CONTRIBUTIONS TO THE BIOLOGY OF THE GREAT LAKES.

ROTATORIA OF THE UNITED STATES, WITH ESPECIAL REFERENCE TO THOSE OF THE GREAT LAKES.*

By H. S. JENNINGS,
Instructor in Zoology, University of Michigan.

INTRODUCTION.

Among the objects to be attained in the biological investigations of the Great Lakes, inaugurated by the United States Fish Commission, a preliminary one is the collection and determination of the animals and plants found in the lakes and the placing of these on record. A portion of the first summer in the field (1898) was spent by the writer in a study of the Rotatoria of the region of Lake Erie about South Bass Island, where the summer laboratory was situated; the observations and collections there made form the basis of the present paper. Three summers had been spent previously by the writer in study of the Rotatoria of other parts of the Great Lakes and of some of the inland lakes of Michigan; other observations in the Great Lakes have been made by Kellicott ('96 and '97) on the Rotatoria of Lake Erie. These researches, taken together, make possible an extended, though of course incomplete, list of the Rotatoria of the Great Lakes. As the work on the Great Lakes has included the larger number of species observed in the United States, it has been deemed advisable, in this first report of work done for the United States Fish Commission, to include a record of all the Rotifera thus far observed in the United States, together with all the localities in which they have been observed, so far as possible. Notices of the Rotifera are scattered through many publications, and it is believed that nothing will serve better as a basis for future work than to bring these scattered notices together.

In beginning a study of a circumscribed group of animals such as the Rotatoria, in connection with a general biological survey of the Great Lakes, it is well to have clearly in mind an outline of the problems upon which work is to be done. The lake is to be looked upon as an organism, the various groups of animals and plants in the lake, as well as the chemical and physical conditions and forces there present, being the organs which make up the whole. These organs are necessarily as closely corre-

* The papers in this series are based on investigations of the U. S. Fish Commission, under the direction of Prof. Jacob Reighard, of the University of Michigan. Three other articles of the series, by the same author, have been published in the American Journal of Physiology, vol. II, 1898 (pp. 311–341, and 355–379), and vol. III, 1900 (pp. 229–260), as follows: (1) The Mechanism of the Motor Reactions of Paramecium; (2) Laws of Chemotaxis in Paramecium; (3) On the Movements and Motor Reflexes of the Flagellata and Ciliata.

lated and adapted to each other as the organs of an animal, and the network of interrelations forms the chief object of study for such a biological survey. Our special problem is to determine just what place the Rotatoria occupy as members of this organic whole. For this a study of the group in all its relations will be necessary. Such a study will follow some such lines as the following:

First, the objects of study must be known and described. To this end there must be on record somewhere full and complete descriptions and figures of all the Rotifera found in the lake, with their correct names. An important preliminary feature of the work consists, therefore, in figuring and describing such forms as have been incorrectly or incompletely described or not described at all. On account of the large number of minute species found among the Rotifera, and the unsatisfactory work that has been done upon many of them, much remains to be accomplished in this line. The best method of carrying on this work will consist in studying carefully circumscribed groups—the species of a single genus, perhaps—describing and figuring all the species, and going critically over the literature of the group in such a way as to set the synonymy in order. Studies of this sort on the genus *Monostyla*, on *Cathypna* and *Distyla*, on *Metopidia*, on *Colurus*, on the *Rattulidæ*, or, for a much more extensive problem, on the *Notommatadæ*, would be exceedingly valuable.

Lists of all the species found in the given body of water must also be placed upon record, in order that the investigator may know with what material he has to deal. Such lists, carefully prepared, are also of much interest for a study of the general problem of the geographical distribution of the group with which we are dealing.

The work above characterized must be considered as purely preliminary to the main object of study; the present paper includes only such preliminary matter. The distribution of the animals within the lake and the study of the conditions under which they live constitute a problem of much greater interest. Most of the species of rotifers seem fitted to some special environmental conditions; what these conditions are may be determined by observation and by experiment. From the side of observation, lists should be kept of Rotifera of the different regions into which a body of water may be divided—distinguishing thus, as is usually done, limnetic species, littoral species, bottom species, and swamp species. This classification is, however, much too general to give precise results. It should be supplemented by a careful study of the Rotifera of regions of different character, with regard to the depth of the water, the character of the bottom, and especially with relation to the plant life of the water. The rotifers from the *Chara* beds, *Ceratophyllum* beds, *Naias* beds, *Potamogeton* beds, the *Cladophora*-covered surfaces, should be studied and listed, to see what relation there is between the animal and plant life of the lake. A beginning of this work was made during the summer of 1898, but in the two months during which the party was in the field not enough could be done, in addition to other work, to permit the drawing of any conclusions, so that the results will not be presented till further study is made.

The changes in the character of the fauna with different seasons of the year and with variations in climate must be studied as an important feature of the conditions of existence. The problem may be attacked more directly under experimental conditions. The animals may be kept in laboratory cultures, and suitable changes produced artificially in the conditions within these cultures. The results of these changes on the life of the animals may thus be observed. Proper control cultures will always be necessary in such work.

The effects of varying conditions in modifying a given single species is a problem

of the greatest interest, leading to the general question of the origin and nature of species and to the deepest questions of morphogenesis. The variations of a given species should be recorded and studied; from a sufficient number of records the laws of the variations may be deduced. More important still is a study of the causes of the variations. The variations occurring with a change of conditions, or with a change of season, are worthy of careful study, such a study as has recently been made by Lauterborn ('98) of *Anuræa cochlearis*. An experimental study of the production of variations promises most for this problem; to this end the very variable and hardy species *Brachionus bakeri* would probably be a most useful form.

The life-history and reproductive habits of the animals furnish a further important field for study. Many features in the life-history of the Rotifera are of much interest and need such study as has been carried on thus far only for *Hydatina senta*, by Maupas, Nussbaum, and others. The striking sexual dimorphism; the conditions of the occurrence of males at certain periods; the determination of the different kinds of eggs produced at different times; the sex of the offspring—all present problems of the greatest interest for an experimental study.

A most important and neglected field lies in a study of the activities by which the animals respond to their environment. Proper conditions of existence are necessary, but these are not sufficient alone to preserve the life of the organisms; the animals must respond to their environment by appropriate activities. We must know what these activities are and the laws which govern them. In other words, a study of the physiology and especially the psychology of the animals is necessary before we can understand the interaction of organism and environment; the functions and movements of the organisms constitute one of the chief factors in the network of interrelations of the "organs" of the lake. Having determined the general laws according to which the organisms respond to their environment—in other words, having made a study of the psychology of the animals—it will then be possible to determine by observation and experiment the specific factors which cause migrations, the sudden appearance of the animals in a given locality, their quick disappearance from another locality, and the like. In any group of animals the investigation must follow some such line as marked out above, in each case a study of the normal psychology of the animals being a prerequisite to an understanding of the laws of their migrations and other striking activities. Commencing at the beginning, a study of this nature was made on the Protozoa during the summer of 1898, the results of which are resumed in another paper, which deals with the Protozoa; it is hoped soon to extend this study to the Rotatoria. The psychology of the Rotatoria has been studied scarcely at all; notes as to the nature of the food and the method of taking it, together with descriptions of the method of forming the tube in some tube-dwelling species, being the chief matters that can be gleaned from the literature.

The only way in which the problems above characterized can be solved, the relations of the Rotifers (or of any other group) to their environment worked out, is for investigators to choose definite limited problems for solution and devote time and energy to observation and experimentation till the questions proposed are answered. Mere isolated observations, collected during a systematic study of the group, can do little; investigators must take up the work in the same spirit in which morphological problems are attacked, concentrating all efforts upon a given point until that is settled. The activities of animals are as worthy of such study as are their structures. Until a large amount of investigation has been done it will not be possible to give any

satisfactory discussion of the place occupied by the Rotatoria in the life system of the lake. In this paper it is only attempted to point out here and there problems that await settlement at the hands of careful investigators.

The paper is, therefore, purely preliminary in character, aiming to show merely what species have thus far been recognized in the United States and where they are found, as well as giving descriptions and figures of some species that are in need of study. Future reports need not take the shape of a formal list, but will give accounts of special studies in any line or record additions to the fauna. Formal lists of species are perhaps the most uninteresting of scientific writings, yet they form a disagreeable necessity as a basis for further work. An ideal list is such a one as that given by Weber ('98) of the Rotatoria of the basin of Lake Geneva, every name accompanied by a beautiful figure of the animal. The short time spent on the work thus far has rendered this impossible for the Rotatoria of the Great Lakes. Most of the figures must be reserved for the future development of the work along this line. In the case of new species, or where there are other causes for special interest, figures are given in the present paper. These figures were drawn by Mrs. Louise Jennings from camera sketches made by the author.

The author has endeavored to avoid, as far as possible, the naming of new species. Since the publication of Hudson and Gosse's Monograph of the Rotifera, about ten years ago, study of this group has been very active, resulting in the multiplication of papers on the subject, often without relation to one another, and describing the same forms under different names. A certain amount of this was perhaps inevitable at first, but heedless work has multiplied the resultant confusion many fold. No one has a right to cumber scientific literature with the names of species "presumably undescribed," as a recent paper naively puts it, without recognizing the fact that a vast volume of literature has appeared on the group since the publication of Hudson and Gosse's Monograph, including descriptions of many new species (295 up to 1897, according to Rousselet, '97). The recognition and description of a new species must therefore be regarded as a most laborious piece of work, involving a careful examination of large numbers of papers in various languages, besides a consultation of Hudson and Gosse. There is no excuse for omitting such a study before publishing descriptions of species as new, in view of the full lists of new rotifers published at intervals by Mr. Charles Rousselet ('93 and '97), with the titles of the papers in which the descriptions are published. If a student finds himself unable to see a large share of these papers it is his duty to recognize the fact that he is not in a position to publish names of new species. If he wishes to publish his notes and drawings, these may be of great use to other workers, but if he proceeds to append new names to his descriptions, increasing the already heavy burden of synonymy, his work becomes a positive injury to science and a nuisance to all careful scientific students. The record of American workers on the Rotifera has not always been so good in this matter as might be wished. In the American paper above referred to as giving names to "presumably undescribed" species, six so-called new species are figured on the plate, with new specific names in the descriptions. Of these six, four are easily recognizable as old friends by anyone familiar with the recent literature of the subject, while the other two are thought by another reviewer to be old species. This illustrates the value of the description of "presumably new" species without comparison with those described in recent papers. Science is burdened with four, perhaps six, new synonyms.

Another mistake to be avoided, as has been emphasized by Rousselet ('96), is the

making of new species because the observer finds some structure not previously figured or described in what would otherwise be considered an old species. It must be recognized that very few of the older figures and descriptions are in any sense complete; it was the purpose of many of the older authors to give merely such a figure and description as would lead to ready recognition of the animal, not to give an exhaustive anatomical account. Moreover, the improvements in optical instruments and in technique have been such as to enable even the amateur to see much that formerly remained hidden to the best investigators.

A third opportunity for the introduction of confusion into the study of the Rotatoria lies in the great variability of many forms. There are few species that are not sufficiently variable to permit an observer to find specimens that differ from the type enough to allow him to immortalize his name by appending it to a synonym, if his ambition runs in that direction. Rousselet ('97) has already pointed out that many of the recent new species are but slight variations of well-known forms. It must be recognized, however, that the limits of variability are not easily defined, and that it is often very difficult to say whether a given specimen should be considered a new species or a variation of an old one. Mistakes from this source are therefore to a certain extent excusable, while those resulting from the first two causes above mentioned are usually due to carelessness or ignorance.

To describe a new species, one should therefore have access to all the papers in which new species have been described since the publication of Hudson and Gosse's Monograph, or at least to all papers describing any species belonging to the genus under consideration. The titles of the papers bearing directly on the genus of which it is proposed to describe a new species may be determined—up to 1897, at least—from Mr. Charles Rousselet's lists of new species of Rotifera (Rousselet '93 and '97). As a further precaution against error, it would be well to submit either mounted specimens or drawings and notes on proposed new species before publication to someone thoroughly competent to judge as to their claims. Mr. Charles Rousselet, 2 Pembridge Crescent, Bayswater, London W., England, is doubtless as well acquainted with the Rotifera as anyone in the world, and is always willing, with uniform courtesy and kindness, to give expert advice as to the publication of what seem to be new species.

On account of the recent great multiplication of new species, a description of a new rotifer should be accompanied by a careful comparison with any other species of the same genus that at all nearly resemble it and the points of difference brought out clearly. In a number of recent cases the lack of ground for giving a new name would at once have been evident if this had been done. For example, Stenroos ('98) in his recent valuable paper on the animal life of Lake Nurmijärvi, in Finland, after describing as new *Cathypna magna* n. sp., gives a list of the known species of Cathypna, among them *Cathypna ungulata* Gosse. A careful comparison of *Cathypna magna* Stenroos with *Cathypna ungulata* Gosse would have disclosed their identity.

The publication of a new species without a figure, which has been practiced by some American authors, as well as by some of those of Europe, is greatly to be deprecated. Usually the figure is the most important part of the account of a rotifer, and a description could, as a rule, be much better dispensed with than a good figure.

To sum up, therefore, anyone who proposes to publish a description of a rotifer as new should fulfill the following conditions:

1. Not only Hudson and Gosse's Monograph, but all subsequent papers containing descriptions of rotifers in any way related to the one in hand, should be consulted.

2. New species should not be described as a result of the discovery of some hitherto unmentioned anatomical detail in an otherwise known species.

3. Great care should be exercised not to describe as new species mere variations of an old species.

4. If any doubt can possibly exist, the figures and descriptions should be submitted, before publishing, to some expert who has all the literature at hand.

5. A description of a new species should be accompanied by a detailed comparison with any very closely related species that may exist, to show wherein this one differs and why it is considered new.

6. Every description of a new species should be accompanied by a good figure or figures.

For the two cases in which it has seemed necessary to describe certain forms as new in the present paper, an attempt has been made to fulfill these conditions.

The subjoined list contains not only the species found by the author in Lake Erie, in the region of South Bass Island in the summer of 1898, but also, so far as known to the writer, all the species that have been found in the United States, together with the localities from which each species has been recorded. An attempt has been made to make this list as complete as possible, but the references to the Rotatoria are exceedingly scattered, so that I can not hope that none have been overlooked. Nevertheless it is believed that the omitted references are very few.

A brief review of the history of the study of the Rotatoria in this country may be of interest in this connection. The first recorded observation of any member of the group in America seems to be that of Bosc (1802), who observed some rotifer belonging to the *Philodinidæ* in Carolina. Ehrenberg in his great work ('38) held Bosc's animal to have been *Rotifer vulgaris*, while in a later paper (Ehrenberg, '43) he considers it to have been probably *Callidina rediviva* Ehr.

The next notice of American Rotatoria that I have been able to find is that by Ehrenberg ('43). He lists a few rotifers observed by him in material sent to him from this country by various men of science.

In 1855 Bailey ('55) described *Limnias annulatus* Bailey.

Schmarda ('59) in his trip around the world, 1853 to 1857, observed two rotifers "in brackish water near New Orleans."

From this time on, up to 1879, little notice of the Rotifera is to be found in American journals, save a few notes by Leidy ('51, '57, '74, and '74*b*) and one by Peirce ('75), in the Proceedings of the Academy of Natural Sciences of Philadelphia.

In 1879 the late Dr. D. S. Kellicott published his first note on the Rotifera, a description of *Notholca longispina* Kellicott. This was followed by many other papers on the group, up to the year before the death of this author in 1898. The decade from 1880 to 1890 was marked by numerous brief papers and notes on the group, by Kellicott, Herrick, Leidy, Attwood, Vorce, Forbes, Foulke, Stokes, Up de Graff, and others. The first formal list of American species was that of Herrick ('85) of rotifers found in Ohio and Minnesota, followed with one by Kellicott ('88) of rotifers found at Corunna, Mich.

In the decade now coming to an end, work on the group has been much increased, especially in connection with the founding of fresh-water biological stations. Extended local lists of species have been published by Turner ('92), the present writer ('94 and '96), Kellicott ('96 and '97), and Hempel ('98).

In the following list those species representing the author's investigations of Lake Erie during the summer of 1898 are numbered consecutively; those not observed here are not numbered. After each locality is given the name of the investigator who has recorded it, followed by numerals showing the year in which the publication took place. The exact reference may then be determined by turning to the list of literature at the end of the paper, where the authors' names are arranged alphabetically, and the papers of a given author are distinguished by prefixing to each the number of the year (in the century) in which it was published. In certain cases species are recorded in proceedings of societies as having been exhibited by some member of the society; in every such case the citation is given under the name of the member who made the exhibit. In some cases I have recorded here for the first time localities other than Lake Erie in which I have at some time observed a species; these localities are signed with my own initials (H. S. J.).

The region studied by the author during the summer of 1898 consisted of the waters about South Bass Island, especially the waters of the lake along the shore of the island. Naturally the waters in the immediate neighborhood of Put-in Bay were most carefully examined, since the laboratory was situated on the shore of this bay. Many excursions, however, were made to more distant regions. East Harbor, south of the island, on the northern shore of Ohio, furnished many of the rotifers. Others came from towings made in Lake Erie at a distance from shore. Two swamps on South Bass Island were carefully examined; one lies close to the United States fish-hatchery, while the other lies on the east shore of the island, just east of the village of Put-in Bay. The latter is referred to in the list as "East Swamp." The swamp near the fish-hatchery is connected with the lake by a channel about 50 feet long, and is situated at such a level that at times water flows from the lake into the swamp, while again it flows from the swamp into the lake; therefore, as might be expected, the limnetic rotifers of the lake sometimes occur in the swamp, while at other times the fauna of the swamp is of the most pronounced stagnant-water type. East Swamp has no connection with the lake.

The proper classification of the Rotatoria presents great difficulties. The system most in use is that of Hudson and Gosse, as given in their Monograph of the Rotifera. This classification is unsatisfactory in many ways, and what I consider a better one in many respects has recently been proposed by Lund ('99). After consideration it was decided, however, not to introduce this new classification into the present paper, as most workers on the group are now better acquainted with the classification given by Hudson and Gosse, so that the use of their system will best facilitate reference to the list. The sequence of orders, families, and genera adopted is therefore that of Hudson and Gosse, in the Monograph of the Rotifera published in 1889, with some modifications rendered absolutely necessary by more recent investigations.

A LIST OF ALL ROTATORIA HITHERTO FOUND IN THE UNITED STATES, AND THE LOCALITIES WHERE THEY HAVE BEEN OBSERVED, WITH DESCRIPTIONS OF TWO NEW SPECIES.

[Accompanied by plates 14–22, figs. 1–46.]

Order I. RHIZOTA.

Much less study has been given to the Rhizota, or attached Rotifera, by the present writer, than to the free-swimming forms, and the same seems to be true of other students of American Rotatoria. Doubtless much remains to be done before even an approximately full list of the American Rhizota can be given, and some of the forms already listed are sadly in need of careful study. There is much room for work in preparing full and accurate descriptions and figures of the American Rotifera of this group.

ıily 1. FLOSCULARIADÆ.

FLOSCULARIA Oken.

1. F. cornuta Dobie.

On *Elodea* from East Harbor, Lake Erie.

Pond near Bangor, Me. (J. C. S., '83). Nigger Creek, Grand Island, Niagara River (Kellicott, '87). Shiawassee River at Corunna, Mich. (Kellicott, '88). Chippewa Lake, Mecosta County, Mich., and Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie, and Buffalo, N. Y. (Kellicott, '96).

2. F. algicola Hudson.

On *Cladophora* and *Chara*, in East Swamp, South Bass Island.

The specimens found agreed perfectly with the description given by Hudson in the small size (210μ=0.01 inch in length), in the dots on the corona arranged in symmetrical patterns, and in other respects; but they inhabited evident tubes, while Hudson was unable to find a tube.

3. F. mutabilis Bolton.

This free-swimming form seems widely distributed in waters of the Great Lakes, although it is never present in large numbers. It was frequently taken with the tow net and plankton net in the open lake about South Bass Island, in Lake Erie. Also found in a swamp close to United States fish-hatchery on South Bass Island, at times when the water of the lake flowed into the swamp.

Lake St. Clair (Jennings, '94). Lake Michigan, Pine Lake, Round Lake, and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96).

4. F. pelagica Rousselet.

The distribution of *F. pelagica* is about the same as that of *F. mutabilis*. I found it in collections made with the tow net and plankton net in Lake Erie at various places near South Bass Island. It is noteworthy that neither of these limnetic *Floscularias* have been reported from the carefully studied waters of the Illinois River.

Lake St. Clair (Jennings, '94). Lake Michigan, Round Lake, and Pine Lake, near Charlevoix, Mich. (Jennings, '96).

5. F. millsii Kellicott.

A single specimen attached to a *Difflugia* shell, from the Portage River, Ohio, about a mile from Lake Erie.

Black Creek, Ontario, Canada (Kellicott, '85). Nigger Creek, Grand Island, Niagara River (Kellicott, '87). Sandusky Bay, Lake Erie (Kellicott, '97). Also found by Mr. J. B. Shearer at Bay City, Mich. (according to Kellicott, '97).

