. **Body** *compressed;* **front** *truncate;* **eye** *adherent to mastax; body, foot, and toes of about coequal length.*

The most remarkable peculiarity of this species is the anomalous character of the **eye**,—a large flattened capsule, with crimson pigment not quite filling it, permanently attached to the surface of the mastax, and apparently not connected, as usual, with the occipital **brain**, which, however, presses upon it from above and behind. The **trophi**, too, are very abnormal. (See my Mem., *loc. cit.*) The animal, with its long unwieldy foot and toes, reminds us, not less by its movements than by its form, of *Dinocharis*. It is active, swimming with unequal, not very swift, action, with little movement of the foot and toes. It has the habit of making sudden springs, using, apparently, for this purpose, the fore parts, *not the toes*.—P.H.G.]

[1] I suspect this to be the case in *S. eudactylotum*; but in *S. longicaudum* Mr. Gosse is confident that the eye is inseparably seated on the mastax.

Length, $\frac{1}{60}$ inch. **Habitat.** Stratford; Maidenhead; Cheltenham; Birmingham; Starmont Loch, Dundee (P.H.G.); pools and dykes: rare.

S. EUDACTYLOTUM, *Gosse*, sp. nov.

(Pl. XXI. fig. 4.)

SP. CH. **Lorica** *pear-shaped, depressed and narrowed in front;* **toes** *as long as all the rest of the animal.*

[*S. eudactylotum* was discovered in September 1881 in a small loch in Perthshire, by Mr. Hood, who sent me a tube of the water. This I found well peopled with this charming species. It is much more globose than *longicaudum*, and much more translucent, looking like an oval bubble of clear glass. The **head** is small, formed of several ciliated eminences. Among the turbid clouds, which are probably brain-matter, there are one or two oval spots, which refract the light strongly; but I cannot interpret them. As a small red **eye** always moves to and fro with the movements of the mastax, I conclude that they are organically united as in *longicaudum*. The incus and mallei are much more normal than in that species. The manubria, however, are tripartite, and the middle joint is largely and somewhat irregularly looped. The apparatus is unusually minute, obscure, and difficult. The mastax is distinctly three-lobed. There are a long œsophagus, wide **stomach**, intestine, and small **ovary** with nucleated ovarian vesicles. In one example was a small maturing egg. The longitudinal **muscles** are numerous, and unusually conspicuous, owing to the brilliant transparency. But the most remarkable feature is the **foot** of three articulations, with strongly marked condyles, and a pair of furcate **toes** of excessive length and tenuity. They are usually straight, but are sometimes a little curved outward at their tips. It is graceful and elegant in its motions. I have never seen one resting, but invariably swimming with a smooth even gliding, not at all rapid, often varied by a sudden spring or skip to one side, like its fellow *S. longicaudum*. The toes are very flexible, and highly elastic; sometimes when the animal suddenly turns, I have seen the toes bent almost double, but recovering their straightness in a moment. That the integument is a proper lorica, closed and vase-like, is undeniable; yet it is so thin and flexible that the head retracted every instant carries with it the in-turned delicate front edge, which is again everted. At the moment of eversion I have repeatedly seen what I believe to be an **antennal seta** of exceeding tenuity; but certainly no tubule or pimple.—P.H.G.]

The **lorica** is tolerably flat on the ventral surface, but on the dorsal is distinctly gibbous behind and depressed in front. Like that of *Brachionus*, it deepens down to the hinder third of its length, and then suddenly drops with two abrupt curves. Viewed dorsally (fig. 4), it can be seen that a central portion of the lower third is arched above the general surface, and kept so bent by transverse muscular fibres. The **head** on the ventral surface is scooped into a hollow above the buccal funnel, and the corona bears two hemispherical ciliated prominences. On the long œsophagus, at a little distance from the stomach, are two small stalked **glands** (fig. 4*a*) similar to those in *Pterodina* and other Rotifera. The **gastric glands** are of unusual size and form. They are Y-shaped (fig. 4), and each has its stem attached to the top of the stomach, and its outer branch continued up to, and round, the inner dorsal surface of the lorica, to which it is attached. Each inner branch hangs down, pointing inwards, towards the ventral surface, to which it is probably tied by a fine fibre. These glands are distinctly, though delicately, spotted with nuclei. The **vascular system** is best seen from the ventral surface (fig. 4*b*), where the lateral canals, surrounded by wide ribbons of delicate floccose matter, seem to adhere to a considerable portion of the lorica, keeping chiefly toward the sides. The **contractile vesicle** (fig. 4*b*) looks as if it consisted of an oval central chamber, surrounded by several smaller: an appearance probably due to the muscular fibres crossing it in a somewhat regular pattern. It is rather large, and a side view (fig. 4*a*) shows that it lies by itself at the hind end of the inner ventral surface, while the rest of the viscera

follow the arch of the dorsal. I detected four **vibratile tags** (fig. 4*b*) on each side: one near the top of the lorica one about the middle, and two on a plexus of tubes lower down. The **muscles** that pass down the foot to move it and the toes are very conspicuous and are coarsely striated; and the condyles of the toes (fig. 4*c*) are remarkable. The **nervous ganglion** (figs. 4, 4*d*) is so extremely transparent, that in can hardly be detected except by a chain of dark spots round its lower edge, which betray its presence when it moves. It is very long, cylindrical, with a rounded free end, and lies across the mastax and **eye** (fig. 4*d*). It may possibly be attached to both. Two rocket-headed **antennæ** can be seen, one on each side of the dorsal surface (fig. 4), and about one-third of its length from its base. I am indebted to Mr. J. Hood for the numerous specimens of this beautiful creature which enabled me to make drawings of it from various points of view, and to supplement the details given by Mr. Gosse.

Length, $\frac{1}{4\,7}$ inch. **Habitat.** Pools near Blairgowrie (J.H.): very rare.

Genus STEPHANOPS, *Ehrenberg*.

[**Lorica** *cylindrical or pyriform, entire; head bearing a permanent, wide,* **circular shield**; **toe** (*or toes*) *often surmounted by a toe-like tail.*

The species which constitute this well-marked group are in general easily recognized by the beautful glassy shield which protects the head, and which, seen dorsally, instantly recalls the ring of glory which surrounds the heads of sacred persons in medieval pictures. This differs from the frontal hood in the *Coluridæ*, by being non-retractile, and having no motion apart from the whole head. Several of the species have spines affixed to the lorica or to the foot. The foot is habitually exserted, composed of joints which are stout, long, and distinct.—P.H.G.]

S. LAMELLARIS, *Ehrenberg*.

(Pl. XXI. fig. 7.)

Stephanops lamellaris . . . Ehrenberg, *Die Infus.* 1838, p. 478, Taf. lix. fig. 13.

[SP. CH. **Lorica** *pyriform, having a narrow neck, and slightly prolonged behind into three sub-parallel slender acute* **spines**; **foot** *furnished with a toe-like spine.*

The **form** is swollen and vase-like, with a marked everted rim or neck, within which the whole head has a slight motion, surmounted by its lovely round glory-shield, which equals the lorica in breadth. Under its shelter is seen the conical front with its rotating cilia, its oblique points, and its two ruby **eyes**, very wide apart. Below the rim or neck the **trophi** are conspicuous, formed on the pattern seen in *Euchlanis*. The viscera are normal, including an ample transversely-ovate **contractile vesicle**. The hind part of the lorica is deeply truncate, and the three **spines** are limited to the dorsal end. The **foot** consists of three joints, long, and strongly marked, of which the last (save the toes) carries a very slender spine seated on a tubercle on its dorsal side, not quite so long as the two toes. The foot joints are permeated with two long chain-like glands.—P.H.G.]

Length, $\frac{1}{1\,6\,0}$ inch. **Habitat.** A garden tub (P.H.G.): rather scarce.

S. MUTICUS, *Ehrenberg*.

(Pl. XXI. fig. 6.)

Stephanops muticus . . . Ehrenberg, *Die Infus.* 1838, p. 479, Taf. lix. fig. 14.

[SP. CH. **Lorica** *cylindric, having a distinct thick neck, and prolonged behind into a spoon-like shield, which is unarmed, as is also the* **foot**.

What I identify with Ehrenberg's *muticus* agrees better with his description and figures than with Eckstein's. Can the latter have made his drawing from two indivi-

duals, *lamellaris* and *muticus*, which he supposed one and the same? I confess I have had suspicions that these are but one species. I have had specimens in my live-box of what seemed *lamellaris*, with the three caudal spines clear enough; yet in a few minutes I could find only specimens of *muticus*, with no spines at all to be discerned, to my great bewilderment. It seemed as if the spines could at will disappear, but I cannot conjecture how. This has happened repeatedly. Except the greater development of the neck, there is little else to discriminate the two.—P.H.G.]

Length, $\frac{1}{160}$ inch. **Habitat.** Fresh waters around London; an aquarium at Torquay (P.H.G.): scarce.

S. UNISETATUS, *Collins*.

(Pl. XXI. fig. 8.)

Stephanops uniseta . . . Collins, *Science Gossip*, 1872, p. 11, figs. 9*a*, *b*.

[SP. CH. **Lorica** *ovate, its hinder end without points, but bearing a dorsal* **spine**, *very slender, straight, as long as the body;* **foot** *with a slender tail and two toes.*

The discoverer of this interesting form has furnished me with a number of examples from its original habitat: all inhabiting the leaves of a subaquatic moss. In the "Jour. Roy. Micr. Soc." 1885, Dr. Hudson has suggested the identity of Mr. Lord's species [1] with this; but I think its thick fore-parts, the curvature of its spine, and several other peculiarities, indicate their diversity. If so, we have five dorsal-spined species. The **spine** here is so attenuate that it may well be called a *seta*. According to my observations, it vibrates with the tremulous motions of the body, but has no proper separate motion. Its base is attached to a shelly knob, level with the bottom of the mastax; it is quite straight, and its point reaches the tips of the toes. The hind edge of the lorica is truncate and unarmed, as in *muticus*. There are two slender pointed **toes**, and a minute spinous **tail** at right-angles from their base.

The species affects concealment, but occasionally comes out to swim with a smooth gliding motion in the open interspaces; often subject to a momentary vibration throughout.—P.H.G.]

Length, $\frac{1}{200}$ to $\frac{1}{160}$ inch. **Habitat.** Sandhurst (Collins; P.H.G.): not rare.

S. CHLÆNA, *Gosse*, sp. nov.

(Pl. XXI. fig. 9.)

[SP. CH. **Lorica** *cylindric, forming a semicircular occipital shield, without any constriction;* **toe** *single.*

Ehrenberg's *S. cirratus* (not yet recognized with us) appears to lead to this, the sides being straight without any neck. The face is oblique, wider than any other part, beset with irregular fleshy lobes, with a retractile lobe forming a kind of chin. A great sac-like **brain** carries *one* minute **eye**, very difficult to be seen. The lorica, without any diminution in width, ends behind in three points, and resembles a short cloak reaching to the loins. From this descends a thick and long foot, whose penultimate joint carries an acute **spine** at a right-angle, which is a proper tail; thence a stout taper pointed toe, along whose middle a line may be dimly seen, suggesting two toes soldered into one. The rectum may be traced to a cloaca between the tail and the toe. Its manners are those of its fellows. In swimming, its movements, already rapid, are accelerated now and then by sudden starts, probably predatory.—P.H.G.]

Length, $\frac{1}{300}$ to $\frac{1}{150}$ inch. **Habitat.** Sandhurst: Woolston (P.H.G.)[2]; pools: rare.

[1] *Micr. News*, vol. iv. 1884, p. 146, fig. 24. The figure of this *Stephanops* has one dorsal spine, and one short spine, or tail, sloping upwards, just above the toes.

[2] There are differences in form and size between the Sandhurst and the Woolston specimens, so considerable that possibly these may be distinct species: the former much larger, more slender, the front not sensibly lobular; the whole animal yellow-tinged.—P.H.G.

Mr. J. G. Tatem ("Quart. Journ. Micr. Sci." vol. vii. 1867, p. 252, with figs.) described and figured a *Stephanops* (*S. longispinatus*) with one long dorsal spine, no posterior spines, and two short straight spines (one on each side) on both the first and second joints of the foot. Mr. T. Bolton (in 1884) published among his fly-leaves a *Stephanops* (*S. bifurcus*) with one long dorsal spine, and one short posterior spine slanting backwards and upwards, from the end of the lorica; both spines on the median line, and none on the foot. Mr. J. Hood in the same year sent me a drawing of yet another species (*S. armatus*) with one long dorsal spine, and two short posterior spines, one on each side of the end of the lorica slanting slightly upwards and outwards, and somewhat convex to the lorica. This species also had no spines on the foot. Mr. Hood's figure is given in pl. xii. of the "Journ. Roy. Micr. Soc." 1885.

Family XIII. SALPINADÆ.

[**Body** *more or less completely inclosed in a firm lorica, which is open at each end, and divided down the back by a fissure whose sides are united by membrane; two furcate* **toes** *always exposed.*

We come now to forms which are indubitably and manifestly loricate, the integument permeated by a peculiar chemical principle known as *chitine*, which imparts hardness and stiffness to it without diminishing its transparency. This substance is unaffected by alkalis, which immediately destroy all the flesh and membranous parts: a fact which is often useful to the scient, as by the addition of a minute drop of caustic potash to the cell containing a specimen to be examined, he can in an instant obtain the external form unchanged, generally clear and bright, with all the internal organs, that had marred distinct vision, dissolved away.

The animals we have now to consider are clothed in a coat-of-mail (*lorica*) more or less complete, of which the edges are sharply marked. Thus they display an evident analogy with the shelled MOLLUSCA, and one more close with the ENTOMOSTRACA, with which, in its bivalve tribe *Ostracoda*, the present family may be advantageously compared.

The lorica here consists of two lateral segments of an ovoid box, open in front and behind, for the emission of the head and the foot, the two edges parallel and approximate along the dorsal line, and either widely open along the belly, as in *Diaschiza*, or united and soldered into one there, as in *Salpina* and *Diplax*. The front is composed of ciliated prominences, not protected by an arching hood; the foot is provided with two furcate toes.—P.H.G.]

Genus DIASCHIZA, *Gosse*, gen. nov.

[GEN. CH. **Body** *compressed; the dorsal half of the trunk inclosed in a carapace, which is split medially; one* **eye** *present, usually cervical;* **trophi** *virgate, not distinguishable from those of* Furcularia; **toes** *long, blade-like, furcate.*

This well-marked group, now consisting of seven species, was wholly unsuspected a few months ago. One after another has occurred to my own observation, within the past year, and I strongly suspect that other species will yet be discovered. The genus forms a very striking link of connection between the Loricate and Il-loricate sub-orders, as will be shown, more in detail, under the remarkable species *D. semiaperta*.—P.H.G.]

D. VALGA, *Gosse*, sp. nov.

(Pl. XXII. fig. 12.)

[SP. CH. **Lorica** *decurved;* **eye** *occipital, small;* **toes** *long, slender, much decurved.*

Among filaments of *Myriophyllum*, growing in an aquarium, very thickly beset with various *Diatomaceæ*, &c., appeared in March 1885 an active, restless, little creature,

which, at first, I thought one of the common forms of the minuter *Notommatæ* or *Furculariæ*. But I presently perceived that it had peculiarities of structure, which were quite unfamiliar to me. Its figure is nearly that of a cylinder, somewhat bowed downward at each end, and a little arched along the dorsal line. A small truncate **foot** carries two slender toes, about two-thirds as long as the body, much decurved, so as to form a segment of one-fourth of a circle; these are usually carried wide apart. A large **brain** bears a red **eye**-point considerably anterior to its extremity, visible only at intervals; in subsequent specimens, however, sufficiently conspicuous.

The whole form and manners of this animal indicate its affinity with species which are il-loricate. The situation, dimensions, and structure of the manducatory apparatus are indistinguishable from those of *Notomm. lacinulata*; yet the dorsal parts are inclosed in a semi-cylindrical shell of transparent chitine, reaching about half-way down each side, with a straight edge; and cleft throughout the dorsal line, into two parallel halves, moderately separated (reminding us of a *Salpina*, or still more of my *Diplax compressa*), reaching to the end of the body, where each terminates in a point slightly over-arching. Anteriorly this bifid carapace terminates transversely at what may be called the neck, allowing the soft tissues of the head to be partially retracted for an instant, when the lateral angles of the lorica are seen as two unchanged blunt points. It is remarkable that, in a lateral view, the very front itself appears as if the integument were so stiffened with chitine as to project both above and below in slightly obtuse points (fig. 12*a*). I soon after found two individuals among conferva in a ditch at Coffin's Well, near Torquay; and still later in waters from many widespread localities. I find little variation in them. The dorsal cleft is shallow, but always visible when the animal turns.—P.H.G.]

Length. Of body, $\frac{1}{260}$ inch; of toes, $\frac{1}{320}$ inch; total, $\frac{1}{114}$ inch. **Habitat.** Torquay; Woolston; Sandhurst; Birmingham; Cheltenham; Oban (P.H.G.): not rare.

D. EXIGUA, *Gosse*, sp. nov.

(Pl. XXII. fig. 13.)

[SP. CH. *Minute;* **lorica** *flexible, constantly thrown into folds;* **eye** *cervical;* **toes** *thick at their base, less than one fourth of total length.*

On one or two occasions I had met with this little species in water sent me by Miss Saunders, from a window tank in her residence at Cheltenham. I had marked differences between it and *D. valga*, but yet set it down as that species, waiting for further light. More than five months afterwards, I was examining some of the pale impalpable floccose alga that grows thickly around the filaments of certain pond-weeds, originally from Dundee, but which had been several weeks on my table, when I saw this little thing in some number, and perceived that its peculiarities entitle it to specific rank. Though *valga* is a small species, this is not half its size; its proportions, too, are different. It is much plumper and more gibbous behind; the **toes**, instead of slender rods uniform in thickness, are long cones, tapering to acute points, and only one-third of the length of the head and body. The investing integument is evidently very flexible, every contraction and every turn throwing it into strong folds. Yet, thin as it is, it is a true **lorica**, reaching half-way down each side, as in *valga*, and displaying the dorsal fissure quite distinctly, as one views it from behind; when it is seen to be very shallow. No other points in its economy seem noteworthy.—P.H.G.]

Length, $\frac{1}{325}$ to $\frac{1}{400}$ inch; toes alone, $\frac{1}{1300}$ to $\frac{1}{1700}$ inch; lorica, $\frac{1}{500}$ inch. **Habitat.** Algæ in fresh-water aquaria (P.H.G.): rare.

D. Hoodii, *Gosse*, sp. nov.

(Pl. XXII. fig. 15.)

[SP. CH. **Body** *gibbous and ventricose behind;* **dorsal cleft** *narrow, parallel-sided;* **eye** *cervical;* **toes** *rather short, blade-shaped, acute, decurved, one-fifth of total length.*

This little species comes near to *D. valga*, but is considerably larger, and more swollen in the posterior half of the body, whether viewed dorsally or laterally. The **toes** afford the most obvious discrimination between them. In both, each toe is a segment of a circle: in *valga* it is a slender rod of about equal thickness throughout its length, which is nearly equal to that of the lorica. In *Hoodii* it is shaped in one aspect like a carving-knife, in another like the half of the moon when three days old. As I have observed the forms of the toes in Rotifera generally to be very constant, I am disposed to rely much on them in specific diagnosis.

Only one individual occurred; and of this my observations were imperfect. I found it in the pale floccose alga, which invests aquatic plants near Dundee. In memory of this origin I honour the little *Diaschiza* with my respected correspondent's name. A few weeks after this, I was so fortunate as to find another example, in water sent me by Mr. Bolton, from Blackroot Pond, near Birmingham. In the former specimen I had not perceived any **eye**; but in this it was very conspicuous, of large size, and of somewhat pale rose-red hue, though brilliant, resembling *D. pæta* in colour, but in a less marked degree. It is cervical, occupying the extremity of an ample **brain**.—P.H.G.]

Length. Not measured, but about one and a half that of *D. valga*. **Habitat.** Loch near Dundee; pool near Birmingham (P.H.G.): rare.

D. pæta, *Gosse*, sp. nov.

(Pl. XXII. fig. 11.)

[SP. CH. **Body** *thick, widest in front;* **lorica** *with the dorsal cleft very narrow, its edges parallel and ridged;* **eye** *cervical, very large, pale;* **toes** *blade-like, recurved.*

In June 1885, soon after I had discovered *D. valga*, a little water was sent me by Miss Saunders, from Woolston, in which were a good many specimens of that species, some much smaller than I have described. In the same water, however, I found one much larger, which proved a second species of the same genus. Again was I deceived into the supposition that I was dealing with a *Notommata*, or a *Furcularia*, such as *F. gibba*, till I caught sight of the cleft down the back; and particularly, when, as the creature turned, I for a moment saw it from behind, and looked up along the furrow.

The **lorica** seems again to be a mere carapace, reaching no more than half-way down the sides, and cleft in a straight line along the back. It has an elevated **ridge** throughout; so that the cleft forms a furrow between the low walls; and these are much closer together than in *D. valga*, so that the furrow is very narrow. The dorsal posterior terminations do not run off into curved points, but make nearly right-angles. I judge the lorica to be very thin and flexible. The **toes** are slender, pointed blades, somewhat recurved, often carried parallel when the animal glides forward. The **mastax** is large, and seems formed quite on the pattern seen in *Furcularia*. Behind this is an ample **brain**, carrying at its sacculate extremity a *very large* globose **eye**, of *extremely pale*, transparent, carneous hue; this species differing thus from the former, in the position, size, and colour of the eye,—itself a well-marked and conspicuous distinction. The digestive canal is divided into stomach and intestine, both which are large and sacculate; and there is a **contractile vesicle**. The forepart of the abdominal viscera was, in this example, delicately tinged of a salmon-colour. At the cloaca, as if a minute portion of the intestine, there was protruded a little clear globose vesicle; perhaps accidental.

This species is in manners restless and recluse, seeking its food and shelter under

the skins of decaying algæ, and other aquatic plants. It seems reluctant to swim in the open water; but yet can glide along, smoothly and swiftly, when it pleases.

Three months had nearly passed, and I had met with no second example of this beautiful species, though examples of *valga* and *semiaperta* had been numerous. But then, in water from the same fruitful pond at Woolston, a specimen occurred, which seemed the counterpart of *pæta*, except that the great brain was destitute, so far as I could discern, of the pink eye, which had been the most conspicuous distinction of the species. Presently, however, another appeared; and here the whole occiput was instantly seen to be radiant with the soft, rose-red tint; the eye, in fact, or at least its pigment, occupying, just as in my first example, the whole lower part of the ample cerebral sac. Hence I infer that the rosy hue, normally pale, may sometimes become so dilute as to be practically undiscernible.—P.H.G.]

Length, $\frac{1}{110}$ inch. **Habitat.** Woolston Pond; Sandhurst, Berks: rare (P.H.G.).

D. SEMIAPERTA, *Gosse*, sp. nov.

(Pl. XXII. fig. 10.)

[SP. CH. **Body** *compressed, highest behind;* **lorica** *with the dorsal cleft closed in front, gaping behind, the ventral edges apparently approximate;* **eye** *frontal;* **toes** *long, slender, recurved.*

In describing *Furcularia gibba* (*supra*, ii. 43) I have spoken of the resemblance borne to that species by the present, a resemblance which extends to other species.

D. semiaperta bears much likeness to *D. pæta*, but is still larger; it is, too, higher behind, and the **brain** has no pink colour. There is, indeed, a well-defined oval **eye**, of *deep* red hue, but of moderate size, and situate near the front (fig. 10*b*). The brain is large, descending far down the back of the neck, quite clear, and strongly defined in outline. The locomotive cilia appear set on minute eminences over the whole rounded front, making no wheels, but visible as a simple fringe. The **trophi** are unusually large (fig. 10*d* [1]). The **lorica**, though split all down the back, has the edges of the fissure in contact at first, so that only the hinder half is open, and this but narrowly. In a succession of fair views that I had of one which was dying, looking down the back from the front of the head, not only was the gape of the lorica well seen to be but partial, but it evidently appeared that the cleft part was not elevated into a ridge, as it is in other species. The lorica-halves *appear* even to approach along the belly, as they do along the back. But I am not certain of this. Each division terminates behind in an obtuse, slightly-decurved point (fig. 10), often obliterate.

One individual of this species had two globose bladders protruding from the cloaca, as I have described in *D. pæta*. It may indicate a prevalent form of disease in the genus. In one specimen was a large dark egg, nearly matured. Another had the alimentary canal greatly distended, and of a greyish-blue hue, an unusual colour in Rotifera; but the mystery was explained by the fact that a colony of the Blue Stentor (*S. cæruleus*) was established on the same sprig of water-moss; and it became evident where the *Diaschiza* had obtained its dinner.—P.H.G.]

Length. Total, $\frac{1}{120}$ to $\frac{1}{88}$ inch. **Habitat.** Cheltenham; Woolston, numerous; Birmingham; Stormont Loch, Scotland (P.H.G.): pools, rather common.

[1] This drawing was made from a protracted and excellent observation of a recently dead specimen, completed without any reference to my published figs. (*Phil. Trans.* 1886). Yet it is seen how exactly the details agree with those figs. (35–40), and especially with 39 and 40 of the Memoir. In examining many dead specimens of *D. semiaperta*, I have obtained accurately the appearance of fig. 37; the long produced, decurved points of the incus explaining what had seemed so inexplicable *in situ*. I am, however, almost sure that these arching points proceed from the *fulcrum* between the *rami*, and are not prolongations of the wide glassy *rami* themselves.

D. TENUIOR, *Gosse*, sp. nov.

(Pl. XXII. fig. 14.)

[SP. CH. **Body** *sub-cylindrical;* **dorsal cleft** *of lorica wide throughout;* **toes** *thick, nearly straight, obtusely pointed.*

Here is a species which bears a relation to *Furcularia gracilis*,[1] similar to that which *D. semiaperta* bears to *F. gibba*. In September, 1885, while I was examining water, sent me by the courtesy of Miss Davies from Woolston Pond, my attention was arrested by first one and presently another, of what appeared indubitable *F. gracilis*. Each was either half-concealed, as it burrowed in the floccose matter, or in swift motion as it glided through the clear water; so that, while I could recognize the form and general character as accurately agreeing with drawings which I had carefully made of that species, many years before (except that these were of rather stouter build), I could get no opportunity of testing the condition of the back. Presently, however, I was so fortunate as to catch sight of the **integument** of a dead specimen of the same, perfect in form, but empty and transparent, the mastax *in situ*. By imparting currents to the water in the live-box, while the object was under my eye, I could turn it into various positions; among others, one in which I could look along the line of the back. It was distinctly double-ridged, and rather wide-cleft. The gap is of nearly uniform width from the occipital edge of the lorica to the hinder edge just over the foot. I have said that the form was stouter than of *F. gracilis*; it appeared stouter now than in the two living restless examples that had first attracted my attention. But I reflected that the dead lorica would naturally be broader than in life, because, the tegumentary membrane of the venter having been ruptured by decay, the elasticity of the dorsal shields would naturally cause their lateral expansion.

Circumstances prevented my further study of the two living specimens; and I can give no further information of the anatomy than what was to be learned from the dead body.[2] The features, however, that were visible were, from the very stillness of death, definable with precision. The **toes**, in particular, are diverse from those of any other known species, being not sensibly recurved nor decurved, but straight, or nearly, not blade-shaped, but round, rather thick, abruptly brought to a point.—P.H.G.]

Length. About $\frac{1}{120}$ inch. **Habitat.** Woolston Pond; Dundee (P.H.G.): rare.

Genus DIPLAX, *Gosse*.

(*Ann. Nat. Hist.* 2 Ser. vol. viii. Sept. 1851, p. 201.)

[GEN. CH. *As* Salpina, *but the* **eye** *is wanting, and the* **lorica** *is destitute of spines in front and rear;* **foot** *and* **toes** *long and slender.*

The two species of this genus I found both in the same water, Oldham's Pond, Leamington, and both on one day, July 13, 1850. Of the first, only one specimen occurred; the second was numerous. With a single exception of the latter, I have never again met with either. They both approach very close to *Salpina*, but the absence of spines is notable, and the toes are proportionally more attenuate and longer. The head is seated in a flexible tube, cleft at the occiput, which is capable of entire involution within the lorica. It seems an approach to the persistent neck-tube of *Dinocharis*, to which genus the present is allied by the condyles of the foot, and by the length and slenderness of the toes.—P.H.G.]

[1] I strongly suspect that Herr Eckstein's delineation of *F. gracilis* (*Sieb. u. Köll.* 1883, pl. xxvi. fig. 43) has actually been drawn from a specimen of *Diasch. tenuior*.

