An Attempt to re-classify the Rotifers.

By

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FIVE-AND-FORTY years have elapsed since Ehrenberg published his classification of the Rotifera, and his system still holds its ground. The mere statement of the fact is high praise; for what have not classifiers altered, and attempted to alter, during the last half century? Not that his classification has escaped challenge. It was sharply criticised in the 'Histoire naturelle des Zoophytes' by Dujardin, in 1841; and the author showed by his criticism that he would probably have invented an excellent classification, if he had only had the requisite knowledge. For his arrangement of the Rotifers into great groups was excellent, and he failed in his subdivisions, obviously from lack of personal acquaintance with the creatures he was classifying.

Leydig, also, in his admirable treatise 'Ueber den Bau und die systematische Stellung der Räderthiere,' in 1854, pointed out some of the obvious faults of Ehrenberg's system; and substituted for it a far inferior one of his own.

Lastly, Dr. Samuel Bartsch, in a pamphlet on 'Die Räderthiere' in 1870, and again in a larger treatise on the 'Rotatoria Hungariæ' in 1877, has essayed a new classification, which is, I think, by no means a success.

I propose now to point out, as briefly as may be, what seem to me to be the chief faults in these four systems; and then, availing myself of all that has been already done, to see how far the accumulated observations of the last forty-five years will enable us to arrange the Rotifers in well-marked and fairly natural groups. I am sanguine enough to think that this can be done with a large proportion of them; though there may remain outstanding some genera, that can at the best have only

provisional places assigned to them; owing either to their unusual forms, or to their not having been sufficiently studied.

The great majority of the Rotifers carry on their heads lines or clusters of moving cilia, by means of which they swim and conduct food into their mouths. Ehrenberg's first division into groups is in accordance with the supposed forms of these ciliated curves and clusters; and each group is again divided into Rotifers that have, and into those that have not, a lorica or case.

Lastly, these groups are sub-divided into genera mainly in accordance with the presence or absence of eyes, with their number and with their situation; while in the larger groups the form of the trochal disc and foot, and the number of teeth in the jaws, are also made use of to help in separating the genera.

The result is that the Rotifera are divided into four groups, according to the following plan:

CLASS—ROTATORIA.

* A simple continuous ciliary wreath . .	Monotrocha.
** A compound or divided ciliary wreath .	Sorotrocha.

* MONOTROCHA.

(*a.*) An unbroken-edged ciliary wreath . . .	Holotrocha.
(*b.*) A scalloped ciliary wreath	Schizotrocha.

** SOROTROCHA.

(*a.*) A many-parted ciliary wreath	Polytrocha.
(*b.*) A two-parted ciliary wreath	Zygotrocha.

and as each of these groups is sub-divided into a loricated and an il-loricated family, we have finally an arrangement by which all known Rotifers are made to take their places in one or other of the eight families of the following neat and symmetrical system:

MONOTROCHA.	Holotrocha	il-loricated	Icthydina.
		loricated	Œcistina.
	Schizotrocha	il-loricated	Megalotrochæa.
		loricated	Floscularia.
SOROTROCHA	Polytrocha.	il-loricated	Hydatinæa.
		loricated	Euchlanidota.
	Zygotrocha	il-loricated	Philodinæa.
		loricated	Brachionæa.

Nothing could be more precise, or more symmetrical; but these merits—dear as they are to most men, and to all classifiers—have been purchased at the expense of grievous faults.

In the first place, there is not a truly loricated animal at all in the whole of the Monotrocha. They are all soft-bodied, flexible Rotifers, and the great majority live in gelatinous tubes secreted from their own skins, and strengthened by the adherence to them of foreign bodies. To give such cases the same name as that chosen for the transparent chitinous carapace of a Brachionus (fig. 7) is surely an absurdity.

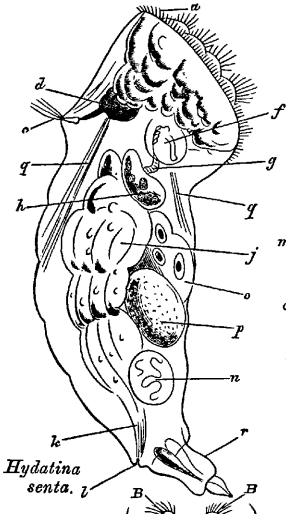
In the next place, the division Holotrocha does not really exist. For rejecting Icthydium and Chætonotus as not being Rotifers at all, as well as the very doubtful genus Glenophora, the remaining three genera, viz. Œcistes, Conochilus, and Ptygura have all gaps in their large ciliary circle precisely as Melicerta (fig. 9) has. The gap is easily seen in Conochilus, and lies on one side of the antennæ, while the mouth is on the other; and in Œcistes, although the gap in the ciliary wreath is small and rather difficult to be made out (unless the animal is fortunately placed), still it is there; and it is on the ant-oral side just as it is in Melicerta (fig. 9).