F. ornata Ehrenberg.—Pond near Bangor, Me. (J. C. S., '83). "American species" (Kellicott, '84). Minnesota (Herrick, '85). Nigger Creek, Grand Island, Niagara River (Kellicott, '87). Shiawassee River at Corunna, Mich. (Kellicott, '88). Exhibited in New York (Helm, '89 and '91). In the neighborhood of Cincinnati, Ohio (Turner, '92). Chippewa Lake, Mecosta County, Mich., and Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

F. campanulata Dobie.—Black Creek, Ontario, Canada (Kellicott, '85). Nigger Creek on Grand Island, Niagara River (Kellicott, '87). Shiawassee River at Corunna, Mich. (Kellicott, '88). West Twin Lake, Muskegon County, Mich.; McLaren Lake, Oceana County, Mich. (Jennings, '94). West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96).

F. edentata Collins.—McLaren Lake, Oceana County, Mich.; Chippewa Lake, Mecosta County, Mich.; Crooked Lake, Newaygo County, Mich. (Jennings, '94). Small pond at Cedar Point, Sandusky, Ohio (Kellicott, '97). Swamp near Norwich, Vt. (H. S. J.).

F. ambigua Hudson.—Shiawassee River, Corunna, Mich. (Kellicott, '84 and '88). Sandusky Bay, Lake Erie (Kellicott, '96).

F. coronetta Cubitt.—"American species" (Kellicott, '84). Shiawassee River at Corunna, Mich. (Kellicott, '88).

F. trilobata Collins.—Pond near Bangor, Me. (J. C. S., '83, under the name *F. trifolium*). Corunna, Mich. (Kellicott, '84, as *F. trifolium*).

F. regalis Hudson.—Found by Up de Graff at Elmira, N. Y. (according to Kellicott, '84).

Acyclus inquietus Leidy.—Schuylkill River, near Philadelphia (Leidy, '82).

APSILUS Metschnikoff.

(Plate 14, figs. 1 and 2.)

What seems to be the young free-swimming form of a species of this genus was found sparingly amid *Lemna, Spirodela,* and *Wolffia* in the swamp near the United States fish-hatchery, on South Bass Island, in July, 1898. It is not possible to determine the species of young specimens from the published descriptions of the members of this genus, because they deal entirely with the adult. In my paper of 1894 I assumed that this was *A. lentiformis* Metsch., that being the only species recognized as certainly well established by Hudson and Gosse. But if Stokes ('96c) is correct in his contention that four species of the genus are to be recognized, then this may belong to any of them. A thorough study of the animal was undertaken, but they disappeared before this was completed; I give my notes and drawings, however, so far as they go. A side view, accurate as far as it goes, but not showing all details, is given in fig. 1.

The body is thick and clumsy and slightly curved, so as to be convex dorsally and concave ventrally. It tapers slightly toward both ends, ending in a truncate fashion, at the anterior end in the head, at the posterior end in the broad disk which serves as a foot. The head is separated from the body dorsally by a slight depression, while ventrally the outline of the body continues uninterruptedly into the head. The posterior disk is marked off from the body by a broad shallow constriction. The animal is very transparent and entirely colorless, except for the two red eyes.

The ciliated face at the anterior end is slightly oblique, a non-ciliated part projecting above the ciliated portion. The cilia are rather long and seem to form a simple circle, but observations on this point are not complete. A large lobed brain lies behind the corona, bearing in front the two red eyes, in which crystalline lenses are clearly visible. The head may be extended considerably farther than is shown in the figure, or may be entirely retracted.

The body of the animal is filled with a bewildering confusion of glands, digestive organs, muscles, and nerve cords. Much of interest might be brought out by a minute study of these parts; I have seen no rotifer that appeared so favorable for a study especially of the muscular and nervous systems. The figure, accurate so far as it goes, gives an idea of the complex of details awaiting disentanglement. I shall not, in the absence of minute study, attempt to interpret the structures shown. The prominent trophi lie, as in other members of this genus, at the bottom of a large sac; they are of the peculiar form characteristic of the genus. They are shown in fig. 2, plate 14.

The body wall seems much more complex than is usually the case in the Rotifera. It appears to be possible to distinguish four layers, beginning with the outside: (1) A thin cuticula; (2) a thick, gelatinous cellular layer; (3) a layer of transverse muscles; (4) a layer of longitudinal muscles. The two muscular layers are not completely separated, and some of the longitudinal muscles traverse the body cavity, but in a general way the distinction into two layers is evident. The posterior disk is retractile into a sort of mantle which partly covers it, and the whole, mantle and all, may be drawn within the body. The disk is concave, with lines radiating from the deeper central portion, and is ciliated. The movements of the animal much resemble those of Asplanchna.

Lund ('99) holds that *Apsilus* should be removed from the *Flosculariadæ* and placed in a separate family near the *Asplanchnadæ*.

The present author ('94) recorded this same form from Lake St. Clair as *A. lentiformis* Metsch.

A. vorax Leidy.—Schuylkill River and Fairmount Park, Philadelphia (Leidy, '57, '82, and '84).

A. bipera Foulke.—Fairmount Park, Philadelphia (Foulke, '84). Pool at Trenton, N. J. (Stokes, '96c). Sandusky Bay, Lake Erie (Kellicott, '97).

A. bucinedax Forbes.—In an aquarium at Normal, Ill. (Forbes, '82). Pool at Trenton, N. J. (Stokes, '96c).

A. lentiformis Metsch.—In Phipps Conservatory tanks at Allegheny, Pa. (Logan, '95).

Stephanoceros eichhornii Ehrenberg.—Philadelphia ? (Peirce, '75). Bangor, Me. (J. C. S., '83). Ponds in New Jersey (Balen, '83 and '85). Found by E. B. Grove in Rogers Glen, Oneida, N. Y., by W. R. Cross at Camden, Me., and by C. F. Park near Poughkeepsie, N. Y., according to Balen ('83). In Canada, across from Buffalo, N. Y. (Kellicott, '84). Pittsburg, Pa. (Mellor, '89). Exhibited in New York (Cox, '89, and Helm, '97). McLaren Lake, Oceana County, Mich., and Horsehead Lake, Mecosta County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '97).

Family 2. MELICERTADÆ.

MELICERTA Schrank.

6. M. conifera Hudson.

East Swamp, South Bass Island, on *Characeæ*.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96).

M. ringens Schrank.—Niagara River (Fell, '82). Bangor, Me. (J. C. S., '83). New Jersey (Balen, '85). Shiawassee River at Corunna, Mich. (Kellicott, '88). Exhibited in New York (Helm, '89, and Walker, '94). Exhibited in San Francisco (Breckenfeld, '89). Lake St. Clair and West Twin Lake, Muskegon County, Mich. (Jennings, '94). Phipps Conservatory tanks at Allegheny, Pa. (Logan, '95). Susan Lake, North Michigan (Jennings, '96). Black Channel, Sandusky Bay, Lake Erie (Kellicott, '97).

M. janus Hudson.—In the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Horsehead Lake, Mecosta County; Chippewa Lake, Mecosta County (Jennings, '94). Mr. John Hood has recently called my attention to the fact that the *Melicerta flocculosa*, described (without a figure) by Kellicott ('96), from Sandusky Bay, resembles in almost, if not quite, every respect *M. janus*, except in the possession of a tube without pellets. Now, Mr. Hood finds *M. janus* in Scotland inhabiting tubes without pellets, so that there is a strong probability that he is right in believing Kellicott's *M. flocculosa* to be really *M. janus*. Kellicott's description of *M. flocculosa* is so meager that it is difficult to find facts upon which to base a positive opinion; the only point in the description of *M. flocculosa* which might be held not to coincide with that of *M. janus* is that Kellicott says the chin is spatulate, whereas in Hudson's description the chin is said to be two-pointed. It will probably be best to consider *M. flocculosa*, at least provisionally, as a synonym of *M. janus*.

M. tubicolaria Ehr.—Exhibited in New York (Helm, '89). Sandusky Bay, Lake Erie (Kellicott, '97).

M. flocculosa Kellicott.—See *M. janus*.

Limnias ceratophylli Schrank.—"Abundant in our rivers" (Leidy, '74). Pond near Bangor, Me. (J. C. S., '83). Shiawassee River at Corunna, Mich. (Kellicott, '88.) Sandusky Bay, Lake Erie, and Niagara River (Kellicott, '96). Exhibited in New York (Helm, '97). Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

L. shiawasseensis Kellicott.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96).

L. annulatus Bailey.—West Point, N. Y. (Bailey, '55). Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96).

L. socialis Leidy = *L. ceratophylli* Schrank.

Cephalosiphon limnias Ehrenberg.—Along shore of Niagara River (Mills, '81). Buffalo, N. Y., and Shiawassee River Michigan (Kellicott, '87). Corunna, Mich. (Kellicott, '88). Olentangy Creek at Columbus, Ohio (Kellicott, '89). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

C. candidus Hudson.—Olentangy Creek, Columbus, Ohio (Kellicott, '89).

C. furcillatus Kellicott = *Œcistes melicerta* Ehrenberg.

Œcistes melicerta Ehrenberg.—Olentangy Creek at Columbus, Ohio (Kellicott, '89, under the name *Cephalosiphon furcillatus*). Swamp on the shore of Lake St. Clair (Jennings, '94). This species is represented by Stokes ('81, fig. 2) without a name, probably from New Jersey. The two dorsal hooks are developed in many specimens into two great branched antler-like structures, which are shown in plate 14, fig. 3. There seems to be no justification for the change of the specific name from *melicerta*, as given by Ehrenberg, to *ptygura*, as given by Hudson and Gosse.

O. longicornis Davis.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and McLaren Lake, Oceana County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Exhibited in New York (Helm, '97).

O. mucicola Kellicott.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96). West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

O. crystallinus Ehrenberg.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96).

O. umbella Hudson.—Sandusky Bay, Lake Erie (Kellicott, '97).

O. intermedius Davis.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Lacinularia socialis Ehr.—Exhibited in New York (Balen, '85; Damon, '86 and '88). Shiawassee River at Corunna, Mich. (Kellicott, '88). Pond near Norris Pass, on the Shoshone Trail, Yellowstone Park (Forbes, '93). Sandusky Bay, Lake Erie (Kellicott, '96). West Twin Lake near Charlevoix, Mich. (Jennings, '96). Much less common than *Megalotrocha alboflavicans*. It seems probable that the latter is often mistaken for it.

MEGALOTROCHA Ehrenberg.

7. M. alboflavicans Ehrenberg.

Very abundant on *Chara* in East Swamp, South Bass Island.

Along shore of Niagara River (Mills, '81, under name *M. flavicans*). Schuylkill River, Pennsylvania (Leidy, '82, under name *M. alba*). Pond near Bangor, Me. (J. C. S., '83). Exhibited in New York (Helm, '94). Lake St. Clair; Mona Lake, Muskegon County, Mich., and Horsehead Lake, Mecosta County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

M. semibullata Hudson.—Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

TROCHOSPHÆRA Semper.

8. T. solstitialis Thorpe.

Swamp near United States fish-hatchery, South Bass Island, in August, 1898.

The genus *Trochosphæra* was instituted by Semper in 1872 (*Zeitschr. f. wiss. Zool.*, Bd. 22, p. 311) for the remarkable rotifer *Trochosphæra equatorialis* Semper, found by that author in the Philippine Islands. *Trochosphæra equatorialis*, as is well known, is a spherical rotifer, with a girdle of cilia dividing the surface of the sphere into two hemispheres. It approaches closely, in many respects, to the structure of the Trochophora larva of annelids and mollusks, and great importance has been attached to it as the nearest representative of the hypothetical ancestor of those groups. *Trochosphæra* seems not to have been seen again until found by Surgeon V. Gunson Thorpe, of the English Navy, in 1889, at Brisbane, Australia. In 1892 the same investigator discovered in China a second species of the same genus, differing from *T. equatorialis* in that the ciliary girdle passes not around the middle of the sphere, but nearer one pole, like the tropic of Cancer around the earth. To this species Thorpe ('93) gave the appropriate specific name *solstitialis*. Much interest was aroused when in 1896 (Science, Dec. 25, 1896) Kofoid announced the discovery of *T. solstitialis* Thorpe in the Illinois River and waters connected therewith near Havana, Ill. Kofoid raised the question whether its presence in America was due to recent importation from China, or whether it is to be considered a native American form. Its occurrence at a station so distant from that recorded by Kofoid, on a small island in Lake Erie, seems to indicate that the latter alternative is probably correct. It is not unlikely that *Trochosphæra* will be found to be widely distributed in America when proper search for it is made.

The swamp in which *Trochosphæra* occurred at Put-in Bay has over its bottom a dense growth of *Ceratophyllum*, while the surface is completely covered with a mantle of plant material consisting of *Lemna, Spirodela*, and *Wolffia* intermixed. It is connected with the lake by a narrow short channel, and is situated at such a level that when the lake is high it receives water from the lake, while under the usual conditions water flows out of the swamp into the lake. Many of the Rotifera in the swamp are common to it and to the lake, while a number were found in the swamp alone; among the latter was *Trochosphæra*. The animal was never abundant, only a few individuals being obtained, and it was found for only a few days in August.

Waters connected with the Illinois River at Havana, Ill. (Kofoid, '96, and Hempel, '98).

CONOCHILUS Ehrenberg.

9. C. unicornis Rousselet.

Common in surface towings and plankton hauls from Lake Erie in the region of South Bass Island and from East Harbor.

Lewis Lake and Yellowstone Lake in the Yellowstone Park (Forbes, '93, under the name *C. leptopus* Forbes). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

C. volvox Ehrenberg.—Water from Plainfield, N. J. (Hitchcock, '81 *b*). Bangor, Me. (J. C. S., '83). Exhibited in New York (Balen, '85, Helm, '89, and Walker, '94). Quincy Bay, Mississippi River, Illi-

nois (Garman, '90, p. 182). Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Van Cortlandt Lake, New York City (Helm, '97).

C. dossuarius Hudson.—Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

C. leptopus Forbes=*C. unicornis* Rousselet.

"*Apœcia amelia.*"—In the Journal of the New York Microscopical Society, vol. 13, 1897, on p. 15, among the "objects exhibited" occurs the following: "Rotifer, *Apœcia amelia*, living, from New Jersey, by Frederick Kato." Further on occurs the following: "Mr. Walker said of Mr. Kato's rotifer, that it is mentioned in Trans. Acad. Nat. Sci. of Phil., and is the same as Mr. A. D. Balen's rotifer of "pond 61," 2½ miles from Westfield, N. J." I have not been able to discover any reference to a rotifer with this generic or specific name elsewhere, though I myself and others have searched carefully through the publications of the Philadelphia Academy for an account of the animal. Through the kindness of Dr. Emily G. Hunt, however, I am able to present the following facts: The rotifer was discovered by Dr. W. Gibbons Hunt, of Philadelphia, about twenty years ago, on the under side of partially decayed water-lily leaves, in a lake in New Jersey. "It was a very large and unusually beautiful rotifer, existing in colonies, the individuals of which had the tails all attached to one common point and radiated out on all sides in a sphere, the whole embedded in a clear jelly." Dr. Hunt named the rotifer *Apœcia amilia*, and is supposed to have published somewhere a description of the new genus and species thus founded; this description, if it exists, it seems impossible now to trace. From the above description it is apparent that the animal belonged to the Rhizota.

Order II. BDELLOIDA.

Family 3. PHILODINADÆ.

PHILODINA Ehrenberg.

10. P. roseola Ehrenberg.

One of the commonest of the Rotifera; abundant among the plants of the bottom of Lake Erie in the region studied. This rotifer was one of the few species found in the small landlocked pools on the rocky surface of Starve Island, just south of South Bass Island.

Pond near Bangor, Me. (J. C. S., '83). Shiawassee River at Corunna, Mich. (Kellicott, '88). Pools in the neighborhood of Cincinnati, Ohio (Turner, '92). Lake St. Clair and the following inland lakes of Michigan: White Lake, Muskegon County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). In old channel connecting Round Lake and Pine Lake, near Charlevoix, Mich. (Jennings, '96).

11. P. citrina Ehrenberg.

Bottom of Put-in Bay Harbor and East Harbor, Lake Erie; also in the swamp near the fish-hatchery on South Bass Island.

Lake St. Clair and the following inland lakes of Michigan: White Lake, Muskegon County; McLaren Lake, Oceana County, and Crooked Lake, Newaygo County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Trenton, N. J.? (Stokes, '96*a*). Round Lake and swamp on the shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Common in pools, Hanover, N. H. (H. S. J.).

12. P. megalotrocha Ehrenberg.

Common in bottom vegetation of Lake Erie in the region of South Bass Island. Also from East Harbor and the small pools on Starve Island.

Pool in the neighborhood of Cincinnati, Ohio (Turner, '92). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Pine Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

13. P. aculeata Ehrenberg.

Swamp near United States fish-hatchery, South Bass Island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and McLaren Lake, Oceana County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Trenton, N. J. (Stokes, '96*a*). Tamarack swamp on shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Apparently the species described by Stokes ('81), as "*Philodina* n. sp.?."

P. macrostyla Ehrenberg.—Lake St. Clair (Jennings, '94). Bottom of Lake Michigan, and pool on the shore of Pine Lake at Charlevoix, Mich. (Jennings, '96). I have lately found it in some *Utricularia* sent from Norfolk, Va. Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

ROTIFER Schrank.

14. R. vulgaris Schrank.

Common among the plants of the bottom of Lake Erie about South Bass Island and in East Harbor; also from the two swamps on the island.

In dirt from the crevices of pavements of Philadelphia (Leidy, '74 *b*). Summit of Roan Mountain, North Carolina (Leidy, '80). Lake Erie (Vorce, '82). Pond near Bangor, Me. (J. C. S., '83). Exhibited in New York (Mitchell, '86, Helm, '89). Shiawassee River at Corunna, Mich. (Kellicott, '88). Pools near Cincinnati, Ohio (Turner, '92). Lake St. Clair and various inland lakes of Michigan (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Pine Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Hanover, N. H. (H. S. J.).

15. R. tardus Ehrenberg.

Abundant in the swamps on South Bass Island and in East Harbor, Lake Erie; also in Portage River, Ohio. The specimens found in this region had the spurs much shorter and thicker than are figured by Hudson and Gosse ('89) and Janson ('93). In every other respect, however, it was exactly Ehrenberg's *R. tardus*. I have since seen at Hanover, N. H., specimens having the long narrow spurs figured by Gosse and Janson.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Pool on the shore of Pine Lake at Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

R. macroceros Gosse.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96).

R. elongatus Weber.—Bogs, Corunna, Mich. (Kellicott, '92). Bottom of Lake Michigan in the neighborhood of Charlevoix, Mich. (Jennings, '96).

R. trisecatus Weber.—Lake St. Clair and pools on shore of Pine Lake near Charlevoix, Mich. (Jennings, '94 and '96).

R. mento Anderson.—Lake St. Clair (Jennings, '94).

R. neptunius Ehrenberg.—Pittsburg, Pa. (Mellor, '88). Lake St. Clair (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

R. macrurus Schrank.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with Illinois River at Havana, Ill. (Hempel, '98). Very abundant in water from a ditch at Hanover, N. H. (H. S. J.).

Callidina papillosa Thompson. Swamp on shore of Pine Lake near Charlevoix, Mich. (Jennings, '96).

C. constricta Duj.—With the last (Jennings, '96).

C. magna Plate.—With the last (Jennings, '96).

C. musculosa Milne.—Bottom of Lake Michigan near Charlevoix, Mich. (Jennings, '96).

C. eremita Bryce.—Swamp 5 miles from Norwich, Vt. (H. S. J.).

C. elegans Ehrenberg.—Doubtfully reported by Kellicott ('96) from Sandusky Bay, Lake Erie. Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

C. socialis Kellicott.—On the larva of *Psephenus lecontei*, Shiawassee River at Corunna, Mich. (Kellicott, '88).

C. rediviva Ehrenberg?—North Carolina, Bosc. (See Ehrenberg, '43.)

Family 4. ADINETADÆ.

Adineta vaga Davis.—Tamarack swamp, on shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96).

Order III. PLOIMA.

Sub-Order ILLORICATA.

Family 5. MICROCODONTIDÆ.

Microcodon clavus Ehrenberg.—Pond near Bangor, Me. (J. C. S., '83). Crooked Lake, Newaygo County, Mich. (Jennings, '94). West Twin Lake, near Charlevoix, Mich. (Jennings, '96).

Microcodides orbiculodiscus Thorpe.—Lake St. Clair (Jennings, '94). Pool on shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Pond in sand on shore of Sandusky Bay, Sandusky, Ohio (Kellicott, '97, under the name *M. dubius* Bergendal).

Family 6. ASPLANCHNADÆ.

ASPLANCHNA Gosse.

16. A. priodonta Gosse.

In towings from Lake Erie. Not abundant.

