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OHIO BIOLOGICAL SURVEY

BULLETIN 4

A REVIEW OF THE DESCRIBED SPECIES OF THE ORDER

Euglenoidina Bloch

CLASS FLAGELLATA (PROTOZOA) WITH PARTICULAR REFERENCE TO THOSE FOUND IN THE CITY WATER SUPPLIES AND IN OTHER LOCALITIES OF OHIO

BY

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VOLUME I BULLETIN 4

Ohio Biological Survey

A REVIEW OF THE DESCRIBED SPECIES OF THE ORDER EUGLENOIDINA BLOCH. CLASS FLAGELLATA (PROTOZOA) WITH PARTICULAR REFERENCE TO THOSE FOUND IN THE CITY WATER SUPPLIES AND IN OTHER LOCALITIES OF OHIO

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THE EUGLENOIDINA OF OHIO

A Review of the Described Species of the order Euglenoidina Bloch. class Flagellata (Protozoa) with particular reference to those found in the city water supplies and in other localities of Ohio.

L. B. Walton

1. Introduction.

(a) GENERAL.

Among the minute forms of life frequenting inland waters and in particular, lakes, ponds, reservoirs, and stagnant pools, is an order of single celled organisms belonging to the class Flagellata of the Protozoa, the representatives of which possess characteristics of both animals and plants. They are not only of interest from their economic importance, inasmuch as many of the species at times occur in great numbers and impart peculiar odors, tastes, and colors to water, rendering it unpalatable for drinking purposes, but they are also of much interest from an educational standpoint, since they furnish an extremely valuable type in general use for biological instruction both in collegiate work and in the laboratory work of the better grades of high schools.

While the majority of species are sufficiently distinct from one another to permit of recognition, the absence of a satisfactory review has prevented any general knowledge of these small organisms and has also resulted in many errors and inaccuracies of classification even among those biologists who have interested themselves in the forms allied to Euglena. It was largely with a view of attempting to remedy such conditions that the present paper, the outcome of studies during the past ten years, was commenced. Just as the work was nearing completion, Pascher and Lemmermann's "Die Süsswasserflora Deutschlands, Osterreichs und der Schweiz" (Flagellatae, 1914) was issued. While the tables of genera and species, nearly all completed at that time in

Contributions from the Biological Laboratory of Kenyon College No. 12.

the manuscript of the present paper, were closely in agreement with those of the "Süsswasserflora," making due allowance for individual viewpoints, there are several distinctions in the treatment of the material which may be mentioned. The synoptic tables for the separation of species, etc., are not dichotomous as are the tables in the following pages where only two possibilities "A^1" and "A^2," etc., are presented at a time. With the assumption that the characters utilized are of equal value, dichotomous tables certainly furnish a better means toward the classification of organisms than tables where three, four or more similar characters are relatively considered at the same time. The present paper furthermore aims to note all recognized species and varieties of the order distributed throughout the world, including the few forms which are marine. The paper of Lemmermann approaches completeness in this respect, inasmuch as the group is a cosmopolitan one, in that almost any restricted area where the organisms are carefully studied will furnish representatives of nearly all known species. He omits the marine forms, however.

The Euglenoidina are of microscopic size, rarely exceeding 200μ[1]—usually 10-60μ—in length and are in general inhabitants of the fresh water, although a few are marine and a few parasitic. In common with most other minute organisms which are aquatic, they are uniformly distributed throughout the temperate and tropical regions of the world. Consequently in a review of the species found in Ohio it has seemed advisable to also include all described forms, inasmuch as a majority of these will eventually be found to occur in the state.

The work hitherto done in connection with the Euglenoidina found in Ohio is comprised in two check lists of Protozoa. The first, a "Report on the Protozoa of Lake Erie," by Jennings (U. S. Fish Com. Bull. 1889), who notes fifteen species of the order from localities near Put-in-Bay. The second, a list of "The Protozoa of Sandusky Bay and Vicinity," by Landacre (Proc. Ohio Acad. of Science, Vol. 4, Pt. 10, 1908), lists thirty species with many interesting notes. Fifty-two species from Ohio are given in the present paper, which also includes one hundred and ninety-four species which have been described from various parts of the world. No tables or figures are presented in either of the preceding lists.

1 One micron (1μ) equals one thousandth of a millimeter.

(b) METHODS.

The apparatus and supplies needed in a study such as outlined consist of a good microscope provided with an oil immersion objective and the general accessories. The instrument will cost approximately $75 and a Spencer 40 or 46 G, or a Bausch and Lomb BB-8 will be found quite satisfactory, although where cost is not a prohibitive factor the Leitz "Monobjective" binocular, costing approximately $250, duty free, with the apochromatic optical equipment is to be recommended. Magnifications should range from 50-2500. Among accessories may be mentioned slides; cover glasses (22-25m round); half dozen small pipettes; one dozen watch glasses (Syracuse pattern); a stage micrometer ruled in 1/10 and 1/100mm; an ocular micrometer; camera lucida ($10-$20); 2-H and 6-H "Kohinoor" drawing pencils; lens paper; dissecting needles, tweezers, and scissors, etc. An Irving Pitt No. 9108 Note Cover (I-P Mfg. Co., Kansas City), with paper punched to fit (procure a light weight bond at a paper supply house, size 8 x 10½, and have punched to fit cover) is useful in keeping notes and drawings together. These supplies, with the exception of the Note Cover, may be procured from the Spencer Lens Co., of Buffalo; the Bausch and Lomb Co., of Rochester, or from the U. S. branch of E. Leitz, 30 E. 18th Street, New York City.

Small drinking glasses with rectangular pieces of glass placed on top to prevent too rapid evaporation (a slight opening should be left), may be used as aquaria, while one or two quart milk pails make excellent collecting receptacles. Where smaller quantities of material are collected, and it is desirable to prevent contamination, ground glass stoppered bottles with metal screw caps (Betz Co., Hammond, Indiana), which come in pads usually containing six bottles, may be used. These are easily sterilized and may be kept as small aquaria until the culture is exhausted. Quantitative methods of study have not been utilized in the present paper.

(c) NEW SPECIES.

Four new species of Euglenoidina are noted in the following pages. *Euglena simulacra* from Fremont, Ohio. *Euglena truncata* from Hiawatha Lake, Mt. Vernon, Ohio. *Scytomonas dobelli* from the digestive tract of *Molge vulgaris*, Europe. *Ploeotia marina*, a marine form, from Woods Hole, Mass.

(d) ACKNOWLEDGMENTS.

It is appropriate to note that much of the systematic work on the Euglenoidina by the writer has been based on material obtained in connection with investigations made possible through the Emerson McMillin Fund.

2. Structure.

The Euglenoidina are typically elongately oval or spindle-shaped in form with a length of from 6-500 microns. They are provided with a single (rarely two) flagellum (1) arising from a cytopharynx (5) and consisting of an axial filament (2) surrounded by protoplasm (3). They possess either a rapid rotating swimming movement drawing themselves forward by means of the flagellum, or a creeping, twisting (metabolic) movement.

The protoplast (22) secretes a periplast (21) which may be thin or thick and covered with longitudinal or spiral striae (18) composed of punctuations (19). The protoplast often secretes a shell in addition to the periplast, which may be covered with spines or other formations. The stigma (6) normally present in the green Euglenidae varies from orange red to a dull yellow. There is usually present a large vacuole (9) with a vacuolar canal opening into the reservoir (7), narrowed anteriorly into a cytopharynx (5), and one or more contractile vacuoles (8) which empty into the large vacuole.

In various genera chloroleucites (17, 23) give the protoplast a green color and may be disciform, with the margin smooth or deeply notched, ribbon-like, or aggregated into star-like clusters. Paramylon (12, 20) in granules of various forms often containing a distinct pyrenoid (24) may also be present as a product of assimilation. The position of the nucleus (14, 15), particularly in the green forms, is designated by a clear space near the middle of the body and consists of a central (15) mass surrounded by chromosomes (14). Near the nucleus and only demonstrable by careful technical methods there is often a basal granule (blepharoplast?) (16), from which the flagellum may arise by two filaments (10). In the family Peranemidae a pharyngeal siphon (11) or rod-like organ of uncertain function is often present.

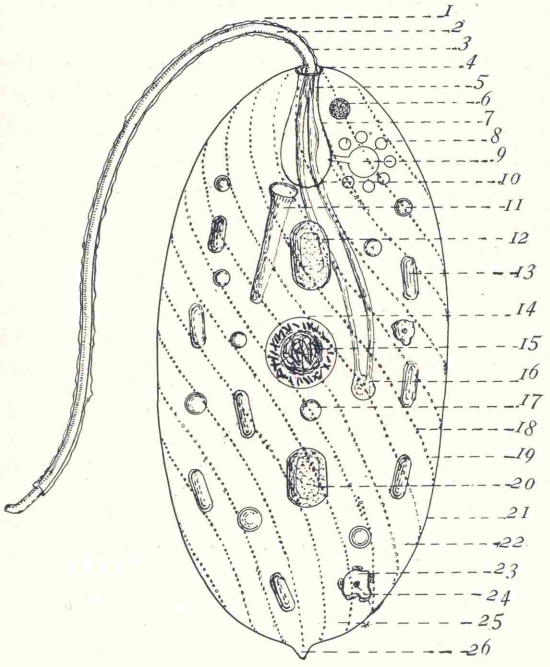

Fig. 1, A Typical Euglenoid.

1. flagellum.
2. axial filament.
3. flagelloplast.
4. collar.
5. cytopharynx.
6. stigma.
7. reservoir.
8. secondary vacuole.
9. primary vacuole.
10. double filament.
11. pharyngeal rod.
12. paramylon (ant. prim. gran.)
13. paramylon (secondary gran.)
14. nucleus (periph. area).
15. nucleus (cent. area).
16. basal granule.
17. chloroleucite. (regular).
18. stria.
19. punctuations.
20. paramylon (post. prim. gran.)
21. periplast.
22. protoplast.
23. chloroleucite (irregular).
24. pyrenoid.
25. interstrial area.
26. tip.

3. Development.

Reproduction may occur by asexual vegetative division or by sexual reproduction, although substantial evidence as to the various phases in the latter is still absent.

The vegetative reproduction consists of either a longitudinal division of the normal individual or the division of the individual after having undergone an encystment stage. In the latter case the cyst often divides a number of times, forming many small cysts more or less closely connected. The small individual escaping from the cyst may grow into a mature form or undergo the complicated process of a sexual cycle by the copulation of the individuals.

The form of the spores, particularly among the Euglena, is of considerable systematic importance.

4. Economic Importance.

(a) GENERAL RELATIONS TO WATER SUPPLIES.

The practical importance of the Euglenoidina in their relation to man is based upon several considerations. They constitute one of the principal groups of the unicellular organisms which possess chlorophyl and are able to absorb the various inorganic salts as well as the oxygen and carbon dioxide contained in the water and thus produce starch-like substances. These substances in turn through the intermediate crustacea, etc., form the basis of the food supply of the fishes and other animal organisms living in an aquatic environment. Economic phases of this nature, which pertain to the fishing industry as well as to water fowl, etc., particularly of the region of the Great Lakes, will be more appreciated as time brings about a diminishing supply of such animal organisms and threatens the commercial importance of the industries dependent thereon.

Water from both public and private supplies often has unpleasant tastes or odors and in the majority of cases the result is due to the presence of organisms of microscopic size which reach their maximum development, so far as numbers are concerned, in reservoirs, ponds, and lakes. Inasmuch as such conditions are usually due to the substances—oil globules, etc.—set free when the minute forms of life are in a state of disintegration, the filtration of the water, particularly mechanical filtration, does not necessarily remove the unpleasant taste, although the proper kind of filtration accompanied by aeration usually proves successful. When ground waters from infiltration galleries—deep wells in

proximity to streams or lakes—or chemically and mechanically purified surface waters are pumped into open reservoirs large numbers of microscopic organisms may develop. If the storage reservoirs are covered and the light necessary to the growth of forms having chlorophyl is shut out, the number of organisms is much lessened.

While the Euglenoidina, which are under consideration in the present paper, form only one of several groups of organisms that from time to time pollute water supplies, they are on many occasions responsible for disagreeable conditions of the water. The specific forms causing the trouble have been recognized with difficulty, however, owing to the absence of satisfactory tables for the separation of genera and species, and thus attempts at identification have only been partially successful, even in the hands of specialists.

Various species of the Euglenoidina give off a recognizable "violet" odor, as has been noted in the Annual Report of the State Board of Health of Massachusetts for 1892. Butschli, 1884, ascribed a "fishy" odor to *Euglena sanguinea* when the cells were found to be disintegrated and suggested that the odor was not due to putrefactive processes as had earlier been supposed, but to the oil vacuoles formed during metabolism and contained in the protoplasm of the individual.

Zacharias in 1902 called attention to the pools of water turned red by the immense numbers of *Astasia haematodes (Euglena haematodes* (Ehrenb.)). A similar condition has often been observed in pools throughout Ohio and other states usually during the months of July and August and results from an allied form, *Euglena sanguinea,* Ehrenb. *Euglena rubra,* Hardy, produces the same result in Australia, while *Euglena orientalis,* Kashyops, is another red form which has been described from the Shalamar Gardens in Lahore, India.

When such organisms as the Euglenoidina pollute water supplies in considerable numbers, they may be eliminated by the copper sulphate method. The quantity required for the specific organisms varies from 0.4 pounds per a million gallons of water for Uroglena to 41.5 pounds per a million gallons for Beggiota.

Trout are killed by an application of 1.2 pounds, while sunfish and black bass can withstand 10-17 pounds. Euglena and probably most other forms of the order are killed by the use of 0.4 pounds to a million gallons of water.

The method employed is that of taking ordinary commercial crystals of blue vitriol to the required amount, placing in a coarse bag and drawing through the water at the stern of a row boat in parallel paths approximately twenty feet apart until the chemical is dissolved.

The various technical details in connection with the calculation of the volume of the water, the influence of the temperature of the water on the solubility of the crystals, the amount of organic material in the water as well as the specific kinds of organisms present, render it advisable to consult some one familiar with the process before undertaking purification by the copper sulphate method.

(b) NOTES ON ORGANISMS IN OHIO WATER SUPPLIES.

A considerable number of water supplies in the state were examined and samples taken from receiving and storage reservoirs. Among the cities visited were Cincinnati, Columbus, Cleveland, Akron, Dayton, Cuyahoga Falls, Canton, Hamilton, etc. While representatives of the Euglenoidina were not found in every instance, a result to be expected inasmuch as the group is a restricted one as compared with the numerous other groups of unicellular and multicellular organisms occurring in fresh water, many species of much interest were noted. Among these may be mentioned *Leptocinclis acicularis* from the Cincinnati water supply, previously known only from Hungary in Europe; *Trachelomonas teres,* known before only from New Zealand (Cincinnati water supply); *Notosolenus apocamptus* and *Entosiphon ovatum,* from the Hamilton storage reservoir; *Trachelomonas rugulosa* and an undescribed species of *Euglena* from the Storage Dam at Columbus; *Trachelomonas volvocina* from Cuyahoga Falls, etc.

While it is somewhat beyond the scope of the present paper, certain other fresh water organisms found in the reservoirs may be mentioned.

In the large storage reservoirs at Cincinnati were noted *Potamogeton spirillum* and *Potamogeton pectinatus,* comparatively

large water weeds. These were in small quantities and were gradually being dredged out after having withstood a considerable amount of a copper sulphate solution. Among the unicellular forms were *Centropyxis aculeata, Trachelomonas teres, Entosiphon sulcatum, Cosmarium, Pleurosigma, Spirillum,* etc. In the storage reservoir containing the purified water from immediately above the weir where the water was aerated, were obtained *Difflugia constricta* among filaments of *Cladophora glomerata, Trachelomonas globularis, Amoeba sp., Aspidisca costata, Navicula, Cosmarium, Oscillatoria,* etc. None occurred, however, in quantities which would impart tastes or odors to the water.

At Hamilton in an uncovered reservoir situated across the river on the hill were found *Cladophora crispata* submerged on the bottom of the reservoir; *Halteria grandinella, Pediastrum tetras, Codonosiga botrytis, Chilomonas paramecium,* species of *Planarians,* etc.

From the Storage Dam at Columbus numerous species of *Paramecium, Amoeba, Euglena, Trachelomonas, Diatoms,* etc., as well as *Aelosoma,* one of the aquatic oligochaetes.

Other interesting species were found from samples at Lisbon, Cuyahoga Falls, Akron, etc.

5. Classification.

(a) HISTORICAL.