Again it is surely a confusing of very unlike things to speak of the nearly motionless setæ of Stephanoceros (fig. 10) and Floscularia (fig. 11) (often in the latter stretching to the animal's full length) in the same terms as those applied to the ciliary wreath of Melicerta (fig. 9). There is no sort of similarity between them; and nothing but the exigencies of a symmetrical system could have led to such a misuse of names.

Strictly speaking too the term Monotrocha is as misleading as any that we have already considered; for nearly all the genera included in this group have not one ciliary wreath, but two, running parallel to each other—one of large cilia, and one of small ones, with the mouth lying between the two.

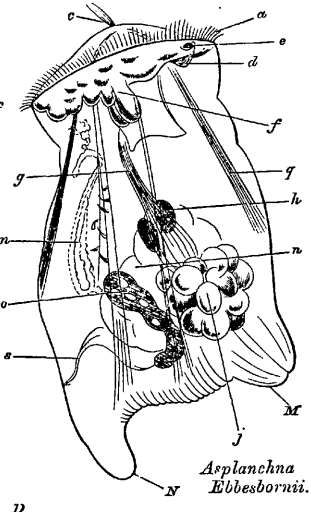
Nor is this all. The sub-division into genera is made to

Fig. 1.



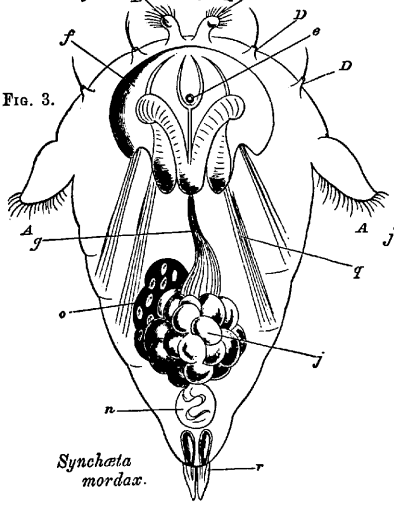
Hydatina senta.

Fig. 2.



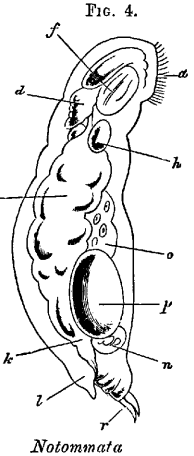
Asplanchna Ebbesbornii.

Fig. 3.



Synchæta mordax.

Fig. 4.



Notommata centrura.

EXPLANATION OF THE WOODCUT ON THE OPPOSITE PAGE.

FIG. 1.—Hydatina.

a. Principal ciliary wreath.
c. Antenna.
d. Cephalic ganglion.
f. Mastax.
g. Œsophagus.
h. Gastric gland.
j. Stomach.
k. Intestine.
l. Anus.
n. Contractile vesicle.
o. Ovary.
p. Ovum.
q. Muscle.
r. Foot.

FIG. 2.—Asplanchna.

a. Principal ciliary wreath.
c. Antenna.
d. Cephalic ganglion.
e. Eye.
f. Mastax.
g. Œsophagus.
h. Gastric gland.
j. Stomach.
m. Convoluted tubes and vibratile tags.
n. Contractile vesicle.
o. Ovary.
q. Muscle.
s. Oviduct.
M. Dorsal protruberance.
N. Ventral protruberance.

FIG. 3.—Synchæta.

e. Eye.
f. Mastax.
g. Œsophagus.
j. Stomach.
n. Contractile vesicle.
o. Ovary.
q. Muscle.
r. Foot.
A. Ciliated side lobes.
B. Setigerous prominences.
D. Antennæ.

FIG. 4.—Notommata.

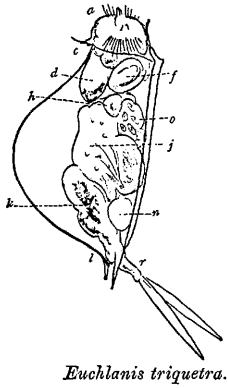
a. Principal ciliary wreath.
d. Cephalic ganglion.
f. Mastax.
h. Gastric gland.
j. Stomach.
k. Intestine.
l. Anus.
n. Contractile vesicle.
o. Ovary.
p. Ovum.
r. Foot.

depend on the absence or presence of eyes, and on their number; and here Ehrenburg is not right as to his facts.

For striking out from his fifteen genera of the Monotrocha, the three already mentioned with Cyphonautes, ten of the remaining eleven genera have two eyes when young.