Pond in Buffalo City Park (Kellicott, '87). Abundant in Lake St. Clair (Jennings, '94). Lake Michigan, Round Lake, and Pine Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. herrickii de Guerne.—It is characteristic of the poorness of the plankton in Rotifera, in Lake Erie, about South Bass Island, that *Asplanchna herrickii* was not found there at all in the summer of 1898, and that *A. priodonta* was not abundant. In previous examinations of Lake St. Clair and Lake Michigan both had been found very abundant. This species was first figured by Herrick ('84, plate v, fig. 8) from Minnesota, under the title "flask-shaped rotifer, hermaphrodite, with eggs and sperm." Other localities where it has since been found in America are as follows: Lake St. Clair (Jennings, '94); Lake Michigan, Round Lake, Pine Lake, and Susan Lake, in north Michigan (Jennings, '96); waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. brightwellii Gosse.—Neighborhood of Cincinnati, Ohio (Turner, '92, under the name *A. cincinnatiensis* Turner). Phipps Conservatory tanks at Allegheny, Pa. (Smiley, '95). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. ebbesbornii Hudson.—Pond near Philadelphia (Leidy, '87). Waters connected with the Illinois River, at Havana, Ill. (Hempel, '98).

A. girodi de Guerne.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. amphora Hudson.—Found at Philadelphia by Leidy, according to Hudson and Gosse, '89 (Supplement, p. 13).

A. cincinnatiensis Turner = *A. brightwellii* Gosse.

A. magnificus Herrick = *Asplanchnopus myrmeleo* Ehr.

ASPLANCHNOPUS De Guerne.

17. A. myrmeleo Ehrenberg.

East Swamp, South Bass Island. Many.

Minnesota (Herrick, '84, under the title "deadly enemy to Chydorus," and '85, under the name *Asplanchna magnificus* n. sp.). Pine Lake and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Marshes in the region of Sandusky, Ohio (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Ascomorpha ecaudis Perty (*Sacculus viridis* Gosse).—Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and Whitmore Lake, near Ann Arbor, Mich. (Jennings, '94). Round Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

There seems to be some question as to the proper specific name of this animal. According to de Guerne ('88) Perty's name *ecaudis* has the priority, dating from 1850. But Weber, '98, in his recent very careful paper, uses the name *helvetica*, likewise credited to Perty, without giving the date of this name, though he cites also the name *ecaudis* as a synonym. Perty's papers have not been at my command in order to settle the uncertainty.

A. hyalina Kellicott.—Pool at Corunna, Mich. (Kellicott, '88). Lake St. Clair and Whitmore Lake, Mich. (Jennings, '94). West Twin Lake, near Charlevoix, Mich. (Jennings, '96).

A. orbicularis Kellicott.—"Biemüllers Cove," Sandusky Bay, Lake Erie (Kellicott, '97). Weber ('98) holds that this species was described from contracted examples of *Gastropus stylifer* Imhof (*Notops pygmæus* Calman). This appears not improbable.

HERTWIGIA Plate.

18. H. parasita Ehrenberg.

In *Volvox* from East Swamp, South Bass Island.

A rotifer parasitic in *Volvox*, and therefore doubtless this species, has been recorded from Paterson, N. J. (N. N., '75), and from Hyde Park, Chicago, Ill. (Attwood, '78). It has also been recorded by name from Sandusky Bay, Lake Erie, and Minerva Park, Columbus, Ohio (Kellicott, '97). I have also found it in the reservoir of the town water supply of Hanover, N. H. (H. S. J.). Though often placed with the *Notommatadæ*, the opinion expressed by many authors that this creature is more nearly related to *Ascomorpha* is probably correct, so that it seems best to place it here in close juxtaposition with that genus.

Family 7. SYNCHÆTADÆ.

SYNCHÆTA Ehrenberg.

19. S. stylata Wierzejski.

Rather rare in the harbor of Put-in Bay, Lake Erie. Few in the swamp near the fish-hatchery on South Bass Island at times when the lake water has poured into the swamp.

Lake St. Clair (Jennings, '94). Lake Michigan, Round Lake, Pine Lake, and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

S. pectinata Ehrenberg.—Pond near Bangor, Me. (J. C. S., '83). Whitmore Lake, Washtenaw County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

S. tremula Ehrenberg?—Doubtfully reported by Kellicott ('97) in marsh water in the neighborhood of Sandusky, Ohio.

Family 8. TRIARTHRADÆ.

POLYARTHRA Ehrenberg.

20. P. platyptera Ehrenberg.

One of the commonest of the Rotatoria. Abundant in surface and bottom towings and in collections of plants from the bottom of Lake Erie in the region of South Bass Island, and from East Harbor. Also in the two swamps on South Bass Island.

Lake Erie (Vorce, '82). Near Minneapolis, Minn. (Herrick, '85). Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair; Chippewa Lake, Mecosta County, Mich.; Whitmore Lake, Washtenaw County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Lake Michigan, Round Lake, Pine Lake, and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

P. platyptera var. *euryptera* Wierzejski.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Anarthra aptera Hood.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

TRIARTHRA Ehrenberg.

21. T. longiseta Ehrenberg.

Swamp near United States fish-hatchery on South Bass Island. Few.

Water from Lake Erie at Sandusky, Ohio (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Pedetes saltator Gosse.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Family 9. HYDATINADÆ.

Hydatina senta Ehrenberg.—This large and interesting rotifer is said to be common in Europe, but in all the waters which I have examined for rotifers in this country *Hydatina* has been conspicuously absent. But it has been reported by Kellicott ('88) from the Shiawassee River at Corunna, Mich., and by Hempel ('98) from waters connected with the Illinois River at Havana, Ill.

NOTOPS Hudson.

22. N. clavulatus Ehrenberg.

Numerous at times in the swamp near the United States fish-hatchery on South Bass Island, in company with *Trochosphæra solstitialis*. Also in East Swamp.

There seem to be no very exact figures of the ciliary apparatus of this species; for the sake of comparison with *Notops pelagicus* n. sp. (see the next) I have made a study of it and present herewith a figure (plate 15, fig. 10). The corona of *Notops clavulatus* consists of the following parts: A circle of large cilia extends around the circumference of the head, interrupted (if at all) only at the mouth on the ventral side. The ventral half of this crown of cilia approaches a semicircle in form, but laterally there is a notch on each side, and the dorsal half is much less regular. Within this outer coronal wreath are three large styligerous prominences surrounding the buccal funnel, corresponding with the three prominences of *N. pelagicus*, and doubtless also with those of *N. brachionus*. The dorsal one of the three prominences is smaller than in *N. pelagicus*, and bears six long styles sheathed at the base, of the sort described and figured by Hudson and Gosse as occurring in *N. brachionus*. The two

lateral prominences bear ten (or sometimes nine?) similar styles. To right and left of the dorsal median prominence are two small bundles of very slender bristles. These take the place of the two large single styles in *N. pelagicus*. As is well known, such large single styles are often formed of cilia or small styles united in bundles; this is probably the case in *N. pelagicus*, so that it is not surprising to find a large style in the one species corresponding to a bundle of small styles in the other. The buccal funnel descends directly from the lateral styligerous prominences; on its lateral walls are two elevations, each bearing five styles that project horizontally across the furrow through which the food passes. These correspond exactly with the two elevations in the buccal funnel of *N. pelagicus* (fig. 8) and with those described by Hudson and Gosse for *N. brachionus*.

Thorpe ('93) has described as a new species *Notops lotos*, from China; the only difference between this and *N. clavulatus* is that the former has but three styligerous prominences on the corona, whereas Hudson says that "*N. clavulatus* has a greater number of styligerous lobes" than *N. brachionus*, which he says has three (Hudson and Gosse, '89, vol. II, p. 12). Hudson's figure shows in *N. clavulatus* some six or seven or more of such lobes (vol. I, plate XV, fig. 3). But it is difficult to say how exact Hudson's figure was meant to be in this respect. From the figure it is not possible to say which structures represent styligerous prominences and which parts of the outer ciliary wreath, and the impression is given that the exact number and position of the prominences was not clear in the mind of the author. Such being the case, it has seemed most probable to me that my specimens are *N. clavulatus*, though but three large and two small "styligerous prominences" exist. Moreover, the two small prominences to right and left of the median one are very easily overlooked, and it seems to me possible that they were thus overlooked by Thorpe, and that his specimens were also *N. clavulatus*. Some exact information as to the corona of the typical *N. clavulatus* of Europe would be a valuable contribution from some of the European workers in this field. It is possible that such information may show that our form should be given Thorpe's new name *Notops lotos*, but I think this highly improbable. In case this should turn out to be *N. lotos* Thorpe, it is worthy of remark that it was found here, as Thorpe found it in China, along with *Trochosphæra solstitialis*.

23. N. pelagicus n. sp. (Plate 15, figs. 7, 8, and 9.)

This interesting new member of the limnetic fauna of Lake Erie occurred rather sparingly in surface and bottom towings and plankton hauls from parts of Lake Erie in the neighborhood of the group of islands about Put-in Bay.

On the first examination of this rotifer the generic affinities are puzzling. It has in many respects the general aspect of a *Brachionus*, seeming, like *N. brachionus*, to form a connecting link between the genera *Notops* and *Brachionus*. Its closest affinities are apparently with *Notops brachionus* Ehr., but with its partially loricated body it seems to resemble very closely also the *Brachionus mollis* of Hempel ('96). Through the kindness of Dr. C. A. Kofoid, superintendent of the Illinois Biological Station, I have been able to examine the type specimens of *Brachionus mollis*. While the resemblance between the two is striking, Hempel's species is clearly a *Brachionus*, while this is as evidently a *Notops*. The body is thick and clumsy, the dorsal surface rising in a regular arch from both ends to the middle (as seen in side view), the ventral surface nearly flat, but its posterior third sloping upward to join the dorsal surface (fig. 7). A ventral view shows a broad surface, widest some distance from the rear, thence narrowing suddenly backward to a blunt point (fig. 8). The coronal surface is so prone as to seem to form an almost direct continuation of the surface of the body. A short unringed foot with two inconspicuous toes completes the animal posteriorly.

The integument is thickened to form a partial lorica, much as in *N. hyptopus* Ehr., to judge from the account given by Hudson and Gosse. In front the loricate nature of the integument is extremely evident, the dorsal edge having even four short teeth, as in species of *Brachionus* or *Anuræa*, while at the junction of the dorsal and ventral parts of the lorica there are in front two marked teeth or angles. The anterior ventral edge is nearly smooth, there being merely a rounded notch at its middle point. The corona can be partly withdrawn within the lorica, giving exactly the appearance of an *Anuræa* or *Brachionus*, with partly retracted corona—the edges of the lorica with its teeth standing out sharp and clear. Over the remainder of the animal the integument is merely stiffened, much as in some of the large species of *Diglena*, forming thus certain permanent folds. A pair of such folds extends backward from the head on either side, separating the lorica into dorsal and ventral portions (fig. 7). Just in front of the base of the foot a transverse fold passes across from one lateral fold to the other (fig. 8), seeming to set a posterior limit to the ventral plate. Yet the entire lorica, if it is to be so called, is pliable, not forming an unyielding shell as in the typically loricate Rotifera, and especially is the posterior region soft and yielding, so that there is no sheath or any indication of lorica about the place of attachment of the foot. Above the foot the body projects backward in a

thick point (fig. 7), yet this is comparable in texture merely to the "tail" of *Copeus pachyurus*, rather than to a projection of the lorica, such as occurs in a *Brachionus*.

A little above the two lateral longitudinal folds above mentioned there is a broad longitudinal depression, above which the arched dorsal part of the body is much less in width than the ventral part. This depression is indicated by a strip of deeper shading along the side in fig. 7.

The corona (fig. 8), is of the typical *Notops* character, resembling in all essential details that of *N. clavulatus*, just described, and in many respects very closely that of *N. brachionus*, as figured by Western ('90). A nearly circular outer ciliary wreath is interrupted on each side by an ear-like unciliated projection, with a deep notch in front of it; there is also a short ventral unciliated region. Within this wreath are three curved styligerous prominences about the buccal funnel; these correspond in position to the three main prominences in *N. clavulatus* and, I should judge, to the middle dorsal and the two ventral prominences shown by Western ('90) in *N. brachionus*. The exact number of styles on each of these prominences was not noted, so that the figure does not attempt to be accurate on that point. At the side of the middle prominence, between it and the lateral prominences, are two thick styles or antennæ, taking the place of the two bunches of small cilia to right and left of the middle prominence in *N. clavulatus*. The ciliated buccal funnel descends from within the three prominences; some distance within there are on the sides two small elevations, each with a number of stiff setæ extending transversely across the buccal groove, exactly as in *N. clavulatus*. As previously mentioned, the coronal surface is very nearly a direct continuation of the ventral surface of the animal, so that a ventral view permits a thorough study of the corona. A thick dorsal antenna projects from a notch in the anterior dorsal margin of the lorica, exactly as in *Brachionus*. Lateral antennæ were not observed.

The foot is short and thick, and is quite without annulations. It is scarcely at all extensible, varying little in length, so far as observed. The two toes are very inconspicuous, at times retracted, so as to be quite invisible. Each ends in a minute tube, through which at times a thick mucus is exuded, by means of which the animal adheres to objects with which it comes in contact. A broad canal can be traced from each toe to a group of small glands at the base of the foot. The trophi (fig. 9) are malleate, agreeing in all essentials with those of *N. clavulatus* as figured by Wierzejski ('93) and Gosse ('56). Each uncus contains five broad blunt teeth. On each side of the mastax, situated apparently in some portion of the alimentary canal, there is—in many specimens at least—a bright red spot, the two making almost the appearance of eyes. The large brain, triangular in side view, carries at its posterior dorsal point the single large red eye. The other internal organs were not studied.

The egg is carried by the mother, attached just above the base of the foot, in exactly the position in which a *Brachionus* carries its eggs.

Notops pelagicus feeds upon the unicellular algæ which float in the clear waters of the lake and form the primary food supply of almost all the water organisms. Thus, if we consider the organisms of the lake as forming a chain, of which these unicellular algæ, deriving their sustenance directly from the inorganic constituents of the water, are the first link, while the highest carnivorous fish are the last, this rotifer forms a part of the second link, standing in relations of dependency only to the primal source of food supply.

Notops pelagicus is noteworthy for its bearing upon the classification of the Rotatoria. It seems to belong unquestionably to *Notops*, and to be more closely related to the soft-bodied members of that genus; yet it has an evident partial lorica. In spite of this lorica, it clearly does not belong at all with those loricate members of the (former) genus *Notops* that have recently been separated off by Weber ('98) as *Gastropus*. Its relations are not with *Gastropus stylifer*, *G. minor*, and *G. hyptopus*, but with *Notops clavulatus* and *N. brachionus*; at the same time, it is evidently related to the species of *Brachionus*. I believe with Lund ('99) that the Hydatinadæ are to be grouped naturally with the Brachionidæ, and that the softness or stiffness of the cuticula (upon which depends whether the animal is called loricate or illoricate) is a character of little significance in classification.

It is to be noted that in the two important papers that have appeared most recently on the Rotatoria, the species of the genus *Notops* have been divided in the same manner, but that the name *Notops* has been left with a different division in each case. Both Weber ('98) and Lund ('99) separate *Notops clavulatus* and *N. brachionus* on the one hand from *N. hyptopus*, *N. minor*, and *N. stylifer* (*pygmæus*) on the other. But while Weber leaves the name *Notops* to the former group, calling the others *Gastropus*, Lund gives the name *Notops* to the *hyptopus* group, relegating the others to *Hydatina*. I have followed Weber, for reasons given under the discussion of the genus *Gastropus*.

N. minor Rousselet; *N. pygmæus* Calman.—See *Gastropus*, under Loricata.

N. laurentinus Jennings.—See *Proales laurentinus* Jennings.

TRIPHYLUS Hudson.

24. T. lacustris Ehrenberg.

This rare and interesting rotifer occurred abundantly in East Swamp, South Bass Island, both the male and the female being found. Western ('92) gives a figure of the male of this species.

CYRTONIA Rousselet.

25. C. tuba Ehrenberg.

East Swamp, South Bass Island, abundant.

Trenton, N. J. (Stokes, '97, under name *Proules hyalina* n. sp.).

Family 10. NOTOMMATADÆ

Albertia naidis Bousfield.

Lake St. Clair (Jennings, '94).

It seems possible that the *Anelcodiscus pellucidus* described by Leidy ('51), from the intestine of *Stylaria fossularis* Leidy, in the neighborhood of Philadelphia, may have been a rotifer of this genus.

TAPHROCAMPA Gosse.

26. T. annulosa Gosse. (Plate 14, figs. 4, 5, and 6.)

Swampy parts of East Harbor, Lake Erie; common.

There is so much characteristic detail about the form and structure of this animal that is not brought out in the published figures, that I have thought it worth while to give some camera figures of specimens killed in extension. Fig. 4 gives a side view. The animal is here represented as curved more than other published figures show it, but in my experience this is about the form the living specimen usually has when moving along the bottom. On account of the fact that it is so curved, the entire body can not well be shown in a single dorsal view. Fig. 6 gives a dorsal view of the anterior three-fourths of body, while fig. 5 gives a corresponding view of the posterior three-fourths, showing the toes, with the broad tail above them. In regard to the internal anatomy, it needs to be said that the intestine does not open in the broad dorsal depression near the posterior end of the body, as Weber ('98) has represented it, but the opening lies just above the toes, beneath the tail. Mr. Gosse's statement in the monograph that the opening of the intestine is *beneath* the two toes is equally incorrect. This is perfectly clear in mounted specimens.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair, and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Channel between Round and Pine Lakes, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

27. T. saundersiæ Gosse.

Portage River, Ohio, among *Utricularia*.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair (Jennings, '94).

28. T. selenura Gosse.

East Harbor, Lake Erie and swamp near fish-hatchery on South Bass Island.

Lake St. Clair (Jennings, '94). Trenton, N. J. (Stokes, 96*a*).

T. clavigera Stokes.—Trenton, N. J. (Stokes, '96*b*).

PLEUROTROCHA Ehr.

29. P. parasitica n. sp. (Plate 16, figs. 13 and 14.)

Parasitic on the annelid *Nais lacustris*, from among plants of the bottom of Lake Erie about South Bass Island.

In waters connected with the Great Lakes I have several times noticed a *Pleurotrocha* attached by its jaws to the external surface of the small annelid *Nais lacustris*. The first one observed I thought I could identify with Ehrenberg's *P. constricta* (Jennings, '94, p. 14), but I have since been able to make a more careful study, with the result of showing that this identification is wrong, the body being much too short and broad. It resembles more nearly *P. gibba* Ehr., yet is clearly distinguished from that species by the much greater size of the toes, as well as by the totally different form of the body and head. It resembles no other of the recently described species of this genus, so that it is necessary to describe it as a new species. Ventral and side views of the animal are shown in plate 16, figs. 13 and 14.

Body very short and broad, oval in dorsal or ventral view. Head much narrower than body, tapering to the obliquely truncate corona, composed of a single wreath of cilia. Body truncate behind; from the lower side of the truncate surface rises the single joint forming the short foot. The two tapering toes are about as long as the body is thick at the posterior end; they stand some distance apart at base. The internal anatomy offers nothing especially noticeable save the lack of an eye, which is of course the character that places this form in the genus *Pleurotrocha*. Length, 110μ. Animal ectoparasitic on the annelid *Nais lacustris*.

Pool near Lake St. Clair (Jennings, '94, under the name *Pleurotrocha constricta* Ehr.).

NOTOMMATA Gosse.

30. N. aurita Ehrenberg.

Rare, among plants on bottom of Put-in Bay Harbor, Lake Erie.

Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

31. N. tripus Ehrenberg.

East Harbor, Lake Erie, in *Utricularia*.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and White Lake, Muskegon County, Mich. (Jennings, '94). Trenton, N. J. (Stokes, '96 *b*, under name *N. mirabilis* n. sp.). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Brook, Hanover, N. H. (H. S. J.).

32. N. truncata Jennings.

In *Naias* and *Chara*, bottom of Put-in Bay Harbor, Lake Erie.

Lake St. Clair (Jennings, '94). This species has recently been found by Stenroos ('98) in Finland.

N. brachyota Ehrenberg.—Lake St. Clair (Jennings, '94).

N. collaris Ehrenberg.—Lake St. Clair (Jennings, '94).

N. torulosa Duj.—Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

N. monopus Jennings.—Lake St. Clair (Jennings, '94). Lake Michigan, Round Lake, Pine Lake, West Twin Lake, and Susan Lake, near Charlevoix, Mich. (Jennings, '96).

N. vorax Stokes.—Trenton, N. J. (Stokes, '97). Sandusky Bay, Lake Erie (Kellicott, '97).

N. cyrtopus Gosse.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

N. mirabilis Stokes.=*N. tripus* Ehr.

N. lacinulata Ehrenberg., see *Diaschiza lacinulata* Ehrenberg.

COPEUS Gosse.

33. C. pachyurus Gosse.

Bottom of shallow parts of Lake Erie near Put-in Bay.

Tamarack swamp on the shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Reservoir of the water supply, Hanover, N. H. (H. S. J.).

C. labiatus Gosse.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair (Jennings, '94). Pine Lake, near Charlevoix, Mich. (Jennings, '96). Brook, Hanover, N. H. (H. S. J.).

