WALDO

Protozoa of Salt Fork

Zoology
B. S.

1900

PROTOZOA OF SALT FORK AND ITS TRIBUTARIES

by

MARIE L. WALDO

THESIS PRESENTED FOR THE DEGREE OF

BACHELOR OF SCIENCE

in

ZOOLOGY,

COLLEGE OF SCIENCE

in the

UNIVERSITY OF ILLINOIS

JUNE 1, 1900.

UNIVERSITY OF ILLINOIS

June 1 1900

THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Marie L. Waldo

ENTITLED Protozoa of Salt Fork and its Tributaries.

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Zoölogy.

S. A. Forbes

HEAD OF DEPARTMENT OF Zoölogy.

TABLE OF CONTENTS.

INTRODUCTION.

In writing this paper it was my original purpose to determine the protozoan fauna of an ordinary western prairie stream, and particularly of Salt Fork and its tributaries. Later, owing to the great territory which this presents, and to convenience, the work was largely confined to that branch of the Salt Fork commonly known as the Boneyard.

I have tried to procure material at all seasons and at all conditions of the stream during one year. Samples have been taken from different places along the stream, usually dipped from promising localities, where the water was still or covered with scum, or along the edges where leaves had fallen in and laid quietly for some time. Such material has usually been brought into the laboratory and kept alive in aquaria until examined. Where it was possible to collect in a boat,- north of Urbana above Crystal Lake- the tow-net was used. The tow-net catch was brought into the laboratory, filtered through hard pressed filter paper which retains even the smallest forms, and the precipitate was then washed off into formalin and so preserved.

I have also studied aquaria about the laboratory a great deal. These have usually been derived from the Bone-yard, but sometimes they contained, in addition, some material brought from the Illinois River. So the paper contains, not only the Protozoa occurring naturally in a prairie stream but also, to some extent, those

breeding in aquaria about a zoological laboratory.

The killing fluids have been 2%-4% formalin, Fleming's fluid and 1% osmic acid. The principal stain used was Orth's Lithium Carmine. It was impossible to make many permanent preparations. Parasitic forms on small Entomostraca have been mounted. *Paramoecium* was found in such quantity that it could be stained and mounted. Also, during the summer of 1899 I found *Bursaria* in quantity, and large enough to be seen with the naked eye and so easily picked out with a pipette, and preserved. The material mounted was killed with Flemming's fluid, and stained in Orth's lithium carmine. The excess of stain was washed out with acid and the material taken through the alcohol grades to cedar oil, which was used as a clearing agent. The material was then mounted in balsam.

My methods of study have been simple. Of course it has all been done with the microscope. I have made drawings of the different species whenever it was possible in the time available. I have studied the forms alive when I could. If they moved too rapidly, and it was necessary to quiet them, one of the agents mentioned above was used. It is sometimes necessary to exercise care in choosing the killing agent, for certain of the Protozoa will go to pieces with one but not with another reagent. In studying parasitic forms the host was entangled in bits of filter paper under the cover, in order to quiet it. After the drawing was made the animal was classified. Leidy ('79) was used principally for determining rhizopods and Kent ('80-'81) and Bütschli ('80-'89) for the others. A list of further literature used is added at the end.

Careful notes have been taken on the characters and habits of the creatures, and record kept of the times of occurrence.

Before closing this preface, I wish to express my sincere thanks to Dr. C.A.Kofoid, who has so kindly directed the work; to Professor S.A.Forbes for his encouragement and advice; and to Professor Frank Smith for his valuable assistance with materials.

Characteristics of the Environment Investigated.

The locality studied is a typical western prairie with the stream, in some places little more than a ditch, winding through it. The Boneyard flows through both Champaign and Urbana, crossing the University campus between Healy and Green streets, just back of Engineering Hall. It empties into Salt Fork, north east of Urbana near the brick yard, at which place it is about twelve feet wide. Salt Fork belongs to the Wabash system, being tributary to the Big Vermilion which empties into the Wabash at Eugene, Indiana.

The banks of the stream are not high, having an average height of about four feet but in some places reaching eight feet or more. They are generally sloping, although in some places they are rather steep. They consist of black mud and clay. The bottom is partly mud and partly sand and gravel. The banks are grass-grown and the vegetation extends clear down into the water in most places. In the stream are found many forms of green algae-- Spirogyra, Protococcus and Oscillaria are most abundant-- a great number of species of diatoms are found, and also many bacteria. Moss, too, is often found growing on stones in the stream.

The stream has been modified more or less by man, since two cities of considerable size are located on it. For instance, the sewage of the city have had an outlet in the Boneyard until the last year or so, and many drains still empty into it. The hot water from the University heating plant has also been blown into it for the past two years.

The depth varies, I should say, from about six inches to fourteen inches. During flood, in the spring, it often overflows its banks and spreads out for a distance of several feet on either side. I have never seen it entirely dry, but during drouth in the summer months, it gets very low and often dries up save for pools dere and there. The water reaches a high degree of temperature during August and September-- about 38° C. It is usually during these months that the water is lowest, due to drouth. This winter there was about eight inches of water in the stream, and this was frozen over for the best part of four months. Twice when I collected, in the month of January, the ice was three inches thick. The course of the stream is exceedingly tortuous. It is a continuous pool through most of its course, riffles being rare. The current is very sluggish.

Synoptic Key.

The following synoptic key will serve for the identification of the species listed in this paper. The classification in the main is based on Bütschli ('80-'89), supplemented by Leidy ('79) for the Rhizopoda and Schaudinn ('96) for the Heliozoa.

CLASS SARKODINA:-

Protoplasmic mass either naked or shelled, which mo moves wholly by potoplasmic movement or by the development of protoplasmic processes.

Subclass Rhizopoda:-

Naked or shelled. Moves by simple flowing of the protoplasm or by the putting forth of pseudopodia. Changeable in form, or if somewhat constant, inclined to monaxial form.

Order Amoebaea:-

Naked Rhizopoda, very changeable in shape. Pseudopodia lobose or reticulate. With or without nucleus and contractile vacuoles.

Family Amoebaea lobosa:-

Lobose pseudopodia not forming a network.

Genus I. Amoeba:-

Containing one or more nuclei. Pseudopodia lobose, often branched or pointed and bifid. Sometimes moves simply by a flowing of the protoplasm, without developing distinct pseudopodia. Contractile vacuoles present. Multiplies by division

in moving condition. Encysting o served with and without reproduction.

Posterior end not villous ... 2.
With evident pseudopodia... ... .A. proteus 1.

Without evident pseudopodia.........A. verrucosa 2.
Posterior end villo us ....A. villosa 3.

Genus II. Pelomyxa:-

Amoeboid. Pseudopodia very blunt and not distinct. Posterior end with villous processes. Encloses a large number of nuclei as well as small rod- or bacteria- like bodies.

One species .... '. ..'. P. villosa 4.

Genus III. Dinamoeba:-

Oval, when at rest. Pseudopodia few or many, and everywhere bristling with rigid, cilia-like processes. Posterior extremity of body with retractile papillae.

One species .... D. mirabilis 5.

Family Amoebaea reticulosa:-

Pseudopodia forming network, and arising from all sides of the body.

Genus IV. Biomyxa:-

Contractile vacuoles many and small. Protoplasm colorless, granular and possessing power of expanding and extending itself in any direction. Pseudopodia arise from all parts of body, branch and anastomose in all directions.

One species .... B. vagans 6.

Order Testacea:-

Rhizopoda with shell of chitinous material, of silicious plates, diatoms, or quartz fragments.

Suborder Imperforata:-

Shell wall solid, not perforated. with fine pores. With a single mouth opening.

Family Arcellina:-

Shell monaxial, dome-shaped to elongate. Sometimes by a one-sided position of the mouth, it is bilateral. Lobose pseudopodia. Nucleus and contractile vacuoles usually present.

Genus V. Arcella:-

Shell dome-shaped with convex upper side and flat under side, in the center of which is the wide circular mouth. Brown to pale yellow in color. Shell sometimes finely punctulate. Body does not fill the shell.

Shell hemispherical
Height half the breadth.......................*A. vulgaris* 7.
Shell shield-shaped
Height one-fourth to one-third the breadth.
.......*A. discoides* 8.

Genus VI. Difflugia:-

Shell encrusted with particles of sand, diatom frustules and other doubtful bodies, cemented with chitinous material; not brownish throughout. Shape variable, spherical to elongated, and with the posterior end sometimes drawn out into points or horn-like processes. Mouth opening sometimes eccentric and then the form is bilateral. Sometimes mouth opening is cren-

ulate, toothed or lobed. Body not entirely filling shell. Pseudopodia lobose, sometimes branching. Vacuoles and nuclei in varying numbers.

Fundus with a circles of spines ....D. corona. 13.
Fundus without a circlet of spines. 2.

Mouth with flaring collar ....D. urceolata. 11
Mouth without flaring collar. 3.

Mouth antero-terminal....... .... D. constricta. 14.
Mouth terminal. 4.

Shell spherical or elliptical 5.
Shell pyriform......... ......D. pyriformis. 10.

Mouth not lobed ....D. globulosa. 9.
Mouth lobed ....D. lobostoma. 12.

Genus VII. Centropyxis:-

Shell circular or oval; brownish; chitinous, scantily incorporated with particles of quartz. Mouth and fundus eccentric in opposite directions. Mouth round and inferior. Fundus with or without conical spines.

With conical chitinous projections ... ...C. aculeata. 15.
Without chitinous projections.. C. aculeata var. ecornis.

Family Euglyphina:-

Shell chitinous or silicious, built up of hexagonal or round plates. Monaxial to bilateral. Pseudopodia thread-like, pointed, anastomosing but little.

Genus VIII. Campascus:-

Form somewhat long purse shaped

with straight neck-like mouth or with mouth pushed to the side. Shell chitinous, encrusted with foreign bodies. Posterior end with horn-like processes at each side.

One species .... C. cornutus. 16.

Family Gromiina:-

Chitinous, usually structurelessshell, monaxial to bilateral, oval form, with rather narrow mouth opening. Pseudopodia reticulose, thin, thread-like and pointed.

Genus IX. Pamphagus:-

Pear-shaped. Very delicate shell membrane, closely applied to body. Pseudopodia long and branching, arising from the broad end; nucleus large.

One species........ .... P. mutabilis. 17.

Subclass Heliozoa:-

Naked or enclosed in a silicious skeleton. Almost regular spherical form. Pseudopodia fine, more or less rigid, and but little inclined to anastomose; radiating from all sides of the surface of the body. One or several nuclei.

Order Aphrothoraca:-

Without a shell save during encystment.

Genus X. Actinophrys:-

Without a stalk. Ectoplasm and entoplasm not clearly distinguished. Pseudopodia with granules and with axisthreads which reach to the upper surface of the central nucleus. One central nucleus. One pulsating vacuole at the surface.

One species.............. . . . .A. sol. 18.

Genus XI. Actinosphaerium:-

No stalk. Ectoplasm and entoplasm clearly distinguished. Axis threads of pseudopodia end at boundary between ectoplasm and entoplasm. Entoplasm with small vacuoles. Ectoplasm with large vacuoles, several of which are pulsating. Several nuclei in entoplasm.

One species. .... A. eichhornii. 19.

Genus XII. Nuclearia:-

Body amoeboid. No distinction between ectosarc and endosarc. Protoplasm vacuolated. Pseudopodia rising from all sides or only from one part of the surface. Some times with acute-angled branched ends. One or several nuclei. Large contractile vacuoles.

One species................ ..... N. polypodia. 20.

Order Chlamydophora:-

Having spherical, soft, gelatinous shell, often containing foreign bodies.

Genus XIII. Heterophrys:-

Entoplasm and ectoplasm rather clearly distinguished. One nucleus in entoplasm. One or several pulsating vacuoles. Pseudopodia on all sides, thin, with streaming of granules. Surrounded by a spherical, rather thick, gelatinous shell, which is hyaline within and granular without. Surface provided with fine, fringe-like radiating processes.

One species. ....H. myriapoda. 21.

Order Chalarothoraca:-

With spherical shell of isolated silic-

ious particles, which are produced by the animal itself.

Genus XIV. Acanthocmstis:-

Ectoplasm and entoplasm clearly distinguished. Entoplasm eccentric, finely granulate, with one nucleus. Ectoplasm with several small pulsating vacuoles and frequently with chlorophyll bodies. Pseudopodia fine, with axial threads, which unite in a central body. Shell skeleton of radiating spines.

One species........................ . A. turfacea. 22.

CLASS MASTIGOPHORA:-

One-celled, more or less flexible organisms, bearing one or several flagella which aid both in movement and in the capture of food. May or may not form colonies.

Order Flagellata:-

Having one or more flagella at the anterior end of the body.

Subordar Modina:-

Small; simple structure; naked, often more or less amoeboid, but sometimes with a shell. Usually colorless. One anterior important flagellum or one or two small side-flagella. Special mouth opening sometimes lacking; sometimes present at base of flagellum. Never a well-developed pharynx.

Family Rhizomastigina:-

Simple, mouthless forms with one or two flagella. Sometimes presenting Rhizopoda-like pseudopodia and sometimes, heliozoa-like, changing from a flagellate condition, without pseudopodia, into a sarcode condition, without flagella.

Genus XV. Mastigamoeba:-

Generally oval in shape. Greater or less number of from finger-shaped to branching pseudopodia. One prominent flagellum. Ectoplasm and entoplasm sometimes differentiated. One or several contractile vacuoles.

One species..........................M. simplex. 23.

Family Cercomonadina:-

Small; from oval to elongate in shape. Somewhat amoeboid. One prominent flagellum, at the anterior end, forwardly directed.

Genus XVI. Cercomonas:-

Small colorless, spherical to oval in shape. Anterior end with a strong flagellum. Posterior end drawn out into a long, flagella- or pseudopodia-like thread. Pointed pseudopodia sometimes developed at posterior end. Nucleus in anterior half of the body. One to several contractile vacuoles. Mouth at the base of the flagellum.

One species.................. .. ....C. typica. 24.

Family Bikoecina:-

Loricate monads of peculiar structure. Shape somewhat oval, with broader posterior end and narrower anterior end, which bears one flagellum and a peristome process, between which and the base of the flagellum, the mouth lies. Posterior end of body attach to back of lorica by a delicate, contractile thread-like process. Lorica is vase-shaped and usually attached to a stalk. Often colony-building. Nucleus central. Contractile vacuoles 1-3.

Genus XVII. Stylobryon:-

Colony-forming: shells united to each other or to common pedicle by slender footstalks. Bodies ovate with projecting lip-like anterior border. One flagellum.

One species.. ....S. abbotti.25.

Family Heteromonadina:-

Small, colorless monads, distinguished by a prominent forward flagellum, which is usually accompanied by from one to two small wavy ones. Frequently forming colonies, and then with a stalk separated from the posterior end.

Subfamily Monomonades:-

Characterized by lack of colony-building, and also by occasional increase in number of side flagella.

Genus XVIII. Paramonas:-

Ovate or globular: uniflagellate; more or less persistent in shape, incepting food substances through a distinct oral aperture, which is situated anteriorly at the base of the flagellum.

One species....... ....P. globosa. 26.

Subfamily Dendromonades:-

Characterized by formation of colonies, and also by the fact that there is always but one small accessory flagellum.

Genus XIX. Anthophysa:-

Cone-shaped with broad truncate anterior end, and produced on one side into a beak-like pointed peristome process. At the base of t his arises the main flagellum

and beside it the small one. Nucleus and contractile vacuole in anterior half of body. United in rosette-like clusters on a dichotomously branching stalk which unite in colonies.

One species.................. *A. vegetans*. 27.

Suborder Euglenoidina:-

Usually amoeboid movement, but some species are rigid. Uniflagellate. Slightly asymmetrical. Contractile. Colored or colorless. Mouth opening just back of base of flagellum which leads into a more or less prominent pharynx. Contractile vacuoles near pharynx, and sometimes with reservoir.

Family Euglenina:-

Body monaxial, generally inclined to bilateral symmetry, since the mouth is a little on the ventral side. Elongate, and posterior end mostly sharply pointed. Cuticular surface more or less obliquely striate. Metabolic. Small mouth and strong tubular pharynx, from which the single flagellum arises. One to several contractile vacuoles. Body usually green. Prominent nucleus in center of body.

Genus XX. *Euglena*:-

Without distinct shell. Spindle-shaped to elongated needle-shaped and with pointed posterior end: or cylindrical to ribbon-shaped. Very metabolic. Oblique striations very fine. Chromatophores usually numerous and disc-shaped. Mouth and pharynx usually well-developed, with flagellum arising in the pharynx.

{ Surface spirally beaded........... *E. spirogyra*. 29.
{ Surface not spirally beaded 2.

Anterior end tapering, abruptly truncate. Posterior end long acuminate............................E. [illegible] 31.
Posterior end not long acuminate 3.

Posterior end abruptly ac minate. Somewhat rigid.
.....E. oxyuris 30.
Posterior end gradually acuminate. Very mobile.
......E. viridis. 28.

Genus XXI. Trachelomonas:-

Structure essentially as in Euglena. Main characteristic is the separation of a firm, flexible to brittle, colorless to brown shell, whose shape varies between spherical and long egg-shaped. The shell has a small round anterior opening, from which the flagellum protrudes.

Surface hispid. Without tail-like process.
......T. hispida. 32.
Surface smooth. With tail-like process.
...T. acuminata. 33.

Family Chloropeltina:-

General structure like Euglenina, but different in the strength and resistance of the cuticula and by the almost complete lack of flexibility. Always a prominent caudal process. Sometimes from one to several disc-shaped paramylon bodies.

Genus XXII. Phacus:-

More or less asymmetrical, flattened, elipsoidal to pear-shaped, with a more or less prominent posterior tail, which sometimes increases the asymmetry by its distorted

position. Cuticular surface longitudinally or obliquely striate. The whole body sometimes twisted like a screw. Usually one large paramylon body in the center, back of the nucleus.

Caudal prolongation short and curved. P. trigueter. 34.
Caudal prolongation long and twisted.
.........P. longicaudus. 35.

Family Petalomonadina:-

Colorless; with constant form; somewhat oval and flattened. Large flagellum at the anterior end and close behind, on the ventral side is the mouth opening which leads into a poorly developed pharynx.