The history of the minute forms of aquatic life is closely connected with that of the microscope and may be said to date from Leeuewenhoeck, 1675, who was succeeded by Trembley, 1744; Muller, 1786, and Ehrenberg, 1838. The latter, by aid of improved microscopes, worked out details of structure with great care, although erroneously interpreting many of them. For instance the red pigment spot—the stigma—so generally found among the Euglenidae was supposed to be actually an eye, while the nerve ganglion which was assumed must accompany it, was described in a species of Astasia. Following Ehrenberg came Dujardin, 1841, who clearly outlined the class Mastigophora (Flagellata) as animals provided with one or more flagella. Later Stein, 1850; Kent, 1880, and others who did excellent work taking

into consideration the microscopes which they employed and the extent of the systematic territory which they attempted to cover.

During the present period careful systematic studies of the Euglenoidina began with Butschli, 1883, in Bronn's, "Classen und Ordnungen des Tierreichs." Senn in 1900 reviewed the genera of the group (Euglenineae) in connection with Engler-Prant's "Die naturlichen Pflanzenfamilien," giving excellent illustrations of representatives of each genus with tables of genera. The paper by Dangeard, 1902, entitled "Recherches sur les Eugleniens," formed a most valuable contribution to the literature on the group, covering both the systematic and structural parts, omitting largely, however, the family Peranemidae. From a systematic side it could well be criticized by the lack of conciseness so essential to papers dealing with the problems of classification. Species were enumerated, although no tables for the separation of either genera or species were included, a serious oversight in a modern systematic work. A table of contents as well as an index was also lacking.

Lemmermann in 1913 presented as a part of Pascher's "Die Süsswasserflora Deutschlands, Osterreichs und der Schweiz" a review of the "Eugleninae" (Euglenoidina) with excellent figures of nearly all species described.

(b) PRINCIPAL CHARACTERS.

Following Klebs the order is separated into three families, the *Euglenidae,* which obtain their nourishment primarily by the action of sunlight in connection with chlorophyl (holophytic), and the *Astasiidae* and *Peranemidae,* which obtain their nourishment by the absorption of organic substances through the surface of the body (saprophytic or saprozoic).

Without entering into any argument as to the relative position of the Euglenoidina among animals and plants, the termination *-idae* has been used with the family names in accordance with Zoological classification.

The principal characters utilized for the purposes of classification are the *form* of the cell—radial, bilateral, elongate, spherical, broad, fusiform, provided with a collar which may be notched

or consist of an annular thickening, etc.; structure of *periplast*—elastic or metabolic, firm, striated either spirally or more rarely longitudinally, the striae consisting of minute elevations as a rule, development of a *shell* with or without spines, punctuations, wart-like processes, etc.; *chloroleucites* (chloroplasts) absent or present in the form of ribbon-like bands, elongated cylindrical rods, disks with margins smooth or lobed, star-like masses, all of which may or may not contain *pyrenoids; paramylon* with granules of varying forms, usually elongately spherical; *pharyngeal siphon,* a rod-like organ of unknown function present in certain *Peranemidae; stalk* present in a few forms, long, short, branched or not branched; length of *flagellum* as well as the number and position where two flagella are present; *stigma* present or absent, etc. The structural position of the characters noted is indicated in Fig. 1 on a preceding page.

Many other minor characters are used, mention of which will be made in the tables for separating genera and species.

(c) METHOD OF STUDY.

Material from standing water—small ponds, stagnant pools, ditches, etc.—particularly where organic matter is in a state of decomposition, will invariably yield many interesting species of the Euglenoidina. If such material is placed in small bottles where, however, it should not remain more than 48 hours with the stoppers inserted, and then only when an air space approximately equal to one-third the capacity of the bottle is left, and subsequently transferred to aquaria, the scum rising on the surface within the course of a few days will contain innumerable forms. Ordinary drinking glasses make excellent aquaria. They should be provided with a rectangular glass cover to prevent too rapid evaporation, although this should not entirely close the top, thereby allowing the gases arising in the decaying matter to escape.

Many species of Euglenoidina occur as "plankton" carried from place to place in large bodies of water by winds and currents and may be obtained with a plankton net made of finely meshed "bolting cloth" drawn through the water.

If one wishes to ascertain the number of organisms present in a definite body of water such as a reservoir or pond from which

water supplies are obtained, quantitative methods of study must be used. A measured amount of water—500-2000cc—is passed through an apparatus for concentrating the organisms. This may consist of a glass funnel inserted into the stoppered neck of a wide mouth bottle holding about 250cc and which also has as an overflow, a glass tube with a piece of "'bolting cloth" covering the inner end. The organisms may be reconcentrated after reaching the laboratory by passing through a funnel having some fine quartz sand in the bottom of the funnel supported by a cork with a piece of "bolting cloth" holding the sand in place. The sand must not be allowed to dry but be washed out in a watch glass in distilled water, the distillation of which has been accomplished in glass vessels with due care.

After having obtained material, rough observations made in the laboratory by placing a small quantity of water in a watch glass and examining with a magnification of 60-150 diameters, will give an idea as to the various genera and species represented. In order to properly classify the species, however, one must take a clean slide and cover glass and study with magnifications of from 500-2500 diameters, as well as ascertain the dimensions of the particular organisms with either the ocular micrometer or the camera lucida, the magnification of the microscope having first been obtained with the stage micrometer. In this connection it will be advisable to consult some of the introductory books in microscopy, such as that of Gage (Comstock Publishing Company, Ithaca, N. Y. Price $2.00) if one has not previously had experience.

The method which the writer has found best adapted for studying the Euglenoids and other microscopic organisms in the living conditions is that of utilizing a lens-paper aquarium. A piece of lens-paper is cut with the dimensions smaller than the cover glass, then by trimming out the center a ring-lie piece is left. This is placed on the middle of the slide and attached by a drop of water from a pipette. Then a drop of water containing the organisms is placed in the center, and a cover glass carefully placed over it, avoiding air bubbles by lowering gently with the tweezers. Immediately tilt the slide and draw off any surplus water with the pipette. The aquarium will keep for several hours and the cover glass will be supported by the thin layer of lens-paper and

thus not crush the organisms as the water evaporates. A permanent aquarium may be made by cutting the outside margin of the lens-paper 2-5mm smaller than the cover glass and after the water *in this external area has partly evaporated (15-30 minutes) run*ning a small quantity of paraffin oil around the margin of the cover glass. Such an aquarium will retain organisms for a month or more in a living condition provided there is a proper balance of animal and plant life.

By means of the lens-paper aquarium described the forms may be studied with the 4mm. or even the 2mm. oil immersion objective. If the movements are too rapid, they may be placed in a 2-3% solution of gelatin, which will retard their activities. Inverting a drop of water on a slide over the neck of a bottle containing a 2% solution of osmic acid will instantly kill the forms, usually without any distortion. Their life-like appearance may be lost, however, and it is always best to study first under natural conditions.

(d) CHARACTERS OF THE ORDER EUGLENOIDINA.

Order EUGLENOIDINA Blochmann.

Euclenoidina Blochmann; Die mikoskopische Tierwelt d. Süsswassers, 1895; Doflein, Lehrbuch der Protozoenkunde 1911, p. 505.

Euglenineae Senn, Engler u. Prantl, Natürliche Pflanzenfamilien, p. 173 I Teil, Ab. $1^{a}\mu$. 1^{b} 1900.

Euglenida Delage et Herouard, Traite de Zoologie Concrete, Tome 1, p. 345.

Eugleninae Lemmermann, Die Süsswasserflora Deutschlands, Osterreichs und der Schweiz Heft 2, p. 115, 1914.

Form elongately oval with a pharynx from which one or more, rarely two, flagella extend; body metabolic but not amoeboid, provided with a firm periplast which is often striated or sculptured; excretory system complicated usually with a comparatively large reservoir into which one or more contractile vacuoles open; anteriorly near the base of the pharynx a stigma; protoplasm containing granules of paramylon while chromatophores may or may not be present; nucleus large with central "Binnenkörper"; reproduction agamous with a single or with multiple division, although isogamous copulation has been observed in the genus Copromonas (Scytomonas).

Habitat mostly in fresh water, a few species marine, and a few parasitic.

Length 6-500 microns.

The order may be separated into three families as follows:

(e) TABLES OF FAMILIES, GENERA AND SPECIES.

TABLE OF FAMILIES.

A¹ Green chloroleucites and red stigma present . . . 1. Fam. **Euglenidae**

A² Green chloroleucites and red stigma absent; forms colorless.

B¹ Form radial, usually free swimming, nourishment saprophytic . . . . . 2. Fam. **Astasiidae**

B² Form bilateral, movement usually creeping, nourishment through solid particles taken into the pharynx . . . . . 3. Fam. **Peranemidae**

1. Fam. EUGLENIDAE Stein

Euglenidae Stein

Form oval elongate radial, usually somewhat flattened, the body twisted spirally, metabolic; protoplasm containing green chloroleucites as well as paramylon granules; periplast often with spirally arranged punctuations; cytopharynx present from which arises one or rarely two flagella; red stigma present; reproduction as a rule through division during the encysted stage, the cysts often being enclosed within a gelatinous envelope.

The species are inhabitants of fresh water with the exception of Trachelomonas and Eutreptia, which are also found in salt water.

The number of described species which may be recognized is 127, distributed throughout the world.

TABLE OF GENERA

A¹ Provided with a single flagellum.

B¹ Free swimming, not attached by a stalk.

C¹ Not provided with a brownish protective covering.

D¹ Periplast elastic, forms metabolic; typically radial in structure . . 1. Gen. **Euglena**

D² Periplast firm, thickened, forms not metabolic; radial or compressed in structure.

E[1] Chloroleucites disk form, more or less numerous.
F[1] Form radial not compressed; usually provided with two annular paramylon granules. 2. Gen. **Leptocinclis**
F[2] Form compressed; paramylon granules of various shapes. 3. Gen. **Phacus**
E[2] Chloroleucites in the form of two elongate lateral bands . 4. Gen. **Cryptoglena**
C[2] Provided with a brown or brownish-green protective covering which usually bears rugosities or spine like processes. . 5. Gen. **Trachelomonas**
B[2] Typically sessile (free swimming during part of reproductive cycle) and attached to minute crustacea, rotifers, filamentous algae, etc.
C[1] Not provided with a basal stalk; distinct protective envelope present . . 6. Gen. **Ascoglena**
C[2] Provided with a basal stalk; distinct protective envelope not present . . . 7. Gen. **Colacium**
A[2] Provided with two flagella; form bluntly conical with posterior end more or less pointed . . . 8. Gen. **Eutreptia**

1. Gen. EUGLENA Ehrenberg.

Form oblong or spindle shaped, contractile; free swimming; a single anterior flagellum; body covered by an elastic periplast often provided with minute elevations arranged spirally; on the anterior end a deep groove from the base of which arises a flagellum; an anterior stigma together with a complicated vacuole system consisting of a reservoir into which one or more small contractile vacuoles open; protoplasm containing green chromatophores (chloroleucites), together with paramylon bodies both differing greatly in form and position in the various species; nucleus large, centrally located with an interior nucleolar body.

Reproduction agamous through division occurring either in the free swimming stage, where it is usually longitudinal, or during an encysted stage, where the single cyst often divides into numerous smaller cysts. Conjugation has not been definitely demonstrated, although a sexual cycle probably occurs.

The species are found chiefly in stagnant fresh water, although a few are marine and one has been noted as parasitic in a species of *Mesostoma, one of the Turbellarians, although not described.*

Distribution, cosmopolitan.

TABLE OF SPECIES.

A[1] Chloroleucites (green chromatophores) present with the color rarely obscured by red hematochrome.

B[1] Chloroleucites in the form of more or less flattened rods or ribbons which may be arranged into a star shaped mass or otherwise distributed throughout the protoplasm.

C[1] Color green; species usually not exceeding 70μ in length.

D[1] Some of the chloroleucites collected into star-like masses.

E[1] Star-like masses 1-2 (rarely 3) in number.

F[1] Nucleus posterior; chloroleucites in a single median star-like mass. 1. **E. viridis**

F[2] Nucleus median; chloroleucites in two or three star-like masses. . 2. **E. geniculata**

E[2] Star-like masses more than three in number.

F[1] Posterior end pointed; pyrenoids without shell-like covering . 3. **E. olivacea**

F[2] Posterior end rounded; pyrenoids with shell-like covering . 4. **E. oblonga**

D[2] Chloroleucites not collected into star-like masses, but in the shape of elongated bands.

E[1] A single chloroleucite present.

F[1] Species extremely elongated; chloroleucite straight . . 5. **E. elongata**

F[2] Species comparatively short; chloroleucite spiral . . . 6. **E. minima**

E[2] Two or more chloroleucites present.

F[1] Two lateral chloroleucites . 7. **E. pisciformis**

F[2] Chloroleucites in the form of numerous elongated bands.

G[1] Band like chloroleucites parallel with the longitudinal axis 8. **E. terricola**

G[2] Band like chloroleucites arranged spirally . . 9. **E. splendens**

C[2] Color normally red; species exceeding 70μ in length.

D[1] Periplast striated; length 120-225μ.

E[1] Caudal end acute; length approximately 120μ. . . . . 10. **E. sanguinea**

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1. **E. orientalis** another red species with disk-like chloroleucites is noted on a succeeding page.

E² Caudal end more or less truncate; length approximately 200μ. . . . . 11. **E. rubra**
D² Periplast smooth; length 75-100μ. . 12. **E. haematodes**
B² Chloroleucites in the form of flattened disks which are often much elongated and rarely with an irregular or extremely notched outline.
C¹ Length less than 5 times the diameter.
D¹ Prominent anterior and posterior paramylon granules not present.
E¹ Chloroleucites distinctly lobed.
F¹ Form elongately oval; length 95-100μ. . . . . 13. **E. velata**
F² Form spindle shaped; length 85μ. 14. **E. sociabilis**
E² Chloroleucites not distinctly lobed.
F¹ Length exceeding 55μ.
G¹ Pellicula with many small granules underneath arranged spirally. . . . . 15. **E. granulata**
G² Pellicula without distinct granules *underneath*.
H¹ Color green.
I¹ Chloroleucites round or oval.
J¹ Pyrenoids present in chloroleucites; length 80-90μ. 16. **E. polymorpha**
J² Pyrenoids absent in chloroleucites; length 60-70μ. 17. **E. proxima**
I² Chloroleucites slightly constricted at middle, more or less dumb-bell shaped. 18. **E. caudata**
H² Color red or yellowish red.
I¹ Cysts spherical in form. . . 19. **E. flava**
I² Cysts flasklike in form 20 **E. orientalis**
F² Length less than 50μ.
G¹ Form short cylindrical . 21. **E. variabilis**
G² Form spindle shaped . 22. **E. gracilis**
D² Prominent anterior and posterior paramylon granules present; length of individual approximately 60μ . . . . . 23. **E. torta**
C² Length more than 6 times the diameter.
D¹ Posterior part of body with an acute tip.
E¹ Periplast not covered with prominent punctuations arranged either spirally

or longitudinally.

F[1] Prominent anterior and posterior paramylom granules not present.

G[1] Body extremely metabolic; not normally twisted into a spiral however.

H[1] Chloroleucites in the form of flattened disks, numerous; posterior part of body with short acute tip . . . 24. **E. deses**

H[1] Chloroleucites in the form of elongate cup shaped disks, 2-4 in number; posterior part of body with elongated acute tip 25. **E. mutabilis**

G[2] Body not metabolic, normally twisted into a spiral . 26. **E. spiroides**

F[2] Prominent anterior and posterior* paramylon granules present.

G[1] Anterior part of body immediately in front of stigma nearly equal to the diameter of the median part of the body.

H[1] Anterior and posterior paramylon granules large, suboval or spherical.

I[1] Large paramylon granules, suboval; length of individual 375-500μ. . . 27. **E. oxyuris**

I[2] Large paramylon granules spherical; length of individual, 75μ. . . 28. **E. simulacra**

H[1] Anterior and posterior paramylon granules in the form of elongated rods; length of individual, 70-80μ.

I[1] Body exceedingly metabolic; not prolonged posteriorly into an extended acute tip; length, 120-135μ. 29. **E. intermedia**

* Occasionally lateral in **E. limnophila.**

I² Body not metabolic; prolonged posteriorly into an extended acute tip; length, 70-80μ. . . 30. **E. tripteris**

G² Anterior part of body immediately in front of stigma approximately one-half the diameter of the median part.

H¹ Posterior end not developed into a needle-like tip . . 31. **E. acus**

H² Posterior end developed into a needle-like tip.