C. ehrenbergii Gosse.—Sandusky Bay, Lake Erie (Kellicott, '97).

C. cerberus Gosse.—Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96).

C. quinquelobatus Stokes.—Trenton, N. J. (Stokes, 96c). I have found a *Copeus* at Hanover, N. H., having five lobes to the brain, but agreeing in every other particular with *C. pachyurus;* this also seems true of Stokes's *C. quinquelobatus*. But the specimens at Hanover occurred along with typical specimens of *C. pachyurus*, having but three lobes to the brain; moreover, the specimens with five lobes were a little larger than those with three lobes. I can not but think it probable that *C. pachyurus* develops another pair of lateral lobes on the brain as it becomes larger, and that the species *quinquelobatus* is founded on such specimens. This is rendered the more probable by the fact that in the specimens seen the development of the two lateral lobes varied greatly.

C. americanus Pell.—Locality not given by describer, but probably Highland Falls, N. Y. (Pell, '90).

PROALES Gosse.

34. P. sordida Gosse.

Bottom of Put-in Bay Harbor, Lake Erie.

Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96).

P. felis Ehrenberg.—Lake St. Clair (Jennings, '94).

P. werneckii Ehrenberg.—In *Vaucheria* from ponds along Paxton Creek, Harrisburg, Pa. (Wolle, '82 and '87). Lake St. Clair; rivulet at Ann Arbor, Mich. (Jennings, '94).

P. laurentinus Jennings.—Lake St. Clair (Jennings, '94, as *Notops laurentinus*). Channel between Round Lake and Pine Lake, and in West Twin Lake, near Charlevoix, Mich. (Jennings, '96).

P. decipiens Ehrenberg.—Sandusky Bay, Lake Erie (Kellicott, '96.)

P. gibba Ehrenberg.—Sandusky Bay, Lake Erie (Kellicott, '96).

P. algicola Kellicott.—Sandusky Bay, Lake Erie (Kellicott, '97).

P. hyalina Stokes = *Cyrtonia tuba* Ehr.

FURCULARIA Ehrenberg.

35. F. forficula Ehrenberg. (*F. trihamata* Stenroos, '98).

Very abundant in bottom and littoral vegetation of shallow parts of Lake Erie about South Bass Island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Chippewa Lake, Mecosta County; Round Lake, Mecosta County (Jennings, '94). Pine Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

36. F. longiseta Ehrenberg.

Common among water plants in East Harbor, Lake Erie.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: White Lake, Muskegon County; McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Pool on the shore of Pine Lake; West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Swamp near Norwich, Vt.; pond, Hanover, N. H. (H. S. J.).

37. F. semisetifera Glasscott.

In *Chara* from East Swamp, South Bass Island.

Hood ('95) holds that this species is identical with *Furcularia eva* of Gosse. My specimens did not have the large anterior dorsal hump which Gosse mentions in his description and figures prominently, so that I feel it necessary to accept Miss Glasscott's name, the specimens agreeing with her figures.

Pool on the shore of Pine Lake near Charlevoix, Mich. (Jennings, '96).

F. gracilis Ehrenberg.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair (Jennings, '94). Pool on the shore of Pine Lake near Charlevoix, Mich. (Jennings, '96).

F. gibba Ehrenberg.—Lake St. Clair; Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

F. micropus Gosse.—Pool on the shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96).

Triophthalmus dorsualis Ehrenberg.—Round Lake and Pine Lake, near Charlevoix, Mich. (Jennings, '96).

EOSPHORA Ehr.

38. E. aurita Ehrenberg.

East Swamp, South Bass Island; Portage River, Ohio.

Lake St. Clair (Jennings, '94). Round Lake, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

DIGLENA Ehr.

39. D. grandis Gosse.

Bottom vegetation of Lake Erie about South Bass Island and East Harbor.

Lake St. Clair (Jennings, '94). Old Channel and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

40. D. forcipata Ehrenberg.

In *Naias* from bottom of Put-in Bay Harbor and East Harbor, Lake Erie.

Lake St. Clair, and Chippewa Lake, Mecosta County, Mich.; Crooked Lake, Newaygo County, Mich. (Jennings, '94). Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97).

41. D. catellina Ehrenberg.

Bottom of Put-in Bay Harbor, Lake Erie; land-locked pools on Starve Island.

Round Lake, Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

42. D. biraphis Gosse.

Swamp near fish-hatchery, South Bass Island.

Lake St. Clair, and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

D. circinator Gosse.—Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

D. caudata Ehrenberg.—McLaren Lake, Oceana County, Mich. (Jennings, '94).

D. contorta Stokes.—Trenton, N. J. (Stokes, '97).

Distemma forficula Ehrenberg.—Pond near Bangor, Me. (J. C. S., '83).

Suborder LORICATA.

Family 11. RATTULIDÆ.

There is much confusion in regard to the identification of the species belonging to this family, so that I have thought it best to give figures of the species listed, so far as possible. The group is badly in need of a thorough revision.

MASTIGOCERCA Ehrenberg.

43. M. bicornis Ehrenberg. (Plate 17, fig. 15).

East Harbor, Lake Erie.

Pond near Bangor, Me. (J. C. S., '83). Lake St. Clair, and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Round Lake, and Pine Lake, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pools about Hanover, N. H. (H. S. J.).

44. M. carinata Ehrenberg. (Plate 18, fig. 19.)

East Harbor, Lake Erie; swamp near fish-hatchery on South Bass Island; Portage River, Ohio.

Pond near Bangor, Me. (J. C. S., '83). Shiawassee River, at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: West Twin Lake, Muskegon County; Crooked Lake, Newaygo County, and Chippewa Lake, Mecosta County (Jennings, '94). Lake Michigan, Round Lake, and Pine Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Common at Hanover, N. H. (H. S. J.).

45. M. elongata Gosse. (Plate 17, fig. 16.)

In *Utricularia* from Portage River, Ohio.

Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pools, Hanover, N. H. (H. S. J.).

46. M. bicuspes Pell. (Plate 16, figs. 11 and 12.)

In *Utricularia* from East Harbor, Lake Erie.

This form has recently been redescribed by Stokes ('97) as *M. spinigera* n. sp. As the description and figure of Pell ('90) seem not well known, I give figures of dorsal and lateral views. Like *M. lata*, this species has five sensory projections on the corona, as shown in the figures.

Highland Falls, N. Y.? (Pell, '90, locality not stated). Trenton, N. J. (Stokes, '97, under name *M. spinigera* n. sp.).

47. M. mucosa Stokes. (Plate 17, fig. 18.)

One of the most abundant of the Rotifera among the vegetation of the shallow parts of Lake Erie about South Bass Island.

This is the two-keeled species mentioned without identification in my first paper on the Rotifera ('94), as being abundant in various lakes; it has since been described by Stokes under the above name. It differs from *M. bicristata* Gosse (fig. 17) in its shorter thicker body, and in the fact that the two keels extend only about one-half the length of the body. Lake St. Clair, Chippewa Lake, Mecosta County, Mich., and Crooked Lake, Newaygo County, Mich. (Jennings, '94, as "form with two large dorsal keels"). Round Lake and Old Channel, Charlevoix, Mich. (Jennings, '96, unnamed, p. 91). Trenton, N. J. (Stokes, '96*b*). Pond, Hanover, N. H. (H. S. J.).

M. bicristata Gosse. (Plate 17, fig. 17.) West Twin Lake near Charlevoix, Mich. (Jennings, '96); Sandusky Bay, Lake Erie (Kellicott, '97; possibly this was *M. mucosa* Stokes). Waters connected with the Illinois River near Havana, Ill. (Hempel, '98).

M. capucina Wierz. and Zach.—Lake St. Clair (Jennings, '94). West Twin Lake near Charlevoix, Mich. (Jennings, '96).

M. lata Jennings.—Lake St. Clair (Jennings '94). West Twin Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). This species has recently been found also by Stenroos ('98) in Finland.

M. rattus Ehr.—New York (Ehrenberg, '43). Near Minneapolis, Minn. (J. W., '83). Near Cincinnati, Ohio (Turner, '92). (Possibly the same thing was seen by Herrick ('85), who speaks of a rotifer resembling *Monocerca rattus.*) Sandusky Bay, Lake Erie (Kellicott, '97).

M. multicrinis Kellicott.—Sandusky Bay, Lake Erie (Kellicott, '97).

M. spinigera Stokes = *M. bicuspes* Pell.

RATTULUS Ehrenberg.

48. R. tigris Müller. (Plate 18, figs. 20 and 21.)

In *Naias*, Put-in Bay Harbor, Lake Erie.

The animal described and figured by Gosse in the Monograph under the above name is apparently not Ehrenberg's species at all; my specimens seem to agree with those of Ehrenberg. Characteristic seems to be the curved body, not enlarged in front as is figured by Gosse, but tapering gradually from about the middle to the foot; also the single large tooth at the anterior margin of the lorica. The anterior part of the lorica has about nine longitudinal folds, extending from the anterior margin to the constriction separating that part of the lorica covering the head from that covering the body. At the base of each of the two main toes are four minute substyles (fig. 21).

Pond near Bangor, Me. (J. C. S., '83). Turner ('92) records "*Rattulus tigris*" from the neighborhood of Cincinnati, Ohio, citing *Rattulus tigris* of Hudson and Gosse and *Diurella tigris* of Herrick ('85) for accounts of the animal. Now, these two latter represent two entirely different animals, Herrick's animal being *Cœlopus porcellus*, while, as noted above, the *Rattulus* described by Gosse is not the real *Rattulus tigris*. It is therefore impossible to say what the animal observed by Turner was.

49. R. sulcatus Jennings.

Not uncommon in shallow parts of Lake Erie about South Bass Island.

Lake St. Clair (Jennings, '94). Old Channel and West Twin Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96).

R. palpitatus Stokes (= *Cœlopus brachyurus* Gosse?).—Trenton, N. J. (Stokes, '96*b*).

"*Diurella tigris* Bory," Herrick ('85) = *Cœlopus porcellus* Gosse.

Diurella insignis Herrick ('85). See *Cœlopus tenuior*.

CŒLOPUS Gosse.

As has been several times pointed out of late, this is a genus which was founded on an incorrect interpretation of the structure of the toes. When the Rattulidæ are subjected to the revision which they so much need, probably the name *Cœlopus* will disappear; until that is done it will be best to retain the names commonly used.

50. C. porcellus Gosse. (Plate 18, figs. 22 and 23.)

Not uncommon in the vegetation of shallow parts of Lake Erie about South Bass Island.

Ohio and Minnesota (Herrick, '85, under the name *Diurella tigris* Bory). Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair, Crooked Lake, Newaygo County, Mich. (Jennings, '94). Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pools, Hanover, N. H. (H. S. J.).

51. C. brachyurus Gosse. (Plate 18, fig. 24.)

East Harbor, Lake Erie; swamp near fish-hatchery on South Bass Island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Pools, Hanover, N. H. (H. S. J.).

C. tenuior Gosse. Doubtfully reported by Kellicott ('88) from the Shiawassee River at Corunna, Mich. Old Channel, Charlevoix, Mich. (Jennings '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel '98). *Diurella insignis* Herrick ('85) apparently should be referred to this species. Weber ('98) refers it to *Cœlopus porcellus*, yet an inspection of Herrick's figure shows that the proportions are totally different from those of the latter species, while they agree fairly well with those of *C. tenuior;* moreover, Herrick had already described *C. porcellus* on the preceding page of his paper, under the name *Diurella tigris*. *Diurella insignis* (*C. tenuior*) was found in Minnesota.

Heterognathus notommata Schmarda (=*Cœlopus tenuior?*). Brackish water near New Orleans (Schmarda, '59).

Family 12. DINOCHARIDÆ.

DINOCHARIS Ehrenberg.

52. D. pocillum Ehrenberg.

East Harbor, Lake Erie, in bottom vegetation.

Minneapolis, Minn. (J. W., '83). Pond near Bangor, Me. (J. C. S., '83). Minnesota (Herrick, '85). Shiawassee River, at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Round Lake, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

53. D. tetractis Ehrenberg.

Bottom vegetation of Put-in Bay Harbor and East Harbor, Lake Erie; more numerous than the last. Herrick ('85, p. 52) mentions as occurring in Minnesota a species of *Dinocharis* resembling *D. pocillum*, but lacking the spine on last joint of the foot; this was evidently *D. tetractis*. Shiawassee River, at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). West Twin Lake, and pool on the shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Hanover, N. H. (H. S. J.).

POLYCHÆTUS Perty.

54. P. subquadratus Perty.

Bottom vegetation, Put-in Bay Harbor and East Harbor, Lake Erie.

Lake St. Clair (Jennings, '94). Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97).

55. P. collinsii Gosse.

In *Myriophyllum* from East Harbor, Lake Erie; in *Utricularia* from Portage River, Ohio, not far from the mouth.

Pools and Old Channel, Charlevoix, Mich. (Jennings, '96).

P. serica Thorpe.—Sandusky Bay, Lake Erie (Kellicott, '97).

SCARIDIUM Ehrenberg.

56. S. longicaudatum Ehrenberg.

Very abundant in shallow parts of Lake Erie about South Bass Island and in East Harbor.

Shiawassee River, at Corunna, Mich. (Kellicott, '88). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Pine Lake and Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Trenton, N. J. (?) (Stokes, '96*a*). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

S. eudactylotum Gosse.—This animal is represented in fig. 1, plate IV, of Herrick, '85, under the title "undetermined." It was thus evidently found by Herrick somewhere in America; no locality is given. Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

Stephanops muticus Ehrenberg.—Said by Herrick ('85) to occur somewhere in America. Lake St. Clair; Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '97).

S. lamellaris Ehrenberg.—Minneapolis, Minn. (J. W. '83). Shiawassee River, at Corunna, Mich. (Kellicott, '88). Sandusky Bay, Lake Erie (Kellicott, '96).

S. chlæna Gosse.—Sandusky Bay, Lake Erie (Kellicott, '96).

Family 13. SALPINADÆ.

DIASCHIZA Gosse.

57. D. semiaperta Gosse.

Abundant in bottom vegetation of Put-in Bay Harbor and East Harbor, Lake Erie.

Lake St. Clair (Jennings, '94). Round Lake and pools, Charlevoix, Mich. (Jennings, '96).

58. D. lacinulata Ehrenberg. (*Notommata lacinulata.*)

Common in vegetation of bottom of shallow parts of Lake Erie about South Bass Island.

Shiawassee River, at Corunna, Mich. (Kellicott, '88). Abundant in Michigan lakes (Jennings, '94).

Round Lake and West Twin Lake, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pond, Hanover, N. H. (H. S. J.).

DIPLAX Gosse.

59. D. trigona Gosse.

Rather common at times in the swamp near the fish-hatchery on South Bass Island.

SALPINA Ehrenberg.

60. S. brevispina Ehrenberg.

Bottom vegetation, East Harbor, Lake Erie; swamp near fish-hatchery, South Bass Island.

Shiawassee River, at Corunna, Mich. (Kellicott, '88). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96).

61. S. macracantha Gosse.

In swamps on South Bass Island; in *Utricularia* from Portage River, Ohio.

S. ventralis Ehr.—Lake St. Clair; Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96).

S. mucronata Ehr.—Near Cincinnati, Ohio (Turner, '92).

S. eustala Gosse.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

S. macrocera Jennings.—Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

S. similis Stokes (=*S. macracantha* Gosse?).—Trenton, N. J. (Stokes, '96*b*).

S. affinis Herrick (=*S. mucronata* Ehr.?).—Minneapolis, Minn. (Herrick, '85).

Family 14. EUCHLANIDÆ.

EUCHLANIS Ehrenberg.

62. E. dilatata Ehrenberg.

Very common in vegetation of the bottom of Put-in Bay Harbor and East Harbor, Lake Erie; also in swamps on South Bass Island, and from Portage River, Ohio.

Minnesota (Herrick, '85). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and the following inland lakes of Michigan: West Twin Lake, Muskegon County; White Lake, Muskegon County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

63. E. deflexa Gosse.

In bottom vegetation, Put-in Bay Harbor, Lake Erie.

Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Old Channel, Charlevoix, Mich. (Jennings, '96). Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

64. E. pyriformis Gosse.

In *Elodea* from East Harbor, Lake Erie.

Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

65. E. triquetra Ehrenberg.

In bottom vegetation of Put-in Bay Harbor and East Harbor, Lake Erie.

Shiawassee River, at Corunna, Mich. (Kellicott, '88). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair; McLaren Lake, Oceana County, Mich.; Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Pool near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Brook, Hanover, N. H. (H. S. J.).

66. E. oropha Gosse.

Common in bottom vegetation of Put-in Bay Harbor and East Harbor, Lake Erie; also in swamps on South Bass Island and in pools on Starve Island.

Lake St. Clair (Jennings, '94). Round Lake and Old Channel, Charlevoix, Mich. (Jennings, '96). Pond, Hanover, N. H. (H. S. J.).

E. ampuliformis Herrick.—Minnesota (Herrick, '85).

E. parva Rousselet=*E. oropha* Gosse, according to Rousselet.

Family 15. CATHYPNADÆ.

Owing to the large number of species of this family, and the confusion and obscurity in regard to their determination, I have wherever possible introduced a figure of the species found in Lake Erie, in order that the animal may be identified without regard to considerations of nomenclature.

CATHYPNA Gosse.

67. C. luna Gosse. (Plate 19, figs. 28 and 29.)

Abundant in bottom vegetation of Lake Erie near the shore, in the region of South Bass Island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Old Channel and West Twin Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

68. C. leontina Turner. (Plate 19, fig. 25.)

In *Chara* from East Harbor, Lake Erie, and East Swamp, South Bass Island.

This species was recently redescribed by Stokes ('97) as *C. scutaria* and by Daday ('98) as *C. macrodactyla*. The identification of *C. leontina* Turner with *Distyla ichthyoura* Anderson and Shephard ('92) (*Cathypna appendiculata* Levander, '94), as proposed by Rousselet ('97, p. 12) and Stenroos ('98, p. 162), seems to me impossible. I believe that a comparison of fig. 25 of *C. leontina* with the figures given by the above-named authors makes this at once evident. *Cathypna leontina* is broad and short (a true *Cathypna*), with immensely long, slender toes, and with the lorica ending in a short plate which projects backward at the angles into two large points with a concavity between them. *Distyla ichthyoura*, on the other hand, is slender (a true *Distyla*), the toes are short, and the posterior projection of the lorica is much broader at the distal end and is there squarely truncate.

Near Cincinnati, Ohio (Turner, '92). Lake St. Clair (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '97). Trenton, N. J. (Stokes, '97, under the name *C. scutaria*). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

69. C. ungulata Gosse. (Plate 19, figs. 26 and 27.)

Common among aquatic plants of East Harbor, Lake Erie, and Portage River, Ohio; also in East Swamp, South Bass Island.

This is the largest of the Cathypnadæ, measuring 310μ in length, including the toes. It is one of the commonest of the Rotifera in the Great Lakes. This species has recently been redescribed by Stokes ('97) as *C. glandulosa* n. sp., and by Stenroos ('98) as *C. magna* n. sp. The variety *tenuior* of Stenroos was common in Lake Erie among the type specimens.

Minnesota (figured by Herrick, '84, plate v, fig. 5, without a name). Lake St. Clair (Jennings, '94). Trenton, N. J. (Stokes, '97, under the name *C. glandulosa* n. sp.).

C. scutaria Stokes ('97) = *C. leontina* Turner.

C glandulosa Stokes ('97) = *C. ungulata* Gosse.

DISTYLA Eckstein.

70. D. ohioensis Herrick ('85). (Plate 20, fig. 30.)

East Harbor, Lake Erie, and East Swamp, South Bass Island.

This species resembles in many respects *D. icthyoura* Anderson and Shephard ('92), (*Cathypna appendiculata* Levander, '94). But it differs from that in the fact that the posterior projection of the lorica is not broader at the end, so as to make it "fish-tailed," and in the presence of the facets on the dorsal surface. Herrick's description and figure of *D. ohioensis* are exceedingly poor, yet his account differs from those of the above-named authors in exactly the points just mentioned. Herrick's name is therefore accepted for this species. All distinctive features are shown in the figure.

Ohio (Herrick, '85). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and Crooked Lake, Newaygo County, Mich. (Jennings, '94). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

71. D. gissensis Eckstein ('83). (Plate 20, figs. 33 and 34.)

Swamp near fish-hatchery on South Bass Island.

Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

72. D. ludwigii Eckstein ('83). (Plate 20, fig. 32.)

On aquatic plants in Put-in Bay Harbor, Lake Erie.

The specimens found agree precisely with *D. oxycauda* as described by Stenroos ('98). This author holds that the differences between the specimens found by him and Eckstein's figure of *D. ludwigii* are sufficient to justify describing them as a new species. These differences concern chiefly the form and distribution of the facets on the dorsal surface, and the shape of the toes. But Eckstein's figure certainly gives the impression of trying to represent the facets only in a most general way, without attention to detail; and as for the toes, a study of Eckstein's other figures, of known forms, shows that he made little attempt to be precise in his representation of such external characters. I therefore agree with Weber ('98) in considering *D. oxycauda* a synonym of *D. ludwigii*.

Lake St. Clair (Jennings, '94).