[2] Recently (March 1886) I have found it, in an aquatic moss sent me by Mr. Hood. It was very restless, but I saw that the trophi, viewed dorsally, were on the pattern of *Notommata lacinulata*.—P.H.G.

D. COMPRESSA, *Gosse*.

(Pl. XXII. fig. 8.)

Diplax compressa . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. Sept. 1851, p. 201.

[SP. CH. **Body** *much compressed; lateral* **outline** *of lorica nearly a parallelogram.*

The **lorica** consists of two trapezoidal plates, of which the ventral is the longest side, connected together a little within the dorsal edges, so as to leave a double ridge. The plates are bowed outward, laterally, and seem to be conjoined below. The whole lorica may be rudely compared to a cell made by two spoon-bowls soldered edge to edge. The transparent dorsal ridges can approach and recede, and are probably connected merely by elastic skin. The whole frontal region is occupied by the **brain**, which descends sac-like into the occiput, but shows no trace of **eye**. The **mastax** is small, and the trophi obscure. A digestive canal, very wide at its origin, almost opaque from granulation, diminishes, with no apparent constriction, direct to the cloaca in a straight course. The **ovary** was normal, and I saw an ample **contractile vesicle** of sluggish action. No **lateral** vessels were traced, but one **vibratile tag** was seen. Along the line which, in the lateral view (fig. 8), indicates the bottom of the dorsal cleft, there are seen three oval scars, possibly insertions of muscles for closing the valves. The **foot** consists of three lengthened joints, two of which are decidedly condyliform (as in *Dinocharis*), habitually protruded; it carries two divergent toes, straight, rod-like, acute.

The manners of the single specimen found were much like those of *Salpina*, but it swam more, rarely resting on its toes. It was found among the sediment in the phial, after several days' keeping.—P.H.G.]

Length. Of lorica, $\frac{1}{176}$ inch; total, when rotating, $\frac{1}{110}$ inch. **Habitat.** Leamington (P.H.G.): rare.

D. TRIGONA, *Gosse*.

(Pl. XXII. fig. 9.)

Diplax trigona . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. Sept. 1851, p. 201.

[SP. CH. **Body** *triangular in section; lateral* **outline** *of lorica ovate.*

There is much resemblance between this and the preceding; but the ventral side is flat, and about equal to each of the lateral sides; and the longitudinal outline of the back forms one third of a circle. The pectoral edge, which in *D. compressa* is but slightly notched, is in *trigona* indented with a broad and deep sinus (fig. 9). The neck-tube which incloses the head is only so far retractile, that, when its sides are brought together, they protrude between the lorica-edges, in form of a thin fold (fig. 9*a*). The frontal cilia are strong and bristle-like, grouped on prominences; behind which a very small **brain-sac** descends, with no visible eye. The **trophi**, of the common *Salpina* pattern, and the internal structure generally, are as in the preceding; almost always obscured by a vast aggregation of air-bubbles. A thick **tortuous vessel** runs down each side. The **toes** are very slender, straight rods, in some examples much longer than here figured. The surface of the lorica is delicately punctured.—P.H.G.]

Length. Of lorica, $\frac{1}{160}$ inch; total, $\frac{1}{90}$ inch. **Habitat.** Leamington; Stratford (P.H.G.): rare.

Genus SALPINA, *Ehrenberg*.

[GEN. CH. **Lorica** *an oblong box, furnished with spines, but widely open at each end, split down the back;* **head** *and* **foot** *protrusile;* **toes** *furcate, long, straight;* **trophi** *sub-malleate;* **eye** *single, cervical.*

A homely illustration of this common and well-marked genus may be obtained by supposing a *Notommata* or *Diglena* of long straight toes inclosed in a transparent shell. This shell, the **lorica**, may be compared to a pillow-case, open at the two ends, with one

long side (the dorsal) unsewn, whose edges remain approximate, yet separate.[1] Both ends run off into projecting points, which are grouped into four series, *occipital* and *pectoral* in front, *lumbar* and *alvine* behind; and these terms may be convenient for definition. The head can be retracted wholly within the lorica; but the **foot** only partially, and the toes never. These are moderately long, blade-shaped, acute, straight, divergent. The **eye** is usually conspicuous, single, rather large, placed on the occipital end of an ample **brain**. The **mastax** is large, globose, the **mallei** and incus well-developed, the former many-fingered. A bristle-bearing **antenna** is protruded between the occipital spines.—P.H.G.]

S. MUCRONATA, *Ehrenberg*.

(Pl. XXII. fig. 1.)

Salpina mucronata . . . Ehrenberg, *Die Infus.* 1838, p. 469, Taf. lviii. fig. 4.

[SP. CH. **Occipital spines** *two, procurved;* **pectoral** *two, wide apart, separated by a deep sinus;* **lumbar** *single, short;* **alvine** *two, recurved, separated by a wide and deep sinus; dorsal parts of the lorica minutely stippled.*

The **lorica** is somewhat three-sided, the back arched, and doubly ridged, with a narrow but deep furrow; the sides gracefully swelling; the belly nearly flat. The two **occipital spines**, antler-like, are bent forward and slightly approximate at their points, with a deep sinus between their bases. From the two edges of this sinus spring the two dorsal carinæ, arching to the middle in an elegant curve, and meeting in the conical lumbar spine. The two pectoral spines are short and nearly lateral, as are the two alvine; both pairs are mutually severed by a broad and deep excavation of the ventral surface of the lorica, while a similar sinus, less deep, bounds each of these pairs on the right and left. The flat ventral surface bulges out abruptly to form the pectoral spines. The head is very large, and is composed of many globose lobes, each of which carries a group of rotating cilia. An ample **brain** carries a small horizontal antenna, and a large cervical crimson **eye**. The **trophi** are frequently seen to protrude obliquely from the front, to nibble the floccose matters on which the animal feeds, which are, I think, exclusively vegetable. The **alimentary canal**, large and very sacculate, following a short œsophagus, carries two ovate clear **glands**, and leads (apparently without division) to the cloaca. In an experiment, it readily received carmine. An **ovary** often shews embryonic vesicles; and sometimes a great maturing egg adds to the size and to the beauty of the animal. The lorica is elastic; in looking up along the cleft I have distinctly seen the ridges approach and recede, sometimes nearly closing up and then gaping widely. The latter is coincident with retraction of the head-parts, and at the same time some of the viscera are forced up between the ridges, considerably above the level of their basal line (fig. 1).

Though active, it does not swim much. It chiefly courses up and down among the roots of the duckweed, which it affects, examining each in detail. It is not very sensitive to alarm, caring little for taps or jars upon the instrument. The toes are often expanded and closed. It is nearly colourless.—P.H.G.]

Mr. E. C. Bousfield has seen a male *Salpina* attached by its penis to a female which was probably *S. mucronata*. It seemed to him that the male organ pierced the ventral surface of the foot at the base of the first joint. This appearance was doubtless due to the male's adhering externally by the broad end of the retroverted penis. Dr. Plate[2] says that the male of *Hydatina senta* pierces the female, anywhere, with its penis. He admits that he has never seen the organ within the female's body, and that he never could find any aperture after the apparent penetration; but suggests that the cilia of

[1] The dorsal fissure is not of fixed width, but variable at the will of the animal. An example (not quite mature) of *S. brevispina*, which was sitting quite still, end-on, so as to give me an excellent sight, had its dorsal cleft rather wide open; while I looked at it, it deliberately closed up the sides to mutual contact.

[2] *Jenaisch. Zeits. f. Natur.* 1885, p. 37.

the penis make very minute punctures in the skin, and that the rod-like spermatozoa find their way through these. Such hypothesis scarcely requires serious notice; but I may mention that Mr. Brightwell, Mr. Gosse, Mr. Hood, and myself have all seen coïtus take place, in various Rotifera, at the cloaca.

Length. About $\frac{1}{100}$ inch; lorica, $\frac{1}{150}$ inch. **Habitat.** Weedy pools; duckweed; around London (P.H.G.); Sandhurst, Berks (Dr. Collins).

S. SPINIGERA, *Ehrenberg*.

(Pl. XXII. fig. 2.)

Salpina spinigera . . . Ehrenberg, *Die Infus.* 1838, p. 470, Taf. lviii. fig. 5.

[SP. CH. **Occipital** *and* **pectoral spines** *scarcely diverse from the preceding;* **lumbar** *a long, slender, acute spine, slightly recurved;* **alvine pair** *slightly divergent and decurved; sinuses separating the occipital from the pectoral, and the lumbar from the alvine, with straight bottoms.*

The species of this genus are so consimilar that little more is needful than an enumeration of the points of technical difference. These will be better discerned from the figures than from verbal description. Though minute, they are constant, and I think, therefore, specific. The most marked, here, is the production of the **lumbar point** into a true spine in which the ridges meet, and which takes a direction different from their outline. The sides have oblique corrugations; and the general surface is coarsely stippled in various degrees. The **eye** is large and pale red. It is certainly a rare form; yet I have met with it on various occasions.—P.H.G.].

Length. Of lorica, $\frac{1}{150}$ inch. **Habitat.** Pools at Battersea Rise; Hampstead Heath; Leamington; on *Ceratophyllum* (P.H.G.).

S. BREVISPINA, *Ehrenberg*.

(Pl. XXII. fig. 4.)

Salpina brevispina . . . Ehrenberg, *Die Infus.* 1838, p. 470, Taf. lviii. fig. 8.

[SP CH. **Occipital spines** *wholly wanting;* **pectoral pair** *short and straight;* **lumbar** *and* **alvine** *as in* mucronata.

The total lack of the pair of **occipital spines** to the lorica is a clear distinction of this species, the anterior extremities of the dorsal carinæ not sensibly projecting beyond the level of its truncate front, which, however, is not quite a straight line. The dorsal arch, and the lumbar joint which terminates it, are nearly as in *mucronata*, only the point is much shorter, and the sinus between it and each alvine spine is circular. The surface is delicately stippled or covered with impressed dots. The ventral plane of the lorica has not that abrupt bulging, which marks both the preceding species; the dorsal is more strongly arched than in either.

This species is sufficiently common in the fine-leafed aquatic vegetation of ponds and ditches. Its manners are precisely such as have been recently described. I do not know how to distinguish between this and the *S. redunca* of the same author.—P.H.G.]

Length. About $\frac{1}{150}$ inch. **Habitat.** Lakes and pools: very common (P.H.G.).

S. MACRACANTHA, *Gosse*, sp. nov.

(Pl. XXII. fig. 6.)

[SP. CH. **Occipital spines** *wanting;* **pectoral pair** *short, straight;* **lumbar spine** *and* **alvine pair** *long, straight; the latter much longer than the former; the anterior and posterior ends of the ventral side of the lorica deeply excised; lorica-surface not stippled.*

The **lorica** of this fine species is ventricose; the dorsal cleft is widely gaping. The lumbar union of the carinæ forms a true spine comparatively long and slender, yet is

much exceeded by the stout straight and long alvines. For many years I knew it only by a single dead specimen found in a pool at Maidenhead in September 1851. But recently (March, 1885) I met with a healthy example on *Myriophyllum* in one of my reservoirs at Torquay, which enabled me to complete my diagnosis and delineation.

The great head is sub-lobate, beset with brushes of cilia, stout in the middle, becoming more slender on all sides. A great occipital **brain** carries a very large and brilliant red **eye**, and a rounded **antennal lobe**, bearing a few setæ. The great **mastax**, when feeding, is protruded through the mental sinus. The abdominal viscera are normal, except that the **gastric glands** seem wanting; and there appear to be two **contractile vesicles**, into which the two lateral canals open by a trumpet-shaped mouth.

The manners were similar to those of other *Salpinæ*, nibbling eagerly and perseveringly, as it crept, the vegetable surface of the milfoil, with its protruded trophi.

After it had remained in energy for several hours, I killed it, by mingling with the water in the live-box a minute drop of sol. caust. pot., whereby all the soft parts were instantly dissolved. There remained, however, uninjured, 1, the great red eye, which, in one aspect, had a quadrate form: 2, the two toes: 3, the whole manducatory apparatus. A few minute air-bubbles were scattered through the visceral cavity. I could now discern that the surface of the lorica is not at all scabrous, by which (as well as by the other peculiarities already adduced) it may well be distinguished from Ehrenberg's *S. ventralis*, to which it yet approximates.—P.H.G.]

Length. Of lorica, $\frac{1}{78}$ inch; breadth and depth, each $\frac{1}{200}$; length of toes, $\frac{1}{900}$.
Habitat. Maidenhead; Torquay (P.H.G.).

S. EUSTALA, *Gosse*, sp. nov.

(Pl. XXII. fig. 5.)

[SP. CH. **Occipital spines** *wanting;* **pectoral pair** *short, incurved;* **lumbar spine** *conical, short, arched;* **alvine pair** *very long, stout, and incurved;* **dorsal cleft** *narrow, of equal width.*

The **lorica** is gracefully ventricose, the back and sides being much arched, the belly slightly. The great alvine spines strike attention, as a conspicuous feature in all aspects; they being long, thick at their bases, and incurved to the points, which are obtuse and approach each other. The lumbar spine is the united termination of the two dorsal ridges; it is only half the length of the alvines, conical and sharp-pointed, slightly arched on the dorsal edge. The dorsal cleft, narrow and of equal width throughout, reaches to the very front edge, which then is nearly horizontal on each side, but on reaching the pectoral side, after a deep sinus, rises to a short sharp spine. The whole surface of the lorica, ventral as well as dorsal, appears stippled or punctured with minute sunken dots. But, in some examples, this is hardly perceptible; while, in others, it is coarse and conspicuous. The head, viewed laterally, is about as deep as the body; the front is made up of an intricate series of eminences (carefully delineated in fig. 5*a*); one large lobe, toward the *mentum*, is crowned with stout and long cilia, which curve forward uniformly when in vigorous motion; other lobes carry much finer, shorter, and straighter cilia. There is a thick, obtuse, **antennal lobe**, bearing a brush of fine setæ near, *but not at*, its extremity; and, within its walls, are seen curves and lines connected interiorly with a great descending **brain**, near the point of which is a round red **eye**. The internal structure is, in general, normal. But what appears peculiar is that there are (if I have not greatly erred) two coequal and consimilar contractile bladders symmetrically placed, large and conspicuous, each of which receives the dilated end of a lateral vessel.[1] And this does not seem to be a series of twisted cords, but a long slender sac, dilated here and there, where globular vacuoles are seen within.

[1] These vesicles were exactly alike, each subtrigonal, seated (optically) on each side of the circular orifice for the outlet of the foot. Each was evidently the terminus of the respiratory apparatus of its side, which, a rather wide ribbon or bag of clear tissue, containing several vacuoles, opens by a trumpet-

This large and handsome species, one of the finest of the *Salpinæ*, I was at first inclined to identify with *S. redunca* of Ehr.; but it is more than double the size of that species, and the great development of its alvine spines sufficiently distinguishes it. It may be regarded as bearing the same relation to *redunca* as *S. macracantha* bears to *ventralis*. I have seen several examples; one from the Lake at The Grove, Stanmore, the residence of my esteemed relative, Mrs. George Brightwen.—P.H.G.]

Length, $\frac{1}{82}$ inch; horizontal width, $\frac{1}{175}$ inch; depth, $\frac{1}{235}$ inch. **Habitat.** Woolston; Stanmore (P.H.G.); rare.

S. SULCATA, *Gosse*, sp. nov.

(Pl. XXII. fig. 7.)

[SP. CH. **Occipital spines** *two, slightly procurved;* **pectoral** *two, straight, acute;* **lumbar** *single, short, with a widened base;* **alvines** *longer, straight;* **dorsal cleft** *very wide, with outcurved edges.*

The **lorica** is of the usual outline, but somewhat wide, both in the vertical and lateral aspects. Of the anterior spines the pectoral are the shorter and straight, the occipital incurved. In the rear, the alvine pair the longer, and recurved; the lumbar short, straight, acute, with an abruptly widened cuneate base. From this lumbar point two dorsal ridges run up, curving outward to the occipital spines (figs. 7, 7*b*), inclosing a shallow depression, which appears covered with only membranous integument. The lorica, on the ventral surface, is quite continuous and evenly rounded. I had some protracted and satisfactory sights of the creature in various positions, particularly from a point directly in the rear, and at different angles, by which I distinctly saw the dorsal furrow. One of these views is carefully delineated at fig. 7*b*.

I know this form only from a single specimen just dead (but with the soft parts not yet decayed), which occurred, Sept 14, 1885, in water from Woolston Pond, sent me just a month before. It seems to be undescribed, yet well-marked by its broad dorsal furrow, widening forward. It has no relationship with Ehrenberg's *S. bicarinata*, from which, however (to judge by his figures,—for of diagnosis he gives none), it is sufficiently distinct. It is a small but interesting form.—P.H.G.]

Length. Of lorica, without toes, $\frac{1}{160}$ inch; transverse width, $\frac{1}{315}$ inch. **Habitat.** Woolston (P.H.G.): rare.

[I am indebted for my knowledge of a very distinct species, *S. mutica*, to Dr. Collins's Note-book of pencilled sketches, minute but carefully executed. I have enlarged his figures (Pl. xxii. fig. 3). He has added no note to this form; but his delineations were made from specimens procured from a secluded pool near Sandhurst Military College, in December 1866. He identifies the species with *S. mutica* of Herr Perty.

From these it appears that the lorica does not vary much from the normal form (as in *S. brevispina*, for instance); save that the front is straightly truncate, without any spines, that the dorsal fissure is narrow and shallow throughout, and that it slightly widens behind, where its edges terminate in two very slightly prominent lumbar points: alvines seem wholly wanting. This species looks toward the genus *Diplax*, as *sulcata* looks toward *Diploïs*, yet both appear to be true *Salpinæ*.—P.H.G.]

Genus DIPLOÏS, *Gosse*, gen. nov.

[GEN. CH. **Lorica,** *more or less depressed, ovate in outline; formed of two subequal plates, united by elastic membrane; the* **dorsal plate** *arched, ridged, and split down the middle; the* **ventral** *flat;* **toes** *straight, furcate;* **eye** *single, cervical.*

shaped expansion, into the upper obtuse point of the bladder. (See the description of the preceding species.)

Of the two noble species for which this genus is constituted, the general form and aspect suggest their location in the next family, while the technical characters fix them here. At the first glance at their elegant forms, like ample oval plates of the clearest glass, evidently broader than deep, we hesitate not instantly to pronounce them normal *Euchlanes*; but a moment's observation reveals a fissure through the back, so characteristic of the *Salpinadæ*. The affinity between *Diplois propatula* and *Salpina sulcata* is very close.

The internal organization, so far as observed, agrees with that of *Euchlanis*.

It is possible that the *E. bicarinata* of Herr Perty and the *E. Weissii* of Dr. Leydig may belong to this genus; but I have seen no diagnosis, or figure, of either.—P.H.G.]

D. PROPATULA, *Gosse*, sp. nov.

(Pl. XXIV. fig. 2.)

[SP. CH. **Dorsal cleft** *wide before, closed behind;* **ventral plate** *considerably less in outline, furnished with three spines behind;* **toes** *very long, of uniform thickness.*

This species is broadly ovate, sometimes nearly circular, in outline, the **dorsal plate** strongly arched, and medially ridged; the ridge cleft so widely that the lorica is obliterated at its front in a vertical view, forming an acute point at each side. Each side of the fissure, from the lateral point, approaches the other in a graceful curve, till, at the hind-back, they unite at an acute angle. The posterior margin of the plate extends beyond this, forming the uninterrupted segment of a circle. The ventral plate is of similar outline, but very much smaller, and quite flat. It ends behind in three acute spines, of which the laterals diverge and the middle one projects from the general level. The **foot**, of strongly marked articulations, is protruded between the plates; the toes, of great length and tenuity, are straight, of uniform thickness throughout, with blunt points. No setæ have been detected on the foot-joints. The internal organization presents nothing distinctive, so far as it has been observed.[1]

The interspace between the lorica-plates is considerable; and this, together with the great width of the dorsal cleft, produces a curious effect, as the animal twists about, making the triple character of the lorica, with its points and angles, very apparent.

This distinct and imposing form has but recently come under my personal observation. But it is figured by Dr. F. Collins in his Note-book, from specimens obtained twenty years ago near Sandhurst Mil. Coll. Figs. 2 and 2*a* are carefully copied from his pencil sketches.[2] On two separate occasions I have found the species, at each time in water sent from the original pool, which thus is its only recognised habitat. Its motions are elegant and lively, and its appearance most attractive.—P.H.G.]

Length. Fully extended, about $\frac{1}{60}$ inch. **Habitat.** Pool at Sandhurst, Berks (Dr. Collins; P.H.G.): rare.

D. DAVIESIÆ, *Gosse*, sp. nov.

(Pl. XXIV. fig. 3.)

[SP. CH. **Dorsal cleft** *narrow, parallel-sided, open throughout;* **ventral plate** *nearly equal, with no posterior spines;* **toes** *blade-shaped.*

This species occurred in water dipped from Miller's Pond, Woolston. The **lorica** is decidedly triquetrous, the dorsal plate rising with sides slightly bulging, to what would

[1] It will be observed, however, that while in my own figure (2*a*) the gastric glands are of the ordinary form, Dr. C. has represented a pair of large pyriform sacs, each containing a vacuole, with long and slender ducts which lead from (or into) the œsophagus. These suggest the remarkable structure found in *Pterodina*, to which I refer the reader.

[2] The toes are here represented as out-curved; whereas, in the living examples I have seen, these organs were quite straight. Dr. Collins is a very accurate observer, and the length and curvature of the toes ("slightly curved") are distinctly mentioned in his MS. notes. In his transverse section, moreover, the lorica-plates are much closer together than I have seen them. Possibly, in both these particulars, there is some individual variation.

be a sharp medial line, but that it is split throughout, and so forms a narrow furrow with low walls. Though the *fissure* can be distinctly traced to the occipital edge of the lorica, I am not quite sure that the *ridge*, or *wall*, begins to rise above the dorsum-level quite so early; perhaps not till the middle of the length, and then gradually. The two strong sharp points at the hinder end of the dorsum, so conspicuous in many aspects of the living animal, are but the optical expression of the ends of the dorsal ridges seen vertically. The ventral plate is sensibly less in outline than the dorsal: it is ovate with the pectoral edge truncate; flat, thin, and glassy; at each extremity it becomes delicately membranous. The **foot** consists of three distinct joints, long, and regularly diminishing; they are habitually extruded between the plates, perhaps in a sinus of the ventral; but I am not sure of this. The toes are moderately long, slender, blade-shaped, being (very slightly) dilated beyond the middle, and then rather abruptly pointed. No setæ are visible. The condition of the **dorsal cleft** is not invariable. Sometimes it is seen to extend not more than half-way up from the tip: or even to be closed nearly to the points, expanding there rather suddenly. Possibly the lorica is elastic, and subject to the animal's will; for I have certainly seen the fissure wide throughout. The hyaline transparency of the whole, while it enhances the beauty of the creature, increases the difficulty of discerning all particulars of its structure, even those that are external; especially as, from the incessant movements and changes of axis in swimming, it is almost impossible to focus any one part in any one position. The **front** consists of a number of low prominences, each rising to an obtuse cone, and each crowned with a row of vibrating cilia. The **mastax**, an oblate sphere, presents nothing noteworthy; the **brain** descends sac-like behind it, with a round deep-red **eye** near the middle of its internal side, distinctly crowned with a refracting lens. The stomach and intestine, not separable, occupy a large space in the body-cavity, usually filled with contents of an uniform rich deep-brown hue. This greatly adds to the animal's beauty, as it constantly roves up and down the narrow cells made by the crossing filamentous leaves of *Myriophyllum* in the live-box.

In general form and appearance this species very closely resembles the larger *Euchlanes*, which all its manners and actions perfectly represent, and do not in the least remind one of a *Salpina*. It is a fine addition to our Rotiferous fauna. Since it appears new, I honour it with the name of Miss Davies, of Woolston, Hants: a lady who has long made the Rotifera her special study, and to whose courtesy I am indebted for my first knowledge of the species.

Specimens have come under my observation, not only from the extreme south of England, but, on repeated occasions, from Scotland. It is, however, rare.—P.H.G.]

Length. Extended, $\frac{1}{50}$ inch. **Habitat.** Woolston; Dundee (P.H.G.).

Family XIV. EUCHLANIDÆ.

Lorica *of two dissimilar plates, one dorsal, one ventral, united so as to form two confluent cavities, of which the upper is much the larger;* **foot** *jointed, furcate.*

Genus EUCHLANIS, *Ehrenberg.*

GEN. CH. **Dorsal plate** *with the medial portion arched;* **ventral plate** *nearly flat, usually with a flange on either side;* **eye** *single, just above the mastax.*

There are no more beautiful or perplexing Rotifera than those contained in the genus *Euchlanis*. Their large size and brilliantly transparent loricæ render them most attractive objects for dark-field illumination; and it is by this method of exhibiting them that the true structure of their loricæ can be best determined. The animal must have room enough to swim at its ease, and there must be a few bits of algæ for it to creep on. Then, as it turns while swimming, or as it works its way over and round the weeds, the creature will display all the beauties of its glassy armour; which, invisible at one moment, will flash out at another in broad plates and unsuspected surfaces.

To get a clear notion of the form of the **lorica**,[1] suppose that the shell of a tortoise has its flat base split longitudinally down the middle; and then that half of each part, on either side of the split, is bent down at right-angles to the flat base. Further suppose that a second flat oval plate, smaller than the base, is cemented to the free edges of the bent-down parts, and the resulting form will closely resemble the lorica of an *Euchlanis*. It is obvious that a small box will thus be formed below the true base of the tortoise-shell, and that its cavity will be continuous with that of the shell, and that its bottom will project on either side as a **flange**. Moreover, on the outside of this box, on either side of it, will be a long furrow, bounded by the oval plate above, the flange below, and by the side of the box. In the actual lorica of *Euchlanis* the portion corresponding to the small box, below the true shell, contains a considerable portion of the viscera; while the furrow (when the animal is viewed sidewise) often presents the edges of the two bounding planes so as to look merely like two parallel lines running from front to rear. If we further suppose that the altered tortoise-shell, with its attached second plate, is made of glass, and that it is held up so as to have the lower plate fully exposed to view, it is clear that we shall see *three* sets of **edges**. First the outside edge of the proper base of the shell; secondly, within the first and parallel to it, the smaller oval edge of the lower attached plate; and thirdly, within this latter oval, the edges of the bent portions to which the lower oval plate is attached, and which connect the upper oval plate to the lower one. All these lines can be plainly seen in the ventral surface of *E. dilatata* (Pl. xxiii. fig. 5); where *a* is the edge of the dorsal plate, *b* is the edge of the ventral plate, and *c* the edge of the connecting portion at right-angles to both. The position of the inner two of these three lines varies greatly with the different species, according to the relative sizes of the upper and lower flat plates; and so does the distance between these plates, and consequently the breadth of the longitudinal side furrows. These differences are great helps in distinguishing the species, which have been much confounded. Another assistance is the presence or absence of a sharp **notch** (Pl. xxiii. fig. 2*b*) in the occipital dorsal surface of the lorica. In some species there is no such notch, but a wide gap (Pl. xxiii. fig. 5*a*), and the dorsal portion of the lorica near the head is membranous; so that it has no constant outline when the head is retracted.

Mr. Gosse is of opinion that his two species, *E. deflexa* and *E. pyriformis*, as well as a third lately discovered by him, have no ventral plate, but have a ventral membrane instead of it. On this account, as well as on account of a peculiarity in the structure of their rami, he would separate them from *Euchlanis* as a new genus, under the name *Dapidia*. As, however, we do not agree on the first of these two points, we have thought it better to leave the creatures, for the present, with their names unaltered.

Ehrenberg has made use of delicate **setæ**, which are sometimes found on the foot, in order to separate the species; but neither Mr. Gosse nor myself thinks this a character that can be trusted. For the setæ are difficult to be seen, are liable to injury, and are certainly not constant in their presence in the same species. The internal structure of the various species is so closely alike that a description of it in one species will very nearly serve for that in any other.

E. LYRA, *Hudson*, sp. nov.

(Pl. XXIII. fig. 1.)

SP. CH. **Lorica** *long, narrow, oval, depressed;* **transverse section** *a low circular segment;* **dorsal occipital edge** *membranous;* **hind dorsal edge** *without a notch;* **ventral plate** *with a very narrow flange, of wavy outline, elliptical and broadest at the hind end;* **setæ** *absent.*

[1] Ehrenberg quite misunderstood the lorica of *Euchlanis*, which he imagined to be open down the ventral surface between the two inner lines *c*, *c* (pl. xxiii. fig. 5). This mistake, and the omission to draw or account for the line *b*, *b*, has led to endless confusion in determining the species. Dr. Cohn, however (in *Sieb. u. Köll. Zeits.* ix. 1858, p. 289), fully explained the error about the lines *c*, *c*; but missed the flange of the ventral plate with its edges *b*, *b*.