I¹ Chloroleucites not spirally arranged; length, 80μ. . . . 32. **E. limnophila**

I² Chloroleucites spirally arranged; length 125μ 33. **E. acutissima**

E² Periplast covered with prominent punctuations, arranged either spirally or longitudinally.

F¹ Flagellum short; punctuations arranged spirally. . . . 34. **E. spirogyra**

F² Flagellum as long as body; punctuations, arranged longitudinally 35. **E. fusca**

D² Posterior part of body with a rounded or truncate tip.

E¹ Paramylon granules in the form of elongate rods; tip of body rounded; length, 250-300μ. . . . 36. **E. ehrenbergii**

E² Paramylon granules not rod-like; tip truncate or emarginate; length, 175μ. 37. **E. truncata**

A² Chloroleucites apparently absent and the individuals colorless; stigma yellow to orange brown. . . 38. **E. quartana**

*1. **E. viridis** Ehrenb (Fig. 1, Pl. XII).

Oval or fusiform; periplast striated spirally; flagellum as long as body; stigma prominent; nucleus posterior; chloroleucites in the form of elongated rods collected into a median stellate mass; paramylon granules small, round or oval, with pyrenoids.

Reproduction by longitudinal division or by encystment in a spherical state with thickened membrane colored a yellowish brown.

* Species from Ohio.

L 50-60μ. D. 14-18μ.

(var. *olivacea* L. 72-80μ. D. 16μ.)

Distribution, cosmopolitan. Storage Dam, Columbus.

Many other species have been erroneously classified as *E. viridis* in ordinary biological instruction. The posterior position of the nucleus, together with the single stellate group of chloroleucites, should easily distinguish it from several closely allied forms. The following varieties have been noted: var. *mucosa* Lemm., surrounded by mucous in swimming stage and only slightly metabolic; var. *olivacea* Klebs, distinguished primarily by the olive green color of the chloroleucites and the tendency of these to be separated into disciform fragments, together with the larger size of the form. Dangeard has suggested that the var. *hyalina* Klebs possibly belongs to the genus Astasia, inasmuch as it is deprived of chlorophyl and possesses only a rudimentary stigma.

Hiawatha Lake, Mt. Vernon, O.; Kokosing River, Gambier, O.

*2. **E. geniculata** Dujard (Fig. 2, Pl. XII).

Cylindrical elongate with periplast striated spirally; flagellum as long as body; stigma prominent; nucleus central; chloroleucites in the form of elongate rods collected into 2 or 3 stellate masses, one mass posterior to the nucleus; paramylon with pyrenoids.

Reproduction by longitudinal division, or by encystment without thickened membrane as in *E. viridis*.

L. 70-85μ. D. 12-22μ.

Distribution, cosmopolitan. Storage Dam, Columbus.

3. **E. olivacea** Schmitz (Fig. 3, Pl. XII).

Fusiform, short posteriorly, metabolic; periplast striated spirally; flagellum as long or longer than the body; chloroleucites numerous, stellate; pyrenoids not covered with paramylon; paramylon granules short, oval.

Reproduction by longitudinal division. Encystment not known.

L. 68-89μ. D. 14-21μ.

Distribution, cosmopolitan.

4. **E. oblonga** Schmitz (Fig. 4, Pl. XII).

Oval, short with rounded ends; periplast spirally striated; flagellum longer than body; nucleus central;(?); chloroleucites numerous, stellate; pyrenoids with shell; paramylon (?).

Reproduction (?).
L. 50-70μ. D. 25-35μ.
Distribution (?)

5. **E. elongata** Schew. (Fig. 5, Pl. XII).

Extremely elongate, fusiform, scarcely metabolic; periplast smooth; flagellum 2/3 length of body; nucleus slightly posterior; chloroleucites elongated bands; pyrenoids absent; paramylon (?).

Reproduction (?).
L. 64μ. D. 5-6μ.
Distribution, New Zealand in cold springs.

6. **E. minima** Francé (Fig. 6, Pl. XII).

Small, fusiform, extremely metabolic; periplast weakly striate spirally; flagellum ½ body length; nucleus (?); chloroleucites in form of spiral bands; pyrenoids 2, with shells; paramylon small, rods.

Reproduction by longitudinal division; cysts (?).
L. 27μ. D. 8-9μ.
Distribution, cosmopolitan (?) in swamps.

*7. **E. pisciformis** Klebs (Fig. 7, Pl. XII).

Fusiform, rounded anteriorly, short posteriorly, slightly metabolic; periplast weakly striate spirally; flagellum as long as body; stigma with prominent granulation; nucleus posterior (?); chloroleucites 2 or 3 (?) in number arranged longitudinally and nearly as long as body; pyrenoid with double shell; paramylon (?).

Reproduction by cysts forming several cells (8?) within a single membrane.
L. 25-30μ. D. 5-7μ.
(var. *minor* L. 18-20μ. D. 4.5-5μ.)
Distribution, cosmopolitan.

The var. *minor* Hansg. has a length of 18-20μ and a diameter of 4.5-5μ. *E. pisciformis* is a small species with swimming movements analogous to those of a fish, whence the name. The body becomes metabolic to a slight extent when the individual ceases swimming.

Gambier, O. Pool "Hotel Hill," var. *minor* (18μ in length).

8. **E. terricola** (Dang.) (Fig. 8, Pl. XII).

Cylindrical, elongate, tip distinct, decidedly metabolic; periplast weakly striate spirally; flagellum ½ length of body; nucleus central; chloroleucites numerous, band-like, arranged longitudinally posterior to nucleus; pyrenoids 2, enclosed in paramylon; paramylon granules small, short, cylindrical.

Reproduction.

L.(?). D.(?).

Distribution, cosmopolitan(?).

9. **E. splendens** Dang. (Fig. 9, Pl. XII).

Oval with short tip; periplast with prominent punctuations arranged spirally; flagellum longer than the body; nucleus central; chloroleucites numerous, ribbon-like, arranged spirally between striate punctuations; pyrenoids absent; paramylon round, rarely rod-like.

Reproduction by longitudinal division. Encystment with division in spherical condition.

L. 70-80μ. D. 22-27μ.

Distribution, France, Casette near Potiers.

Distinguished from other species by the peculiar arrangement of chloroleucites, more numerous and shorter than in *E. sanguimea* and without pyrenoids.

*10. **E. sanguinea** Ehrenb (Fig. 10, Pl. XII).

Elongately oval, red, fusiform to cylindrical, with short tip, metabolic; periplast striate spirally with indistinct punctuations; flagellum 2 times length of body; chloroleucites in the form of rods or ribbons or extremely notched disks; pyrenoid with shell; paramylon round or oval; green chlorophyl of the chloroleucites obscured by the red haematochrome which may however disappear in small aquaria with changed metabolism.

Reproduction by copulation of gametes. Encystment with division in spherical state, the gelatinous envelope thick.

L. 55-120μ. D. 28-33μ.

Distribution, cosmopolitan.

An interesting species which at times colors pools and small ponds an intense red on the surface. In the var. *furcata* Hübner the cell is narrowed anteriorly so that a neck-like appearance results, while a spiral furrow reaches from the cytopharynx to the middle of the body.

Ohio, Cedar Point; Sandusky, in quarry ponds.

11. E. rubra Hardy (Fig. Pl. XII).

Cylindrical, red, with broadly rounded anterior end and posterior end suddenly narrowed into a distinct tip which is rounded posteriorly; periplast spirally striate; flagellum approximately as long as body; chloroleucites (?); pyrenoids (?); nucleus slightly posterior; paramylon short cylindrical.

Reproduction by encystment with formation of distinct membrane.

L. 150 (?)-200μ. D. 50 (?)-60μ.

Distribution, cosmopolitan. Australia; Europe, Bohemia.

The species was described by Hardy, 1911, in association with *E. viridis* in small pools at Donocaster, Australia, and more recently it has been noted from Bohemia. It appears quite distinct from *E. sanguinea.*

12. E. haematodes (Ehrenb), (Fig. 12, Pl. XII).

Fusiform, red, metabolic; periplast smooth; flagellum 1½-2 times length of body; stigma absent (?); chloroleucites in the form of rods and ribbons (notched disks ?); pyrenoids (?); paramylon round or oval; protoplast colored red by haematochrome.

Reproduction by longitudinal division. Encystment with a thick membrane and subsequent division.

L. 75-103μ. D. 28-36μ.

Distribution, cosmopolitan (?).

***13. E. velata** Klebs (Fig. 13, Pl. XII).

Elongately oval with short tip, rounded anteriorly, metabolic; periplast weakly striate spirally; flagellum as long or somewhat shorter than the body; nucleus large, median; stigma large, granu-

lar; chloroleucites 20-30 in number, distinctly lobed; pyrenoids double shelled; paramylon (?).

L. 90-100μ. D. 25-30μ.

Distribution, Europe and North America; Ohio, Gambier, Brook, McElroy Farm, with filaments of Lyngbya.

14. **E. sociabilis** Dang. (Fig. 1, Pl. XIII).

Fusiform with short tip, metabolic; periplast (?) flagellum longer than body; nucleus (?); chloroleucites numerous—about 10 in number; pyrenoids double shelled; paramylon oval or rod-like.

Reproduction by encystment with subsequent division resulting in spherical colonies of 2, 4, or 8 cells each with stigma and nucleus distinct.

L. 85μ. D. 25μ.

Distribution, France.

15. **E. granulata** (Klebs), (Fig. 2, Pl. XIII).

Fusiform with short tip, metabolic; pellicula spirally striate, yellowish brown with distinct punctuations; flagellum as long as body; nucleus central; chloroleucites in the form of large disks with slightly irregularly borders, each containing a prominent pyrenoid; paramylon (?).

Reproduction by encystment within a gelatinous envelope.

L. 60-90μ. D. 20-25μ.

Distribution, Europe. Cosmopolitan (?)

The var. *luteo* Lemm. is colored light green.

*16. **E. polymorpha** Dang. (Fig. 3, Pl. XIII).

Oval approaching cylindrical, metabolic with short tip; periplast striated spirally, light brown in color; flagellum twice as long as body; nucleus central (?); chloroleucites 15 or more in number in the form of disks with irregular borders, each containing a pyrenoid; paramylon oval, often absent.

Reproduction, encystment spherical with gelatinous membrane.

L. 80-90μ. D. 20-25μ.

First found by Dangeard near Potiers in company with *E. sanguinea*.

Mirror Lake, O. S. U., O., from stems of *Eleodea*. Length 93μ.

*17. **E. proxima** Dang. (Fig. 4, Pl. XIII).

Fusiform, not elongately cylindrical with colorless tip, metabolic; periplast spirally striate; flagellum 1-1½ times length of body; nucleus central; chloroleucites numerous, disciform, about 50 in each individual; pyrenoids absent; paramylon small, elongately oval or annular(?).

Reproduction by encystment with cysts spherical, two cells being formed in a common envelope.

L. 60-70μ. D. 20μ.

Distribution, France, Potiers. Storage Dam, Columbus.

The elongately oval chloroleucites suggests a form somewhat intermediate between those possessing elongated rods and those with flattened disks.

18. **E. caudata** Hübner (Fig. 5, Pl. XIII).

Broadly fusiform with narrowed elongate tip, metabolic; periplast spirally striate; flagellum as long as body; nucleus central; chloroleucites numerous, dumb-bell shaped; pyrenoids with a double shell; paramylon(?).

Reproduction(?).

L. 110μ. D. 38μ.

Distribution, Europe(?).

19. **E. flava** Dang. (Fig. 6, Pl. XIII).

Fusiform with short tip, red, metabolic; periplast(?); flagellum about length of body; nucleus(?); chloroleucites 3-15 in number, disciform; pyrenoids with double shell; paramylon(?).

Development by longitudinal division. Encystment with spherical cysts.

L. 60μ. D. 25-30μ.

Distribution, France at Potiers.

20. **E. orientalis** Kashyop (Fig. 7, Pl. XIII).

Fusiform approaching cylindrical, color red; periplast(?); flagellum about as long as body; chloroleucites globular; pyrenoids(?); paramylon disiform, about 7μ in diameter.

Reproduction by flask shaped cysts from which it escapes laterally.

L. 60-120μ. D. 25(?)-40(?)μ.

Distribution, East India, Lahore.

A species apparently quite distinct by reason of flask-like cysts and development of haematochrome.

*21. **E. variabilis** Klebs (Fig. 8, Pl. XIII).

Cylindrical, short, rounded anteriorly, decidedly metabolic; periplast strongly striate spirally; flagellum 2-3 times length of body; nucleus (?); stigma large, dark red; chloroleucites disciform, without pyrenoids; paramylon one large granule anteriorly, many small granules (?).

Reproduction by division while provided with thin gelatinous envelope.

L. 30-46μ. D. 9-13μ.

Distribution, cosmopolitan.

Gambier, O., Hotel Hill Spring. A form which may at least be placed as a variety of the above, although not agreeing in detail with the figure from Klebs.

22. **E. gracilis** Klebs (Fig. 9, Pl. XIII).

Cylindrical to bluntly oval without pronounced tip, decidedly metabolic; periplast spirally striate; flagellum about length of body; nucleus central; chloroleucites 12-15 in number, disciform with irregular margin; with pyrenoids; paramylon absent (?).

Reproduction by division while provided with thin gelatinous membrane. Encystment with thick gelatinous membrane.

L. 37-45μ. D. 6-22μ.

Distribution, France, Potiers.

A small but exceedingly active species.

*23. **E. torta** Stokes (Fig. 10, Pl. XIII).

Elongately fusiform with tip twisted, not metabolic (?); flagellum as long as body; periplast smooth; chromatophores (?); pyrenoids (?); paramylon in the form of 2 long rod-like granules anterior and posterior to the nucleus.

Reproduction by division.

L. 63μ. D. (?).

Distribution, United States.

This species described by Stokes is closely allied to *E. tripteris* and may prove identical with that form.

Ohio, Milford Center.

*24. **E. deses** Ehrenb. (Fig. 1, Pl. XIV).

Elongately cylindrical or band-like in form with short tip, metabolic; periplast weakly striate spirally; flagellum short; nucleus large, oval, central; stigma prominent; chloroleucites numerous, disciform; pyrenoids without shell; paramylon in the form of short or elongate rods.

Reproduction by division with or without encystment in a gelatinous covering.

L. 70-200μ. D. 17-24μ.

Distribution, cosmopolitan. Gambier, O.

The species is not free swimming but constantly undergoing contortions.

25. **E. mutabilis** Schmitz (Fig. 2, Pl. XIV).

Elongately cylindrical, slightly narrowed anteriorly, tip elongate, decidedly metabolic; periplast smooth; flagellum (?); chloroleucites 2-4 in number in the form of entire or a single half of hollow cylinders; pyrenoids 2, without shell; paramylon small, rod-like or disk-like.

Reproduction by cysts, fusiform or cask-like in appearance.

L. 80-90μ. D. 7μ.

A species particularly noticeable by reason of its comparative length.

26. **E. spiroides** Lemm. (Fig. 3, Pl. XIV).

Spirally twisted in the form of an elongate band with tip at a pronounced angle; periplast weakly striate longitudinally; flagellum short; nucleus central (?); chloroleucites numerous, disciform; pyrenoids absent; paramylon round, small.

Reproduction (?).

L. 60-170μ. D. 16μ.

Distribution, Europe.

*27. **E. oxyuris** Schmarda (Fig. 4, Pl. XIV).

Extremely elongate cylindrical or slightly flattened, rounded anteriorly, posteriorly with elongate tip, form usually twisted; periplast decidedly striate spirally; flagellum ½ length of body; nucleus central; chloroleucites numerous, disciform; pyrenoids absent; paramylon in the form of 2 large annular elongate rings, one anterior, the other posterior to the nucleus.

Reproduction by longitudinal division. Encystment not known.

L. 375-490μ. D. 30-45μ.

Distribution, cosmopolitan.

The species is a large and interesting one, extremely well adapted for biological instruction in laboratory work. After once having found a locality it may be obtained in abundance. Longitudinal division of the mature form has been observed to take place within five hours without the reconstruction of the second paramylon granule. This was from aquarium material during midwinter, but at ordinary room temperature during the day.

Ohio, Gambier; E. Swamp on S. Bass Island, Lake Erie (Jennings); Sandusky Basket Factory Cove, L. Erie (Landacre).

*28. **E. simulacra** n. sp. (Fig. 5, Pl. XIV).

Elongately cylindrical or slightly flattened, rounded anteriorly, posteriorly with long acute tip, metabolic; periplast without pronounced spiral striations; chloroleucites disciform, numerous; pyrenoids(?); paramylon in the form of two large spherical granules, one anterior and one posterior to the nucleus, which is round.

Reproduction(?).