Genus XXIII. Petalomonas:-

Oval, very much flattened. Central longitudinal furrow. Very long anterior flagellum which is vibratile only at the anterior end. Mouth on ventral side, at base of flagellum, with very short, if any, pharynx. One contractile vacuole in anterior half of body, to the left. Nucleus to the right.

One species .... P. mediocanellata. 36.

Family Astasiina:-

Colorless; flexible or rigid; similar in structure to Euglenoidina. Bütschli reports a side flagellum. Other authorities do not.

Genus XXIV. Astasia:-

Elongate cylindrical, pointed at both ends. Very strongly metabolic, even while swimming. Mouth terminal leading into a well developed pharynx.

One species.........................A. trichophora. 37.

Genus XXV. Heteronema:-

Slender, elongate cylindrical, tapering to both ends. Side flagellum prominent, extending posteriorly. Not so metabolic as Astasia.

One species.................................. .... .. H. acus. 79.

Suborder Heteromastigoda:-

Naked and becoming amoeboid at times, or rigid and then frequently possessing cuticular similar to Euglenina. Two flagella; one is directed forward and accomplishes forward motion; the other and longer one is directed backward. Both are attached at the anterior end. In some forms the posterior one is increased to two. Mouth leading into distinct pharynx.

Family Anisonemina:-

Oval, persistent in shape. Body flattened. Considerable difference in length of flagella. Distinct mouth opening at base of anteriorly directed flagellum, on ventral side, in connection with a long tubular pharynx.

Genus XXVI. Anisonema:-

Oval; asymmetrical; very much flattened. Delicate spiral striations. Trailing flagellum arises from mouth opening and extends around the anterior edge of the body in a curve to the right, and runs back, down the right edge of the body. One contractile vacuole in the anterior end, on the left side. Nucleus round, behind the center of the body.

One species............. .... A. grandis. 39.

Suborder Isomastigoda:-

Small forms. Anterior end with 1, 2, 4,

or 5 equal flagella, arising close beside each other. Sometimes colorless, sometimes colored. Naked or with shell. Mouth opening and pharynx unusual.

Family Chrysomonadina:-

Solitary or colony forming individuals. shell and stalk usually lacking. Usually two, rarely one, brown to greenish brown chromatophores. Usually an eye spot at base of flagellum. Usually two flagella, nearly always equal. Free swimming colonies, spherically grouped.

Genus XXVII. Mallomonas:-

Not colony forming. Oval. One flagellum. Body covered with long, delicate, rigid, spinous processes.

One species..............................M. plosslii. 40.

Family Chlamydomonadinae:-

From spherical to elongate spindle-shaped. 2 or 4 flagella. Almost always green from chromatophores. Usually delicate shell around body. 1 or 2 contractile vacuoles at base of flagella. Usually one eye spot.

Subfamily Chlamydomonadin

Always a delicate shell; pores for the entrance of the flagella; no inclination to divide into two flaps.

Genus. XXVIII. Carteria:-

Four flagella.

One species.......................C. multifilis. 41.

Family Volvocinae:-

Colony building. Zooids with two flagella. Number of zooids in colony varies with genus.

Genus XXIX. Pandorina:-

Colonies spherical to oval, of 16, rarely 32, individuals. Each individual has an especial sheath and the colony has a common sheath of concentric layers. Cells compactly grouped in colony.

One species.............................. P. morum. 42.

Genus XXX. Eudorina:-

Colonies spherical or oval, of 32, rarely 16 or 64, cells with sheath. Cells widely separated. Common sheath simple.

One species............................ E. elegans. 43.

Genus XXXI. Pleodorina:-

Colony consists of a spherical or elliptical coenobium of greenish biflagellate cells of two types, vegetative and gonidial, in the anterior and posterior parts of the colony respectively, which lie in the periphery of a hyaline gelatinous matrix and are surrounded by a common hyaline envelope. Cells each with one reddish stigma, which is more prominent in the anterior part of the colony. No connecting filaments between the cells. Non-sexual reproduction by gonidia, which are formed by increase in size of a part of the cells of the colony. Daughters escape from parent as small colonies of biflagellate cells which at this stage are all similar. Sexual reproduction not known.

Number of cells in colony 64 or 128. Vegetative cells constituting approximately one-half the colony. Gonidial cells 2-3 times diameter of vegetative cells.
...... P. californica. 44.

Number of cells in colony usually 32, rarely 16 or 64. Vegetative cells always four in number. Gonidial cells approximately 1.1-2 times diameter of vegetative cells.
...... P. illinoisensis. 45.

Genus XXXII. Platydorina:-

Cells arranged in flattened colony-horse-shoe shaped. Cells not crowded together. Poles differentiated by arrangement of cells: posterior end with tails.

One species............................P. caudata. 48.

Genus XXXIII. Volvox:-

Colonies large, spherical, and consisting of great numbers of cells. Common colony sheath. All the cells of a colony in direct connection by plasma threads.

One species........................ ... V. aureus. 47.

Order Dinoflagellata:-

Having two flagella, one anterior, the other encircling the body like a girdle. Body usually with a sculptured cellulose shell.

Suborder Dinifera:-

One or more cross furrows, in which the simpleor complex cross furrow flagellum is laid. Long flagellum generally directed backwards.

Family Peridinida:-

One cross furrow in or near the middle of the body. Mostly with, but occasionally without, a shell. Rarely the cross furrow is not developed, but then the position which it would have is indicated by the structure of the shell. Shape variable.

Genus XXXIV. Peridinium:-

Shape spherical to egg-shape or somewhat elongate. Apex frequently drawn out into distinct tubes. Cross and longitudinal furrows well developed. The former generally slightly twisted to the left, sometimes to the right, or they are circular. The latter are broad and often grow broader, posteriorly.

Both halves of the body equal, or with the posterior half slightly shortened. Posterior half with equal thick shell. Anterior half with seven equatorial plates, the plates cut in facets. The two posterior plates sometimes have each a tooth-like process. Edges of the longitudinal furrow, little elevated. Colorless, green or brown. Crevice of the flagellum somewhat posterior.

One species.............................P. tabulatum. 48.

Genus XXXV. Ceratium:-

Subspherical, with peculiar horns developed. Body halves equal. Cross furrow circular. Longitudinal furrow very broad. Shell thick, sometimes faintly spinous; very distinctly porous. Anterior half formed of three prominent equatorial plates and three or more apical plates. Posterior half formed of three equatorial plates and one apical plate. The apical plate always prolonged into a posterior horn, which is either straight or curved. The right posterior equatorial plate is produced into a similar horn. The left posterior equatorial plate may also form a horn. There are 2, 3, 4 or 5, horns. The flagellum is long and is inserted in the left edge of the longitudinal furrow. Green to yellowish brown.

One species.........................C. kumaonense. 49.

CLASS INFUSORIA:-

Those protozoa whose bodies are clothed with a large number of cilia.

Subclass Ciliata:-

Those forms which, when not encysted, have a coat of cilia and which take their nourishment by means of a fixed mouth opening, unless degenerated by parasitism. Multiplication by simple cross division.

Order Gymnostomata:-

Mouth round to slit-shape; closed. Without undulating membrane. Cilia surrounding mouth somewhat modified. Pharynx, if developed, never ciliate but generally provided with little rods.

Family Enchelina:-

Short to long forms inclined to bilateral symmetry. Mouth always terminal: usually round, sometimes slit-like. Pharynx, if developed, a straight tube directed posteriorly; either short or long.

Subfamily Holophryina:-

Whole surface evenly ciliate, that around the mouth being sometimes much larger. The cilia is occasionally limited to the anterior half of the body.

Genus XXXVI. Enchelys:-

Small, with anterior end decreasing in size to form a neck-like prolongation. Posterior end rounded. Anterior end truncate and occupied by the mouth, which is usually surrounded by a sphincter-like lip. Cilia short and fine with a row of larger cilia around the mouth.

Subfamily Colepina:-

Body short, shaped like a small barrel. The anterior end broadly truncate, and wholly occupied by the large mouth opening. The mouth is surrounded by a wreath of larger cilia. The rest of the cilia is rather scattered, or confined to the left side.

Genus XXXVII. Coleps:-

Body barrel-shaped to somewhat flattened, and generally a little curved to one side. Posterior end rounded. Anterior end broadly truncate, wholly occupied by the mouth.

Shell but slightly resistant. Simple contractile vacuole subterminal. Moves quickly, rotating on long axis. Shell made up of small pieces grown together, which are arranged around the body in four chief circles.

One species............. .... C. hirtus. 51.

Family Trachelina:-

Body either bilateral or asymmetrical. Seldom twisted. Strongly compressed laterally and with left side more arched than right. The mouth is either a long slit extending from the anterior end posteriorly, on the ventral side of the projecting process, or only a slit-like or round opening at its base. Pharynx lacking or short. Cilia regularly distributed, or limited to the flat right side.

Subfamily Amphileptinae:-

The mouth always lies on the convex ventral edge of the snout, which is bent dorsalwards. Sometimes it is a long slit; sometimes a round opening.

Genus XXXVIII. Amphileptus:-

Sac-shaped with snout-like projection anteriorly, and generally more or less compressing the anterior end. Contractile. The whole snout edge encloses a long slit-like mouth. No pharynx. One terminal contractile vacuole, or numerous scattered ones. Trichocysts sometimes in the snout end. Macronucleus bilobed or in four parts.

One species........................... A. anser. 52.

Genus XXXIX. Lionotus:-

Contractile; shape essentially like Amphileptus, though usually longer and with a much longer snout. Right side always flattened and it alone covered with cilia; left side strongly arched. The snout and the body edges always compressed. Mouth as in Amphileptus. Trichocysts along ventral edge of snout.

Along the mouth edge there is generally a row of large cilia, which forms a sort of adoral zone. Contractile vacuoles, one to many. Movement, gliding and swimming. Macronucleus bilobed.

Tail region short, obtusely pointed. Neck region less than one-half the body length.............. L. fasciola. 53.
Tail region extremely pointed. Neck region three-fifths the length of the body............. ..L. wrzesniowskii. 54.

Family Chlamydodonta:-

Oval to kidney-shaped, never very long. From rather round to flattened, dorso-ventrally. Mouth always far toward the anterior end, sometimes in the middle of the ventral side, and sometimes placed to the right or left of the middle. Pharynx usually with rods, but sometimes it is a smooth tube. Usually gorged with food.

Subfamily Nassulina:-

Round or a little flattened. Cilia on all sides.

Genus XL. Nassula:-

Flexible to somewhat contractile. Egg-shaped to elongate; sometimes flattened dorso-ventrally. Ends equally rounded. Mouth ventral, some distance from the anterior end. Anterior end bent a little to the left. About the mouth is a row of strong adoral cilia. The remainder of the body evenly ciliate. Striations delicate and weakly spiral. Mouth circular and pharynx rodded. Pharynx usually extends to the left and dorsally. Contractile vacuoles changing; sometimes one in the center of the ventral side, sometimes as many as four, some on the ventral, and some on the dorsal side. Usually a complete coat of trichocysts. Colorless or colored red, blue, or brown, by pigment. Macronucleus spherical and central.

One species................ .... N. rubens. 55

Subfamily Chilodontina:-

Strongly flattened. Cilia confined to ventral side or else much larger on ventral, than on dorsal side. No distinct caudal style at the posterior end.

Genus XLI. Chilodon:-

Persistent egg-shape. Flattened dorso-ventrally. Anterior end bent to the left in rather pointed beak. Ventral side is slightly concave. Posterior end broadly rounded, surface finely striate longitudinally. Only the ventral side ciliate. Cilia thick about mouth, forming an adoral zone. Mouth median, in anterior half of body. Pharynx rods well developed: straight or with inner ends spirally rolled. Contractile vacuoles varying from one to many, increasing in number with size of body. Macronucleus oval, central.

One species..........................C. cucullulus. 58.

Order Trichostomata:-

Cilia of the body of very different kinds. Mouth, as a rule, open. Pharynx usually developed: tubular and open. Margin of mouth with undulating membranes which sink into pharynx, or pharynx provided with undulating membrane, or with cilia which may be derived from the adoral zone.

Suborder Aspirotricha:-

More or less ellipsoidal to kidney-shape; almost always distinctly asymmetrical. Mouth primitively a longitudinal ventral slit: but usually an oval, kidney-shape, or crescentic opening, more or less removed from anterior end. Pharynx is either not developed or is a regular, rather long, smooth tube. Pharyngeal rods never present. At the edge of the mouth opening or in the pharynx is one to two undulating membranes which move like lips and which are not evident in smaller forms.

Family Chilifera:-

Mouth in anterior half of body. Pharynx either scarcely developed or short sac-shaped. Undulating membranes either at the edges of the mouth or deep in the pharynx. Peristome field leading to the mouth, lacking or only poorly developed.

Genus XLII. Glaucoma:-

Egg-shaped, rounded posteriorly and a little pointed or less round, anteriorly. Dorso-ventrally flattened. Finely and evenly ciliate. Mouth ventral, near to anterior end; at times shoved to the right. Anterior end sometimes curved to the right. Mouth triangular to half- moon-shaped. At each edge of mouth a strong undulating membrane, the two being unequal. Pharynx hardly evident. One dorsal contractile vacuole, central or subterminal. At times, a thick coat of trichocysts. Movement rapid and steady; sometimes gliding on ventral side. Macronucleus round, central.

One species..................... G. scintillans. 57.

Genus XLIII. Frontonia:-

Elongate cylindrical, with evenly rounded or somewhat pointed poles, the two differing somewhat, at times. Sometimes a little flattened dorso-ventrally. Somewhat contractile. Evenly ciliate and regularly striate. The large wide open mouth in anterior half of ventral side is an elongated oval shape. To the left side is fastened one undulating membrane, which may cover the whole mouth opening. On the right edge of the mouth is a small trichocyst-free field, upon which is a row of cilia, which are a little differentiated from the body cilia and whose lively motion gives them the appearance of a second undulating membrane. Pharynx little developed. Usually a complete coat of trichocysts. One or two contractile vacuoles on the right side. Macronucleus oval and central. Body colorless, or green from Zoochlorellae, or brown to black from pigment.

One species.................. .. ..F. acuminata. 58.

Genus XLIV. Colpidium:-

Oval to kidney-shape. Somewhat compressed. Dorsal side arched; ventral side slightly concave anteriorly. Anterior end not so broadly rounded as the posterior end. Mouth in anterior half of body in a transverse depression upon the ventral side; leading into a long, tubular pharynx; mouth triangular or crescentic with two undulating membranes. The right membrane extends far down into the pharynx and appears to be fastened to its anterior or dorsal wall. Striations in front of mouth twisted to the left, so that those of the right side run obliquely from right to left. One central or terminal contractile vacuole. Macronucleus spherical.

One species..........................C. colpoda. 59.

Family Paramaecina:-

Mouth sometimes in anterior, sometimes in posterior half of body, with a triangular, flat oral groove extending to it from the left anterior margin. Pharynx tubular, rather long, with longer undulating membrane or corresponding row of cilia attached to dorsal wall. Cilia thick and regularly distributed.

Genus XLV. Paramaecium:-

Flexible. Longer than broad. Dorso-ventrally flattened. Ends rounded or pointed. Mouth large, oval, near the center of the ventral side, with peristome field leading to it from the left. Pharynx rather long with one undulating membrane on its dorsal edge. Usually a complete trichocyst coat. 1, or more often 2, contractile vacuoles. Macronucleus oval, central; 1 or 2 micronuclei.

One species..........................P. caudatum. 60.

Family Urocentrina:-

Mouth in the middle of the ventral side, with long tubular pharynx, similar to that of Paramaecina. Cilia in

two broad wreaths, one in the anterior and one in the posterior half of the body.

Genus. XLVI. Urocentrum:-

Flexible. Somewhat cask-shaped with broad rounded ends. A circular furrow in the equatorial region which divides the body into an anterior and a posterior half. The large oval mouth lies in this furrow on the ventral side, and from it extends a long groove over the ventral side of the posterior half, to the posterior end. Above the mouth a circle of delicate cilia surrounds the body. A broad wreath of strong cilia encircles the body in the anterior half and another in the posterior half. Caudal cirri project from the ventral furrow Pharynx long, a row of thickly placed cilia at the ventral and d sal lines. Vacuole terminal with four long canals giving it a rosette appearance. Has a rapid waltzing movement. Sometimes attached by its tail process. Macronucleus posterior, horse-shoe-shaped.

One species......................... ...U. turbo. 61.

Family Pleuronemina:-

Oval or elongate. Dorso-ventrally or laterally compressed. Ciliated on all sides. Mouth at the end of a long peristome on the ventral side, sometimes near the posterior and sometimes near the anterior end. Peristome usually fluted. The entire left peristome edge with undulating membrane, which frequently curves around the posterior edge of the peristome to the right side, forming a kind of sac which leads into the mouth. The right peristome edge also has a weak membrane or a row of thickly placed cilia. Pharynx but slightly, if at all, developed.

Genus XLVII. Pleuronema:-

Inflexible. Lentiform, laterally compressed; the two margins equally arched. Ventral edge nearly straight, dorsal edge convex. Poles equally rounded. Peristome extends

along the whole ventral side: it is deeper in the middle with the mouth at the base. Undulating membrane along the whole left edge. The right edge with a thick row of strong cilia. Generally a long spine at the posterior end. Contractile vacuole subterminal and dorsal. Macronucleus round or kidney-shaped, in the anterior half of the body. Swimming and springing movement.

One species.................... [illegible]chrysalis. 82.

Genus XLVIII. Cyclidium:-

Smaller than Pleuronema. The peristome groove is smaller than in Pleuronema and the inlet of the mouth opens to the right. The undulating membrane of the left edge of the peristome extends around the mouth behind, then rises a little to the right. Generally one posterior spine of considerable length, more evident than in Pleuronema.

One species.......................... C. glaucoma. 83.

Suborder Spirotricha:-

always with a distinct adoral zone consisting of membranellae, which has a more or less spiral course and which, wholly or in part, surrounds the peristome field.

Section Heterotricha:-

Well developed adoral zone and always a complete covering of uniform cilia without differentiation on dorsal and ventral surfaces.

Family Plagiotomina:-

Short or long; frequently compressed laterally, yet sometimes round. Peristome always like a small groove which generally begins close to anterior end and runs straight back, ventrally, to the mouth, which varies in position between the middle of the body and the posterior end. Adoral zone extends from the mouth on the left side of the peristome groove to the anterior end of the body, thus having a straight course, except when it is twisted, due to a screw-like twisting of the body. An undulating mem-

brane may be present at the right edge of the peristome. Pharynx tubular.

