

ON A NEW CLASSIFICATION OF THE BDELLOID ROTIFERA.

BY DAVID BRYCE.

(Read June 28th, 1910.)

It has long been felt by those who are interested in the BDELLOID ROTIFERA that a revision of the classification of this group would considerably facilitate further investigation into a comparatively little-known corner of the animal kingdom. During the last eighteen years the number of known species has more than doubled, the great majority of the new forms being additions to the two genera *Philodina* and *Callidina*, which have consequently become overcrowded, unwieldy, and unsatisfactory. Besides this, a more intimate acquaintance with the diversities of structure and of habit of a greatly extended array of species has proved that not only are the old generic definitions inadequate, but that they are also unreliable, and should no longer be accepted.

The object of this paper is to place the classification of the BDELLOIDA on a more satisfactory basis, and it is hoped that the arrangement now put forward will provide a sound foundation, or, at the least, a new starting-point for future work, and that the lines on which it is framed will prove to be reliable and true to the natural relationships of the species with which it deals.

From the point of view of classification the BDELLOID ROTIFERA have already experienced a somewhat complicated career. Their history as a recognised group of allied species seems to have begun in 1830, when Ehrenberg published his first Classified List of Micro-organisms (2), wherein he introduced the family *Zygotrocha*, comprising all Rotifera with a ciliary wreath of two similar parts. So far as regards the BDELLOIDA this earliest classification may be summarised thus:

FAMILY ZYGOTROCHA.

Rotifera with corona of two similar parts ("cilorum coronulis binis").

Loricata	Section <i>Brachionaea</i> .
Illoricate	Section <i>Philodinaea</i> .

SECTION PHILODINAEA.

Without eyes	Gen. <i>Callidina</i> .
With two eyes.	
Eyes frontal:	
Foot thrice furcate ("cauda ter furcata")	Gen. <i>Rotifer</i> .
Foot ending in two spurs and three toes ("caudæ quinque apicibus")	Gen. <i>Actinurus</i> .
Eyes dorsal:	
Foot simply furcate ("cauda simpliciter furcata")	Gen. <i>Monolabis</i> .
Foot thrice furcate ("cauda ter furcata")	Gen. <i>Philodina</i> .

In the following year, 1831, Ehrenberg published a more comprehensive arrangement (3), in which the *Philodinaea* were advanced to the rank of a family, and this position was again assigned to them in his great work of 1838 (4), based upon his third and best-known system of classification. In these later schemes the two genera *Typhlina* and *Hydrias* were added to the Family with the following characters:

Without rostrum or spurs:

Trochal discs on pedicels	Gen. <i>Hydrias</i> .
Trochal discs without pedicels	Gen. <i>Typhlina</i> .

It has not yet been found possible to recognise any of the species assigned to the genera *Monolabis*, *Hydrias*, and *Typhlina*, and these genera have not been accepted by later writers, who believe them to have been founded on imperfect observations of animals which, if again seen, have been referred to other groups of the Rotifera. The four genera, *Callidina*, *Philodina*, *Rotifer*, and *Actinurus*, have fortunately proved to be recognisable, and the majority of the species, which have been discovered since 1838, have been assigned to one or other of them.

As in the classification of 1830, so in his later schemes, Ehrenberg distinguished the four genera last named principally upon characters afforded by the presence or absence of eyes, and, when present, by their position, either in the front of the head or in the neck. As a quite subsidiary character, to distinguish *Rotifer* from *Actinurus*, and *Philodina* from *Monolabis*, he made

use of the number of spurs and of toes on the foot. It has been pointed out by Murray in a recent paper (63) that the distinction made was inaccurate as between *Rotifer* and *Actinurus*, since the foot is not thrice furcate in the species assigned to *Rotifer*. But if inaccurate in that case, the phrase "cauda ter furcata" is correct with regard to the genus *Philodina*, and clearly indicates the two spurs, the two dorsal toes, and the two terminal toes possessed by all but one of the species which were described by Ehrenberg as members of that genus.

In 1884 Hudson (17) recognised the distinctive character of the manner of creeping peculiar to the group, and proposed that the several genera should form a separate order, that of the BDELLOIDA, or Leech-like Creepers, and this proposal was further established by its adoption in *The Rotifera*, published by him in 1886 in collaboration with Gosse (19). In this work the new family *Adinetadae* and the new genus *Adineta* were created for the reception of a species which differed markedly in the type of the corona from all others of the group included by them at that time. The four recognisable genera of Ehrenberg were placed in the new family *Philodinadae*, and were distinguished as before by the presence and position of the eyes.

Earlier in the same year, 1886, the importance given by Ehrenberg to the eyes in the generic distinction of the *Philodinae* had been challenged by Milne (18), who proposed to arrange the various species into genera either new or redefined, and to discard altogether all generic characters relating in any way to the eyes. He claimed for his scheme that it did not dissociate manifestly similar forms, at least as regards some nineteen species examined by him. His most valuable suggestion in this paper was that the genus *Philodina* should be distinguished by the possession of four toes, thus giving first place to the character which Ehrenberg had indicated in 1830 in the phrase "cauda ter furcata."

In 1888 Milne (23) adduced fresh instances in support of his previous contention, and proposed further that the genus *Rotifer* should be distinguished by the character "viviparous."

Another important advance was made in 1889, when Plate (27) pointed out that the *Bdelloida* shared with the *Seisonidae* the peculiarity of having two ovaries, whereas all other *Rotifera* have one only. He proposed therefore to divide the class ROTIFERA

into two sub-classes, the DIGONONTA (or two-ovariated), comprising the Bdelloida and the Seisonidae, and the MONOGONONTA (or one-ovariated), including all other Rotifera.

In a useful monograph on the *Philodinacea*, published in 1893, Janson (38) discussed at some length the views and suggestions of earlier writers and, in particular, those of Hudson and Gosse, and of Milne. On the one hand, he criticised the creation by the former authors of the family of the *Adinetadae*. On the other, he admitted the contention of Milne that under the definition of Ehrenberg many eyeless species would be classed as *Callidinae*, although in respect of their structure they should clearly be regarded as belonging to the genus *Rotifer*. Nevertheless he hesitated to accept the genera proposed by Milne, and preferred for the time to abide by the Ehrenbergian family of *Philodinacea*, which in his view covered all the various genera. He made the one correction of transferring to the genus *Rotifer* the two species which had been assigned to *Actinurus*, recent discoveries, having shown the differences between these two genera to be less definite than had previously appeared.

In an important treatise published in 1899 Wesenberg Lund (50) dealt in great detail with the wide question of the relationship to each other of all the various groups of the Rotifera, and, in conclusion, put forward a new classification based largely upon results afforded by his own investigations. At the outset he followed Plate in dividing the class ROTIFERA into the sub-classes MONOGONONTA and DIGONONTA according to the number of ovaries possessed by each species. So far as regards the MONOGONONTA, the subsequent grouping of the families and genera was carried out on principles essentially different from those of Hudson and Gosse. The DIGONONTA, on the other hand, were little affected by the investigations of the author, according to whom this sub-class included the two orders BDELLOIDA and SEISONACEA, the latter created to receive the family of the Seisonidae. While accepting from Hudson the order of the BDELLOIDA, Wesenberg Lund followed Janson in placing all the Bdelloid genera in one family, *Philodinidae*, and in rejecting the genus *Actinurus*. The family *Philodinidae* of Wesenberg Lund would thus be equivalent to Ehrenberg's family *Philodinacea*, and according to the author included the five genera *Rotifer*, *Philodina*, *Callidina*, *Discopus*, and *Adineta*.

In 1905 James Murray (55) announced the discovery of the curious Bdelloid, *Microdina paradoxa*, for which he created the new family *Microdinadae*. This and numerous other discoveries of Bdelloid forms hitherto unknown, and in all cases communicated to me before publication, led naturally to the discussion in our correspondence of the demerits of the current classification of the group. The arrangement of the genera and species now advanced is in great measure the outcome of that discussion. To some extent the lines on which it is mainly framed have been indicated by my correspondent in recent papers, notably in (56) "The Bdelloid Rotifera of the Forth Area" (1905) and in (63) "*Philodina macrostyla* and its Allies" (1908).

In the former of these he provisionally redefined the genera *Philodina*, *Callidina*, and *Rotifer* as follows :

PHILODINA.—Having four toes and a corona consisting mainly of a pair of wheel-like ciliated discs.

- A. Eyes present; oviparous.
- B. Eyes absent; oviparous.
- C. Viviparous; eyes present or absent.