I found this large and beautiful new *Euchlanis*, in June 1885, in water sent to me by Mr. Thos. Bolton, from Sutton Park, Birmingham. It can be easily recognized by its long oval **dorsal plate**, which has not a trace of a **notch** behind, and by the curiously rounded end of the flange of its ventral plate, which, unlike that of any other *Euchlanis*, is widest at the hind end, and elliptical there in outline. As in *E. dilatata* and *E. macrura*, the dorsal plate is membranous near the head. The creature is very transparent, and it has a way of jerking its toes apart and then keeping them open, which is very characteristic. It has unusually large **foot-glands**, and shows the adhesive nature of their secretion by slowly twirling round, first on one toe and then on the other, for several minutes at a time. From the ventral surface it is easy to see the structure of the **corona**. It is truncate, and gouged out, as it were, above the buccal orifice, somewhat in the fashion of *Hydatina senta* (Pl. xiv. fig. 1*c*). A fringe of small **cilia** surrounds its outer and inner edges, and on the face of the corona itself are curves of larger cilia, whose ground plan is shown in black lines in Pl. C. fig. 10. Two **papillæ** rise from the same surface, very visible on a dorsal view, which seem to be tubular, but in which I have never detected anything like a tactile organ. Dr. Plate[1] figures the similar organs in *E. dilatata* with a triradiate passage down their length. He says that they are covered with a very delicate membrane, and suggests that they serve for respiration. The **trophi** are sub-malleate with five teeth in each uncus. The **stomach** is tied on either side by muscles, which are attached to the border of the lorica at one end and to the middle of the alimentary canal at the other. From these latter points muscular fibres pass diagonally upwards along the surface of the stomach, and by their perpetual contractions throw it into ever-varying folds; while at the same time the lateral muscles twitch the stomach from one side to the other. Yellow oil-globules, often prettily arranged in quincunx fashion, are imbedded in the thick stomach-walls; and in the intestine, which is usually most obvious, the furious motion of its lining cilia can be seen with ease. The **gastric glands** are curiously lobed on the ventral side (fig. 1*a*) and contain large nucleated cells. The **foot-glands** are very long, club-shaped, and bent over almost to the edge of the lorica; they are continued down the short three-jointed foot, and end in each toe in what appear to be three very delicate, adhering, quill-shaped vessels (fig. 1*b*), with their pointed ends near the toe's extremity. The toes are two short, stout, sword-like blades; and, so far as I could see, without **setæ**. The **vascular system** is conspicuous. Two intertwined lateral canals, hanging in bold loops just on a level with the mastax, and at the summits of the foot-glands, run down each side of the lorica to a large and normally placed **contractile vesicle**. I have seen four vibratile tags on each side: one close to the head, one at the upper loop, another at the lower, and one midway between them; doubtless there is a fifth. The **ovary** is a large cushion-like mass stretching across the venter with unusually large germs: fig. 1*a* shows a maturing ovum. The **nervous ganglion** (fig. 1) is very large, with nearly parallel sides, a scalloped front edge, and a rounded hind end, which is distinctly cellular. It stretches far below the mastax, in front of which, on its inner surface, it bears a dark-red **eye**. Two small setigerous pimples rise from the corona behind the tubular papillæ mentioned above. On the neck is another setigerous eminence, the dorsal **antenna**. I have not succeeded in finding any dorso-lateral antennæ. There are two pairs of longitudinal **muscles** for withdrawing the head, which are plainly striated; the rest of the muscular system is very similar to that already described (i. p. 8) in *Brachionus rubens*.

Length, $\frac{1}{50}$ inch. **Habitat.** A pond in Sutton Park (C.T.H.): rare.

E. DILATATA, *Ehrenberg.*

(Pl. XXIII. fig. 5.)

Euchlanis dilatata . . . Ehrenberg, *Die Infus.* 1838, p. 463, Taf. lviii. fig. 2.
" " . . . . Cohn, *Sieb. u. Köll. Zeits.* ix. 1858, p. 289, Taf. xiii. fig. 4.

[1] *Jenaisch. Zeits. f. Natur.* 1885, Taf. ii. fig. 18.

Euchlanis dilatata . . . Moxon, *Trans. Linn. Soc.* vol. xxiv. 1864, p. 459, with figs.
" " . . . . . Eckstein, *Sieb. u. Köll. Zeits.* xxxix. 1883, p. 385, fig. 33.

SP. CH. **Lorica** *a broad oval;* **dorsal plate** *depressed in front, arched behind;* **transverse section** (*through the highest point*) *a low circular segment;* **dorsal occipital edge** *with a broad gap, joined to the head by a membrane;* **hind dorsal edge** *notched;* **ventral plate** *flat with a broad flange of oval outline;* **trophi** *with five teeth in each uncus.*

This species, like that which precedes and that which follows it, has no occipital **notch** in the dorsal plate, but has a broad gap (fig. 5*a*), which is only visible when the head is completely withdrawn. The edge of the gap is united to the head by a softer continuation of the lorica, which effectually obliterates the gap when the head is protruded. The **lorica**, though depressed, slopes upwards a little to a point not far from the top of a posterior notch in it, and then drops abruptly as if pinched in on either side of the notch. The ventral plate is nearly as wide as the dorsal, and a ventral view shows the edge of its flange running parallel to the edge of the dorsal plate just within it. A side view shows the two edges as two parallel lines near together, and drawn along the animal's side from end to end. Ehrenberg says that there are no **setæ** on the foot, but both Dr. Moxon and Herr Eckstein draw a pair of pedal setæ, and I have met with specimens bearing setæ in no other respect differing from those that lacked them. Dr. Cohn (*loc. cit.*) gives a full description of the **male**. It is a reduced copy of the female with a **sperm-sac** and **penis** taking the place of the alimentary canal and mastax, which as usual are entirely wanting, Dr. Cohn has seen the wand-like **spermatozoa** " swarming " in the sperm-sac.

Length. Female, $\frac{1}{70}$, male, $\frac{1}{95}$ inch. **Habitat.** Clear ponds and ditches: common.

E. MACRURA, *Ehrenberg.*

(Pl. XXIII. fig. 6.)

Euchlanis macrura . . . Ehrenberg, *Die Infus.* 1838, p. 463, Taf. lviii. fig. 1.

SP. CH. " *Closely resembling* E. dilatata; **lorica** *a narrower oval;* **toes** *somewhat longer;* **trophi** *with seven teeth in each uncus; a pair of recurved* **setæ** *on the foot.*"

I have met with an *Euchlanis*, whose figure is given in fig. 6, which had all the above characteristics given by Ehrenberg, but I doubt whether *E. macrura* is a good species, as none of the corresponding characters seem constant in *E. dilatata*, except the number of teeth in each uncus; and, unfortunately, I found several specimens, of what I should otherwise have termed *E. macrura*, with only five teeth in each uncus.

Length. About $\frac{1}{70}$ inch. **Habitat.** Clear ponds and ditches: not uncommon.

E. TRIQUETRA, *Ehrenberg.*

(Pl. XXIII. fig. 4.)

Euchlanis triquetra . . . Ehrenberg, *Die Infus.* 1838, p. 461, Taf. lvii. fig. 8.
" " . . . . . Hudson, *Mon. Micr. J.* viii. 1872, p. 97, pl. xxviii.

SP. CH. **Lorica** *oval, with a high flat median plate at right-angles to the dorsal surface;* **transverse section** (*through the highest point*) *triangular;* **dorsal occipital edge** *notched;* **hind dorsal edge** *notched;* **ventral plate** *concave, and* (*with its flange*) *two-thirds of the width of the dorsal plate;* **trophi** *with five teeth in each uncus.*

This most beautiful species is often to be found among the confervoid growth on the walls of old ponds. Its **lorica** rises in a high thin plate, and is not unlike a delicate glass dish-cover set over an inverted glass dish somewhat narrower than itself. The vertical plate, that thus rises like a crest from the dorsal surface, is very flexible and elastic, and can be easily bent aside by the compressorium without injury. The ventral plate is curved downwards all round its edge, so that the lateral furrow between the two plates is wide; and, as shown in fig. 4*b*, its flange stretches barely half-way across the base of

the dorsal plate. The outline of the dorsal portion of the lorica, when seen directly from the front or rear (fig. 4c), is triangular; the **section**, so obtained, having a base just twice its height. There is a well-marked occipital **notch** (fig. 4*b*) in the dorsal plate, through which a short, stout, dorsal **antenna** usually protrudes. Dr. Grenacher has detected two dorso-lateral antennæ close together "lying near the crest of the lorica." Ehrenberg says that there are no **setæ** on the foot; but I have never failed to find two when using dark-field illumination. The rest of the structure requires no further notice, as it is a tolerably close repetition of that of *E. lyra*.

This is one of the choicest of microscopic objects, when shown in a dark field; especially when it is quietly gliding over and round a few tangled algæ. Its strange armour is now invisible, and now blazes out as it catches the light; while the ruby eye, the daintily-tinted stomach studded with glittering drops on canary-coloured quiltings, the ruddy intestine softened by the tremor of its ceaseless cilia, and the restless head crowned with an ever-varying halo of flashing setæ, form a picture that once seen can never be forgotten.

There is a variety of *E. triquetra*, with a lower **vertical plate**, which I have met with now and then; and which, on several occasions appeared to have but one long **seta** on the foot. Possibly this is Leydig's *E. uniseta* (Pl. xxiii. fig. 3).

Length. Up to $\frac{1}{15}$ inch. **Habitat.** Clear ponds and ditches: not uncommon.

E. DEFLEXA, *Gosse*.

(Pl. XXIV. fig. 1.)

Euchlanis deflexa . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 200.

[SP. CH. *Outline of* **lorica** *ovate;* **ventral gape** *wide, equal, with deep walls;* **toes** *broad, blade-shaped; lateral horns of* **incus** *straight.*

This is a large and very beautiful species. It is not to be distinguished at first sight from a true *Euchlanis*, but the **carapace**, which is highly arched, turns in at the lateral edges, and after proceeding for a space horizontally, *i.e.* across the ventral surface, is bent down at a right-angle to a considerable width and then terminates, as if we might suppose the ventral plate to have been originally flat and continuous; then to have been slit down the middle, and each side to have been bent down at a line midway between the slit and the outer margin. Thus the abdominal cavity is enlarged, and the viscera are protected only by the common integument which is stretched across from edge to edge. This being flexible, a variation of contained space is allowed, for development of eggs, for distension of the alimentary canal, &c., which, in *Euchlanis*, is obtained by the flexibility of the skin that connects the two plates. The lorica is almost circular behind, where a very minute central notch admits the two sides to overlap in the slightest possible degree. The **foot** issues, of course, from the ventral hiatus; it bears two toes, which are thin, flat, and wider in the middle part. The penultimate joint of the foot proper has on its dorsal side a curved projection, which arches over a deep excavation. It carries two pairs of long **setæ**, one or both of which are sometimes wanting. Each toe has a corrugated **mucus-gland** (?) running through it. The broad head is composed of many (ten ?) transparent globate lobes; the front is divided into several pairs of lobes, which carry bundles of cilia. The three strong lines which (with the front) form a square, reaching behind the **mastax**, are puzzling, but I believe they represent the wide, clear brain. The sacculate **stomach** is enormous, with two **gastric glands**; and two glands, beside, are attached to the mastax: there is a small, distinct intestine in which the epithelial cilia may occasionally be seen; a great **ovary**, with embryonic vesicles, and sometimes one (or more) dark ovum maturing. The **branchial tubules**, two or more, contorted and very loosely twisted, carrying four **vibratile tags** on each side, open by *two distinct mouths* on each side, into an ample **contractile vesicle**, just before the cloaca, whose periods are very irregular, even in the same individual: now emptying once in two minutes, then several times per minute. Many **muscles** are seen, some indubitably

striate. An **eye-spot** which appears to be unconnected with the brain, is situate nearer the pectoral than the dorsal side.

I found this species in 1849 in ponds around London, and have seen it often since. It has sometimes occurred so large that even with the naked eye I have had no difficulty in distinguishing the head from the foot.—P.H.G.]

I once found among a number of specimens of *E. deflexa* a perfectly empty **lorica**, belonging to this species, and fortunately standing up vertically, so that it turned round and round on its pointed end, as on a pivot (Pl. xxiv. fig. 1*c*). I was thus enabled to see with the utmost distinctness that it was *closed everywhere* except a large opening in front, where the head had protruded, and a small one behind, that had given a passage to the foot. The **ventral plate** (fig. 1*c*; *v*), as I term it—the **ventral membrane** as Mr. Gosse considers it—had no **flange**, but seemed to me quite as stout and stiff as (not to say stiffer than) the other ventral parts of the lorica. Whatever it was, whether chitinous plate or membrane, it had remained with the rest of the lorica while the softer tissues of the animal had disappeared.

Length, $\frac{1}{80}$ to $\frac{1}{40}$ inch; breadth, $\frac{1}{100}$ inch. **Habitat.** Pools and lakes (P.H.G.; C.T.H.): widespread.

E. PYRIFORMIS, *Gosse*.

(Pl. XXIII. fig. 2.)

Euchlanis pyriformis . . . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 200.

[SP. CH. **Outline of lorica** *constricted in the middle;* **ventral gape** *narrow, widest in front, with shallow walls;* **toes** *narrow, rod-shaped; lateral horns of* **incus** *over-curved.*

The peculiar narrowing of the edge which gives to this species a pear-shaped outline is caused by the edge of the upper plate being curved right under on each side, this edge being formed by two surfaces thinned off to great tenuity, so as practically to become but one layer at some distance from the edge. The under sides then proceed inwards till they nearly meet, when they are bent downwards into shallow walls, just as in *E. deflexa*, which recede from either to form projecting lateral points at the front; while behind they merge into a shallow groove and small sinus, at the end of the upper plate. Along this the **foot** is extruded, which usually has two **setæ**, a prominence and notch, as in the preceding, and two long toes, quite straight, slender, of equal width, except that they are abruptly pointed. The **brain** and whole internal organization scarcely differ from those just described; but the four slender horns that stand up from the sides of the **incus** are curiously bent over outwardly in the form of hooks. The **eye** is small, as in the preceding. In both species the beauty is much enhanced by a line of minute corrugations, running parallel with, and a little within, the margin of the lorica, like the "milling" around the edge of a new coin. **Muscles** in much profusion, longitudinal, transverse, and oblique, are to be defined in this very fine species.

I obtained it first at Battersea Rise, only the day before my discovery of *E. deflexa*. Few specimens occurred, and it has always been a rarity with me. It swims with swiftness and grace; is of sprightly manners; is beautiful and attractive, and being large and brilliantly transparent, is well suited for study.—P.H.G.]

The **transverse section** (fig. 2*a*), was obtained by viewing the animal, which I have drawn in fig. 2, directly in front; it is taken through the turned-in portions of the dorsal plate. It shows that at these spots, the **flange** of the ventral plate (according to my interpretation of the lorica), almost touches the dorsal edge. These curiously bent portions varied somewhat in different specimens; but all my examples had four **setæ** on the foot. The hind portion of the **nervous ganglion** was darker, denser, and more obviously cellular than the fore-part, from which it was separated by a wavy outline. Its front edge was also scalloped like that of *E. lyra*.

Length. Up to $\frac{1}{70}$ inch; of lorica, $\frac{1}{82}$ inch; of toes, $\frac{1}{103}$ inch. **Habitat.** Ornamental waters (P.H.G.); garden pond, Clifton (C.T.H.): rare.

Family XV. CATHYPNADÆ.

[**Body** *inclosed in a* **lorica**, *open at each end, of two plates; the* **dorsal** *more or less elevated; the* **ventral** *nearly flat, the two divided by a deep lateral longitudinal sulcus, covered with flexible membrane;* **toes** *two, or one, always exposed.*

This is a well-marked, easily recognised, and compactly coherent group, the two divisions of the lorica, and their connection, readily identifying its members, notwithstanding the diversity in toes. The appearance, viewed from behind, reminds one of a pair of bellows, if we only imagine the upper board arched instead of flat; the leathers representing the lateral sulci. The toes, in two of the genera, are two, furcate; in the others there is but a single toe: yet the form, position, and use of these organs are so exactly identical, and yet so peculiar, that the genera cannot be dissociated. An ample brain, descending into the occiput, carries a single eye, usually conspicuous. The trophi are large, the mallei much more developed than the incus, virgate.

All the genera are marked by a common habit, which is not found elsewhere. One will rest on the tip of its toe (or toes), and having bent down the whole body, remain motionless, and as if asleep, for a long interval, the whole fore-parts retracted. Then it will seem to awake, and languidly swing round the body, first to the one side, and then to the other, without letting go its moorings, and without protruding its head; and then, perhaps, go to sleep again. Or it may rouse itself into activity, and begin to grope away among the floccose, or glide deliberately off, soon coming again to anchor.

Five species were known to Ehrenberg, who placed the two with furcate toes in the genus *Euchlanis*, with which, however, they have no close affinity.—P.H.G.]

Genus CATHYPNA, *Gosse*, gen. nov.

[GEN. CH. **Lorica** *sub-circular horizontally, usually much arched vertically;* **lateral inangulation** *wide and deep;* **toes** *two, furcate.*

The characters by which the species of this genus are distinguished are sometimes minute, and even obscure, yet constant; the shape assumed by the toes, and especially by the extreme points of these organs, demanding attention. In one group they are narrow, parallel-sided, like a carpenter's rule; in another, much widened in the middle, with the sides curving to the point: the former I call *rod-shaped*, the latter *blade-shaped*. The former, too, do not taper gradually to the tip, but are abruptly narrowed with a right-angle, so as to make a sensible shoulder, whence the point descends as a marked claw. And this may be only on one edge, or on both edges; the toe being one-shouldered or two-shouldered.—P.H.G.]

C. LUNA, *Ehrenberg*.

(Pl. XXIV. fig. 4.)

Euchlanis luna . . . Ehrenberg, *Die Infus.* 1838, p. 462, Taf. lvii., fig. 10.

[SP. CH. **Dorsal and ventral plates of lorica** *sub-equal, occipital edge crescentic;* **toes** *rod-shaped, two-fifths as long as lorica, clawed; the* **claw** *one-shouldered, one-fifth as long as toe.*

The lorica, broadly ovate in horizontal outline, ending in front by a crescentic excavation, and in rear by a small sinus between two points, and the toes, very narrow, parallel-edged, generally carried in contact, with short, sharp claw-tips, may easily serve to identify this common species. The dorsal and ventral plates are of nearly the same form and curvature; high and deep behind, they come into contact in front, at least at the lateral edges, which project in two acute points. During the long retractations of the fore-parts, the lorica may be considered shut by this contact. When activity is resumed, the plates separate, and a broad head protrudes, the front of which is truncate,

with two equidistant incisions, at each of which appears a bristle (fig. 4). The rotating cilia are set along the edge. A mastax of very ample dimensions, with a pair of long malleï, but rather small incus, is always conspicuous. Behind this the occipital brain carries an eye, usually large and brilliant. A great saccate stomach, without sensible œsophagus, with large gastric glands, and followed by a separate intestine, passes obliquely across the dorsal region; and the ovary, as usual, occupies the ventral.[1] In the adult, the surface of the lorica is smooth, and the whole animal is transparent and colourless.

Though individuals swim actively now and then, yet the habitual sluggishness and inertia of the species cannot fail to attract attention. As described, it will balance itself, by the hour, on its united toe-tips, with an occasional lazy swaying to and fro; or even loosen this feeble hold, and allow its body to sprawl away at right-angles to the food-surface, free in the water, the foot being bent up to the belly.—P.H.G.]

Length. Total, $\frac{1}{125}$ inch; of lorica, $\frac{1}{175}$ inch. **Habitat.** Fresh waters (P.H.G.): common everywhere.

C. RUSTICULA, *Gosse*, sp. nov.

(Pl. XXIV. fig. 6.)

[SP. CH. **Lorica** *regularly ovate, with the frontal opening very narrow;* **dorsal surface** *coarsely tesselated;* **ventral plate** *nearly flat;* **toes** *blade-shaped.*

This fine species is very hyaline, notwithstanding that the broadly-oval and arched surface is cut into facets. These are not very regular, nor very distinctly marked, having the appearance of folds in leathery skin. They appear to be limited to the carapace. This is turned-in along each side, with a sharp lateral angle meeting the edge of the ventral plate, similarly turned-in, as is clearly seen when the creature is viewed from behind (fig. 6*b*). The union is doubtless completed by a flexible and extensible membrane.

The head is included between firm plates, which, seen vertically (fig. 6), appear as two lateral projecting points, between which the front, of many conical lobes that carry vibratile cilia, works to and fro. The brain and its lozenge-shaped eye are normal; and so are the great trophi, the stomach with trigonal gastric glands and distinct intestine, and the ovary. A contractile vesicle is sometimes conspicuous, but no details of the respiratory nor of the muscular systems have been defined. A rather thick and short foot, rounded laterally, bears the two toes, which are articulated with round condyles. They are moderately thick blades of fusiform outline, when seen laterally, thinner towards the base, and rather bluntly pointed.

I first met with this form, in July 1885, in the sediment of water in which aquatic weeds had been sent from the north of London. Subsequently other examples occurred, in water from Caversham and Woolston, and from near Dundee, in December.

The earlier specimens were even more clumsy and sluggish than ordinary, moving waywardly from side to side, as if not quite under control, adhering all the while by the toes. Hence I called it *rusticula*. This, when too late, I would have changed; for some were much more attractive, transparently beautiful, with the eye large and of a lovely rose-pink hue, and so sprightly in manners as to be worthy of a more courtly designation. In these, too, the digestive canal was distended with food of a clear rich orange-brown hue. These were Woolston specimens. Scottish examples bred freely and increased in my phials.—P.H.G.]

Length, $\frac{1}{150}$ inch. **Habitat.** Pools throughout England and Scotland (P.H.G.): common.

[1] In one example the ovary was fastened, by two threads with swollen enlargements, to each side of the lorica, near the middle; and the gastric glands were also tied to the same points (fig. 4). Long threads (muscular ?) with like enlargements were seen to pass from the foot-bulb to near the same points, if not higher.

C. SULCATA, *Gosse*, sp. nov.

(Pl. XXIV. fig. 5.)

[SP. CH. **Lorica** *broadly ovate, much elevated;* **anterior edges** *straight;* **ventral plate** *much smaller in outline than dorsal, both strongly fluted;* **toes** *blade-shaped.*

The general form and appearance of this species may cause it to be easily confounded with *luna*, especially when viewed from the side. The arched carapace comes to a sharp edge all round, bending far-in abruptly; then bending outward again with a like angle, and coming to a like edge, to form the ventral plate. This, when seen sidewise (fig. 5*a*), seems to be of the same dimensions as the dorsal; but when seen direct from below it is much less all round (fig. 5*c*), except in front, where the pectoral edge is parallel with the occipital, both being transversely straight, but bounded, as usual, by two small lateral points. Both surfaces are coarsely and deeply fluted; the incised lines of the dorsal passing round and beyond the inbent edge. The bulbous foot projects slightly through an excavation in the dorsal plate's thickness: it is kidney-shaped; in its hollow the toes are articulated. The lorica is, by the graving of its surface, rendered so opaque that the internal organs are not easily defined. There is, however, a small but conspicuous crimson eye in the occiput, and, by inference, a brain. The mastax is so large that, when the head is withdrawn, it occupies fully one-third of the visible area, at the middle of the lorica. Below this appears the ample stomach, dark with digesting food, and (in the condition just named) pushed far up above the mastax on either side.

This well-marked species I obtained in a number of examples, both alive and dead, haunting aquatic moss, in water sent me by Dr. Collins from his historic pool at Sandhurst. For awhile I thought I had got hold of the *Euchl. lynceus* of Ehrenberg, but examination of his text and figures forbade the identification. It is of the usual manners. It often swims smoothly and swiftly, continuing the exercise for long periods without rest, the toes usually carried behind, in mutual contact; yet at intervals anchoring, retracting the head and foot, and assuming still repose, broken, now and then, to sway wildly in all directions, on its glued toes, as on a pivot, *more E. lunæ*.—P.H.G.]

Length. Extended, $\frac{1}{180}$ inch; of lorica, $\frac{1}{360}$ inch; of toes, $\frac{1}{750}$ inch; width of lorica, $\frac{1}{433}$ inch. **Habitat.** Pool at Sandhurst, Berks (P.H.G.): uncommon.

Genus DISTYLA, *Eckstein.*

[GEN. CH. **Lorica** *of the form of a long ellipse, open and membranous before, closed behind, depressed, higher before than behind;* **lateral inangulation** *feeble;* **toes** *two;* "*selvage-like thickenings of the lorica around the foot.*"

Herr Eckstein has described and figured two species of this genus, whose toes bear the same relation to each other as those of *C. luna* and *rusticula*. The genus is closely linked with the preceding; yet the lengthened and flattened form, the habitual protrusion of the head, and the more constant activity of the species distinguish it. Only one of Herr Eckstein's species has occurred with us, but I add (doubtfully) another.—P.H.G.]

D. GISSENSIS, *Eckstein.*

(Pl. XXIV. fig. 8.)

Distyla Gissensis . . . Eckstein, *Sieb. u. Köll. Zeits.* xxxix. 1883, p. 383, pl. xxvii.

[SP. CH. **Lorica** *round behind, broadly truncate in front, with short lateral points;* **toes** *rod-shaped, thick, obscurely two-shouldered, claws small;* **brain** *simple.*

The outline is that of a narrow ellipse abruptly cut-off a little before the middle, so that the lorica, at its truncate front edge, is scarcely diminished in width. It becomes,

however, very thin and flexible, so as to be subject to much inversion in retraction. The head, very freely extruded, is thick and large, a truncate cone, with a slight *auricle* at each lateral angle, and a central bladder-like lobe, which is retractile. The whole head, which is very mobile, projects between two pointed shelly shields. In death, the head being abnormally extruded, these appear as stout oval (or lozenge-shaped) shields, quite separate from the lorica. The foot, of one apparent joint, is bulbous and kidney-shaped; to it are jointed the toes, which are much stouter and shorter than in *Cathypna luna*. They terminate in similar small acute claws, but the shoulders are less sharply angular. It is very thin, viewed laterally (fig. 8*a*). The dorsal plate comes down to a blunt edge on each side, with feeble duplication; the hinder ventral parts, inclosed in membrane, being small, and much overlapped by the clear thin edge of the lorica. A very favourable sight of one, as it *deliberately* turned-up endwise (so slowly, indeed, that I could carefully focus it as it moved), showed that the ventral plate is co-extensive with the dorsal; but is very thin at the edge, sloping upward toward the middle half; this forms a downward arch to contain the viscera.

Herr Eckstein describes the brain in *D. Ludwigii*, as divided into three long sacs, like as in *Copeus centrurus* and *C. Cerberus*. In the present species there seems to be a broad base rather abruptly diminished in width, but forming only one sac, which carries a great crimson ovate eye, at its very point.

I have received the species rather plentifully in water from Mr. Hood; and more sparsely from Mr. Bolton: the former averaging much larger size. Its manners are much more sprightly than those of *Cathypna*. I have also found it (with lorica very flexible and expansible) in spring, in a domestic aquarium of my own, which had remained unchanged for more than a year.—P.H.G.]

Length, $\frac{1}{150}$ to $\frac{1}{100}$ inch; width, $\frac{1}{350}$ to $\frac{1}{250}$ inch. **Habitat.** Bracebridge Pool, Birmingham: rare. Starmont Loch, Dundee: abundant (P.H.G.).

D. FLEXILIS, *Gosse*, sp. nov.

(Pl. XXIV. fig. 7.)

[SP. CH. **Lorica** *narrow, nearly parallel-sided, corrugated, flexible, plicate.*

I am not by any means sure that this is entitled to specific rank; nor, if it is, whether it ought to be placed in the genus *Distyla*. It may be but the immature condition of some other species, such as *C. sulcata*. Yet the condition, *at birth*, of the lorica of *M. cornuta*, appears to forbid the conclusion that flexibility and corrugation are marks of immaturity in this family. A lorica is evidently present, soft and flexible, covered with irregular wrinkles; marked also with a series of longitudinal folds, scarcely amounting to flutings. The eye is large, rectangular, bright rose-red, seated on the inner side of the brain, close to its point. The other organs are normal.

Its manners are lively, often wild, searching the edges and surfaces of the water-moss which it haunts, and often creeping within them. It sometimes anchors by its toes, and appears to go to sleep, just like its brothers and cousins.—P.H.G.]