Genus XLIX. *Spirostomum*:-

Colorless or green. Very contractile and flexible. Very elongate; cross section circular. The ends tapering; the posterior one often diminished into a long thread-like tail but sometimes truncate. Peristome extends backward as a groove from the anterior end to about the middle. Pharynx very short. No undulating membrane. Striations spiral and very distinct. One posterior contractile vacuole with a long canal extending along the entire dorsal or right side. Macronucleus oval and central. Movements manifold.

One species............................*S. ambiguum*. 64.

Family Bursarina:-

Body purse-shaped. Dorso-ventrally flattened. Peristome is short or long and quite broad. It is a three cornered space, broad in front and diminishing towards the mouth; it is deeply hollowed out. The adoral zone includes only the left edge of the peristome or extends forward along the anterior border so as to include the right anterior angle of the peristome. Little or no pharynx. Right edge of peristome with or without undulating membrane.

Genus L. *Bursaria*:-

Colorless to brown. Flexible. Body elongate sac-like, or funnel-shape. Ventral side flattened. Anterior end broadly truncate. Posterior end broadly rounded or a little pointed. The narrowed posterior part of the large peristome bends around to the left and leads into a mouth opening. Body evenly ciliate. No undulating membrane . Contractile vacuoles are sometimes lacking; and other times they are numerous. Long, bent, band-like macronucleus.

One species......................... *B. truncatella*. 65.

Family Stentorina:-

Body purse-shaped to elongate funnel-shaped.

Peristome field short, with its surfaceoblique to, or almost perpendicular with, its longitudinal axis. The adoral zone may include only the front edge or the whole of the peristome. Peristome surface, therefore, ciliate throughout and spirally striate, with striations parallel to the left border of the peristome. No undulati[illegible] the two halves of the peristome are produced into lo[illegible]s. Pharynx tubular. Body sometimes attached.

Genus LI. Stentor:-

Colorless to blue, red, or brown, from pigment, or green from Zoochlorellae. Mostly very contractile. Trumpet- or tube-shape. Attachable posterior end narrowed to a stalk. Anterior end broad, truncate and somewhat arched. Contracts into a sac or spherical shape. Surface of the peristome perpendicular to the longitudinal axis. Adoral zone completely surrounding peristome edge. Right end of the zone a little higher than the rest. The mouth lies in a hollow between the two ends of the zone. Pharynx long and tubular. Body striations wide, more or less spiral. Long bristles frequently mingled with the body cilia. Contractile vacuole on the left side with two canals leading to it: one to the posterior end and one around the peristome border. Macronucleus elongate, often moniliform. When attached they sometimes form gelatinous protective tubes.

With gelatinous tube about sessile animal.	S. roeselii.	67.
Without gelatinous tube		2.
Bluish color...........................	S. coeruleus.	68
Whitish or grayish, never bluish......	S. polymorphus.	66.

Section Oligotricha:-

Never very long. Mostly spherical to sac-shaped, or inverted cone-shaped. Peristome field similar to that of Stentor. Adoral zone nearly or completely circular. Cilia of the

posterior end sometimes well developed, sometimes almost or quite reduced.

Family Halterina:-

Spherical to cone-shaped, flexible. Peristome field without cilia, also the posterior end, unless sometimes a few scattered cilia are developed on the ventral side, sometimes rigid bristles are scattered in with cilia. Peristome border not developed.

Genus LII. Halteria:-

Colorless. Persistent in a spherical form. The rigid bristles are arranged into a wreath. No trichocysts. One contractile vacuole. Moves by quick springs with resting pauses between.

One species............................H. grandinella. 69.

Section Hypotricha:-

Body dorso-ventrally flattened. Dorsal side arched. Three cornered peristome field lies approximately in the same plane with the rest of the ventral surface. The adoral zone reaches from the mouth over the trunk to the right anterior peristome corner. Peristome generally bounded by the adjoining part of the ventral surface. The dorsal side without moveable cilia but with long rows of stiff little bristles. The cilia which aid in locomotion are confined to the ventral side. Pharynx poorly, if at all, developed.

Family Euplotina:-

Short, rigid form. Cilia greatly reduced in number. The marginal rows are especially reduced, only isolated cirri being found at the side of the body or at the posterior end. Upon the antero-ventral side, a varying number of scattered cirri; always a considerable number of anal cirri. Contractile vacuole

posterior and on the right side.

Genus LIII. <u>Euplotes</u>:-

Colorless or green through <u>Zoochlorella.</u>
Flattened; Arched dorsally. Somewhat oval. Anterior end broadly rounded to somewhat truncate; posterior end rounding to somewhat pointed. Nine or ten cilia on the anterior ventral field; five prominent anal cirri in an oblique row, and which project over the posterior end; two other small marginal cirri at the posterior end, and two similar ones on the posterior part of the left side. Dorsal side generally longitudinally furrowed. Contractile vacuole on the right side. Macronucleus long, band-like, and bifid; placed to the left.

One species........................ . <u>E. patella</u>. 70.

Family <u>Aspidiscina</u>:-

Small. Marginal cirri entirely wanting. Number of anterior cirri varying; one row of anal cirri. Peristome small and on the left edge. Adoral zone shortened, reaching only to the anterior end of the left edge. Macronucleus long, band-like.

Genus LIV. <u>Aspidisca</u>:-

Shape circular to shortly oval. Left edge rather straight; right edge convex; right ventral edge thickened. Ventral side straight; dorsal side arched and with from one to several longitudinal ridges which run parallel with right margin. Right peristome edge grows out to the left in a projecting plate, which is small at the anterior end and grows broader toward the posterior end. In the posterior region, to the right, are from 3-12 styles. Seven cilia on the anterior half of the ventral surface arranged in four rows. Contractile vacuole under right side. Macronucleus horse-shoe-shaped, in the anterior half of the body.

One species.......................... . <u>A. costata</u>. 71.

Family Oxytrichina:-

Peristome and front region clearly set off from each other. Ventral cilia not regular but in numerous oblique rows. Usually a few larger cirri developed at the anterior end and also at the posterior end. Contractile vacuole on the left side of the central part of the body. Macronucleus likewise on left side, and more or less segmented.

Subfamily Urostylinae:-

At least two uninterrupted ventral rows of cilia, to which are added two uninterrupted marginal rows. Anterior and posterior cirri usually well distinguished.

Genus E. Urostyla:-

Colorless to yellow, red, or brown. Very flexible, but not always contractile. Oval; posterior end rounded, sometimes broader, sometimes smaller, than the middle region; anterior end always smaller. Peristome clearly bounded anteriorly; broad and long, reaching sometimes to the middle of the body. Two undulating membranes: paroral, endoral, and adoral rows of cilia, also two marginal and five ventral rows of cirri; [illegible] five to twelve anal cirri extending to the left. Macronucleus two or many segmented.

One species............................ U. grandis. 72.

Subfamily Pleurotrichina:-

Frontal cirri well developed and where they are the only cilia of the frontal region they are arranged in the order represented in the figure to the left. The two marginal rows of cirri well developed. Ventral series sometimes numerous, but generally reduced to two. One or more of these series interrupted and almost always some of the cilia differentiated

into ventral cirri.

Genus LVI. Stylonychia:-

Colorless. [illegible] long oval in shape. Right peristome edge somewhat S-shaped. The five ventral cirri arranged as in figure to the left; three caudal cirri very long; the two marginal rows of cirri interrupted posteriorly. Quick and nimble in movement, swimming and creeping.

One species........................ ....S. mytilus. 73.

Section Peritricha:-

Cilia limited to the ventral surface and to the adoral zone, which describes a complete circle, and to a wreath around the posterior ventral half. In attached forms the ventral circlet of cilia disappears and the adoral circlet of cilia surrounds the anterior end of the erect body. Tubular ciliate pharynx. Contractile vacuole in mouth region.

Family Vorticellina:-

Adoral cilia in a circle, consisting of two rows of cilia, lying close together, [illegible] more or less deep vestibulum. The outer row of cilia is replaced by an undulating membrane some distance in front of the vestibulum. Contractile vacuole lies in the center of the vestibulum, and sometimes has a reservoir. Macronucleus a long band.

Tribe contractilia:-

Stem with contractile threads. Colony-building or solitary.

Genus LVII. Vorticella:-

Colorless to yellowish, or green with Zoochlorellae. Inverted bell-shaped. [illegible] peristome end is generally very wide. It is attached at the posterior end by a simple, short or long contractile thread. Does not build colonies.

One or two contractile vacuoles in the anterior end, usually with a sac-like reservoir.

One species........................ [illegible]. 74.

Genus LVIII. Carchesium:-

Zooids bell-shaped. Very contractile. Colony building by continued dichotomous division. Contractile threads running through stalk is not continuous at the branches, so each part may contract separately.

One species.............. ....C. polypinum. 75.

Genus LIX. Zoothamnium:-

Structure essentially like Carchesium. Colony building. Chief distinction from Carchesium is that the contractile thread is continuous at each branching, so that when one part contracts the whole colony contracts.

One species.............................Z. [illegible]. 76.

Tribe acontractilia:-

Stem without contractile thread. Solitary or colony building. At times a gelatinous secretion to the stem.

Genus LX. Opercularia:-

Zooids ellipsoidal to egg-shaped. Colorless and contractile. Colony building. Peristome end always considerably decreased in size, and the peristome margin not broadened. The peristome and ciliary disc of small diameter. The ciliary disc is elevated on a stalk, so it appears as a cover. [illegible] vestibulum very wide, and includes the oral [illegible] groove. Macronucleus horse-shoe-shaped or short sausage-shaped, lying transversely in the mouth region.

Colonies including many zooids which have a nodding position, at time of contracting........O. nutans. 77.

Colonies including from 1-[illegible] zooids [illegible]

.... O. stenostoma. 78.

Subclass Suctoria:-

The possession of cilia is confined to a short, free swimming stage; when it passes over to a sedentary life, they are lost. No mouth opening. Nourishment is taken through tubular, pseudopodia-like tentacles which vary in number.

Family Podophryina:-

More or less spherical in shape. Stalked or not. Occasionally with gelatinous cover. Tentacles numerous; on the whole surface or confined to the apex; all or a part capitate.

Genus LXI. Sphaerophrya:-

Spherical; not stalked. Capitate tentacles radiating from the whole surface. One or two contractile vacuoles. Endoparasitic forms have no tentacles so long as they live in the body of the host.

One species.......................... S. magna. 79.

LIST OF SPECIES.

The following pages contain a list of the species with references to authoritative figures and descriptions, a few descriptive notes based on my own observations, and such ecological data as I have accumulated during my own work.

1. Amoeba proteus Leidy. Pl. I, II Fig. 1-8.

Leidy ('79)..pp. 31-33. Pl. I, figs. 1-8; II, 1-13; IV, 22-25; VII, 13-19; VIII, 17-30.

It is somewhat spherical when at rest. It is usually larger than A. villosa, but not always. The protoplasm is colorless, homogeneous and vacuolated. The protoplasm is differentiated into a thin ectosarc and an entosarc. Within the entosarc is contained a nucleus, one or more contractile vacuoles, and many water vacuoles.

The pseudopodia are greater in number, and longer, than in A. villosa, and are more pointed. They extend from all parts of the periphery. The animal moves quickly through the water by means of these pseudopodia.

A large posterior contractile vacuole may always be found, with sometimes one or several smaller ones scattered through the body.

The nucleus is round to oval and varies in size. It is usually almost centrally placed.

Their food, like that of the other species, consists principally of diatoms and other algae. It is held by the pseudopodia, and enclosed by the protoplasm of the body which ingests the part which can be used for food, and lets the rest go. One immense A. proteus was observed with a small A. villosa creeping in between two pseudopodia which closed around it. When the small Amoeba tried to get away the pseudopodia held it tightly for some time, but it finally escaped.

Division and encystment were not observed.

They have appeared and disappeared in the aquaria throughout the year. A collection was seldom made in which they were not represented. Schewiakoff ('93) reports this species from Asia, Africa, Australia, America, and Europe.

2. Amoeba verrucosa Ehrbg. Pl. III, IV Fig. 9-17.

Leidy ('79) pp. 53-58. Pl. III, figs. 1-38.

This is a somewhat slipper-shaped animal, with the broad, blunt, thin end directed ahead. According to Leidy ('79) and others it is smaller than A. proteus. The most of those which I observed were quite as large as A proteus. The protoplasm like that of the other species is homogeneous, colorless, and much vacuolated. There is a very sharp distinction between ectosarc and entosarc.

It moves ver slowly and does not put forth such distinct pseudopodia as the other species. It rather extends the whole surface of ectosarc and then pushes up into it. It varies considerably in shape, though owing to this manner of movement, not so much as the other species.

The nucleus is round and is generally posterior and a little to one side of the center.

The contractile vacuole is usually single. It is large and round and is located posteriorly.

Its food consists of algae, principally. One large A. verrucosa was observed eating a shelled rhizopod, probably a Centropyxis

Division and encystment were not observed.

Like the other species it has occurred and disappeared in the laboratory aquaria throughout the year and has also been found in most collections. Schewiakoff ('93) reports the species from Asia,

Africa, Australia, Oceanica, and America.

3. Amoeba villosa Wallich. Pl.V,VI.Fig.18-26.

Leidy ('79) pp. 82-88. Pl. I, figs. 9, 10; II, 14-18; VIII, 1-18.

This is an elongated ovoid form when at rest, broader at the anterior end and having a villous appearance at the posterior one. It is a homogeneous, colorless mass of protoplasm, constantly moving and changing in shape. Within the protoplasm, this contained a nucleus, one or more contractile vacuoles, and a number of water vacuoles. The protoplasm is differentiated into a thin film of ectosarc, and a granular and exceedingly vacuolated entosarc. The protoplasm is very mobile so that the animal constantly changes shape, much resembling A.proteus in this particular.

The animal may have a great number of pseudopodia at one time and extending from any part of the periphery although usually there are but two or three, and these are mostly anterior or antero-lateral. The pseudopodia are never long nor pointed but are simply blunt extensions of the ectosarc with the entosarc running down into them. They serve for taking food as well as for locomotion.

There is one almost spherical nucleus toward the posterior end, although often this can not be seen in the living animal.

The contractile vacuoles vary in number. Sometimes there is but one, and sometimes there are several. There is usually one large one toward the posterior end, and the others are scattered through the protoplasm elsewhere. They pulsate rather quickly and attain to quite a size before systole.

Their food consists principally of diatoms and other algae. The food is caught by the pseudopodia, the body is folded over it, and the protoplasm ingests the part needed for food, then lets the rest go.

Division and encystment were not observed.

This species has occurred and disappeared in aquaria in the laboratory throughout the year. In nearly every collection there has been at least a few. Leidy ('79) reports it from the United States.

4. Pelomyxa villosa Greeff. Pl. VII. Fig. 27, 28.

Leidy ('79) pp. 73-80. Pl. V; VIII, 31-33. Bütschli ('80-89) Pl. II. fig. 6.

A very characteristic form in the species I observed, was an elongate one with two posterior horns. It is brown in color. The specimens observed by me were very small. It is amoeboid in locomotion. The ectosarc is a very thin film, and is thrown out at times for great distances. The entosarc is very granular and very flexible, and is not much vacuolated.

The pseudopodia extended from all parts of the periphery, but the most prominent ones were from the corners. These were sometimes very long, being almost equal in length to the length of the body. They were often branched at the ends, and were extended and withdrawn quickly.

No contractile vacuole was observed. Leidy ('79) says that the contractile vacuoles are numerous, but that they are small and inconspicuous.

The thin ectosarc was thrown out around the animal and engulfed algae and everything with which it came in contact, so that the bodies were gorged with foreign matter. The animal moved rapidly and evenly, with a characteristic sidewise motion.

I observed but two. This was on November 8, 1899, in material from an aquarium started a few weeks before from Crystal Lake. Schewiakoff ('93) reports it from Australia and America.

5. Dinamoeba mirabilis Leidy. Pl. ~~VIII~~ IX. Fig. 29-32.

Leidy ('79) pp. 81-84. Pl. VI; VII, 1-11.

The animal is ovate in form when at rest, but is very changeable. It is almost colorless except for contained food particles. The proto-

plasm is sharply distinguished into ectosarc and endosarc. It is granular and very mobile. The surface is covered with spicules which do not occur on the pseudopodia.

The pseudopodia are usually of clear ectosarc and do not attain to any great length. They are extended and withdrawn very quickly.

Both the nucleus and contractile vacuole were hidden because of the gorged condition of the endoplasm.

Within the body were diatoms and many smaller food particles. One was observed taking a diatom. It was first caught in the ectosarc and then in the endosarc, and so passed in until it was all contained within the inner body. While swallowing the diatom the body of the Dinamoeba underwent a series of changes in shape, shortening and thickening posteriorly, and then lengthening out again, until at last it regained its normal state. One gorged specimen was seen exuding food particles from one side.

This species did not occur in great numbers at any time. One was observed November 27, from an aquarium which had been about the laboratory for over a year and contained material from several sources. Another was observed on January 5, 1900, and five more on January 29, 1900, from collections made under the ice in the Boneyard. Of these latter three were large ones and two were very small. One was observed again on April 2, 1900, from a Boneyard collection. Schewiakoff ('93) reports this species from America only.

6 Biomyxa vagans Leidy. Pl. X. Fig. 33-35.

Leidy ('79) pp. 281-287. Pl. XLVII, figs. 5-12; XLVIII.

This is a large, colorless, irregularly shaped creature. It resembled a group of Amoebae connected by strands of protoplasm. It was constantly changing, however, some parts growing together and others separating. At times the protoplasm would thin out so as

to form holes.

The pseudopodia were usually short and rather slender. They were sometimes branched at the ends and formed a network.

The nucleus I did not observe. There were usually two good-sized contractile vacuoles but sometimes three. They varied in position with the change of shape of the animal.

Many Naviculae and Bacteria were eaten. Associated with it were Navicula, Spirillum, Spirocheata, Actinophrys sol and Amoeba.

I found but one. This was on April 4, 1899, in material taken from an aquarium started early in January, 1899, from the Boneyard near the heating plant. It is reported and described by Leidy ('79) from New Jersey and Pennsylvania, while Schewiakoff ('93) reports it also from Australia.