CALLIDINA.—Having three toes or a perforate disc formed by a union of the toes; oviparous; eyes present or absent.

- A. Food moulded into pellets.
- B. Toes bearing a number of cup-like suckers, or united to form a broad disc.
- C. Toes three; distinct, food not moulded into pellets.

ROTIFER.—Viviparous; toes three.

In the latter paper he discusses exclusively the genus *Philodina*, which he redefines as distinguished by :

Four toes, eyes cervical or none;

and subdivides into five groups of species :

- I. Oviparous.
- II. Semiloricated.
- III. Parasitic.
- IV. Short-spurred.
- V. Viviparous.

During the period covered by the foregoing retrospect the number of species known to belong to the Bdelloid group has very considerably increased. In Ehrenberg's classification of

1830 there are enumerated nine species, of which one, at least, has not been recognised since. The present arrangement deals with a total of 105 species considered to be capable of recognition, in addition to which some 49 species have been placed in a separate list as either insufficiently described or otherwise invalid.

These "doubtful" species are not necessarily hopeless. Before the lists are again revised, further observations may well have provided sufficient reason for reinstating some of them among the species considered good.

I do not desire to offer any remarks upon the position to be assigned to the BDELLOIDA among other Rotifera. Although it would now seem that the BDELLOIDA do not stand quite so far from the others as was formerly believed, yet the interval which separates them appears still to be a wide one. It is sufficient to accept the position assigned to them by Plate and Wesenberg Lund and to regard them as an order of the sub-class DIGONONTA, distinguished from the SEISONACEA by their ramate jaws, their more or less effective rostrum, the telescopic retractability of their distal segments, and their contractile cloaca.

To the order of the BDELLOIDA I assign the three families, PHILODINIDAE, ADINETIDAE, and MICRODINIDAE. In my opinion both Janson and Wesenberg Lund, in rejecting the family *Adinetidae* of Hudson and Gosse, have failed to appreciate the physiological difference, which is so intimately connected with the structural distinctions between the *Adinetidae* and the *Philodinidae*. The former family, while possessing certain minor capacities which are not shared with the latter, falls nevertheless far behind in structural development and in functional equipment. It need only be pointed out that the *Adinetidae* are practically unable to swim and that their locomotive abilities are limited to creeping about by means of their corona, aided by the foot. The *Philodinidae*, on the other hand, can all swim in a more or less vigorous manner. They can also creep about in leech-like fashion by the alternate use of the tip of the rostrum and of the foot. But what in my view is most important, is that this creeping about is not in any degree dependent upon the use of the corona. That delicate organ is for the time hidden away within the mouth and so secured from possible injury. This power of withdrawal of the corona without absolute prejudice to the power of locomotion is associated with and consequent upon

a whole series of structural developments, and distinguishes the *Philodinidae*, not only from the *Adinetidae*, but from all other members of the class ROTIFERA.

The *Microdinidae* are even more feebly equipped than the *Adinetidae*. The corona is practically absent, and the animals can only creep about in a slow and clumsy manner by means of the rostrum and foot. They have some little compensation in being able to partly protrude their jaws from the buccal opening. It is hoped that the discovery of forms allied to the single species yet known will provide further indications of its affinities with other Bdelloida, but meanwhile I agree with Murray that *M. paradoxa* is well placed in a genus and a family of its own.

The recently discovered and very remarkable species to which De Beauchamp (65) has given the specific name "*intermedia*" shows a distinct advance in the direction of *Microdina* in the structure of the mastax, in its adaptation to prehensory movements, and in the absence of any throat. But it possesses a fully developed rostrum, and a corona which, although differing in important details from that which is typical of the *Philodinidae*, is nevertheless retractile at will within the mouth, and the species therefore comes well within the limits of that family as indicated in the definition following.

The family MICRODINIDAE, distinguished by the presence of a rostrum and the absence of a corona, consists therefore of the single genus MICRODINA, represented by one species.

The family ADINETIDAE, having an imperfect or retrograde rostrum, and a corona which cannot be retracted within the mouth, comprises the two genera ADINETA and BRADYSCELA, the latter created to receive the species "*clauda*," which differs very notably from the *Adineta* type in the structure of the foot.

The family of the PHILODINIDAE includes all Bdelloids with well-developed rostrum and corona, the latter always capable of retraction within the mouth. With the exception of the four forms placed in the new genera CERATOTROCHA, SCEPANOTROCHA, and ABROCHTHA, the numerous species conform in most respects very closely to one structural plan.

Of the few deviations from uniformity of plan, I regard as of great importance that which is found in the structure of the stomach of certain species. Although not hitherto employed or suggested as a means of generic distinction, it has not quite

escaped observation, as may be judged from Ehrenberg's figure of the stomach of *Philodina collaris* (4), and from his description of that organ both in that species and in his *Callidina rediviva*. Gosse, in his turn, observed some peculiarities about the stomach of *Callidina bidens* (19) which he did not rightly interpret. Lastly, Milne (18) in his descriptions of species discovered by him drew attention in several cases to the remarkable habit of moulding the food into pellets, which is universal amongst species whose stomach-structure deviates from the customary form in the manner now to be pointed out.

Briefly stated, the distinction made consists in the proportion of the cavity of the inner or lining membrane of the stomach to the cavity of the outer or enclosing membrane, and it is constantly associated with a difference in the method of digestion and with other structural differences, which, if not of great value in themselves, indicate clearly enough that the difference in the stomach-structure is one that goes a long way back in the evolution of the Bdelloida. Making use of this distinction I have divided the genera of the PHILODINIDAE into two Sections:

- A. Lumen of stomach relatively wide, or bag-like; food usually in pellets; upper lip usually entire; oviparous.
- B. Lumen of stomach relatively narrow, or tube-like; food particles free, never agglutinated into pellets; upper lip usually bilobed or divided; oviparous or viviparous.

In the genera of Section B the inner tube is very much narrower than the outer, the interspace being occupied by a finely granulated digestive fluid, having a frequent admixture of fat-particles. In the genera of Section A the inner tube is almost as wide as the outer, and the granulated fluid is usually scanty or apparently absent. Again, when the lumen is tube-like one frequently finds ciliary action visible either in the stomach or in the intestine. In my experience such action is never seen when the lumen is relatively wide. The moulding of the food into pellets, which is universal among the species of Section A, has never been detected in any species with a relatively narrow lumen.

It is not to be expected that among so many species all should conform with equal fidelity to the distinction made between the relatively narrow and the relatively wide lumen of the stomach. Notably in the genus *Rotifer* many species have

the lumen tube-like, but the outer membrane is not conspicuously of much greater capacity.

To Section A belong the three new genera, *HABROTROCHA*, *CERATOTROCHA*, and *SCEPANOTROCHA*. In the first-named the corona conforms with relatively minor modifications to the type usual in the family. In *CERATOTROCHA* that portion of the skin which supports the upper lip and the lateral cushions of the mouth is produced into two horn-like processes upon whose lower or ventral surface are inset the ciliated discs, the pedicels which usually support the latter being either rudimentary or absent. In *SCEPANOTROCHA* the upper lip itself is modified into a membranous hood-like expansion larger than the corona, which it completely covers (save the extremities of the cilia), and which it dorsally screens.

These three genera claim about one-fourth of the species of the *PHILODINIDAE*. In my opinion they are representative of an earlier stage in the development of the typical *Philodine*, the genera of Section B representing, broadly speaking, a *distinct advance in development, shown by their greater average size, the greater proportional development of the corona, especially of the trochal discs, and their greater activity, mobility, and boldness.*

The genera of Section B, comprising all *PHILODINIDAE* in which the lumen is tube-like, divide naturally into three Subsections:

- I. With four toes (two dorsal, two terminal).
- II. With three toes (one dorsal, two terminal).
- III. With toes bearing a number of cup-like suckers, or united to form a broad disc, or twin discs.

Subsection I., with four toes (the dorsal pair usually somewhat distant from the terminal).—In this subsection the remarkable foot of the *Bdelloid* rotifer attains its highest development. The comparatively wide separation of the two pairs of toes, the independent action of each pair, their consequent control by different muscles and nerves, the rapidity and certainty of their affixment, indicate greater specialisation than is exhibited by any other groups, however closely approached by individual forms. In the same way, the four-toed species surpass their relatives in the development of the corona. The average width of the trochal discs, in some species extremely ample, and its proportion to the body-length are much in excess of those seen in other

Philodinidae. In my opinion these details form good indices to the functional perfection of the food-collecting organ.