73. D. stokesii Pell. (Plate 20, fig. 31.)

On aquatic plants in Put-in Bay Harbor, Lake Erie.

Pell ('90) describes this form without giving the locality where found; it was probably at Highland Falls, N. Y. Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

74. D. flexilis Gosse.

In *Characeæ* from Put-in Bay Harbor, Lake Erie, and from East Swamp, South Bass Island.

D. signifera Jennings.—West Twin Lake near Charlevoix, Mich. (Jennings, '96).

D. inermis Bryce.—Sphagnum swamp near Pine Lake, Charlevoix, Mich. (Jennings, '96).

D. spinigera Western.—Sandusky Bay, Lake Erie (Kellicott, '97).

D. hornemanni Ehr.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

D. minnesotensis Herrick.—This is an unrecognizable species; it is said by Herrick ('85) to occur "in America,"—from the name, doubtless in Minnesota.

MONOSTYLA Ehr.

The species of this genus have fallen into confusion that seems almost inextricable; the genus is in great need of a critical revision from a single standpoint. Four species of *Monostyla* are very common almost everywhere, and the same four species are to be found frequently described and figured in the literature of the subject. Four specific names are usually distributed among these species—*M. quadridentata* Ehr., *M. lunaris* Ehr., *M. cornuta* Ehr., and *M. bulla* Gosse—but the names and figures are joined together in the most varied ways. I give herewith figures of these four species (figs. 35 to 41) and will attempt by analysis of previous accounts to show the proper name to be applied to each.

The name *Monostyla quadridentata* Ehr. unquestionably belongs to the form shown in fig. 40, plate 21. This species is so strongly marked by the two great spines at the anterior margin of the lorica that confusion with any other species is almost impossible.

As to *M. lunaris* there is much confusion in the literature. Hudson and Gosse ('89) figure under this name the rotifer, a ventral view of which is shown in my fig. 41, plate 21. It is possible also that the *M. lunaris* figured by Levander ('94) is the same, though he represents the animal as having two claws at the end of the toe.

Eckstein ('83) and Weber ('98) figure under this name an entirely different animal—that shown in my figs. 37, 38, and 39, plate 21.

Referring to the original description of *M. lunaris* by Ehrenberg ('38), we find that the chief distinctive feature of this species is the lunate concavity at the front of the lorica—"fronte lunatim excisa." This character gives the specific name *lunaris*, and Ehrenberg's figures show a broad crescentic inward curve from one lateral angle to the other at the wide front edge of the lorica when the animal is retracted. This shows that the animal called *M. lunaris* by Eckstein ('83) and Weber ('98) can not possibly be that species, as it lacks precisely the distinctive feature that gives the name to the species—namely, the crescent-shaped concavity at the front edge of the lorica. No matter how much contracted, this animal never shows a crescentic curve at the anterior margin; the actual contours at the anterior end in retraction are shown in my fig. 39. On the other hand, the animal called *M. lunaris* by Gosse (and Levander?) has this crescentic curve as the anterior margin of the lorica; hence I accept their determination as correct. This same animal (fig. 41) seems to be that figured by Eckstein ('83) as *M. cornuta*.

In regard to *M. cornuta* Ehr., its distinctive features, according to Ehrenberg ('38), are the oval form of the lorica, *not* deeply excised in front. Ehrenberg mentions also its remarkable resemblance to *Cathypna luna*, almost the only difference between the two animals being the presence of two toes

in the latter. An animal fulfilling precisely these requirements is very abundant, and is shown in figs. 35 and 36, plate 20. This seems unquestionably the animal figured under the name *M. cornuta* by Hudson and Gosse; by Levander ('94); by Bryce ('91), and by Ehrenberg himself ('38). The animal figured as *M. cornuta* by Eckstein ('83) is too broad and deeply excised at the anterior margin for this species; it seems more likely to have been *M. lunaris* Ehr.

For *M. bulla*, Gosse's specific characters are as follows: "Lorica a pointed oval; dorsal and ventral plates both gibbous and nearly coequal; toe rod-shaped in vertical aspect, with a two-shouldered claw, but decurved and tapering gradually in lateral aspect." Further along in his description he says that the true distinctive characters are "The great rotundity of the ventral plate, the regular decurvation of the tapered toe, and the deep narrow sinus in both the occipital and the pectoral fronts of the lorica," his figure 4c showing that the sinus in the front of the ventral plate of the lorica ("pectoral front") is deeper than that in the dorsal plate. An animal fulfilling all these conditions and agreeing with Gosse's figures is one of the most abundant rotifers in America. It is shown in figs. 37, 38, and 39, plate 21. This is the species figured by Eckstein ('83) and Weber ('98) as *M. lunaris*. As already pointed out, the contours of the anterior margins of the lorical plates absolutely forbid that identification, while they as clearly point to *M. bulla* Gosse as the correct determination. The same animal is figured by Stokes ('96*b*) as *M. bipes* n. sp. Stokes bases his new name on the fact that there is a line running lengthwise in the middle of the small claw (a fact that had been noted or figured by various previous observers), and that he has seen the two halves of the claw spread apart at this line in dead specimens. Stenroos ('98) finally figures this animal correctly, as I believe, as *M. bulla* Gosse. The animal figured by Weber ('98) as *M. bulla* seems, to judge from Weber's figures, to have had almost none of the distinctive features of *M. bulla* Gosse.

I give the distribution of these four species in the following four numbers:

75. M. quadridentata Ehr. (Plate 21, fig. 40.)

Very abundant in the bottom and littoral vegetation of shallow parts of Lake Erie about South Bass Island and in the swamps on the island.

Minnesota (Herrick, '85). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and Crooked Lake, Newaygo County, Mich. (Jennings, '94). West Twin Lake, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Trenton, N. J. (Stokes, '96*a*). Waters connected with the Illinois River, at Havana, Ill. (Hempel, '98). Pond, Hanover, N. H. (H. S. J.).

76. M. lunaris Ehrenberg. (Plate 21, fig. 41.)

Synonym.—*M. cornuta* Eckstein ('83). (?)

Common in littoral and bottom vegetation of Lake Erie about South Bass Island and in the swamps on the island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and the following inland lakes of Michigan: West Twin Lake, Muskegon County; McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Round Lake and Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

77. M. cornuta Ehrenberg. (Plate 20, figs. 35 and 36.)

In littoral and bottom vegetation of Lake Erie about South Bass Island and in the swamps on the island.

New York (Ehrenberg, '43). Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair; West Twin Lake, Muskegon County, Mich., and White Lake, Muskegon County, Mich. (Jennings, '94). Pool on shore of Pine Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with Illinois River at Havana, Ill. (Hempel, '98). Pond, Hanover, N. H.; Swamp near Norwich, Vt. (H. S. J.).

78. M. bulla Gosse. (Plate 21, figs. 37, 38, and 39.)

Synonyms—*M. lunaris*, Eckstein ('83), and Weber ('98). *M. bipes* Stokes ('96*b*).

One of the commonest rotifers among aquatic plants in parts of Lake Erie about South Bass Island and in the swamps on the island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Old Channel and West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

79. M. closterocerca Schmarda.

Single specimen taken in towings in Lake Erie 2½ miles north of Kelley Island.

Lake St. Clair (Jennings, '94). Lake Michigan, Round Lake, and Pine Lake, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

80. M. hamata Stokes. (Plate 22, figs 42, 43, and 44.)

East Swamp, South Bass Island.

Trenton, N. J. (Stokes, '96*b*).

M. truncata Turner.—Near Cincinnati, Ohio (Turner, '92).

M. mollis Gosse.—Lake St. Clair (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

M. robusta Stokes.—Trenton, N. J. (Stokes, '96*b*).

M. ovata Forbes.—Warm spring on the shore of Yellowstone Lake, Yellowstone National Park (Forbes, '93).

M. bipes Stokes.—This is the same species as is recorded and figured above as *M. bulla*. Trenton, N. J. (Stokes, 96*b*).

Family 16. COLURIDÆ.

COLURUS Ehrenberg.

This is one of the genera which would repay a thorough study and revision.

81. C. bicuspidatus Ehrenberg.

On *Elodea* from East Harbor, Lake Erie.

Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

82. C. deflexus Ehrenberg.

In *Chara* from bottom of Put-in Bay Harbor, Lake Erie; in swamp near fish-hatchery on South Bass Island.

Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

83. C. obtusus Gosse.

On aquatic plants in shallow parts of Lake Erie about South Bass Island.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

C. agilis Stokes.—Trenton, N. J. (Stokes, '96*c*).

C. caudatus Ehrenberg.—Shiawassee River at Corunna, Mich. (Kellicott, '88).

METOPIDIA Ehrenberg.

84. M. lepadella Ehrenberg.

Abundant in vegetation of shallow and swampy parts of Lake Erie about South Bass Island and in the swamps on the island.

The species to which I have applied the above name is abundant everywhere and is very variable, so as to give much opportunity for the creation of new species, an opportunity which has been fully utilized. A thorough revision of the species of *Metopidia* would be of much value to the systematist, besides doubtless furnishing an interesting study in the field of variation.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and McLaren Lake, Oceana County, Mich. (Jennings, '94). Pool on the shore of Pine Lake; Old Channel, Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Pools, Hanover, N. H. (H. S. J.).

85. M. acuminata Ehrenberg.

Common in aquatic plants from bottom of Put-in Bay Harbor, Lake Erie.

Pond near Bangor, Me., (J. C. S., '83). Lake St. Clair; Crooked Lake, Newaygo County, Mich.; Chippewa L., Mecosta County, Mich. (Jennings, '94). Round Lake, Charlevoix, Mich. (Jennings, '96). Waters connected with Illinois River at Havana, Ill. (Hempel, '98). Pool near Norwich, Vt. (H. S. J.).

86. M. rhomboides Gosse.

In *Characeæ* from Put-in Bay Harbor and East Harbor, Lake Erie, and from swamps on South Bass Island.

Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

87. M. solidus Gosse.

East Swamp, South Bass Island.

Sphagnum Swamp near Pine Lake, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

88. M. triptera Ehrenberg.

In *Chara* from East Harbor, Lake Erie.

Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair, and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County (Jennings, '94). Swamp on shore of Pine Lake, Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pool near Norwich, Vermont (H. S. J.).

89. M. ehrenbergii Perty. (*Notogonia ehrenbergii* Perty.)

In *Myriophyllum* from East Harbor, Lake Erie; in swamp near fish-hatchery on South Bass Island.

Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Pool on shore of Pine Lake; West Twin Lake; Old Channel at Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97).

90. M. salpina Ehrenberg. (*M. oxysternum* Gosse.)

Swamp near fish-hatchery on South Bass Island.

As Bilfinger ('94) has shown, Gosse's *M. oxysternum* is the same as Ehrenberg's *Lepadella? salpina*, so that there seems no sufficient reason for using Gosse's specific name any longer.

Sandusky Bay, Lake Erie (Kellicott, '96, as *M. oxysternum*). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98, as *M. oxysternum*).

M. oblonga Ehrenberg.—Near Cincinnati, Ohio (Turner, '92, as *M. elliptica* n. sp.). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Ditch at Hanover, N. H. (H. S. J.).

M. dentata Turner.—Near Cincinnati, Ohio (Turner, '92).

M. bractea Ehrenberg.—Minnesota (Herrick, '85; identification uncertain). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair, and McLaren Lake, Oceana County, Mich. (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

M. collaris Stokes.—Trenton, N. J. (Stokes, '96*b*).

M. collaris var. *similis* Stokes.—Trenton, N. J. (Stokes, '96*b*).

M. (*Lepadella*) *cornuta* Schmarda.—Brackish water near New Orleans (Schmarda, '59).

M. elliptica Turner = *M. oblonga* Ehr.

Cochlearetur bo Gosse.—Lake St. Clair; also Crooked Lake, Newyago County, Mich., and Chippewa Lake, Mecosta County, Mich. (Jennings, '94).

Family 17. PTERODINADÆ.

PTERODINA Ehrenberg.

91. P. patina Ehrenberg.

Common in aquatic vegetation of Put-in Bay Harbor and East Harbor, Lake Erie; also from Portage River, Ohio.

Herrick ('85) figures this species, but does not give the locality where found. Niagara River (Kellicott, '87). Shiawassee River at Corunna, Mich. (Kellicott, '88). Near Cincinnati (Turner, '92). Lake St. Clair, and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Pool on the shore of Pine Lake and West Twin Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Trenton, N. J. ? (Stokes, '96*a*). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

92. P. reflexa Gosse.

In aquatic vegetation from East Harbor, Lake Erie.

Lake St. Clair, and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Pine Lake and West Twin Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96).

P. bidentata Ternetz.—Lake St. Clair (Jennings, '94).

P. parva Ternetz.—West Twin Lake, near Charlevoix, Mich. (Jennings, '96).

P. valvata Hudson.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

Family 18. BRACHIONIDÆ.

BRACHIONUS Ehr.

93. B. bakeri Ehrenberg. (Plate 22, figs. 45 and 46.)

One of the commonest rotifers in East Harbor, Lake Erie, and in the swamps on South Bass Island. The animal varies exceedingly in the form of the lorica and in the development of the spines on the lorica. In small land-locked pools in the glacial markings on Starve Island, a form with very short spines (fig. 45) was abundant; in the swamps of South Bass Island the long-spined variety (fig. 46) was found. The pools on Starve Island are subject to evaporation and frequent drying up by the sun; possibly the different form found in these pools is due to the greater concentration of various salts in this water or to some kindred factor. *B. bakeri* is known to vary excessively (see Rousselet, '97*b*, for figures of the chief variations); it would probably be a favorable form for an experimental study of the causes of variation. It seems hardy, and can usually be procured in quantity, so that it could probably be cultivated under experimental conditions.

Granville, Ohio (Herrick, '85). Shiawassee River at Corunna, Mich. (Kellicott, '88). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Pool on shore of Pine Lake, and in West Twin Lake, near Charlevoix, Mich. (Jennings, '96). Trenton, N. J. (Stokes, '96*a*). Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

B. bakeri var. *brevispinus*. Waters connected with Illinois River at Havana, Ill. (Hempel, '98).

94. B. militaris Ehrenberg.

Very abundant in swampy parts of Lake Erie, in Portage River, Ohio, and in the swamps on South Bass Island.

In Hemlock Lake, near Rochester, N. Y. (Attwood, '81, under the name *B. conium*). Croton water, the New York water supply (Hitchcock, '81, under the name *B. conium* Attwood). Minnesota (Herrick, '84, plate v, fig. 6, not named). "Common in the West" (Herrick, '85). Creek on Grand Island and in Buffalo City Park (Kellicott, '87, under the name *B. conium* Attwood). Shiawassee River at Corunna, Mich. (Kellicott, '88, under the name *Noteus conium* Attwood). Near Cincinnati, Ohio (Turner, '92). Lake St. Clair (Jennings, '94). Susan Lake and West Twin Lake, in north Michigan (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Water connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. pala Ehrenberg.—Near Minneapolis, Minn. (J. W., '83). Near Cincinnati, Ohio (Turner, '92). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. urceolaris Ehrenberg.—Near Cincinnati, Ohio (Turner, '92). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. tuberculus Turner.—Near Cincinnati, Ohio (Turner, '92). Sandusky Bay, Lake Erie; also found by C. C. Mellor at Newark, Ohio (Kellicott '97).

B. mollis Hempel.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '96 and '98).

B. dorcas Gosse.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. dorcas var. *spinosus* Wierz.—With the type (Hempel, '98).

B. punctatus Hempel.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '96 and '98).

B. rubens Ehrenberg.—Shiawassee River at Corunna, Mich. (Kellicott, '88). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. variabilis Hempel.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '96 and '98).

B. angularis Gosse.—Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

B. angularis var. *bidens* Plate.—Waters connected with Illinois R. at Havana, Ill. (Hempel, '98).

B. gleasoni Up de Graff.—Elmira, N. Y. (Up de Graff, '82 and '83).

B. conium Attwood = *B. militaris* Ehr.

B. intermedius Herrick ('85).—Insufficiently described for recognition. It seems probable from the points mentioned that the animal was *Noteus quadricornis* Ehr. Locality not given.

Schizocerca diversicornis Daday.—Waters connected with Illinois R. at Havana, Ill. (Hempel, '98).

S. diversicornis var. *homoceros* Wierz.—With the type (Hempel, '98).

NOTEUS Ehr.

95. N. quadricornis Ehrenberg.

East Swamp, South Bass Island.

Near Minneapolis, Minn. (J. W., '83). Shiawassee River at Corunna, Mich. (Kellicott, '88). Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Pool on the shore of Pine Lake near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Ditches, Hanover, N. H. (H. S. J.).

Noteus conium Attwood = *Brachionus militaris*.

Family 19. ANURÆADÆ.

ANURÆA Gosse.

96. A. cochlearis Gosse.

Abundant in towings from Lake Erie in the region about South Bass Island.

Lake Erie (Vorce, '81; figured (fig. 181) but not named). Near Cincinnati, Ohio (Turner, '92). Water from Lake Michigan at Chicago (Jelliffe, '93). Lake St. Clair and the following inland lakes of Michigan: McLaren Lake, Oceana County; Crooked Lake, Newaygo County; Chippewa Lake, Mecosta County (Jennings, '94). Lake Michigan, Round Lake, Pine Lake, West Twin Lake, and Susan Lake, in north Michigan (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. cochlearis var. *tecta* Gosse.—Near Cincinnati, Ohio (Turner, '92). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. aculeata Ehr.—Lake St. Clair and in Whitmore Lake, Washtenaw County, Mich. (Jennings, '94). Lake Michigan, near Charlevoix, Mich. (Jennings, '96). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. aculeata var. *valga* Ehr.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. serrulata Ehr.—This is figured by Herrick ('85) as "*Anuræa* sp.," and is said by him to be "very common in the West." Lake St. Clair (Jennings, '94). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

A. hypelasma Gosse.—Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Pond at Hanover, N. H. (H. S. J.).

A. stipitata Ehr.—New York (Ehrenberg, '43). Lake Erie (Vorce, '81, and Kellicott, '96). Niagara River (Mills, '82).

NOTHOLCA Gosse.

97. N. longispina Kellicott.

In towings from Put-in Bay Harbor, Lake Erie; few.

Niagara River (Kellicott, '79, and Mills, '82). Lake Erie (Vorce, '81). Lake Mendota, Wisconsin (Forbes, '90). Lake St. Clair and Chippewa Lake, Mecosta County, Mich. (Jennings, '94). Lake Michigan, Round Lake, and Pine Lake, near Charlevoix, Mich. (Jennings, '96). Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

N. scapha Gosse.—Lake Michigan and Round Lake, near Charlevoix, Mich. (Jennings, '96).

N. foliacea Ehrenberg.—Round Lake, Charlevoix, Mich. (Jennings, '96).

N. acuminata Ehr.—New York (Ehrenberg, '43, identification doubtful). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98). Huron River at Ann Arbor, Mich. (H. S. J.).

N. labis Gosse.—Huron River at Ann Arbor, Mich. (H. S. J.).

N. striata Ehrenberg.—Lake Michigan, near Chicago (Forbes, '83, p. 106).

Family 20. PLŒSOMADÆ.

Following the example of Weber ('98), I place together, at the end of the Loricata, the three families Plœsomadæ, Gastropodidæ, and Anapodidæ, comprising loricate Rotifera that have been described for the most part since the publication of Hudson and Gosse's Monograph. In a former list ('94) I placed *Plœsoma* and *Gastropus* in the Hydatinadæ, while *Anapus* was given a place next to *Ascomorpha;* all three genera thus among the Illoricata. I still believe such an arrangement expresses more nearly the relationship of the animals; that the separation of the Rotifera into two great groups, according as the cuticula is or is not stiffened to form a lorica, is an artificial classification, often widely separating species that are really closely related. But since I am, from motives of convenience, using in this list Hudson and Gosse's classification, it will be more logical to place these three loricated groups among the Loricata; this will not separate closely related species any more widely than is done by this classification in many other parts of the system.

PLŒSOMA Herrick.

98. P. lenticulare Herrick.

From aquatic plants in Put-in Bay Harbor, Lake Erie; also in towings from the open lake.

The synonymy of this species is much confused and has led to a great deal of discussion; an excellent summary of this is given by Hood ('95). In a note in the *Zoologischer Anzeiger* of 1894 I pointed out that the generic name *Plœsoma*, due to Herrick ('85), has the priority for this genus, and this has been generally accepted, except by Scandinavian investigators, who cling to the name *Gastroschiza*, proposed by a Scandinavian, without regard to the laws of priority. In that note I considered it probable that this species is the *Euchlanis* (?) *lynceus* of Ehrenberg, and in accordance with that view I have used the name *P. lynceus* in my papers of 1894 and 1896. The note above referred to concludes, however: "If it be held that this is not the *Euchlanis lynceus* of Ehrenberg, then Herrick's name, *Plœsoma lenticulare*, has the priority." In view of recent studies on the genus by various authors this conditional statement must be held to represent the more probable view, so that the name *P. lenticulare* should be used for this species.