7 Arcella vulgaris Ehrbg. Pl. XI. Fig. 36-37.

Leidy ('79) pp. 170-173. Pl. XXVII; XXVIII, 1-7.

Bütschli ('80-'89) pp. 183. Pl. II, fig. 9.

This is a circular disc in shape, when seen from above, and like a concavo-convex lens from the side, and is from a light to a very dark brown in color. There is a central spot which is lighter in color and which marks the place of the mouth opening. The shell is really dome-shaped.

This species of Arcella was not observed with sarcode extended. Leidy ('79) tells us that the pseudopodia are digitate and that the sarcode mass is oblately spheroid.

The specimens which I observed were of such a dark brown that both nuclei and contractile vacuoles were obscured.

The animal did not creep about while observed. One edge of the shell is sometimes reflected back over the dome making the outline of the shell appear more as a semicircle. The food consists of small diatoms and desmids.

It occurred in material collected from under the ice January 25, 1900, in the Boneyard, and which had been standing in an aquarium in the laboratory. Schewiakoff ('93) reports it from Asia, Africa, Australia, Oceanica, Europe, and America.

8 Arcella discoides Ehrbg. Pl. XII. Fig. 38.

Leidy ('79) pp. 173-175. Pl. XXVIII, figs. 14-38.

This species, too, is circular when spread out, but it is not so thick as *A. vulgaris*. It is also a very dark brown in color. The sarcode of this species was extended and was colorless, though more or less granular.

The pseudopodia are long, digitate, and sometimes branching. One granular nucleus was observed to the right.

It occurred associated with *A. vulgaris* in material collected from under the ice in the Boneyard, January 25, 1900. Schewiakoff ('93) reports it only from Australia and America.

9. Difflugia globulosa Dujardin. Pl. XII. Fig. 39.

Leidy ('79) pp. 98-98. Pl XV, figs. 25-31; XVI, 1-24.

This is spheroidal in shape. Usually the border of the shell is smooth but occasionally there is a conical projection. They are light in color, some being almost colorless. Many of the shells are made from quartz sand particles but I found them in great numbers, building shells from diatoms. The mouth is circular and subterminal.

But one was observed with pseudopodia extended. These were very delicate, pointed, and finally branching.

It occurred during the latter part of December, 1899 and during January, 1900, in an aquarium of several months standing. Schewiakoff ('93) reports it from Asia, Australia, and America. Bütschli ('80-'89) reports it from Europe.

10 Difflugia pyriformis Perty. Pl. ~~XIII,~~ XIV. Fig. 40-42.

Leidy ('79) pp. 99-105. Pl. X; XI; XII, 1-18; XV, 32-33; XVI, 36; XIX, 24-26.

The shell is flask-shaped, with a neck-like prolongation at the narrower end. The shell is usually brownish in color and is made up of angular bits of quartz sand and some diatoms. It present a bilateral symmetry, i.e., a line drawn, bisecting the mouth and perpendicular to the plane of the mouth, bisects also the fundus and divides the shell into two symmetrical halves. The mouth is terminal.

The animal puts out very long pseudopodia which move slowly. They are round at the end and branched. The protoplasm is usually granular. The pseudopodia extend far out and procure the food, which consists largely of diatoms and algae. It also moves by means of the pseudopodia.

Several contractile vacuoles were observed, but the nucleus was not seen.

One was observed dividing. The sarcode divides by cross division and the naked animal formed provides a new shell for itself. The old shell was quite dark, while the new one was colorless. The two were the same size, which seems to prove that the shell does not grow after its formation at the time of division, a conclusion which Penard (   ) has recently reaffirmed. I first found this species in June, 1899, since when it has occulred in nearly every collection made and in aquaria about the laboratory. It was the largest Difflugia which I observed, although Leidy ('79) states that D. urceolata is the largest species known. Schewiakoff ('93) reports it from Asia, Africa, Australia, Oceanica and America, and Bütschli ('80-'89) from Europe.

11. Difflugia urceolata Carter. Pl. XV. Fig. 43.

Leidy ('79) pp. 106-108. Pl. XIV; XVI, 32-34; XIX, 28-29.

This species is flask-shaped resembling the amphora of the ancients, i.e., tapering to a posterior point. It has a flaring collar at the anterior end. The mouth is terminal. The shell is made up of angular particles of quartz sand, with occasionally a diatom, and it is rather dark colored. Its food is of a varied nature. According to Leidy ('79) this is the largest of the Difflugia species.

This species did not occur until in January, 1900. It then appeared in a mid-winter collection from the Boneyard. Schewiakoff ('93) reports it from Australia and America. Bütschli ('80-'89) has found it also in Europe.

12. Difflugia lobostoma Leidy. Pl.

Leidy ('79) pp. 112-116. Pl. XV, figs. 1-24; XVI, 25-29.

The shell is nearly spherical, with the fundus obtusely rounded. The mouth is terminal and lobed, and when viewed from the side it looks like a small concave opening. The shell is bilaterally symmetrical.

The sarcode is colorless. The finger-like pseudopodia are extended and withdrawn rapidly and are six or more in number.

Its food consists of diatoms and algae.

It occurred very abundantly in a tow-net collection from Crystal Lake, August 5, 1899, but I did not find it on any other occasion. Schewiakoff ('93) reports it from Asia, Australia, and America. It is also reported from Europe.

13. Difflugia corona Wallich. Pl. XV Fig. 44.

Leidy ('79) pp. 117-120. Pl. XVII.

This form is spheroidal in shape. The fundus of the shell is usually provided with several conical projections, which vary in

number. There are generally from three to seven and they are about equidistant from each other, usually forming an eccentric circle on the upper third of the shell. Occasionally there is but one long ventral spine, and sometimes it is present with the others around it. The shell is made up of particles of quartz sand, and varies in color from whitish to dark brown. The mouth is large, circular and crenulate.

The animals extends pseudopodia quite freely. They move rather quickly, are rounded at the ends, and branch.

It occurred in a mid-winter collection from the Boneyard in January, 1900, associated with D. urceolata. Bütschli ('80-'89) reports it from Europe and Leidy ('79) from the United States, and he also states that Wallich reported and described it from England.

14. Difflugia constricta Ehrbg. Pl. XVI. Fig. 45.

Leidy ('70-79) pp.120-124. Pl. XVIII.

The shape of the shell is a compressed pear-form, with the long axis oblique to the plane of the mouth. The posterior end usually has about three or four conical projections. The shell is made up of angular particles of quartz sand. The round mouth is antero-inferior.

Only once did I observe pseudopodia and then only for a moment. They were clear, simple, and with rounded ends.

Their food consists of algae and diatoms. This species is very similar to Centropyxis.

I first found D. constricta early in June, 1898, and since then it has occurred at all times both in aquaria and in field collections. Schewiakoff ('93) reports it from America only.

Difflugia was more apt to occur in collections from the stream where leaves had fallen in and laid for a long time. In one aquarium, in particular, they became very numerous. There were a number of leaves in it, and on and under these all of the species became

abundant. The animals creep about rather slowly by means of their pseudopodia, usually lying on one side.

15 Centropyxis aculeata Ehrbg. Pl. XVI. Fig. 46.

Leidy ('79) pp. 180-184. Pl. XXX, figs. 20-34; XXXI; XXXII, 29-37.

The shell of Centropyxis is ovoid in shape and is composed of chitinous matter mixed with particles of quartz sand. It is from yellowish to brownish in color. The mouth is eccentric and round. The posterior end of the shell is rounded and is provided with a number of spines, sometimes straight and sometimes curved. It resembles Difflugia constricta very much.

Ihave never seen the animal with pseudopodia extended. Neither have I observed nucleus and contractile vacuoles.

These have occurred in great numbers throughout the year in one aquarium which was started early in January, 1899. It has occurred at intervals in other aquaria usually associated with Arcella and Difflugia. Schewiakoff ('93) reports the species from Asia, Africa, Australia, and America, and Bütschli ('80-'89), from Europe.

Centropyxis aculeata var. ecornis Leidy. Pl. XVI. Fig. 47.

This is simply a variety of C. aculeata, having no spines. Its structure and habits are the same, but it is not so abundant. I first found it on January 19, 1900, associated with C. aculeata.

16. Campascus cornutus Leidy. Pl. XVII, Fig. 48.

Leidy ('79) pp. 204-206. Pl. XXXIV, figs. 17-24.

This is one of the shelled rhizopods, with a chitinous shell shaped like a retort, and having a process developed on either side of the fundus. When the animal is seen from the side, the processes on the side give it a triangular shape. There is a short curved neck.

The mouth is circular, and is directed downwards.

Pseudopodia are delicate and are very finely branched.

I could detect neither nucleus nor contractile vacuole.

I found two or three of these on January 18, 1900, in material collected from under the ice on January 5, 1900. Bütschli ('80-'89) reports it as occurring in Europe. Schewiakoff ('93) reports it from America only.

17. Pamphagus mutabilis Bailey. Pl. XVII. Fig. 49.

Leidy ('79) pp. 190-194. Pl. XXXIII, figs. 1-9.

This is a shelled rhizopod but the shell is very thin and elastic so that the animal is constantly changing shape. When at rest it has an oval shape, with the fundus sometimes rounded and sometimes pointed. The sarcode can easily be seen: it entirely fills the shell, is very granular, and is usually gorged with food. The mouth is small and terminal, and is directed downwards.

The pseudopodia are delicate and branching. They are sometimes very long, being extended and withdrawn slowly, and are the means of locomotion for the animal.

There is one large contractile vacuole situated to the left of the center.

The animal was observed eating diatoms and other algae. The body was sometimes pressed entirely out of shape by the food. One was seen to take a diatom which was longer than its own body, so the body became stretched out at each end to the left of the diatom, causing it to appear pointed at each extremity.

These were rather numerous on January 17, 1900, in material collected under the ice on January 5, 1900. Leidy ('79) has found them in pools in Pennsylvania, New Jersey, and Wyoming. Schewiakoff ('93) reports it from America only. Bütschli, however, reports it from Europe.

18. <u>Actinophrys sol</u> Ehrbg. Pl.XVIII,Fig. 50.

Leidy ('79)pp. 235-241. Pl. XL. Schaudinn ('96) p.10.

The body is spherical. It is very much vacuolated and the protoplasm which holds the vacuoles together is granular. It is usually colorless, although on one occasion I observed several which were not so vacuolated but consisted of brown granular protoplasm, with red bodies enclosed in the brown, thus resembling <u>Vampyrella laterita</u>.

The pseudopodia are long straight rays, which are very numerous and which vary in length, being usually from two to three times the diameter of the body. These all draw toward the contractile vacuole when it collapses.

The nucleus is central but it can not always be seen.

The contractile vacuole is single, and located at the periphery. It is not easily distinguished from the other vacuoles of the body until it contracts. It appears and disappears slowly, usually reappearing in about the same position after each contraction.

I observed one in process of division. When first seen, there were two individuals connected by an isthmus and having a third sphere between them. The two had rays and each had a contractile vacuole but the one in the center had neither rays nor vacuole. Upon looking at them a little later, the middle sphere was smaller and a second intervening sphere had formed. These spheres grew smaller all the time, while the isthmus connecing the two outer individuals became longer and narrower. The substance of the spheres flowed over into the connecting isthmus. I was obliged to leave them at this point, and so did not see them actually divide.

I first observed them April 3, 1899, in an aquarium started from below the heating plant early in January. I did not observe them again until November and they were plentiful after that. Leidy ('79) reports the species from most parts of the United States, from Nova

Scotia, and from Canada. schaudinn ('96) reports it as occurring in Europe, Asia, America, and Australia.

19. Actinosphaerium eichhornii Ehrbg. Pl. Fig.

Leidy ('79)pp. 259-264. Pl. XLI. Schaudinn ('96) p. 10-11.

This is a colorless, spherical animal having a clear layer of vacuoles at the periphery, while the interior of the body is granular.

The pseudopodia are rays which project from the body in every direction, and are very numerous. They are usually not much longer than the diameter of the body.

The nucleus was not observed by me although some authorities report as many as one hundred, scattered through the inner granular mass.

There are two contractile vacuoles, located in the layer of peripheral vacuoles, at opposite sides. They can not be distinguished from the other vacuoles until they contract, when they give the entire body a shock. They reappear at the same place.

These occurred plentifully during the last of February and the first of March in branches of Salt Fork, east of Urbana. Schaudinn ('96) reports the species as occurring in Europe, Asia, America, and Australia.

20. Nuclearia polypodia Schewiakoff. Pl. XIX. Fig. 51.

Schewiakoff ('93) p. 7. Pl. I, figs 1-2.

This is a colorless spherical animal, consisting of protoplasm, which contains a nucleus and a contractile vacuole, and which has pseudopodia. The protoplasm is not differentiated into ectoplasm and endoplasm. It is homogeneous, somewhat granular and vacuolated. The animal was very quiet while observed, not changing from its spherical form.

The pseudopodia are pointed and rather broad at the base. They vary in length and number, usually being five or six. They are sometimes as much as six times as long as the diameter of the body. These move,

after the manner of rays of Actinophrys, with the contraction of the vacuole. The pseudopodia are free from granules.

The nucleus is single; it is spherical and central.

There is but one contractile vacuole which is located laterally. It grows very large, in fact almost as large as the body and pulsates rather slowly.

This was found in December, 1899, in material from pools near the brick yard, Urbana. They were not numerous. The species was described by Schewiakoff in 1893 from ponds on the island of Bali in the Malayan Archipelago, on rice plants in stagnant water.

21. Heterophrys myriapoda Archer. Pl. XX., Fig. 56.

Leidy ('79) pp. 243-248. Pl. XLV, figs. 1-8; XLVI, 4-13.

Schaudinn ('96) pp. 13.

The body is a soft spherical mass of protoplasm, usually colored a bright green. They are somewhat similar to Actinophrys in appearance, but are larger.

The pseudopodal rays are long, pointed, and numerous, all drawn toward the contractile vacuole when it contracts. On the rays are particles which move in and out on the ray and which give it a bead-like appearance. They vary in length the longest being three times the length of the body diameter. The animal seems to just float along very easily and steadily and very slowly, without the rays seeming to be any aid to locomotion.

The nucleus was not observed. The contractile vacuole is single, being located near the periphery. It is very large and during the thirty minutes that I observed it pulsated regularly in exactly the same place, once every forty seconds.

I did not observe the animal take food but Leidy ('79) says that the food consists of diatoms and algae which become brown by

digestion. He also tells of seeing a Heterophrys capture a rotifer but it was not able to retain it against the struggles which it made.

This was found first October 25, 1899, in a collection made from a branch of Salt Fork in the woods north of Crystal Lake. I have found it since , rather abundantly in aquaria about the laboratory but not in fresh collections. It is reported from Ireland and from Germany by Leidy ('79), while Schaudinn ('96) reports it only from continental Europe.

22. Acanthocystis turfacea Carter. Pl. XXI, Fig. 57.

Leidy ('79) pp. 264-268. Pl. XLII, figs. 1-6. Schaudinn ('96) p. 19.

This is a spherical animal and is usually bright green, with a granular and vacuolated protoplasm.

The pseudopodia rays are numerous and extend in every direction from the periphery. They are of two kinds, some very long, delicate, pointed rays, which are three times as long as the body diameter, then there are shorter rays of the same kind about the length of the body diameter; and for each of these and alternating with them is a forked ray about half as long as the others.

There is a clearer space in the center of the body, which probably represents the location of the nucleus.

The contractile vacuole is single, although it did not always reappear at the same place. It pulsates very slowly.

The animal moves slowly. At first one would think it was fixed, because of its easy floating movement.

These were found rather abundantly in a collection made January 5, 1900, from under the ice. It is reported by Schaudinn ('96) from different parts of Europe, North America, and the East Indies.

23. Mastigamoeba simplex Saville-Kent. Pl. XIX, Fig. 52-55.

Kent ('80-82) pp. 221-222. Pl. I, fig. 30.

This is a small mass of protoplasm, which is amoeboid, i.e., constantly changing in shape. It is very small and almost spherical when contracted, and is differentiated into ectosarc and endosarc. It has both pseudopodia and a flagellum.

The pseudopodia are usually but two or three in number, and are generally directed backwards. They are extened and withdrawn quickly and somewhat regularly, i.e., first on one side and then on the other. There is one flagellum, a little longer than the body. It is directed forwards and is in constant motion.

There is one contractile vacuole situated anteriorly, but the nucleus was not observed.

I found this species twice, once in April, 1899, and again in March, 1900. Both times, it occurred in aquaria of long standing although not foul. It is reported only by Kent ('80-'82) who worked in England.

24. Cercomonas typica Saville-Kent. Pl. XXII, fig. 58, 59.

Kent ('80-'82) p. 259. Pl. XIV, figs. 22-30. Bütschli ('80-'89) Pl. XXXIX, fig. 12.

This is a small colorless form, spherical when at rest, but soft and changeable in shape when moving. The posterior end is drawn out into a thread-like process.

There is one flagellum, four or five times as long as the body diameter. It is very active, lashing in food particles and assisting in swimming.

There is one contractile vacuole near the center of the body.

I observed one in the process of division, which is a simple act of cross-division. After the two have nearly separated, they are connected for some time by the protoplasmic thread which is to become the posterior process, but this finally divides in the middle and they swim apart.

This was found throughout the summer and fall of 1899, in laboratory aquaria. It is also reported from infusions, by Kent ('80-'82)

25. Stylobryon abbotti Stokes. Pl. XXII, Fig. 60.

Stokes ('88B pp. 79-81. Pl. I, fig. 12.

The lorica is conical in shape and is about twice as long as broad. The enclosed body is small and ovate and is attached to the posterior part of the lorica, but does not half fill the lorica. They form colonies, two growing out from each preceding one. I did not find a colony containing over seven individuals. They appear to be sessile on the antero-lateral margin of the supporting lorica but are really attached to the inner lateral wall by a short stalk. The primary stalk is about six times as long as a lorica.

The enclosed body has two flagella, one short one and one long one. The body darts forward and projects from the lorica and then, if disturbed, retreats into the lorica.

There is one contractile vacuole posteriorly located.

These were found in April, 1900, in aquaria, attached to threads of algae or free swimming in the preparations. They were not abundant. S. abbotti is described by Stokes ('88) for the first time. He found it near Philadelphia.

26. Paramonas globosa Fromentel. Pl. Fig.

Kent ('80-'82) p. 370. Pl. XX, fig. 1.