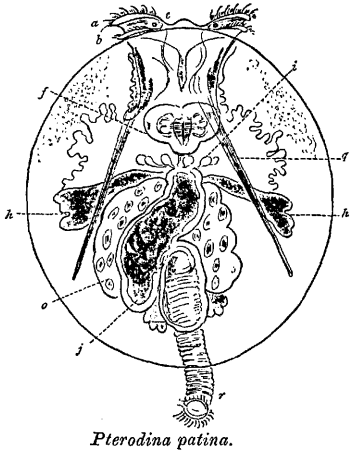
Though the use of the red eye-spots has on this occasion

FIG. 5.



Euchlanis triquetra.

FIG. 6.



Pterodina patina.

FIG. 5.—*a.* Principal cilary wreath. *c.* Antenna. *d.* Cephalic ganglion. *f.* Mastax. *h.* Gastric gland. *j.* Stomach. *k.* Intestine. *l.* Anus. *n.* Contractile vesicle. *o.* Ovary. *r.* Foot.

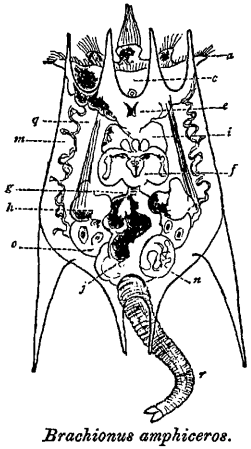
FIG. 6.—*a.* Principal ciliary wreath. *b.* Secondary ditto. *e.* Eyes. *f.* Mastax. *h.* Gastric gland. *i.* Salivary glands. *j.* Stomach. *o.* Ovary. *q.* Muscle. *r.* Foot.

been unfortunate, still I cannot agree with those who object to their being used as generic characteristics, and who doubt of their being eyes at all. In some of the Rotifers, as in Triarthra longiseta (fig. 8), Pedalion mirum (fig. 12), and Conochilus volvox, they are beautiful little diaphanous spheres, resting on plates of ruby pigment, while the splendid eye

of Microcodon clavus crowns a rounded ganglion covered with purple segments; and, in all the cases which I have been able to investigate, the eye-spots are either seated on the principal nervous mass, or have nerve-threads passing to them from it.

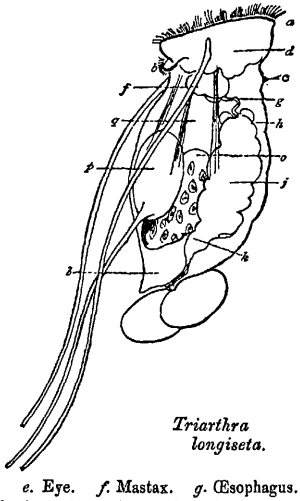
Unfortunately however it often happens that eyes which are conspicuous in the egg, or in the young, become difficult of detection in the adult. This is the case with Stephanoceros (fig. 10) and the Floscules (fig. 11); in which genera the eyes of the adults

Fig. 7.



Brachionus amphiceros.

Fig. 8.



Triarthra longiseta.

Fig. 7.—*a.* Principal ciliary wreath. *e.* Eye. *f.* Mastax. *g.* Œsophagus. *h.* Gastric gland, *i.* Salivary gland. *j.* Stomach. *m.* Convoluted tubes. *n.* Contractile vesicle. *o.* Ovary. *q.* Muscle. *r.* Foot.

Fig. 8.—*a.* Principal ciliary wreath. *b.* Secondary ditto. *c.* Antenna. *f.* Mastax. *g.* Œsophagus. *h.* Gastric gland. *j.* Stomach. *k.* Intestine. *l.* Anus. *o.* Ovary. *p.* Ovum.

are best seen by treating them as opaque objects, and throwing a strong light upon them from above. Moreover, there are often red spots on Rotifers which are not eyes at all; so that

on the whole it would seem best to use this characteristic as sparingly as possible, and then only when the structure has been thoroughly made out.

If we now turn to the genera to see how far Ehrenberg's system has brought similar forms together, we find Œcistes (which greatly resembles Melicerta (fig. 9)) separated from its kinsfolk, and classed with animals some of which are not Rotifers at all; Conochilus and Ptygura being in the same predicament.

Fig. 9.

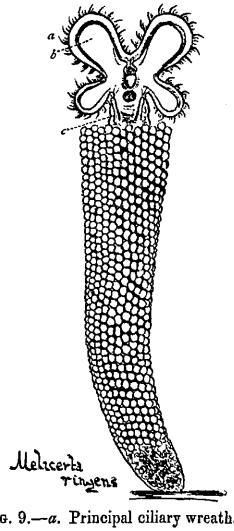


Fig. 10.

