SURFACE PLANKTON PROTOZOA FROM LAKE ERIE IN THE PUT-IN-BAY REGION.

MABEL E. STEHLE
Department of Zoology, Clemson College

CONTENTS.

INTRODUCTION.

The observations recorded in the present paper were made during the summer of 1920, from July 7th to August 1st, at the Lake Laboratory, maintained at Put-in-Bay, Ohio, by Ohio State University. The writer is indebted to Dr. F. H. Krecker for help in selecting and procuring collecting apparatus and to Dr. R. C. Osburn for helpful encouragement.

DESCRIPTION OF THE COLLECTING STATIONS.

Collections were made (1) from the open lake, (2) from Put-in-Bay, in the vicinity of the United States Bureau of Fisheries buildings, from July 7th until July 22 only, and (3) from Terwilliger's Pond throughout the period of study.

In the open lake, the bottom mud was hard. Larger vegetation was absent. The algæ, *Pediastrum*, *Tabellaria* and *Asterionella* were plentiful. Diatoms also occurred in large numbers.

Where collections were made from Fishery Bay, as the second station will be termed, the water was about eight feet deep. The bottom mud was hard. The same algæ and diatoms were present as in the open lake. During the first part of July, the larger vegetation was lacking, but toward the end of the month, a great quantity of eel grass and a small quantity of *Myriophyllum* were present near the Bureau of Fisheries docks.

Terwilliger's Pond is about 100 yards long by 75 yards wide. The average depth is two feet. The bottom was covered with soft mud. *Myriophyllum* and eel grass were abundant.

The former reached the surface in a number of places during the latter part of July. The shore sloped gradually and there were many floating tree trunks in the water and along its edge. The pond was well lighted throughout the day. It was well protected from the wind because the surrounding land was considerably higher and covered with trees. Even when Fishery Bay and the lake were rough, the surface of Terwilliger's Pond was only slightly disturbed.

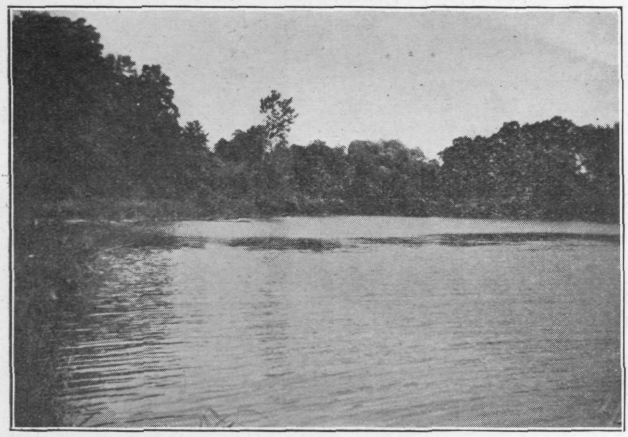

FIG. 1—Terwilliger's Pond

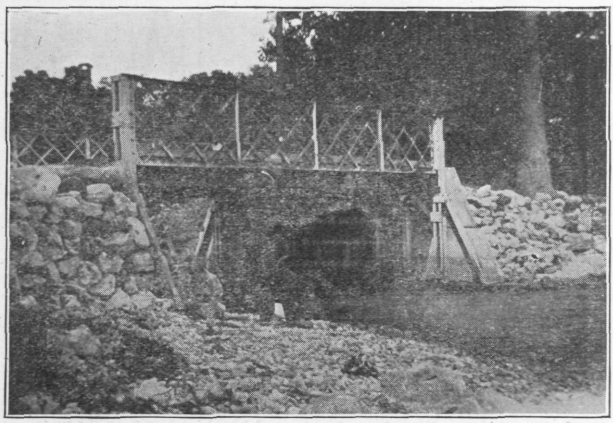

FIG. 2—Entrance to Terwilliger's Pond

At one end, Terwilliger's Pond is connected with Fishery Bay by a channel about fifteen feet wide. The current in this channel reversed every eight to fourteen minutes. These intervals were of longer duration when a large boat came into the bay.