The four-toed species constitute about one-third of the PHILODINIDAE in the present list. I have divided them among five genera, of which three correspond to groups suggested by Murray as already quoted, viz. the "parasitic," the "viviparous and long-spurred," and the "semi-loricate" groups. For these I propose the new genera EMBATA, DISSOTROCHA, and PLEURETRA respectively.

For the present I hesitate to separate the "short-spurred species" (of Murray) from the "oviparous." Together they form a fairly compact genus, which includes nearly all the species assigned by Ehrenberg to the genus PHILODINA, and for which I therefore retain that generic name. In these four genera the corona is always in close conformity with the family type, and in every case there is a distinct throat or passage to the mastax. In the recently described (*P.*) *intermedia*, de Beauchamp, the corona differs from the type in several details (most notably in the partial absence of the cingulum or secondary wreath), and there is practically no throat, the mastax being placed so closely below the mouth that the jaws themselves can be employed in seizing the food. For generic distinction the latter character appears to me to be the most suitable, and I propose therefore to refer to it in creating for this remarkable species the new genus ABROCHTHA.

Subsection II., with three toes (the dorsal toe usually close to the terminal pair).—The species with three more or less well-developed toes are divided according to their customary course of reproduction. For those which are viviparous I have retained the generic name ROTIFER as suggested by Milne (23). This emendation of the distinctive character makes little change in the constituent species. With the exception of the discordant form "*roeperi*," now transferred to the genus HABROTROCHA, all the species with rostral eyes are viviparous, and therefore remain in the genus with which they have been hitherto associated, whilst to their number is added the blind but closely related species "*longirostris*" Janson, and "*magnicalcarata*" Parsons. For those other three-toed species which are oviparous I retain the generic name CALLIDINA, not because the genus as now presented contains any of the eight species described by Ehrenberg, who created the genus (for the opposite is the case), but because the majority of

the species now assigned to it have of late years seemed to me to represent the central group of the very heterogeneous crowd of forms which the too elementary definition of "no eyes" has caused to be associated with this name. For reasons which will be later explained I am far from satisfied that the identity of Ehrenberg's *Callidina elegans*, the species for which he created the genus *Callidina*, has been rightly determined by any of the authors who have hitherto accepted it, nor, although particularly anxious to establish as many as possible of the old but too scantily described forms, have I myself succeeded in finding it. As to his next described species, *Callidina rediviva*, which would seem to be a pellet-making form, I am in the same position. Of six other species described by him after a long interval, three are now recognisable, but belong to two very distinct groups, (*C.*) *alpium* having four toes, and (*C.*) *scarlatina* and (*C.*) *tetraodon* having the foot ending in a sucker-like disc. Under these circumstances I have felt myself at liberty to employ the familiar name for those species which remain in the old genus after relieving it of the most aberrant forms. The new definition is perhaps somewhat too comprehensive still. The genus includes three rather distinct groups of species which may be characterised respectively as :

1. Rough-skinned.
2. Smooth-skinned, short-footed, non-parasitic.
3. Smooth-skinned, long-footed, and parasitic.

For the rough-skinned and the parasitic groups I think it will ultimately be desirable to provide separate genera. The second group of smooth-skinned, short-footed, non-parasitic forms I regard as generally representing the type of the genus CALLIDINA.

Subsection III., with toes bearing cup-like suckers or united to form a broad disc or twin discs.—Although the species included in this subsection are relatively few in number, certain of them have been more exhaustively studied than all the other Bdelloida together. The majority are large forms, possessed of well-developed coronae, and they usually inhabit ground-mosses and liverworts of various kinds. But besides the moss-dwelling forms there are two species which are parasitic in habit and very distinct in some structural details, viz. *Discopus synaptae* Zelinka, and *Anomopus telphusae* Piovanelli. The genera DISCOPUS and ANOMOPUS are

distinguished from each other by the arrangement of the foot-glands, which in *DISCOPUS* are placed in transverse series, but in *ANOMOPUS* in longitudinal series as in all other *Bdelloida*. For the moss-dwelling species I propose the new genus *MNIOBIA*, distinguishing it from *DISCOPUS* by the longitudinal arrangement of the foot-glands, and from the long-footed *ANOMOPUS* by the relatively short foot.

The order in which these families and genera should be placed is more than difficult to determine. If, as I think is the case, the pellet-making species are nearest to the primitive *Bdelloid* type, the genera *HABROTROCHA*, *SCOEPANOTROCHA*, and *CERATOTROCHA* may be taken as representing the central line of growth from which at one period or another other groups have branched off, in most cases to subdivide again. If, however, the functional development of the various genera—that is to say, their capacities for gathering food, for locomotion, their general activity and endurance—be considered, then I think the genus *PHILODINA* should stand first, yet be closely approached by *ROTIFER* and *CALLIDINA*, while at the foot of the list should appear *MICRODINA* and *BRADYSCELA*, with *CERATOTROCHA* but little above them.

But it is impossible in the mere sequence of genera and species to give any adequate idea of both the relationships and the comparative development of the several groups which the genera are intended to represent. For the sequence of genera which after various rearrangements I have finally adopted I make no claim save that of convenience.

The new genus *SCOEPANOTROCHA* is represented only by two species new to science, and descriptions of these accompanied by figures follow after the general classification.

The list of species regarded as insufficiently described or otherwise invalid is supplemented by remarks on certain of the species included therein.

I conclude this paper with a list of works dealing with earlier classifications of the *BDELLOIDA*, or containing original or supplementary descriptions of species, so far as I am acquainted with them. Throughout the text reference is made to these works by numbers enclosed in brackets after the author's name.

(In the event of any described species or work having been omitted from the respective lists I shall be grateful if the fact be made known to me.)

SYNOPSIS OF THE FAMILIES, GENERA,
AND SPECIES.

ORDER BDELLOIDA	}	Fam. ADINETIDAE	{	Gen BRADYSCELA gen. nov.	
				" ADINETA Hudson and Gosse.	
			A		" CERATOTROCHA gen. nov.
				" SCEPANOTROCHA gen. nov.	
				" HABROTROCHA gen. nov.	
				" CALLIDINA Ehr.	
			B		" ROTIFER Schrank.
				" DISSOTROCHA gen. nov.	
				" PLEURETRA gen. nov.	
				" EMBATA gen. nov.	
				" PHILODINA Ehr.	
				" ABROCHTHA gen. nov.	
	" DISCOPUS Zel.				
	" ANOMOPUS Piov.				
	" MICRODINIDAE	" MNIOBIA gen. nov.			
		" MICRODINA Murray.			

BDELLOIDA,

An Order of the Sub-class DIGONONTA Plate 27
(Rotifera with two Ovaries).

ROTIFERA, with spindle-shaped, maggot-like bodies of numerous segments, those of the anterior and posterior extremities telescopically retractile within those of the central body; having ramate jaws, a more or less developed rostrum, and a contractile cloaca. Males unknown.

I. FAMILY Adinetidae.

Bdelloids, with usually imperfect non-revertile rostrum. Corona consisting of a prone surface clothed with short cilia (which create no vortices), and non-retractile within mouth.

Two genera.

Bradyscela gen. nov.

Foot stout, with three toes, spurs modified or absent.

B. clauda (Bryce) 36.

Adineta Hudson and Gosse 19.

Foot slender, with two spurs and three toes.

- | | | |
|----------------------------------|--|----------------------------------|
| <i>A. vaga</i> (Davis) 15. | | <i>A. tuberculosa</i> Janson 38. |
| <i>A. oculata</i> (Milne) 18. | | <i>A. barbata</i> Janson 38. |
| <i>A. longicornis</i> Murray 59. | | <i>A. gracilis</i> Janson 38. |
| <i>A. grandis</i> Murray 66. | | |

II. FAMILY Philodinidae.

Bdelloids with fully developed rostrum, usually revertile. Corona of two functionally distinct wreaths of cilia; the trochus, dorsally and ventrally interrupted, passing nearly round the peripheries of two elevated discs, and creating twin vortices; the cingulum, dorsally interrupted, passing from behind the pedicels round their bases, and thence round inferior margin of mouth. Corona retractile within mouth.

Thirteen genera.

A. Lumen of stomach relatively wide or bag-like. Food usually agglutinated into pellets. Upper lip usually undivided. Oviparous.

a. Pedicels rudimentary or absent.

***Ceratotrocha* gen. nov.**

Trochal discs inset between or beneath two fleshy processes resembling horns.

C. cornigera (Bryce) 37.

***Scepanotrocha* gen. nov.**

Trochal discs inset beneath wide hood-like membranous expansion of upper lip.

S. rubra sp. nov.

| *S. corniculata* sp. nov.

b. Pedicels more or less developed.