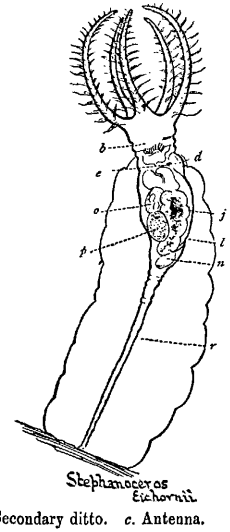


Fig. 9.—*a*. Principal ciliary wreath. *b*. Secondary ditto. *c*. Antenna.

Fig. 10.—*b*. Secondary ciliary wreath. *d*. Cephalic ganglion. *e*. Eye. *j*. Stomach. *l*. Anus. *n*. Contractile vesicle. *o*. Ovary. *p*. Ovum. *r*. Foot.

Worse than this, Stephanoceros (fig. 10) and Floscularia (fig. 11) are placed in the same family with Melicerta (fig. 9) and Limnias. Now the former pair differ from the latter most

strikingly, in the shape of the trochal disc, in the disposition of the vibratile cilia, in the position of the mouth, and in the form of the jaws; and it is difficult to understand how Ehrenberg could have persuaded himself to place them together.

Again, Lacinularia, Megalotrocha, and Conochilus all find themselves in different families; though the two former are so alike as to be at times mistaken for each other, and the latter (though its parts are arranged in an unusual manner) is certainly more nearly akin to them than to any other genera. Conochilus is indeed a tough morsel for a classifier. In all

FIG. 11.

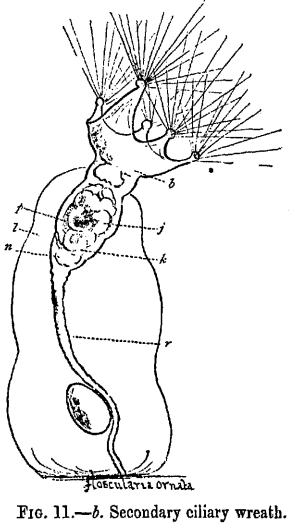


FIG. 12.

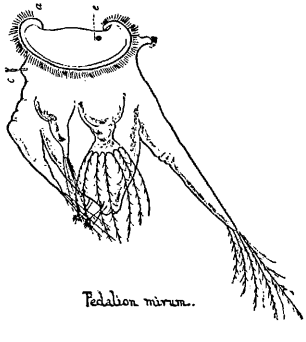


FIG. 11.—*b*. Secondary ciliary wreath. *j*. Stomach. *k*. Intestine. *l*. Anus. *n*. Contractile vesicle. *p*. Ovum. *r*. Foot.

FIG. 12.—*a*. Principal ciliary wreath. *c*. Antenna. *e*. Eye.

other Melicertans the row of smaller cilia encloses the row of larger ones and also the mouth—the antennæ being outside

of both rows; but in Conochilus all this is reversed; the row of larger cilia encloses that of the smaller ones, the mouth, and also the antennæ.

Ehrenberg's next great group, the Sorotrocha, with its divisions and subdivisions, is more successful; for the trochal discs have to a considerable degree the characters assigned to them, and the "loricated" families really have loricæ. The families too are in the main natural; and two of them, viz. the

FIG. 13

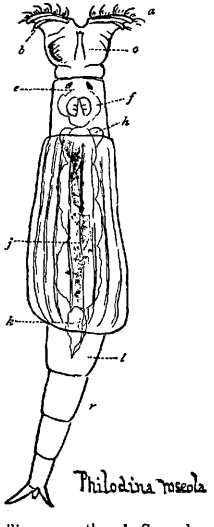


FIG. 13.—*a*. Principal ciliary wreath. *b*. Secondary ditto. *c*. Antenna. *e*. Eyes. *f*. Mastax. *h*. Gastric gland. *j*. Stomach. *k*. Intestine. *l*. Anus. *r*. Foot.

Philodinæa and the Brachionæa, are so well marked and thoroughly natural, that any system of classification would, I think, leave them almost untouched.

Unfortunately Ehrenberg has thrown these two families into one group—the Zygotrocha, and has thus brought together most widely differing forms; for the Brachionæa are highly organised Rotifers, while some of the Philodinæa are very worm-like, and the structure of the trochal disc, jaw, and foot in the two families is widely unlike.

Of the two remaining families, I think that the Euchlanidota should be retained, though its genera require revision; but the other family, the Hydatinæa, contains such a number of dissimilar creatures that nothing can save it from subdivision. A glance at such a motley group as Hydatina senta (fig. 1), Notommata aurita (fig. 4), Triarthra longiseta (fig. 8), Synchæta mordax (fig. 3), Pedalion mirum (fig. 12), and Asplanchna Brightwellii (fig. 2), would be enough to make one hesitate to include them in one family; and when it is found that they differ greatly in their internal structure, as well as in their outward form and habits, it becomes tolerably certain that this very large and heterogeneous family cannot be retained as it is.