Weber has recently founded the family Plœsomadæ for this and related rotifers, placing the family among the Loricata. In my previous papers I have followed Wierzejski ('93) in placing this genus in close proximity to the genus *Notops* (as formerly constituted), among the Hydatinadæ. This disposition of the genus has repeatedly been credited to me (Hood, '95; Weber, '98, p. 737). While I believe that its relationship is much better expressed in this way than by transferring it to the purely artificial group Loricata, I must disclaim having originated this view.

Lake Erie (Vorce, '82, as "remarkable rotifer, undescribed"; Vorce, '87, as *Gomphogaster areolatus* Vorce; Kellicott, '96). Reservoir near Hebron, Ohio (Herrick, '85). Lake St. Clair; Crooked Lake, Newaygo County, Mich.; Chippewa Lake, Mecosta County, Mich. (Jennings, '94, as *P. lynceus* Ehr.). Lake Michigan, Round Lake, Pine Lake, West Twin Lake, and Susan Lake, all in north Michigan (Jennings, '96, as *P. lynceus* Ehr.). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98, under name *P. lynceus* Ehr.).

P. hudsoni Imhof.—Lake St. Clair (Jennings, '94). Lake Michigan and Round Lake, near Charlevoix, Mich. (Jennings, '96).

P. truncatum Levander.—Among the specimens of *P. lenticulare* found in Lake St. Clair in 1893 were numbers of a smaller form, with a more wrinkled, less angular lorica. Notes were made at the time, but thinking it might possibly be a young form of *P. lenticulare*, I did not describe it. It has since been described as a new species, *P. truncatum*, by Levander; this must, then, be added to the list of species inhabiting Lake St. Clair. It has since been found by Kellicott ('97) in Sandusky Bay, Lake Erie.

P. molle Kellicott.—Sandusky Bay, Lake Erie (Kellicott, '97).

Family 21. GASTROPODIDÆ.

GASTROPUS Imhof ('88).

Weber ('98) has revived this name for the animal which has been called *Hudsonella picta* and *Notops pygmæus*. The name *Gastropus*, published in 1888, undoubtedly has the priority as a name for this distinct genus unless it be held that Imhof's description is insufficient for a recognition of the animal described. The description is undoubtedly meager, and most investigators have since been inclined to disregard the name as insufficiently founded; on that account I also have in previous papers used another name. But one investigator in good standing is in a position to force others to use a name which unquestionably has priority, when he maintains that he is able to recognize the species, one positive instance being worth more than many negative ones. Weber ('98) takes this position in regard to *Gastropus*, so that I believe it best to accept the name which he uses as inevitable, without further ado. Moreover, in my opinion, Imhof's *Gastropus stylifer* is, as a matter of fact, plainly recognizable, and I used this name for the animal in question as far back as in my paper of '94*b*, dropping it only when opinion seemed unanimous against this view. To the same genus are to be referred *Notops hyptopus* Ehr., *Notops minor* Rousselet, *Notops fennicus* Steuroos, and *Hypopus ritenbenkii* Bergendal.

99. G. stylifer Imhof ('88). (*Notops pygmæus* Calman; *Hudsonella picta* Zacharias.)

A single specimen in towings from Put-in Bay Harbor, Lake Erie.

Lake St. Clair and Whitmore Lake, Washtenaw County, Mich. (Jennings, '94, under the name *Notops pygmæus* Calman). Round Lake, Pine Lake, Lake Michigan, and West Twin Lake, near Charlevoix, Mich. (Jennings, '96, as *Notops pygmæus* Calman).

G. minor Rousselet.—Sandusky Bay, Lake Erie (Kellicott, '97, as *Notops minor*).

Family 22. ANAPODIDÆ.

ANAPUS Bergendal.

100. A. ovalis Bergendal.

One specimen, from surface towing in Lake Erie, taken 2½ miles north of Kelley Island.

Lake St. Clair (Jennings, '94); Lake Michigan, Round Lake, and West Twin Lake near Charlevoix, Mich. (Jennings, '96).

Family 23. PEDALIONIDÆ.

Pedalion mirum Hudson.—Sandusky Bay, Lake Erie (Kellicott, '97). Waters connected with the Illinois River at Havana, Ill. (Hempel, '98).

SUMMARY.

The foregoing list shows that (excluding varieties, synonyms, and doubtfully identified animals) 246 species have been recorded as occurring in the United States. These are distributed by States, as follows: Michigan 160, Ohio 155, Illinois 112, New Jersey 29, New Hampshire 23, New York 21, Maine 18, Minnesota 18, Pennsylvania 13, Vermont 6, Yellowstone Park 4, Louisiana 2 (?), North Carolina 2 (?), Virginia 1, Wisconsin 1, California 1.

It will be understood of course that the fact that large numbers are recorded from certain States, while in others few or no rotifers have been observed, is due purely to unequal distribution of investigators. It is probable that at least as many species of Rotifera as are included in the entire list might by careful investigation be found in any State in the Union.

The only large bodies of water that have been investigated with any degree of completeness are Lake St. Clair, Lake Erie, and the Illinois River. In the Great Lakes there have been found altogether 164 rotifers. Lake Erie has 132 species, Lake St. Clair 111 species, Lake Michigan 25 species. From the other Great Lakes no rotifers have been recorded. From the Illinois River 105 species and 5 varieties have been recorded; 74 of these are common to the Illinois River and the Great Lakes; 25 are found in the Illinois River and not in the Great Lakes; 90 in the lakes and not in the Illinois River. 57 species have been found neither in the Great Lakes nor in the Illinois River, but in small ponds, pools, streams, and swamps in various parts of the United States.

The fauna of the Illinois River is characterized, as compared with that of the Great Lakes, by a greater proportion of species living in swampy regions. The 25 species which are recorded from that stream and which have not been found in the Great Lakes include, for example, 3 species of *Asplanchna* and 7 Brachionidæ, characteristic swamp Rotifera. Several of the species occurring in the Illinois River and not found in the Great Lakes have been found in swamps or small bodies of water in immediate proximity to the lakes. This is true for example of *Trochosphæra solstitialis*. On the other hand, the fauna of the Great Lakes is marked by the presence of a number of distinctly limnetic Rotifera not found in the Illinois River, such as *Floscularia mutabilis* Bolton, *F. pelagica* Rousselet, *Conochilus volvox* Ehr., *Notops pelagicus* n. sp., *Notommata monopus* Jennings, *Plœsoma hudsoni* Imhof, *Gastropus stylifer* Imhof, and *Anapus ovalis* Bergendal.

A striking characteristic of Lake Erie, as exhibited during the summer of 1898, was the poverty in limnetic Rotatoria. In others of the Great Lakes the Rotifera have been found to form at times a considerable portion of the plankton. In Lake Erie the proportion formed by them was so small as to be hardly noticeable. The following 12 limnetic forms were seen; none of them were abundant and most of them were rare: *Floscularia mutabilis* Bolton, *F. pelagica* Rousselet, *Conochilus unicornis* Rousselet, *Asplanchna priodonta* Gosse, *Synchæta stylata* Wierzejski, *Polyarthra platyptera* Ehr., *Notops pelagicus* n. sp., *Anuræa cochlearis* Gosse, *Notholca longispina* Kellicott, *Plœsoma lenticulare* Herrick, *Gastropus stylifer* Imhof, and *Anapus ovalis* Bergendal. This list contains one species not hitherto found in others of the Great Lakes, namely, *Notops pelagicus* n. sp. On the other hand, the following species found in others of the Great Lakes were not found in Lake Erie: *Conochilus volvox* Ehr., *Asplanchna herrickii* de Guerne, *Plœsoma hudsoni* Imhof, *Notommata monopus* Jennings, and *Anuræa aculeata* Ehr. The first of these has been found in Lake Erie by another observer; the others have not.

The littoral, bottom, and swamp Rotifera of Lake Erie are, on the other hand, very abundant, as shown by the fact that 120 species have already been recorded from this lake. The shallow and marshy parts of the lake teem with rotifers.

Investigation of the Rotifera is as yet far too incomplete to draw very positive conclusions in regard to the geographical distribution of these animals. The evidence of all kinds, so far as it goes, seems to indicate that the following is true: Whether any given rotifer shall be found in a given body of water depends, not upon the locality of this body of water, not upon its connection with or separation from any particular drainage system, but upon the conditions present in that particular body of water. In stagnant swamps all over the world are likely to be found the characteristic Rotifera of stagnant water, with little regard to the country in which the swamp is found; in clear lake water will be found everywhere the characteristic limnetic Rotifera; in sphagnum swamps everywhere the sphagnum Rotifera. Variation in the rotifer fauna of different countries is probably due to variation in the conditions of existence in the waters of these countries, not to any difficulty in passing from one region to another. The Rotatoria are thus potentially cosmopolitan, any given species occurring wherever on the earth the conditions necessary to its existence occur. The number of different sorts of Rotifera to be found in any given region depends, then, upon the variety of conditions to be found in the waters of this region. Two bodies of water a half mile apart, presenting entirely different conditions, are likely to vary more in the make-up of their rotifer faunas than two bodies of water 5,000 miles apart that present similar conditions. Of course on this view it is likely that the Tropics will have many characteristic species not found in the cooler regions, since the Tropics present many conditions of existence not found elsewhere, and the same may be true of Arctic regions. The problem of the distribution of the Rotifera is, then, a problem of the conditions of existence, not a problem of the means of distribution. The ability of the eggs to live in dried mud, which may be carried about on the feet of birds or blown about as dust by the winds, seems to give sufficient opportunity to any species to multiply wherever occur the conditions necessary to its existence.

The fact that different rotifers do thus require different conditions for existence is, of course, evident to all who have worked on the group. A striking example of the fact that it is the life conditions, not the means of distribution of the animals, that determines the character of the fauna in a given body of water is given by a com-

parative study of the Rotifera of one of the swamps on South Bass Island and of those in the parts of Lake Erie immediately adjoining. This swamp lies near the United States fish-hatchery, on a narrow point of land, so that the distance to the lake is not great on either side. On the east the lake is about 50 feet away, and the lake and the swamp are connected by a small channel. Under usual conditions the water flows from the swamp through this channel into the lake. The swamp is shallow and its muddy bottom is covered by a dense growth of *Ceratophyllum*, while its surface is completely mantled by *Lemna, Spirodela*, and *Wolffia*. In this swamp occurs a characteristic fauna, *Rotifer tardus*, *Brachionus militaris*, *Brachionus bakeri*, *Apsilus*, *Monostyla quadridentata*, *Diplax trigona*, *Diglena biraphis*, *Metopidia ehrenbergii*, *Distyla gissensis*, *Notops clavulatus*, *Trochosphæra solstitialis*, etc. Almost the only one of these that is common in the adjacent lake is the ubiquitous *Monostyla quadridentata*. Towings in the lake just outside the mouth of the swamp reveal *Anuræa cochlearis*, *Synchæta stylata*, *Floscularia mutabilis*, *F. pelagica*, *Asplanchna priodonta*, *Notholca longispina*, and other characteristic limnetic Rotifera, while the bottom of the lake has likewise a fauna differing markedly in character from that of the swamp. At certain times, under a northeast wind, the water of Lake Erie is driven toward the west end of the lake, where it rises much above the usual level. At these periods the direction of the current in the channel above mentioned is reversed, and water flows from the lake into the swamp, which therefore likewise rises a foot or more. At such times all the characteristic limnetic Rotifera of the lake above mentioned are found in the swamp. There is thus at intervals a thorough intermixing of the two faunas. Yet in a short time after the lake has returned to its usual level it is found that the swamp has again only its characteristic swamp fauna, while the limnetic forms from the lake have entirely disappeared.

Certain rotifers thus require very special conditions of existence, and such conditions may exist only in a limited area, so that the rotifer will be confined to this area. Yet if the conditions do recur in any even distant part of the globe, the same rotifer is likely to be found there also. The history of *Trochosphæra*, for example (see p. 77), seems to bear out this conclusion.

DARTMOUTH COLLEGE, HANOVER, N. H., *May 29, 1899*.

LITERATURE CITED.

ANDERSON, H. H., and SHEPHARD, J.
'92. Notes on Victorian rotifers. Proc. Roy. Soc. of Victoria, n. s., vol. IV, pp. 69–82.

ATTWOOD, H. F.
'78. *Volvox globator*. Am. Journ. Micr. and Pop. Sci., vol. III.
'81. *Brachionus conium*—a new rotifer. Am. Monthly Micr. Journ., vol. II, p. 102.

BAILEY, J. W.
'55. Notes on new species and localities of microscopical organisms. Smithsonian Contributions to Knowledge, vol. VII, art. III, pp. 1–16.

(BALEN, A. D.)
'83. Notes. Am. Month. Micr. Journ., vol. IV, p. 37.
'85. Objects exhibited. Journ. New York Micr. Soc., vol. I, p. 17.
'85*b*. Objects exhibited. Ibid., vol. I, p. 122.
'85*c*. Objects exhibited. Ibid., vol. I, p. 189.

BILFINGER, L.
'94. Zur Rotatorienfauna Württembergs. Zweiter Beitrag. Jahreshefte d. Vereins f. Vaterl. Naturkunde in Württemberg, 1894, pp. 35–65.

BOSC.
'02. Le rotifère de Carolina, Vorticella rotatoria. Histoire natur. des vers, suite de Buffon, éd. par Deterville, pp. 176, 184. (Reference taken from Ehrenberg, '38.)

(BRECKENFELD, A. H.)
'89. Exhibit before San Francisco Micr. Soc., Am. Month. Micr. Journ., vol. X, p. 190.

BRYCE, D.
'91. Remarks on Distyla, with descriptions of three new rotifers. Sci. Gossip, No. 321, Sept., 1891.

(COX, C. F.)
'89. Objects exhibited. Journ. N. Y. Micr. Soc., vol. V, p. 89.

DADAY, E. VON.
'98. Mikroskopische Süsswasserthiere aus Ceylon. Budapest.

(DAMON, W. E.)
'86. Objects exhibited. Journ. N. Y. Micr. Soc., vol. II, p. 55.
'88. Objects exhibited. Ibid., vol. IV, p. 90.

ECKSTEIN, KARL.
'83. Rotatorien der Umgegend von Giessen. Zeitschr. f. wiss. Zool., Bd. 39, pp. 343–443.

EHRENBERG, C. G.
'38. Die Infusionsthierchen als vollkommene Organismen. Leipzig.
'43. Verbreitung und Einfluss des mikroskopischen Lebens in Süd- und Nord-Amerika. Berlin.

(FELL.)
'82. Proceedings of the Buffalo Micr. Soc. The Microscope, vol. II, p. 167.

FORBES, S. A.
'82. A remarkable new rotifer. Am. Month. Micr. Journ., vol. III, pp. 102–103.
'83. The food of the smaller fresh-water fishes. Bull. Ill. State Lab. of Nat. Hist., vol. I, Bull. 6, p. 106.
'90. Preliminary report upon the invertebrate animals inhabiting lakes Geneva and Mendota, Wisconsin. Bull. U. S. Fish Commission for 1888, pp. 473–487.
'93. A preliminary report on the aquatic invertebrate fauna of the Yellowstone National Park, Wyoming, and of the Flathead region of Montana. Bull. U. S. Fish Commission for 1891, pp. 207–258.

FOULKE, S. G.
'84. On a new species of the genus Apsilus. Proc. Acad. Nat. Sci. Phil., 1884, pp. 36–41.

GARMAN, H.
'90. A preliminary report on the animals of the Mississippi bottoms near Quincy, Ill. Part I. Bull. Ill. State Lab. of Nat. Hist., vol. III, art. IX, p. 182.

GOSSE, P. H.
'56. On the structure, functions, and homologies of the manducatory organs in the class Rotifera. Philosophical Transactions, 1856, pp. 419–452.

GUERNE, JULES DE.
'88. Note monographique sur les rotifères de la famille des Asplanchnidæ. Translation in Annals and Mag. of Nat. His., ser. 6, vol. II.

(HELM, S.)
'89. Objects exhibited. Journ. N. Y. Micr. Soc., vol. V, pp. 40, 44, 117.
'91. Objects exhibited. Ibid., vol. VII, p. 96.
'94. Objects exhibited. Ibid., vol. X, p. 17.
'97. Objects exhibited. Ibid., vol. XIII, pp. 15, 74, 75.

HEMPEL, A.
'96. Descriptions of new species of Rotifera and Protozoa from the Illinois River and adjacent waters. Bull. Ill. State Lab. of Nat. Hist., vol. IV, art. X, pp. 310–317.
'98. A list of the Protozoa and Rotifera found in the Illinois River and adjacent lakes at Havana, Ill. Bull. Ill. State Lab. of Nat. Hist., vol. V, art. VI, pp. 301–388.

HERRICK, C. L.
'84. A final report on the crustacea of Minnesota included in the orders Cladocera and Copepoda. 12th Ann. Rep. of the Geol. and Nat. Hist. Survey of Minn.
'85. Notes on American rotifers. Bull. Sci. Lab. Denison Univ., vol. I, pp. 43–62.
(HITCHCOCK, R.)
'81. Croton water in August. Am. Month. Micr. Journ., vol. II, p. 156.
'81*b*. Pond life. Ibid., II, p. 198.
HOOD, J.
'95. On the Rotifera of County Mayo. Proc. Roy. Irish Acad., 3d ser., vol. III, No. 4, pp. 664–706.
HUDSON, C. T. and GOSSE, P. H.
'89. The Rotifera or Wheel-Animalcules. 2 vols. with supplement. London.
IMHOF, O. E.
'88. Fauna der Süsswasserbecken. Zool. Anz., Jahrg. 11, p. 166.
JANSON, OTTO.
'93. Versuch einer Übersicht über die Rotatorien Familie der Philodinaeen. Beilage zum XII. Bande der Abhdlg. d. Naturw. Vereins z. Bremen.
JELLIFFE, S. E.
'93. The Chicago water supply in the World's Fair grounds. Am. Month. Micr. Journ., vol. XIV.
JENNINGS, H. S.
'94. The Rotatoria of the Great Lakes and of some of the inland lakes of Michigan. Bull. Mich. Fish Commission, No. 3.
'94*b*. Rotifers related to *Euchlanis lynceus* Ehr. Zool. Anz., Feb. 19, 1894.
'96. Report on the Rotatoria. From: A biological examination of Lake Michigan in the Traverse Bay Region. Bull. Mich. Fish Commission, No. 6, pp. 85–93.
KELLICOTT, D. S.
'79. A new Rotifer. Am. Journ. Micr. and Pop. Sci., vol. IV, p. 19.
'84. Notes: Infusoria, Rotatoria, etc. Proc. Am. Soc. Micr., Seventh Ann. Meeting, pp. 126–130.
'85. A new Floscule. Ibid., Eighth Ann. Meeting, pp. 48–50.
'87. Additional notes on certain species of Rotifera. Ibid., vol. IX, pp. 181–186.
'88. Partial list of the Rotifera of Shiawassee River at Corunna, Mich. Ibid., vol. X.
'89. A new Rotiferon. Ibid., vol. XI, pp. 32–33.
'92. Rotifer notes. Am. Month. Micr. Journ., vol. XIII, p. 12.
'96. The Rotifera of Sandusky Bay. Proc. Am. Micr. Soc., vol. XVIII, pp. 155–164.
'97. The Rotifera of Sandusky Bay. (Second Paper.) Ibid., vol. XIX, pp. 43–54.
KOFOID, C. A.
'96. On the occurrence of *Trochosphæra solstitialis* in the Illinois River. Science, n. s., vol. IV, pp. 935–936.
LAUTERBORN, R.
'98. Vorläufige Mittheilung über den Variationskreis von *Anuræa cochlearis* Gosse. Zool. Anz., Jahrg. XXI, pp. 567–604.
LEIDY, J.
'51. *Anelcodiscus pellucidus*. Proc. Acad. Nat. Sci. Philadelphia, vol. V, p. 287.
'57. (Note on *Dictyophora vorax;* no title.) Ibid., 1857, p. 204.
'74. Notice of some fresh-water Infusoria. Ibid., 1874, p. 140.
'74*b*. Remarks on the revivification of *Rotifer vulgaris*. Ibid., 1874.
'80. Rhizopods in the mosses on the summit of Roan Mountain, North Carolina. Ibid., 1880, p. 333.
'82. Rotifera without rotatory organs. Ibid., 1882, pp. 243–250.
'84. Dictyophora as *Apsilus vorax*. Ibid., 1884, pp. 50–51.
'87. *Asplanchna ebbesbornii*. Ibid., 1887, p. 157.
LEVANDER, K. M.
'94. Materialien zur Kenntniss der Wasserfauna in der Umgebung von Helsingfors. II. Rotatoria. Acta Soc. pro Fauna et Flora fennica, vol. XII, No. 3.
LOGAN, J. H.
'95. Microscopical life in the Phipps Conservatory Tanks, Allegheny. Am. Month. Micr. Journ., vol. XVI, p. 1.
LUND, C. WESENBERG.
'99. Danmarks Rotifera. I. Grundtrækkene i Rotiferernes Økologi, Morfologi og Systematik. København, 1899.
MELLOR, C. C.
'88. *Actinurus neptunius*. The Microscope, vol. VIII, p. 53.
(MELLOR, C. C.)
'89. Exhibit before Iron City Microscopical Society. Am. Month. Micr. Journ., vol. X, p. 19.
MILLS, H.
'81. A month's pond hunting. Am. Journ. Micr. and Pop. Sci., vol. VI, pp. 173–175.
'82. Microscopic organisms in the Buffalo water supply and in the Niagara River. Proc. Am. Soc. Micr., Fifth Ann. Meeting, pp 165–175.
(MITCHELL, W. R.)
'86. Objects exhibited. Journ. N. Y. Micr. Soc., vol. II, p. 55.
"N. N."
'75. *Volvox globator*. Am. Journ. Micr. and Pop. Sci., vol. I, p. 18.
PEIRCE, C. N.
'75. Remarks on Stephanoceros. Proc. Acad. Nat. Sci. Philadelphia, 1875, p. 121.