Water snakes, turtles and fish were plentiful in the pond.

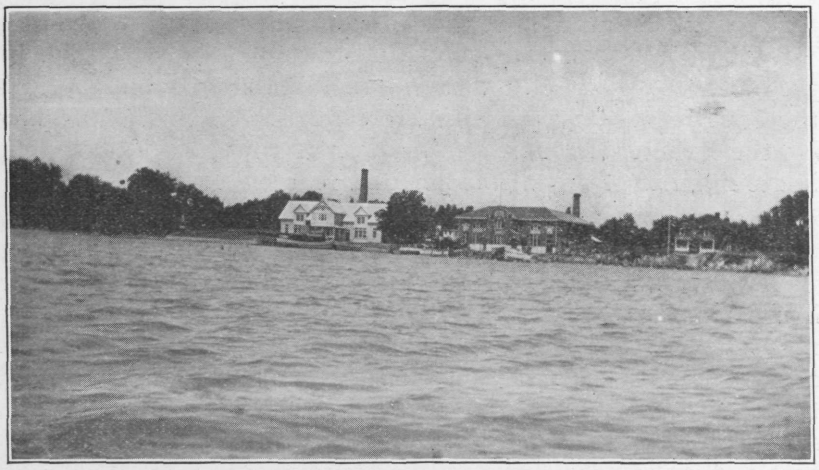

FIG. 3—Fishery Bay

TABLE I.

Shows the Transparancy and Temperature Variations of the Three Stations.

	TEMPERATURE	TRANSPARENCY
Open lake	22—24 degrees	3 ft.—3 ft. 6 in.
Fishery Bay	22—25 degrees	2 ft.—3 ft. 6 in.
Terwilliger's	20—28 degrees	9 in.—17 in.

PLANKTON.

The Protozoa found in the plankton may be separated into two groups; namely, (a) those forms which are large enough to be captured readily with a regular plankton net whose straining surface is made of bolting cloth, and (b) those forms which are so small that they readily pass through the meshes of this bolting cloth. The former constitutes the net plankton and the latter is called the nannoplankton.

Net Plankton Methods.

Identifications were made from the living material only. Twenty-four gallons (approximately one cubic meter) of water from the upper foot, were poured through a silk plankton net and the Protozoa in this amount of tow were counted as follows: one drop of tow was found to be equal to one-tenth of a cubic centimeter. The Protozoa were enumerated by placing a drop (one tenth cubic centimeter) of tow on a slide and, by means of a mechanical stage and compound microscope, the organisms present were counted. This number multiplied by ten gave the equal of one cubic centimeter and this number multiplied by the number of cubic centimeters of tow gave the approximate number of organisms per cubic meter of water.

Nannoplankton Methods.

To determine the number of nannoplankton Protozoa, one-half gallon of the water which had passed through the plankton net, was filtered through hard surface filter paper. The filtered organisms were carefully washed from the paper, the volume of the wash water containing the organisms was taken, and the samples of it were then used for enumeration. Even with the best quality of hard surface filter paper, many individuals must have become embedded in the meshes so firmly that they could not be washed out. The method of counting was the same as that used for the net plankton.

The filter method was a very slow one. Two hours were required to filter one-half gallon of water.

List of Surface Plankton Protozoa.

The forms observed during the brief period of study numbered 66. The greatest number, 59, was listed from Terwilliger's Pond; 23 forms came from Fishery Bay and 18 forms from the open lake.

The Protozoa were distributed as follows among the groups: 27 flagellates, 25 ciliates and 14 rhizopods.