To sum up then, we may safely say that the majority of the Rotifers in the first great section, the Monotrocha, do form a distinct and fairly natural group; but that its subdivisions, the Holotrocha and the Schizotrocha, cannot be maintained, while its families must be altered and the genera re-arranged.

The other great section, the Sorotrocha, must be abandoned; as containing animals that by no means resemble each other in the way that those of the Monotrocha do: and its subdivisions, the Polytrocha and Zygotrocha, are equally faulty; uniting dissimilar families such as the Philodinæa and Brachionæa, while separating similar ones, as the Brachionæa and Euchlanidota. The families, the Philodinæa, Brachionæa, and Euchlanidota, will in the main hold their ground, but the Hydatinæa must be split up and rearranged.

Leydig's Classification.

Leydig based his classification on the Rotifer's external form, and on the presence or absence of the foot, as well as on the foot's shape and length. As he quite disregarded the whole of the internal structure, as well as that of the trochal disc, it is not to be wondered at that his arrangement is a bad one. The first of these three primary divisions brings together, on account of their shape, such dissimilar creatures as Melicerta (fig. 9), Dinocharis, Synchæta (fig. 3), and Philodina (fig. 13)—animals differing alike in habits and internal structure, and only faintly resembling each other in shape. His second primary division, instead of containing any of the great natural groups, simply picks out a few species on account of their sac-like shape, and throws together Notommata clavulata, Polyarthra platyptera, Diglena lacustris, and Asplanchna Brightwellii, Rotifers that have hardly one feature in common. His third primary division, containing the Brachionæa and Euchlanidota is a reasonable one enough; and of his eleven families four are natural, but the rest are so unsuccessful that I propose to pass over his attempt without further comment, while at the same time fully admitting the great value of his observations and researches. It would be doing Leydig the greatest injustice to judge of the rest of his work from his classification of the animals that he so successfully studied.

Dujardin's Classification.

Of Dujardin I must speak in very different terms. His book is mainly critical; and, so far as I can find, contains little on the Rotifers that was new, except his observations on Albertia and Lindia.

His criticisms are shrewd, and often just; he points out that Ehrenberg's respiratory tube is probably an antenna, and suggests that the convoluted tubes with their flickering tags and contractile vesicle are a respiratory system; an erroneous

suggestion, I believe, but one that has found wide acceptance. On the other hand, he could not see Floscularia's (fig. 11) tube, could not make out the striated muscles in any Rotifer, could see no difference between the muscles and the nerves, and doubted the existence, as specialised structure, of either the one or the other. He denied, also, that there was good reason for believing that any of the red spots were eyes.

But although he has small claim to be considered either an original or an accurate observer of the Rotifers, his classification has one happy hit. He formed his primary groups according to their various modes of locomotion. This produces three orders—Rotifers that are fixed; those that swim only; and those that both swim and creep like a leech. The first includes the Floscules and Melicertans; the second, the Brachionæ, Euchlanidota and Notommata; and the third, the Philodinæa. The arrangement is excellent, and requires only to be supplemented by the addition of a fourth group to contain Rotifers (like Pedalion mirum (fig. 12)), which not only swim, but also skip by means of real limbs.

In the details of his system Dujardin often fails, and obviously from lack of personal acquaintance with the forms he is classifying. For instance, he places Œcistes and Conochilus in the same genus, declaring that the only important difference between them is their tube.

I have already pointed out above how widely the structure of Conochilus differs from that of Melicerta (fig. 9), and how closely that of Œcistes agrees with it. Dujardin could not have made a more unfortunate selection of two Rotifers to form a genus with. He follows Ehrenberg in placing Tubicolaria (a form of the ordinary Melicertan type) in a genus by itself; and he places in the same genus Hydatina (fig. 1) and Synchæta (fig. 3), genera whose trochal discs, jaws, alimentary canals, and vascular systems are widely unlike. On the whole however his system has great merit; and would have had much more, had his knowledge of details been at all commensurate with his critical faculty.

Dr. Bartsch's Classification.

Dr. Bartsch, in his first publication of his system in 1870, divided all the Rotifers into the Enterodela (with stomach, intestine, and anus) and the Gasterodela (without intestine or anus); and in this latter was one family formed for one genus Ascomorpha (Gosse's Sacculus); all the rest of the Rotifers were in the first division.

In his second publication, 'Rotatoria Hungariæ,' he abandoned this primary division, and simply arranged the Rotifers in six families, as follows:

1. Floscularinæ.
2. Philodinæa.
3. Hydatinæa.
4. Longisetæ.
5. Scaridina.
6. Loricata.

Of these 1, 2, and 6 are natural, though 1 is made to contain Floscularia (fig. 11) and Stephanoceros (fig. 10) along with the Melicertans; and the first two differ too much from the last to be so placed.