Length. Expanded, $\frac{1}{200}$ inch. **Habitat.** Sandhurst, Berks (P.H.G.): rare.

Genus MONOSTYLA, *Ehrenberg*.

[GEN. CH. *As* Cathypna, *but that there is only a single toe.*

This group, consisting of numerous species, is so exactly the counterpart of *Cathypna*, *except for the toe*, that one can scarcely avoid the conclusion that this is, structurally, of slight importance. The details of the form, the habits (as the use of the toe as a pivot, and the frequent and long-continued inertia), and even the specific variations in the shape of the toe, all are so accurately the reflection of what has been described as to

suggest that *Cathypna* is *Monostyla* with the toe cleft through the middle, or that *Monostyla* is *Cathypna* with its two parallel toes soldered into one.—P.H.G.]

M. LUNARIS, *Ehrenberg*.

(Pl. XXV. fig. 2.)

Monostyla lunaris . . . . Ehrenberg, *Die Infus.* 1838, p. 460, Taf. lvii., fig. 6.

[SP. CH. **Lorica** *broadly ovate, the dorsal plate round and greatly elevated, the ventral nearly flat; both in front projected into wide, triangular, flattened points, between which the edge is deeply excavate;* **toe** *straight, rod-shaped;* **claw** *protruded between two slender spines.*

The gibbous lorica descends abruptly before it is produced into the wide clear triangular lobes in front. And there seems no noticeable difference in outline, either of the lobes or of the intervening sinus, between the dorsal and the ventral plates. For, in retraction, these are very firmly appressed, with a *common* outline; so that no change of position, and no focusing, makes the eye cognizant of more than a single, somewhat thickened, crescentic line. The general figure is so elevated that it is more than half a sphere, if we neglect the inangulation of the lateral sulcus, which, in this species, is not deep. The foot-bulb appears to lie in a hollow of the ventral plate; it is wide and kidney-shaped behind, where the straight-edged, rod-like toe is articulated. This terminates in a slender acute claw, not with a rectangular shoulder; but with a pair of fine points, between which the claw is, as it were, imbedded. Herr Eckstein describes certain appearances, which he interprets of the thickened lorica-structure, for strengthening the foot against the violent strains endured as the animal throws itself to and fro. He also depicts certain pale-red specks and excessively fine lines, going upwards from the claw, which he would connect with the nervous system, as well as with the mucous glands. "The rotatory organ is simple, but almost retired, so that only a slight elevation with a single seta projects out of the lorica. When it is extended, we discern two great lobes, which overlap the lorica-edge on each side, overreaching each other dorsally, but ventrally running off into the buccal orifice" (*Ibid.*).

A specimen in my possession, anchored by the toe to the glass of the live-box, threw itself vigorously into all possible positions, for twenty-four hours, without once removing;[1] all that time, so far as observed, active in this special way, but close shut-up. The movements, indeed, though constant, were not incessant, but very forceful, spasmodic, and sudden. In general the animal is clear and colourless: of this specimen, the whole body was stained of a yellow-brown hue, like sherry wine, so deep, while yet clear, that no definition of viscera was possible. Yet the red eye was now and then defined, and, under direct sunlight, came out very rich, and of a deep crimson hue. The great triangular lobes of the lorica, being very thin, were quite colourless and glass-like.—P.H.G.]

Length. When extended, $\frac{1}{180}$ to $\frac{1}{140}$ inch. **Habitat.** Woolston; Sandhurst; Thames, near Reading; Snaresbrook (P.H.G.): mostly in pools: not uncommon.

M. CORNUTA, *Ehrenberg*.

(Pl. XXV. fig. 1.)

Monostyla cornuta . . . . Ehrenberg, *Die Infus.* 1838, p. 459, Taf. lvii. fig. 4.

[SP. CH. **Lorica** *ovate, moderately depressed, the front shallowly incurved;* **toe** *somewhat blade-shaped, the* **claw** *without a distinct shoulder.*

This species is very much like *M. lunaris*, so as, when retracted, scarcely to be distinguished from it except that the anterior dorsal edge of the lorica is *slightly* less incurved. It is smaller, and rather more oval in outline; in the act of extruding the

[1] During the latter part of the time, however, it became very sluggish, and less willing to move and jerk about.

frontal disk, and when it is extruded, there is an appearance of two lateral, slender, incurved horns, and between them two spots which look like a pair of ill-defined eyes; neither of which we see in *lunaris*. But these are not what they seem: the horns are the optical effect of the somewhat thickened and stiffened edges of the extruded head-mass, which, in the process of contracting and expanding, incline to each other, resembling conical knobs; and the spots are only the summits of certain fleshy eminences, which bear vibratile cilia. There is a true eye-spot of large size and crescent form, and of pale-red hue, seated on the inner side of the brain-mass, that hangs behind the mastax.

The ventral plate has its pectoral margin quite straight; it is considerably less than the dorsal along each side, while commensurate with it behind. There is a square hollow in it for the reception of the foot-bulb, which is somewhat kidney-shaped. The toe, viewed vertically, is more blade- than rod-shaped, for the outer margins bulge outward in a greater or less degree, the widest part generally (but not invariably) near the point. This point has often the semblance of a claw; but this is illusory, for there is no true angled shoulder. The trophi are of the normal form, but of unusual length. It is a very common species, and from its sluggish habits, combined with its minuteness, the observer is apt to pass it by with contemptuous neglect.—P.H.G.]

Length. Of lorica, $\frac{1}{200}$ inch; total, extended, $\frac{1}{150}$ inch. **Habitat.** Still waters (P.H.G.): common everywhere.

M. BULLA, *Gosse*.

(Pl. XXV. fig. 4.)

Monostyla bulla . . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii., 1851, p. 200.

[SP. CH. **Lorica** *a pointed oval;* **dorsal** *and* **ventral plates** *both gibbous, and nearly co-equal;* **toe** *rod-shaped in vertical aspect, with a two-shouldered* **claw**, *but decurved and gradually tapering in lateral aspect.*

This species I found in a small pool on Hampstead Heath, in August 1850, and, soon after, in the lake of Richmond Park, abundant. Lately it has occurred in water from Woolston, and from Caversham. The yellow hue is not, as I first supposed, invariable. Some are quite colourless, except for the digesting food. The great rotundity of the ventral plate; the regular decurvation of the tapered toe; and the deep narrow sinus in both the occipital and the pectoral fronts of the lorica,—these are the true distinctions. The oval outline is so acute in front that the sinuses are bounded only by two obtuse points. The gibbous dorsum ends behind with an oblique retrocession, showing laterally a great rounded foot-bulb. The head projects in two receding lobes, ciliated on their inner surfaces, just as in *cornuta*. The mallei are certainly two-fingered. The animal burrows among Charæ, Confervæ, &c.—P.H.G.]

Length. Expanded, $\frac{1}{110}$ inch; of lorica, $\frac{1}{175}$ inch. **Habitat.** Pools (P.H.G.).

M. LORDII, *Gosse*, sp. nov.

(Pl. XXV. fig. 5.)

[SP. CH. **Dorsal plate** *of lorica tesselate, its hinder end excavate, the excavation forming three sides of a square;* **toe** *rod-shaped;* **claw** *shouldered.*

This is a rare species, bearing much the same relation as *Cathypna rusticula* does—each to its congeners. Indeed, they are so much alike as to be easily confounded till the foot is seen to be two-toed in that case, one-toed in this. It in general resembles *M. cornuta*, but is much more transparent. The single toe is more slender in proportion to its length, and much longer in proportion to the whole animal; it is a straight parallel-sided rod, with a minute acute claw apparently forming a separate joint. If this is the case, we should perhaps consider this joint as itself the toe, and the long rod as the penultimate joint of the foot. The shoulder is double, viewed vertically, but single and much rounded, viewed laterally. The outlines of the toe, however viewed, are always a little uneven; suggesting that the surface is irregularly pitted. The lorica

is ovate, not so pyriform as in *cornuta*. The edges of the upper and lower plates come closer together; for the anterior two-thirds the edge of the dorsal plate is about level with that of the ventral, but much exceeds it in length. The dorsal is straightly truncate behind, with the margin on each side, following the ovate outline and descending much farther, so as to form two points. The dorsal surface is somewhat coarsely tesselated, like that of *Cathypna rusticula*, but with the pattern slightly different (Pl. XXIV., fig. 6). The whole surface appears as if irregularly crumpled, interfering with distinct definition in spite of the transparency. The head is a low truncate cone, produced into a number of slight frontal eminences, on which the locomotive cilia are arranged in tufts or bundles. These do not appear to create sensible vortices in the surrounding water.

This species is, I conjecture, the fig. 22 of Mr. J. E. Lord ("Microsc. News," June 1884, page 146), as *M. cornuta* is his fig. 21. I therefore distinguish it with his name. I have met with it myself, on rare occasions recently, among decaying vegetation in the water of Woolston Pond, and abundantly in water kindly sent me by Miss Saunders.

Length, $\frac{1}{250}$ to $\frac{1}{100}$ inch. **Habitat.** Woolston; Newbury; Dundee (P.H.G.): rare.

There is a form,—of which I am almost inclined to make a separate species,—in general like *Lordii*, but remarkable for the excessive length and slenderness of the toe, which almost equals the length of the lorica. It may be but an extreme *var.* of the present form. Yet the lorica seems to lack the square excavation behind, and to be more pyriform in outline, running off in front into broader lobes, as in *lunaris*. This I have found in water sent me by Mr. Bolton from Sutton Park.—P.H.G.]

M. QUADRIDENTATA, *Ehrenberg*.

(Pl. XXV. fig. 3.)

Monostyla quadridentata . . . Ehrenberg, *Die Infus.* 1838, p. 459, Taf. lvii., fig. 5.

[SP. CH. **Lorica** *nearly circular, greatly depressed, especially behind;* **front** *deeply cleft, with two horn-like spines decurved and expanding at their tips.*

The horns well distinguish this form. During retraction these are drawn together, and made even to cross each other (fig. *c*). Besides these, and outside them, the dorsal plate projects into a broad-based triangular point on each side; while the pectoral margin forms a flexible membrane, very deeply cleft in the middle, and further deepened at will. The hind part is exceedingly flattened, merging into the foot, of which the last joint is cubical, with a central notch. Here is articulated the toe, rod-shaped, but that the outline of each side, instead of being straight, is strongly waved: an appearance which may possibly indicate the waves of a tenacious mucus. At one-fifth from the tip a double shoulder, rounded rather than rectangular, leaves the usual acute claw. The head protrudes (fig. *b*), much as described in *cornuta*. Of the **trophi**, the mallei (fig. *d*) are remarkable for a conspicuous horn projecting upward from each angle. The **gastric glands** are large; there is a large separate **intestine**, and also an ample **contractile vesicle**.

Several examples have occurred to my observation. In one I was witness to a curious phenomenon. A large shelled Infusory, *Arcella vulgaris*, was within the *Monostyla*, though how it had managed to force its way in, I cannot imagine, for it almost filled the cavity of the lorica. Its fleshy processes were protruding in front, and, by the death of the *Arcella*, unable, I suppose, after it had devoured its host, to get out, these processes gradually lengthened inordinately. It was a curious sight.—P.H.G.]

Length, $\frac{1}{10}$ to $\frac{1}{5}$ inch; of lorica, $\frac{1}{160}$ to $\frac{1}{140}$ inch. **Habitat.** Barking; Stratford; Maidenhead; Hampstead (P.H.G.); among duckweed, in pools and ditches: rare.

Family XVI. COLURIDÆ.

[**Body** *inclosed in a* **lorica**, *usually of firm consistence, variously compressed or depressed, open at both ends, closed dorsally, usually open or wanting ventrally;* **head** *surmounted by a chitinous arched plate or* **hood**; **toes** *two, rarely one, always exposed.*

The arching **hood** over the front, looking, in a lateral view, like a thin hook, movable, and so distinguished from the "glory-crown" of *Stephanops*, always conspicuous, is the most notable mark of this family, in which I propose to unite the mostly flat *Metopidiæ* with the high-backed *Coluri*. As no subdivision above *species* exists in nature, but all (as Genera, Families, Orders, and Classes) are arbitrary collocations, made simply to facilitate the study of the species, which alone is natural history; it follows that the more constant, and the more obvious, the characters on which we found our Divisions, the better. Hence I would not choose the form of the trophi, the presence or position of the eye-specks, or the distribution of the cilia, for distinction—*if I could get others*; because all these are found, in practice, so very difficult to determine. The existence of eyes in some *Coluri* and *Metopidiæ*, for instance, is so very uncertain and indeterminable, that I incline to agree with Dujardin in rejecting some of Ehrenberg's genera. The distinction between *Lepadella*, *Metopidia*, and *Squamella*, is more than doubtful; while in *Metopidia* and *Colurus*, individuals of indubitably the same species are found, some displaying eye-specks, and others in which no search detects them.—P.H.G.]

Genus COLURUS, *Ehrenberg.*

[GEN. CH. **Body** *subglobose, more or less compressed;* **lorica** *of two lateral plates, open in front, united on the back, gaping behind, and (in general) wholly so up the belly; frontal* **hood** *in form of a hook, not retractile;* **foot** *permanently extruded, of distinct joints, terminated by two furcate* **toes**.

A very familiar group, of minute dimensions, agreeable form, and sprightly action, the *Coluri* give the impression of being, while sub-circular in lateral outline, very thin in transverse diameter. This, however, is an illusion, arising from their being most frequently presented to the eye in the lateral aspect. When we do catch a glance at one in turning or swimming, we see that the body is moderately broad, ventricose, and even globose in the middle. The **lorica** consists of two glassy shells, each a segment of a hollow sphere, which are, normally, soldered edge to edge, at the fore-back, and begin to gape at the loins, the cleft then passing round behind, usually widening for emission of a stout foot, and passing up the belly to the front, by which time it has generally become as wide as the body itself. So constructed it may be imagined to be highly expansile, and in fact we observe that its width is constantly increasing and diminishing. The fore edges of the two plates, in the retraction of the head, are appressed so close as to seem but one lamina; but separate for the protrusion of the head with its rotating cilia. The **hood**, a decurved plate, often broad but sometimes narrow, of hyaline delicacy, is not retractile, but is seen when the lorica is shut up, resembling a semi-crescentic hook. The **foot** consists of three strongly marked joints bearing straight, acute, slender toes, often thrown wide apart, but, in some cases, so uniformly adherent that it is difficult to see whether they are two or one. The whole foot is often stretched behind; but much more commonly it is projected forward under the belly, through the ventral gape. The presence, the position, and even the number of eyes, seem subject to much variation.

Most of the known species are lacustrine in habit, but some are exclusively marine.

It is a characteristic habit of the species of the genus, particularly of *C. obtusus*, to elevate themselves to the utmost on the toe-point as on a pivot, and then awkwardly tumble over, as if they had not power to maintain their balance. The *Monostylæ* perform in somewhat similar style, but though their posturings and gyrations are wild, they seem to have better control over them.

In general, the species cannot be discriminated, while in life and activity, without extreme difficulty; their differences are so very slight, their dimensions so minute, and their restlessness so incessant.—P.H.G.]

C. DEFLEXUS, *Ehrenberg*.

(Pl. XXVI. fig. 1.)

Colurus deflexus . . . Ehrenberg, *Die Infus.* 1838, p. 476, Taf. lix. fig. 9.

[SP. CH. **Lorica**, *viewed dorsally, broadly ovate, bluntly pointed before, produced behind into two acute spines, separated by a wide, deep sinus: viewed laterally, the outline is the quadrant of an oval: the venter cleft from end to end;* **foot** *robust, with two short, slender, acute toes.*

If I rightly identify the species, there is little difference of aspect between this and *bicuspidatus*. In this the posterior spines are said to point slightly below, in the other slightly above, the horizontal line. Yet as this depends on the angle at which the animal is viewed, which is every instant varying, the distinction is evanescent, and, I fear, worthless. Yet, on careful study, this, which is by much the more robust species, is seen to have the two halves of the lorica severed all round, except in the middle of the back. The fore edges of these halves, deeply truncate, but a little out-curved, are firmly pressed together in retraction; and the effect of this appression, when seen from above, is the dividing line of the blunt cone, which is seen minutely opening and closing every moment. A **muscle-band** passes, in relaxed curves, from the front of each of the appressed sides to the surfaces of the retracted organs seen in a confused heap far down, evidently for the purpose of pulling out the trochal apparatus when required.

A large pale crimson **eye** seated on an ample **brain**-sac; a **mastax** of the *Euchlanidan* pattern; a cylindrical **stomach** succeeded by a wide intestine; an **ovary** often containing a nearly developed **egg**; and a small **contractile vesicle**; are usually seen. But in the middle of the back, just under the lorica, are two curious organs, each apparently an agglomeration of minute, clear vesicles, perhaps of air, perhaps of oil, observed long ago by Ehrenberg. He declared them inexplicable; and I cannot supply the explanation.

When, after a self-inflicted imprisonment, it may be of hours, the *Colurus* opens its closed cheek-plates, a trochal mass of conglobate lobes, fringed with wreaths of cilia, is thrust out, by whose vibration the creature smoothly but rapidly shoots away. The frontal **hooked-plate**, which, even in the inert state, has been discernible by the delicate, thin, curved line of its edge, moves to and fro, and under very favourable circumstances we may see that its inferior surface is fringed with vibratile cilia. I judge it to be an organ of touch; Herr Eckstein's opinion to the contrary notwithstanding.—P.H.G.]

Length. Of lorica, $\frac{1}{2\,5\,0}$ inch; from hook to toes, $\frac{1}{1\,7\,2}$ inch. **Habitat.** Ponds and ditches; quite common (P.H.G.).

C. BICUSPIDATUS, *Ehrenberg*.

(Pl. XXVI. fig. 2.)

Colurus bicuspidatus . . Ehrenberg, *Die Infus.* 1838, p. 476, Taf. lix. fig. 7.

[SP. CH. *Almost exactly those of* C. deflexus, *except that the* **lorica** *is not cleft either dorsally or ventrally; but only excavate behind, slightly on the dorsal, deeply on the ventral side.*

I have seen only a few examples of this form, all from Sutton Park, Birmingham. It is, I presume, Ehrenberg's *bicuspidatus*, his figures showing a **lorica** undivided beneath. In examples long under examination, I became quite certain that neither the dorsum nor the venter was cleft; but a narrow sinus, reaching to more than one-third of the lorica in length was excavated up the flat ventral plate, and a very slight one out of the dorsal end. Through this orifice the foot is thrust, of rapidly diminishing joints,

and what appears a single, slender, acute toe. At least I could not, with close watching, detect any sign of its division. In the dorsal view the frontal **hood** (fig. 2) appears not as the segment of a sphere, but somewhat indented in front. It ever moves backward and forward, as protruded and retracted. The venter appears quite flat, the semi-globose dorsal plate rising abruptly from it with a sharp angle. In one, as it turned slowly, I saw distinctly the form. If we suppose one-third of an egg to be removed longitudinally, and replaced by a flat plate, we shall gain a fair idea of the general outline.

This is certainly an uncommon form. My acquaintance with it is limited to a very few examples, obtained from Woolston Pond, and Sutton Park, Birmingham. Its manners are peculiar. It swims constantly, never resting to grope, as other species do, but sailing deviously and deliberately about; now and then quickening its pace; almost constantly with the venter at the glass of the cell; so that whereas I obtained plenty of ventral views, I got few dorsal, and scarcely one good lateral.—P.H.G.]

Length. Extended, $\frac{1}{300}$ inch; transverse width $\frac{1}{650}$. **Habitat.** Woolston; Birmingham (P.H.G.); very rare.

C. UNCINATUS, *Ehrenberg.*

Colurus uncinatus . . . Ehrenberg, *Die Infus.* 1838, p. 475, Taf. lix. fig. 6.

[SP. CH. **Lorica**, *viewed dorsally, broadly ovate, truncate before, produced behind into two short spines: viewed laterally, the outline is rondo-triangular, high in the middle of the back, the posterior spines short, blunt, and abruptly set-on;* **venter** *widely cleft throughout;* **toes** *two, short, slender, acute. Lacustrine.*

The **lorica** is turgid, the back not ridged but smoothly rounded; its ventral gape parallel-edged, the edges apparently bent downward (as in *Euchlanis deflexa*), making an angle with the swell of the sides, the anterior portion lengthened into a short tubular neck. The **hook** is narrow and spoon-shaped. The internal structure is obscure, partly from its sphericity; yet the **mastax**, **stomach**, intestine and cloaca, the **ovary** and the **contractile vesicle**, can be defined. It is usually of minute dimensions, and, though widely spread, rather rare. I have known it since 1849.—P.H.G.]

Length. Lorica, from $\frac{1}{320}$ to $\frac{1}{260}$ inch. **Habitat.** Clapton; Battersea; Bath; (P.H.G.).

C. OBTUSUS, *Gosse*, sp. nov.

(Pl. XXVI. fig. 3.)

[SP. CH. **Lorica** *ovate in all aspects, the posterior ends rounded without any points, ventrally cleft throughout, gradually expanding for the foot-orifice, the fissure reaching round to the back, both before and behind;* **foot** *small, with two minute slender, expanding toes. Lacustrine.*

This little unrecognised species, which I find not uncommon, is clearly marked by the blunt ends of the **lorica**. The lateral plates are separate for above three-fourths of their circumference, being soldered together with a sharp suture, only in the very middle of the back, and generally much compressed. The **foot** and toes together are about one-third as long as the lorica; the toes, like setæ for tenuity, with no shoulder, are often separate. The internal economy is normal; including the common bubbles in the back; two colourless refractile globules have been seen on the brain, which may be **eyes**. Its manners are sluggish, swimming laboriously, with jerks.—P.H.G.]

Length. Without foot, $\frac{1}{500}$ to $\frac{1}{375}$ inch. **Habitat.** Near London; Woolston; Leamington; Dundee (P.H.G.): not uncommon.

C. CAUDATUS, *Ehrenberg.*

(Pl. XXVI. fig. 6.)

Colurus caudatus . . . . Ehrenberg, *Die Infus.* 1838, p. 476, Taf. lix. fig. 8.

[SP. CH. **Lorica**, *in dorsal aspect, pear-shaped, widest behind;* **dorsal hind sinus** *shallow, between very short terminal points, not at all produced;* **ventral cleft** *close, abruptly becoming a semi-circular foot-orifice;* **toes** *slender, frequently expanded; foot and toes three-fourths as long as lorica;* **eyes** *two. Lacustrine.*

There are several species which may, almost equally well, serve as the *caudatus* of Ehrenberg, to distinguish which requires minute examination. The above characters are carefully noted from many observations, and need not be repeated. The free expansion of the long **toes**, unusual in this group, is noteworthy. The frontal **hook** is normal, and I have repeatedly seen two **eyes** just beneath it. On the ventral surface the *abrupt* expansion of the fissure from a linear cleft to a broad round opening for the emission of the wide basal foot-joint, should be noticed.—P.H.G.]

Length. Total $\frac{1}{300}$ inch. **Habitat.** Birmingham; Woolston (P.H.G.): weedy pools.

C. AMBLYTELUS, *Gosse*, sp. nov.

(Pl. XXVI. fig. 5.)

[SP. CH. **Lorica**, *in dorsal aspect, broadly ovate, the hind ends rounded, without projecting points;* **ventral cleft** *gaping, widening before and behind;* **toe** *single, long, with a medial depression;* **foot** *and* **toe** *two-thirds as long as lorica;* **eyes** *cervical. Marine.*

This species also may be very readily confounded with *C. caudatus*, but the characters above given, though minute, seem to distinguish it satisfactorily and constantly. The **lorica** is arched, so that its dorsal outline forms about one-fourth of a circle, split at its occipital end, and also for a little way above the foot; the two lateral extremities being rounded. When the animal in its turnings shows the ventral side, even though slightly, we seem to see sharp points to the lorica; but this is an illusion, for the points are but the ends of the curved plates *seen edgewise*; another turn, and they at once become again obtuse. On the ventral surface, which is nearly flat, the edges of the two plates are either wide apart or very closely approach each other, or may even overlap, but recede on each side of the foot, so as to leave the orifice nearly circular. The single long slender **toe**, running off to a fine point, has a medial mark throughout, as in those *Metopidiæ*, &c., which keep the toes ordinarily appressed; but I have never seen a separation, and the most delicate focusing with high powers fails to divide the fine point. The usual **hood** is displayed. The **mastax** and its trophi are normal. The **brain**, large and turbid but undefined, occupies the occiput; and two minute red **eyes**, rather close together, are situate on it cervically. The other interior organs are as ordinary. One oil-globule (sometimes two) occupies in general the middle of the back, and is conspicuous.

This species seems exclusively marine. I have found it somewhat numerous among algæ, collected by Mr. Hood from tide-pools at low-water at Taymouth, near Dundee, and also in Torbay. It is very restless, ever roaming, yet mainly affecting the conferva, at which it nibbles constantly; when swimming it shoots along with smooth rapidity. The form is plump and round, the blunt corners low-descending; the body hyaline and colourless, the taper toe stretching far behind.[1]—P.H.G.]

[1] I am very confident that other species of this long-toed group exist, in both our fresh and salt waters. But though I have some drawings and notes, I have not as yet materials sufficient for satisfactory diagnosis.—P.H.G.

Length. From hood to ends of lorica, $\frac{1}{280}$ inch; foot and toe, $\frac{1}{520}$ inch; total, $\frac{1}{175}$ inch. **Habitat.** Marine pools at low tide (P.H.G.).

C. DACTYLOTUS, *Gosse*, sp. nov.

(Pl. XXV. fig. 12.)

[SP. CH. **Lorica** *wide in front, shallowly tubular behind, without points;* **foot** *very short but wide;* **toes** *thick, large, and curved. Marine.*

A somewhat thickset form. The **lorica** is ovate, viewed dorsally, with a broad anterior gape, out of which what seems another shelly valve projects, connected by an involute joint with the lorica (as seen in fig. 12*a*), a sort of **hood**, protecting the ciliate front and answering to the usual hooked plate, but of very different form. The front consists of several fleshy eminences (fig. 12) bearing vibratile cilia.

The lorica ends behind in a short truncate tube, through which the foot finds exit. This is exceedingly short and inconspicuous, though broad; the toes are furcate, thick at their base, blunt-pointed, and slightly decurved, when seen laterally (fig. 12*a*).

I have seen but a single example, in sea-water from tide-pools near Taymouth.—P.H.G.]

Length, $\frac{1}{175}$ inch. **Habitat.** Marine pools (P.H.G.).

C. PEDATUS, *Gosse*, sp. nov.

(Pl. XXV. fig. 13.)

[SP. CH. **Lorica** *cleft behind, ending in two square points;* **foot** *stout, long;* **toes** *minute, straight. Marine.*

Two examples of this little insignificant species occurred in water sent by Mr. Hood, from the Tay Firth marine pools. They were both in the same live-box as *C. dactylotus*. The thick foot-joints and the very small toes forming a small cone, when closely appressed as they usually are, will distinguish the species from all others. It is somewhat less than its congener just named. I detected nothing in it worthy of record besides.—P.H.G.]

Length. About $\frac{1}{160}$ inch. **Habitat.** Marine tide-pools; rare (P.H.G.).

C. CŒLOPINUS, *Gosse*, sp. nov.

(Pl. XXVI. fig. 4.)

[SP. CH. **Toe** *very long and slender, consisting of a narrow plate laid within a similar, but wider plate, and closely appressed to it. Marine.*

In the form of the **toe** we have here an example, quite unique in this genus, of the structure which characterises the genus, hence named *Cœlopus*, in the Rattulidæ. The toe consists first of an extremely long, tapering, hollow, thin plate of transparent chitine, such as would be presented by the bowl of a glass spoon, if drawn out to excessive length and tenuity. Then suppose a similar plate of glass, but narrower throughout, to be laid in the hollow of the former, fitted exactly to it, and reaching its taper point far before the other. What is the relation of the one spine to the other, and of both to the body; what their functions, what their movements, separately or conjointly, I know not. I have met with but one example, and that a dead and nearly empty lorica. The occurrence of such is often of great value. It is true that it may give little or no information of the internal structure, and, of course, none of manners. But of the external form and its appendages, composed of undissolved chitine, we can often obtain views of beautiful clearness, given with a minute precision that we can seldom hope for from a living animal. For the object is perfectly still, and remains so as long as we choose, while it is generally feasible to make it revolve in various directions by producing mechanical

currents in the water, and so to examine its appearance in other aspects. Thus was this creature delineated, and I vouch for its accuracy so far as the details are given.

The **lorica** *seems* (I can say no more) to be widely severed on the ventral aspect, and to end in rectangular points behind. The frontal **hook** appears normal.—P.H.G.]