This has a small spherical body, is very granular, and quite persistent in shape although slightly distorted when eating. The mouth is large and circular, situated at the base of the flagellum.

There is one long, actively vibrating flagellum, which lashes in food bodies and transfers them to the mouth opening at its base.

The contractile vacuole is simple and is situated near the periphery.

They occurred abundantly during September, October and November,

in aquaria which had been standing in the laboratory for some time. It is reported from Europe.

XXIV.,
27. Anthophysa vegetans Müller. Pl. ~~XXIII~~, Fig. 61-63.

Kent ('80-'82) pp. 267-271. Pl. XVII, figs. 13-28; XVIII, 1-10. Bütschli ('80-'89) Pl. XLI, fig. 5.

The body is irregularly pyriform and is truncate anteriorly. The zooids are grouped in rosette-like clusters at the ends of granular, brown, branching pedicles, which are arranged in branching colonies.

There are two flagella attached at the anterior end and both are directed forward. One is shorter than the other

The nucleus is situated a little below the center.

There are two contractile vacuoles in the posterior part.

Sometimes the clusters or heads break loose from the pedicle and then they go swimming about rapidly and with a whirling motion. Sometimes, too, the clusters break up into single zooids.

I found these abundantly in June, 1899, in material from Crystal Lake. In March, 1900, they became very abundant in an aquarium, forming a thick brown scum over the top. They are reported from Europe, Asia, Africa, Australia, Oceanica, and America by Schewiakoff ('93).

28. Euglena viridis Ehrbg. Pl. XXV, Fig. 64-66.

Kent ('80-'82) pp. 381-382. Pl. XX, figs. 29-31. Butschli ('80-'89) Pl. XLVII, fig. 6.

This is a highly metabolic animal, which is sub-cylindrical when at rest, with a short, pointed, tail-like prolongation. It is full of ovate chlorophyll bodies which give it a green color. There is a red pigment spot at the anterior end. The surface shows a faint oblique striation. The caudal prolongation is colorless.

The flagellum is single and is long and slender.

The nucleus is spherical and is centrally located.

The contractile vacuole is located at the anterior extremity close to the red pigment spot.

These were found at all seasons, throughout the year, in aquaria and in field collections, even under the ice. It is reported by Schewiakoff ('93) from Asia, Africa, Australia, Oceanica, America, and Europe.

29. Euglena spirogyra Ehrbg. Pl. XXV, Fig. 67.

Kent ('80-'82) pp. 382. Pl. XX, figs. 27-28. Bütschli ('80-'89) Pl. XLVII, fig. 9.

This is an elongate animal, six times as long as broad when extended. It is slightly truncate anteriorly, and at the posterior end is prolonged into a decided tail, which is colorless, while the body is green. The surface has oblique rows of bead-like [illegible] places. There are two oval amylaceous bodies located about one-third of the way from the head and from the posterior end of the colored body. There is an anterior red pigment spot.

The single long flagellum is directed forward and is very active.

The nucleus is spheroidal and is located about the center, between the two amylaceous bodies.

The contractile vacuole is anterior and is in close relation to the pigment spot.

These have occurred throughout the year in connection with E. viridis and E. acus, but not so abundantly as [illegible] species. Schewiakoff ('93) reports it from Asia, Australia, Oceanica, America, and Europe.

30 Euglena oxyuris Schmarda. Pl. XXV, Fig. 68.

Kent ('80-'82) pp. 383. Pl. XX, fig. 26.

This is an elongate form which never straightens itself out

but is twisted spirally. The anterior end is rounded, while the posterior end is prolonged into a curved, abruptly and sharply pointed tail. It is green in color and contains two elongate rectangular amylaceous corpuscles. The usual red pigment spot is developed in the anterior extremity. The surface is obliquely striate.

The slender flagellum is about equal to the body in length.

The nucleus is oval and is located centrally, between the two rectangular amylaceous corpuscles.

The contractile vacuole is large and is located just at the side of the pigment spot.

I found this form but once. It was in association with the other species of Euglena and was taken from a green scum on the surface of Crystal Lake the latter part of September, 1899. Schewiakoff ('93) reports it only from America, but Kent ('80-'82), who worked in England has also reported it.

31 Euglena acus Ehrbg. Pl. XXVI, Fig. 69.

Kent ('80-'82) pp. 383-384. Pl. XX, figs. 24-25. Bütschli ('80-'89) Pl. XLVII, fig. 8.

Body is elongate and very slender. It is ten times as long as broad and tapers toward both extremities, the anterior end being abruptly truncate, while the posterior one tapers to a point. The body is green in color and contains many elongate rectangular amylaceous bodies. A red pigment spot is developed at the anterior end.

The flagellum is slender and is not longer than the body.

The contractile vacuole is large and is situated in the anterior end just back of the pigment spot.

This occurred quite commonly througout the year, associated with E. viridis. Schewiakoff ('93) has reported it from Asia, Africa, Oceanica, and America, while Bütschli ('80-'89) reports it from Europe.

32. Tracnelomonas hispida Perty. Pl. XXVII, Fig. 70.

Kent ('80-'82) p. 320. Pl. XXI, figs. 21-23. Bütschli ('80-'89) Pl. XLVIII, fig. 2.

These animals are provided with an evenly ovate, dark brown shell, which is hispid upon the surface which also has a scarlet or crimson tint. At the anterior end is a very short cylindrical neck. The inner body is granular and vacuolated, and fills the shell save for a narrow border. There is a red pigment spot in the anterior end.

From the neck extends one long slender flagellum.

There is one contractile vacuole situated near to the pigment spot.

This species was obtained during the latter part of September, 1899, in a tow net collection from Crystal Lake. It is very cosmopolitan, being reported by Schewiakoff ('93) from Europe, Asia, Australia, Oceanica, and North America.

33 Tracelomonas acuminata Schmarda. Pl. Fig.

Kent ('80-'82) pp. 321. Pl. XXI, fig. 26.

The shell is flask-shaped being inflated posteriorly and with the posterior extremity produced into an acuminate tail-like process. The anterior end is produced into a short, obliquely truncate, cylindrical neck. The inner body follows the shape of the shell, and nearly fills it. A red pigment spot is located in the anterior part of the granular inner body.

The long slender flagellum protrudes from the short neck.

The contractile vacuole is located in the anterior end close to the pigment spot.

I found but one specimen of this species. It was associated with two hispida in tow net collections from Crystal Lake, September 30, 1899. It is reported from Europe.

34. Phacus tricueter Ehrbg. Pl. XXVII, Fig. 71.

Kent ('80-'82) pp. 387. Pl. XXI, fig. 1.

This is a flattened leaf-like form, with a ridge down the center of the right hand side, with a pointed tail-like prolongation. The mouth is terminal. The surface is longitudinally striate. It is green in color with a red pigment spot at the anterior end.

There is a single long flagellum, arising from the mouth.

The contractile vacuole is small, and located near to the pigment spot in the anterior end.

These occurred abundantly in acuaria and in field collections, throughout the year, associated with Euglena and with green algae. Schewiakoff ('93) reports it from Australia, Oceanica, America, and Europe.

35. Phacus longicaudus Ehrbg. Pl. Fig.

Kent ('80-'82) pp. 387. Pl. XXI, figs. 6-7. Bütschli ('80-'89) Pl. XLVII, fig. 12.

The body is flattened and leaf like in shape. It is green and contains a red pigment spot in the anterior end. The surface is longitudinally striate. The body is usually twisted more or less on its axis, and has a caudal prolongation which is long and pointed, and which is ecual to the body in length. P. longicaudus does not have the ridge down the right hand side, is more flattened, and has a much longer caudal prolongation than P. tricueter.

The flagellum islong and slender. The contractile vacuole is located in close relation to the pigment spot.

I observed this species but once, September 30, 1898. It was in association with P. tricueter, Euglena, Mallomonas, and green algae. The collection was made from water bloom on the surface of Crystal Lake on a sunny day, September 28, 1898. Schewiakoff ('93) reports it from Asia, America, and Europe.

36. Petalomonas mediocanellata Stein. Pl. XXIX, Fig. 73.

Kent ('80-'82) p. 371. Pl. XX, fig. 3.

The body of this animal is ovate, rounded posteriorly and pointed anteriorly. The mouth is terminal and extending back from it in a median line and almost to the posterior end of the body, is a groove or channel. It is colorless.

There is one vibratile flagellum about equal to the body in length and which is very active, drawing in food bodies with which it comes in contact.

The contractile vacuole is situated in the anterior end, to the left of the median groove.

The nucleus is more posterior than the contractile vacuole and is on the right hand side of the channel.

They multiply by longitudinal division. This process was observed by me, and while dividing, the flagellum was very active in each.

I found it in October, 1899, in acuaria in the laboratory. Schewiakoff ('93) reports it from America, and it has also been found in Europe.

37 Astasia trichophora Ehrbg. Pl. XXVIII, Fig. 72.

Kent ('80-'82) p. 378. Pl. XX, figs. 17-21.

When stretched out, the body, which is a colorless mass of protoplasm, is about six times as long as broad, broad at the posterior end and tapering gradually at the anterior end. The protoplasm is homogeneous, containing many granules and vacuoles, a distinct pharyngeal cavity, and a nucleus. It is extremely mobile and contorts itself into unrecognizable shapes.

The flagellum is fixed and is about one and one-half times as long as the body. It wraps about food and draws it into the mouth, which is terminal, and which is succeeded posteriorly by a pharyngeal

tract about one-fourth the length of the body.

The contractile vacuole is anterior.

The nucleus is large and spherical, located centrally.

A recent paper by Zumstein ('99) comparing Astasia with Euglena, concludes that they are two conditions of the same species. He says that Euglena in the dark is colorless and that Astasia may become chlorophyll-green in the light. [illegible] in light aquaria and no evidence of transformation to Euglena-like forms were noted. It may be that certain species of Astasia are valid.

It was found abundantly throughout the year in aquaria as well as in field collections. Kent ('80-'82) reports this species from England.

38. Heteronema acus Ehrbg. Pl. XXIX, Fig. 74.

Kent ('80-'82) p. 430. Pl. XXIV, figs 14-15. Bütschli ('80-'89) Pl. XLVII, fig. 10.

The body is about seven times as long as broad. It is slender, being widest about the center and tapering to a point at each end. It is quite metabolic. The endoplasm is granular.

The animal has two flagella both attached at the anterior end, the more rigid of the two is about equal in length to the length of the body and is directed forward. The other one is about half as long and trails behind, being visible only when the animal turns.

Contractile vacuole is situated near the anterior end.

The nucleus is oval, and is situated near the center of the body.

I found this species only in the month of December, 189-, in material collected a few days before, [illegible] the boneyard on Mathews Avenue, Urbana. It is reported from America [illegible] Schewiakoff ('93) and from Europe by Bütschli ('80-'89).

39. Anisonema grande Ehrbg. Pl. XXX, Fig. 76.

Kent ('80-'82) pp. 432-433. Pl. XXIV, figs 28-30.

Bütschli ('80-'89) Plate XLVI, fig. 8.

The body of the animal is ovate, being about twice as long as broad and broader and rounder posteriorly than anteriorly. It is colorless and finely granulate. The mouth is terminal and is just beside the origin of the trailing flagellum. A short tubular pharyngeal tract follows the mouth.

There are two flagella. The anterior vibratile one is very slender and is about equal to the body in length. The posterior trailing one is three or four times as long as the other, and is thicker.

The contractile vacuole is single and is located just back of of the mouth opening.

The nucleus is spherical and is situated on the right side, towards the posterior extremity.

I found them but once, and then only for a short time during November, 1899, in one of the laboratory aquaria. They are reported from Europe by Bütschli ('80-'89) and from America and Oceanica by Schewiakoff('93).

40. Mallomonas plosslii Perty. Pl. XXIX., Fig. 75.

Kent ('80-'82) pp. 464-465. Pl. XXIV, figs. 72-73.

Bütschli ('80-'89) pp. [illegible]-834.

The body is ovate, being some narrower at the anterior end than at the posterior one. The surface is covered with long flexible, ray-like spines. It is yellowish-brown in color, due to the two chromatophores. In addition to the cilia, the animal has one long slender flagellum, arising at the anterior end, and directed ahead. There were many colorless empty skins present. One emptied while I was watching it. The yellowish contents floated out leaving the colorless lorica with spines and flagellum attached.

This was obtained from water bloom on the surface of Crystal Lake on a sunny day in the latter part of September, 1899. Bütschli

('80-'89) reports this species from Europe only.

41. *Carteria multifilis* Fresenius. Pl. XXI., Fig. 77, 78.

Raoul France ('96). pp. 105-112, Pl. III. figs 1-5, 7, 9, 11-12, 14-15, 20. Goroschankin ('91) pp. 43. Pl. II, figs. 14-23.

The body of this protozoan is small and spherical. It is green in color with red pigment spot in the anterior end.

The little animal possesses four flagella of length about equal to that of the body, and all having a common origin at the anterior end.

Just back of the origin of the flagella, one contractile vacuole and sometimes two, may be seen.

The nucleus is spherical and central.

They were sometimes observed grouped, usually in fours, forming a sort of colony. I found them abundantly in material collected from Crystal Lake, September 28, 1899. They are reported from Europe and from the East Indies by Bütschli ('80-'89).

42. *Pandorina morum* Bory. Pl. Fig.

Bütschli('80-'89) pp. 839-840. Pl. XLIV, fig. 8.

This is an ellipsoidal or spherical colony consisting of 16, rarely 32, dark green cells which are compactly grouped. Each cell contains a red pigment spot and a pyrenoid, and is also enclosed in a distinct cell membrane. The gelatinous sheath of the colony is composed of concentric layers, and rarely has blunt pseudopodia-like processes at the posterior end. The colony moves by rotation on its principal axis, either to the left or to the right.

This occured in association with the other species of Volvocinae in tow net collections from Crystal Lake, August 5, 1899. Schewiakoff ('93) reports it from Asia, Africa, and America, and Bütschli ('80-'89), from Europe.

43. Eudorina elegans Ehrbg. Pl. Fig.

Bütschli ('80-'89) p. 840.

This is a colony of 32, 16, or 64, similar cells which are widely separated from each other. Each cell [illegible] colony is enclosed in a simple common sheath. There is a prominent pigment spot near the anterior end of each cell.

Near to the pigment spot of each cell arise two equal flagella, side by side.

The locomotion of this species as observed by Kofoid ('98) is by rotation on its longitudinal axis, with a predominance of turn from right to left.

It occurred associated with the other species of Volvocinae in tow net collections from Crystal Lake, August 5, 1899. Bütschli ('80-'89) reports it from Europe and the East Indies, Schewiakoff ('93), from Asia, and Kofoid ('98), from the Illinois River.

44. Pleodorina californica Shaw. Pl. Fig.

Shaw ('94) pp. 279-283. Pl. 27.

This is an almost spherical colony consisting of 64 or 128 greenish cells of two kinds, vegetative and gonidial cells. The vegetative cells are smaller and fill most of the anterior half of the colony. The stigma, which is conspicuous in early stages, [illegible] colony enlarges.

Each cell has two equal flagella.

The nucleus is central. The contractile vacuole I did not observe, although Shaw ('94) reports a single one in the anterior end of young cells. Colonies of this species were very abundant in a tow net collection from Crystal Lake, August 5, 1899. The species was describe by Shaw ('94) from California and it has since occurred in ponds, ditches, and streams in Indiana and Illinois.

[illegible]. *Pleodorina illinoisensis* Kofoid. Pl. [illegible] Fig. [illegible].

Kofoid ('98) pp. 273-2[illegible]. Pl XXXVI; [illegible].

This is an ellipsoidal colony of 32, rarely 1[illegible], cells and is quite constant in shape. The cells are of two kinds, vegetative and gonidial. The vegetative cells are four in number and are in the anterior end, being always directed ahead. The cells are [illegible] in color, with a reddish brown stigma in the anterior end of each. Each cell has a distinct cell membrane.

Each cell has two equal flagella, which unite with the cell at the anterior end, adjacent to the stigma.

The nucleus lies in about the center of the cell in the midst of a mass of protoplasm enclosed by the chromatophore.

No contractile vacuole was observed.

The colonies moved by rotation on the [illegible] axis, sometimes from right to left and sometimes from left to right.

They occurred [illegible] in [illegible] al [illegible], August [illegible], 1899. This species was described by Dr. C. A. Kofoid in 1898, and at that time had [illegible] [illegible] along the Illinois River. It has [illegible], however, been [illegible] of the Mississippi valley.

48. *Platydorina caudata* Kofoid. Pl. XXXI, Fig. 79.

Kofoid ('99) pp. 419-440. Pl. [illegible].

This is a flattened, horse-shoe-shaped colony of 16 or 32 round cells. There are three or five tails formed at the posterior end, by the extension of the common outer sheath. The colony is sometimes twisted about one-eighth of a turn from right to left. There is a pigment spot in each zooid in the protoplasm at the anterior edge, near the origin of the flagella.

Each cell has two equal flagella.

There is a prominent central nucleus, round in shape, and containing a central round nucleolus.

There is one small contractile vacuole situated a little posterior to the pigment spot.

I found this species abundantly in August, 1898, and less abundantly in September, 1899. It was reported and described by Kofoid ('99) for the first time. It has never been reported outside of the Mississippi basin.

47. *Volvox aureus* Ehrbg. Pl. Fig.

Kofoid ('99) pp. 427-428.

This is a colony of great numbers of cells, arranged in a sphere or an ellipsoid. The cells are all connected by protoplasmic processes into which the chromatophore does not enter. The animal moves by rotation on its principal axis from left to right, which rotation may be reversed occasionally. Backward motion is rarely seen and lasts but a short time.

This species was abundant in tow net collections from Crystal Lake, August 5, 1899. It is reported from Europe and America.

48. *Peridinium tabulatum* Ehrbg. Pl. Fig.

Kent ('80-'82) pp. 448-449. Pl. XXV, figs. 1-5 and 55-57.

Bütschli ('80-'89) Pl. LII, fig. 66.

The shell is a somewhat elongate egg-shape. The body is divided transversely into two almost equal parts, by a ciliated groove, and the upper half is divided longitudinally by another groove which is not ciliated, while the whole shell is irregularly grooved, marking it off into polygonal spaces. The mouth is on the ventral side at the junction of the transverse and longitudinal grooves. The shell is of a brownish hue and has a redpigment spot developed.

There is a single long flagellum, which arises from the oral aperture.