Family 3 ranks together Hydatina (fig. 1), Synchæta (fig. 3), Asplanchna (fig. 2), and Lindia; four forms that ought to be in separate families: while family 4 connects the dissimilar genera Triarthra (fig. 8), Mastigocerca, Polyarthra, and Furcularia.

This system is much on a par with Leydig's, but the publication in which it occurs contains plates which though coarse are well worth attentive study. I can say nothing of the text, which is unfortunately in a language that I cannot read.

Having thus discussed the four rival systems, I propose next to offer my own attempt at a reclassification of the Rotifers. Of course I can lay little claim to originality, and cannot pretend to do much more than select and combine the best thoughts of my predecessors. I have availed myself of Dujardin's orders, and of Leydig's use of the foot, and I have left

Ehrenberg's genera in the main unaltered; I have also made ample use of that mine of information, the essay on the Rotifera,

FIG. 14.

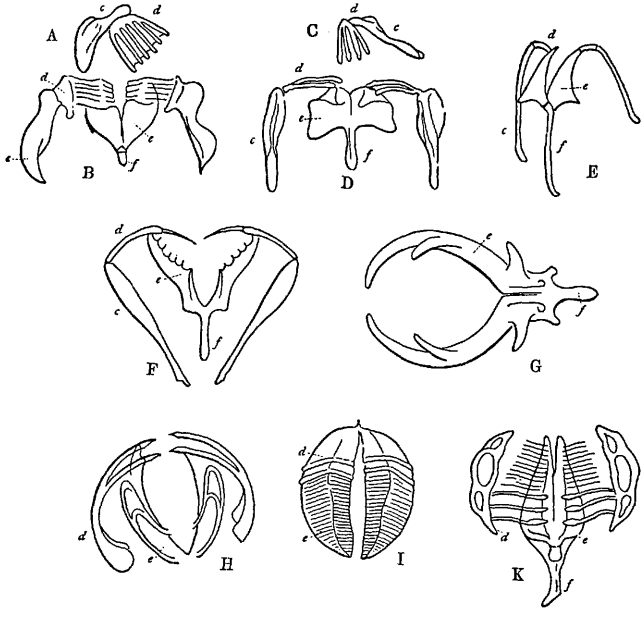


FIG. 14.—*A*. Single malleus of Brachionus urceolaris. *B*. Trophi of Brachionus urceolaris. *C*. Single malleus of Euchlanis deflexa. *D*. Trophi of Euchlanis deflexa. *E*. Trophi of Notommata petromyzon. *F*. Trophi of Diglena forcipata. *G*. Trophi of Asplanchna priodonta. *H*. Trophi of Stephanoceros Eichornii. *I*. Trophi of Philodina roseola. *K*. Trophi of Limnias Ceratophylli. *c*. Manubrium. *d*. Uncus. *c* and *d*. Malleus. *e*. Ramus. *f*. Fulcrum. *e* and *f*. Incus. All after Gosse, except *G* and *H*.

in Pritchard's 'Infusoria' (1861), as also of Gosse's admirable

though unfinished sketch in vol i and ii of the 'Popular Scientific Review' (1862 and 1863); and finally I have adhered to the utmost to the old nomenclature, and endeavoured to meddle as little as possible with the great Prussian naturalist's original plan.

The class Rotifera falls then, I think, into four natural orders according to their modes of locomotion. There are some that swim only; others that both swim and creep like a leech; those that both swim and skip; and lastly, those that when adult are fixed: and these orders differ in the main from each other in the form and use of the foot.

In each order too there are typical genera, round which the rest may be grouped, differing from each other in the shape of the trochal disc, and the position of its ciliary wreaths, as also in the structure of the manducatory organs; and sometimes in other important points as well.

But before I describe the families that can be formed round these typical genera, I must digress a little to explain certain technical names which I shall find it necessary to use.

Gosse's exhaustive treatise on 'The Manducatory Organs in the Class Rotifera,' enables us to see that these organs present seven or eight types of structure, distinguished from each other by the prominence of some particular part.

To make this clear it may be as well to state that in the typical mastax of a Brachionus there are two hammer-like bodies (mallei) (fig. 14, *B; c, d*), which work on a kind of split anvil (incus) (fig. 14, *B, ef*); and that each malleus consists of an upper part or head (uncus) (fig. 14, *B, d*), and a lower or handle (manubrium) (fig. 14, *B, c*); while the incus also consists of two, the upper divided into two symmetrical halves (rami) (fig. 14, *B, e*), which are supported on the lower piece (fulcrum) (fig. 14, *B, f*); these hard portions of the mastax are termed the trophi.