Length, to tip of spine, $\frac{1}{163}$ inch; of which the spine is about one-fourth. **Habitat.** Among confervæ in tide-pools in the Firth of Tay (P.H.G.); rare.

Genus METOPIDIA, *Ehrenberg.*

[GEN. CH. **Lorica** *usually depressed, entire, with an opening at each end for the emission of the head and foot; frontal* **hood** *in form of a hook;* **foot** *and* **toes** *as in* Colurus; **eyes** *usually two.*

For reasons already given I include in this genus, not only the species so named by Ehrenberg, but also his genera *Lepadella* and *Squamella*; thus agreeing in principle with Dujardin ("Infus." p. 632) while I cannot accept his details. They seem to fall into the same natural family as *Colurus*; for though the prevailing plate-like form seems at first sight to differ greatly from the compressed *Coluri*, yet this form is not invariable, *M. oxysternum* and *M. triptera* presenting notable exceptions; while in the arched frontal hook there is a remarkably conspicuous feature in common. Some of the species are among the most familiar of Rotifera.—P.H.G.]

M. LEPADELLA, *Ehrenberg.*

(Pl. XXV. fig. 6.)

Metopidia lepadella . . . Ehrenberg, *Die Infus.* 1838, p. 477, pl. lix. fig 10.

[SP. CH. **Lorica** *oval, much depressed, evenly rounded above;* ***its*** **ventral plate** *shorter behind than the* **dorsal,** *and slightly excavate.*

That Ehrenberg's *Lepadella ovalis, Squamella bractea* and *S. oblonga*, and *Metopidia lepadella* are but species of one genus, I cannot doubt, and even the *specific* differences between them are very evanescent. The number, and even the visibility, of the **eye-specks** vary in individuals, and cannot be trusted for diagnosis. The present is a common form in most fresh waters. The **lorica** in its dorsal outline, both longitudinal and transverse, is a segment of a circle, and the ventral is straight. Seen from above it is oval, pointed at both ends, and yet truncate; the ventral plate round behind, and so considerably shorter, and slightly emarginate for the emission of the foot. The frontal **hood** agrees with that in *Colurus*, slightly protrusile, and is used for raking the rubbish among which it feeds. The ciliate face is almost prone, and the trophi can be brought to its surface.

I think I have seen the **male**; a minute creature, in form a very long cone, tapering to a point, with two slender toes; in front, quite truncate, with a sharp horn projecting from its forehead. No organization was visible within, save two conspicuous clear vesicles, side by side in the middle of the body, not at all like oil-globules, being irregularly oblong: nor accidental, being found in each of a large number of individuals, seen at different times. A pair of fine lines ran far down the two sides of the body, and in the hinder part was a large angular web of thin yellowish tissue. Else the whole seemed structureless and of hyaline clearness. It contracted into a shorter oval figure.—P.H.G.]

Length. Of lorica, $\frac{1}{300}$ inch. **Habitat.** Fresh waters everywhere (P.H.G.).

M. SOLIDUS, *Gosse.*

(Pl. XXV. fig. 11.)

Metopidia solidus . . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 201.

[SP. CH. **Lorica** *nearly circular, depressed, with a low rounded ridge above;* **ventral plate** *commensurate with the* **dorsal** *behind, but deeply excavate;* **dorsal** *having a submarginal line of corrugation.*

This charming species, though in technical characters very similar to the preceding, is yet readily distinguished when once it is known. It is very much rarer, averages nearly twice its size, while its outline, in retraction, far more nearly approaches a circle. This, with its crystalline brilliance, recalls the lovely *Pterodinæ*, of which it is no unworthy rival; and its resemblance to them is much augmented by a delicate line of corrugations, which run round just within the margin, like the "milling" within a shilling. It was this feature that suggested the specific name, and no allusion to the adjective *solidus*. The arch of the **lorica** is much lower than in *lepadella*, especially towards the edge, while down the middle there runs a very low, rounded ridge. The fore and hind excavations are nearly as in *lepadella*. Besides the frontal **hood**, there is another clear disk which appears to protect the rotating cilia, and a transparent bulb is placed on each side of this, within each of which is seen a minute red **eye**, so that these organs are widely separated.

Some curious facts connected with digestion were illustrated by mixing a little carmine with the water. Particles were readily imbibed, and soon appeared as a red cloud in the fore part of the **stomach**. Presently this pellet passed into the upbent viscus at the bottom, which I supposed the intestine; and a second pellet, swallowed at the same instant, took the vacated place. After an hour, the whole alimentary canal had assumed the appearance of fig. 11*f*, the supposed intestine being only a lobe or pocket of the stomach. The pellet No. 1 now moved rapidly down to the cloacal extremity of the twofold viscus, but, instead of being discharged, it swiftly passed up (as between the dotted lines) to its first position at the base of the stomach; then returned to the cloacal end, and quickly again mounted; repeating these movements several times, till at length it coalesced with the second pellet. All the while the whole interiors of both chambers were full of an incessant quivering from the action of epithelial cilia. From all this, it really seems as if something analogous to rumination occurred in these minute creatures. The **gastric glands** and the **lateral canals** are very abnormal; and the contractile vesicle is sometimes ample, sometimes totally wanting.—P.H.G.]

Length, $\frac{1}{150}$ inch. **Habitat.** Walthamstow; Leamington; Birmingham; Woolston; Dundee (P.H.G.).

M. ACUMINATA, *Ehrenberg*.

(Pl. XXV. fig. 9.)

Metopidia acuminata . . . Ehrenberg, *Die Infus.* p. 477, Taf. lix. fig. 11.

[SP. CH. **Lorica** *ovate, ending behind in an acute point; occipitally deeply notched between projecting spines; the edges very thin.*

Besides the above peculiarities there is little to mark this obscure little species, which yet is amply distinct. When seen sidewise it has much likeness to a *Colurus*, save that its form is flatter; and the decurved frontal **hood** is more conspicuous. It is an eager and persevering feeder, raking with its hood-edge among the floccose.—P.H.G.]

Length. Of lorica, $\frac{1}{300}$ to $\frac{1}{340}$ inch. **Habitat.** North London; Leamington; Sandhurst (P.H.G.); very scarce.

M. OXYSTERNUM, *Gosse*.

(Pl. XXV. fig. 8.)

Metopidia oxysternon . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 201.

[SP. CH. **Lorica** *an ovate box of tesselated surface; with a thin ridge running down the* **dorsum**; **venter** *with a similar medial ridge terminating abruptly in mid-length.*

This is a very curious form. It is a depressed rhomboid-oval, with a rather high and thin arched ridge running down the back from the bottom of a deep frontal sinus. The ventral surface is also ridged as far as the mid-length, where the ridge ends, like the sternum of a bird. Then the surface is deeply excavated, and again projects, forming a prominent sheath for the emission of the foot. The whole **lorica** is cut into facets, as

in *Noteus* and in many *Anuræa*, and all minutely shagreened. The head is deep, forming three lobes, all ciliated. In retraction the two sides of the lorica close on each other, leaving within a large clear space, exactly as in many *Coluri*, to which a further resemblance is borne by the position and direction of the foot and toes; the former inclined forward, and the latter bent abruptly backward. A rather small **brain** carries an **eye** as large as half the **mastax** (possibly two suffused, since in some specimens two are observed), pale but rich, transparent rose-red. In rotating a narrow, parallel-sided, truncate lip is seen thrust out in front, as in *M. triptera*. The **trophi** are on the plan common in the *Euchlanidæ*, and neighbouring families.

I first obtained the species in an ornamental water near London in 1849; recently in a ditch at Coffinswell, near Torquay, and in water from the Black Loch, Dundee, in company with *Œcistes Stygis* and *Œ. brachiatus*. It is of lively manners.—P.H.G.]

Length, $\frac{1}{175}$ inch. **Habitat.** London; South Devon; Dundee (P.H.G.): rare.

M. RHOMBOIDES, *Gosse*, sp. nov.

(Pl. XXV. fig. 10.)

[SP. CH. **Lorica** *rhomboid-ovate in outline*; **dorsal surface** *tectiform, lower behind, ending in an obtuse point*; **ventral surface** *flat*.

This seems to come between *oxysternum* and *triptera*. The **œsophagus** is long, and often thrown into curves. The **gastric glands** are peculiar, being placed at the ends of two long threads, probably tubular, which are seated on the corners of the stomach, the globular glands themselves being affixed to the lining of the lorica.—P.H.G.]

Length, $\frac{1}{155}$ inch. **Habitat.** North London (P.H.G.): very rare.

M. TRIPTERA, *Ehrenberg*.

(Pl. XXV. fig. 7.)

Metopidia triptera . . . . . Ehrenberg, *Die Infus.* 1838, p. 478, Taf. lix. fig. 12.

[SP. CH. **Lorica** *nearly circular, as viewed dorsally, dilated into three wide, but thin*, **wings**, *one dorsal and two lateral*.

The aspect of this tiny living jewel, viewed dorsally, is almost exactly that of *M. lepadella*, and so it is if viewed sidewise. But an instant turn, or a slight change of level, and the broad **planes** come into view, with an effect that surprises. Each of these is, speaking loosely, a semi-oval, formed of two thin glassy plates, soldered into one for about half their width, then diverging to constitute, with the like structure of the vertical plate, a sub-cylindrical sheath, in which the organs and viscera are inclosed. The **foot** finds its exit by a sinus excavated out of the lower part of the cylinder, whose fore end is truncate for the extrusion of the head. This is surmounted by a broad chitinous **hood** descending in front to a sharp edge (as usual hook-like in lateral perspective), quite distinct from the tripterous lorica, within which its base is slightly retractile. It is conspicuous in all aspects. From above, the ciliate front, with its minute crimson **eyes**, one at each extreme lateral joint, is clearly discerned through its transparency.

It is a most exquisite little creature, of crystal brilliance, and sprightly in manner, without being swift. It swims little, but scrapes and pokes in the parasitic floccose. Here, as it turns and twists deviously about, we see constantly changing aspects of the three shining planes, whose surfaces and edges are ever crossing each other, all visible through each other, from their perfect translucency. Thus, though the difficulty of resolving the organic details of the active atom is augmented rather tantalisingly, one cannot but be charmed by the beauty and variety displayed. I have seen one, slowly gliding in a straight line, go on revolving on its axis, bringing the six surfaces into view in quick succession, with a striking effect. On another occasion one came sidling up to a noble *Euchlanis*. The contrast, and yet the resemblance, was curious; the one could have lain comfortably within the ample mastax of the other.—P.H.G.]

Length, $\frac{1}{288}$ inch. **Habitat.** Sandhurst (Collins); Woolston; Dundee (P.H.G.): rare.

M. BRACTEA, *Ehrenberg*.

Squamella bractea . . . Ehrenberg, *Die Infus.* p. 480, Taf. lix. fig. 16.

[SP. CH. **Lorica** *oval, much depressed, its front deeply excavated especially on the pectoral side;* **dorsal plate** *ending behind in two minute projections;* **ventral** *deeply excavate;* **eyes** *four.*

The differences perceptible between this and *lepadella* are exceedingly small; the four minute **eyes**, set in square, are very rarely discerned; but I have seen them. One deposited an **ephippial egg**, clothed with very long spines, while under my observation. P.H.G.]

Length. Of lorica, $\frac{1}{300}$ inch. **Habitat.** Pools and infusions; common (P.H.G.).

Genus MONURA, *Ehrenberg*.

[GEN. CH. *As Colurus, but the toe is a simple style.*

It is mainly in deference to the great Prussian zoologist, that I retain the generic distinction between this and the preceding group. With the recollection that in *C. leptus* I can discern no trace of a medial depression in the toe, that in *C. amblytelus* there is the depression, which I have never seen separated, that in *C. caudatus* there is the depression apparently as inseparable, which, yet, on occasion, palpably opens and expands; to build a genus exclusively on this condition of the toe is most precarious.—P.H.G.]

M. COLURUS, *Ehrenberg*.

(Pl. XXVI. fig. 7.)

Monura colurus . . . . Ehrenberg, *Die Infus.* 1838, p. 474, Taf. lix. fig. 4.

[SP. CH. **Lorica** *ovate, much compressed, highest at the front, with the hind ends rounded;* **eyes** *two, approximate. Marine.*

Viewed vertically this animal has the **form** of a mussel, gaping widely all along the venter and around each extremity, with no sensible change of outline for the emission of the foot, and hinged only along the middle of the dorsum. In a lateral view the **lorica** forms the half of a very long ellipse, flattened ventrally, obtuse behind, thence gradually rising till it is highest at the front, whence it descends in a bold curve to rejoin the belly side. Thus the outline is markedly different from that which is characteristic of *Colurus*, though the difference depends on minute peculiarities.

The round anteriors of the valves are, often and long, firmly appressed (fig. 7*a*), the whole head and viscera being far withdrawn, and a wide hyaline space left, within whose edge a very delicate corrugation marks the line of mutual contact. At intervals the valves part, and a head is protruded, armed with long and coarse cilia, and overarched by a conspicuous frontal **hood**. This has the unusual appearance of a wide veil of exceeding tenuity, strengthened by an acute taper hook of chitine running through its medial line. Under the base of this organ are seen two brilliant crimson **eyes**, moderately near each other. Slight indications of a manducatory apparatus are seen, and occasionally the globose form of the mastax; but all so evanescent as to defy definition. A large sacculate **stomach**, divided by constriction from a still ampler intestine; an **ovary** and a small **contractile vesicle**, with the cloaca at the dorsal base of the foot, are all normal. The **foot** itself is prominent, moderately thick, of three long, well-marked joints; the **toe**, a single, long, acute style, thick at base, and suddenly diminishing in its dorsal outline, has the remarkable peculiarity of being as flexible and elastic as whalebone. The extruded foot and toe are two-thirds as long as the lorica.

I first met with this species, congregating in great numbers around my marine

aquarium, in September 1854. Its manners agreed with those of the larger *Coluri*, shutting itself within its valves, and that so stubbornly, as to die rather than open them. Lately I have received specimens from Mr. Hood, found in marine tide-pools in the Firth of Tay; and have taken many in Torbay.

Length. Of lorica, $\frac{1}{150}$ inch; of foot and toe, $\frac{1}{320}$ inch; total extended, $\frac{1}{250}$ to $\frac{1}{100}$ inch.
Habitat. Marine pools in Forfarshire and Devonshire; domestic aquarium (P.H.G.).

Very recently specimens of what I suppose *M. dulcis*, Ehr., have been sent me, from fresh water, by Mr. Lord of Rawtenstall. The lorica is acute, instead of obtuse, behind.—P.H.G.]

Genus MYTILIA, *Gosse*, gen. nov.

[GEN. CH. **Body** *ovate;* **lorica** *as in* Colurus, *but the head and neck habitually protruded, as well as the whole foot; no frontal* **hook.**—P.H.G.]

M. TAVINA, *Gosse*, sp. nov.

(Pl. XXVI. fig. 8.)

[SP. CH. **Eyes** *two, frontal, wide apart. Marine.*

The **lorica** is essentially similar to that of *Colurus* (though the facies of the animal is quite different), being a shell of two lateral valves, like that of a mussel, unbroken on the dorsum, descending on each side, and open all along the venter. Behind they are patent, where the thick foot emerges; but their edges approach, or even overlap, as in *Pterodina*, at the pectoral front. A massive head, and an equally thick, distinct neck, both about equal to that part of the trunk that adjoins them, are normally projected from the lorica, and not, as in *Colurus*, concealed between the valves. As there is, moreover, no trace of the **hood**, or hooked plate, that shields the face in kindred forms, the difference of aspect is very marked, and one of the Illoricate forms is involuntarily suggested.[1] This is augmented by the circumstances, that the **foot** is long and thick, especially at its base, that it tapers *there* gradually from the thickness of the trunk, and that it is habitually carried in the line of the body. Whereas, in *Colurus* and *Monura*, it is much smaller than the visible body, is usually projected at a sensible angle, and appears to come out between the ventral edges of the valves. The lorica, too, is of much less depth in proportion to its length; for, whereas, in *Colurus* the depth to the length may be about 2 : 3, in *Mytilia* it is about 2 : 5. It is obliquely truncate at the hind margin, the lateral edges diverging thence till they meet at the pectus. The body, which is arched on the dorsum, diminishes along the lumbar line, and forms a minute conical projection, representing a true tail, behind which the cloaca opens, whence the foot proceeds, in a similar ratio of diminution and in the same line, for a considerable length, terminating in two stout pointed toes, often jerked widely apart. Each is permeated by the usual **mucus-gland**, long, thick, and clavate. The internal structure is with difficulty defined. The extreme restlessness of the creature, combined with its minuteness, renders an examination during life almost impossible; and, after death, the outlines of the delicate organs become blurred, and soon obliterated. I believe I have perceived, on repeated occasions, and in many specimens, two minute **eye specks** at the front, rather wide apart. The **mastax** is comparatively large, and the trophi normal (as in fig. 8c). But the whole interior is almost opaque from granulation, and so, very difficult to penetrate.

It is a pretty little creature, sprightly and attractive, with much in its manners and ways that reminds us of its kindred *Coluri*, one of which, *C. amblytelus*, is its constant

[1] I cannot avoid a lurking suspicion that under Ehrenberg's figure of *Distemma marinum* may have lain *Mytilia tavina*, notwithstanding discrepancies.

associate. The species is another of the discoveries of Mr. Hood, of Dundee. He finds it in sea-water, and has sent me many specimens in vigorous health.—P.H.G.]

Length, $\frac{1}{180}$ to $\frac{1}{140}$ inch; width and depth equal, about $\frac{1}{133}$ inch. **Habitat.** Tide-pools at the mouth of the River Tay (J.H.); and in Torbay (P.H.G.).

Genus COCHLEARE, *Gosse*, gen. nov.

[GEN. CH. **Lorica** *not half the length;* **foot** *long, annulate;* **toes** *two, furcate.*

The two species which I include in this genus are minute and inconspicuous, but peculiar. The **lorica** is quite a subordinate feature, the parts behind this greatly developed into what appears a very stout and long **foot**, of many annulose joints, terminated by two minute toes, on which the creature usually elevates itself, and turns as on a pivot. Both the species are lacustrine.—P.H.G.]

C. STAPHYLINUS, *Gosse*, sp. nov.

(Pl. XXVI. fig. 9.)

[SP. CH. **Lorica** *hemispheric.*

The integument is wrinkled irregularly, and scarcely firm enough to be called a **lorica**. It is nearly circular in outline, arched dorsally, and flat ventrally, abruptly attenuated to the stout and long **foot** of four distinct joints, ending in what looks like two acute toes soldered together, frequently turned up in a threatening manner. **Eyes** and internal organs dim and uncertainly discerned. I have found but one specimen, in a dyke near Stratford, in 1851.—P.H.G.]

Length, $\frac{1}{195}$ inch; width, $\frac{1}{390}$ inch (P.H.G.).

C. TURBO, *Gosse*, sp. nov.

(Pl. XXVI. fig. 10.)

[SP. CH. **Lorica** *three-sided.*

The form of the **lorica** may not be constant, yet the facies of this differed so much from that of the preceding, that, until we have more knowledge, it is well to treat them as distinct. The flexible lorica is nearly parallel-edged, but rises to a dorsal angle, like a roof; yet each of the sloping lateral surfaces consists of two planes, very slightly inclined to each other. The head appears as if it had a broad **hood** like that of *Stephanops chlæna*, but flexible, for sometimes a lobe of it flaps inward. The front is formed of two half-cones, ciliated on their inner faces, which approach and recede at will, making two vortices. A large occipital **brain** bears a red **eye** near its point. The **toes** are distinctly furcate.—P.H.G.]

Length, $\frac{1}{260}$ inch; width, $\frac{1}{750}$ inch. **Habitat.** Black Loch, near Dundee (P.H.G.).

Family XVII. PTERODINADÆ.

Lorica *entire, various;* **corona and ciliary wreath** *those of the* Philodinadæ; **trophi** *malleo-ramate;* **foot** *wholly retractile, transversely wrinkled, jointless, toeless, ending in a ciliated cup;—or* **foot** *absent.*

This is a singular group of Rotifera. Unlike all other loricate free-swimmers, *Pterodinadæ* possess a corona of a Bdelloïdic, and trophi and foot of a Rhizotic type. The corona is that of *Philodinadæ*, the trophi are those of *Melicerta*, while the foot (when present) would be very like that of *Œcistes serpentinus*, but for its extremity. The two genera of which the family consists differ in the shape of the lorica, and in the foot.

In *Pterodina* the lorica consists of two delicately thin, and nearly flat plates, soldered together at their edges; in *Pompholyx* it is continuous, flask-shaped, and without edges. In the former the ventral plate is perforated for the emission of a long, wrinkled, toeless foot; the latter is footless.

Genus PTERODINA, *Ehrenberg*.

GEN. CH. **Lorica** *entire, greatly depressed, of two oval, but nearly circular plates soldered together at their edges;* **foot** *wholly retractile, transversely wrinkled, jointless, toeless, ending in a ciliated cup.*

The species of this genus differ from each other chiefly in the flexibility, shape and adorning of the lorica. In all, the **corona** consists of two circular lobes, whose ciliary wreaths, seen from above, present as perfect an appearance of two revolving wheels as in *Philodina* or *Rotifer*. The cylindrical **foot** is encircled by deep constrictions, which cease abruptly at some distance from its free end, and is remarkable not only from its being the foot of a fixed Rotiferon, but also from its ending in a richly-ciliated hemispherical cup. There are, too, some other points common to all the species, that deserve notice. The **salivary** (?) **glands** on the œsophagus are very numerous, and the **gastric glands** are of unusual length and shape. They are attached to the junction of the œsophagus and stomach by long tapering stalks; and, crossing the lorica transversely, are fastened to the dorsal surface by their broad ends. Between these attached ends of the gastric glands, and the lowest portion of the head, lie curiously-scalloped **foliations** (of a delicately blue-tinted substance) of which it is difficult to say whether they are continuous with the gastric glands, or are expansions of the lobed masses investing the base of the head, or are something analogous to the floccose ribbons which in so many Rotifera surround the lateral canals. They are very conspicuous in *P. patina*, but only faintly visible in *P. valvata;* and the upper portions of the lateral canals, with the attached vibratile tags, lie across them.[1] The **contractile vesicle** appears to be absent. The longitudinal **muscles** are coarsely striated, and the two **eyes** are distinct, colourless, transparent spheres resting on ruby pigment. I failed to find any dorsal **antenna**, but the dorso-lateral antennæ lie with their rocket-shaped heads close to the surface of the lorica near its edge at about one-third of the semi-circumference from the top.

P. PATINA, *Ehrenberg*.

(Pl. XXVI. fig. 11.)

Pterodina patina . . Ehrenberg, *Die Infus.* 1838, p. 517, Taf. lxiv. fig. 4.
„ . . Eckstein, *Sieb. u. Küll. Zeits.* xxxix. 1883, p. 401, Taf. xxvii. fig. 59.

SP. CH. **Lorica** *inflexible, nearly circular, stippled just within the edge, especially on its upper third;* **bosses** *absent from the lorica;* **gastric glands** *with broad, lobed ends.* **Lateral foliations** *very conspicuous.*

This is the common species; but, though no rarity, Müller has rightly described it as "Animalculum crystallinum, splendore nulli secundum"; for it is a lovely creature. The dorsal and ventral plates are pressed close together into a glassy **shield** of marvellous thinness. The former is more or less roughened round the edge; and, about the level of the mastax, this roughening spreads inwards to some distance. Occasionally, too, I have met with specimens in which there were faint traces of bosses, at irregular intervals, within the edge; but usually these are absent. A side view enables one to see that the ventral plate bulges out along the longitudinal axis, so as to form half of a hollow cone, whose broad end is forward, and whose point lies on the ventral surface at

[1] Mr. Gosse differs from me concerning the use of the "gastric glands"; the presence of the vibratile tags; the structure of the foliations; and, generally, concerning the Branchial System in *Pterodina*. His account of this structure will be found in the Appendix.

a distance of about one-third of the axis from the edge of the lorica. From the broad front opening the head protrudes; and here the cone is slit down a little, and the flaps rounded off, to give the head a freer passage. When the head is withdrawn, the flaps are drawn by muscles close together, up to the under side of the dorsal plate. Just below the pointed end of the conical hollow, there is a circular opening in the ventral plate, through which the foot can be protruded or withdrawn. The **gastric glands** are very conspicuous. They are unusually long pear-shaped bodies, stretching from the top of the stomach at right-angles to the animal's length, and having their broad heads fastened to the inner lining of the lorica. Round these points of attachment spread out wide **foliations** of a filmy substance, curiously and deeply scalloped, and passing upwards towards the head, and outwards nearly to the edge of the shield. It is not easy to see either the **lateral canals** or the **vibratile tags**, as they are often obscured by other organs. Lately, however, I succeeded in holding a *P. patina* firmly down in a clean drop of water, without hurting it; and, as its head moved backwards and forwards, I could see one of the thick, striped, longitudinal muscles bend aside, and permit a view of two vibratile tags, as well as of the lateral canals to which they adhered. The former lay about midway between the gastric gland and the bottom of the head; while the latter sloped upwards and inwards, towards the funnel in which the head moved, and were cut off abruptly below by the edge of the gastric gland, at about its middle point: I could see no trace of a **contractile vesicle**. Two pear-shaped glands are attached by long stalks to the œsophagus just below the mastax, and lower down is a cluster of similar glands crowding round the spot where the œsophagus enters the stomach. The **stomach** and intestine lie usually side-by-side, and distinctly separate. The latter no doubt discharges through a cloaca at the root of the foot, on its dorsal side, just where it issues from the circular opening in the ventral plate.[1]

Length. Of lorica, $\frac{1}{135}$ inch. **Habitat.** Clear ponds and ditches: tolerably common.

P. VALVATA, *Hudson*.

(Pl. XXVI. fig. 13.)

Pterodina valvata . . . . Hudson, *Mon. Micr. J.* vol. v. 1871, p. 25, pl. lxxii.

SP. CH. **Lorica** *capable of being folded down on each side, nearly circular, smooth;* **bosses** *studding the edge at regular distances;* **gastric glands** *very long, club-shaped, with rounded ends.* **Lateral foliations** *inconspicuous.*

I found *P. valvata* at Abbot's Pond, near Clifton, in the summer of 1871. It was in great abundance, and in company with *P. patina*; and in captivity it increased so amazingly, that the glass sides of my aquarium were frosted with the adhering Rotifera. The **lorica** is remarkably transparent, and is ornamented within its edge with ten bosses, which add greatly to its beauty. When the two species are present together, the difference between them is recognized at a glance; for, delicate as *P. patina* is, *P. valvata* far surpasses it in filmy transparency. While watching some of the new *Pterodinæ*, I was surprised to see one of them sailing by with its lorica folded down (fig. 13*a*) like the flaps of a Pembroke table:[2] its outline was so altered that it scarcely seemed the same animal. This curious infolding of the lorica is due to the contraction of two conspicuous transverse muscles, which do not necessarily act together; as a friend, who was watching with me, saw some specimens with only one side folded at a time.

The **gastric glands** have not such broad heads as those in *patina*, and are altogether

[1] Herr Eckstein (*loc. cit.*) says that the foot is not an organ of prehension, but is the intestine, the ciliated cup being the cloaca. He does not, however, state that he has ever seen the fæces discharged through the foot; and, indeed, such a statement would seem incredible. Mr. Gosse, however, has witnessed the fæcal discharge, and says: "As well as I could see, it takes place at the upper side of the orifice through which the foot protrudes, projected in a strong current, and not immediately diffused."

[2] [As a rule the folding of the valves is somewhat rarely performed. I have observed, probably, hundreds at various times, and I think I have not seen half-a-dozen folded.—P.H.G.]

narrower. The **foliations** are so slight as to permit the **lateral antennæ** with their nerve-threads to be easily seen. Their rocket-shaped extremities lie close to the lorica, not far from its edge, and between the first and second bosses on either side: they are therefore, in an unusually forward position. The **lateral canals** can also be traced, in many convolutions, from the lower part of the head, to the point where they are abruptly cut off by the gastric glands. In young specimens, in which the ovary is a small, transverse, pyriform sac, and so does not obscure the view, they are seen again below the gastric glands on either side of the stomach; and, passing behind it, appear to end below it on either side, in small pear-shaped expansions. I could never find any **contractile vesicle**; but, under favourable conditions, I have seen three pairs of vibratile tags: one a little above the heads of the gastric glands, one on a level with the middle of the stomach, and one not far from the pear-shaped sacs in which the lateral canals seem to end.

Length. Lorica, $\frac{1}{120}$ inch. **Habitat.** Abbot's Pond, Clifton (C.T.H.): not common. Abundant near Torquay (P.H.G.).