L. 75μ. D. 8-8.5μ.

Distribution, Ohio, Fremont.

This interesting species is described from several specimens observed May 6, 1913, obtained in cultures procured from Fremont, O., early in the spring. It differs from *E. oxyuris* by the presence of two large spherical instead of oval paramylon granules, by the rounder nucleus and by its much smaller size. All the forms observed were nearly identical in size. Camera lucida drawings were made. No swimming movements took place, but instead a series of slow, twisting contortions.

29. **E. intermedia** (Klebs), (Fig. 6, Pl. XIV).

Elongately cylindrical with short tip, decidedly metabolic; periplast weakly striate spirally; flagellum short; chloroleucites disciform, numerous; pyrenoids absent; paramylon consists of 2-3(?) large rod-like granules anterior and posterior to the nucleus.

Reproduction, division in gelatinous membrane.

L. 120-135μ. D. 8-12.5μ.

Distribution, Europe.

The var. *klebsii* Lemm. is 78-80μ long, 7-8μ in diameter and has rod-like paramylon granules much shorter.

*30. **E. tripteris** (Dujard.), (Fig. 7, Pl. XIV).

Elongately band-like in form, spirally twisted with very long and acute tip, not metabolic; when swimming three definite areas are formed by the body; periplast weakly striate longitudinally; flagellum ½ length of body; chloroleucites numerous, disciform; pyrenoids absent; paramylon in the form of 2 elongate rod-like granules, one anterior and the other posterior to the nucleus.

Reproduction by division without formation of thickened membrane.

L. 70-80μ. D. 8-14μ.

Distribution, cosmopolitan.

The species appears rather rare, but is easily known by its peculiar tripartate areas when swimming. It is not metabolic.

Ohio, Gambier (Academy Pond); Milford Center.

*31. **E. acus** Ehrenb. (Fig. 8, Pl. XIV).

Extremely elongate, fusiform, tip attenuate, weakly metabolic; periplast weakly striated spirally; flagellum about 1/3 length of body; nucleus central, oval; chloroleucites numerous, discoid; pyrenoids absent; paramylon elongate rods, usually 7-12 in number, scattered through protoplast.

Reproduction (?).

L. 70-200μ. D. 7-12μ.

Distribution, cosmopolitan.

Two varieties have been recognized, var. *minor* Hansg. 70-75μ long and 4-6μ in diameter, from peat bogs, and var. *rigida* Hübner, extremely rigid, 110μ long and 7.5μ in diameter, with paramylon arranged spirally. The species is not found commonly. Dangeard notes only isolated examples from two localities in France. The Hiawatha Lake forms are somewhat larger than the dimensions (180μ) ordinarily given.

Ohio, Mt. Vernon (Hiawatha Lake); Milford Center; Sandusky (Landacre), in vegetation from basket factory cove.

32. **E. limnophila** Lemm. (Fig. 9, Pl. XIV).

Fusiform with straight or slightly bent needle-like tip, slightly metabolic; periplast scarcely striate; flagellum short;

chloroleucites numerous, discoid; pyrenoids absent; paramylon in the form of 1-2 elongate rods anterior and posterior or lateral to the nucleus.

Reproduction (?).

L. 82μ. D. 10μ.

Distribution, Europe.

*33. **E. acutissima** Lemm. (Fig. 10, Pl. XIV).

Elongately fusiform, rigid, with needle-like tip; periplast weakly striate spirally; flagellum short; chloroleucites numerous, discoid, arranged in spiral lines: pyrenoids absent; paramylon in the form of 2 elongate rods, one anterior, the other posterior to the nucleus.

Reproduction (?).

L. 123μ. D. 7μ.

Distribution, cosmopolitan.

Ohio, Fremont.

*34. **E. spirogyra** Ehrenb. (Fig. 1, Pl. XV).

Elongately cylindrical, narrowed anteriorly while posteriorly produced into an acute tip often slightly bent into a crescentic shape, slightly metabolic; periplast yellowish brown with prominent spiral punctuations, a prominent row often alternating with a less prominent row; flagellum short; chloroleucites numerous, discoid; pyrenoids absent; paramylon in the form of 2 prominent annular granules, the one anterior, the other posterior to the nucleus.

Reproduction by longitudinal division and by cysts without a gelatinous envelope.

L. 80-150μ. D. 6-20μ.

Distribution, cosmopolitan.

Three varieties have been recognized, var. *abrupte-acuminata* Lemm., 125μ in length and 15μ in diameter with alternate prominent and weak rows of punctuations, and the tip distinctly set off from the rest of the cell; var. *laticlavius* (Hübner), 130μ in length and 20μ in diameter with weakly but uniformly developed rows of punctuations, and var. *marchia* Lemm., 79-100μ in length and 6-12μ in diameter with equally developed rows of punctuations which are almost in contact with one another.

The forms thus far observed by the writer from Ohio are larger than any hitherto recognized, with L. 150μ and D. 20μ.

Ohio, Gambier (Acad. Pond, Bishops Pool); E. Swamp, S. Bass Island, and Portage River (Jennings); Sandusky, L. Erie, basket Factory Cove (Landacre).

35. **E. fusca** (Klebs), (Fig. 2, Pl. XV).

Elongate band-like in form, gradually narrowed posteriorly with short tip, weakly metabolic; periplast dark brown to black with longitudinal rows of distinct punctuations; flagellum as long as body; chromatophores numerous, discoid; pyrenoids absent; paramylon in the form of 2 large annular granules, anterior (?) and posterior to the nucleus.

Reproduction by longitudinal (?) division and by cysts without gelatinous covering.

L. 90-225μ. D. 23-27.5μ.

Distribution, Europe.

This was originally described as a variety of *E. spirogyra* by Klebs but later given a specific rank by Lemmerman.

36. **E. ehrenbergii** Klebs (Fig. 3, Pl. XV).

Elongately band-like in form with rounded ends, decidedly metabolic; periplast weakly striate spirally; flagellum less than length of body; chloroleucites numerous, discoid; pyrenoids absent (?); paramylon in the form of elongate cylindrical rods which at times are somewhat flattened or even discoid.

Reproduction (?).

L. 290μ. D. 26μ.

Distribution, Europe.

*37. **E. truncata**; n. sp. (Fig. 4, Pl. XV).

Elongately cylindrical or band-like in form, slightly metabolic and often assuming a twisted appearance; periplast spirally striate; flagellum less than length of body; nucleus anterior, oval; posteriorly body normally emarginate or truncate; chloroleucites numerous, discoid, 2.5μ in diameter; pyrenoids apparently absent; paramylon with large granules absent, but with many small granules about 1.5μ in diameter and 2μ in length.

Reproduction (?).

L. 175μ. D. 27-29μ.

Distribution, Mt. Vernon (Hiawatha Lake), O.

This species has been found in almost all cultures from Hiawatha Lake, at Hiawatha Park, Mt. Vernon, during a period of three years. Large paramylon granules are absent, while the emarginate posterior end of the body is a character of interest. The body is often twisted into bipartate or tripartate areas similar to *E. tripteris*.

The species is allied to *E. ehrenbergii* Klebs to which *Amblyophis viridis* Ehrenb. (Kent, V. 1, p. 386) must be referred but differs by the characters in the "Table." *Amblyophis aegyptiaca* Schmarda (fresh water Egypt) is not sufficiently described to place it with certainty, systematically.

38. **E. quartana** Moroff (Fig. 5, Pl. XV).

Colorless, fusiform, gradually narrowed behind, decidedly metabolic; periplast distinctly differentiated, thick but smooth; flagellum 1½ times length of body; nucleus in posterior third of body; chloroleucites absent; paramylon granules usually oval, comparatively large.

Reproduction (?).

L. 50μ. D. 15μ.

Distribution, Germany (Munich).

The species was described by Moroff in cultures made from drainage water at Munich in which Beggiota had developed in quantities. It should be regarded as a valid species with some doubt by reason of the possible loss of the chlorophyl due to artificial conditions.

2. Gen. LEPTOCINCLIS Perty.

Forms radial not compressed usually with periplast striate spirally, not metabolic. Flagellum and vacuole system as in Euglena. Chloroleucites numerous, disciform in form and normally contiguous to the pellicula. Usually provided with two large lateral annulate paramylon granules. Reproduction through division in a resting stage. Nourishment holophytic or saprophytic.

Distribution, cosmopolitan.

TABLE OF SPECIES.

A¹ Pellicula striate.
- B¹ Posterior end suddenly constricted to form a more or less pronounced tooth.
  - C¹ Periplast with striae spiral.
    - D¹ Anterior end rounded. . . . **1. L. ovum**
    - D² Anterior end produced into a neck-like process. . . . . **2. L. sphagnophila**
  - C² Periplast with striae not distinctly spiral. . **3. L. steinii**
- B² Posterior end either gradually narrowed or broadly rounded.
  - C¹ Posterior end gradually narrowed.
    - D¹ Anterior end broadly rounded.
      - E¹ Form oval, posterior third not decidedly narrowed. . . . **4. L. buetschlii**
      - E² Form spindle shaped, posterior third decidedly narrowed. . . . **5. L. teres**
    - D² Anterior end gradually narrowed.
      - E¹ In the form of a short and broad spindle. . . . . **6. L. fusiformis**
      - E² In the form of a long and narrow spindle. . . . . **7. L. acicularis**
  - C² Posterior end broadly rounded. . . . **8. L. texta**

A² Pellicula smooth.
- B¹ Anterior end not mouth-like in appearance. . **9. L. globosa**
- B² Anterior end mouth-like in appearance. . . **10. L. marssonii**

*1. **L. ovum** (Ehrenb), (Fig. 6, Pl. XV).

Oval, posterior end with distinct spike 6-7μ in length; periplast decidedly striate spirally; flagellum twice length of body.

Reproduction (?).

L. 30-38μ. D. 15-18μ.

Distribution, cosmopolitan. Standing water and Plankton.

Lemmermann recognizes four varieties: var. *globula* (Perty), spherical, L. 20-27μ, D. 16-21μ, with flagellum 2-3 times length of body; var. *striata* (Hubner), approaching cylindrical, L. 37-38μ, D. 25μ, with many annular paramylon granules; var. *punctuato-striata* Lemm., L. 27-28μ, D. 20-21μ, oval with punctuate striae; var. *palatina* Lemm., L. 20μ., D. 20-21μ., with striae composed of elongate markings. The spike is usually shorter in the varieties.

Ohio, Landacre, Sandusky (Biemiller's Cove); Magnetic Springs (Baker's Creek); Coll. Osborn.

2. **L. sphagnophila** Lemm. (Fig. 7, Pl. XV).

Oval, narrowed neck-like anteriorly, tip distinct; flagellum about twice the length of the body; periplast weakly striate spirally.

Reproduction (?).

L. 33μ. D. 12μ.

Distribution, Europe. Sphagnum swamps and in Plankton.

3. **L. steinii** Lemm. (Fig. 8, Pl. XV).

Short fusiform with tip distinct; periplast with distinct striae which are scarcely spiral.

Reproduction (?).

L. 22-30μ. D. 8-15μ.

Distribution, Europe. Standing water and Plankton.

A single variety is recognized by Lemmermann, var. *suecica* Lemm., with the posterior end slightly enlarged near the tip and with L. 24.5-26μ, D. 9.5-12μ.

4. **L. buetschlii** Lemm. (Fig. 9, Pl. XV).

Oval with short tip; periplast distinctly striate spirally; flagellum about 2 times length of body.

Reproduction (?).

L. 34-38μ.D. 21-23μ.

Distribution, Europe. Standing water.

*5. **L. teres** (Schmitz), (Fig. 10, Pl. XV).

Oval to fusiform, broadest anteriorly and with short tip; periplast distinctly striate spirally; flagellum 2 times length of body.

L. 34-38μ. D. 21-23μ.

Distribution, Europe. Standing water.

Gambier, O.

6. **L. fusiformis** (Carter), (Fig. 1, Pl. XVI).

Short and broadly fusiform; periplast distinctly striate spirally, flagellum about as long as body.

Reproduction (?).

L. 25-36μ. D. 14-23μ.

Distribution, cosmopolitan. Standing water and Plankton.

*7. **L. acicularis** Francé (Fig. 2, Pl. XVI).

Elongately fusiform; periplast with not more than 12 spiral striae; flagellum somewhat exceeding length of body.

Reproduction (?).

L. 21-22μ. D. 6-9μ.

Distribution, Hungary (Balaton), and North America.

A small individual 12μ. long having a central nucleus and a large circular spherical (?) paramylon granule, was found among filaments of Cladophora taken from the storage reservoir immediately above the weir at the Cincinnati water works, Ohio.

*8. **L. texta** (Duj.), (Fig. 3, Pl. XVI).

Broadly oval; periplast distinctly striate spirally; flagellum 2-3 times length of body; paramylon granules numerous, cylindrical, spherical or annular in form.

Reproduction (?).

L. 52-60μ. D. 38μ.

Distribution, Europe. Standing water and Plankton.

Gambier, O. var. 48μ in length.

9. **L. globosa** Francé (Fig. 4, Pl. XVI).

Spherical, slightly pointed anteriorly; periplast with weak rhomboidal markings; flagellum shorter than length of body.

Reproduction (?).

L. 14-21μ. D. 12-18μ (?).

Distribution, Europe.

Two varieties, *cylindrica* Lemm., short cylindrical rounded at extremities, and *fusiformis* Lemm., broadly fusiform.

10. **L. marssonii** Lemm. (Fig. 5, Pl. XVI).

Fusiform, emarginate anteriorly; periplast smooth; flagellum 1-2 times length of body.

Reproduction (?).

L. 39-40μ. D. 11-13μ.

Distribution, Europe. Standing water and Plankton.

3. Gen. PHACUS Dujardin

Form compressed, free swimming with thick, firm pellicula; not metabolic; a single flagellum; vacuole system as in Euglena;

chloroleucites numerous, disciform; paramylon granules of various forms, at times absent; reproduction during encystment in gelatinous capsules which multiply rapidly.

Distribution, cosmopolitan.

TABLE OF SPECIES.

A¹ Posterior part of body more or less uncinate.
- B¹ Periplast smooth or with longitudinal striae.
  - C¹ Sides concave. . . . . 1. **P. anacoelus**
  - C² Sides convex.
    - D¹ Lateral margins much expanded. . 2. **P. alata**
    - D² Lateral margins not expanded.
      - E¹ Form circular from a lateral view except posterior spike-like process. . 3. **P. orbicularis**
      - E² Form elongate.
        - F¹ Dorsal area without longitudinal carina. . . . . 4. **P. pleuronectes**
        - F² Dorsal area with longitudinal carina. . . . . 5. **P. triqueter**
- B² Periplast with fine wart-like processes. . . 6. **P. suecica**

A² Posterior part of body not uncinate, the spike-like process either being straight or absent.
- B¹ Periplast smooth or with longitudinal striae.
  - C¹ Posterior tooth-like process as long as or longer than the body. . . . . 7. **P. longicauda**
  - C² Posterior tooth-like process when present, shorter than the body.
    - D¹ Posterior end with tooth-like process.
      - E¹ Tooth-like process approximately ⅓ length of body. . . . 8. **P. caudata**
      - E² Tooth-like process extremely short. 9. **P. acuminata**
    - D² Posterior end without tooth-like process.
      - E¹ Posterior end slightly constricted. 10. **P. brevicaudata**
      - E² Posterior end broadly rounded. . 11. **P. stokesii**
- B² Periplast with spiral striations, minute spines, or course wart-like processes.
  - C¹ Periplast with spines or wart-like processes, but without spiral striations.
    - D¹ Periplast covered with minute spines. . 12. **P. hispidula**
    - D² Periplast covered with coarse wart-like processes. . . . . 13. **P. monilata**
  - C² Periplast with spiral striations.
    - D¹ Posterior end gradually narrowed to form a tooth-like process. . . . . 14. **P. pyrum**
    - D² Posterior end either suddenly narrowed to form tooth-like process, or process absent,

the posterior end rounded.
E¹ Posterior tooth distinct and approximately as long as body.
F¹ Transversely oval with lateral wing-like processes. . . 15. **P. nordstedtii**
F² Elongately oval or cylindrical without wing-like process. . 16. **P. setosa**
C² Posterior tooth either much shorter than the body or absent.
D¹ Posterior end acute, in some species elongated into a tooth-like process.
E¹ Posterior end with long tooth-like process ½ to ⅔ the length of the body. . . . . 17. **P. striata**
E² Posterior end without long tooth-like process.
F¹ A single large annular paramylon granule present.
G¹ Posterior end suddenly narrowed. . . . 18. **P. oscillans**
G² Posterior end gradually narrowed. . . . 19. **P. parvula**
F² Two large annual paramylon granules present.
G¹ Elongately oval, gradually narrowed posteriorly, the length approximately 3 times the diameter. . . 20. **P. clavata**
G² Oval, more broadly rounded posteriorly, the length approximately 2 times the diameter. . . . 21. **P. pusilla**
D² Posterior end rounded. . . . 22. **P. dangeardii**

1. P. anacoelus Stokes (Fig. 6, Pl. XVI).

Oval or spherical with margins concave and posterior spike short and uncinate; periplast (?); flagellum approximately as long as the body.