I found them abundantly in September, 1899, associated with Ceratium kumaonense. They are very cosmopolitan, being reported by Schewiakoff('93) from Asia, Australia, Oceanica, America, and Europe.

49. Ceratium kumaonense Carter. Pl. XXXII., Fig. 80.

Kent ('80-'82) pp. 458. Pl. XXV, fig. 25.

The shell is triangular, having two anterior and one posterior, large horn-like processes. These processes are produced from the angles of the triangle. The shorter anterior horn and the posterior one together are a little more than equal to the body in length. The other anterior horn is about half as long as the other two. They are all finely cerrate. The shell is divided transversely into two equal parts, by ciliated grooves. The shell is brown in color. The mouth is located about the center of the body.

From the mouth arises a single, long, slender flagellum, which is very active.

They were very abundant in a tow net collection made from Crystal Lake in September, 1899. They were reported in 1871 from Hindostan by Carter ('71), and this seems to be the first report of their occurrence elsewhere.

50. Enchelys sp. Pl. Fig.

This is a colorless, elongate, cylindrical form, with the anterior end somewhat pointed. It closely resembles Enchelys pupa, but differs in that it is longer and more slender. It is very contractile, and its movements are manifold. The body is delicately striate longitudinally. The mouth occupies the anterior end and there is no pharynx.

The entire surface is evenly ciliate, but about the mouth the

cilia are longer and are very thickly placed.

The nucleus and contractile vacuole were not observed.

They occurred but once and then very abundantly for a few days during the latter part of March, 1900, in aquarium started from the Boneyard.

51. Coleps hirtus Ehrbg. Pl. XXXII, Fig. 81, 82.

Kent ('80-'82) pp. 506-507. Pl. XXVII, figs. 3-4.

Butschli ('80-'89) Pl. LVIII, fig. 1.

The body is barrel-shaped, rounding posteriorly and about twice as long as broad. The cuticular surface is divided into many square spaces by longitudinal and transverse ridges. The most of the specimens observed were brownish in color. The cilia are found not on the squares, but in the grooves between, and are very active. The animal swims rapidly, revolving on its longitudinal axis. The mouth is terminal, and is surrounded witi cilia of a larger size than those of the general surface.

There is but one contractile vacuole, which is placed posteriorly and can not always be seen.

When this species was found it was usually in large numbers. It occurred in the aquaria at all seasons of the year and was especially plentiful in very stagnant water. It is reported by Schewiakoff ('93) from Asia, Africa, Australia, Oceanica, America, and Europe.

52. Amphileptus anser Ehrbg. Pl. XXXIII, Fig. 83.

Kent ('80-'82) p. 525. Pl. XXVII, figs. 39-40.

The body is elongate-lanceolate, pointed posteriorly, and with a neck-like prolongation in front, equal to the body in length. The protoplasm is very granular and very vacuolated. The animal is

very flexible. The mouth is situated at the base of the neck. The whole surface is evenly and finely ciliate but the cilia around the mouth are some larger.

The macronucleus is bi-lobed and lies near the center of the body.

The contractile vacuole is large and situated posteriorly.

These were found in abundance in collections made from under the ice in January, 1900; also in early March collections, and they have continued abundant in aquaria founded from these collections. It is reported from Europe.

53. Lionotus fasciola Ehrbg. Pl. Fig.

Kent ('80-'82) pp. 743-744. Pl. XLII, figs. 5-11.

Butschli ('80-'89) Pl. LIX, fig. 6.

This is a colorless elongate form. The neck, body, and tail are not so sharply distinguished from each other as in L. wrzesniowskii. The neck is less than half as long as the body, and is not so slender as in the other species found. It is set with trichocysts along the left border and the cilia are larger than those of the body. The tail is short, and pointed. The mouth is situated at the left and about the center of the middle portion. The animil swims rapidly. It is very flexible but not contractile.

The single large contractile vacuole is situated posteriorly.

This was observed in February and in March, 1900, from material collected from the Boneyard on two cold days. This material was collected in February and remained standing in the laboratory. Schewiakoff ('93) reports it from Asia, Africa, Oceanica, America, and Europe.

54. Lionotus wrzesniowskii Saville-Kent. Pl. XXXIV., Fig. 84.

Kent ('80-'82) pp. 742-743. Pl. XLII, figs. 12-13.

Butschli ('80-'89) Pl. LIX, fig. 5.

This is a colorless, elongate form. It shows three distinct regions. The anterior portion is prolonged into a slender neck which is very flexible and is about half the length of the body. The cilia in this region are longer than those of the rest of the body and there is a row of trichocysts on the left margin. The mouth is at the base of this neck, to the left. The central thickened portion contains a granular endoplasm. The cilia are fine and evenly distributed in this region. The posterior portion is a short, clear, pointed, tail-like region.

There is a bi-lobed spherical macronucleus about the center, and alarge spherical contractile vacuole at the posterior end of the thickened portion.

The animal swims very rapidly, bending and turning particularly in the neck region. It is very flexible and contractile.

This was first observed in December, 1899, in an aquarium started in the fall from the Boneyard. They occurred here in numbers. Again in January, 1900, I broke ice near the bank of the Boneyard and found many of them. I have not observed them since. It is reported from Europe by Butschli ('80-'89).

55. Nassula rubens Claparede & Lachmann. Pl. XXXV., Fig. 85.

Kent ('80-'82) pp. 495-496.

The body is ovate and is equally rounded at both ends. It is finely and evenly ciliate throughout and contains a granular endoplasm. The mouth is situated one-fourth of the way back on the left hand side, and leads into a pharynx armed with a cyl-

indrical fascicle of rod-like teeth. The tube of the pharynx is dilated anteriorly. The most striking characteristic of this species is its striking and brilliant rose color.

There is but one macronucleus, which is large, granular, spherical, and is located a little back and to the right of the center.

The contractile vacuole is single. It is large and spherical, and is situated to the left of the nucleus. It sometimes leaves two smaller ones after systole.

I observed two of these on March 20, 1900, in an aquarium which had been started about two months before from the Boneyard and had become foul. A scum was formed on the top which was largely made up of Stentors. It is reported from Europe.

56 Chilodon cucullulus O.F.Müller. Pl. XXXVI. Fig. 86.

Kent ('80-'82) pp. 746-747. Pl. XLII, figs. 16-22.

Butschli ('80-'89) Pl. LX, fig. 8.

The body is flattened, sub-ovate in outline, and is very flexible. It is rounded at the posterior end: anteriorly, on the right side, the body is projected forward in a sort of lip, and is curved over to the left. The cilia about this projection and down the left border are larger than elsewhere. The surface is longitudinally striate. A vibrating line leads from the tip of the lip into the mouth opening. This line projects a little beyond the edge of the body.

The macronucleus is single, ovate, and centrally placed.

There are many contractile vacuoles scattered irregularly through the endoplasm.

This is one of the first forms which I observed. It has oc-

curred plentifully throughout the year, and especially in very stagnant water with Paramoecium. Schewiakoff '93 reports it from Asia, Oceanica, America, Europe.

57. Glaucoma scintillans Ehrbg. Pl. Fig.

Kent ('80-'82) pp. 795-796. Pl. XLV, figs. 39-40.

Butschli ('80-'89) Pl. LXII, fig. 5.

The animal is egg-shaped, being rounded posteriorly and a little pointed anteriorly. It is somewhat flattened. The animal is colorless. It has a steady and rapid movement. The body is longitudinally striate, and is finely and evenly ciliate. The mouth is on the ventral side, toward the anterior end, a little to the right of the center. It is curved and is bounded by a strong undulating membrane.

The large spherical macronucleus is contractile.

The contractile vacuole is single and located posteriorly.

This was found in a mid-winter collection from the Boneyard, in the latter part of January, 1900. I saw but a single specimen. Schewiakoff('93) reports it from Africa, Oceanica, America and Europe.

58. Frontonia acuminata Ehrbg. Pl. Fig.

Butschli ('80-'89) Pl. LXII, fig. 4.

This has an ovate body with one end rounded, and the other prolonged into a point. It is somewhat flattened. The surface is longitudinally striate, and is finely and evenly ciliate. The elongated mouth lies along the left side on the ventral surface, and has an undulating membrane. The endoplasm is considerably vacolated.

The nucleus is oval and centrally situated.

there is but one contractile vacuole and it is posteriorly situated.

I found this form but once. It was associated with Glaucoma scintillans. It is reported from Europe by Butschli ('80-'89).

59. Colpidium colpoda Schrank. Pl. XXXVI, Fig. 87.

Butschli ('80-'89) Pl. LXII, fig. 6.

The body is kidney-shaped with the anterior end less rounded than the posterior. The endoplasm is considerably vacuolated and granular. The surface is finely and evenly ciliate and is longitudinally striate. The mouth is on the ventral side to the left, and is similar to that of Glaucoma. It is curved and bounded on the sides by an undulating membrane.

The nucleus is oval and is centrally located.

The single contractile vacuole is posterior.

I first identified it March 5, 1900. They were very numerous at that time. It occurs abundantly in aquaria which are stagnant and contain numbers of Paramoecium and Bacteria. Schewiakoff ('93) reports it from Africa, Oceanica, America, and Europe.

60. Paramoecium caudatum Ehrbg. Pl. XXXVII, Fig. 88, 89.

Butschli ('80-'89) Pl. LXIII, fig. 1. Blochmann ('95) p. 105. Pl. VI, fig. 194.

This is an elongate spindle-shaped animal three or four times as long as broad. The posterior end is somewhat pointed, and there the cilia, which are evenly distributed over the rest of the surface are longer. The mouth is at the termination of the oral groove, which extends from the anterior left hand extremity posteriorly over the ventral surface, to the center of the body. The animal has a complete coat of trichocysts.

The macronucleus is large and ellipsoidal, with one micronucleus. They are situated about the center of the body.

There are two contractile vacuoles, one near the anterior, and one near the posterior, ends. They frequently have a star-like appearance, due to the canals leading to them.

I have frequently seen them in conjugations, with the oral groove closely applied. They occurred abundantly throughout the year, especially in stagnant aquaria. Schewiakoff ('93) reports them from Africa, Oceanica, and Europe.

61. Urocentrum turbo O.F.Muller. Pl. Fig.

Kent ('80-'82) pp. 641-643. Pl. XXXIII, fig. 7-10.

Butschli ('80-'89) Pl. LXIX, fig. 15.

The body is somewhat pear-shaped, being largest at the posterior end. There is a stylate caudal appendage which is about half the length of the body. The cilia are distributed in two wreaths which encircle the body. The anterior wreath is just a littleback of the anterior border of the body: the posterior wreath is a little back of the center of the body. The mouth lies on the ventral side in this posterior wreath of cilia. The animal swims rapidly with a whirling motion.

Both the nucleus and the contractile vacuole are located posteriorly. The vacuole presents some peculiarities, by taking on a series of forms. When it is full it is round, but on contracting it has somewhat the appearance of a rosette. The nucleus is band-like.

It occurred in November, 1899, in a large aquarium started more than a year before and to which had been added, besides Boneyard material a little water from the Illinois River at Havana. Schewiakoff('93) reports it from Asia, Australia, Oceanica, America,

and Europe.

62. Pleuronema chrysalis Ehrbg. Pl. XXXVIII., Fig. 90.

Kent ('80-'82) p. 543. Pl. XXVII, fig. 55. Butschli ('80-'89) Pl. LXIV, fig. 6.

The body is ovoid, equally rounded at both ends, concave below and convex above. The cilia are somewhat rigid and are developed all over the cuticular surface. It is rather quick, but when irritated, it moves out of the way with a quick leap or spring. A large extensile undulating membrane is found beneath ventrally attached to the left edge, which may be either extended or withdrawn. The mouth is located centrally, on the ventral side, in a little depression, and leads into a tubular pharynx.

The nucleus is situated a little below the center.

The contractile vacuole is single and is located toward the posterior end.

Food is caught by the extensile membrane. I have often found the animal paired, as though in conjugation.

They occur very commonly and in great numbers. I have found them throughout the year in various aquaria about the laboratory, often with Paramoecium, but more generally present than this genus. Schewiakoff ('93) reports it from Asia, Africa, Australia, Oceanica, America, and Europe.

63. Cyclidium glaucoma Ehrbg. Pl. XXXVIII., Fig. 91.

Kent ('80-'82) pp. 544-545. Pl. XXVII, figs. 57-58. Butschli ('80-'89) Pl. XIV, fig. 8.

The body is ovate, convex above and a little concave beneath. Fine setae are developed over the surface, and at the posterior end are several very much longer setae. The mouth opening occurs

about the center of the ventral side, and below it is an extensile membrane. As in Pleuronema this is sometimes withdrawn and sometimes extended.

The nucleus is spheroidal and is situated below the center.

The single contractile vacuole is located in the posterior end of the body.

These, too, are very common in all collections throughout the year. Pleuronema and Cyclidium are intimately associated. They are reported from Asia, Africa, Australia, Oceanica, America, and Europe, by Schewiakoff ('93).

64. Spirostomum ambiguum Ehrbg. Pl. Fig.

Kent ('80-'82) pp. 586-587. Pl. XXIX, figs. 13-14.

Butschli ('80-'89) Pl. LXVII, fig. 2.

The body is an elongate cylinder, about fourteen times as long as broad. The animal is colorless, flexible and contractile. The mouth is an elongate opening beginning in the middle of the ventral side, and extending down into the middle of the body. The whole cuticular surface is finely ciliate, but the cilia about the mouth are of a much larger size.

Tie nucleus is a moniliform chain and extends through the central two-thirds of the body.

The contractile vacuole extends almost through the body like a canal. It is much dilated at the posterior end.

These were observed through the month of February, being plentiful in one collection and in the aquarium started from it as long as it was kept. I have not found them since. Schewiakoff ('93) reports them from Asia, Africa, Australia, Oceanica, America, and Europe.

65. Bursaria truncatella Muller. Pl. XXXIX, Fig. 92.

Kent ('80-'82) p. 576. Pl XXIX, figs 1-2. Butschli ('80-'89) Pl. LXVII, fig. 6.

These animals are broadly ovate, very much flattened, and truncate at the anterior end. The mouth cavity is sac-shaped. It has a broad opening in front and a lateral fissure which extends from the left side of it back into the middle of the body. The mouth leads into along, bent, funnel-shaped pharynx.

The nucleus is band-like and curved, lying in the central part of the body.

There are many small contractile vacuoles scattered through the body.

The first that I observed of these animals were very large— so large that they could be seen with the naked eye. Large individuals measured 1.5 mm. in length. The material was from Crystal Lake, and was very foul, having been collected when it was very hot and the scum was forming on the water. This was in September, 1899. They occurred again in February, 1900, in Boneyard material. They are reported by Schewiakoff ('93) from America and Europe.

During February, 1900, another species was found which must have been Bursaria, although it was considerably different from the above described form. It was ovate, not so flattend as B. truncatella, and finely and evenly ciliate. The oral aperture was antero-terminal and the anal aperture was postero-terminal. The body was so gorged with food that the structure could hardly be made out. When some of these food particles were expelled, a contractile vacuole was seen at the posterior end. The animal moves with a rolling motion.

66. Stentor polymorphus O. F. Müller. Pl. XL, Fig. 93.

Kent ('80-82) pp. 590-591. Pl. XXX, figs. 10-20.

This is a grayish white, trumpet-shaped animal. It is larger than the other species of Stentor. When the anterior end is fully expanded it equals one-third the length of the body. It swims free or attaches itself to bits of algae. The body is highly flexible and contractile, and so varies in shape.

There is a single moniliform nucleus.

The contractile vacuole is large and situated near the anterior border.

Food is swept in by the current of water which the large adoral cilia keep up about the mouth.

I first found S. polymorphus in July, 1899, in a Boneyard collection made below the heating plant, at which time they were numerous. I did not find it again until March 20, 1900. This time it was in a very stagnant aquarium started two months previous. A scum had formed over the top, which was largely composed of Stentors. Schewiakoff ('93) reports it from Australia, Oceanica, America, and Europe.

67. Stentor roeselli Ehrbg. Pl. XLI, Fig. 94.

Kent ('80-'82) pp. 591-593. Pl. XXX, figs. 22-23.

Bütschli ('80-'89) Pl. LXVIII, fig. 5.

The body is long. The diameter of the peristome region, when fully extended, is equal to about one-fourth of the length of the body. The surface is finely ciliated throughout, and in addition to the cilia a few setae are developed. The adoral cilia are larger and stronger than the surface cilia. This species dwells in a mucilaginous tube, and when irritated darts back within the

tube. It sometimes leaves its tube, however and swims free. One day I noticed one which was being teased by a Coleps, from which it could not escape, even by retreating into the tube, and so it left and swam away.

The nucleus is moniliform, as is characteristic with this family.

The contractile vacuole is large and anterior.

This species was found associated with S. polymorphus and S. coeruleus an a stagnant aquarium in March, 1900. It is reported by Schewiakoff ('93) from America and Europe.

68. Stentor coeruleus Ehrbg. Pl. Fig.

Kent ('80-'82) pp. 593-594. Butschli ('80-'89) Pl. LXIX, fig. 1.

This is what is commonly known as the blue Stentor because of its bluish green color. It is trumpet-shaped. It attaches itself to bits of algae or even sometimes to the surface of the slide or to the surface film of the water. The width of the peristome is equal to about one-third of the length of the body. The cilia are fine and are evenly distributed over the cuticular surface, but those around the peristome are longer and stronger. The body is highly metabolic, often extending to its full length, then when irritated in any way at the anterior extremity, suddenly contracting into little more than a ball.

The nucleus is compound and extends through the body like a chain of small nuclei.

The contractile vacuole is situated in the peristomal region.

The adoral cilia keep up a constant current of water about

the mouth, and sweep everything that comes into the current into the pharynx. I have seen it take all kinds of small algae and many small Protozoa. Once I saw it sweep a small Pleuronema into its mouth.

One of these animals was one day crushed by the cover glass. Upon watching it a few minutes, it was seen to form three new Stentors. Each piece which had contained a fragment of nucleus had developed into a new Stentor, and in a remarkably short length of time.

S. coeruleus was found first in January, 1900, and from that on was abundant in several aquaria. They seemed to be most plentiful in stagnant water. Schewiakoff ('93) reports this species from Africa, Oçeanica, America, and Europe.