I met once with an empty lorica (Pl. XXVI. fig. 17) which I suppose to be that of Ehrenberg's *P. elliptica*. It came from a pond in Sutton Park, Birmingham.

P. MUCRONATA, *Gosse*, sp. nov.

(Pl. XXVI. fig. 15.)

[SP. CH. **Lorica** *usually circular; dorsal plate furnished with an acute mucro projecting from its front. Lacustrine.*

In April 1885, associated with *P. patina* and *P. valvata*, which were swarming in one of my window reservoirs, I first met with this very pretty form. It never became very numerous; but, in the course of a few weeks, during which I was paying special attention to the genus, I met with more than thirty examples. The thought occurred that it might be the young condition of one of its larger fellow-species; and, if so, *valvata* would be the more probable. Yet I have found the young of *valvata* no larger than *mucronata*, but with no trace of the mucro: and I have seen a nearly mature egg in *mucronata*, which, though not conclusive, augments the probability of adult condition. On the other hand, slight unevenness of frontal outline is not rarely discernible in adult specimens of both the larger species. The matter is still *sub judice*; but for the present *mucronata* seems worthy of specific rank.

The **lorica** has not only the intra-marginal granulation of its fellows, which gives them so elegant a resemblance to a new silver coin, but is shagreened or studded with close-set rugosities over the entire surface of the dorsal plate, so delicate, however, that the hyaline transparency is not interrupted. What I consider the **branchial organs** are small; the efferent lobe, answering to the pyriform (**gastric gland**), is generally inconspicuous, and the afferent tubes are clustered in form of a cone around the base of the sub-horizontal muscle. I have not satisfactorily observed the existence of **eyes.** The pair of diagonal **muscles** is unusually well-developed. The lorica has about two-thirds of the diameter of *valvata*.—P.H.G.]

Length. About $\frac{1}{180}$ inch. **Habitat.** A domestic aquarium (P.H.G.); rare.

P. CLYPEATA, *Ehrenberg.*

(Pl. XXVI. fig. 14.)

Pterodina clypeata . . . Ehrenberg, *Die Infus.* 1838, p. 518, Taf. lxiv. fig. 6.

[SP. CH. **Lorica** *elliptical, truncate at each end;* **coronal disks** *widely separated. Marine.*

I first formed acquaintance with this attractive species in July 1850, in sea-water from the Essex coast; and lately it has been sent me in abundance by Mr. Hood from

the Firth of Tay. I have been able to preserve it in health for many weeks in phials of sea-water. Its ovate outline well distinguishes it from lacustrine forms; and this outline is subject to some variation by the action of a stout transverse muscle-band across the venter, drawing together the two sides; the medial length of the ventral plate being membranous and flexible, and the pectoral edge being cleft and overlapping. It is well suited for illustrating the **branchial system**. The plexus of the anastomosing afferent tubes is wide and particularly clear, and seems to be distributed on all sides of the great funnel. And the union of these can be readily traced into a large sac, which (placed on the ventral surface) presently bends dorsum-wards into a great pyriform vessel (as in *P. valvata*) on each side, and so pours its deoxygenated water by a slender duct into the œsophagus. The **abdominal viscera** are rather small. The long and flexible **foot** appears to be furnished with a central piston which protrudes and retracts its ciliated end; this is endowed with considerable power of adhesion.—P.H.G.]

Length. Head and foot extended, $\frac{1}{8\pi}$ inch. Width, $\frac{1}{225}$ inch. **Habitat.** Among confervæ in tide-pools; mouth of the Naze, and of the Tay (P.H.G.): not rare.

P. TRUNCATA, *Gosse*, sp. nov.

(Pl. XXVI. fig. 16.)

Pterodina elliptica . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 203.

[SP. CH. **Lorica** *ovate, somewhat pointed behind, the occipital edge abruptly truncate and slightly notched, the pectoral widely cleft. Lacustrine.*

I know this from a single specimen only, which I took in the autumn of 1850, in the expanse of water locally known as the Black Sea, at Wandsworth. My study of it is imperfect; for though it rotated freely, I was called away before my observation had proceeded far, and when I returned it was retracted and soon died. The **eyes** are small, remote, and almost colourless. The extrusile **foot**, the **trophi**, the **digestive** apparatus, the pair of diagonal **muscles**, and (so far as seen) the plexus of **branchial tubules** on each side, were all generally normal.—P.H.G.]

Length. Of lorica, $\frac{1}{197}$ inch. **Habitat.** A lake near London (P.H.G.): very rare.

Genus POMPHOLYX, *Gosse*.

[GEN. CH. **Lorica** *entire, bottle-like;* **foot** *wanting; two frontal* **eyes**; **corona** *double behind, united before; eggs attached after extrusion. Lacustrine.*

Two species, so far as we know, compose this genus; both small, obscure, and rarely seen. The one was found by myself in 1850; the other by Mr. Bolton in 1884.—P.H.G.]

P. COMPLANATA, *Gosse*.

(Pl. XXVII. fig. 1.)

Pompholyx complanata . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 203.

[SP. CH. **Lorica** *two-sided, nearly circular, with rounded edges; occipital edge obtusely pointed, pectoral edge notched.*

The **form** is that of a round flat scent-bottle. The **corona** is composed of two disks, resembling those of a Bdelloïd, but united in front, with a deep occipital sulcus, wherein an **antenna** protrudes. The **eyes** are placed one on each side of this sulcus, large, globular, ruby-red, and highly refractile. The **jaws** and **alimentary canal** seem of the *Pterodina* pattern, but the minuteness of the animal precludes definite observation. The **cloaca** appears at the end of the lorica, as a round orifice, with a slightly raised edge around it. Yet the great size of the egg suggests either that this orifice must be expansible, or that there must be a separate duct.

In manners it resembles the *Pterodinæ*; but it revolves as it goes like the *Anuræa*.

It is somewhat slow of motion. The medial line of the venter is a salient angle; and this has a curious effect as the creature revolves.—P.H.G.]

Length. Of lorica, $\frac{1}{300}$ inch. **Habitat.** Pond at Lower Clapton (P.H.G.).

P. SULCATA, *Hudson.*

(Pl. XXVII. fig. 2.)

Pompholyx sulcata . . . Hudson, *J. Roy. Micr. Soc.* 1885, p. 613, pl. xii. figs. 7, 8.

SP. CH. **Lorica** *entire, divided into four convex lobes, by four longitudinal furrows.*

The **lorica** of this species is very unlike that of Mr. Gosse's *P. complanata.* In the latter the dorsal and ventral surfaces are so compressed that they are slightly concave, while in the former both these surfaces are sharply convex, and so are the connecting lateral surfaces. A transverse section, consequently, consists of four segments of circles, as shown in fig. 2*b*. It is easy to obtain this view, as well as a good sight of the corona with its two wheels and red **eyes**, for the animal is fond of swimming upright close to the cover-glass, or of exploring the bottom of the live-box, head downwards. I had little opportunity for studying the creature, but I noticed that the lorica had an aperture in its lower, pointed, and somewhat curved extremity.

I am indebted to Mr. Bolton for this pretty little Rotiferon, which he discovered in company with *Conochilus dossuarius* in the summer of 1884.

[A curious habit which this genus has in common with *Brachionus* is that of carrying the **eggs**, after they are successively discharged, until the young burst the shell. These are nearly circular (absolutely so as often presented to the eye), very large in proportion to the animal, each connected by a highly elastic thread to the hindmost part of the lorica, between its two terminal points. This thread can be lengthened or shortened at the will of the animal, and this in a surprising manner; for by very careful observation I perceived that, in elongating, the slender elastic thread was *actually projected*, the egg of course being inert, and nothing pulling or even touching it. And to a surprising extent; for I have seen the thread to equal in length the longer diameter of the egg.

The front edge of the **lorica** rises to a rounded projection dorsally, and two of less elevation laterally; these latter appear to be separated by a shallow sinus pectorally. The **mastax** is small, the **trophi** formed on the pattern seen in *Pterodina*, an *incus* with small *fulcrum* and quadrantiform *rami*, and with obsolescent *mallei*. I have seen retraction of the anterior parts to such an extent that the foot of the incus was very nearly at the bottom of the visceral cavity.—P.H.G.]

Length, $\frac{1}{220}$ inch. **Habitat.** Near Birmingham (T.B.): rare.

Family XVIII. BRACHIONIDÆ.

[**Lorica** *box-like, open at each end, generally armed with anterior and posterior spines;* **foot** *long, excessively flexible, wholly retractile, wrinkled, ending in two toes.*

Genus BRACHIONUS, *Ehrenberg.*

GEN. CH. **Lorica** *without elevated ridges, gibbous both dorsally and ventrally;* **foot** *very flexible, uniformly wrinkled, without articulation, toes very small. Lacustrine and marine.*

This genus contains Rotifera mostly of large size and of showy appearance, being inclosed in glassy shells of regular outline, adorned with symmetrical projections, and always presenting a broad surface to observation. They have been favourites with observers from the dawn of microscopy; and they are still. Fortunately most of the species are common and easily accessible. The form of the foot is peculiar; it is a long

and thick muscular tube, very transparent, covered with minute and close wrinkles, full of muscles, which admit of rapid protrusion and retraction, and of motion in all directions, with amazing flexibility (so that I have actually seen it tied in what, for the moment, looked like a knot!). The toes,—so small and apparently feeble,—have considerable power of grasping. They are sometimes used as a pivot on which the animal revolves. The mutual relations of the sexes are very distinct; as I have shown in detail in my Memoir "On the Dicœcious Character &c." (*Phil. Trans.* 1856). The female carries the excluded eggs attached to her body till they are hatched.

The distinction of the species rests mainly on the number, dimensions, and relations of the spines. Yet recent observations on *B. pala* throw doubt on the validity of such characters.—P.H.G.]

B. PALA, *Ehrenberg*.

(Pl. XXVII. fig. 3; and Pl. XXVIII. fig. 3.)

Brachionus pala	Ehrenberg, *Die Infus.* 1838, p. 511, Taf. lxiii. fig. 1.
„ *amphiceros* . .	„ *Die Infus.* 1838, p. 511, Taf. lxiii. fig. 2.
„ *polyacanthus* . .	Cohn, *Sieb. u. Köll. Zeits.* Bd. xii. 1863, Taf. xxii. fig. 4.
„ *amphiceros* . .	Plate, *Jenaisch. Zeits. f. Natur.* 1885, p. 65, Taf. ii. figs. 23–24.

SP. CH. **Lorica** *thin, smooth, transparent; with four, long, sharp,* **occipital spines.**

B. pala has a colourless, smooth and transparent **lorica**, armed with four long spines in front, but unarmed and rounded off behind. The lorica is flexible, and generally dragged-in a little on either side, round the attachments of the long dorsal muscles. The opening for the foot is a mere slit, through a pap-like protuberance at the end of the lorica; and its sides can be brought close together when the foot is withdrawn. The animal's internal organization is very like that of *B. rubens*, which has already been so fully described in Chapter I. that, beyond a reference to Pl. A, vol. i., and Pl. XXVII. fig. 3, only a few points require notice. The **mastax** is very large; and so are the transparent vesicles which are seated on it on the ventral side, and may possibly be salivary glands. By transmitted light they show only two curved lines (their outer bounding walls) rising from the mastax to the head. The **gastric glands** are stalked, as in *B. rubens*, but the stalks are generally hidden behind the broad triangular ends of the glands.[1] The **vascular system** is very conspicuous, and the five tags on each side can be readily found. I once obtained an admirable view of the top of a vibratile tag, which was pointing up the microscope. It was not at all like that of *Euchlanis dilatata* given by Dr. Plate, and taken from the same point of view. Dr. Plate figures the summit of the tag as an oval with pointed ends. I found that of the lowest tag of *B. pala* to be a thin straight edge, like that of a chisel. If there be an aperture there, it must be extremely narrow. As the animal moved, the tag turned too, so as to present also the two characteristic appearances given in Pl. XIII. fig. 8*b*.

Along with the undoubted specimens of *B. pala* were a good many of what appeared to be Ehrenberg's *B. amphiceros*, with two short thorn-like spines on the lumbar regions, and two others still smaller, one on each pap-like protuberance by the foot (fig. 3*c*). Ehrenberg says that *B. amphiceros* differs from *B. pala* in its smaller size, in having no coronal styles, in having four sharp posterior spines on the lorica, in lacking side muscles in front, and in having four vibratile tags instead of three. Moreover he says that he could not find a dorsal antenna. Now I carefully examined these specimens with four posterior spines, and found them to be of the same size as *B. pala*, with styles on the corona, with side muscles in front, and possessing a large dorsal antenna. In fact they were the exact counterparts of *pala*. I may add, too, that both those which had, and those which had not posterior spines, showed, under favourable circumstances, five vibratile tags on each side. Nor is this all: for I found some specimens with two

[1] The lower ends of these glands are tied to threads, which are attached to the lorica just above the heads of the lateral antennæ, and at their other extremities to the stomach. Mr. Gosse discovered and drew this arrangement, as well as the lateral antennæ themselves, in 1850.

lumbar spines but none on the foot-paps (fig. 3*d*), and others with spines on the foot-paps but none on the lumbar regions (fig. 3*e*); and, in all, the size and structure were the same. From this I conclude that Ehrenberg's *B. amphiceros* is only a variety of *B. pala*. [As is also, I have little doubt, my *B. ōon* ("Ann. and Mag. N. H." Sept. 1851.—P.H.G.] The lateral, or lumbar-spines are very variable, and occasionally reach an extravagant length, as shown in Pl. XXVIII. fig. 3, where they are nearly as long as the body of the lorica. In this specimen the spines were hollow nearly to their ends, and were, in fact, true prolongations of the body-cavity. They were, too, as flexible as the lorica, so that they could be brought all four together at the tips, or even crossed.

Length. Lorica, $\frac{1}{75}$ inch. **Habitat.** Ponds and ditches: common.

B. DORCAS, *Gosse*.

(Pl. XXVIII. fig. 4.)

Brachionus dorcas . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 203.
" " . . . " *Phil. Trans.* 1857, pl. xv. figs. 15–19.

[SP. CH. *As* B. pala; *but the* **occipital spines** *longer and more slender; and the antlers curved forward;* **pectoral edge** *undulate, with a central notch.*

This, too, may possibly prove only a variety of *pala*; but the appearance of the antlers struck me as unique; particularly the elegant sinuous curvature, like that of the horns of the Gazelle Antelopes, which suggested the specific name. I had ample opportunities of studying it in both sexes, and in all ages, from Forest-school Pond at Walthamstow, in 1850; but I have not met with it since. The figures, in which I have delineated its anatomy in detail, will render much description needless. I could find no **contractile vesicle** in any specimen, but distinctly traced the lateral canals of each side to a *common* termination at the cloaca. An excellent sight of one of the vibratile tags, endwise, showed these organs to be attached by a very minute papilla, and to be flattened on two opposite sides (as at fig. 4*d*). The parent carries her eggs after exclusion.—P.H.G.]

Length. Of lorica, $\frac{1}{60}$ inch; width, $\frac{1}{95}$ inch. **Habitat.** Walthamstow (P.H.G.): rare.

B. URCEOLARIS, *Ehrenberg*.

(Pl. XXVII. fig. 6.)

Brachionus urceolaris . . . Ehrenberg, *Die Infus.* 1838, p. 512, Taf. lxiii. fig. 3.

[SP. CH. **Lorica** *with six straight* **occipital spines** *and a deep sinus in the middle; the* **pectoral edge** *rising slightly to the middle, which is slightly excavate: orifice for the foot bounded by two papillæ.*

We have now species whose front is armed with six spines, usually low, but variable in height. In the present each **spine** is the origin of a shelly ridge, which runs for some distance down the lorica. Viewed dorsally, its outline is that of an elegant rounded cup; but, laterally, the occipital spines, and the gibbous dorsum descending below the flatter venter, destroy the resemblance. A round, or sub-square, orifice gives emission to the very agile wrinkled foot, as rapidly retracted. The lorica is somewhat scabrous. The internal organization is that common to the genus. The **lateral canals** begin at the highest point of the head-funnel, at the bases of the lateral spines. They pass down into close contact with the **gastric glands**, each of which is of great size and of retort-shape,[1] and each canal has at that contact a dilatation into an oblique plexus. Before it reaches its end, it is tied to the lorica, and makes an abrupt angle, to join the contractile vesicle *at the very neck* of its discharge.

Females carry, attached to the base of the foot, many small eggs which produce **males**, or few large eggs which produce females. (*Phil. Trans.* 1856, pl. xv. figs. 3–5;

[1] In one specimen the gastric glands evidently merged into the substance of the lateral canals.

where the species is named *rubens*.) The **eye** consists of three cells of ruby crimson, from the edges of each of which, under sunlight, brilliant reflection is seen.—P.H.G.].

Length. Of lorica, $\frac{1}{8}$ inch; total, foot and head extruded, $\frac{1}{56}$ inch. Width $\frac{1}{110}$ inch.
Habitat. Ponds and ornamental waters near London; Birmingham (P.H.G.): rather uncommon.

B. RUBENS, *Ehrenberg*.

(Pl. XXVII., fig. 5; and Pl. A.)

Brachionus rubens . . . Ehrenberg, *Die Infus.* 1838, p. 513, Taf. lxiii. fig. 4.

[SP. CH. *Nearly as the preceding, but the* **occipital spines** *have the form of saw-teeth, sloping inward; and of the* **pectoral edge** *the central elevation is more marked.*

I have strong doubts whether *B. urceolaris* and *B. rubens* are specifically distinct. Very different individuals may, indeed, readily be presented; but a series do certainly run into each other. Considering them for the present as distinct, I refer to the figs. on Plate A, and its explanation, in which it has been selected for illustration as typically representing the organization of the whole class. In examples which we may call more characteristically *rubens*, we may see the **gastric glands** in a very peculiar condition; each consisting of two sacs, quite distinct, each separated by a long duct, and the inner one leading by a duct to the œsophagus, while the outer is manifestly united with the **lateral canal.** Then the canals themselves form several distended sacs with necks, just before they enter the contractile vesicle, which is here unusually small, for the genus.—P.H.G.]

Length and **Habitat.** As the preceding.

B. MÜLLERI, *Ehrenberg*.

(Pl. XXVII. fig. 7; and Pl. XXX. fig. 8.)

Brachionus Mülleri . . . Ehrenberg, *Die Infus.* 1838, p. 513, Taf. lxiii. fig. 5.
„ *hepatotomus* . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 203.

[SP. CH. *The* **occipital spines** *reduced to low saw-teeth, much wider than high, with their outer edges sinuate; the* **pectoral line** *nearly straight, notched into round lobes. Marine.*

This is a very fine, elegant, and attractive species; and its marine habitat at once distinguishes it. I obtained it on the Essex coast six-and-thirty years ago; and recently Mr. Hood has sent it to me in abundance from tide-pools in the Firth of Tay, and Mr. Brightwell from Norfolk. It is a good traveller and lives long in small phials. I have had it in abundance in my own marine aquarium.

Each **gastric gland** is a great sac divided nearly to its base, so as to appear two; and these vary greatly in shape and in relative size. They are very distinctly connected with the lateral canals. Both male and female eggs are carried, and males are produced in abundance. The middle of the body in this sex is occupied by the **spermatic sac**, a great pyriform vessel connected by a bottle-like neck with the head-mass. On pressure this sac is seen to be full of bodies having a vermicular motion; and, on the pressure being continued, it bursts, freeing about thirty spermatozoa of unusual size, each being $\frac{1}{300}$ inch long, a slender body merging into a long whip-like tail which maintains a quivering undulatory motion for several minutes after exclusion.—P.H.G.]

Some fine specimens sent to me by Mr. J. Hood enabled me to make a drawing of the ventral aspect of this *Brachionus* (Pl. XXX. fig. 8), and to add a few notes to the above. The transparent **vesicles** which embrace the buccal funnel, and, resting on the mastax, reach up to the head, are here unusually large and conspicuous. The **lateral antennæ** can be readily seen protruding the tips of their heads from a dent in the lorica on either side just below the gastric glands: they are here, as is often the case, attached also to the floccose investment of the lateral canals, and their nerve-threads are obvious.

On the dorsal surface it is easy to bring into view the four bases of the **muscles** which work the foot; and which show as four spots nearly in a line crossing the lorica where it first begins to lessen in width.

Length. Lorica, $\frac{1}{100}$ inch; width, $\frac{1}{140}$ inch. **Habitat.** Sea-water. Essex and Norfolk coasts; Firth of Tay (P.H.G.; C.T.H.): common.

B. Bakeri, *Ehrenberg.*

(Pl. XXVII. fig. 8.)

Brachionus Bakeri . . . Ehrenberg, *Die Infus.* 1838, p. 514, pl. lxiv. fig. 1.
" " . . . Gosse, *Phil. Trans.* 1857, pl. xv. figs. 11, 12.

[SP. CH. **Occipital spines** *six, the intermediate pair almost obliterate; the* **pectoral line** *nearly level, undulate; behind two large* **lateral spines**, *and two smaller bounding the orifice for the foot. Lacustrine.*

This species has been dedicated to an early English microscopist; and it is both named and figured in Adams's great work on the Microscope, published just a century ago. It is a common species, and from its elegant form and ample breadth very attractive. Individuals differ much in the length, stoutness, and direction of the **spines**; the hind lateral pair being sometimes bent inward. The **ventral surface** is marked with minute granules, which are arranged in a pattern of some regularity. The **gastric glands** are again large, retort-shaped, with long necks, and are in contact, if not in union, with the lateral canals, which open into a small **contractile vesicle** at its *cloacal* end.—P.H.G.]

Length. Of lorica, $\frac{1}{02}$ inch: width, $\frac{1}{135}$. **Habitat.** Fresh waters around London, and widely spread (P.H.G.): rather common.

B. angularis, *Gosse.*

(Pl. XXVII. fig. 4; and Pl. XXX. fig. 9.)

Brachionus angularis . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 203.
" " . . . " *Phil. Trans.* 1857, pl. xv. figs. 13, 14.

[SP. CH. **Occipital spines** *reduced to slight undulations, with a slight (usually) rounded sinus in the middle;* **pectoral edge** *nearly straight*; **hind extremity** *with two short, blunt processes;* **outline** *more or less angular.*

The **figure**, jutting out into blunt angles, though characteristic, is not absolutely invariable; for I have seen a specimen whose dorsal outline was as regular as that of *urceolaris*. I first found it in the pond at Walthamstow in 1849; then in the ornamental water at Kensington Palace; and on many occasions since; often associated with *B. pala*. The parent carries both male and female **eggs** to the hatching. The **male** I have described and figured elsewhere. I have seen the sexual *coitus*. The internal structure presents nothing notable. It is of lively, restless manners.—P.H.G.]

The highly-arched dorsal surface of the **lorica** is not only facetted (as I have shown in Pl. XXX. fig. 9) but is carved out into curious hollows that are well seen in Pl. XXVII. figs. 4, 4*a*, which drawings I made from an empty lorica of unusual beauty. The ventral plate is quite overlapped by the dorsal, which hangs down all round it; so that the ventral surface, taken as a whole, is concave, although its middle portion is convex. Nothing is easier than to clip the creature gently by its sides, so as to be able to look into the ventral hollow; and then, with dark-field illumination, and the binocular, the true shape of this curious lorica can be seen at a glance. A side view shows also the very stout, wide-based dorsal **antenna**; which, as usual, plays in the hollow between the occipital spines. The lateral antennæ are well worth notice. The tip of each rocket-shaped head lies at an aperture in the lorica (Pl. XXX. fig. 9) which has, raised round it, a small chitinous ring; through which the brush of setæ can be seen to protrude

(Pl. XXX. fig. 9*a*). This is a little advance on the structure in *Noteus quadricornis*, in which Rotiferon two distinct circular perforations, with smooth edges slightly raised above the general level of the lorica, give passage to the antennal brushes.

Length. Of lorica, $\frac{1}{200}$ inch. **Habitat.** Near London; Birmingham; Dundee (P.H.G.); Clifton (C.T.H.); pools of fresh water: not uncommon.

Genus NOTEUS.

GEN. CII. **Lorica** *facetted, and covered with raised points; gibbous dorsally, flat ventrally;* **foot** *obscurely jointed;* **toes** *moderately long;* **eyes** *wanting.*

N. QUADRICORNIS.

(Pl. XXVIII. fig. 5.)

Noteus quadricornis	. . .	Ehrenberg, *Die Infus.* 1838, p. 503, Taf. lxii. fig. 1.
" "	. . .	Leydig, *Ueb. d. Bau d. Räderth.* 1854, p. 53, fig. 41.
" "	. . .	Eckstein, *Sieb. u. Köll. Zeits.* Bd. xxxix. 1883, p. 394.
" "	. . .	Plate, *Jenaisch. Zeits. f. Natur.* Bd. xix. 1885, p. 65.

The **lorica** of this handsome creature, the sole species of the genus, consists of two saucer-like plates; the dorsal one convex, facetted, and stippled; the ventral concave all round the edge but bulging in the middle, stippled and not tesselated. The front of the ventral plate is a concave circular segment with a minutely serrated edge, and the front of the dorsal plate has a similar, but unserrated, edge, with its outline broken by two projecting strips of the lorica which curve gradually over the head. At the hind end, the lorica is armed with two long, and nearly straight spines, widely separated by a straight edge set with a row of minute dots. The passage for the foot is a deep funnel-shaped cavity at the bottom of the ventral surface, covered by a loose flexible skin attached to its lower, inner edge, and also to the foot. The **head** is something like a broad and very thick basin. Seen from above, it shows the sides as circular lobes, connected on the dorsal side by an arched ridge. Its central hollow is small, and is laid open on the ventral surface by a V-shaped gap. The edges of the gap bear stout cilia, and there is a fan of similar cilia on the centre of the arched ridge connecting the circular lobes. On each side of the corona, apparently on the edges of the circular lobes, is a pimple bearing one or two styles. The rest of the corona is edged with ordinary cilia. The **foot** has three feeble false joints, and two rather long and sharp toes, which have the usual power of adhering to glass; though the two dusky objects running down its whole length are, I think, muscles for moving the toes, and not **secreting glands**. The **mastax** has a high position, and the **trophi** are weak examples of the sub-malleate type. The **gastric glands** are of unusual size and shape. They spread out like fans up into the extreme front corners of the lorica, and appear to be thin and delicately corrugated. They are joined to the apex of the stomach by long ducts. Just below the mastax there are small pear-shaped, and probably glandular, bodies attached by their stalks to the œsophagus. The **contractile vesicle** is large, and the lateral canals and vibratile tags are very conspicuous; the canals edging the lorica all round down to the base of each hind spine. In the individual shown in fig. 4, a narrow ovary had one ovum beginning to form near its smaller end; and below this ovum lay, in wrinkles, the empty pointed end of the ovisac. The **side muscles** for moving the head, a pair on each side, are unusually stout and obvious; the others are much as in *Brachionus*. A small heart-shaped **nervous ganglion**, with its broad end downwards, lies on the occiput between the frontal horns; and, seated on it, sloping downwards, is the conical sheath of the short **dorsal antenna**, whose tip just emerges at the base of the gap in the lorica between the horns. Dr. Plate (*loc. cit.*) has seen two

lateral antennæ protruding from small orifices on the dorsal surface of the lorica: one on each side, between the edge and the five-sided facets on the centre of the back.[1]

This is a bottom-haunting creature; and, in my experience, not a very common one. When captured it betrays its presence by its slow gliding motion, trailing foot, and white lorica: a whiteness due to the minute dots of chitine with which it is frosted. Happily the lorica is very thin, so that it is easy to see the viscera, in spite of the ridges, facets, and frosting.

Length. Of lorica, $\frac{1}{7^{0}}$ inch. **Habitat.** Ponds and ditches, near London, (P.H.G.); Clifton (Mr. Brayley; C.T.H.); Birmingham (Mr. Bolton junior): not very common.

Family XIX. ANURÆADÆ.

[**Lorica** *box-like, broadly open in front, behind open only by a narrow slit; usually armed with* **spines**, *or elastic setæ;* **foot** *wholly wanting.*

The genus *Anuræa* of Ehrenberg, already extensive, and now augmented by many new species, ought to constitute a distinct family, very different in form, structure and habit from the *Brachionidæ;* and including several genera. The body is inclosed in a compact box-like **lorica**, open in front and rear. They have no **foot**, and therefore are incessant swimmers, never resting. The **trophi** differ from those of the *Brachionidæ* in that the *manubria*, though usually clubbed, never take the expanded semi-circular shape. The **cilia**, too, are not set around a two-flapped corona, but on three large eminences, each of which terminates in a globose lobe, crowned with stout setæ. One **eye** is conspicuous, cervical. They are both marine and lacustrine.—P.H.G.]