Habrotrocha gen. nov.

Corona of family type without horn-like processes or hood-like expansions.

- | | |
|--------------------------------------|-------------------------------------|
| <i>H. angusticollis</i> (Murray) 55. | <i>H. reclusa</i> (Milne) 23. |
| var. <i>attenuata</i> (Murray) 59. | <i>H. bidens</i> (Gosse) 8, 19. |
| <i>H. longiceps</i> (Murray) 58. | <i>H. tripus</i> (Murray) 60. |
| <i>H. perforata</i> (Murray) 59. | <i>H. tridens</i> (Milne) 18. |
| var. <i>americana</i> (Murray) 60. | <i>H. lata</i> (Bryce) 33. |
| <i>H. pusilla</i> (Bryce) 37. | <i>H. angularis</i> (Murray) 66. |
| var. <i>textrix</i> (Bryce) 44. | <i>H. pulchra</i> (Murray) 55. |
| <i>H. collaris</i> (Ehrenberg) 3, 4. | <i>H. constricta</i> (Dujardin) 6. |
| <i>H. eremita</i> (Bryce) 41. | <i>H. microcephala</i> (Murray) 56. |
| <i>H. elegans</i> (Milne) 18. | <i>H. minuta</i> (Murray) 61. |
| <i>H. annulata</i> (Murray) 55. | <i>H. aspera</i> (Bryce) 33. |
| <i>H. leitgebii</i> (Zelinka) 20. | <i>H. crenata</i> (Murray) 55. |
| <i>H. roeperi</i> (Milne) 23. | var. <i>nodosa</i> (Murray) 59. |

B. Lumen of stomach relatively narrow or tube-like. Food never agglutinated into pellets. Upper lip usually bilobed or divided. Oviparous or viviparous.

a. Foot ending in three toes.

Callidina Ehrenberg 2.

Oviparous.

- | | |
|---------------------------------------|--------------------------------------|
| <i>C. aculeata</i> (Milne) 18. | <i>C. habita</i> Bryce 41. |
| <i>C. fusca</i> Bryce 41. | var. <i>bullata</i> Murray 58. |
| <i>C. muricata</i> Murray 55. | <i>C. angusta</i> Bryce 41. |
| <i>C. multispinosa</i> (Thompson) 34. | <i>C. crucicornis</i> Murray 55. |
| var. <i>brevispinosa</i> Murray 64. | <i>C. natans</i> Murray 58. |
| var. <i>crassispinosa</i> Murray 60. | <i>C. plicata</i> Bryce 33. |
| var. <i>zickendrahti</i> Richters 67. | var. <i>hirundinella</i> Murray 61. |
| <i>C. pinnigera</i> Murray 64. | <i>C. musculosa</i> (Milne) 18. |
| <i>C. papillosa</i> (Thompson) 34. | <i>C. ehrenbergii</i> Janson 38. |
| <i>C. quadricornifera</i> (Milne) 18. | <i>C. cancrophila</i> Piovanelli 53. |
| <i>C. vesicularis</i> Murray 57. | <i>C. branchicola</i> Némec 43. |
| <i>C. formosa</i> Murray 59. | <i>C. speciosa</i> Murray 60. |

Rotifer Schrank 1

Viviparous.

- | | |
|---------------------------------------|--|
| <i>R. longirostris</i> (Janson) 38. | <i>R. vulgaris</i> Schrank 1. |
| var. <i>fimbriata</i> Murray 59. | <i>R. macrurus</i> Schrank 1. |
| var. <i>bitorquata</i> Murray 64. | <i>R. ovatus</i> (Anderson) 30. |
| <i>R. tardigradus</i> Ehrenberg 2, 3. | <i>R. neptunius</i> Milne 18. |
| <i>R. elongatus</i> Weber 26. | <i>R. actinurus</i> Janson 38 |
| <i>R. triseccatus</i> Weber 26. | (= <i>Actin. neptunius</i> Ehr. 2, 3). |
| <i>R. spicatus</i> Murray 51. | <i>R. magnicalcarata</i> (Parsons) 32. |
| <i>R. mento</i> Anderson 30. | (= ? <i>Callidina socialis</i> Janson |
| <i>R. citrinus</i> Ehrenberg 4. | 38). |

b. Foot ending in four toes.

* With distinct throat.

† Skin coarse and leathery.

Dissotrocha gen. nov.

Viviparous; abdominal transverse skinfolds few and corresponding to segment boundaries.

- | | |
|--------------------------------------|------------------------------------|
| <i>D. spinosa</i> (Bryce) 33. | <i>D. macrostyla</i> (Ehrenberg) 4 |
| <i>D. aculeata</i> (Ehrenberg) 2, 3. | |

Pleuretra gen. nov.

Oviparous; abdominal transverse skinfolds numerous and not corresponding to segment boundaries.

- | | |
|----------------------------------|------------------------------|
| <i>P. alpium</i> (Ehrenberg) 10. | <i>P. brycei</i> (Weber) 47. |
| <i>P. humerosa</i> (Murray) 55. | |

†† Skin usually smooth and flexible.

Embata gen. nov.

Spurs usually long and heeled; animals mostly ectoparasitic upon water-dwelling larvae, isopods, etc.; viviparous or oviparous.

- | | |
|-------------------------------------|------------------------------------|
| <i>E. parasitica</i> (Giglioli) 12. | <i>E. laticeps</i> (Murray) 55. |
| <i>E. hamata</i> (Murray) 58. | <i>E. commensalis</i> (Western) 35 |
| <i>E. laticornis</i> (Murray) 55. | |

Philodina Ehrenberg 2.

Spurs usually short and without heel; animals wandering and free in habit. Mostly oviparous, rarely viviparous.

<i>P. roseola</i> Ehrenberg 3.	<i>P. nemoralis</i> Bryce 54.
<i>P. erythrophthalma</i> Ehrenberg 2.	<i>P. rugosa</i> Bryce 54.
<i>P. flaviceps</i> Bryce 58.	var. <i>callosa</i> Bryce 54.
<i>P. vorax</i> (Janson) 38.	var. <i>coriacea</i> Bryce 54.
<i>P. citrina</i> Ehrenberg 2, 3.	<i>P. plena</i> (Bryce) 41.
<i>P. acuticornis</i> Murray 51.	<i>P. squamosa</i> Murray 59.
<i>P. megalotrocha</i> Ehrenberg 3.	<i>P. gregaria</i> Murray 66.
<i>P. indica</i> Murray 59.	<i>P. antarctica</i> Murray 66.
<i>P. convergens</i> Murray 61.	<i>P. alata</i> Murray 66.
<i>P. brevipes</i> Murray 51.	

** Without throat.

Abrochtha gen. nov.

Gullet absent. Rami immediately below mouth-cavity and protrusible thereinto.

A. intermedia (de Beauchamp) 65.

c. Foot ending in sucker-like disc or twin discs.

* Foot-glands in transverse series.

Discopus Zelinka 25.

No rostral lamellae, viviparous.

D. synaptae Zelinka 25.

** Foot-glands in longitudinal series.

Anomopus Piovanelli 53

Foot elongate.

A. telphusae Piovanelli 53.

Mniobia gen. nov.

Foot short.

<i>M. magna</i> (Plate) 27.	<i>M. tetraodon</i> (Ehrenberg) 7.
<i>M. russeola</i> (Zelinka) 29.	<i>M. armata</i> (Murray) 55.
<i>M. symbiotica</i> (Zelinka) 20.	<i>M. incrassata</i> (Murray) 55.
<i>M. scarlatina</i> (Ehrenberg) 10.	<i>M. circinata</i> (Murray) 61.

III. FAMILY *Microdinidae* Murray 55

Bdelloids with fully developed but non-revertile rostrum. Corona absent or represented by few cilia about the mouth.

1 genus.

Microdina Murray 55

Toes four.

M. paradoxa Murray 55*Scepanotrocha rubra* sp. nov. (Pl. 2, Fig. 1.)

SPECIFIC CHARACTERS: Hood-like expansion slightly convex, without median notch or lateral projections; hinder margin excised, merging into upper lip. Rami with six or seven fine teeth. Spurs short blunt-looking cones, with small interspace.

When creeping about, this species has some resemblance to young examples of *Habrotrocha constricta* (Duj.), especially if colourless, yet may be distinguished by its more slender head and general outline, its more uniform width, and the blunt-looking, less divergent spurs. When newly obtained from moss-washings it is exceedingly restless and marches about vigorously. After a few days' isolation it becomes very quiet and displays its corona quite freely. While feeding it remains affixed with the foot, and does not drift about, nor does it readily move away.