Now, in Brachionus (fig. 7) 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, 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 rami.

The typical trophi then may be named as follows:

1. Malleate.

Mallei stout; manubria and unci of nearly equal length; unci 5- to 7-toothed; fulcrum short; as in Brachionus urceolaris, Fig. 14, A, B.

2. Sub-Malleate.

Mallei slender; manubria about twice as long as unci; unci 3- to 5-toothed; as in Euchlanis deflexa, Fig. 14, C, D.

3. Virgate.

Mallei rod-like; manubria and fulcrum very long; unci 1- or 2-toothed; as in Notommata petromyzon, Fig. 14, E.

4. Forcipate.

Mallei rod-like; unci pointed or evanescent; rami much developed, and used as a forceps; as in Diglena forcipata, Fig. 14, F.

5. Incudate.

Rami highly developed into a curved forceps; mallei evanescent; fulcrum stout; as in Asplanchna priodonta, Fig. 14, G.

6. Uncinate.

Unci 2-toothed; manubria evanescent; incus slender; as in Stephanoceros Eichornii, Fig. 14, H.

7. Ramate.

Rami sub-quadrantic, each crossed by 2 or 3 teeth; manubria evanescent; fulcrum rudimentary; as in Philodina roseola, Fig. 14, I.

8. Malleo-ramate.

Mallei fastened by unci to rami; manubria 3 loops soldered to the unci; unci 3-toothed; rami large, with many striæ parallel to the teeth; fulcrum slender; as in Limnias Ceratophylli, Fig. 14, K.

Now, if we leave out Diglena forcipata, the other examples

FIG. 15.

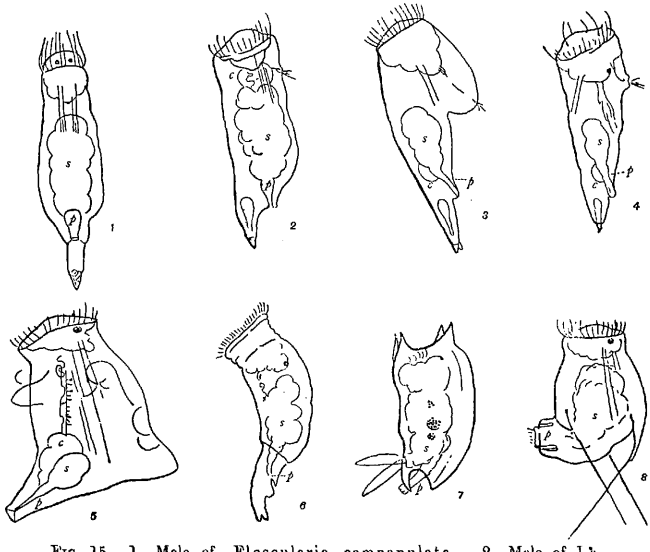


FIG. 15.—1. Male of Floscularia campanulata. 2. Male of Lacinularia socialis. 3. Male of Notommata Brachionus. 4. Male of Synchæta tremula. 5. Male of Asplanchna Ebbesbornii. 6. Male of Brachionus urceolarias, copied from a drawing by Mr. P. H. Gosse, F.R.S. 7. Male of Salpina mucronata, from a drawing by Mr. E. C. Bousfield. 8. Male of Pedalion mirum. *s*. Sperm-sac. *p*. Penis. *c*. Contractile vesicle.

of the typical trophi give us seven rotifers very distinct from

each other; and show that the form of the trophi is a good characteristic for separating the families. But a difference in the shape and disposition of the trochal disc and its ciliary wreaths generally accompanies a difference in the manducatory organs; and the two together will, I think, serve as good guides to a re-classification of the Rotifers into families. This I have attempted in the annexed scheme, but of course there are genera which do not fall readily into this arrangement; such aberrant forms as Trochosphæra, Acyclus, and Dictyophora, it would be difficult to place in any classification.

The parasitic Rotifers (as might have been expected) contain some very strange creatures, such as Drilophaga and Seison; and would I think be better put in a class by themselves. Such difficulties however must attend every attempt to marshal Nature's endless varieties into well-marked battalions. Nature knows no hard lines of separation, and the best of classifications can be only that which contains the fewest faults.

Perfectly satisfactory classification is the product of imperfect knowledge; when the commoner and better separated forms are alone known to us, and when the rarer intermediate forms (which are the despair of the classifier and the delight of the naturalist) are as yet undiscovered.[1]

Class—ROTIFERA.

Order I.—Rhizota.

Fixed forms; foot attached, transversely wrinkled, non-retractile, truncate.

Fam. 1. Floscullariadæ (figs. 10, 11).