Genus ANURÆA, *Gosse, nec Ehrenberg.*

[GEN. CH. **Lorica** *an oblong box, open widely in front, narrowly in rear; dorsal surface usually tesselated;* the **occipital edge** *always, the anal sometimes, furnished with spines;* the **egg** *after extrusion is carried attached to the lorica. Lacustrine.*—P.H.G.]

A. CURVICORNIS, *Ehrenberg.*

(Pl. XXIX. fig. 9.)

Anuræa curvicornis . . . Ehrenberg, *Die Infus.* 1838, p. 505, Taf. lxii. fig. 5.

[SP. CH. **Lorica** *oblong, rounded behind, tesselated, armed with six* **occipital spines**, *of which the middle pair are procurved; no spines behind.*

Of the **tesselations**, the medial row alone is perfect, of five facets; the posterior three are hexagons, the next square, the foremost an incomplete hexagon. From the lateral angles other ridges proceed laterally, forming other polygons, which are usually evanescent. Of the **spines**, the central pair (antlers) are strong, and curved forward, sometimes mutually approaching, sometimes receding. The lateral pairs are short, straight and pointed. From the outmost pair descends a prominent ridge on each side, making a sharp lateral edge to the lorica (fig. 9*a*). The **eye** is very large and brightly conspicuous; the **mastax** is a wide oblate spheroid, with mallei and incus well developed. A wide sacculate **stomach** follows, crowned with normal **gastric glands**, and descending with no distinct constriction to the hind end of the lorica, where there is a small orifice, through which I have seen the rectum protruded for a short distance, and then retracted. There is an ample contractile **vesicle**. The three main lobes of the **rotatory organ** are large and prominent when in action, each bearing a great round fleshy papilla, besides a smaller one on each side; each carries a divergent fan or brush of stout setæ. The

[1] I missed these in the living animal, but, afterwards, found the apertures (fig. 5*a*, *a'*) easily in an empty lorica, in the spots mentioned by Dr. Plate.

cilia produce vortices, but not wheels. A curved tubular **antenna**, with terminal bristles, issues from the sinus between the antlers.

This pretty species occurred by myriads in one of my garden pans near London in the autumn of 1849; and I met with it again in the watering pond on Hampstead Heath; but I have no record of it since. A great *Bursaria*, as well as *Asplanchnæ*, feeds voraciously upon it. It swims giddily, to and fro, with some swiftness.—P.H.G.]

Length, $\frac{1}{100}$ inch. **Habitat.** Near London; Birmingham (P.H.G.): not rare.

A. HYPELASMA, *Gosse.*

(Pl. XXIX. fig. 6.)

Anuræa fissa . . . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 202.

[SP. CH. **Lorica** *without spines, consisting of two plates, the* **dorsal** *arched, the* **ventral** *flat, commensurate; and widely cleft through its medial line.*

When I obtained this species, in 1850, I could not satisfactorily determine the character of its **ventral plate**; but subsequently, on many occasions, and with great precision, I saw that it is a thin flat plate, of the full width, apparently connected with the dorsal only by membrane. It is, moreover, divided down the middle by a fissure of varying width; I have even seen the pectoral edges of the fissure overlapping. These peculiarities, combined with the straight transverse **occipital edge**, might almost entitle this species to generic separation. The **egg** is (proportionally) of vast size, nearly half as large as the whole animal; and not symmetrical, for, from the side at one end, projects a nipple, by which it remains attached to the parent. One I saw hatched. The young escaped at the part where the pedicle was, head foremost, rotating freely. It was exactly like the parent, and fully three-fourths of its size. There is evidently an anal orifice, whence frequently protrudes a very delicate membrane (doubtless the rectum), with its end expanded and recurved (fig. 6). When the rotating front is retracted, there are seen two shelly lobes rising from within the lorica, which approach to contact, and thus protect the head (fig. 6*a*). The internal structure is normal. Some specimens were thickly infested with a minute Infusorium (*Colacium*?).—P.H.G.]

Length, $\frac{1}{220}$ inch. **Habitat.** Near London; Leamington; Stapleton Park, Yorkshire; Dundee; Torquay (P.H.G.): rather common.

A. TECTA, *Gosse.*

(Pl. XXIX. fig. 10.)

Anuræa tecta . . . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 202.

[SP. CH. *Nearly as* curvicornis, *but more pointed; and the* **tesselations** *are larger, and arranged on each side of a mesial dorsal ridge, which gives to the back the form of a vaulted roof.*

Of this pretty little species I have slight record. The arrangement of its facets sufficiently distinguishes it. It is high and nearly circular in transverse section. One that I saw carried a large egg-shell.—P.H.G.]

Length, $\frac{1}{200}$ inch. **Habitat.** Near London; Birmingham (P.H.G.): rare.

A. ACULEATA, *Ehrenberg.*

(Pl. XXIX. fig. 4.)

Anuræa aculeata . . . . Ehrenberg, *Die Infus.* p. 508, Taf. lxii. fig. 14.
„ *brevispina*. . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 202.

[SP. CH. **Lorica** *oblong-square in outline, slightly arched dorsally, flat, or concave, ventrally; the normal* **occipital spines** *six, of which the antlers are procurved; each of*

the two posterior angles produced into a slender straight spine of varying length; **surface** *minutely punctated, and hexagonally tesselated.*

The **form** of this very abundant species exactly resembles, whether viewed from the back or side, that of a wicker hand-barrow familiar in some parts of the country. When the empty **lorica** is seen, it is a beautiful microscopic object. The rotating head, and whole internal organization agree with those common to the genus. It swims rather swiftly, in a peculiar style, continually revolving, both on the long and the transverse axis, throwing perpetual somersaults. Its irregular plunging and rolling strongly remind me of the motion of a ship in a heavy sea.

My *A. brevispina* (*loc. cit.*) (Pl. XXIX. fig. 5) is, I feel assured, only a *var.* of this species, with the spines degenerate, and the puncturing nearly evanescent. Ehrenberg's *A. testudo* and *A. valga* will, I think, fall into the same category.—P.H.G.]

Length (including spines), $\frac{1}{115}$ inch; width, $\frac{1}{280}$ inch. **Habitat.** Pools and lakes (P.H.G.): very common.

A. COCHLEARIS, *Gosse.*

(Pl. XXIX. fig. 7.)

Anuræa cochlearis . . . . Gosse, *Ann. Nat. Hist.* 2 Ser. vol. viii. 1851, p. 202.

[SP. CH. **Lorica** *spoon-shaped, ending behind in a straight slender spine; the back ridged and tesselate, as in* A. tecta.

This bears the same relation to *A. stipitata*, Ehr., as *A. tecta* bears to *A. curvicornis*; differing from *stipitata* by the roof-like back, and the mesial division of the facets, which latter (as shown in Ehrenberg's figures) are decidedly of the hexagon pattern. The outline, too, of *stipitata* is that of a broad, or even triangular shovel; whereas that of *cochlearis* is decidedly spoon-shaped, broadly ovate. It is delicately punctate or stippled. The protrusile **front** is very ample; a great chin of two fleshy lobes is seen sidewise, besides the lateral and frontal lobes. The **eye** is manifestly on a lens, which sparkles in focusing, like a gem, but pale in hue. An **egg** of enormous proportions is carried before the caudal spine, reaching nearly to the chin. The **spine** varies much in length, from a mere tubercle to equal length with the lorica-body.

The species is not uncommon in clear waters, often associated with *Asplanchna*, of which it forms a common article of food. I have taken an *Asp. priodonta* with an *An. cochlearis* in its stomach, which, *after an hour or two*, was ejected, and instantly swam about, *as lively*, and apparently *as uninjured* as ever!—P.H.G.]

Length (including spines), $\frac{1}{150}$ to $\frac{1}{130}$ inch. **Habitat.** Clear ponds and lakes (P.H.G.): common.

A. SERRULATA, *Ehrenberg.*

(Pl. XXIX. fig. 8.)

Anuræa serrulata . . . . Ehrenberg, *Die Infus.* 1838, p. 508, Taf. lxii. fig. 13.

[SP. CH. **Lorica** *oblong-square, much as the shorter-spined forms of* A. aculeata; *dorsally* **tesselate** *with hexagons, except that the hind row of facets are two great polygons mesially divided; ridges serrate; both surfaces punctate.*

The most prominent character of this species is its extreme roughness, the edges of all the facet-divisions, and the back of every spine being jagged with minute round excavations, which stud every part of the surface. I have counted about seventy punctures in one facet. This roughness varies in degree. The **antlers** are often greatly developed in stoutness, length, and curvature: the hind spines are sometimes nearly obliterate. The **pectoral edge** makes two arches (each with an intra-marginal line) with a notch between them. The **viscera** sometimes protrude in a globose form beyond the end of the lorica: I think this is when the **contractile vesicle** is filling. The **frontal lobes** take the form of three short cylinders, each with its fan, of vibratile setæ; each of

the lateral pair projects from the midst of a much thicker cylinder. There are two square **antennæ**. The **eye** is large, sparkling in sunlight, and refractile.—P.H.G.]

Length, $\frac{1}{12}$ inch. **Habitat.** Near London; Birmingham; Dundee (P.H.G.): common.

Genus NOTHOLCA, *Gosse*, gen. nov.

[GEN. CH. **Lorica** *ovate, truncate and* **six-spined** *in front, sometimes produced behind; of two spoon-like plates united laterally; no hind spines; dorsal surface marked longitudinally with* **alternate ridges** *and* **furrows**; *expelled egg not usually carried. Lacustrine and marine.*

The genus thus indicated may include the species *biremis*, *striata*, *inermis* (young ?), *acuminata*, and *foliacea* (?) of Ehrenberg, together with others, which appear to be hitherto undescribed.—P.H.G.]

N. ACUMINATA, *Ehrenberg.*

(Pl. XXIX. fig. 3.)

Anuræa acuminata . . . Ehrenberg, *Die Infus.* 1838, p. 506, Taf. lxii. fig. 9.

[SP. CH. **Lorica** *produced behind into a long truncate point, spoon-shaped;* **ventral** *plate concave, one-third shorter than the* **dorsal.**

The form is very elegant. Of the **frontal spines** the antlers are nearly straight, the laterals moderately long, the intermediaries very short. From their six points, and from their five interspaces, run strongly marked lines throughout the lorica, of which the former are elevated, the latter depressed angularly. The junction of the ventral plate is about one-third from the point where the cloaca opens. Here two muscle-threads are affixed, connected with the rectum, which they draw down. An ample **contractile vesicle** receives on each side a conspicuous branchial duct, which in some parts is slender, in others much expanded and corrugated, including many vacuoles, and carrying two vibratile tags each. A remarkable structure is seen in apparent connection with these organs, which recalls the pyriform sacs seen in *Pterodina*. The **œsophagus** is long, and attached to it on each side is a small vessel which seems the ordinary **gastric gland.** But somewhat behind these are seen a pair of sacs, connected with the stomach on each side, and each giving off two threads, by one of which it is fastened to the lining membrane of the lorica, while the other runs down for some distance parallel with, and close beside, the tortuous vessel (branchia ?), and is then attached to the interior, where two remarkable shelly bosses are seen. The stomach itself is tied to the lorica by threads, which are probably muscular.—P.H.G.].

Length, $\frac{1}{83}$ inch. **Habitat.** Ornamental waters near London (P.H.G.): very rare.

N. LONGISPINA, *Kellicott.*

(Pl. XXVIII. fig. 6.)

Anuræa longispina . . . . Kellicott, *Amer. J. Micr.* iv. 1879, p. 20, with fig.
" " . . . . (Abstracted) *J. Roy. Micr. Soc.* ii. 1879, p. 157, with fig.
" " . . . . Levick, *Midland Naturalist*, ii. 1879, p. 241, 1 pl.
" *spinosa* . . . . Imhoff, *Zool. Anzeig.* Sept. 1883, No. 147, with fig.

SP. CH. **Lorica** *greatly produced behind so as to resemble a frontal spine;* **dorsal** *and* **ventral plates** *commensurate; of the six* **occipital spines** *the central pair consists of one very long curved spine, and of one aborted straight spine; the lateral pair, of two long, and curved; and the remaining pair, of two short, and straight; the* **ventral plate** *has a movable flap with a straight* **pectoral edge.**

Notholca longispina does not readily lend itself to any theory on the cause of an

animal's **form**; as it is hard to see how its extravagantly long spines can be of much service to it. They evidently forbid its approach to the confervæ and floating rubbish that are the favourite haunts of its class, under penalty of being probably anchored for life to the same spot; and they can scarcely serve as floats, for the animal is a heavy swimmer, as if overburdened with these great projections, and is usually found four or five feet below the surface. Neither can they be very serviceable as weapons of defence, for even the fry of a gudgeon would soon learn to snap it sidewise. At any rate it is a most interesting form, and though rare and impatient of captivity it is easily managed in the compressorium, as it can be firmly yet lightly held by its long curved spines without injury. The **lorica** is triangular in outline, the dorsal surface convex both lengthwise and across, the ventral slightly concave and rather more sharply curved as it approaches the hind end. Six **spines** spring from the anterior edge of the lorica. Two are lateral, and are continuations of thickened ridges running part way down the edges where the dorsal and ventral surfaces meet. They are equal in size, taper to a point, and curve first outward and then upwards and inwards. Then, on either side of the median dorsal line is a strikingly unmatched pair. One, the largest of all the six, is stout at the base, tapering to a point, and curved first downwards and then upwards, with a graceful sweep. The other is an abortive looking spine, of uniform thickness, about one-fifth of the length of its partner. In the gap between these two lies the **dorsal antenna**; and, as this antenna is exactly on the median line, it follows that the longest spine is not in the middle of the lorica (as it has been hitherto drawn [1]), but slightly on one side of it. There is yet another pair of spines, of equal length, considerably shorter than the lateral spines, and lying one on each side between the dorsal and lateral pairs. The hind end of the lorica flows off into yet another tapering spine curving downward and then upward, like the longest; and, with it and the body, presenting on a side view an elegant sigmoid curve. At the top of the ventral surface the lorica has a square flap, which can move, as on a hinge, to permit the head to come out, and which closes over it, when it is withdrawn. There is also a slit, like a trap-door at the hind end of the ventral surface, through which the cloaca is emptied. All the front spines are rough, but the hind spine is smooth. The **corona** has a thick dorsal wall crowned with ciliated eminences, and surrounding a deep cavity leading to the buccal orifice. This cavity is thrown open on the ventral surface by a scalloped V-shaped slit; and is guarded at each side on the top by two teat-shaped protuberances armed with stout vibrating styles. All the edge of the corona is **ciliated**, and so are the edges of the ventral slit, at the bottom of which lies the buccal orifice. The **mastax** with its sub-malleate trophi is close to the buccal orifice. There is a distinct **œsophagus** bearing two stalked **glands** below the mastax, and a cluster of rather larger glands just above the stomach. The **gastric glands**, **stomach** and **intestine** require no notice. A **contractile vesicle** lies just below the latter, close to the cloaca; the **lateral canals** and **vibratile tags** are conspicuous. The **muscular system** is like that of *B. rubens* (i. p. 8); and it is curious to see how, owing to the flexibility of the lorica, the longitudinal muscles can draw together all the frontal spines. As these are really continuations of stout chitinous ridges in the lorica itself, the approaching spines, with the flexible lorica folding up between them, look exactly like a closing umbrella. My specimens died before I had seen the **nervous ganglion**; but there is a dorsal antenna, protruding between the longest and the abortive spine when the head is expanded, and pulled in when the head is withdrawn. The adult had a single red **eye**, at the lowest part of the occiput, near the dorsal surface. Mr. Levick says that many of the first specimens that he found had two eyes; and that he thinks these animals were young ones. It would be very curious should it prove to be the case that two eyes in the young approach with age, and coalesce in the adult; especially as *Brachioni*

[1] Dr. Kellicott, Mr. Levick, and Dr. Imhoff, all place the largest frontal spine exactly on the median line of the lorica, and half-way between two small spines; I am satisfied that this is a mistake. Dr. Imhoff's figure shows *four* small frontal spines besides the three long ones: this also is wrong; there are only three, the abortive spine and a pair.

have an eye which has every appearance of being a coalesced pair. The extruded **egg** is carried on the ventral surface just above the hind spine.

Dr. Kellicott discovered this fine *Anuræa* in Niagara water at Buffalo, and soon after Mr. Levick found it in Olton reservoir. I am indebted both to Mr. Levick and Mr. Dunlop for many living specimens, and to Mr. Levick also for several mounted.

Length. Total, $\frac{1}{40}$ inch; of longest spine, $\frac{1}{150}$ inch. **Habitat.** Buffalo, U.S. (Dr. D. S. Kellicott); Birmingham (Mr. J. Levick); Greenock (Mr. M. F. Dunlop).

N. THALASSIA, *Gosse*, sp. nov.

(Pl. XXIX. fig. 2.)

[SP. CH. *The two* **lorica-plates** *commensurate;* **dorsal** *arched, long-ovate in outline;* **ventral**, *with* **pectoral edge** *straight. Marine.*

The **antlers** and lateral spines are moderate, nearly straight and sub-equal: the intermediate pair mere tubercles. The **pectoral edge** has no conspicuous unevenness. The **lorica** is scarcely changeable in outline, as if it were stiff and unyielding. Yet the shelly substance merges so insensibly into thin and evanescent membrane at the hind end (where a very delicate membrane, like a truncate tail [*rectum?*] is protruded), that we cannot determine the point of transition. The form and lobes of the **front**, and the array of fan-like setæ; the **brain** and great **eye**; the **mastax** and jaws; and the abdominal organization, do not notably vary from what we see in *Anuræa*. The broad protrusile and retractile membrane at the **cloaca** excretes mucus for temporary anchorage. One which I saw forcing its way through thick clusters of diatoms, emerged with several of them glued to its rear, which were then detached with some difficulty. In free swimming it is headlong and rapid, and very restless. In one example the intestinal canal was full of the frustules of diatoms. It is exclusively marine.—P.H.G.]

Length, $\frac{1}{18}$ inch. **Habitat.** Tide-pools in the Firth of Tay (P.H.G.): common.

N. SCAPHA, *Gosse*, sp. nov.

(Pl. XXIX. fig. 1.)

[SP. CH. **Lorica** *nearly as broad as long;* **dorsal plate** *greatly exceeding the* **ventral** *in width;* **pectoral edge** *sinuate. Marine.*

The transverse **outline** is highly rounded, resembling the half of an egg-shell, far within the margins of which a flat (ventral) plate is fixed across the cavity, leaving wide overhanging edges. The **lorica** is very flexible, so that, when the fore-parts are forcibly retracted, the dorsal outline suddenly appears perfectly circular, except at its spinous front edge, and then bears much resemblance to that of a *Brachionus*. The cloacal orifice is a very short and thin fissure at the extremity, and does not extend sensibly up each side.

In swiftly swimming, the wide but thin wing-like expansions of the **dorsal plate** are very conspicuous by their glassy clearness, and by their peculiar form, especially when seen end-wise; and this gives a very distinct aspect to the species, which is more than usually attractive. When alarmed it suddenly retracts with a snap; and if it happens to be presented sidewise at the moment, the frontal spines close with the sinuous pectoral edge, so as to cross and interlace. I saw one eagerly feasting on an *Actinophrys*, and watched it for half-an-hour. At first the frontal cilia worked energetically at it, gradually drawing it into the open front of the lorica, and holding it there. But the jaws were not applied to it; and it seemed as if the ciliary action alone were drawing off invisible gelatinous juices into the buccal funnel. Yet, when at length the *Notholca* relinquished its hold, the prey seemed uninjured. The species has been sent me by Mr. Hood, associated with the preceding, in sea-water from the estuary of the Tay.—P.H.G.]

Length, $\frac{1}{150}$ inch. **Habitat.** Firth of Tay (J.H.).

Genus ERETMIA, *Gosse*.

[GEN. CH. **Lorica** *neither tesselated nor ridged; destitute of spines proper, but furnished with long attenuate rigid bristles.*

This seems to be a natural group, containing numerous species. They appear to be destitute of the spines common to *Anuræa*, pointed extensions of the lorica itself; for the slender appendages are quite different in form, and probably in function.—P.H.G.]

E. PENTATHRIX, *Gosse*, sp. nov.

(Pl. XXIX. fig. 12.)

[SP. CH. *Five long* **bristles** *projected from the lorica; one dorsal and two from each side: no frontal or posterior spines.*

This species I know only from a single dead and empty lorica which I found in the sediment of water, dipped in June, from a pool at Sandhurst, Berks, by Dr. Collins. The **lorica** is ovate, truncate in front, with no spines of the ordinary pattern, but bearing attached to the medial line of the dorsum a long stiff seta, or attenuate spine, the base of which is deep but very thin, the depth gradually diminishing. From the sides, about two-thirds down, spring a pair of similar bristles of less basal depth; and, at a short distance from the round extremity of the lorica, another pair. All radiate from the surface of the lorica, and are consimilar in length and tenuity. No trace of the internal organs was left.

This has evident affinities with the *A. biremis* of Ehrenberg, which he describes from a single specimen obtained in the Baltic Sea. That species, however, has four frontal spines.—P.H.G.]

Length, unrecorded. **Habitat.** Pool near Sandhurst Mil. Coll. (P.H.G.): very rare.

E. CUBEUTES, *Gosse*, sp. nov.

(Pl. XXIX. fig. 11.)

[SP. CH. **Lorica** *bag-like, round behind, truncate before; with a diverging* **seta** *from the dorsum and one from the venter; four straight* **spinous processes** *from the rounded end; the whole surface cut into cubical tesseræ.*

This minute and very curious form I place in the genus *Eretmia*, though the body processes seem rather spines than setæ. I have found it, but only as a dead lorica, on two separate occasions, and in water from widely distant localities; but Mr. Hood has since found it living, and sent me a good drawing of it, which well agrees with my own. All were in autumn and winter of 1885–86.

The **lorica edge** is not spined, but notched. Yet the notches are but the intervals between the *tesseræ* of the front row, of which three are seen beside the lateral two. For the entire surface of the lorica is marked with two series of **depressions**, those of each series parallel to each other, but the two series crossing each other at right angles (or nearly); so as to leave a multitude of square tesseræ, or cubical knobs,—like dice set corner-wise:—a form of surface quite unique, so far as I know. I was, indeed, disposed to think it an *Arcelline* Infusory of the genus *Difflugium*, till I received Mr. Hood's report, which showed it a true *Anuræad*. He describes the **rotatory front** as bearing the normal three great ciliate lobes. The large red **eye** I had myself seen.—P.H.G.]

Length (including spines), $\frac{1}{316}$ inch (P.H.G.); $\frac{1}{200}$ inch (Hood). **Habitat.** Birmingham (P.H.G.); Black Loch, Dundee (Hood): rare.

CHAPTER XI.

SCIRTOPODA.

Cætera de genere hoc mirande multa videmus,
Quæ violare fidem quasi sensibus omnia quærunt:
Nequidquam; quoniam pars horum maxima fallit
Propter opinatus animi quos addimus ipsei
Pro visis ut sint, quæ non sunt sensibus visa.
Nam nihil ægrius est quam res secernere apertas
Ab dubiis, animus quas ab se protinus addit.

LUCRETIUS, *De Rerum Natura*, Lib. iv. l. 464.

The life of the brute has commonly one immense compensation in its favour; the perfection of the individual existence is so rarely sacrificed to the prosperity of the race. It is not necessary, in order that one hippopotamus should cut his food conveniently, that another hippopotamus should lead an unhealthy existence like a Sheffield grinder; nor does the comfort of any bird's nest require that another bird should slowly poison itself in preparing acetates of copper, sulphurets of mercury, or oxides of lead. The pride and beauty of a brute are never based upon the enduring misery of another brute. The wild drake's plumage, splendid as it is, suggests no painful thought of consumptive weavers, of ill-paid lace-makers, of harassed over-worked milliners: and the most sensitive of us may enjoy the sight of it without painful thoughts; for it is God's free gift, causing no heart-burning of envy, no care nor anxiety of any kind. —P. G. HAMERTON, *Chapters on Animals.*

We are then in a world of spirits, as well as in a world of sense; and we hold communion with it, and take part in it, though we are not conscious of doing so. If this seems strange to anyone, let him reflect that we are undeniably taking part in a third world, which we do indeed see, but about which we do not know more than about the Angelic hosts;—the world of brute animals. Can anything be more marvellous or startling, unless we were used to it, than that we should have a race of beings about us, whom we do but see, and as little know their state, or can describe their interests, or their destiny, as we can tell of the inhabitants of the sun and moon? It is indeed a very overpowering thought, when we get to fix our minds on it, that we familiarly use, I may say hold intercourse with, creatures who are as much strangers to us, as mysterious, as if they were the fabulous, unearthly beings, more powerful than man, yet his slaves, which Eastern superstitions have invented.—NEWMAN, *Parochial Sermons*, 'The Invisible World.'

CHAPTER XI.

Order IV. **SCIRTOPODA.**

Swimming with their ciliary wreath, and skipping with Arthropodous limbs; **foot** *absent.*

The fourth order, *Scirtopoda*, although it contains but two Rotifera, each in a genus by itself, is one of no little importance, as it is that in which the ROTIFERA and CRUSTACEA most nearly touch. The true position of the ROTIFERA in the animal kingdom has long been a matter of keen dispute, and the chief authorities have taken opposite sides: Professor Owen, Dr. Leydig, and others, rank them among CRUSTACEA[1]; while M. Milne-Edwards, Dr. Cohn, Professor Huxley, with the majority, would consider them as VERMES. Nor is this surprising; for the ROTIFERA possess many characters that are common, in various degrees, to ARTHROPODA and VERMES alike; and, so far as their nutritive, reproductive, or nervous systems are concerned, might with little difficulty be placed in either sub-kingdom. But there were three respects, before the discovery of *Pedalion* and *Hexarthra*, in which the ROTIFERA appeared to differ from ARTHROPODA, and to resemble VERMES. These are, first, that they do not possess pairs of jointed appendages, articulated to the body, with muscles prolonged into their interior; and on this point great stress was laid. Secondly, that they swim by means of ciliary wreaths; and thirdly, that they possess a vascular system, with ciliated tags, whose chief function is probably a respiratory one.

But the discoveries of *Pedalion* and *Hexarthra* have shewn that Rotifera exist whose internal structure is perfectly normal, and which yet possess three pairs of unquestionably Arthropodous limbs; and these discoveries have in consequence disposed of the chief objection to the ranking of the ROTIFERA among ARTHROPODA. It may, on the other hand, be fairly urged that the balance of argument even now inclines towards those who are in favour of the opinion that the ROTIFERA, as a class, are nearer to VERMES: yet no one, I think, who has studied both *Pedalion* and the Nauplius larva of one of our fresh-water ENTOMOSTRACA, would feel satisfied with their being placed in two distinct sub-kingdoms.

In conclusion, I see no reason why the ROTIFERA should be assigned solely to VERMES or ARTHROPODA; and I would propose to consider them as a class that links these two sub-kingdoms together.[2]

Family XX. PEDALIONIDÆ.

Arthropodous limbs *six;* **head** *truncate;* **corona** *of two concave lobes;* **ciliary wreath** *as in Philodinadæ;* **trophi** *malleo-ramate.*

The family contains two genera, *Pedalion* and *Hexarthra*, each containing only a single species. The two are much alike[3] in the possession of six Arthropodous limbs

[1] [I consider the ROTIFERA a class of the sub-kingdom ARTHROPODA, co-equal in rank with INSECTA and CRUSTACEA.—P.H.G.]

[2] Of course I am here treating the matter simply as one of formal classification; and from this point of view it is enough to say that if we knew none but the humbler forms of the ROTIFERA, we should call them VERMES; whereas if *Pedalion* and *Hexarthra* were our only examples, we should call them the lowest forms of ARTHROPODA.

[3] Mr. Julien Deby, in the *J. Roy. Micr. Soc.* 1879, p. 384, has suggested that the two Rotifera are

ending in fans of imbricated setæ, in the conical shape of the body, and in the broad truncate corona; but they differ strikingly in the way in which the limbs are set on the body: for in *Pedalion* they are arranged around it parallel to its longitudinal axis, while in *Hexarthra*, as in the Nauplius larva, they radiate from the centre of the ventral surface. Nor is this the only difference. *Hexarthra's* limbs are in three graduated pairs, while *Pedalion's* ventral limb is far longer than any of the others: moreover, *Hexarthra* lacks two long stylate appendages, ciliated at the ends, which are to be found on the posterior end of *Pedalion's* dorsal surface.

Genus PEDALION, *Hudson*.

GEN. CH. **Limbs** *arranged round the body in pairs, and parallel to its longitudinal axis; two stylate, ciliated* **appendages** *on the posterior dorsal surface.*

P. MIRUM, *Hudson*.

(Pl. XXX. fig. 1.)