PELL, A.
'90. Three new Rotifers. The Microscope, vol. x, pp. 143–145.
ROUSSELET, C. F.
'93. List of new rotifers since 1889. Journ. Roy. Micr. Soc., 1893, pp. 450–458.
'96. Structural features in Rotifera. Science Gossip, n. s., vol. III, p. 189.
'97. Second list of new rotifers since 1889. Journ. Roy. Micr. Soc., 1897, pp. 10–15.
'97*b*. *Brachionus bakeri* and its varieties. Journ. Quekett Micr. Club, ser. 2, vol. VI, pp. 328–332.
"J. C. S."
'83. Pond life in winter. Am. Month. Micr. Journ., vol. IV.
SCHMARDA, L. K.
'59. Neue wirbellose Thiere beobachtet und gesammelt auf einer Reise um die Erde, 1853 bis 1857. Erster Band.
(SMILEY, C. W.)
'95. (Editorial.) Am. Month. Micr. Journ., vol. XVI, p. 27.
STENROOS, K. E.
'98. Das Thierleben im Nurmijärvi-See. Acta Soc. pro Fauna et Flora fennica, vol. XVII, pp. 1–259.
STOKES, A. C.
'81. Leaves from a summer note-book. Am. Journ. Micr. and Pop. Sci., vol. VI, pp. 189–194.
'96*a*. Structural features in American Rotifera. Science Gossip, n. s., vol. III, Nos. 29 and 30, pp. 121–122 and 148–149.
'96*b*. Some new forms of American Rotifera. Ann. and Mag. of Nat. Hist., vol. XVIII, pp. 17–27.
'96*c*. Notes on the genus Apsilus and other American Rotifera. Journ. Roy. Micr. Soc., 1896, pp. 269–278.
'97. Some new forms of American Rotifera. II. Ann. and Mag. of Nat. Hist., vol. XIX, pp. 628–633.
THORPE, V. G.
'91. New and foreign Rotifera. Journ. Roy. Micr. Soc., 1891.
'93. The Rotifera of China. Ibid., 1893, pp. 145–152.
TURNER, C. H.
'92. Notes upon the Cladocera, Copepoda, Ostracoda, and Rotifera of Cincinnati, with descriptions of new species. Bull. Sci. Lab. Denison Univ., vol. VI, pt. II, pp. 57–74.
(UP DE GRAFF, T. S.)
'82. Proceedings of the Elmira Microscopical Society. The Microscope, vol. II, p. 167.
UP DE GRAFF, T. S.
'83. Descriptions of certain worms. Proc. Am. Soc. Micr., Sixth Ann. Meeting.
VORCE, C. M.
'81. Forms observed in water of Lake Erie. Proc. Am. Soc. Micr., Fourth Ann. Meeting, pp. 50–60.
'82. Microscopic forms observed in the waters of Lake Erie. Ibid., Fifth Ann. Meeting, pp. 187–196.
'87. Note on a new rotifer—*Gomphogaster arcolatus*. Ibid., vol. IX, pp. 250–253.
"J. W."
'83. To the editor. Am. Month. Micr. Journ., vol. IV, p. 18.
(WALKER, J.)
'94. Objects exhibited. Journ. N. Y. Micr. Soc., vol. X, p. 83.
WEBER, E. F.
'98. Faune rotatorienne du bassin du Léman. Revue Suisse de Zool., tome V, pp. 263–785.
WESTERN, G.
'90. Notes on the rotifers exhibited at the meeting of the Quekett Microscopical Club, March 21, 1890. Journ. Quek. Micr. Club, ser. II, vol. IV.
'92. Two male Rotifers hitherto undescribed. Ibid., ser. II, vol. IV, p. 374.
WIERZEJSKI, A.
'93. *Rotatoria (Wrotki) Galicyi*. Krakau, 1893.
WOLLE, F.
'82. Rotifer nests. Am. Month. Micr. Journ., vol. III, p. 101.
'87. Fresh-water Algæ of the United States. Bethlehem, Pa.

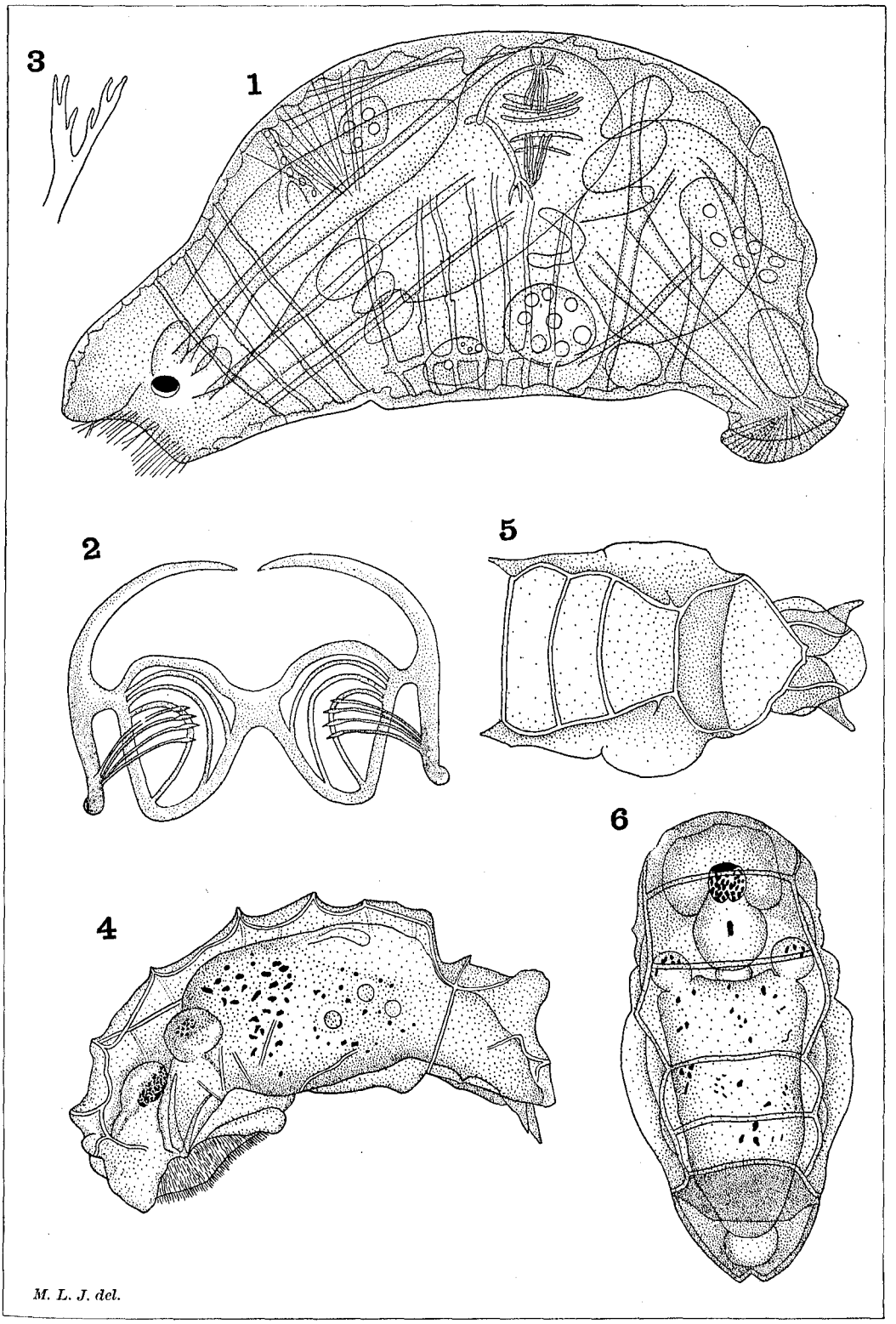


Fig. 1. Apsilus, young, free-swimming individual. Side view.
Fig. 2. Trophi of young Apsilus.
Fig. 3 Branched dorsal hooks of Œcistes melicerta Ehr.
Fig 4. Taphrocampa annulosa Gosse. Side view. (× 640.)
Fig. 5. Taphrocampa annulosa Gosse Dorsal view of posterior three-fourths of body, showing the broad "tail" and the toes. (× 640.)
Fig. 6. Taphrocampa annulosa Gosse, as seen from above; body curved so that the foot is not visible. (× 640.)

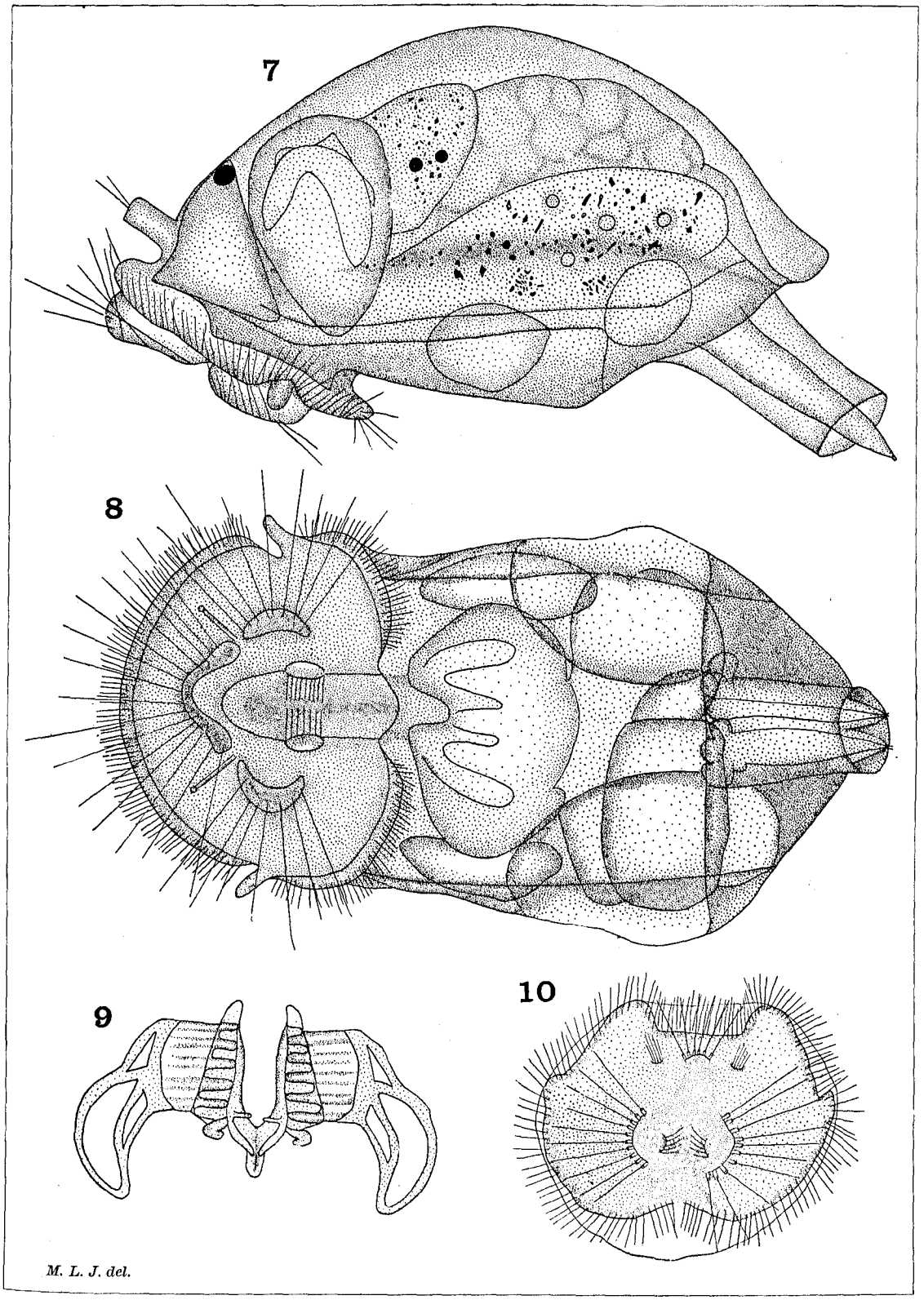


Fig. 7. Notops pelagicus n. sp. Side view. (× 800.)
Fig. 8. Notops pelagicus n sp, Ventral view. (× 800.)
Fig. 9. Notops pelagicus n. sp. Trophi.
Fig. 10. Corona of Notops clavulatus Ehr

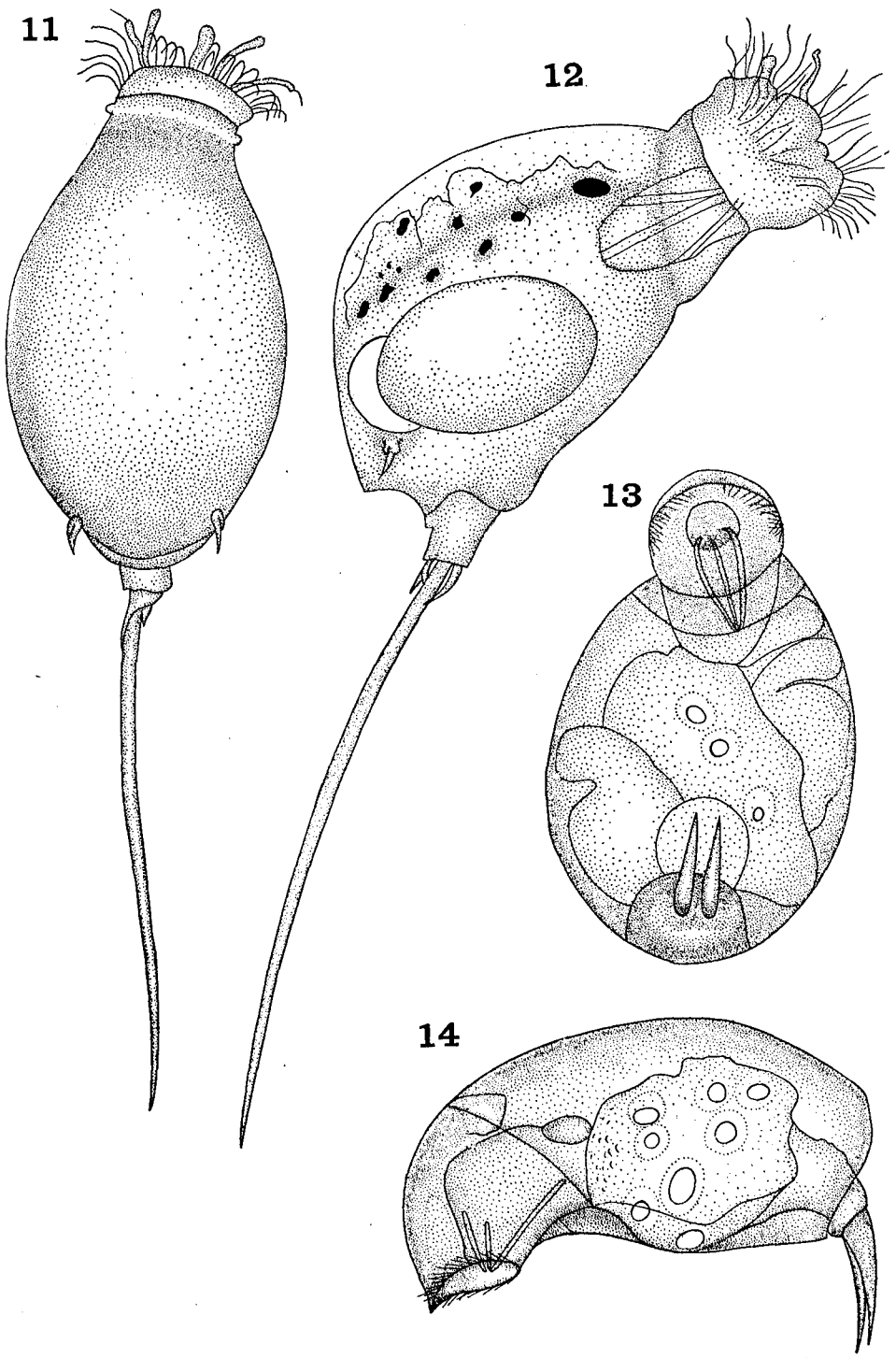


Fig. 11. Mastigocerca bicuspes Pell. Dorsal view. (× 640.)
Fig. 12. Mastigocerca bicuspes Pell. Side view. (× 640.)
Fig. 13. Pleurotrocha parasitica n. sp. Ventral view. (× 640.)
Fig. 14. Pleurotrocha parasitica n. sp Side view. (× 640.)

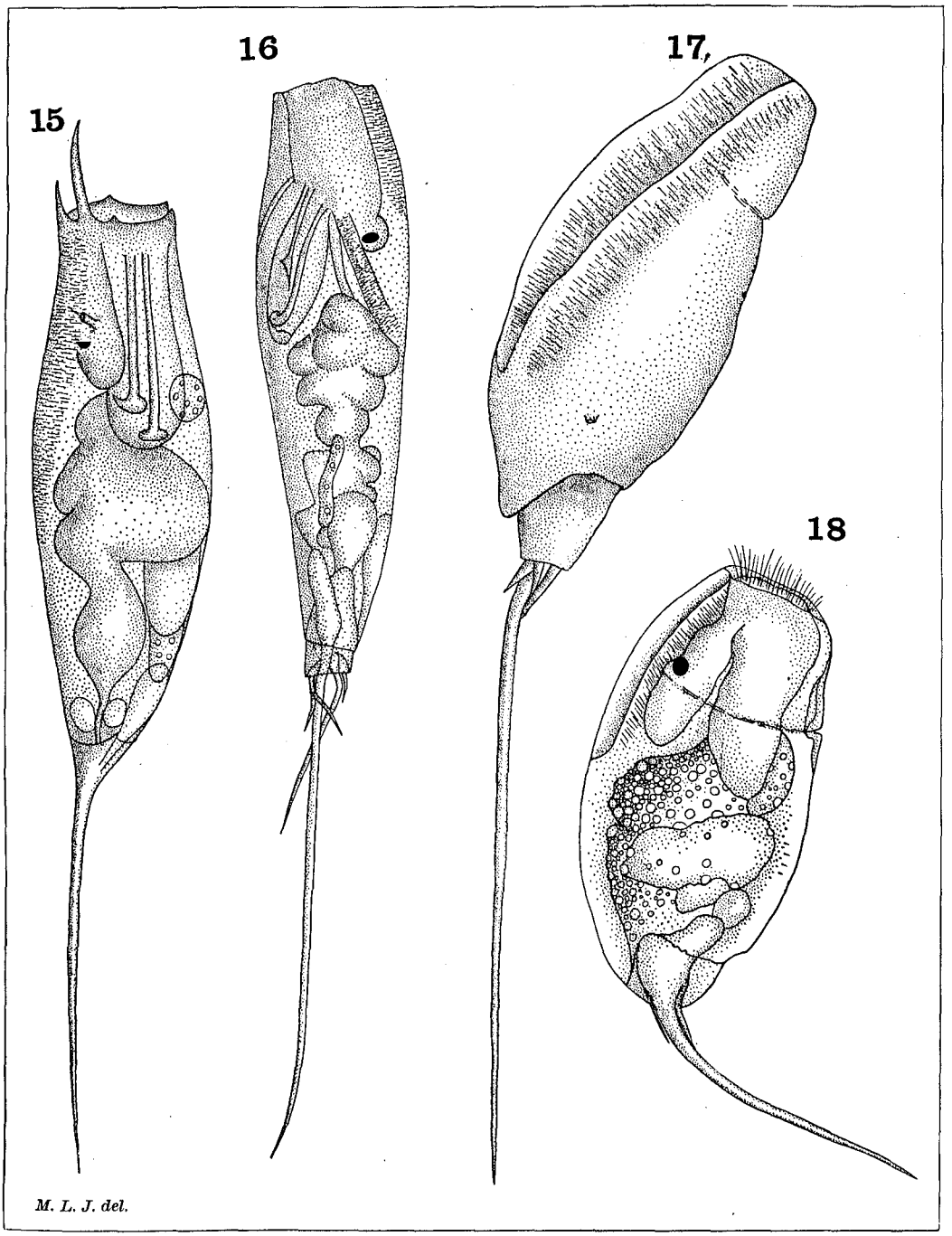


Fig. 15. Mastigocerca bicornis Ehr. Side view. (× 285.)
Fig. 16. Mastigocerca elongata Gosse. Side view. (× 285.)
Fig. 17. Mastigocerca bicristata Gosse. Side view of lorica, showing the two ridges. (× 490.)