Mouth central; ciliary wreath a single half-circle above the mouth; trophi uncinate.

[1] Some years ago it was thought that the Rotifers might possibly be divided into two groups; the one monœcious, the other diœcious. But later researches have rendered this improbable. For, of the twelve families into

Fam. 2. Melicertadæ (fig. 9).

Mouth lateral; wreath two marginal curves nearly surrounding the head with mouth between; trophi malleoramate.

Order II.—Bdelloida.

That swim and creep like a leech; foot retractile, jointed, telescopic, termination furcate.

Fam. 3. Philodinadæ (fig. 13).

Trochal disc two transverse circular lobes; wreath two marginal curves on each lobe with mouth between; or trochal disc of one lobe ventrally furred with cilia; trophi ramate.

Order III. Ploïma.

That only swim.

* Il-loricated.

Fam. 4. Hydatinadæ (fig. 1).

Trochal disc transverse with ciliated prominences; wreath double; trophi malleate; brain small, not sack-like; foot furcate.

Fam. 5. Synchætadæ (fig. 3).

Trochal disc rounded; wreath of interrupted curves, surrounding the head; trophi virgate; foot absent, or minute.

Fam. 6. Notommatadæ (fig. 4).

Trochal disc oblique; wreath of interrupted curves and clusters; trophi virgate or forcipate; brain large, sack-like; foot furcate.

which I have divided the Rotifera, no less than eight contain species of which the males have been seen (see Fig. 15); and in the remaining four the sexual organs exactly resemble those of the females in the other eight families. That males will be ultimately discovered in the four families where they are at present unknown, I have little doubt.

Fig. 15 contains the male of one species only in each of the above eight families; but the males of many more than these have been observed and figured.

Fam. 7. Triarthradæ (fig. 8).

Trochal disc transverse; wreath single, marginal; trophi malleo-ramate; foot absent.

Fam. 8. Asplanchnadæ (fig. 2).

Trochal disc rounded; wreath single, marginal; trophi incudate; intestine, anus, and foot absent.

* * Loricated.

Fam. 9. Brachionidæ (fig. 7).

Trochal disc transverse with ciliated prominences; wreath single, marginal; trophi malleate; lorica entire, simple; foot transversely wrinkled, wholly retractile, 2-toed or absent.

Fam. 10. Pterodinadæ (fig. 6).

Trochal disc two transverse circular lobes; wreath on each double, marginal; trophi malleo-ramate; foot transversely wrinkled, wholly retractile, ending in a ciliated cup.

Fam. 11. Euchlanidæ (fig. 5).

Trochal disc rounded; wreath in interrupted curves, and clusters; trophi sub-malleate or virgate; lorica in two parts, meeting in a furrow, or entire with additional pieces; foot jointed, feebly retractile, not telescopic or transversely wrinkled—furcate or stylate.

Order IV.—Scirtopoda.

That swim with their ciliary wreath, and skip by means of hollow limbs with internal locomotor muscles.

Fam 12. Pedalionidæ (fig. 2).

Trochal disc transverse; wreath two marginal curves with mouth between; trophi malleo-ramate; foot replaced by two posterior ciliated processes.

GENERA.[1]

1. Floscullariadæ .	Floscularia (fig. 11), Stephanoceros (fig. 10).
2. Melicertadæ . .	Melicerta (fig. 9), Limnias, Œcistes, Cephalosiphon, Lacinularia, Megalotrocha, Conochilus.
3. Philodinadæ . .	Philodina (fig. 13), Rotifer, Callidina.
4. Hydatinadæ . .	Hydatina (fig. 1), Rhinops.
5. Synchætadæ . .	Synchæta (fig. 3), Polyarthra.
6. Notommatadæ .	Notommata (fig. 4), Diglena, Furcularia, Scaridium, Pleurotrocha, Distemma.
7. Triarthradæ . .	Triarthra (fig. 8).
8. Asplanchnadæ .	Asplanchna (fig. 2).
9. Brachionidæ . .	Brachionus (fig. 7), Noteus, Anuræa, Sacculus.
10. Pterodinadæ . .	Pterodina (fig. 6), Pompholyx.
11. Euchlanidæ . .	Euchlanis (fig. 5), Salpina, Diplax, Monostyla, Colurus, Monura, Metopidia, Stephanops, Monocerca, Mastigocerca, Dinocharis.
12. Pedalionidæ . .	Pedalion (fig. 12).

[1] The principal ones; several of Ehrenberg's are omitted for various reasons that cannot here be detailed; and the genus Notommata, though the name is retained, is here supposed to have lost a large number of Ehrenberg's species.

The thirteen figures, given as illustrations of the various families, are not drawn on the same scale; and no attempt has been made to show in them all the details of internal structure.