Pedalion mirum . . .	Hudson, *Mon. Micr. J.* vol. vi. 1871, p. 121, pl. xciv.; and p. 215.
„ „ . . .	„ *Quart. J. Micr. Sci.* vol. xii. 1872, p. 333, pl. xix.
„ „ . . .	„ *Mon. Micr. J.* vol. viii. 1872, p. 209, pl. xxxiii.
„ „ . . .	Lankester, *Quart. J. Micr. Sci.* vol. xii. 1872, p. 338.

SP. CH. **Ventral limb** *much the largest;* **dorsal limb** *on the median line;* **lateral limbs** *in two unequal dissimilar pairs; the* **bases** *of all the limbs, lying in a transverse section behind the dorsal antenna; their free ends terminating in fans of imbricated setæ.*

It was in July 1871 that I had the good fortune to discover this remarkable Rotiferon in a small road-side pond near the head of Nightingale Valley at Clifton. On placing a specimen of it under the microscope I for a moment fancied that I had brought home by mistake some Entomostracous larva, for its outline, its six limbs ending in fans of imbricated setæ, and its habit of jerking itself through the water, made it resemble the ordinary Nauplius of a *Cyclops*. However, a brief examination showed it to be a true Rotiferon, with a splendid corona and with internal organs much like those of *Triarthra longiseta*. The external **form** is extraordinary; not only has it six well-developed limbs, but all these limbs are hollow, communicating with the body cavity, and containing pairs of opposing muscles prolonged into their interior. The arrangement of the limbs too is more effective for locomotion than that in a Nauplius; for in *Pedalion* they are attached in pairs to its anterior end, and lie parallel to the longitudinal axis of the body, so that their united stroke acts at a great mechanical advantage; but in the Nauplius larva the limbs radiate from a spot on the ventral surface; and, in consequence of this inferior method of attachment, produce a very feeble skip compared with the furious rush of *Pedalion*. The **corona** is unusually large, and consists of two oval saucer-like lobes, so set as to give together a heart-shaped appearance to the head. The **ciliary wreath** is double, and precisely on the pattern of the *Philodinadæ* (Pl. C, fig. 3). Between the upper and lower wreath is the usual groove along which the food is conducted to the mouth. On either side the lower wreath dips down to the buccal orifice, which is prolonged ventrally into a great curved lip, fringed with very large cilia. The rather small **mastax** has two

identical, and that the differences between my description and Dr. Schmarda's "reside principally in the incompleteness of the details given by the latter, and are consequently differences of omission rather than anything else." It is difficult to understand how it can be an "omission" to describe and draw all the *six* legs as radiating from a spot on the ventral surface, while (on the supposition of the identity of the two creatures) there is only *one* on that surface, and all lie round the body and parallel to its length. Neither can it well be an "omission" or an "incomplete detail" to say that there are *two* legs of equal size longer than all the others, when there is only *one* such leg. Indeed, were Dr. Schmarda really capable of the gross blunders attributed to him by Mr. Deby, the whole of his observations would be worthless.

chitinous lips, which may be seen constantly advancing and receding in the buccal funnel, and apparently selecting the morsels which are allowed to reach the trophi. The **œsophagus** is short, and the nearly cylindrical **stomach** has very thick elastic walls; in a dying specimen I have seen the food expelled, and the walls close in quite upon themselves. The **gastric glands** are somewhat oval; and I think that I have seen two small stalked glandular-looking bodies attached to the œsophagus. The **intestine** is a broad short chamber with thicker walls and coarser cilia than those of the stomach. The two ciliated straight **processes**, on the hind end of the dorsal surface, have also a glandular structure and secrete a viscous fluid, by threads of which *Pedalion* may be found moored to algæ, or to the floating masses of floccose sediment.

These processes vary greatly in length in different individuals; they are always very short in the newly hatched female, and are wanting in the male. It is unusually difficult to demonstrate the **vascular system**, as its parts are so frequently obscured by the alimentary canal and the limbs. There are two lateral canals, each commencing in a plexus close to an eye and bearing a vibratile tag. Hence the canal runs down to a second plexus, halfway down the body, with two vibratile tags; and, skirting the side, finally unites with the cloaca. There is no contractile vesicle. The **ovary** requires no notice. *Pedalion* carries its extruded egg attached to its posterior extremity till it is hatched. Of the large oval female eggs only one at a time is so carried; the small, round male eggs are carried in clusters: the eggs of different sexes are never present together. The newly hatched female resembles its mother, and passes through no change but that of growth. The **muscular system** is very greatly developed. There are at least forty striated muscles arranged in pairs of elevators and depressors, not mere repetitions of each other like the muscles of a caterpillar, but very various in shape and arrangement, and obviously intended for different duties. Figs. 1*d*, 1*e*, 1*f* show these pairs very carefully drawn and, with the printed explanation facing Pl. XXX., render any detailed account superfluous. The **nervous ganglion** lies closely applied to the dorsal side of the buccal funnel, and has above it two **eyes**, widely apart and close to the surface of the corona; one in each of its lobes. They are clear refractive spheres set on plates of red pigment. Nerve-threads pass from the ganglion to lateral rocket-headed **antennæ**, one on each shoulder; and another nervous thread supplies a similar antenna which moves up and down in a protuberance on the dorsal median line (figs. 1*a*, 1*b*) just behind the dorsal gap in the ciliary wreath.

The **male** (figs. 1*h*, 1*k*) is the merest caricature of the adult female. The large, shapely **corona**, with its flowing curves has become a ciliated knob; the six **limbs**, with their fan-shaped plumes, have been altered into three little stumps, with a bristle or two at the end of each; even the huge ventral limb has vanished, and the whole creature has shrunk up to barely one-fifth of the length of the adult female. It swims very differently from its mother; for it spins constantly round its own length, like a joint on a spit, while at the same time moving forward. Now and then it jerks its side limbs, and it uses them to free itself from its shell. There are two longitudinal **muscles** for retracting the head and a pair of red **eyes**, but I could discover no other internal organs except the **testis** and **penis**. This latter I have seen protruded to a length quite equal to that of half the animal.

Length. Female, corona and body, $\frac{1}{120}$ inch; from corona to end of ventral limb, excluding setæ, $\frac{1}{85}$ inch: male, $\frac{1}{370}$ inch. **Habitat.** Clifton (C.T.H.); Birmingham (T.B.); warm water-lily tank in the Duke of Westminster's gardens at Eaton, and ponds in the neighbourhood of Chester (Mr. Thos. Shepheard): very rare.

The only other Rotiferon in this Order is *Hexarthra polyptera* (Pl. XXX. fig. 2),[1] which was discovered by Dr. Schmarda in some brackish water near El Kab in Egypt, in March 1853. He describes the **body** as a blunt cone with a right and left group of **cilia** on its broad end. The **trophi** resemble those of *Triarthra*. The **stomach** is short and broad; the

[1] Copied from Dr. Schmarda's fig. 1, *Zur Naturgesch. Ägyptens*, Taf. iii.

intestine is frequently constricted and narrow towards its end. The **gastric glands** are two lobed. He further notices the **lateral canals**, and a bladder-like organ which he conjectures to be the testicle, but which was probably the contractile vesicle. Two red globular **eyes** are seated in the corona, not far asunder. The mature **eggs**, which are green, are carried at the posterior end of the body. There are three pairs of **limbs** attached to *the ventral surface*. The foremost pair is the longest, the middle pair is less, and the lowest pair is the least. Two streaked **muscles** run down the first pair of limbs, and one muscle down each of the other four. All the limbs are terminated by fans of setæ. *H. polyptera* does not appear to have any ciliated **processes** on the dorsal hind surface.

ADDENDA.

[Asplanchna myrmeleo, *Ehrenberg* (vol. i. p. 123: footnote). This interesting species is no longer an alien. Mr. Hood has lately sent me, from Dundee, living and healthy examples. They seemed to possess no contractile vesicle.—P.H.G.]

[Eretmia trithrix, *Gosse*, sp. nov. (Pl. XXVIII. fig. 2). **Lorica** a three-sided box, of which the posterior end is a triangle, and carries a long elastic **seta** at each angle: **egg**, when laid, carried between the alvine setæ. **Length**, $\frac{1}{160}$ inch. *Lacustrine.*—P.H.G.]

[Eretmia tetrathrix, *Hood*, sp. nov. (Pl. XXVIII. fig. 1). **Lorica** shaped like a deep obconic wine-glass, of which the foot is represented by a very long straight **seta**: three similar **setæ** stand up from the occipital margin. **Length**, of lorica, $\frac{1}{100}$ inch; total $\frac{1}{50}$ inch. *Lacustrine.*—P.H.G.]

Notommata Wernecki, *Ehrenberg*. I am indebted to Mr. Fred. Bates for some threads of *Vaucheria sessilis* bearing many of the galls caused by this parasitical Rotiferon. Mr. Bates says that he has found the animal in abundance inhabiting these galls, which may occur anywhere along the thread of the *Vaucheria*: but that he has *not* found the parasites in the reproductive cells (see vol. i. p. 39).

Length (according to Balbiani), $\frac{1}{100}$ inch. **Habitat.** Neighbourhood of Leicester (Mr. F. Bates).

Œcistes ptygura, *Ehrenberg* (Pl. XXX. fig. 3). This is no doubt Ehrenberg's *Ptygura melicerta*. It has a two-lobed **corona**; a wide **dorsal gap**; no visible **ventral antennæ**; a pair of large dorsal **hooks**, adnate for half their length; a stout wrinkled **foot**; and an irregular floccose **tube**. It was found last May, at Twickenham, by Mr. G. Western, who kindly sent me the living specimen, from which fig. 3 has been drawn. Its position, in one of the axils of the plant to which it was attached, prevented me from measuring it; but it seemed to be about the size of an ordinary *Œcistes crystallinus*.

The following remarkable Rotifera are as yet unknown in Britain.

Balatro calvus (Pl. XXX. fig. 6), *Ed. Claparède* (15). This is an **il-loricated** Rotiferon, parasitic on different species of *Oligochæta*. Its peculiar hind extremity is shown in the figure. **Mastax** very small, containing two minute curved rami; **stomach**, simple and straight; **ovary** large; **ciliary wreath** and **antenna** wanting; **nervous**, and **vascular systems** apparently absent.

Drilophaga bucephalus (Pl. XXX. fig. 5), *F. Vejdovský* (150). An **il-loricated** *Proales*-like Rotiferon, parasitic on *Lumbriculus variegatus*; it adheres by its trophi to the worm's hinder segments, and sucks its juices; **nutritive, secreting,** and **vascular systems** normal.

Seison Grubei (Pl. XXX. fig. 4), *C. Claus* (17, 18). A doubtful Rotiferon; **il-loricated**, of extraordinary form, parasitic on *Nebalia*; **ciliary wreath** a few cilia at the mouth; **secreting system** highly developed; **nutritive system** present in the male as well as in the female; **vascular system** very rudimentary; **jaws** rotiferous.

APPENDIX.

THE VASCULAR SYSTEM.

*** *The numbers in brackets, as* (138), *refer to the memoirs in the Bibliography, pp.* 140–142.

1. This system of vessels, in its usual form, has already been described in vol. i. p. 8. There are three [1] principal varieties of it, including that already given above.

(i.) The lateral canals open into a contractile vesicle, which discharges itself into the cloaca. This is the ordinary plan.

(ii.) Each of the lateral canals ends in an expanded portion which dilates, and contracts, and discharges into the cloaca. This doubling of the contractile vessel is to be found, among others, in *Conchilus volvox* [2] and *Salpina macracantha*.[3]

(iii.) The lateral canals pass unexpanded directly into the cloaca, and the contractile vesicle is absent.[4]

2. It is probable that the contractile vesicle is filled by a fluid flowing into it through the lateral canals, and it is certain that it usually [5] empties itself outwards through the cloaca. This has been directly observed [6] in *Asplanchna priodonta* and in *Hydatina senta* by myself, and can be easily verified. It has been suggested that a return current of fresh water is drawn up by the expanding contractile vesicle through the cloaca; but no one has seen any appearance of this in the cloaca itself; and though Dr. Cohn [7] thinks that he saw a return current draw particles of carmine towards the opening of the cloaca of *Brachionus militaris*, after the outward current had driven them away from it, no one else seems to have succeeded in repeating the observation.[8] Occasionally the contents of the cloaca are driven into the intestine. Dr. Moxon has seen this in *Euchlanis dilatata*,[9] and Dr. Semper has seen it in *Trochosphæra æquatorealis*.[10] In each case it was effected by closing the aperture of the cloaca and opening that of the intestine simultaneously; but this is not the usual action, and (as Dr. Moxon suggests) seems only to be a method of obtaining a natural enema for a clogged intestine.

3. In all the three plans, given in § 1, the lateral canals sometimes appear surrounded by a filmy, floccose substance, through which they meander (generally two on each side)

[1] Dr. Semper (138) says that in *Trochosphæra æquatorealis* there is a contractile vesicle which has no connection with the lateral canals: if this is really the case, it would be unique. Mr. Gosse has described, p. 138, another variety of the vascular system in *Pterodina*, and in other Rotifera; but, as we differ widely here about the facts, as well as about the inferences drawn from them, I have (for the sake of brevity and clearness) omitted this variety from my account.

[2] Vol. i. p. 90. [3] Vol. ii. p. 85.

[4] Professor Huxley (91) states that this is the case in *Lacinularia socialis*; but Dr. Leydig (108) says he has seen a small contractile vesicle in this *Rotiferon*. Neither *Pedalion mirum*, *Pterodina patina*, nor *P. valvata* appears to have any contractile vesicle.

[5] See below; same paragraph. [6] Vol. i. p. 123. [7] (21).

[8] I have never seen *B. militaris*, which from the great size of its contractile vesicle is admirably adapted for such observations.

[9] (118). [10] Vol. i. p. 88.

in many loops and curves, and occasionally forming a plexus of complicated intertwinings. Attached to the canals by long stalks are the little flickering bodies called vibratile tags. The canals are generally visible just under the head, near a plexus, and run down each side of the body, from one plexus to another, till they reach the surface of the contractile vesicle. There are usually five vibratile tags on a side, and a plexus is a favourite point of attachment.

4. The tags are of various shapes. In some they seem to be simple cylinders, or cones with their bases at the free end. In others they are somewhat wedge-shaped; so that they have a broad triangular surface from one point of view, and a narrow spindle-shaped surface from another. If a tag happens to point straight up the microscope, a full view may be obtained of its free end; and the outlines, so obtained, of these free ends, vary considerably: in the case of *Euchlanis dilatata* it is a narrow oval with prolonged pointed ends;[1] and in that of *Brachionus pala*,[2] only a fine straight edge. Whenever I have obtained a distinct edgewise view of a tag, it has had the *appearance* of being closed at its free end with a knob. Down the length of the tag (when so seen) run an endless succession of swift undulations; which, on several occasions, in the dying animal, I have seen slowly slacken, till they have gradually resolved themselves into what *seemed* to be one stout, tapering, undulating cilium, of the length of the tag itself, attached by its broad base to the knob mentioned above, and pointing its taper extremity to the lateral canal.

But when the tag presents its broad triangular surface to the observer, there is a totally different appearance; and it seems to be crossed by quivering, parallel, straight lines that stretch from one side to the other (Pl. XIII. fig. 3*b*). It is obvious that no single cilium could present such an appearance. Possibly an undulating membrane might, the cross-lines being the summits of the waves which happened to be in focus; but the lines seem to be too sharp for this. Dr. Moxon suggests that the cross-lines are produced by rows of extremely minute cilia on each inner broad surface of the tag. It is not easy to imagine what such an apparatus might look like when seen in motion sidewise; but possibly the apparent waves produced by the cilia on either side might together cause the illusory appearance of an undulating cilium as long as the vibratile tag. That many of the inner surfaces of the Rotifera are lined with minute cilia has long been known. The whole alimentary tract is so; and, what is more to the point, this very appearance of a long undulating cilium is certainly produced in the tube of *Floscularia campanulata* by very minute cilia running in straight lines down its length.[3]

5. The next point is whether these tags are open or closed at their free ends. On this point it is enough to say that direct observation has entirely failed to decide the question. The chief authorities have come to opposite conclusions, and there seems to be no hope of settling the point by the microscope. The close analogy between the vibratile tags of the Rotifera and the appendages on the water-vessels of the Naids would, however, lead us to infer that in the former case, as well as in the latter, the tags in spite of appearances may be open funnels, furred inside with minute cilia. A similar difficulty awaits us when we inquire how the lateral canals originate in the head. In some cases the canals on either side are said to have their fore ends on the surface[4] in communication with the free water, in others to cross from side to side and anastomose[5]; so that the whole apparatus forms a loop with its two ends attached either to the cloaca or to the contractile vesicle; while in the great majority of cases it is impossible to say what is the real arrangement.

6. In attempting to determine the use of this apparatus we are met by this obvious difficulty; that we are not sure of the facts. Are the vibratile tags open at their free

[1] Dr. Plate (126) Taf. ii. fig. 19, c. [2] C.T.H. vol. ii. p. 117.

[3] Pl. D, fig. 1; also Dr. Moxon (118).

[4] As observed by Mr. Gosse in *Pterodina patina* and *P. valvata*, vol. ii. p. 138.

[5] As observed by Professor Huxley in *Lacinularia socialis* (91); by Dr. Leydig in the same (108); and by myself in *Stephanoceros Eichhornii*, Pl. iv. figs. 2, 4.

ends, or are they closed? Do they contain an undulating membrane, or are their inner surfaces furred with minute cilia? Does a current pass through them (supposing them to be open funnels) *towards* the lateral canals, as it seems to do, or in the opposite direction? Are the lateral canals open at their upper ends, or are they blind passages having no outlet save at the contractile vesicle? Is the substance surrounding the lateral canals a glandular secreting substance, or a mere mechanical support for the canals? Does the contractile vesicle fill itself by drawing up fresh water through the cloaca, or is it filled by fluid passing into it from the lateral canals?

I do not know how these questions are to be answered with any approach to certainty, and I have no expectation of their receiving any answers that will meet with general acceptance, for on all these points the best observers disagree: I shall, therefore, do no more than state, in the following paragraph, the view of those who consider the vascular system to be an excreting one; and leave to my colleague the advocacy of the opinion which he has long held, viz. that the system is mainly branchial, with, possibly, a subordinate excreting function.

7. The perivisceral fluid is in part[1] derived from the products of digestion which pass by endosmose through the cellular walls of the stomach; and it is out of this fluid that the various organs are repaired, and at its expense that the animal moves and grows. This growth, repair, and action change the constitution of parts of the perivisceral fluid, and render an excreting organ a necessity. The vascular system is this excreting organ; and, indeed, no other has ever been suggested as having an excreting function. The lateral canals with their floccose investments, or the vibratile tags,[2] or both, are the excreting vessels; while the part played by the contractile vesicle is one probably of storage and discharge: for the contractile vesicle varies extremely in size and frequency of action in different Rotifera, and in some is altogether absent.

The oxygenation of the perivisceral fluid, both in males and females, probably takes place at the fore part of the head, where the skin is never loricated, but appears to be thin; and, where, too, it is possible that there may be definite spots, covered with delicate membrane, so as to take advantage of the constant rush of water, drawn to the head by the ceaseless action of the cilia.

8. Now it is obvious (from § 6) that the above explanation (given in § 7) of the vascular system, rests on a number of assumptions which it is impossible to verify. But then as much, I think, may be said of the explanation that would make the function of this system a branchial one, or a combination in various degrees of both.

[1] Leydig is of opinion (110) that water passes by endosmosis into the body cavity. This, indeed, seems probable; for indigo-coloured water when swallowed (*e.g.* by *R. vulgaris*) almost instantly imparts a blue tint to the thick cellular walls of the stomach up to their outmost boundary. It can hardly be supposed that it goes no further, if the products of digestion do. It seems unlikely that the inner walls of these stomach-cells should be pervious to the products of digestion, and to water, alike; and that the outer walls should be pervious to the former, and impervious to the latter. It has, however, been objected, that we never *see* the indigo-coloured water in the perivisceral fluid. But it is hardly to be expected that we should. When we look at the blue stomach-walls, we are looking at a colour produced by a depth of solution equal to that of one or two thick cells; whereas the coloured fluid, oozing out through the stomach-walls, would be presented to our eyes in films of almost infinitesimal thinness; which would never be suffered to accumulate and so become visible, but would be at once broken up and lost, by the constant motion of the perivisceral fluid. Besides the blue tint after a time disappears from the cells. It seems more likely that this is due to the indigo-solution continuing its course through the cells into the body cavity along with the products of digestion, than to its parting company with these latter at the outer wall, and then alone reversing its course, and returning into the stomach.

[2] If the vibratile tags be supposed to be open ciliated funnels, through which the perivisceral fluid passes into the lateral canals, to be discharged through the cloaca, then we are met with the difficulty that this supposition would imply the frequent discharge of a fluid analogous to blood. But, on the other hand, if it were admitted that, in the perivisceral fluid, the products of digestion are largely diluted with water (see previous note), the force of this objection would be much weakened; for the supposed difficulty would be mainly due to our having applied, to so simple a fluid, the name of such a highly organised product as blood.

The conclusion seems a lame one, and yet I fear that it is hardly possible to hope for a better, when dealing with an apparatus of whose structure we know so little; one which we are unable to examine except with our eyes, and yet one in which we have strong reasons for suspecting that, on crucial matters of detail, our sight deceives us.

P. H. G. *on the Vascular System.*

[My opinion is,—as it was in 1850 ("On the Anat. of *Not. aurita*;" Tr. Micr. Soc. Lond., iii. 98),—that the vascular system is a proper respiratory system, and that the lateral canals are proper branchiæ. The water enters at the head, circulates, and is poured out at the cloaca. I believe these three facts may be predicated of the entire class. Accessories to the process are: (1) the afferent tubules; (2) the "gastric glands;" (3) the vibratile tags; (4) the contractile vesicle.

1. In so many species that I consider the arrangement universal, I trace up the canals to the funnel through which the head-mass constantly moves up and down. The canals *never* partake of this motion, and it is evident that they are attached to the wall of the funnel, which I presume to be perforated with minute orifices through which the external water constantly percolates into the afferent tubules. In many species these appear to be numerous, and they are seen to branch and to anastomose very irregularly into each other, forming single, double, or multiple canals, which run, sometimes nearly straight, but more commonly bent sinuately in various degrees, throughout the length of the animal. In *Pterodina*, (especially in *patina* and *clypeata*) the tubules ramify and spread into broad fan-shaped plexuses of flat laminæ (which I consider tubular, and ciliate within), filling the wide triangular areas on each side of the mastax. Then they begin to unite again, and presently (in *P. valvata* especially), bending abruptly from the ventral to the dorsal side, form one broad and long pyriform sac which narrows to a long slender duct, and joins the œsophagus one on each side, pouring the effete water into the alimentary canal, and ultimately through the cloaca, without the intervention of a contractile vesicle.

2. The "gastric glands."—The organs thus named have usually been considered as ancillary to the digestive system. But their evident connection with the aquiferous system in *Pterodina* makes this doubtful; and a number of other curious facts are observable, which confirm, more or less manifestly, this connection.

Sometimes these organs take the form of large reservoirs of delicate texture and wrinkled surface, joined to the œsophagus by long ducts, and affixed by threads (perhaps tubular) to the lateral canals, or to the lorica. In *Metopidia solidus*, each appears as an aggregation of saccules into a large three-sided and three-angled body, one angle passing up to the origin of the canal, and another by a long duct to the œsophagus, while the canal seems in some inexplicable way united with both. This, excessively slender at its origin, expands as it proceeds, becoming corrugate, till it attains a width almost rivalling the plexus of *Pterodina patina*, just before it enters the cloaca, without the intervention of a contractile vesicle. Yet, in some individuals, the contractile vesicle itself and its action are quite distinct.

In *Notholca acuminata* the "gastric gland" much resembles the *pyriform* of *Pter. valvata*, with a slender duct to the long œsophagus, and another duct from an outer angle leading down for some distance closely parallel with the lateral canal, and connected with it by a short transverse duct at each end.

Cathypna luna has a structure somewhat like this; and, in a less degree, *Metopidia rhomboides*.

Several species of *Brachionus* display anomalies in these organs. Thus in *B. Bakeri* and *B. urceolaris* each is a great wrinkled sac of very delicate tissue, and of retort-shape, at the end of a long neck. In *B. rubens* there are *two* sacs on each side, united by a long sinuous duct. In *B. Mülleri* there is but one on each side, but it is cleft almost to the base into two varying portions. In all these the organs seem to have more or

less obvious connection with the expansions of the lateral canals. But, in one example, which I cannot distinguish from *urceolaris*, the sac is, at its outer extremity, indefinitely expanded, *fore and aft*, and seems to merge into the length of the canal itself, which yet begins clearly in the wall of the head-funnel, and terminates normally in a contractile vesicle.

On the other hand, in *Asplanchna*, the glands, which are small oval organs, are connate, on each side of the very long œsophagus, remote from, and apparently quite unconnected with, the canals.

3. Of the "vibratile tags" I have little to say of direct observation. In *Pterodina* they seem to me wholly wanting. I judge it nearly certain that they are tubular, and that *something* is driven through them, whose course is *from* the lateral canal to the body-cavity.[1] Assuming that the function of the system is the separation of oxygen from the water, may it not be that the tags are reservoirs in which pure oxygen collects, and from which it is pumped into the perivisceral blood, while the hydrogen left pursues its course, perhaps to fulfil some office still, mechanical or vital?

4. Of the contractile vesicle, the normal position, form, structure, and function are well known.[2] But in the two largest species of *Salpina*, *macracantha* and *eustala*, there are two of these organs, of ample dimensions, one on each side, into which the comparatively straight and thick lateral canals empty by trumpet-mouths. Strange to say, in the former species the "gastric glands" seem wholly wanting.

In the great *Asplanchnæ*, the organ, though manifest enough, is very small; in *Metopidia*, as already mentioned, it is only now and then present; while in *Pterodina*, it is (according to my experience) invariably wanting.

On the whole, then, I judge that ROTIFERA possess a well-marked branchial system, which has several striking parallels with that of the ANNELLIDA—the *Lumbricidæ* in particular.—P.H.G.]

THE SETIGEROUS SENSE-ORGANS.

The nervous system of the Rotifera is simple. It consists of one nervous ganglion situated on the dorsal side of the buccal funnel, usually near the mastax; and sending out nervous threads to the eyes,[3] and to certain organs of sense, which have been termed *antennæ* or *tentacles* as they are possibly tactile organs; but whose function is by no means certain. They consist of knobs or cylinders, which usually carry a bunch of fine setæ at their outer extremity. Sometimes they are enclosed in tubular sheaths rising from the surface of the body; and at others their extremities lie close to apertures in that surface, through which the setæ may be seen to protrude. The antennæ are in two pairs. Of these the upper pair is invariably dorsal; and its constituents, though sometimes widely separate,[4] are most frequently pressed close together,[5] or fused into one.[6] The lower pair is to be found sometimes on the dorsal surface,[7] sometimes on the ventral,[8] and sometimes on the line between the two.[9] In one case this lower pair is also fused together,[10] and the creature has but two antennæ; both dorsal, and both on the median line. It is only necessary to add that, in many species, one or other pair appears to be absent; notably the lower pair in all the *Philodinadæ*: but in some of these cases their absence may be only apparent; as the antennæ are often reduced to minute setigerous pimples, and so can be easily missed.

[1] The perivisceral fluid, or blood, is surely neither effused from the body, nor augmented in quantity, *sensibly*.

[2] Since a special reservoir would seem needless for the *mere* discharge of the effete water, an urinary office may belong to this bladder.

[3] When there is only one eye it is generally seated on the nervous ganglion itself.

[4] As in *Asplanchna priodonta*, Pl. xii. fig. 2c; *Copeus spicatus*, Pl. xxx. fig. 7; and *Brachionus plicatilis* (117).

[5] As in *Synchæta pectinata*; Pl. xiii. fig. 3c.

[6] The common case.

[7] As in *Notops Brachionus*; Pl. xv. fig. 1.

[8] As in *Melicerta ringens*; Pl. v. fig. 4.

[9] As in *Stephanoceros Eichhornii*; Pl. iv. fig. 2.

[10] As in *Copeus caudatus*; Pl. xvi. fig. 5a.

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N.B. The references marked † have been copied from Herr Eckstein's list in "Sieb. u. Köll. Zeits.," Bd. xxxix. 1883, p. 433; and those marked * from Mr. Darcy W. Thompson's "Bibliography of Protozoa, Sponges, Cœlenterata, and Worms," 1885. I possess, or have had access to nearly the whole of these memoirs, but have been unable to consult those which are marked §.

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