Fig 18. Mastigocerca mucosa. Side view, showing the furrow between two dorsal ridges. (× 490.)

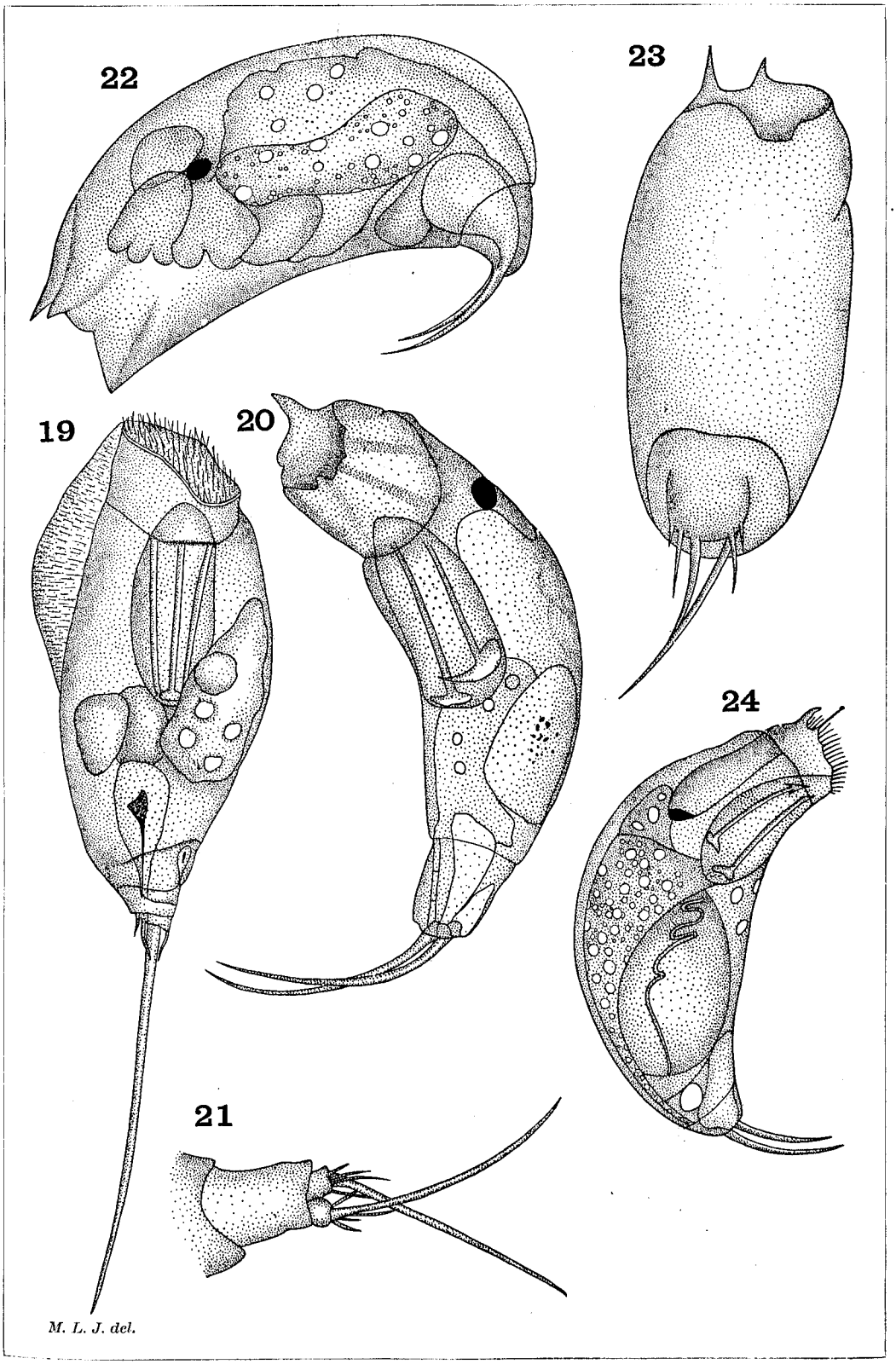


Fig. 19. Mastigocerca carinata Ehr. Side view. (× 490.)

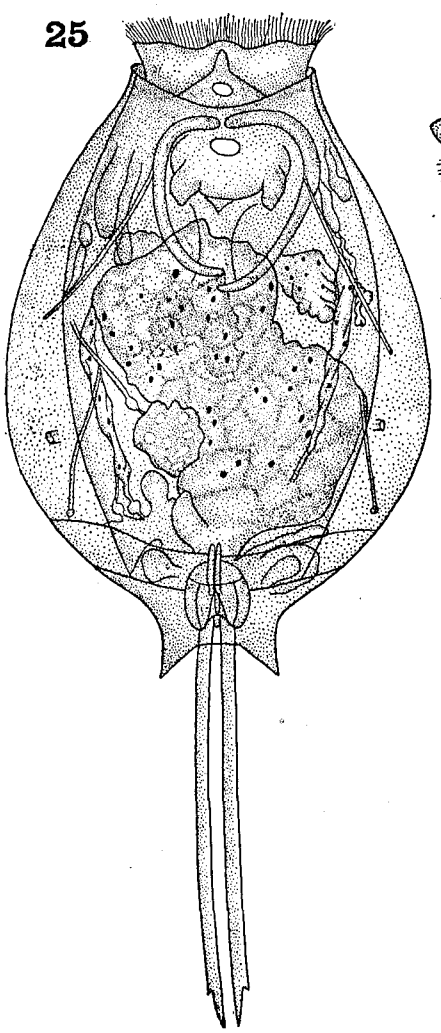
Fig. 20. Rattulus tigris Müller. Side view of retracted animal. (× 640.)

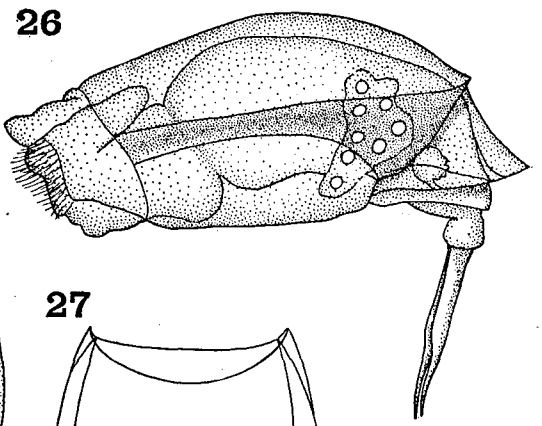
Fig. 21. Rattulus tigris Müller, foot. Ventral view, with the two main toes crossed, showing the four substyles at the base of each toe.

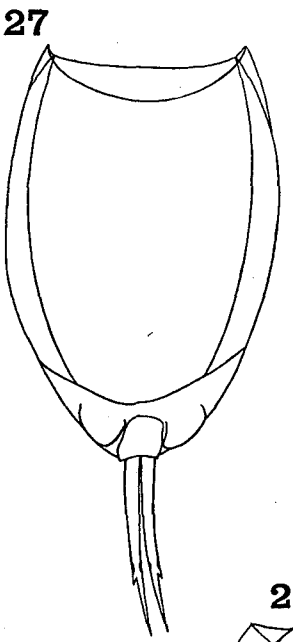
Fig. 22. Cœlopus porcellus Gosse. Side view of retracted animal (× 640.)

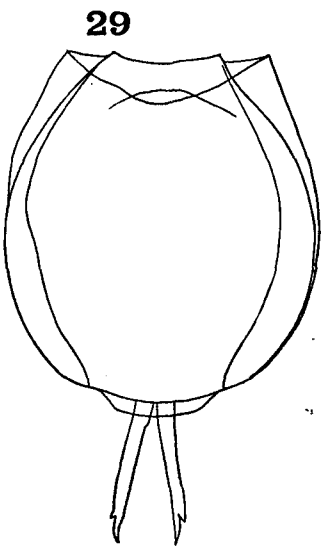
Fig. 23. Cœlopus porcellus Gosse. Ventral view of lorica, showing the two teeth at the anterior margin and the six styles on the foot. (× 640.)

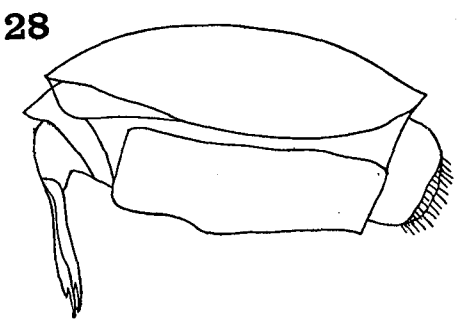
Fig. 24. Cœlopus brachyurus Gosse. Side view of specimen with head extended. (× 640.)





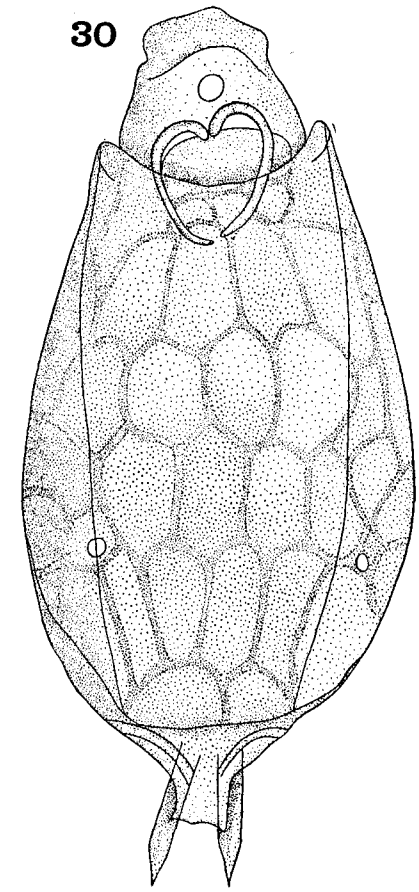


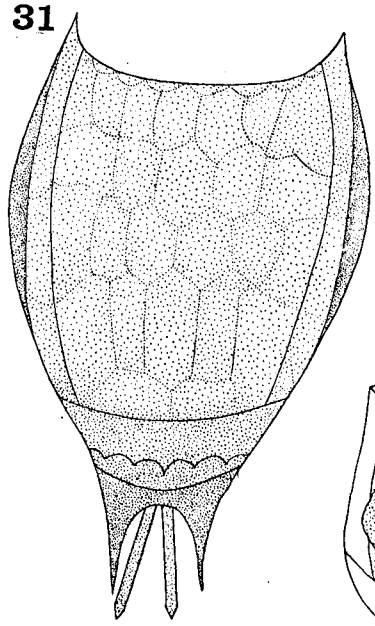


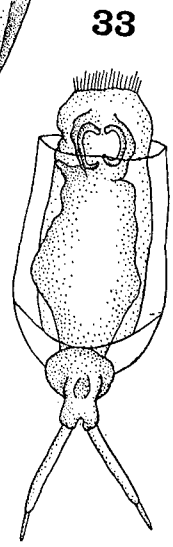


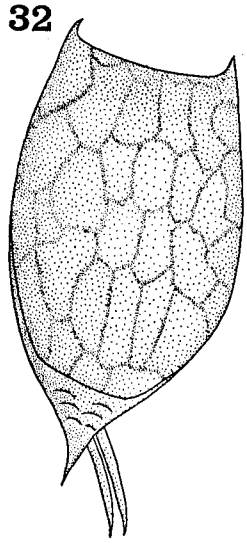
M. L. J. del.

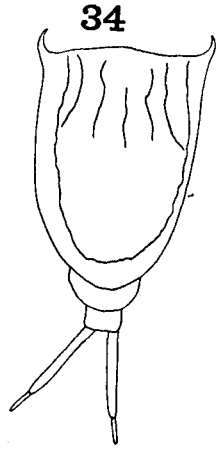
Fig. 25. Cathypna leontina Turner. Dorsal view. (× 490.)
Fig. 26. Cathypna ungulata Gosse. Side view. (× 215.)
Fig. 27. Cathypna ungulata Gosse. Outline of ventral view of smaller specimen. (× 215.)
Fig. 28. Cathypna luna Ehr. Side view. (× 365.)
Fig. 29. Cathypna luna Ehr. Ventral view. (× 365.)

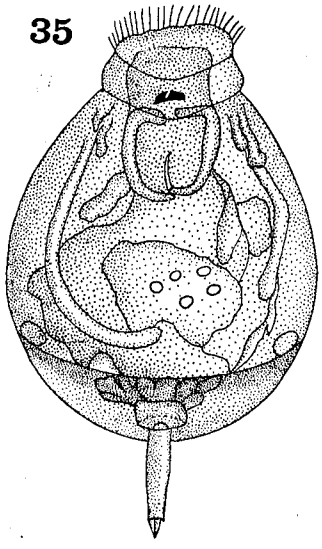


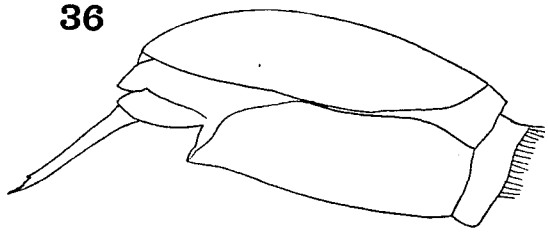






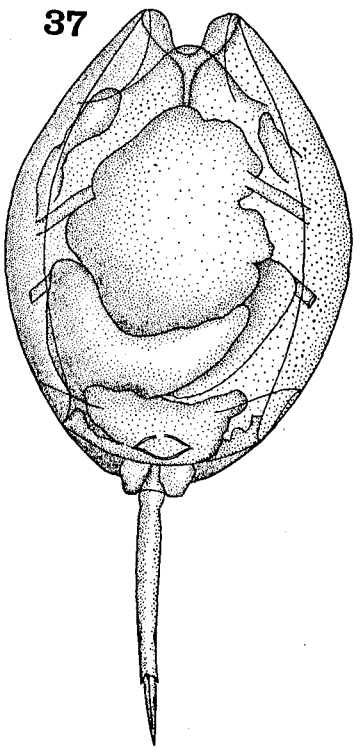


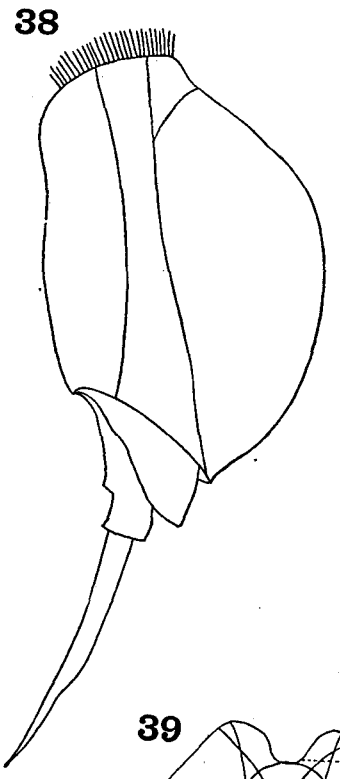


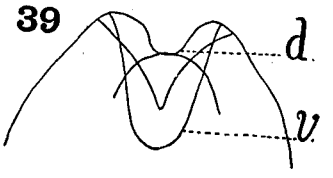


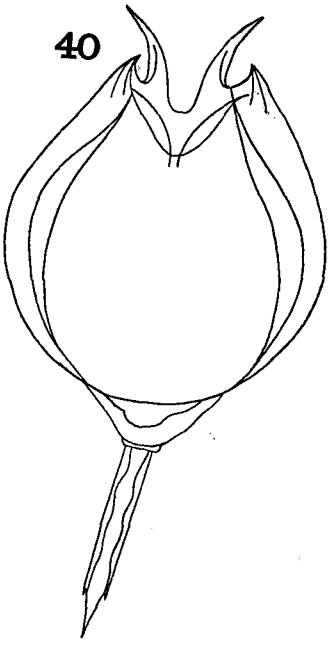
M. L. J. del.

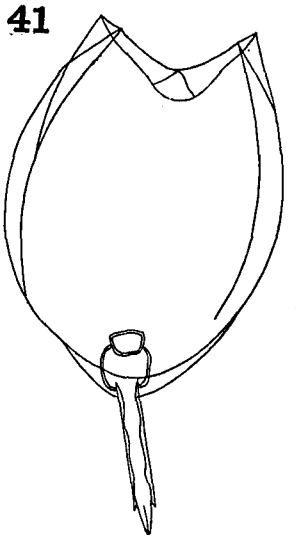
Fig. 30. Distyla ohioensis Herrick. Dorsal view. (× 640.)
Fig. 31. Distyla stokesii Pell. Dorsal view of lorica, showing the arrangement of the facets. (× 460.)
Fig. 32. Distyla ludwigii Eckstein. Dorsal view of lorica (× 385.)
Fig. 33. Distyla gissensis Eckstein. Dorsal view of partially extended animal. (× 315.)
Fig. 34. Distyla gissensis Eckstein. Dorsal view of completely retracted animal. (× 315.)
Fig. 35. Monostyla cornuta Ehr. Ventral view. (× 365.)
Fig. 36. Monostyla cornuta Ehr. Side view. (× 365.)





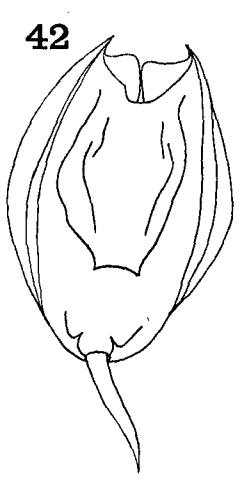


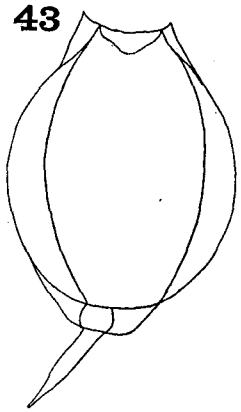


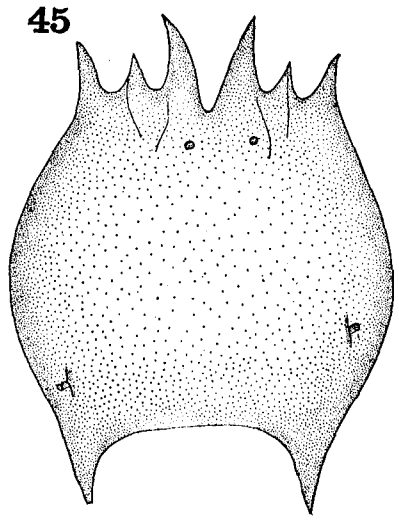


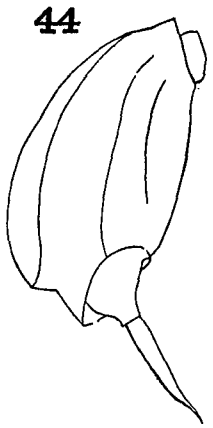
M. L. J. del.

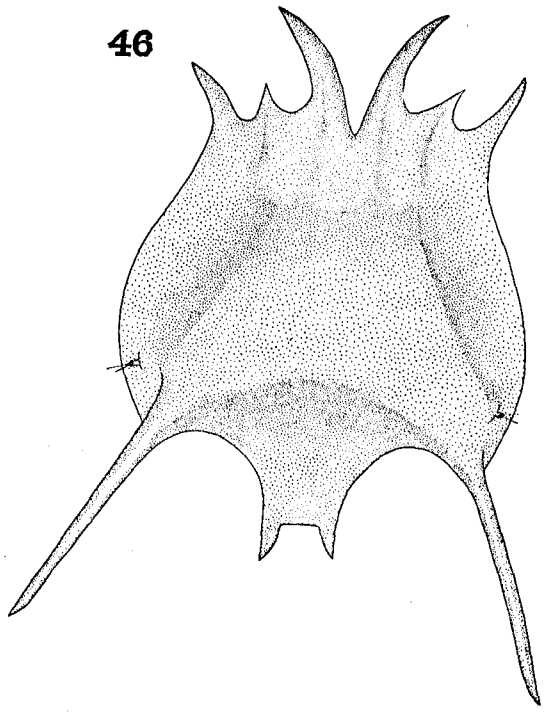
Fig. 37. Monostyla bulla Gosse. Dorsal view. (× 480.)
Fig. 38. Monostyla bulla Gosse. Side view. (× 480.)
Fig. 39. Monostyla bulla Gosse. Anterior margin of lorica in retraction, showing notches in dorsal and ventral plates of the lorica. *d*, Dorsal notch; *v*, ventral notch.
Fig. 40. Monostyla quadridentata Ehr. Dorsal view.
Fig. 41. Monostyla lunaris Ehr. Ventral view, retracted. (× 315.)











M. L. J. del.

Fig. 42. Monostyla hamata Stokes. Ventral view. (× 480.)
Fig. 43. Monostyla hamata Stokes. Dorsal view. (× 480.)
Fig. 44. Monostyla hamata Stokes. Side view. (× 480.)

Fig. 45. Brachionus bakeri Ehr. Short-spined variety, from pools on the rocky surface of Starve Island.
Fig. 46. Brachionus bakeri Ehr. Long-spined variety, from swamps of South Bass Island.