Reproduction (?).

L. 42μ. D. 35μ (?).

Distribution, cosmopolitan. U. S. A., Western New York; Austria (Prague). Shallow ponds.

2. P. alata Klebs (Fig. 7, Pl. XVI).

Oval or spherical with lateral margins much expanded and posterior spike short and decidedly uncinate; periplast longitudi-

nally striate; flagellum longer than body; paramylon in the form of 2 large granules, one on each side.

Reproduction (?).

L. 19μ. D. 18μ.

Distribution, Europe.

*3. **P. orbicularis** Hübner (Fig. 8, Pl. XVI).

Spherical with short uncinate posterior spike; periplast longitudinally striate; flagellum as long as body; paramylon in the form of one large annular granule.

Reproduction (?).

L. 70μ. D. 45μ.

Distribution, Europe and North America in standing water.

Ohio, Hiawatha Lake, Mt. Vernon.

*4. **P. pleuronectes** (Mull.), (Fig. 9, Pl. XVI).

Broadly oval, slightly twisted with short uncinate posterior spike, and median fold reaching posteriorly to middle of cell; periplast longitudinally striate; flagellum as long as or slightly longer than the body; paramylon, 1-2 annular granules.

Reproduction (?).

L. 45-49μ. D. 33-35μ.

Distribution, cosmopolitan, in standing water and Plankton.

Sandusky, Basket Factory Cove (Landacre); Magnetic Springs (Baker's Creek, O.); coll. Osborn.

*5. **P. triqueter** (Ehrenb.), (Fig. 10, Pl. XVI).

Oval, decidedly concave-convex, posterior spike short and uncinate; dorsal fold prominent, reaching from anterior to posterior end; periplast longitudinally striate; flagellum as long as body; paramylon 1-2 annular granules.

Reproduction (?).

L. 49-55μ. D. 33-35μ.

Distribution, cosmopolitan. In standing water.

The species is common and easily identified by the longitudinal carina or fold reaching to the posterior end, although closely allied to *P. pleuronectes* and placed as a variety of that species by some investigators. It was found in East Swamp, S. Bass Island, and East Harbor, Lake Erie, by Jennings, and in Sandusky Bay by Landacre.

Gambier, Mt. Vernon, O. (Hiawatha Lake).

6. **P. suecica** Lemm. (Fig. 1, Pl. XVII).

Broadly oval with posterior spike slightly acuminate; periplast with longitudinal striae which possess fine wart-like processes; flagellum about as long as body and arising from an anterior elevation; paramylon in the form of small round or oval granules.

Reproduction (?).

L. 34μ. D. 20-21μ.

Distribution, Europe.

*7. **P. longicauda** (Ehrenb.), (Fig. 2, Pl. XVII).

Oval with elongate straight posterior spike; periplast longitudinally striate; flagellum less than length of body; paramylon in the form of 1 large discoid granule.

Reproduction (?).

L. 85-115μ. D. 46-70μ.

Distribution, cosmopolitan, in standing water and Plankton.

Variety *torta* Lemm. is decidedly twisted.

Found by Jennings in swamps on South Bass Island and East Harbor, in Lake Erie and also by Landacre in Sandusky Bay (Basket Factory Cove).

Gambier, O.

8. **P. caudata** Hübner (Fig. 3, Pl. XVII).

Oval concave-convex with posterior spike short, straight, and the dorsal fold reaching to the posterior end; periplast longitudinally striate; flagellum as long as body; paramylon in the form of one large annular granule anterior to the nucleus and one smaller granule near the posterior spike.

Reproduction (?).

L. 45μ. D. 22.5μ.

Distribution, Europe. Standing water.

*9. **P. acuminata** Stokes (Fig. 4, Pl. XVII).

Broadly oval or circular with short posterior spike and a pronounced dorsal fold nearly reaching the posterior end; periplast longitudinally striate; flagellum about length of body; paramylon, 2 small round granules.

Reproduction (?).

L. 25μ. D. 25μ.

Distribution, North America. Streams and ponds. Storage Dam, Columbus, O.

Stokes notes the habitat in connection with Myriophyllum.

10. P. brevicaudata (Klebs), (Fig. 5, Pl. XVII).

Oval, without spine and with dorsal fold reaching posterior end; periplast longitudinally striate; flagellum as long as body; paramylon one annular granule.

Reproduction (?).

L. 31-35μ. D. 23-25μ.

Distribution, Europe. In standing water.

11. P. stokesii Lemm. (Fig. 6, Pl. XVII).

Broadly oval to spherical with dorsal fold attaining posterior end; periplast longitudinally striate; flagellum as long as body; paramylon 1 round granule in posterior part of cell.

Reproduction (?).

L. 46μ. D. 43-46μ.

Distribution, North America. In pools.

12. P. hispidula (Eichw.), (Fig. 7, Pl. XVII).

Oval with short straight posterior spike and tubular opening for flagellum; periplast longitudinally striate, the striae covered with minute spines; flagellum as long as body; paramylon either discoid or rod-like.

Reproduction (?).

L. 30-55μ. D. 18-33μ.

Distribution, cosmopolitan. Standing water.

This is probably the species figured but unnamed in Conn's paper on the protozoa of Connecticut.

13. P. monilata Stokes (Fig. 8, Pl. XVII).

Spherical, covered with wart-like processes, posterior spike straight; flagellum as long as body, arising from a minute elevation; paramylon (?).

Reproduction (?).

L. 39μ. D. 30μ (?).

North America. Ponds.

***14. P. pyrum** (Ehrenb.), (Fig. 9, Pl. XVII).

Oval, broadest anteriorly, provided posteriorly with elongate straight spine; periplast spirally striate; flagellum as long as body;

paramylon consisting of 2 large or several small lateral discoid granules.

Reproduction, longitudinal division without encystment.

L. 30-55μ. D. 13-15μ.

Distribution, cosmopolitan. Standing water.

15. **P. nordstedtii** Lemm. (Fig. 10, Pl. XVII).

Transversely oval with posterior spike distinct, straight, and as long as body; periplast forming wing-like lateral extensions with distinct spiral striae; flagellum as long as body; paramylon(?).

Reproduction(?).

L. 53μ. D. 29μ.

Distribution, Europe and Asia Minor.

16. **P. setosa** Francé (Fig. 11, Pl. XVII).

Broadly oval, approaching cylindrical, emarginate anteriorly, the posterior spike pronounced, straight, and as long as body; periplast spirally striate; flagellum(?); paramylon in the form of numerous spherical or cylindrical granules.

Reproduction(?).

L. 30-31μ. D. 15μ(?).

Distribution, Europe, Hungary (Balaton).

Lemmermann notes the length of this species as 30-31μ, which if including the posterior spike would be an extremely small form. The magnification of the figured specimen is given as 610, and if correct makes the actual size approximately 100μ for the total length, which is evidently an error.

17. **P. striata** Francé (Fig. 12, Pl. XVII).

Oval, often broadest posteriorly with posterior spike distinct and 1/2-1/3 the length of the body; periplast spirally striate; flagellum scarcely as long as body; paramylon 1 large discoid granule.

Reproduction(?).

L. 20-24μ. D. 4-9μ.

Distribution, Europe, Hungary (Balaton).

*18. **P. oscillans** Klebs (Fig. 13, Pl. XVII).

Oval, broadest anteriorly, gradually narrowed posteriorly with short but distinct tooth, lateral margins turned in toward the con-

cave ventral surface; periplast spirally striate; flagellum about length of body; paramylon 1 large discoid granule.

Reproduction (?).

L. 26μ. D. 10μ.

Distribution, Europe. Standing water. Storage Dam, Columbus, O.

19. P. parvula Klebs (Fig. 14, Pl. XVII).

Oval, broadest anteriorly, posterior end acute but without pronounced tooth; periplast spirally striate; flagellum as long as body; paramylon 1 annular granule.

Reproduction by free longitudinal division as well as by division within an envelope.

L. 17-30μ. D. 9-10μ.

Distribution, Europe. Standing water.

20. P. clavata Dang. (Fig. 15, Pl. XVII).

Conical gradually narrowed posteriorly; periplast spirally striate; flagellum about 2/3 length of body; paramylon 2 annular or several rod-like granules.

Development (?).

L. 25μ (?). D. 10μ (?).

Distribution, France.

Dangeard in the description of the species fails to note the size, stating, however, that it is allied to *P. oscillans*. Consequently provisional dimensions are given.

21. P. pusilla Lemm. (Fig. 16, Pl. XVII).

Elongately oval, with wing-like thickening laterally, the posterior end slightly pointed; periplast spirally striate; flagellum ½ length of body; paramylon, 2 annular granules.

Reproduction (?).

L. 20μ. D. 7.5μ.

Distribution, Europe. Standing water.

22. P. dangeardii Lemm. (Fig. 17, Pl. XVII).

Elongately oval with rounded ends, often slightly narrowed posteriorly; periplast spirally striate; flagellum as long as body; paramylon, 1 annular granule.

Reproduction (?).

L. (?). D. (?).

Distribution, France.

4. Gen. CRYPTOGLENA Ehrenberg.

Form oval, short, scarcely acute posteriorly, compressed, free swimming, with ventral longitudinal furrow; a single flagellum; pellicula thick as in Phacus; chloroleucites in the form of two elongate bands.

Distribution, cosmopolitan.

A single species in the genus.

*1. **C. pigra** Ehrenb. (Fig. 1, Pl. XVIII).

Body oval, rigid, flattened, slightly pointed behind; a single flagellum inserted at the bottom of a slight depression equivalent to the cytopharynx of Euglena, etc.; nucleus posterior; two elongate chloroleucites situated one on each side and extending nearly the entire length of the body; stigma in contact with anterior end of one of the chromatophores; vacuole present.

Reproduction (?).

L. 11-15μ. D. 6-7μ.

Distribution, cosmopolitan.

Landacre notes the species from Sandusky Bay in decaying vegetation of Biemiller's Cove under the name *Chloromonas pigra* in accordance with Kent.

5. Gen. TRACHELOMONAS Ehrenberg.

Free swimming forms having a single flagellum and normally provided with a protective shell of a brownish color. The individuals frequenting the shells are colored green by the chloroleucites contained in the protoplasm and are provided with a stigma, paramylon granules and other structures characteristic of the family Euglenidae. Reproduction through division inside of the shell, the new individual leaving and forming a new shell.

Distribution, cosmopolitan.

The species inhabit fresh water in ditches, pools, and ponds, particularly in stagnant waters where rusty patches of "ooze" are observable.

TABLE OF SPECIES.

A[1] Surface of shell not provided with distinct spines.

B[1] Posterior end of shell not produced into a spine-like process.

C[1] Form approximately spherical or slightly oval, but never decidedly longer than wide.

D¹ Spherical or elongately oval.
E¹ Surface smooth or finely punctuate.
F¹ Surface smooth.
G¹ Shell not provided with minute perforations. . 1. **T. volvocina**
G² Shell provided with minute perforations. . . 2. **T. perforate**
F¹ Shell finely punctured. . 3. **T. intermedia**
E² Surface with wart-like processes, with folds, or with numerous minute compact rod-like protuberances.
F¹ Surface with wart-like process. 4. **T. verrucosa**
F² Surface with folds or minute rod-like protuberances.
G¹ Surface covered with folds.
H¹ Folds short, not reaching from anterior to posterior end.
I¹ Folds minute, diagonal. . . 5. **T. rugulosa**
I² Folds, large irregular. . 6. **T. vermiculosa**
H² Folds elongate, reaching from anterior to posterior end. . 7. **T. stokesiana**
G² Surface with numerous rod-like projections.
H¹ Opening for flagellum without a collar. . 8. **T. spiculifera**
H² Opening for flagellum with a collar. . 9. **T. vestita**
D² Transversely oval. . . . 10. **T. bernardi**
C² Form elongately ovoid or cylindrical, the length approximately 2 times the diameter.
D¹ Form oval or ovoid, not cylindrical.
E¹ Form that of a regular oval.
F¹ Shell smooth.
G¹ Opening for flagellum approximately ½ the diameter of the shell; length 25μ. . . . . 11. **T. teres**
G² Opening for flagellum less than ⅓ the diameter of the shell; length 13-16μ. . 12. **T. oblonga**
F² Shell covered with granulations or punctuations.
G¹ Collar distinct. . . 13. **T. crebea**

G² Collar absent. . . 14 **T. lemmermannii**
E² Form ovoid, being broader either anteriorly or posteriorly.
F¹ Broadest posteriorly.
G¹ Shell smooth. . . 15. **T. ovalis**
G² Shell covered with punctuations or granulations.
H¹ Covered with fine irregular punctuations. . 16. **T. similis**
H² Covered with coarse regular granulations. . 17. **T. volzii**
F² Broadest anteriorly.
G¹ Shell smooth.
H¹ Collar absent or low.
I¹ Flagellum opening with a notched collar. . . 18. **T. eurystoma**
I² Flagellum opening only slightly thickened. . . 19. **T. incerta**
H² Collar comparatively high. . . . 20. **T. africana**
G² Shell covered with fine punctuations and lines. . 21. **T. reticulata**
D² Form cylindrical.
E¹ Shell smooth. . . . . 22. **T. euchlora**
E² Shell with coarse granulations. . 23. **T. conspersa**
B² Posterior end of shell produced into a spine-like process.
C¹ Shell either with 3 annular transverse furrows or with elongated collar the height of which approximates the diameter of the shell.
D¹ With 3 annular furrows. . . . 24. **T. annulata**
D² With elongated collar. . . . 25. **T. minor**
C² Shell without transverse furrows and elongated collar.
D¹ Anterior end of shell obliquely truncate.
E² Form oval.
F¹ Elongately oval. . . . 26. **T. affinis**
F² Transversely oval. . . 27. **T. volgensis**
E¹ Form triangular or trapezoidal. . 28. **T. acuminata**
D² Anterior end transversely truncate.
E¹ Posterior spike-like process not longer than diameter of shell.
F¹ Median part of shell cylindrical. 29. **T. urceolata**
F² Median part of shell oval.
G¹ Median part longitudinally oval. . . . 30. **T. fluviatilis**

G² Median part transversely oval. . . . . 31. **T. schauinslandii**

E² Posterior spike-like process longer than diameter of shell . . 32. **T. ensifera**

A² Surface of shell provided with distinct spines.

B¹ Spines not uniformly distributed over entire surface.

C¹ Posterior spines absent. . . . 33. **T. acanthostoma**

C² Posterior spines present.

D¹ Spines in a single row on posterior or posterior and anterior end . . 34. **T. armata**

D² Spines covering entire shell except an equatorial belt . . . . . 35. **T. raciborskii**

B² Spines uniformly distributed over entire surface.

C¹ Form spherical or nearly spherical.

D¹ Posterior part of shell not produced into a spike-like process.

E¹ Spines short and numerous.

F¹ Form spherical, covered with prominent short but distinct spines. . . . . 36. **T. globularis**

F² Form oval, largest anteriorly, covered thickly with fine minute spines . . . . 37. **T. westii**

E² Spines extremely long, equal in length to diameter of shell, about 10 in number . . . . . 38. **T. americana**

D² Posterior part of shell produced into a spike like process . . . 39. **T. aegyptiaca**

C² Form not spherical, the length approximately twice the diameter.

D¹ Posterior part of shell not produced into a spine like process.

E¹ Form regularly oval, neither the anterior nor the posterior end broadest.

F¹ Anterior end developed into a neck like process . . . 40. **T. piscatoris**

F² Anterior end broadly rounded.

G¹ Granulations between spines absent.

H¹ Spines as long as or longer than length of shell . . . 41. **T. setosa**

H² Spines short.

I¹ Spines bent . 42. **T. spinosa**

I² Spines straight.