The outline of the "hood" is best seen in young individuals, where it is distinctly broader than the corona, having a breadth of about 24 μ , a depth of about 9 μ . The lateral margins are rounded off and the anterior is really slightly curved, but is frequently sufficiently depressed to give the central portion a flat outline. Posteriorly the "hood" merges into the upper lip, but I have thought that I could now and again distinguish a faint but boldly curved line marking the actual transition. Below the "hood," the trochal discs appear to occupy the normal position, having their planes about transverse to the body-axis, but the cilia on the dorsal portions of the discs are comparatively feeble, and the "cog-wheel" appearance is only presented by the cilia on the ventral portions. The short pedicels are approximate but distinct. The "cheeks," or lateral cushions of the mouth, are thickened, externally and ventrally prominent, and somewhat

decurrent, so that in dorsal view they are partially visible to right and left of the head. The brain is moderately remote from the antenna, which in recent examples seems to be short, but was perhaps not fully protruded, as early notes describe it as long. It is, however, by no means infrequent among Bdelloids to keep the antenna partially invaginated. In the feeding position the lumbar segments show dorsally the two prominent longitudinal skinfolds familiar in some other species but not universal, and which I propose to distinguish as "the lumbar plicae." The mastax is rather small; the rami about $13\ \mu$ long, each with six or seven very fine teeth. In most examples the digestive fluid is distinctly tinted, usually reddish pink, occasionally pale brown. In the act of creeping the foot is distinctly shown. It consists of three segments, and the spurs are short cones with an unusually blunt appearance in dorsal view.

My largest examples measured about $220\ \mu$ when fully extended, about $170\ \mu$ when feeding.

This interesting species has been known to me, albeit imperfectly, for many years past. I have notes of its occurrence in sphagnum from Epping Forest, Sandown, I.W., Callander, Pitlochry, and Stuttgart. Some months ago I found several examples in sphagnum kindly sent to me by Dr. V. A. Latham, of Chicago, and these have enabled me to improve my acquaintance with its peculiarities. I have never found it in other mosses, and look upon it as almost as distinctively a sphagnum form as is *Habrotrocha roeperi* (Milne).

Scepanotrocha corniculata sp. nov. (Pl. 2, Fig. 2)

SPECIFIC CHARACTERS: Membranous hood-like expansion, having anterior median notch, two small lateral processes, and a straight posterior margin.

From ground-moss collected for me at Bournemouth early in 1909 I obtained a single specimen of this curious form, whose striking divergence from the customary type I did not detect until, some weeks after its isolation, I first saw it feeding. The membranous expansion (seemingly of the upper lip) was perfectly transparent, and the position of the trochal discs upon the ventral side could be defined, although I could not see whether they were quite prone or somewhat obliquely placed.

In dorsal view the cilia of the discs were partially visible beyond the frontal margin, and appeared as though flanked by longer bristle-like setae (?), whose nature I was unable to determine, although I supposed them to be possibly homologous with the trochal setae-pencils possessed by many Philodinidae.

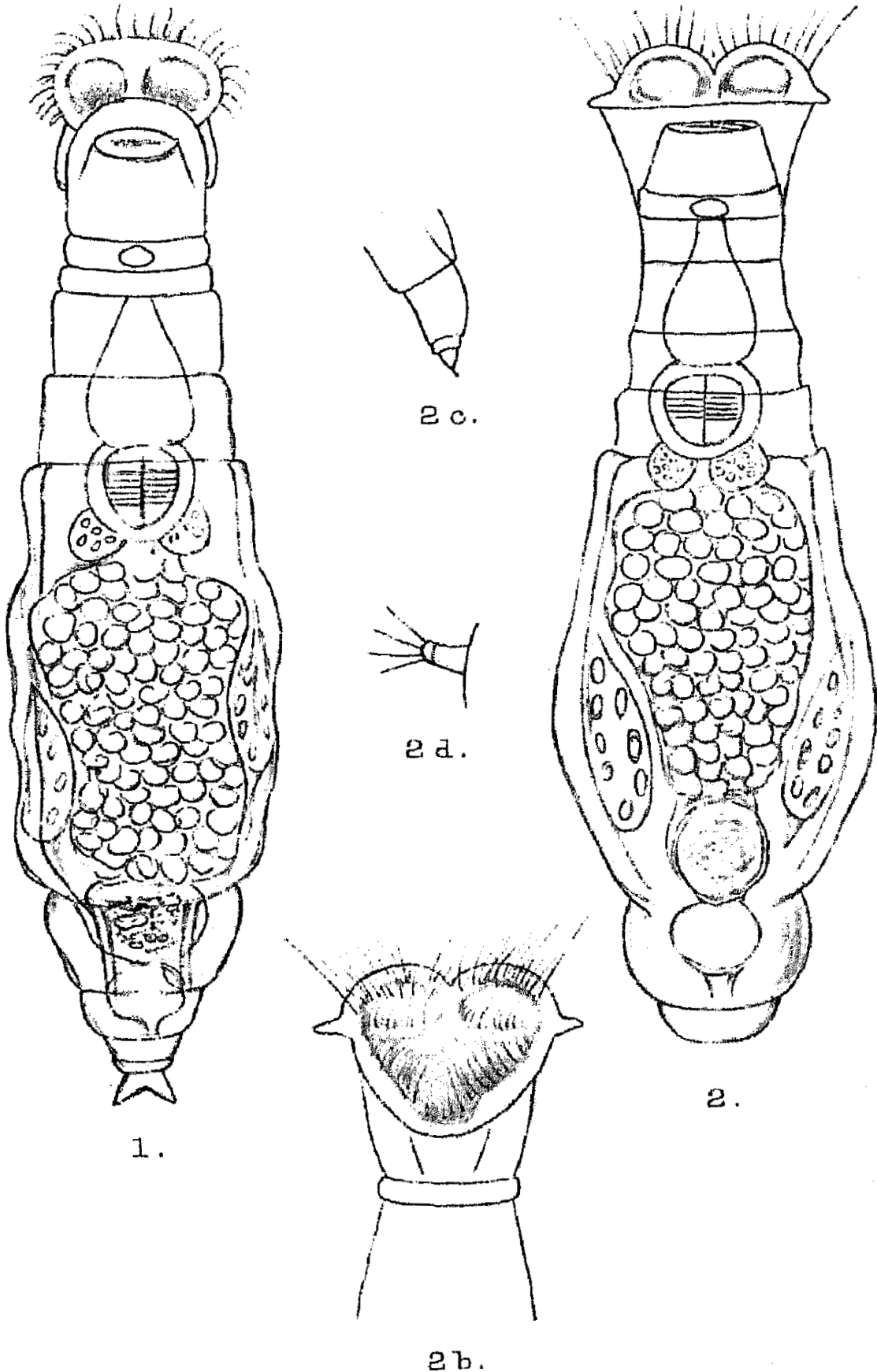
This original example had some difficulty in extending and using its foot, which I never saw protruded or affixed. Thus when extended the animal was never still, either sprawling about as it tried to creep, or when the corona was displayed being driven slowly along by the ventrally placed cilia. I failed therefore to ascertain the number of teeth, but thought that each ramus had three or four. When the corona was withdrawn, and with it the distinctive "hood," the rotifer did not present any obvious peculiarity save that the head seemed somewhat long and the rostral lamellae rather large and prominent. The anterior margin of the "hood" had a central angular depression, from which it curved outwards to right and left till it arrived at the lateral processes, which were somewhat pointed and ventrally deflexed. Their tips were about $35\ \mu$ apart. Behind them the "hood" seemed to be abruptly truncate, the hinder edge forming a straight line, behind which could be seen the reverted rostrum.

A second example was hatched from an egg produced by the original individual. In the young specimen, which did not long survive, the points of the "hood" had a rather backward direction. The foot was normally protruded and occasionally affixed, but usually the young rotifer swam slowly along like its parent. The foot seemed to have three segments: the first rather long and dorsally swollen; the second small, with short, cone-like spurs, about $6\ \mu$ long, and without interspace; the post-oral segment was laterally thickened, and carried a rather short antenna. The stomach contained distinct food-pellets.

The length of the adult example was estimated as about $205\ \mu$.

DESCRIPTION OF PLATE 2.

- Fig. 1. *Scepanotrocha rubra* sp. nov., dorsal view.
 " 2. " *corniculata* sp. nov., dorsal view.
 b. Corona from ventral side. c. Foot.
 d. Dorsal antenna.



D. Bryce, del.

A. H. Searle lith.

Scephanotrocha gen. et sp. nov.