69. Halteria grandinella Müller. Pl. XLII, Fig. 95.

Kent ('80-'82) p. 632. Pl. XXXII, figs. 35-38. Bütschli ('80-'89) Pl. LXIX, fig. 6.

The body has a truncate oval shape, being cut off at the anterior end, where there is a wreath of rather large cilia. Long setae called springing setae are found on the body forming a central girdle, by means of which the animal moves so rapidly, darting here and there with a leaping or springing motion, that it is difficult to make out detail.

There is one large spherical contractile vacuole near the center of the body, and near to it a spherical nucleus.

This was first found in November, 1899, in an aquarium started a year before, which contained, besides Boneyard material, some from the Illinois River at Havana. They were very numerous. It was also found plentifully in the collections during January and

February 1900, some of which were made under the ice. Schewiakoff ('93) reports it from Asia, Africa, Australia, Oceanica, America, and Europe.

70. Euplotes patella O.F.Muller. Pl. Fig.

Kent ('80-'82) p. 798. Pl. XLIV, figs. 23-25. Butschli ('80-'89) Pl. LXXII, fig. 2.

The animal has a shell or carapace which is elliptical, with its anterior margin truncate. It has eleven styles: six of these are at the front border, and two at the posterior margin. The two posterior ones are larger and branched. There are also three scattered styles on the ventral surface. This little animal often uses the styles as legs, and walks over any vegetation which may be present. They both swim and walk rapidly.

The nucleus is band-like.

There is but one contractile vacuole and it is situated posteriorly.

They were found in July, 1899, in quantity, in a collection from Crystal Lake. Schewiakoff ('93) reports them from Africa, Oceanica, America, and Europe.

71. Aspidisca costata Dujardin. Pl. Fig.

Kent ('80-'82) pp. 794-795. Pl. XLV, figs. 25-29.

The carapace of this animal is ovate in shape, and is longitudinally furrowed on the dorsal surface. On the left side the shell is extended out into a sort of triangular flap. In a dorsal view one can see four pointed curved styles, projecting from the upper right hand side and five pointed ones from the posterior margin; on the ventral side are three others in a line parallel with the anterior ones. Bounding the mouth which runs in under

the triangular flap is a row of heavy cilia called cirri.

The nucleus I did not observe.

The contractile vacuole is placed posteriorly and to the right.

The animal often turns over in a lateral position and "walks" by means of its styles on any vegetation which may be present.

I observed them in collections from a branch of Salt Fork north of Crystal Lake, made in October, 1899. They are reported from America and Europe by Schewiakoff ('93).

72. Urostyla grandis Ehrbg. Pl. XLIII, Fig. 96, 97.

Kent ('80-'82) p. 765. Pl. XLIII, figs. 6-8. Butschli ('80-'89) Pl. LXX, fig. 8.

The body is oblong, and is rounded at both ends. It varies considerable in shape. In addition to the cilia styles are developed, five being found on the ventral surface, near the anterior border, also many occurring along the right side of the mouth. Setae are developed all over the ventral surface, and sear the posterior border are ten more short styles. The mouth is triangular and around it is a thick development of cilia.

The nucleus is spherical and is situated a little anterior to the center.

The contractile vacuole is single and small. It is situated a little ahead and to the left of the nucleus.

These were found for the first in October, 1899& and have occurred several times since. In March, 1900 they were found in great numbers, and wure associated with Sphaerophrya pusilla. (See Sphaerophrya pusilla) Large numbers of the Urostyla were parasitized by the embryos of S. pusilla, which in some instances were seen escaping from their hosts. Schewiakoff ('93) reports it from America and Butschli ('80-'89) from Europe.

73. Stylonychia mytilus O.F.Muller. Pl. Fig.

Kent ('80-'82) pp. 790-791. Pl. XLV, fig. 1& 18-22.

Butschli ('80-'89) Pl. LXXI, fig. 10.

The shape of the body is elongate elliptical being a little larger and rounder at the anterior end. Setae are developed instead of cilia. There are eight styles on the anterior part of the ventral surface, arranged with three in front, three behind, and two in the middle. Near the center of the ventral surface are five more styles, and at the posterior end there are also five. The animals move about very rapidly. The mouth is large, beginning at the anterior left hand edge and extending back more than one-third the length of the body, and in to the median line.

The nucleus is elongate and occupies a central position.

The contractile vacuole is single and small, and is located to the left a little anterior to the center.

These are very common forms and have occurred throughout the year in collections and especiallm in stagnant aquaria associated with Paramoecium. They are reported from Africa, Australiay Oceanica, America, and Europe, by Schewiakoff ('93).

74. Vorticella nebulifera Ehrbr. Pl. XLIV, Fig. 98.

Kent ('80-'82) pp. 673-675. Pl. XXXIV, fig. 20; XXXV, figs 32-47; XLIX, fig. 1.

The body is conical-campanulate, and is not quite symmetrical. It contracts into a somewhat pyriform or almost spherical ball. The protoplasm is colorless and the cuticular surface is smooth. From the posterior end extends a slender pedicle which is five times the length of the body, and by which it may be attached to algae or small Entomostraca. The cilia are limited to the adoral region, where they keep up a constant current of water.

The right limb of the wreath of cilia descends into the pharynx.

The nucleus is elongate and band-like.

The contractile vacuole is single and spherical and is situated in the anterior end.

These occurred abundantly at all seasons throughout the year in aquaria and in field collections. It is cosmopolitan.

75. *Carchesium polypinum* Ehrbg. Pl. XLVI, XLV, Fig. 99, 100.

Kent ('80-'82) pp. 690-691. Pl. XXXV, figs. 30-31 & 51; XXXVI, figs. 1-8.

This somewhat resembles *Vorticella*, but is united in social clusters. The bodies are conical, with a dilated peristome. There is a compound pedicle, consisting of one main stalk which branches freely, and these branches may again divide. A muscular fiber runs through the center of this stalk but it is not continuous at the places of branching, so the stalk mam contract either all together, or in part. There are large numbers in a colony, sometimes as high as one hundred and fiftm or two hundred. The cuticular surface of the body is smooth, the cilia being distributed as in *Vorticella*,in a wreath around the mouth.

The nucleus is ribbon-like, long and curved.

The contractile vacuole is single and placed near the anterior border.

These were found in quantity in crllections from under the ice made from the Boneyard in January, 1900, and they occurred again in February. It was reported by Schewiakoff ('93) from Africa, Oceanica, America, and Europe.

76. *Zoothamnium aselli* Claparede & Lachmann. Pl. Fig.

Kent ('80-'82) pp. 698-699.

The zooids are elongate, being about three times as long as

broad, and occurring in large colonies, attached to a dichotomously branching stalk. The muscular fibes is continuous throughout the stalk, so that when one part of the colony contracts, it all contracts. The cilia are distributed about the peristome, and keep up a constant current of water.

The nucleus is small and oval, situated near the center of the body.

The contractile vacuole is small and near the anterior margin.

This was found in May, 1899, on the appendages of _Asellus aquaticus_, to which it attaches itself merely for purposes of locomotion. The colonies were found in large numbers. It has been reported only from Europe.

77. _Opercularia nutans_ Ehrbg. Pl. Fig.

Kent ('80-'82) pp. 710-711. Pl. XXXIX, figs. 22-23.

These occur in large colonies having an exceedingly dichotomously branched pedicle. The bodies are ovate and are three and a half times as lon. as broad. They taper toward both extremities, but more toward the posterior one. The cilia are arranged in two rows on a ciliary disc which is attached by one side to the peristome margin. A membranous collar can readily be seen protruding over the edge of the peristome. The zooids may be either erect or drooping, and the pedicle is transversely segmented. The pharynx extends to about the center of the body.

The nucleus is band-like and curved. It is somewhat centrally placed.

The contractile vacuole is single and is located towards the anterior end.

Colonies of these were numerous in collections made in the

Boneyard during the last of February, 1900. They were attached to *Tubifix rivulorum*. They are reported from [illegible] Schewiakoff ('9[illegible]).

78. *Opercularia stenostoma* Stein. Pl. Fig.

Kent ('80-'82) pp. 712-713. Pl. XXXIX, fig. 17.

The body is elongate pear-shaped, with a narrow peristome. The cilia are arranged on a narrow ciliary disc which is attached by one side to the peristome margin. and which fits into the peristome. There is a membranous collar which extends from the peristomal opening, and which can only be made out with difficulty. The mouth extends down into a pharynx which reaches to about the center of the body. There were but four zooids in the colony examined. The pedicle was very short and stout, and the zoids seemed to grow right out from it because the secondary branches were so short.

The nucleus is long and curved like a horse-shoe.

The contractile vacuole is single and is placed to one side, near the peristome margin.

I observed colonies of these but once-- in April, 1899. They each contained four zooids and were attached to the body of *Crangonyx*. It is reported from America only by Schewiakoff ('93), although Stein has found it in Europe.

79. *Sphaerophrya pusilla* Claparede & Lachmann.

Pl. XLVII, Fig. 101, 102.

Kent ('80-'82)p. 108. Pl. XLVI, fig. 6. Butschli ('80-'89) Pl. LXXVI, fig. 10. Plochmann ('95) p. 127.

This is a very small, colorless spherical animal in the adult stage which is free swimming. The "larvae" are elliptcal. The protoplasm is very vacuolate. The adult is provided with numerous slender

rays or tentacles all of which are capitate. Some are very long, while others are only about the length of the long diameter.

There are two peripheral contractile vacuoles.

I oobserved but two free swimming adults. In March, 1900, Urostyla, parasitized by Sphaerophrya, occurred abundantly in an aquarium and embryos of S. pusilla escaped from the bodies in large numbers when the Urostyla were treated with some reagent which caused it to go to pieces. In October, 1899, I observed cysts of S. pusilla. The cysts are queer horned forms with a segmented outer cover, and are stalked and attached by the stalk. A contractile vacuole can be plainly seen about the center of the cyst.

The species occurred in October and November, 1899, and in March, 1900. It is endoparasitic in Urostyla, Paramoecium, Nassula, and Stentor. Schewiakoff ('93) reports it from America and Blochmann ('95) from Europe.

DISCUSSION.

The list includes 79 species, 17 being Rhizopoda, 5, Heliozoa; 25, Flagellata; 2, Dinoflagellata; and 29, Ciliata; and 1, Suctoria. I think the list would be considerably extended in a longer time, and especially in certain groups, since every fresh aquarium examined and every collection made under different conditions contained species not before seen.

It has been very evident that climatic conditions, especially temperature, have much effect on the occurrence of many of the different species of Protozoa. For instance, after heavy rains in the spring, *Stylonychia*, *Urostyla*, and *[illegible]* were more abundant than at any other time. During the heat of midsummer, *Euglena* became so plentiful that it caused a green scum, commonly known as *Euglena* scum to be formed on the surface of the water in many places, particularly where there was no current and where the water was low. This scum also contains *Phacus* in abundance. Then, too, at this time a delicate green film, known as water bloom, was often found on the surface of Crystal Lake where the water was deeper. This film was caused by the little animals and plants collecting at the surface on warm days, and was rich in *Euglena*, *Phacus*, *Mallomonas*, *Coleps*, *Petalomonas*, and *Peridinium*. All of the species found of the family Volvocinae were found during the very hot weather of August and September, 1899. Then, in midwinter, upon collecting under the ice I was very much surprised to find *Euglena* and *Phacus* which had been so richly found in the hot weather, represented here rather abundantly. I also found *Carchesium* and *Opercularia stenostoma* now for the first time, and these with *Zoothamnium* became common in all winter collections. *Vorticell*

and a few others persisted throughout the year.

The Protozoa in the laboratory aquaria varied also. Those in stagnant aquaria differed from those in fresh ones. One species would appear and be abundantly represented for a time, then it would suddenly disappear, sometimes to return and sometimes not. To cite one instance, in April, 1899, Actinophrys sol was very abundant in a sample from one of the aquaria, and the next day not one could be found. Whether this was due to the disturbance of the aquarium caused by taking the sample the first day, to variation in temperature which is hardly possible, or to the growth of something else which ate or killed the actinifers, is a question not easily answered. Neither is it known where they go when a species suddenly disappears from an aquaria in that way.

Following, are two tables: one describing the kind of location in which the species occurred: the other, a table representing the seasonal distribution.

Local Distribution.

Species.	Field	Aquaria	Foul water	Water bloom	Common	Rare	America only
1. Amoeba proteus.	+	+	+		+		
2. " [illegible]	+	+	+		+		
3. " [illegible]	+	+	+		+		
4. P[illegible]		+				+	
[illegible]	+	+				+	+
Biomyxa [illegible]		+				+	
7. [illegible]	+	+			+		
[illegible]	+	+			+		
[illegible]	+	+			+		
[illegible]	+	+			+		
[illegible] reticulata	+				+		
[illegible]	+				+		
[illegible]	+				+		
14 [illegible]	+						
[illegible]		+					
15. " " [illegible]		+					
16 Campascus cornutus.	+						
17 [illegible]	+						
18 [illegible]	+	+			+		
19 [illegible]	+					+	
20 Nuclearia polypodia.	+					+	
21. Heterophrys myriapoda.	+	+					
22 Acanthocystis turfacea.	+						
23. Mastigamoeba simplex.		+					
24 [illegible]			+				
25 [illegible]		+					
26 [illegible]		+					

Local Distribution.

Species.	Field	Aquaria	Foul water	Water bloom	Common	Rare	America only
27 Arthophysa [illegible]		+					
28. [illegible]	+	+		+	+		
29. " [illegible]	+	+		+	+		
30 " [illegible]	+					+	
31 " [illegible]	+	+		+	+		
32 [illegible]	+						
33 " [illegible]	+					+	
34. [illegible]	+	+		+	+		
[illegible]	+			+		+	
[illegible]		+					
37 [illegible]	+	+			+		
[illegible]	+					+	
[illegible]		+					
4[illegible]	+			+		+	
[illegible]	+						
[illegible]	+						
[illegible]	+						
[illegible]	+						+
[illegible]	+						
[illegible]	+						
[illegible]	+						
[illegible]	+						
[illegible]	+						
[illegible]	+						
[illegible]	+						

Local Distribution.

Species.	Field	Aquaria	Foul water	Water bloom.	Common	Rare	America only.
54. Lionotus wrzesniowskii.	+	+			+		
55. [illegible]		+	+			+	
56. [illegible]	+	+	+		+		
57. [illegible]	+					+	
58. [illegible]	+					+	
59. [illegible]							
60. [illegible]	+		+		+		
61. Urocent[illegible]		+					
62. [illegible]			+		+		
63. [illegible]	+	+	+		+		
64. [illegible]	+						
65. [illegible]	+	+					
[illegible]							
[illegible]							
[illegible]							
[illegible]							
70. [illegible]	+						
71. [illegible]	+						
[illegible]	+						
[illegible]	+						
[illegible]	+						
[illegible]							
[illegible]	+						
[illegible]							
[illegible]							
79. [illegible]							

Local Distribution.

Species.		Field	Aquaria	Foul water.	water bloom	Common	Rare	only.
Total	80.	64	47	18	7.	31	19	5
Rhizopoda	18	14	13	3		11	3	1
Heliozoa	5	5	2			2	3	
Flagellata	25	18	12	1	6	5	6	4
Dinoflagellata	2	2			1	'	2	
Ciliata	29	24	19.	14		13	5	
Suctoria	1	1	1					

Discussion of Local Occurrence.

The greatest number of species occurred in field collections, although half of these were common to both field collections and aquaria. 19 species found were rare, 9 never having been found in America before. 5 of the species found have so far been found in America only. 18 occurred in foul water, s[illegible] being found only in foul water. The Rhizopoda occurred about equally in fresh collections and in aquaria and they were not abundant in foul water. Of the 5 Heliozoa found, all occurred in field collections while but 2 occurred in aquaria, and they were absent in foul water. The Flagellata were apt to occur about equally in field collections and in fresh aquaria. Of the 7 Protozoa found in water bloom all were Flagellata, and 4 of the 5 forms occurring in America only, belonged to this group. The Dinoflagellata occurred only in field collections, and one of them has never been reported from America before. The Ciliata occurred abundantly in field collections and in aquaria, and most of the foul water forms were ciliates. The Rhizopoda and the Ciliata, as groups, seem to show less preference for any particular environment than the others.

Seasonal Distribution.

Species.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1. Amoeba proteus.			+			+	+	+	+	+	+	+
2. " [illegible]	+							+				+
3. " [illegible]							+		+			+
4. Pelomyxa [illegible]											+	
5. [illegible]	+			+								
6. [illegible]				+								
7. [illegible]	+											
8. [illegible]	+											
9. [illegible]	+											+
10. " [illegible]						+						+
11. [illegible]	+											
12. [illegible]								+				
13. [illegible]	+											
14. [illegible]	+											
15. [illegible]												
16. [illegible]	+											
16. [illegible]												
17. P[illegible]	+											
18. [illegible]				+								
19. A[illegible]		+										
20. [illegible]												+
21. [illegible]										+		
22. [illegible]	+											
23. [illegible]			+	+								
24. [illegible]												
25. [illegible]												
26. [illegible]												

Seasonal Distribution.

Species.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
27. Anthophora [illegible]			+			+						
28. [illegible]	+	+	+	+	+	+	+	+	+	+	+	+
29. [illegible]						+	+	+	+	+	+	
30. [illegible]									+			
31. [illegible]	+	+	+	+	+	+	+	+		+	+	+
32. [illegible]									+			
33. [illegible]									+			
34. [illegible]												
35. [illegible]									+			
36. [illegible]										+		
37. [illegible]	+	+	+	+	+	+	+	+	+	+		
38. [illegible]												
39. [illegible]											+	
40. [illegible]									+			
41. [illegible]									+			
42. [illegible]												
43. [illegible]												
44. P[illegible]												
45. [illegible]												
46. [illegible]												
47. [illegible]												
48. Pe[illegible]									+			
49. [illegible]									+			
50. [illegible]												
51. [illegible]												
52. [illegible]	+	+	+	+								
53. [illegible]		+	+									

Seasonal Distribution.