J¹ Posterior end broadly rounded 43. **T. hispida**

J² Posterior end pointed . 44. **T. obtusa**
G² Granulations present between spines . . . 45. **T. horrida**
E² Form ovoid, the posterior or anterior end broadest.
F¹ Posterior end broadest . 46. **T. saccata**
F² Anterior end broadest.
G¹ Posterior end rounded, and only slightly narrower than anterior end; collar notched 47. **T. bulla**
G² Posterior end becoming decidedly narrowed; collar not notched . . . 48. **T. obovata**
D² Posterior end of shell produced into an acute or spike like process.
E¹ Definite posterior spike like process absent; collar not toothed . 49. **T. helvetica**
E² Definite posterior spike like process present; collar toothed . . 50. **T. caudata**

*1. **T. volvocina** Ehrenb. (Fig. 2, Pl. XVIII).

Shell spherical, smooth; flagellum opening with slightly thickened margin, rarely with low collar; flagellum 2-3 times length of body.

L. 7-21μ.

Distribution, cosmopolitan. Standing water and Plankton.

Three varieties are recognized, var. *papillata* Lemm., shell spherical and flagellum opening surrounded by papilla; var. *cervicula* (Stokes), shell spherical with flagellum opening developed into an internal tube 7-8μ in length; var. *subglobosa* Lemm., with shell slightly elongate and flagellum opening developed into a short internal tube.

The water in small pools is at times colored a deep brown by the large numbers of individuals of the species.

Ohio, Lake Erie (Jennings) (Landacre), Gambier (Walton).

2. **T. perforata** Awerinz. (Fig. 3, Pl. XVIII).

Shell spherical with minute openings; flagellum opening with annular thickening or with low collar.

L. 17-20μ. D. 16-19μ.

Distribution, Europe. Standing water and Plankton.

3. **T. intermedia** Dang. (Fig. 4, Pl. XVIII).

Shell spherical, finely punctuate; flagellum opening with annular thickening; flagellum 2 times length of body.

L. 20μ. D. 16μ.

Distribution, Europe.

4. **T. verrucosa** Stokes (Fig. 5, Pl. XVIII).

Shell spherical, colorless, emarginate anteriorly, covered with wart-like processes; flagellum (?).

L. 24-24.5μ.

Distribution, North America. Ponds.

*5. **T. rugulosa** Stein (Fig. 6, Pl. XVIII).

Spherical with weak spiral folds; flagellum 2-3 times length of body.

L. 15-23μ.

Distribution, cosmopolitan. Standing water and Plankton; Columbus Storage Dam.

6. **T. vermiculosa** Palmer (Fig. 7, Pl. XVIII).

Spherical with short irregular folds; flagellum opening with annular thickening.

L. 23μ.

Distribution, North America (Palmer). Found accompanying *Eunotia pectinalis* (Kutz.).

7. **T. stokesiana** Palmer (Fig. 8, Pl. XVIII).

Spherical with numerous longitudinal folds which often anastomose and at the extremities become spiral; flagellum opening a short conical tube in a flattened depression.

L. 18μ.

Distribution, North America. Ponds Penn. Valley, Bucks County (Palmer).

8. **T. spiculifera** Palmer (Fig. 9, Pl. XVIII).

Spherical with numerous short projections; flagellum opening with thickening either annular or in the form of a polygon.

L. 25μ.

Distribution, North America (Palmer). With *Eunotia pectinalis* (Kutz.).

9. **T. vestita** Palmer (Fig. 10, Pl. XVIII).

Spherical, thickly covered with radial spicules thickened on

distal end and with a flagellum collar having a height of between 1/3 and 1/2 the diameter of the shell; collar broadest at top; flagellum (?).

L. 25μ.

Distribution, North America. Ponds with *Eunotia pectinalis* (Kutz.).

10. **T. bernardi** Wolosz. (Fig. 11, Pl. XVIII).

Transversely oval, truncate anteriorly; flagellum opening with annular thickening; flagellum 4 times length of body.

L. 10-15μ. D. 15-18μ.

Distribution, Java. Plankton (Sawa).

*11. **T. teres** Maskell (Fig. 12, Pl. XVIII).

Oval, smooth; flagellum opening extremely wide; collar low; flagellum about as long as body.

L. 35μ. D. 15μ (?).

Distribution, New Zealand. A form 29μ long which must be referred to this species was obtained in water from one of the upper storage reservoirs at the Cincinnati water works.

*12. **T. oblonga** Lemm. (Fig. 13, Pl. XVIII).

Oval, smooth; flagellum opening with annular thickening which is at times developed into a low collar.

L. 13-16μ. D. 11-12μ.

Distribution, Europe and North America. Standing water.

Mirror Lake, O. S. U., Columbus, O.

Var. *truncata* Lemm. is truncate anteriorly, comparatively shorter than *oblonga* with dimensions L. 12-13μ, D. 11μ. Var. *punctuata* Lemm. is elongately oval and thickly covered with fine punctuations.

*13. **T. crebea** Kellicott (Fig. 1, Pl. XIX).

Oval, thickly covered with granulations; collar widened at mouth, normally straight, and minutely notched; flagellum (?).

L. 25μ. D. (?).

Distribution, North America.

Found by Kellicott in Ohio and by Palmer in the Delaware, although it is here noted that the prevalent form has a collar curved to one side. This is the form which Lemmermann has considered as var. *dentata* by reason of the teeth on the collar.

14. T. lemmermanaii Wolosz. (Fig. 2, Pl. XIX).

Elongately oval, narrowed posteriorly, truncate anteriorly, finely punctuate; flagellum about 2 times length of body.

L. 26μ. D. 13μ.

Distribution, Java. Plankton (Sawa).

15. T. ovalis Daday (Fig. 3, Pl. XIX).

Oval, smooth, distinctly narrowed anteriorly where it is truncate, broadly rounded posteriorly; flagellum 4/5 length of body; flagellum opening 4μ in diameter and with fine marginal teeth.

L. 32μ. D. 18μ.

Distribution, East Africa.

16. T. similis Stokes (Fig. 4, Pl. XIX).

Oval, broadly rounded at both ends, irregularly punctuate; collar curved to one side and provided with irregular teeth.

L. 28μ. L. 14μ.

Distribution, North America.

17. T. volzii Lemm. (Fig. 5, Pl. XIX).

Oval, thickly covered with granulations, collar cylindrical, 4μ high.

L. 32μ. D. 15.

Distribution, Sumatra.

18. T. eurystoma Stein (Fig. 6, Pl. XIX).

Oval, broadest anteriorly, rounded posteriorly, smooth; collar low truncate, with indentations; flagellum 2 times length of body.

L. 30-31.5μ. D. 7.

Distribution, Europe. Standing water.

var. *acuta* Lemm. is pointed posteriorly with collar obliquely truncate.

19. T. incerta Lemm. (Fig. 7, Pl. XIX).

Oval, broadest anteriorly, gradually narrowed posteriorly; flagellum opening with annular thickening; flagellum 2-2½ times length of body.

L. 37.6μ. D. 18μ(?).

Distribution, Europe. Standing water.

var. *punctuata* Lemm. is 15.5μ in length and 7μ in diameter.

Oval, smooth, slightly broadest toward anterior end, collar comparatively high (5μ) and small; flagellum(?).
with a collar 1μ in height.

20. T. africana Fritsch (Fig. 8, Pl. XIX).

L. 27-33μ. D. 12μ.

Distribution, Madagascar. Forest streams.

In material preserved (?) from Analamagotra near Perinet, Madagascar, collected by P. A. Methuen. The truncate posterior end of species together with its comparatively high and slender collar easily distinguishes it from other forms.

21. T. reticulata Klebs (Fig. 9, Pl. XIX).

Oval, colorless, broadest anteriorly, gradually narrowed posteriorly, thickly covered with fine punctuations and marks; stigma prominent; flagellum 2 times length of body.

L. 26μ. D. 17μ.

Distribution, Europe. In cultures of decaying organisms.

22. T. euchlora (Ehrenb.), Fig. 10, Pl. XIX).

Cylindrical, rounded at ends, smooth, collar low; flagellum? chloroleucites 6-10 each with pyrenoid;

L. 25μ. D. ?

Distribution, Cosmopolitan. Standing water.

var. *cylindrica* (Ehrenb.) is smaller, L.23.5-27μ. D.8-9μ.

23. T. conspersa.

Broadly cylindrical, bottle shaped, widest toward base which forms a flat surface, anteriorly a prominent neck; brown or yellowish brown in color covered with irregular granules; flagellum 3 times length of body.

L. 25-35μ. D. 10-25μ.

Distribution, Austria (Prague). Stagnant pools.

24. T. annulata Daday (Fig. 12, Pl. XIX).

Fusiform with elongate neck and posterior spike, and with three transverse annular furrows which separate the shell into four areas; chloroleucites rod like; flagellum ?

L. 97μ. D. 40μ.

Distribution, Paraguay. Swamps and bogs.

25. T. minor Palmer (Fig. 1, Pl. XX).

Spherical, with extremely long collar and posterior spike; shell covered with scattered granules; spike often bent or twisted and with a length of about 17μ, while the collar is 5μ in height. Flagellum ?

L. 30? D. ?

Distribution, North America. Found with *Eunotia pectinalis* (Kütz.).

26. **T. affinis** Lemm. (Fig. 2, Pl. XX).

Cylindrical with undulations, with an extended neck like process obliquely truncate, and with short but pronounced spike; flagellum 1½ times length of body.

L. 51μ. D. 27μ.

Distribution, Europe. Standing water.

Var. *planctonico* Wolosz., has a rough shell, L.45μ D.25μ while var. *levis* Lemm. has a shell which is comparatively broad, L. 60μ. 68.5μ., D. 26-27μ.

27. **T. volgensis** Lemm. (Fig. 3, Pl. XX).

Transversely oval with prominent neck, smooth; posterior spike distinct; flagellum slightly longer than body.

L. 20-40μ. D. 15-20μ.

Distribution, Europe. Plankton of the Volga.

Var. *treubii* Wolosz., has a rough shell, L.20-40μ, D.15-20μ, with posterior spike 15-20μ. in length. Var. *javanica* similar to *treubii* but 25μ in length, 18-20μ in diameter and with a posterior spike only 5μ long.

28. **T. acuminata** (Schmarda), (Fig. 4, Pl. XX).

Triangular or in the form of a trapezoid, smooth, distinctly narrowed anteriorly with prominent straight or slightly curved posterior spike; collar obliquely truncate; flagellum 2 times length of body.

L. 50-59μ. D. ?

Distribution, Europe. In standing water.

Var. *verrucosa* Teodor. has a shell with L.26-34μ and a D.14-22μ which is irregularly covered with spinous warts or protuberances.

29. **T. urceolata** Stokes. (Fig. 5, Pl. XX).

Cylindrical with anterior neck like process transversely truncate and a prominent posterior spike; flagellum about length of body.

L. 45μ. D. ?

Distribution, North America. Ponds.

30. **T. fluviatilis** Lemm. (Fig. 6, Pl. XX).

Oval, smooth or somewhat rough, with neck-like process transversely truncate, gradually narrowed posteriorly into a long (5.5μ) spike; flagellum ?

L. 28.7-34μ. D. 12-12.5μ.

Distribution, Siam. Plankton Menam River.

Var. *curvata* Lemm. has a shell with L.63μ and D.23μ, with the posterior spike (16.5μ) curved.

31. **T. schauinslandii** Lemm. (Fig. 7, Pl. XX).

Transversely oval, covered with fine granulations, with anterior neck-like process; gradually narrowed posteriorly into a spike; flagellum ?

L. 27.5μ. D. 14μ.

Distribution, Siam. Plankton Menam River.

32. **T. ensifera** V. Daday (Fig. 8, Pl. XX).

Spherical or transversely oval, smooth, with anterior neck-like process and massive (42-70μ) posterior spike; flagellum ?

L. 130μ. D. 44μ.

Distribution, Paraguay. Swamps and bogs.

Var. *ornata* Lemm. has the median part of the shell covered with minute elevations.

33. **T. acanthostoma** Stokes (Fig. 9, Pl. XX).

Spherical, finely punctuate; flagellum opening with two irregular rows of short spines.

L. 36.5μ.

Distribution, North America. Ponds.

34. **T. armata** (Ehrenb.), (Fig. 10, Pl. XX).

Broadly oval, not punctuate, with a circular row of comparatively long spines at posterior end; terminal spike absent; flagellum opening thickened or with low toothed collar; flagellum 2 times length of body.

L. 29-64μ. D. ?

Distribution, Cosmopolitan? Standing water and Plankton.

Var. *steinii* Lemm. Possesses an anterior wreath of short spines behind a circle of longer spines.

35. **T. raciborskii** Wolosz. (Fig. 11, Pl. XX).

Oval, surface thickly covered on both ends with heavy short spines; flagellum 3 times length of body.

L. 40μ. D. 30μ.

Distribution, Java. Plankton of Sawa River.

*36. **T. globularis** (Awerinz.), (Fig. 12, Pl. XX).

Spherical, covered with short scattered spines; flagellum opening without collar although an annular thickening often present; flagellum?

L. 20μ.

Distribution, Russia (Bologoje). North America (Gambier, Ohio).

Specimens which must be referred to this species were found in a sample of water from a pool at the foot of Bishop's Hill, Gambier, Ohio, and also from the Cincinnati Storage Reservoir. The shell was green in color and covered with short blunt spines regularly arranged. No prominent collar was noticeable.

D. 27μ.

37. **T. westii** Wolosz. (Fig. 13, Pl. XX).

Broadly oval, slightly widened anteriorly; thickly covered with extremely fine spicules; flagellum ?

L. 18μ. D. 15μ.

Distribution, Java. Plankton of Sawa River.

*38. **T. americana** Lemm. (Fig. 14, Pl. XX).

Spherical, with about 12 extremely long (12μ) spines scattered irregularly over surface and with a cylindrical collar 7μ in height with spherical enlargement on the end; flagellum ?

L. 13μ.

Distribution, North America. With *Eunotia pectinalis* (Kütz.). Mirror Lake, O. S. U., Columbus, O.

39. **T. aegyptiaca** Lemm. (Fig. 15, Pl. XX).

Spherical, thickly covered with fine spines; with prominent collar and posterior spike; flagellum ?

L. 56.4μ.

Distribution, Cosmopolitan? Standing water.

40. **T. piscatoris** (Fisher), (Fig. 16, Pl. XX).

Cylindrical rounded posteriorly with prominent neck-like process anteriorly provided with small teeth and at times with spines; surface covered with spines; flagellum 1½-2 times length of body.

L. 25-40μ. D. ?

Distribution, North America. Pools.

41. **T. setosa** Zykoff (Fig. 1, Pl. XXI).

Oval with numerous long thin spines, approximating the length of the shell, directed posteriorly; collar widened at mouth and provided with teeth; flagellum ?

L. 30μ.

Distribution, Russia. Plankton of the Volga River.

*42. **T. spinosa** Stokes (Fig. 2, Pl. XXI).

Oval, thickly covered with short and somewhat curved spines; collar low, flagellum?

L. ?

Distribution, North America. Pools. Akron, Ohio, Water Reservoir.

*43. **T. hispida** (Perty), (Fig. 3, Pl. XXI).

Oval, yellowish brown, thickly covered with short spines; collar short, often absent; flagellum 1½-2 times length of body.

L. 20-42μ. D. 15-26μ.

Distribution, cosmopolitan. Standing water and Plankton.

The following varieties have been recognized:

var. *punctuata* Lemm. finely punctured and without spines.

var. *coronata* thickly covered with short spines while the opening of the flagellum is circled by larger spines.

var. *crenulatocollis* (Maskell) flagellum opening wide with collar expanded at top and provided with teeth.

var. *caudata* Lemm. thickly covered with spines and provided with distinct posterior spike.

var. *cylindrica* Klebs, cylindrical and thickly spined.

var. *subarmata* Schröder, covered with spines, those on the ends being much longer.

In form, number, size, and arrangement of spines the species varies widely.

Ohio, in E. Swamp on South Bass Island and in Portage River (Jennings) and on vegetation in Basket Factory Cove, San-

dusky (Landacre). Landacre also notes a variety "with spines on the ends and smooth in the middle" which may possibly be referred to *subarmata*.

Hamilton, O., storage reservoir.

44. **T. obtusa** Palmer (Fig. 4, Pl. XXI).

Cylindrical, broadly rounded anteriorly and conical posteriorly; thickly covered with spines; flagellum opening narrow; flagellum (?).

L. 33μ. D. 16μ.

Distribution, North America. Ponds and ditches.

45. **T. horrida** Palmer (Fig. 5, Pl. XXI).

Broadly oval, covered with numerous spines with nearly parallel margins and abruptly pointed at ends; minute wart-like processes between base of spines; collar low with widened mouth, the margin undulating; flagellum (?).

L. 40μ. D. (?).

Distribution, North America. Ditches. Obtained in N. J. by Palmer and in Iowa by Edmundson.