LIST OF SPECIES OMITTED FROM CLASSIFICATION AS INSUFFICIENTLY DESCRIBED OR OTHERWISE INVALID. WITH REMARKS.

- Actinurus neptunius* Ehr. 2 & 3
(= *Rotifer actinurus* Janson).
- Adineta allaudi* Certes 70
(= *A. oculata* (Milne) 18).
- Callidina elegans* Ehr. 2 & 3.
 „ *rediviva* Ehr. 45 & 7.
 „ *triodon* Ehr. 7.
 „ *hexaodon* Ehr. 7.
 „ *oktodon* Ehr. 7.
 „ *pigra* Gosse 21.
 „ *bihamata* Gosse 19.
 „ *socialis* Kellicott 24.
 „ *sordida* Western 35
(= *Rotifer longirostris* Janson).
 „ *laevis* Bergendal 31.
 „ *tentaculata* Ber. 31.
 „ *lutea* Zelinka 29.
 „ *mülleri* Zel. 29.
 „ *holzingeri* Zel. 29.
 „ *lejeuniae* Zel. 29.
 „ *venusta* Bryce 44
(= *Habrotrocha elegans* (Milne)).
 „ *cataractu* Lord 48
(= *Pleuretra brycei* (Weber)).
 „ *quadridens* Hilgen-
dorff 46.
 „ *ornata* Murray 51.
- Hydrias cornigera* Ehr. 3.
Monolabis conica Ehr. 2 & 3.
 „ *gracilis* Ehr. 3.
- Macrotrachela bidens* Milne 18.
Philodina hirsuta Ehr. 5.
 „ *gracilis* Schmarda 11.
 „ *calcarata* Schm. 11.
 „ *macrosipho* Schm. 11.
 „ *setifera* Schm. 11.
 „ *tuberculata* Gosse 19.
 „ *cinnabarina* Zacharias 69.
 „ *hexodonta* Bergendal 31.
 „ *microps* Gosse 22.
 „ *parasitica* Marchoux 49.
 „ *decurvicornis* Murray 51.
 „ *obesa* Murray 51.
 „ *emini* Collin 45.
- Rotifer erythraeus* Ehrenberg 3.
 „ *maximus* Bartsch 14.
 „ *motacilla* Bartsch 14.
 „ *megaceros* Schmarda 11.
 „ *tardus* Ehr. 4
(= *Rotifer tardigradus* Ehr.).
 „ *hapticus* Gosse 19.
 „ *phaleratus* Glascott 39.
 „ *quadrioculatus* Murray 51.
 „ *forficulatus* Barrois & Daday 42.
 „ *inflatus* Dujardin 6.
Typhlias viridis Ehr. 3.

*1.—*Callidina elegans* has appeared so frequently, both in local lists and in more important works, as an accepted and valid species, that it is incumbent upon me to enter more fully than I should otherwise do into the reasons which force me to discredit

all the identifications which I have seen of this elusive species. It has first to be noted that, although Ehrenberg mentions it both in 1830 (2) and in 1831 (3), the few particulars he gives (on the latter occasion) may be taken as superseded by those given in 1838 (4), since in the interval he had found the species on two occasions (but from the same locality as the original capture). Further, that his description of the genus *Callidina* was based on this one species only, as the second known to him—*Callidina rediviva*, also mentioned in the same work (4)—was only found about the time when the proof-sheets were already under revision. Thus the identity of *C. elegans* is to be judged not only from the specific description, but also from the description of the genus *Callidina*, wherein particulars are given which have much importance. Collating both descriptions, it is to be gathered that *C. elegans* of Ehrenberg was a blind Philodine, oviparous and spindle-shaped, having a stout ciliated rostrum and a long-extending foot with two spurs and four toes; a corona of two small discs, not mounted on pedicels; rami with many very fine teeth; stomach thread-like; antenna short; with some resemblance to *Philodina erythrophthalma*, but with spurs somewhat longer than in that species yet shorter than in *P. macrostylis*, and with very short terminal toes. Some seven figures are given to supplement this description, and are principally noteworthy for the curious presentment of the corona, which gives some ground for Milne's (18) interpretation of it as of the *Adineta* type, and which certainly gives no clear suggestion of any form of corona known to me.

The description of the stomach as thread-like ("fadenartig") in the generic description is to be understood as referring to *C. elegans*. In the description of *C. rediviva*, interpolated at the time of proof-revision, Ehrenberg notes as a conspicuous mark the breadth of the food-canal, apparently meaning the lumen of the stomach, and he speaks of the stomach-structure as resembling that of *P. collaris*. It is clear from the further details given that both *P. collaris* and *C. rediviva* had stomachs with a wide lumen, and that both were pellet-makers. That such is the case with *C. rediviva* gives the more weight to the description of the stomach in *C. elegans* as thread-like.

If one may rely on the various details given by Ehrenberg, his *C. elegans* differs in several respects from that described by

Hudson and Gosse (19) as his species. These authors neither confirm nor deny the accuracy of Ehrenberg's statements. Yet they state that the form recognised by them as his *C. elegans* has an antenna longer than the width of the corona, that it has three toes, that the spurs are middling, and that the foot is thick—a final detail which is important, since it contradicts the resemblance to *P. erythrophthalma*, which has a foot as long and as slender as that of *P. roseola*. That Hudson and Gosse's species had no prominent teeth does not perhaps conflict with Ehrenberg's description of the rami as having many fine teeth.

It has, however, seemed to me to be possible to recognise the animal which Hudson and Gosse had in mind. Their description of the corona is the one happy touch which indicates a species common enough in weedy pools. They say that the corona is scarcely wider than the body, the double disc being very little more than a full circle or two circles very slightly separated.

The species to which this description in my opinion applies the best has a number of fine teeth, a corona with discs whose pedicels are somewhat squat or truncate, and in these details would not appreciably conflict with Ehrenberg's description; but the foot has no resemblance to that of *P. erythrophthalma*, the spurs have a most distinctive form not suggested by either of the authors, and, above all, the species has a *wide lumen* and is distinctly a *pellet-maker*.

It is probable that the form which Janson (38) cursorily describes as Ehrenberg's species is identical with that of Hudson and Gosse, if one may judge from his description and figure of the spurs. He states that the foot has only three segments, that the rami have ten to eleven fine teeth, and that the antenna is somewhat large.

Ehrenberg was possibly mistaken as to the number of toes. It is known that he was inaccurate on this point with respect to the genus *Rotifer*, while correct with regard to the genus *Philodina*. But I cannot think that he would have failed to distinguish between the short stout foot of Hudson and Gosse's *C. elegans*, and the long slender foot of *P. erythrophthalma*, and that he would only be able to distinguish the two species by examination of the rami, as in effect he states with regard to his *C. elegans*. And again, I cannot brush aside his statement that the stomach

was thread-like, when I know how particularly he was interested in the structure of the alimentary canal and in the appearances presented when the rotifers were fed with indigo or other pigments.

2.—*Callidina rediviva*, as stated above, was clearly a pellet-maker, and had a stomach with a wide lumen. It had two teeth on each ramus, and some resemblance to *Philodina roseola* in colour and form. It occurred in sand from a rain-water gutter in Ehrenberg's house. These details were given in 1838. At a later date, 1848 (7), Ehrenberg states that the colour is brick-red and that the body is spindle-shaped. The two-toothed pellet-makers known to-day are comparatively few. The above particulars apply best in my opinion to *Habrotrocha bidens* (Gosse), which has the spindle-shaped body and a superficial resemblance to *P. roseola*; but I have never seen it of a reddish colour, but always colourless or nearly so. To regard the two forms as identical on such faint particulars and resemblance would not, I think, be satisfactory.

3.—*Philodina hirsuta*, Ehrenberg, wrongly ascribed to Pritchard by Janson (38), appears to have been accepted by the last author solely upon the faith of its supposed recognition by Anderson (30), who in turn seems to have been misled by a ludicrous error in Pritchard's *Infusoria* (1861 edition). In Ehrenberg's description the spurs are thus described: "Pedis corniculis dorsualibus praelongis," the phrase meaning in modern terminology "Spurs very long," but translated in Pritchard as "Foot prolonged by dorsal spines." Anderson remarks that the foot is not prolonged by dorsal spines, and figures a species with quite short spurs, which cannot possibly be the species seen by Ehrenberg. If *Philodina commensalis* of Western be really viviparous as described (of which I have doubts) it is possible that it is a rediscovery of the original *P. hirsuta*, as not only does it fit the few particulars given by Ehrenberg, but I have also seen it partially covered with hair-like bodies, noticed both by Ehrenberg and by Anderson on their respective species. It is now well understood that the supposed "down" does not really appertain to the rotifer, but is a parasitic fungoid growth, either a species of *Cladotrix* or allied thereto. A similar growth was seen on examples sent to me of *Anomopus telphusae*, which, like *P. commensalis*, is itself of parasitic habits.