Species.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
54. [illegible]	+											+
55. [illegible]			+									
56. Chilodon [illegible]	+	+	+	+	+	+	+	+	+	+	+	+
57. Glaucoma scintillans.	+											
58. Frontonia [illegible]ata	+											
59. Colpidium [illegible]oda.			+	+								
60. Paramoec[illegible]	+	+	+	+	+	+	+	+	+	+	+	+
61. [illegible]											+	
62. [illegible]	+	+		+	+	+		+		+	+	+
63. [illegible]	+			+		+				+		+
64. [illegible]												
65. [illegible]a truncatella.		+							+			
66. [illegible]			+									
67. [illegible]			+									
68. [illegible]	+		+									
69. [illegible]	+	+										
70. E[illegible]							+					
71. Asp[illegible]										+		
72. [illegible]			+							+		
73. Stylo[illegible]	+	+										
74. [illegible]	+											
75. [illegible]	+			+								
76. [illegible]												
77. [illegible]		+										
78. [illegible]												
79. [illegible]												

Seasonal Distribution.

Species		Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Total	80	37	28	31	28	19	20	21	26	29	25	27	25
Rhizopoda	18	15	6	6	8	6	6	6	7	6	6	8	7
Heliozoa	5	3	3	3	2						1	2	4
Flagellata	25	5	5	6	6	4	7	6	12	12	8	7	6
Dinoflagellata	2									2			
Ciliata	29	14	15	16	12	9	7	9	7	8	9	9	8
Suctoria	1			1							1	1	

Discussion of Seasonal Distribution.

The largest number of species reported in any month is 37, the least, 19. The small number found in any single month is probably due to the accidents and limitations of observation. The small number observed during the summer months is doubtless due [to] the same cause. Individual groups, however, show some indication of a seasonal preference: thus the Rhizopoda are most [illegible] January; the Heliozoa are apparently absent during the warm[illegible] months; the Flagellata are more abundant during the [illegible] months of fall; and the Ciliata, during the colder part of the year. The data at my disposal are insufficient for any extended generalizations on the subject of seasonal distribution.

Comparison with other Lists.

The limits of this paper do not permit of an extensive comparison of the list of species occurring here with the lists of other parts of the world. I make but a few to illustrate the similarities and differences of species occuring in different localities.

	Hucke	Hempel	Kofoid	Awerinzeff	Waldo.
Year.	'93.	'94-'98.	'94.	'99. '00	'99-'00.
Locality studied.	Boneyard	Illinois R.	Great Lakes	Russia	Boneyard
Total no. species.	20.	93.	81.	214.	80.
Rhizopoda.		19.	22.	53.	18.
Heliozoa.		4	5	6.	5.
Flagellata.		25.	16.	36.	25.
Dinoflagellata.		3.	4	7.	2.
Ciliata.	20.	36.	32.	32.	29.
Suctoria.		3.	2.	1.	1.

The four lists with which my list is here compared have been made from field collections, without attention having been paid to aquariam collections. I have found out 6 of the species [illegible]

Hucke ('93), who worked in the same stream, reports. This indicates that further work here would largely increase the list. Of Hemple's list, 32 were found in the Boneyard; of Kofoid's 25; and of the long list of Awerinzeff, only 37.

The conclusion is that the Protozoa are largely cosmopolitan. The larger the lists found, the greater is the similarity in different localities. The cosmopolitan distribution is due to the ease with which the germs are carried in dust by the wind.

LITERATURE CITED.

Blochmann, F.

'95. Die Mikroskopische Thierwelt des Susswassers. Th. II, Abth. I: Protozoa. pp. I-XV: 1-134, Pl. I-VIII.

Butschli, O.

'80-'89. Broun's Klassen und Ordnungen des Theirreichs Protozoa. Vols. I, II, and III, 2028 pp. Pl. I-LXXIX.

Carter, H.J.

'71. Note on a Fresh water species of ceratium from the Lake of Nynee (Naini) Tal in Kumaon. Ann.Mag. Nat. Hist., Ser. 4, Vol. VII., pp. 229, 230.

France, Raoul

'96. Beitrage zur Kentniss der Algengatteing Carteria. Termeszetrajzi Fuzetek, XIX Kolet, pp. 105-112. Pl. III.

Goroschankin, J.

'91. Beitrage zur Keuntniss der Morphologie und Systematik der chlamydomonaden. II. Chlamydomonas Reinhardi (Daugeard) une seine Verwandten. Bull. de Moscow, No.1,1891. pp. 1-50, Pl. I, II.

Kofoid, C.A.

'98. Plankton Studies II. Oer Pleordina illinoisensis, a new species from the Plankton of the Illinois River. Bull. Ill. State Läb. Nat. Hist., Vol. V., pp. 273-293, Pl. XXXVI, XXXVII.

Kofoid, C.A.

'99. Plankton Studies III. On Platydorina, a new genus of the family Volvocidae, from the Plankton of the Illinois River. Bull. Ill. State Läb. Nat. Hist., Vol. V., pp. 419-440. Pl. XXXVIII.

Leidy, Joseph.

'79. Fresh-water Rhizopods of North America, pp. I-XI: 1-319, Pl. I-XLVIII.

Penard, E.

'99. Sur la croissance supposee de la coquille chez les Thecamoebiens. Arch. Sci. Phys. et Nat., IV. Per., tome VII., 23 pp.

Shaw, W.R.

'94. Pleodorina, a new Genus of the Volvocinae. Bot. Gaz., Vol. XIX., pp. 279-283, Pl. XXVII.

Saville-Kent.

'80-'82. Manual of the Infusoria. Vols. I, II, III, pp. I-X: 1-913, Pl. I-LI London.

Schaudinn, Fritz.

'96. Das Tier reich, Heliozoa. 24pp.

Schewiakoff, W.L.

'93. Uber die Geographische Verbreitung der Susswasser- Protozoen, Mem. l'Acad. Imp. des Sci. de St. Petersbourg, VII. Ser. T. XLI., no. 3. 201pp., Pl. I-IV.

Stokes, Alfred C.

'88. A Preliminary Contribution toward a History of the Fresh-water Infusoria of the United States, Jour. Trenton Nat. Hist. Soc. Vol. I, no. 3, pp. 71-319, Pl. I-XIII.

Stein, F.R.

'59-'78. Der Organismus der Infusionsthiere nach Eigenen Forschungen in Systematischer Reihenfolge Bearbeitet. Abth. 1,2.3. pp. I-X; I-206, Taf. I-XIV: I-VIII: 1-355, Taf. I-XVI: I-X: 1-154, Taf. I-XXV. Leipzig.

Zumstein, Hans.

'99. Zur Morphologie und Physiologie der _Euglena gracilis_ Klebs.

Inaugural-Dissertation, Basel. 1899. 50pp., Taf. VI. (Jahrb. f. wiss. Bot. Bd. XXXIV.).

Awerinzeff, S.

'99. Zur Zenntniss der Protozoen-fauna in der Umgebung von Bologoje. Travaux de la Soc. Imp. des Nat. de St. Petersbourg, vol. XXX., Livr. 1, pp. 213-251; 262-264.

Hempel, A.

'98. A List of the Protozoa and Rotifera found in the Illinois River and adjacent lakes at Havana, Illinois. Bull. Ill. State Lab. Nat. Hist., Vol. V., pp. 301-388.

Hucke, P.M.

'93. A Contribution to the Knowledge of the Ciliated Infusoria of Champaign County, Illinois. Thesis for B.S. Degree in Col. of Sci. U. of I., 22pp., XX. Pl.

Kofoid, C.A.

'94. A Report on the Protozoa Observed on Lake Michigan and the Inland Lakes in the Neighborhood of Charlevoix, during the Summer of 1894. Bull. Mich. Fish Com., No. 6, pp. 76-84.

EXPLANATION OF PLATES.

Abbreviations.

a.	amylaceous body.
ad.c.	adoral cilia.
b.	body.
c.	cilia.
c.d.	ciliary disc.
cl.	cluster.
c.p.	conical projection.
col.	collar.
c.s.	caudal spine.
c.st.	caudal style.
c.th.	contractile thread.
c.v.	contractile vacuole.
d.f.	diatom frustule.
ecs.	ectosarc.
ens.	entosarc.
e.gr.	equatorial groove.
f.	food.
fac.	facet.
fl.	flagellum.
gr.	groove.
l.	lorica.
m.	mouth.
man.	macronucleus.
min.	micronucleus.
m.t.	mucilaginous tube.
n.	nucleus.
nk.	neck.
o.gr.	oral groove.
par.	parasites.
pg.	pigment.
pg.s.	pigment spot.
ph.	pharynx.
ph.r.	pharyngeal rods.
p.r.	pseudopodal rays.
ps.	pseudopodia.
p.st.	primary stalk.
pste.	peristome.
p.t.	pseudopodal thread.
r.	ridge.
s.	sarcode.
set.	setae.
sh.	shell.
sht.	sheath.
sp.	spicules.
spi.	spine.
s.st.	secondary stalk.
st.	stalk.
sti.	striations.
t.	tail.
tr.	trichocysts.
u.m.	undulating membrane.
v.	vacuoles.
w.v.	water vacuole.
z.	zooid.

Plate I.

Fig. 1. Amoeba proteus

Fig. 2. Amoeba proteus, same individual a few moments later.

Plate II.

Figs. 3-8. Successive changes in form in Amoeba proteus as seen in 10 minutes.

Plate III.

Fig. 9. Amoeba verrucosa.

Fig. 10. Same showing pseudopodia.

Plate IV.

Figs. 11-17. Successive changes in form in Amoeba verrucosa as seen in 10 minutes.

Plate V.

Fig. 18. Amoeba villosa.

Fig. 19. Amoeba villosa a few moments later.

Plate VI.

Figs. 20-26. Successive changes in form of Amoeba villosa as seen in 10 minutes.

Plate VII.

Fig. 27. Pelomyxa villosa.

Fig. 28. Pelomyxa villosa a few moments later.

Plate VIII.

Fig. 29. Dinamoeba mirabilis.

Plate IX.

Figs. 30-32. Dinamoeba mirabilis, successive stages in the capture of a diatom.

Plate X.

Figs. 33-35. Biomyxa vagans, successive phases.

Plate XI.

Fig. 36. Arcella vulgaris, lateral view.

Fig. 37. Arcella vulgaris, with shell folded.

Plate XII.

Fig. 38. Arcella discoides.

Fig. 39. Difflugia globulosa.

Plate XIII.

Fig. 40. Difflugia pyriformis, lateral view.

Plate XIV.

Fig. 41. Difflugia pyriformis, top view.

Fig. 42. Difflugia priformis, dividing.

Plate XV.

Fig. 43. Difflugia urceolata.

Fig. 44. Difflugia corona.

Plate XVI.

Fig. 45. Difflugia constricta.

Fig. 46. Centropyxis aculeata.

Fig. 47. Centropyxis aculeata var. ecornis.

Plate XVII.

Fig. 48. Campascus cornutus.

Fig. 49. Pamphagus mutabilis.

Plate XVIII.

Fig. 50. Actinophrys sol.

Plate XIX.

Fig. 51. Nuclearia polypodia.

Figs. 52-55. Mastigamoeba simplex, showing alternation of pseudopodia.

Plate XX.

Fig. 56. Heterophrys myriapoda.

Plate XXI.

Fig. 57. Acanthocystis turfacea.

Plate XXII.

Fig. 58. Cercomonas typica.

Fig. 59. Same dividing.

Fig. 60. Stylobryon abbotti.

Plate XXIII.

Fig. 61. Anthophysa vegetans, branching colony.

Fig. 62. Same, detached zooid.

Plate XXIV.

Fig. 63. Anthophysa vegetans, detached cluster.

Plate XXV.

Figs. 64-66. Euglena viridis, showing metabolic changes.

Fig. 67. Euglena spirogyra.

Fig. 68. Euglena oxyuris.

Plate XXVI.

Fig. 69. Euglena acus.

Plate XXVII.

Fig. 70. Trachelomonas hispida.

Fig. 71. Phacus triqueter.

Plate XXVIII.

Fig. 72. Astasia trichophora.

Plate XXIX.

Fig. 73. Petalomonas medicanellata.

Fig. 74. Heteronema acus.

Fig. 75. Mallomonas plosslii.

Plate XXX.

Fig. 76. Anisonema grande.

Plate XXXI.

Fig. 77. Carteria mulitifilis.

Fig. 78. Same, four young individuals in a quadrate plate.

Fig. 79. Platydorina caudata.

Plate XXXII.

Fig. 80. Ceratium kumaonense.

Fig. 81. Coleps hirtus.

Fig. 82. Same, end view.

Plate XXXIII.

Fig. 83. Amphileptus anser.

Plate XXXIV.

Fig. 84. Lionotus wrzesniowskii.

Plate XXXV.

Fig. 85. Nassula rubens.

Plate XXXVI.

Fig. 86. Chilodon cucullulus.

Fig. 87. Colpidium colpoda.

Plate XXXVII.

Fig. 88. Paramoecium caudatum.

Fig. 89. Same, in conjugation.

Plate XXXVIII.

Fig. 90. Pleuronema chrysalis.

Fig. 91. Cyclidium glaucoma.

Plate XXXIX.

Fig. 92. Bursaria truncatella.

Plate XL.

Fig. 93. Stentor polymorphus.

Plate XLI.

Fig. 94. Stentor roeselii.

Plate XLII.

Fig. 95. Halteria grandinella.

Plate XLIII.

Fig. 96. Urostyla grandis.

Fig. 97. Same, parasitized by Spherophrya pusilla.

Plate XLIV.

Fig. 98. Vorticella nebulifera.

Plate XLV.

Fig. 99. Carchesium polypinum, branching colony.

Plate XLVI.

Fig. 100. Carchesium polypinum, cluster of zooids.

Plate XLVII.

Fig. 101. Sphaerophrya pusilla.

Fig. 102. Same, encysting.

112.
Plate I

Plate II.

114.

Plate III.

Plate IV.

116

Plate V

Plate VI.

20. 21 22.

24

23.

25.

26.

Plate VII

Plate VIII

Plate IX.

Plate X.

Plate XI.

Plate XII.

124

Plate XIII.

Plate XIV.

126.

Plate XV.

Plate XVI.

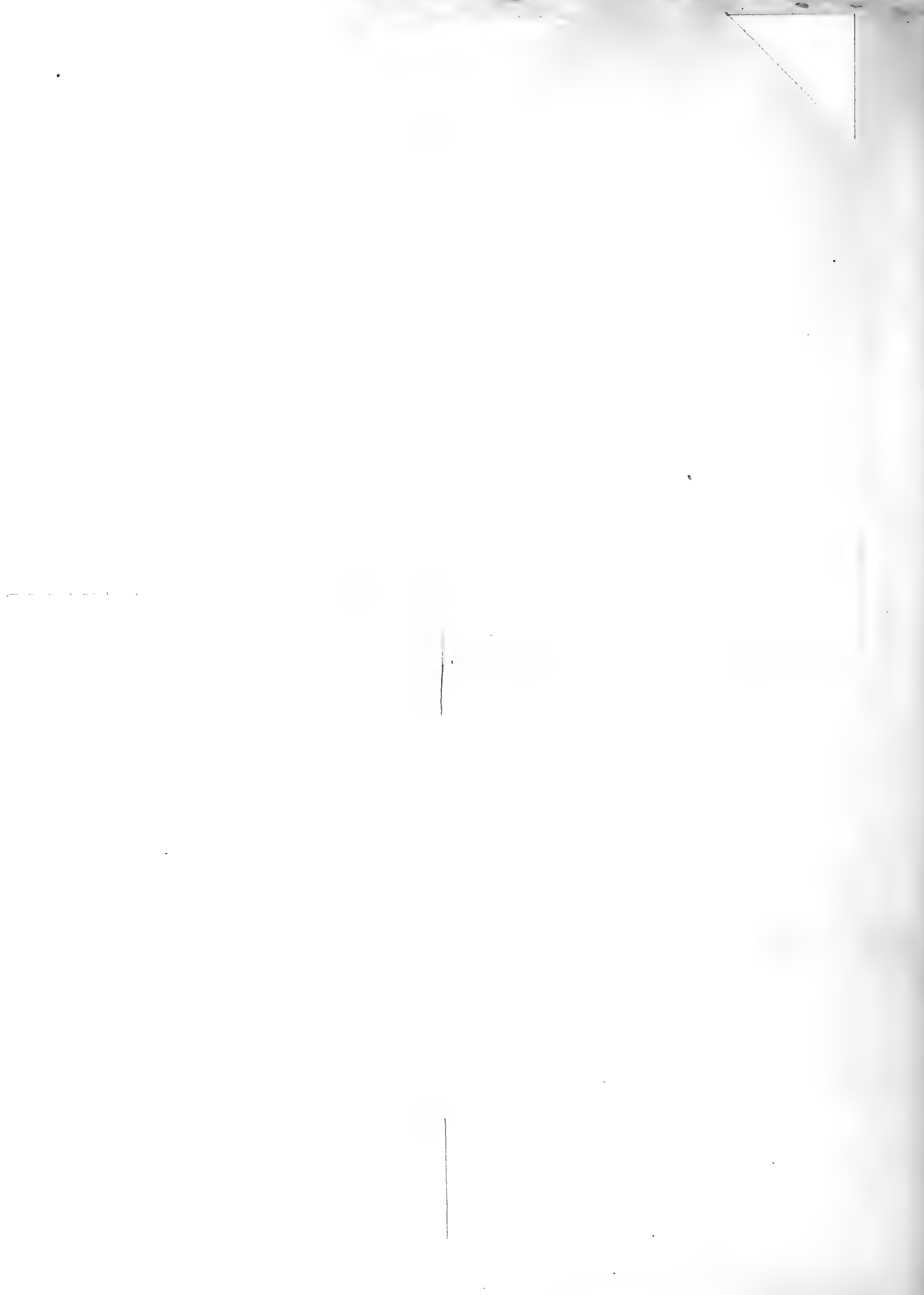
128

Plate XVII.

129

Plate XVIII

Plate XIX.



131.

Plate XX.

Plate XXI.

133.

Plate XXII

Plate XXIII

135.

Plate XXIV.

Plate XXV

Plate XXVI

Plate XXVII.

139.

Plate XXVIII.

Plate XXIX.

247.
Plate XXX.

Plate XXXI.

243.

Plate XXXII.

144.
Plate XXXIII.

145.
Plate XXXIV.

Plate XXXV.

141.
Plate XXXVI.

148.
Plate XXXVII.

149.

Plate XXXVIII.

150.

Plate XXXIX.

Plate XI.

152.

Plate XLI.

153.

Plate XLII.

154.

Plate XLIII.

155.

Plate XLIV.

Plate XLV.

Plate XLVI.

Plate XLVII.