46. **T. saccata** Lemm. (Fig. 6, Pl. XXI).

Oval, gradually narrowed anteriorly into a neck-like process; covered thickly with spines; flagellum (?).

L. (?). D. (?).

Distribution, Paraguay, S. A. Swamps and bogs.

47. **T. bulla** Stein (Fig. 7, Pl. XXI).

Elongately oval, covered with short spines, scarcely narrower posteriorly with distinct collar (6μ in height) provided with teeth; flagellum about length of body.

L. 50-59μ. D. 20μ (?).

Distribution, cosmopolitan (?). Standing water.

Var. *regularis* Lemm. without spines, emarginate anteriorly, neck absent. L.30μ. D.14μ.

48. **T. obovata** Stokes (Fig. 8, Pl. XXI).

Oval, gradually narrowed posteriorly, thickly covered with short spines; flagellum opening with annular thickening; flagellum (?).

L. 22.6μ. D. (?).

Distribution, North America. Swamps and bogs.

49. T. helvetica Lemm. (Fig. 9, Pl. XXI).

Oval, gradually narrowed posteriorly into a spike-like process; thickly covered with spines; collar present, truncate; flagellum (?).

L. (?). D. (?).

Distribution, Europe. Standing water.

50. T. caudata (Ehrenb.) (Fig. 10, Pl. XXI).

Oval, narrowed slightly posteriorly, thickly covered with spines; posterior spike present, straight or slightly curved; collar widened at mouth, provided with teeth; flagellum about as long as body.

L. 29-53μ. D. 21μ.

Distribution, cosmopolitan. Standing water.

Palmer notes this as a rare species occurring as a typical form at Tinicum, Pa., the local species having a length of 40μ.

6. Gen. ASCOGLENA Stein.

Elongately oval similar to Euglena, but secreting a brownish yellow protective covering which gives it a flask-like form, the posterior end being attached to algae or other aquatic plants or debris in the water. General structure as in Euglena.

TABLE OF SPECIES.

A^1 Protective envelope elongately cylindrical and slightly broadened near the base . . . . . 1. **A. vaginicola**

A^2 Protective envelope urn shaped, with distinct neck, broadest near anterior end . . . . . 2. **A. amphoroides**

1. A. vaginicola Stein. (Fig. 11, Pl. XXI).

Body bluntly oval without a pronounced acute tip; stigma not prominent; chloroleucites 12-15 in number, discoid (?); paramylon granules absent (?); secreting a gelatinous protective envelope which is colored yellow or light brown through the action of iron oxide; individual fixed to bottom of protective envelope which is in turn attached to plant debris, algae, etc.

L. 43μ. D. 8-16μ.

Distribution, cosmopolitan (?).

2. A. amphoroides (Francé) (Fig. 12, Pl. XXI).

Protective envelope urn-shaped, yellowish brown, with dis-

tinct neck; interior cell oval, nearly or quite filling protective envelope; chloroleucites large, discoid, without pyrenoids; flagellum (?).

L. 18μ. D. 14μ.

Distribution, Hungary (Balaton). Found on Tribonema.

7. Gen. COLACIUM Stein.

Species attached by a pedicle to Cyclops and other small crustacea as a rule during later stages, free swimming during early stages of development. Form oval or cylindrical, several individuals usually being united into a colony attached by a single stalk; structure similar to Euglena, the flagellum becoming lost as the forms become sedentary.

Distribution, cosmopolitan.

TABLE OF SPECIES.

A[1] Body oval.
  B[1] Basal stalk shorter than length of individual. 1. **C. vesiculosum Eh.**
  B[2] Basal stalk much longer than length of individual. . . . . 2. **C. arbuscula**
A[2] Body cylindrical . . . . . 3. **C. calvum**

***1. C. vesiculosum** Ehrenberg (Fig. 13, Pl. XXI).

Form oval with basal stalk shorter than length of individual; length about two and one-half times the diameter when extended tapering toward each extremity but more attenuate posteriorly, pyriform and widest anteriorly when contracted; motile individuals resembling Euglena; chloroleucites oval, numerous; colonies consist of from two to eight individuals.

L. 19-29μ. D. 9-17μ.

Distribution, cosmopolitan. Found on Cyclops, Copepods, Rotifers, etc.

Variety *natans* Lemm. forms free swimming colonies of 4 transversely arranged cells.

A colony consisting of two representatives was found in a culture March 26, 1912, obtained about two weeks earlier from Mirror Lake on the campus of the State University at Columbus. These were attached to the second right swimming appendage of Cyclops sp. (Nauplius stage). A camera lucida drawing was made and while they were being studied a predatory *Coleps hirtus* happened along devouring both individuals.

Jennings (1900) notes the species from Cyclops in towings taken 2½ miles north of Kelly Island, also on *Polyarthra platyptera* and various crustacea in swamps on S. Bass Island. *C. steinii* Kent, which Jennings found on *Diaptomus sp.* from surface towings in Lake Erie, must be referred to this species.

2. **C. arbuscula** Stein (Fig. 14, Pl. XXI).

Oval with basal stalk much longer than the length of the individual and much branched distally, otherwise as in *C. vesiculosum*.

L. 20-30μ. D. 10-17μ.

Distribution, cosmopolitan.

*3. **C. calvum** Stein (Fig. 15, Pl. XXI).

Cylindrical, with a cup-like base longitudinally striate, and with a short thick stalk; flagellum as long as body.

L. 42-48μ. D. 19-20μ.

Distribution, cosmopolitan. Plankton and on Crustacea.

Common at Sandusky on algae and duckweed roots from Biemillers Cove (Landacre).

8. Gen. EUTREPTIA Perty.

Form bluntly conical, free-swimming, provided with two flagella; posterior end somewhat attenuated when swimming; strongly metabolic with small knot-like swellings appearing anteriorly and moving posteriorly; periplast striated; chloroleucites discoid and without a pyrenoid; stigma present; nucleus central or slightly anterior; metabolic movements accompanying swimming movements as a rule.

Found in both fresh and salt water.

TABLE OF SPECIES.

A^1 Posterior end of body extended into a tail like appendage .	1. **E. viridis**
A^2 Posterior end of body only slightly narrowed. . .	2. **E. lanowii**

1. **E. viridis** Perty (Fig. 16, Pl. XXI).

Broadly fusiform, emarginate anteriorly, with tail-like appendage posteriorly; each flagellum as long as body; paramylon in the form of round or flattened cylindrical rods.

Reproduction in resting condition within gelatinous membrane. Cysts not known except in the var. *schizochlora* Entz.

L. 49-66μ. D. 3-13μ.

Distribution, cosmopolitan. Standing water and Plankton.

A variety *schizochlora* has been described by Entz from ponds containing saline waters in Hungary. The paramylon is absent or in the form of small granules; reproduction by cysts with a thick membrane.

2. **E. lanowii** Steuer (Fig. 1, Pl. XXII).

Fusiform, more elongate than in preceding species, truncate anteriorly, gradually narrowed posteriorly; paramylon spherical or kidney formed.

Reproduction by division during motile condition and also by cysts with definite membrane.

L. 25-60μ. D. 3-13μ.

Distribution, Austria, Trieste (Grand Canal).

2. Fam. ASTASIIDAE Butschli.

Free-swimming, radial, non-colonial, colorless forms obtaining their nourishment as saprophytes; green chloroleucites and red stigma absent as a rule; paramylon present; often extremely metabolic.

The majority of the forms are inhabitants of fresh water, a few, however, being found in salt water.

TABLE OF GENERA

A^1 Provided with a single flagellum.
- B^1 Body strongly metabolic . . . . . 1. Gen. **Astasia**
- B^2 Body rigid . . . . . 2. Gen. **Menoidium**

A^2 Provided with a long and a short flagellum.
- B^1 Body strongly metabolic . . . . . 3. Gen. **Distigma**
- B^2 Body rigid . . . . . 4. Gen. **Sphenomonas**

1. Gen. ASTASIA Dujardin.

Decidedly metabolic; periplast usually striate; a single flagellum; stigma rarely present; reproduction by division during free-swimming stage.

TABLE OF SPECIES.

A^1 Forms not endoparasitic in Cyclops, Catenula, etc.
- B^1 Broadly rounded posteriorly and much narrower anteriorly . . . . . 1. **A. lagenula**
- B^2 Not broadest posteriorly.
  - C^1 Oval, flattened . . . . . 2. **A. inflata**

C² Not flattened.
D¹ Stigma present . . . . . 3. **A. ocellata**
D² Stigma absent.
E¹ Cell straight.
F¹ Nucules central . . . . 4. **A. klebsii**
F² Nucleus posterior . . . 5. **A. dangeardii**
E² Cell lunate . . . . . 6. **A. curvata**
A² Forms endoparasitic in Cyclops, Catenula, etc.
B¹ Living in Catenula . . . . . 7. **A. captiva**
B² Living in Cyclops . . . . . 8. **A. mobilis**

1. **A. lagenula** (Schew.) (Fig. 2, Pl. XXII).

Elongate, posterior end extremely broad and rounded, giving a club-like appearance; periplast smooth; flagellum as long as body; nucleus central; paramylon granules spherical.

L. 25-30μ. D. 10μ.

Distribution, Malay Archipelago (Island Bali). Ditches.

2. **A. inflata** Duj. (Fig. 3, Pl. XXII).

Flattened, short, oval; periplast strongly striate spirally; flagellum as long as body; nucleus central; paramylon granules rod-like.

L. 35-46μ. D. 12μ.

Distribution, cosmopolitan(?). Stagnant water.

*3. **A. ocellata** Khawk. (Fig. 4, Pl. XXII).

Fusiform or somewhat cylindrical, broadest anteriorly; periplast smooth; flagellum 1½-2 times length of body; stigma present; nucleus central; paramylon granules spherical or polyhedral.

Reproduction by cysts with thick membrane.

L. 35-65μ. D. 8-35μ.

Distribution, cosmopolitan. Standing water.

Ohio, Mt. Vernon (Hiawatha Lake).

*4. **A. klebsii** Lemm. (Fig. 5, Pl. XXII).

Fusiform with posterior tail-like process; periplast indistinctly spirally striate; flagellum as long as body; stigma absent; nucleus central; paramylon granules oval.

L. 50-59μ. D. 13-20μ.

Distribution, Europe and North America. Stagnant water.

Gambier, O., Academy Pond.

5. **A. dangeardii** Lemm. (Fig. 6, Pl. XXII).

Oval or fusiform, broadest anteriorly; periplast distinctly striate spirally; flagellum as long as body; stigma absent; nucleus posterior; paramylon granules oval.

Reproduction by oval cysts with thin membrane.

L. 30-58μ. D. 12-20μ.

Distribution, cosmopolitan. Stagnant water.

6. **A. curvata** Klebs (Fig. 7, Pl. XXII).

Elongately cresentic, narrow, usually twisted or somewhat flattened with ends attenuated, truncate anteriorly; periplast weakly striate spirally; flagellum about 2/3 length of body; stigma absent; paramylon extremely small, elongate.

Reproduction (?).

L. 40-46μ. D. 5-6μ.

Distribution, cosmopolitan. Stagnant water, cultures of algae, etc.

7. **A. captiva** Beauch. (Fig. 8, Pl. XXII).

Elongately fusiform with rounded posterior end; periplast spirally striate; flagellum as long as body or absent; stigma rudimentary; nucleus central; paramylon granules round or in the form of elongate rods.

L. 30-40μ. D. (?).

Distribution, France. Endoparasitic in *Catenula lemnae*.

8. **A. mobilis** (Rehberg) (Fig. 9, Pl. XXII).

Fusiform with pointed posterior end; periplast finely striate spirally; stigma present (?); nucleus anterior or posterior; paramylon round or rod-like; flagellum 1½ times length of body or absent.

L. 26-32μ.

Distribution, Europe. Endoparasitic in Cyclops and in the eggs of the egg sack.

Rehberg described a form as *Lagenella mobilis* with a length of 102-103μ which was often of a green color. Alexieff has also noted a species which may be identical with *A. mobilis*.

2. Gen. MENOIDIUM Perty.

Body not metabolic, usually somewhat curved in longitudinal axis; nucleus central or slightly posterior to central area; pellicula

striated longitudinally; paramylon cylindrical or rectangular, numerous granules being present; movement free-swimming, rotating on axis. Four species in fresh water from 16-120μ in length.

TABLE OF SPECIES.

A[1] Form attenuate, length more than 7 times the diameter.
  B[1] Form typically lunate; flagellum as long as body; length approximately 120μ . . . . . 1. **M. falcatum**
  B[2] Form typically sigmoid; flagellum ½ as long as body; length of body 40-80μ . . . . . 2. **M. tortuosum**
A[2] Form not attenuate, length less than 6 times the diameter.
  B[1] Narrowed into a neck like anterior end . . . 3. **M. pellucidum**
  B[2] Broadly rounded anteriorly . . . . . 4. **M. incurvum**

1. **M. falcatum** Zach. (Fig. 10, Pl. XI).

Comparatively narrow and decidedly curved into a form similar to a new moon, the posterior end pointed; periplast(?); flagellum as long as body; nucleus(?); paramylon granules elongate.

L. 120μ. D. 14μ.

Distribution, Europe. Ditches.

2. **M. tortuosum** (Stokes) (Fig. 11, Pl. XXII).

Typically in the form of a letter "S," gradually narrowed and pointed posteriorly; periplast(?); flagellum ½ length of body; nucleus central; paramylon granules elongate.

L. 42-78μ. D. 5-13μ.

Distribution, North America. Among decayed vegetation.

The species was originally placed in the genus Atractonema by Stokes who noted its soft flexible body which, however, was persistent in shape.

3. **M. pellucidum** Perty (Fig. 12, Pl. XXII).

Slightly curved, narrowed posteriorly with extremity rounded, anteriorly developed into a neck-like process; periplast covered with many weak striae; flagellum slightly more than ½ length of body; nucleus posterior; paramylon cylindrical, more or less elongated.

L. 39-40μ. D. 7-10μ.

Distribution, Europe. Stagnant water.

4. **M. incurvum** (Fres.) (Fig. 13, Pl. XXII).

Broadly cylindrical, slightly curved, broadly rounded on the ends; periplast with comparatively distant striations; flagellum

about as long as body; nucleus posterior or central; paramylon(?).

L. 16-25μ. D. 7-8μ.

Distribution, Europe. Stagnant water.

3. Gen. DISTIGMA Ehrenberg.

Decidedly metabolic, elongately fusiform; periplast weakly striate longitudinally; movement free-swimming or creeping; reproduction by division of motile forms, cysts being unknown.

A single species.

1. D. proteus Ehrenb. (Fig. 14, Pl. XXII).

Elongately fusiform; primary flagellum ½ length of body; secondary flagellum short; paramylon granules cylindrical.

L. 46-110μ. D.(?).

Distribution, cosmopolitan(?).

4. Gen. SPHENOMONAS Stein.

Rigid, with longitudinal keels; periplast longitudinally striate, with a primary and secondary flagellum; reproduction by division during motile condition.

TABLE OF SPECIES.

A^1 1 longitudinal carina present	1. S. teres
A^2 4 longitudinal carinae present	2. S. quadrangularis

1. S. teres (Stein) (Fig. 15, Pl. XXII).

Broadly fusiform; longitudinal carina weakly developed; primary flagellum as long as or slightly longer than the length of the body; secondary flagellum short; nucleus anterior.

L. 20-40μ. D. 8μ.

Distribution, cosmopolitan(?). Stagnant water.

2. S. quadrangularis Stein (Fig. 6, Pl. XXII).

Broadly fusiform, quadrate in cross-section, with 4 well developed carinae; primary flagellum 2 times length of body; secondary flagellum short; nucleus central.

L. 30μ. D.(?).

Distribution, Europe. Stagnant water.

3. Fam. PERANEMIDAE Ehrenberg.

Colorless, green chromatophores and red stigma being absent; form bilateral as a rule, movement usually creeping although a

swimming rotating movement occurs in a few species *(Heteronema acus* Ehrenberg, *Euglenopsis vorax* Klebs.); pharynx distinct; nourishment by means of solid particles taken into pharynx; paramylom present.

Inhabitants of fresh water, with representatives of a few genera (Urceolus, Anisonema, Ploeotia, Entosiphon) also found in salt water.

The members of this family are easily overlooked when studying the Protozoa by reason of the small size of many of the species as well as their transparent bodies. Furthermore the majority of the forms are not of frequent occurrence.

TABLE OF GENERA.