4.—*Callidina socialis* Kellicott is probably a good species, but was quite inadequately described by its discoverer, who thought it sufficient to differentiate his species from *Philodina parasitica* as the only Bdelloid previously known to be ectoparasitic upon fresh-water animals, and omitted in particular to ascertain whether it was oviparous or viviparous, and whether it had three or four toes. Janson, who considered that *Rotifer magnicalcarata* (Parsons) is identical with *C. socialis*, assumed that the latter was viviparous and had three toes like Parsons's species. In my view it is quite as likely to have been oviparous and four-toed like *P. commensalis* Western (described as viviparous, but I think in error). There are now known quite a number of these ectoparasitic species, and any amended description of the true *C. socialis* would have to take these into consideration. Meanwhile I retain as valid the *R. magnicalcarata* (Parsons), which I have repeatedly found and which is a much larger form than that described by Janson, attaining sometimes a length of 720μ or $\frac{1}{35}$ inch. Janson's dimensions and details apply very well to another smaller form, found by Murray in Scotland and myself in England, which has the same sword-like spurs as *P. commensalis* and *R. magnicalcarata*, and like these species is usually found on *Asellus*. This third form resembles *P. commensalis* very closely in general appearance, but is viviparous, three-toed, and blind. In *P. commensalis* the eyes are frequently very difficult to define, and I am inclined to believe that Western took the character "viviparous" from examples of this third form which he had failed to distinguish from the true *commensalis*.

5.—*Philodina hexodonta* Bergendal. A form found some years ago in Scotland by Murray, and more recently by myself, was at first referred to the above species, in view of the approximation of the number of teeth (5—5) to that stated by Bergendal. It differs from it, however, in almost every other detail given by that writer. For instance, *P. hexodonta* is said to have a body resembling that of *P. roseola*, but not reddish; and to have spurs so swollen at the base that there is no interstice between them. The Scottish form is quite unlike *P. roseola* in general outline; the proportionate length of the foot is very different, the body is often reddish, and there is a distinct interspace between the short, acute spurs.

After further consideration I came to the conclusion that

the Scottish specimens must be referred to the *Philodina collaris* of Ehrenberg, a species hitherto unrecognised. It is unfortunate that with regard to this very species Ehrenberg was unable to state the number of teeth, as this detail would have been of great value. But I rely less upon the general details given of *P. collaris* than upon the description and figure of the stomach, which prove clearly enough that this species was a pellet-maker, and had a stomach with the wide lumen usual among pellet-making forms.

The Scottish species is the only pellet-maker known which has two eyes in the neck, or, to locate them more precisely, in the brain, and it further agrees with Ehrenberg's description in having a small corona, and in the eyes being round. I did not observe in my own specimens that there was any distinct swelling of the neck such as Ehrenberg describes; but he appears to indicate that annulus-like thickening of the skin of the post-oral segment which is noticeable in many species. As these are nearly all pellet-making forms, this detail supports my view that *P. collaris* was a pellet-maker. In accordance with that view, and in the belief that the Scottish specimens are more correctly to be assigned to *P. collaris*, I have included Ehrenberg's species as recognisable, and placed *P. hexodonta* among those which are insufficiently described.

It seems probable that the specimens which Bilfinger (68) assigned to *P. hexodonta* were similar to the Scottish examples.

6.—*Rotifer hapticus* Gosse. Neither Murray nor myself has met with any species which rivals *R. macroceros* in the length of the dorsal antenna but lacks the tapping motion characteristic of the latter form. But the whole description given by Gosse is so lacking in definite detail that there can be no question of its insufficiency. Indeed, the whole central group of the genus *Rotifer*, viz. *R. vulgaris* and its nearer relations, amongst which *R. hapticus* is probably to be reckoned, stands greatly in need of a much more critical examination than it has yet received.

7.—*Callidina bihamata* Gosse. The value of the description of this species rests solely upon the reality of the two "hooks" at the apex of the rostrum. It seems certain that the supposed "hooks" were simply the lateral presentment of the rostral lamellae, possessed more or less conspicuously by every Bdelloid

known, and which in certain positions might appear to be crossed hooks if imperfectly seen.

8.—*Callidina pigra* Gosse is probably *Habrotrocha constricta* (Dujardin).

9.—*Callidina angusta* Bryce. I had proposed to include this species in the doubtful list, but whilst these notes were in preparation I have been informed by Mr. Murray that he has recently found specimens which agree fairly well with the details noted in my description, although this could perhaps be amplified with advantage. Judging from his specimens he thought that the species seemed to be related to *Callidina habita* Bryce.

10.—*Philodina parasitica* Marchoux is probably a distinct species, but the description is very insufficient, and the specific name has been already appropriated to Giglioli's species, which would possibly prove to be a congener.

11.—*Callidina ornata*, *Rotifer quadrioculatus*, *Philodina obesa*, and *P. decurvicornis*, all described by Murray, are now regarded by him as doubtful, pending further examination.

BIBLIOGRAPHY.

Restricted to works dealing with the classification of the BDELLOIDA, or containing original descriptions or supplementary details of species.

1. 1803. SCHRANK: *Fauna boica*, III., 2, p. 110.
2. 1830. G. C. EHRENBURG: Beiträge zur Kenntniss der Organismen der Infusorien, etc. *Abhand. der Berliner Akad. der Wiss.*
3. 1831. G. C. EHRENBURG: Über die Entwicklung und Lebensdauer der Infusionsthierchen, *Abhand. der Berliner Akad. der Wiss.*
4. 1838. G. C. EHRENBURG: Die Infusionsthierchen als vollkommene Organismen.
5. 1840. G. C. EHRENBURG: Note in *Verhand. der Berliner Akad. der Wiss.*, p. 197.
6. 1841. M. F. DUJARDIN: Histoire naturelle des Zoophytes; Infusoires in, *Suites à Buffon.*

7. 1848. G. C. EHRENBERG: Fortgesetzte Beobachtungen über atmosphäerische Mikroskopische Organismen, *Verhand. der Berliner Akad. der Wiss.*, p. 380.
8. 1851. P. H. GOSSE: A Catalogue of Rotifera found in Britain, *Ann. Mag. Nat. Hist.*, Ser. II., Vol. VIII.
9. 1852. PERTY: Zur Kenntniss der kleinsten Lebensformen.
10. 1853. G. C. EHRENBERG: Über neue Anschauungen des kleinsten nördlichen Polarlebens, *Verhand. der Berlin Akad. der Wiss.*, p. 529.
11. 1857. L. K. SCHMARDA: Neue wirbellose Thiere, etc., Bd. I., pp. 47-66.
12. 1863. H. GIGLIOLI: On the genus *Callidina*, *Quart. Journ. Micr. Science*, N. S., Vol. III., p. 237.
13. 1868. E. RAY LANKESTER: Note on the Synaptae of Guernsey, etc., and a New Parasitic Rotifer, *Quart. Journ. Micr. Science*, N. S., Vol. VIII., p. 53.
14. 1870. S. BARTSCH: Die Räderthiere und ihre bei Tübingen beobachteten Arten, *Jahreshefte des Vereins für Vaterländische Naturkunde in Württemberg*, Stuttgart.
15. 1873. H. DAVIS: A New *Callidina*, etc., *Monthly Micr. Journ.*, Vol. IX., p. 201.
16. 1877. S. BARTSCH: *Rotatoria Hungariae*.
17. 1884. C. T. HUDSON: An Attempt to reclassify the Rotifera, *Quart. Journ. Micr. Science*, N. S., Vol. XXIV., p. 335.
18. 1886. W. MILNE: On the Defectiveness of the Eye-spot as a Means of Generic Distinction in the *Philodinaea*, etc., *Proc. Phil. Soc.*, Glasgow.
19. 1886-9. C. T. HUDSON & P. H. GOSSE: The Rotifera or Wheel Animalcules, 2 vols., 1886-7; Supplement, 1889.
20. 1886. CARL ZELINKA: Über die Symbiose und Anatomie von Rotatorien aus dem genus *Callidina*; Studien über Räderthiere; *Jen. Zeitsch. f. Naturwiss. Zool.*, Bd. XLIV., p. 396.
21. 1887. P. H. GOSSE: Twenty-four New Species of Rotifera, *Journ. Roy. Micr. Soc.*, p. 1.

22. 1887. P. H. GOSSE: Twenty-four more New Species of Rotifera, *Journ. Roy. Micr. Soc.*, p. 861.
23. 1888. W. MILNE: Rotifer as a Parasite or Tube-dweller, *Proc. Phil. Soc.*, Glasgow.
24. 1888. D. S. KELLICOTT: Partial List of Rotifera of Shia-wassee River, *Proc. Amer. Soc. Micr.*, Vol. X.
25. 1888. CARL ZELINKA: Der Raumparasitismus und die Anatomie von Discopus Synaptae; Studien über Räderthiere, *Zeitsch. f. wiss. Zool.* (Jena), Bd. XLVIII., p. 353.
26. 1888. E. F. WEBER: Notes sur quelques Rotateurs des Environs de Genève, *Arch. de Biologie*.
27. 1889. L. PLATE: Über die Rotatorien-fauna des bottnischen Meerbusens, *Zeitsch. f. wiss. Zool.* (Jena), Bd. XLIX., p. 1.
28. 1890. G. WESTERN: Notes on *Phil. macrostyla* and *Rotifer citrinus*, *Journ. Quek. Micr. Club*, Ser. II., Vol. IV., p. 87.
29. 1891. CARL ZELINKA: Zur Entwicklungsgeschichte der Räderthiere, etc., Studien über Räderthiere, *Zeitsch. f. wiss. Zool.* (Jena), Bd. LIII., p. 323.
30. 1891. H. H. ANDERSON: Notes on Indian Rotifers, *Journ. Asiatic Soc. Bengal* (Calcutta), Vol. LVIII., p. 345.
31. 1891-2. D. BERGENDAL: Beiträge zur Fauna Grönlands, I. Zur Rotatorienfauna Grönlands, *Kongl. Fysiog. Sällskapets Handlingar*.
32. 1892. F. A. PARSONS: Notes on Two Rotifers found in Epping Forest, *Journ. Quek. Micr. Club*, Ser. II., Vol. IV., p. 378.
33. 1892. DAVID BRYCE: On the Macrotrachelous Callidinae, *Journ. Quek. Micr. Club*, Ser. II., Vol. V., p. 15.
34. 1892. P. G. THOMPSON: Moss-haunting Rotifers, *Science Gossip*, Vol. XXVIII., p. 56.
35. 1893. G. WESTERN: Notes on Rotifers, etc., *Journ. Quek. Micr. Club*, Ser. II., Vol. V., p. 155.
36. 1893. DAVID BRYCE: On the Adinetadae, *Journ. Quek. Micr. Club*, Ser. II., Vol. V., p. 146.

- 90 D. BRYCE ON A NEW CLASSIFICATION OF THE BDELLOID ROTIFERA.
37. 1893. DAVID BRYCE: On Two New Species of Macrotracheous Callidinae, *Journ. Quek. Micr. Club*, Ser. II., Vol. V., p. 196.
38. 1893. OTTO JANSON: Versuch einer Übersicht über die Rotatorien-Familie der Philodinaeen, *Abhand. der Naturwiss. Vereins in Bremen*.
39. 1893. L. S. GLASCOTT (Miss): A List of some of the Rotifera of Ireland, *Proc. Roy. Dublin Soc.*, Vol. VIII. (N. S.), p. 29.
40. 1893. E. VON DADAY: Cypridicola parasitica, *Természettud. Füzetek XVI.*
41. 1894. DAVID BRYCE: Further Notes on Macrotrachelous Callidinae, *Journ. Quek. Micr. Soc.*, Ser. II., Vol. V., p. 436.
42. 1894. THEOD. BARROIS & E. VON DADAY: Résultats Scientifiques d'un Voyage entrepris en Palestine, etc., *Rotifères, Revue Biologique du Nord de la France*, Lille.
43. 1895. B. NĚMEC: O. ectoparasitech Ligidia, *Vestník Král. České Společnosti Nauk*, Prague.
44. 1897. DAVID BRYCE: Contributions to the Non-marine Fauna of Spitsbergen, Part II., Report on the Rotifera, *Proc. Zool. Soc.*, London, p. 793.
45. 1897. A. COLLIN: Eingeweidewürmer und Räderthiere, *Die Thierwelt Ost-Afrikas*, etc., Vol. IV., Part V. (Carl Moebius).
46. 1898. F. W. HILGENDORFF: A Contribution to the Study of the Rotifera of New Zealand, *Trans. N. Z. Inst.*, Vol. XXXI., p. 108.
47. 1898. E. F. WEBER: Faune Rotatorienne du Bassin du Léman, *Revue Suisse de Zoologie*, Geneva, Tome V.
48. 1898. J. E. LORD: On Two New Rotifers, *Journ. Quek. Micr. Club*, Ser. II., Vol. VII., p. 75.
49. 1898. E. MARCHOUX: Note sur un Rotifère vivant dans le tube digestif de larves aquatiques d'insectes, *Compte Rendu Soc. Biol.*, Tome V., p. 749.
50. 1899. C. WESENBERG LUND: Danmark's Rotifera, Copenhagen.

51. 1902. JAMES MURRAY: Some Scottish Rotifers, etc., *Ann. Scot. Nat. Hist.*, p. 162.
52. 1903. JAMES MURRAY: Some Scottish Rotifers (Bdelloida), *Ann. Scot. Nat. Hist.*, p. 160.
53. 1903. SEBASTIANO PIOVANELLI: Two New Bdelloida commensal in the Branchial Cavities of *Telphusa fluviatilis*, *Journ. Quek. Micr. Club.*, Ser. II., Vol. VIII., p. 521.
54. 1903. DAVID BRYCE: On Two New Species of *Philodina*, *Journ. Quek. Micr. Club.*, Ser. II., Vol. VIII., p. 523.
55. 1905. JAMES MURRAY: On a New Family and Twelve New Species of Rotifera of the Order Bdelloida, etc., *Trans. Roy. Soc. Edin.*, Vol. XLI., p. 367.
56. 1906. JAMES MURRAY: The Bdelloid Rotifera of the Forth Area, *Proc. Roy. Phys. Soc. Edin.*, Vol. XVI., p. 215.
57. 1906. JAMES MURRAY: A New Bdelloid Rotifer, *Callidina vesicularis*, *Journ. Quek. Micr. Club.*, Ser. II., Vol. IX., p. 259.
58. 1906. JAMES MURRAY: The Rotifera of the Scottish Lochs, *Trans. Roy. Soc. Edin.*, Vol. XLV., p. 151.
59. 1906. JAMES MURRAY: Some Rotifera of the Sikkim Himalaya, *Journ. Roy. Micr. Soc.*, p. 637.
60. 1907. JAMES MURRAY: Some South American Rotifers, *Amer. Nat.* (Boston), Vol. XLI., p. 97.
61. 1908. JAMES MURRAY: Scottish Rotifers collected by the Lake Survey, *Trans. Roy. Soc. Edin.*, Vol. XLVI., p. 189.
62. 1908. JAMES MURRAY: Arctic Rotifers, etc., *Proc. Roy. Phys. Soc. Edin.*, Vol. XVII., p. 121.
63. 1908. JAMES MURRAY: *Philodina macrostyla* and its Allies, *Journ. Quek. Micr. Club.*, Ser. II., Vol. X., p. 207.
64. 1908. JAMES MURRAY: Some African Rotifers, *Journ. Roy. Micr. Soc.*, p. 665.
65. 1909. P. DE BEAUCHAMP: *Philodina intermedia* n. sp. et Remarques sur l'origine des Microdinides, *Bull. Soc. Zool. de France* (Paris), Tome XXXIV.

- 92 D. BRYCE ON A NEW CLASSIFICATION OF THE BDELLOID ROTIFERA.
66. 1910. JAMES MURRAY: Antarctic Rotifera, Brit. Antarctic Expedition, 1907-9, *Reports on the Scientific Investigations*, Part III.
67. 1902. FERD. RICHTERS: Neue Moosbewohner, *Bericht der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt a/M.*
68. 1894. L. BILFINGER: Zur Rotatorienfauna Württembergs, *Jahreshefte des Vereins für vaterl. Naturkunde in Württ.*
69. 1886. O. ZACHARIAS: Können die Rotat. u. Tard. nach vollständiger Austrocknung wieder aufleben oder nicht? *Biol. Centralbl.*, Bd. VI., p. 230.
70. 1903. CERTES: Microbiologie, *Mem. Pontif. Accad. Roman. dei nuovi Lincei* (Rome), Vol. XXI., p. 26.