A¹ Flagellum directed posteriorly absent; a single anterior flagellum present.
  B¹ Rod-like organ absent.
    C¹ (Subfam. *Euglenopseae*) Free-swimming with a rotating movement; weakly metabolic; striate spirally . . . 1. Gen. **Euglenopsis**
    C² (Subfam. *Petalomonadeae*) Creeping; not metabolic; not striate spirally.
      D¹ Anterior end pointed; contractile vacuole marginal . . . . 2. Gen. **Petalomonas**
      D² Anterior end truncate; contractile vacuole anterior . . . . 3. Gen. **Scytomonas**
  B² (Subfam. *Peranemeae*) Rod-like organ present.
    C¹ Form spindle shaped . . . . 4. Gen. **Peranema**
    C² Form flask shaped . . . . 5. Gen. **Urceolus**
A² Flagellum directed posteriorly present; an anteriorly directed flagellum also usually present.
  B¹ Granules not arranged spirally in the ectoplasm; species not exceeding 60μ. in length.
    C¹ Two flagella arising from same area present, one directed anteriorly, the other posteriorly.
      D¹ (Subfam. *Heteronemeae*) Posterior flagellum shorter than the anterior flagellum.
        E¹ Body not flattened; weakly metabolic . . . . . 6. Gen. **Heteronema**
        E² Body flattened; not metabolic.
          F¹ With 6-8 longitudinal ribs. 7. Gen. **Tropidoscyphus**
          F² Without longitudinal ribs. 8. Gen. **Notosolenus**
      D² (Subfam. *Anisonemeae*) Posterior flagellum usually longer or at least equal in length to the anterior flagellum.

E[1] Pharyngeal siphon absent.
F[1] Posterior flagellum twice the length of the anterior flagellum.
G[1] Keel like ribs absent . 9. Gen. **Anisonema**
G[2] Keel like ribs present. 10. Gen. **Ploeotia**
F[2] Posterior flagellum approximately equal in length to the anterior flagellum.
G[1] Without an apparent ventral longitudinal furrow; metabolic . 11. Gen. **Metanema**
G[2] Without an apparent longitudinal furrow; not metabolic . . 12. Gen. **Marsupiogaster**
E[2] Pharyngeal siphon present . 13. Gen. **Entosiphon**
C[2] (Subfam. *Clautriavieae*) A single flagellum directed posteriorly . . . 14. Gen. **Clautriavia**
B[2] (Subfam. *Dinemeae*) Granules arranged spirally in the ectoplasm; species 75-80μ. in length. 15. Gen. **Dinema**

1. Gen. EUGLENOPSIS Klebs.

Form spindle shaped, colorless or yellowish white, slightly metabolic, free swimming with rotation on axis; a single flagellum; pellicula more or less spirally striate; an anterior mouth-like fold present.

Habitat, fresh water.

Distribution, cosmopolitan(?).

The genus consists of a single species.

1. **E. vorax** Klebs (Fig. 1, Pl. XXIII).

Possessing the characters of the genus with protoplasm colorless and containing numerous paramylon granules.

L. 20-25μ. D. 8μ.

Distribution, cosmopolitan.

While its small size will aid in distinguishing it from many other species belonging to the family Astasiidae, some of which it resembles, the possession of the mouth-like fold is the character of importance. Thus far it has not been noted from Ohio.

2. Gen. PETALOMONAS Stein.

Cells rigid, not metabolic; unsymmetrical in form and often with peculiarly developed processes; periplast thick and firm and

occasionally developing a longitudinal carina or a longitudinal furrow; 1 flagellum arising from a depression on the right of the cytopharynx; a primary and a secondary vacuole usually to right of cytopharynx; nucleus usually at left of cell.

Reproduction by longitudinal division; cysts not known.

Nourishment, saprobiotic.

TABLE OF SPECIES.

A¹ Longitudinal carinae absent although longitudinal furrows which may be mistaken for carinae may be present.
- B¹ Posterior end without peculiarly developed processes.
  - C¹ Lateral margins not turned inward.
    - D¹ Broadly oval . . . . 1. **P. mediocanellata**
    - D² Elongately oval . . . . 2. **P. angusta**
  - C² Lateral margins turned inward . . 3. **P. inflexa**
- B² Posterior end with peculiarly developed processes.
  - C¹ Posterior lateral processes 2 in number; cell not gradually narrowed anteriorly—but nearly cylindrical . . . . 4. **P. sinuata**
  - C² Posterior processes 6 in number; cell gradually narrowed anteriorly . . . 5. **P. sexlobata**

A² Longitudinal carinae present.
- B¹ 1-3 longitudinal carinae.
  - C¹ 1 longitudinal carina.
    - D¹ Carina with a sharp edge . . 6. **P. steinii**
    - D² Carina rounded . . . . 7. **P. carinata**
  - C² 2-3 longitudinal carinae.
    - D¹ Posterior end rounded or truncate . 8. **P. abscissa**
    - D² Posterior end deeply emarginate . 9. **P. mira**
- B² 4-5 longitudinal carinae.
  - C¹ Carinae not extremely developed.
    - D¹ Fusiform, rounded posteriorly; L.12-15μ. 10. **P. quadrilineata**
    - D² Oval, truncate posteriorly; L.34μ. . 11. **P. sulcata**
  - C² Carinae extremely developed, their height exceeding ordinary diameter of body . 12. **P. alata**

1. P. mediocanellata Stein (Fig. 2, Pl. XXIII).

Broadly oval, ventral and dorsal sides with furrows, that on the dorsal side being narrow; flagellum as long as body.

L. 22-25μ. D.(?).

Distribution, cosmopolitan. Pools containing much vegetation.

Var. *distomata* (Stokes) has the two furrows equally broad and the anterior end of the cell slightly elongated. Found on the surface of decaying leaves in the bottom of shallow pools.

Var. *pleurosigma* (Stokes) is fusiform, similar to *P. mediocanellata,* with the posterior end pointed, and has a length of 17μ. Standing pond water with aquatic vegetation.

2. **P. angusta** (Klebs) (Fig. 3, Pl. XXIII).

Elongately oval, dorsal side convex, ventral side with furrow; flagellum as long as body.

L. 14-23μ. D. 7-14μ.

Distribution, Europe. Pools containing much vegetation.

Var. *pusilla* (Klebs) is 7μ in length and 3-4μ in diameter; var. *lata* (Klebs) is broadly oval with short pointed posterior end, L. 22μ, D. 12-14μ.

*3. **P. inflexa** Klebs (Fig. 4, Pl. XXIII).

Elongately oval, flattened, broadly truncate or emarginate posteriorly, pointed anteriorly; lateral margins curled inwardly; flagellum as long as body.

L. 30μ. D.(?).

Distribution, Europe and North America. Pools containing much vegetation.

var. *obliqua* Klebs has only the left lateral margin curled ventrally, while the flagellum is oblique to the longitudinal axis of the body during the swimming movement.

Var. *pellucida* Klebs is thin, transparent, and the dorsal side possesses a shallow furrow, the lateral margins curled inwardly. L. 8μ, D. 8μ.

Gambier, O. Small forms 11.5μ in length referable to the var. *pellucida* were obtained in a small brook filled with *Lyngbya* on the McElroy Farm.

*4. **P. sinuata** (Stein) (Fig. 5, Pl. XXIII).

Short cylindrical, pointed anteriorly and with a lateral posterior process on each margin; flagellum 1½-2 times length of body.

L. 38μ. D.(?).

Distribution, Europe. Pools with much vegetation.

5. **P. sexlobata** Klebs (Fig. 6, Pl. XXIII).

Broadly oval, pointed bluntly anteriorly, with six short but

thick posterior processes turned inwardly; flagellum 2 times length of body.

L. 27-30μ. D. 21-23μ.

Distribution, Europe. Pools with much vegetation.

6. **P. steinii** Klebs (Fig. 7, Pl. XXIII).

Oval, trianglar in cross section; carina prominent; flagellum as long or longer than the body.

L. 38-42μ. D. 22μ.

Distribution, Europe. Pools with much vegetation.

7. **P. carinata** Francé (Fig. 8, Pl. XXIII).

Elongately oval, with ends rounded; carina broad, formed by membraneous fold rolled toward the right; vacuole and nucleus on median line.

L. 23μ. D.(?).

Distribution, Hungary (Balaton).

8. **P. abscissa** (Duj.) (Fig. 9, Pl. XXIII).

Broadly oval or round, slightly narrowed anteriorly and often truncate posteriorly; ventral surface flat or with furrow; dorsal surface with 2 longitudinal carinae; flagellum longer than body.

L. 27.5μ. D.(?).

Distribution, Europe. Pools rich in aquatic vegetation.

Var. *convergens* Klebs, is pointed anteriorly and emarginate posteriorly with the longitudinal carinae converging anteriorly and the L. 19μ, the D. 17μ.

Var. *parallela* Klebs is rounded anteriorly and emarginate posteriorly with the longitudinal carinae parallel although often unequal in size, L. 30μ, D. 17μ.

Var. *deformis* Klebs is pointed anteriorly, truncate posteriorly, with 3 longitudinal parallel carinae.

9. **P. mira** Awerinz. (Fig. 10, Pl. XXIII).

Oval with anterior end narrowed and curved toward the right, the posterior end deeply emarginate; 3 longitudinal carinae; lateral margins with a row of granules; flagellum 2 times length of body.

L. 26-30μ. D. 18μ.

Distribution, Russia (Bologoje-Sea). In slime.

10. P. quadrilineata Penard (Fig. 11, Pl. XXIII).

Fusiform, rounded posteriorly; flagellum 2 times length of body.

L. 12-15μ. D.(?).

Europe, Wiesbaden.

11. P. sulcata Stokes (Fig. 12, Pl. XXIII).

Oval, less than twice as long as wide, truncate posteriorly, dorsal and ventral surfaces each with 4-5 longitudinal or slightly oblique carinae, which at times meet posteriorly; flagellum equal to length of body.

L. 34μ. D.(?).

Distribution, North America. Ponds.

12. P. alata Stokes (Fig. 13, Pl. XXIII).

Oval, broadly rounded posteriorly, with 4 extremely high longitudinal carinae, height much greater than diameter of body, in furrows between carinae; flagellum 2 times length of body.

L. 23μ. D.(?).

Distribution, North America. Ponds with *Ceratophyllum*.

3. Gen. SCYTOMONAS Stein.

Form oval, somewhat flattened; truncate anteriorly; not metabolic; flagellum arising from one side of anterior end; vacuole anterior, circular or triangular in outline; movement creeping as in Petalomonas.

Distribution, cosmopolitan.

TABLE OF SPECIES.

A[1] Oval, narrowed anteriorly.
  B[1] Frequenting digestive tract of frogs and toads, also stagnant water(?), nucleus posterior . . . . . 1. **S. pusilla**
  B[2] Frequenting digestive trace of *Molge vulgaris*,—nucleus anterior . . . . . 2. **S. dobellii**
A[2] Elongately oval with broadly rounded ends, not distinctly narrowed, anteriorly . . . . . 3. **S. major**

1. S. pusilla Stein (Fig. 14, Pl. XXIII).

Oval, distinctly narrowed anteriorly and rounded, or rarely fusiform or emarginate; flagellum 1¼ times length of body; nucleus posterior, rarely central.

L. 7.5-20μ. D. 7-8μ.

Distribution, Europe. Intestine of frogs and toads.

Lemmermann notes *Copromonas subtilis* Dobell as a synonym of this, while he suggests that *Sytomonas pusilla* Klebs may represent a distinct genus, the cell being oval, truncate anteriorly, nucleus central, flagellum scarcely as long as body, cytopharynx absent. In cultures of decaying algae.

2. **S. dobelli** n.sp. (Fig. 15, Pl. XXIII).

Oval, distinctly narrowed anteriorly; flagellum 1½ times length of body; nucleus anterior.

L. 7-10μ. D. 3-4μ.

Distribution, Europe. Intestine of *Molge vulgaris* L., one of the Salamanders.

It seems evident that this form referred by Lemmermann doubtfully to *S. major* should be considered as a distinct species by reason of difference in host, general size, position of nucleus, etc. Therefore it is fitting that it bear the name of the investigator by whom it was discovered.

3. **S. major** (Berliner), (Fig. 1, Pl. XXIV).

Elongately oval, broadly rounded at the ends; flagellum 1¼ times the length of the body; nucleus central.

L. 20μ. D. 8μ.

Distribution. Europe. Digestive tract of *Lacerta viridis* Gessn., the small green lizard.

4. Gen. PERANEMA Stein.

Form spindle shaped, narrowed anteriorly; strongly metabolic; flagellum longer than body; pharynx prominent; rod-like organ present; pellicula striate spirally; nucleus central; paramylon present; movement a slow swimming one accompanied by decided metabolic contractions of the body.

TABLE OF SPECIES.

A¹ Fusiform or cylindrical, flagellum 1-1½ times length of body, L.22-70μ. . . . . 1. **P. trichophorum**

A² Elongately spherical, flagellum 2½-3 times length of body, L.8-15μ. . . . . 2. **P. granulifera**

*1. **P. trichophorum** (Ehrenb.) (Fig. 2, Pl. XXIV).

Fusiform or cylindrical; periplast spirally striate, the striae

formed of numerous elevations apparently developed as short hairs; flagellum 1-1½ times length of body.

L. 22-70μ. D. 12-20μ.

Distribution, cosmopolitan. In stagnant water generally in company with *Euglena*. The presence of the rod-like organ serves to distinguish the species from members of the genus *Astasia*.

Jennings in his study of the Protozoa of Lake Erie noted under the name of *Astasia trichophora* Ehrb., a form which may be referred to this species. Conn in The Protozoa of Connecticut suggests that the extreme variation in the forms indicates several species in the genus.

2. **P. granulifera** Penard (Fig. 3, Pl. XXIV).

Elongately spherical; periplast covered with granules; flagellum 2½-3 times length of body.

L. 8-15μ. D.(?).

Distribution, Europe. Stagnant pools.

5. Gen. URCEOLUS Meresch.

Form flask shaped with contracted neck; decidedly metabolic; posterior end rounded; anterior end forming a funnel shaped peristome extending into a pharynx and reaching to the posterior third of the body; flagellum somewhat longer than body; rod-like organ present; pellicula either striate spirally or smooth surrounded with mucous containing minute foreign substances; principal vacuole with a small accessory contractile vacuole and with a long excretory canal; movement creeping. Four species.

Habitat, fresh water and marine.

Distribution, cosmopolitan(?).

TABLE OF SPECIES.

A¹ Periplast without a gelatinous layer in which is imbedded numerous minute granules of sand.
- B¹ Periplast striated.
  - C¹ Posterior end with a short tip; prominent spiral carinae not present . . . . . 1. **U. cyclostomus**
  - C² Posterior end developed into an elongate tip; several prominent spiral carinae . . . 2. **U. costatus**
- B² Periplast not striated . . . . . 3. **U. alenizini**

A² Periplast with gelatinous layer in which are imbedded numerous minute granules of sand . . . . 4. **U. sabulosus**

*1. **U. cyclostomus** (Stein) (Fig. 4, Pl. XXIV).

Fusiform with anterior end normally flask-like in form; periplast spirally striate; flagellum slightly longer than body; prominent rod-like organ present.

L. 26-50μ. D. 17-30μ.

Distribution, cosmopolitan(?). Stagnant pools.

Ohio, decaying vegetation from Biemiller's Cove, Sandusky (Landacre).

2. **U. costatus** Lemm. (Fig. 5, Pl. XXIV).

Fusiform with pointed tip and several prominent spiral carinae; flagellum less than length of body.

L. 35-40μ. D. 12-14μ.

Distribution, Europe. Ponds containing much vegetation and also in Plankton.

3. **U. alenizini** Meresch. (Fig. 6, Pl. XXIV).

Broadly fusiform with more or less blunt ends, the anterior end truncate, posterior rounded; periplast smooth; flagellum slightly longer than body.

L. 39μ. D. 24μ.

Distribution, Europe. Stagnant water and water from refuse material.

4. **U. sabulosus** Stokes (Fig. 7, Pl. XXIV).

Broadly fusiform, somewhat widened anteriorly and obliquely truncated with contracted neck-like process of the cytopharynx; covered with gelatinous substance containing numerous minute granules; flagellum as long or longer than body.

L. 58μ. D.(?).

Distribution, North America. Fresh water with algae.

This species placed originally in the genus *Urceolus* by Stokes was later transferred by him to a new genus *Urceolopsis*. The general structure, however, suggests that it may be replaced in the former genus at least for the present. It swims rapidly.

6. Gen. HETERONEMA (Duj.) Stein.

Form elongate, or spherical, usually assuming a more or less twisted appearance; decidedly metabolic; anterior end pointed; provided with two flagella the length of the anterior from 1-2