Juday (1921) called attention to the fact that the quantity of plankton is not so large per unit of surface in the shallower water as it is in the deeper water, but the larger bottom population in the former region tends to counterbalance the deficiency when the question of the total production is consid-

ered. The writer did not find this to be so in the case of surface plankton Protozoa. The number of forms from the surface of the shallow pond, Terwilliger's, outnumbered those in Fishery Bay by 36 and those in the open lake by 41. One exception may be cited. The rhizopod, *Difflugia lobostoma* Ehr., was more numerous in surface plankton catches from the open lake and Fishery Bay than it was in the pond.

Rhizopoda.

Actinophrys sol.
Ameboid forms.
Arcella vulgaris.
Centropyxis aculeata.
Cyphoderia ampulla.
Difflugia acuminata.
Difflugia corona.
Difflugia lobostoma.
Difflugia lucida.
Difflugia pyriformis.
Euglypha ciliata.
Heterophrys (?).
Heterophrys myriapoda.
Raphidiophrys viridis.

Mastigophora.

Anthophysa vegetans.
Ceratium longicorne.
Cryptomonas ovata.
Dinobryon sertularia.
Distigma proteus.
Eudorina elegans.
Euglena spp.
Euglena (sp?).
Euglena acus.
Euglena deses.
Euglena spirogyra.
Euglena viridis.
Gonium pectorale.
Pandorina morum.
Peranema trichophora.
Peridinium (sp?).
Peridinium tabulatum.
Phacus longicaudus.
Phacus pyrum.
Phacus triqueter.
Platydorina caudata.
Trachelomonas acuminata.
Trachelomonas armata.
Trachelomonas caudata.
Trachelomonas hispida.
Trachelomonas volvocina.
Volvox aureus.

Ciliata.

Amphileptus anser.
Aspidisca costata.
Blepharisma musculus.
Cinetochilum margaritaceum.
Codonellacratera.
Coleps hirtus.
Colpoda (sp?).
Cyclidium glaucoma.
Dileptus gigus.
Frontonia (sp?).
Frontonia acuminata.
Glaucoma scintilans.
Halteria grandinella.
Holophyra lieberkuhnii.
Loxodes rostrum.
Oxytricha (sp?).
Pleurotricha grandis.
Prorodon armatus.
Rhabdostyla sphaeroides.
Stentor caeruleus.
Trachelius ovum.
Uroleptus piscis.
Vorticella (sp?).
Vorticella brevistyla.
Vorticella microscopica.

RHIZOPODA.

1. *Actinophrys sol* Ehr. Terwilliger's pond. This pond was plentiful in only two tows, one made at night and the other at 9 o'clock in the morning.

2. Ameboid forms were abundant in the open lake and Fishery Bay between July 8 and 16. During the entire month, they occurred spasmodically in very large numbers in the pond. The largest numbers were present in the filter paper catches.

3. *Arcella vulgaris* Ehr. An occasional individual was seen in water from the open lake and Fishery Bay. Small numbers were taken in Terwilliger's pond throughout the latter part of July.

4. *Centropyxis aculeata* Stein. Only a very few were taken at different times at each of the three collecting stations.

5. *Cyphoderia ampulla* Leidy. One individual was identified from Fishery Bay.

6. *Difflugia acuminata* Ehr. One occurred occasionally in Fishery Bay and Terwilliger's Pond.

7. *Difflugia corona* Wallich. This form occurred in small numbers in one collection from the open lake and at almost the same time in one catch in Fishery Bay. It occurred regularly in small numbers in Terwilliger's Pond throughout the period of study.

8. *Difflugia lobostoma* Ehr. Occurred regularly throughout the period of study in considerable numbers from all three stations. The numbers of this species taken from Terwilliger's Pond were somewhat greater than from the other two stations. The most individuals occurred in filter paper catches. Many were seen to conjugate. One of the individuals extruded protoplasm, a large mass of it containing much water. The protoplasm after remaining relatively motionless for a time, became active.

9. *Difflugia lucida* Penard. Plentiful in two tows made in succession at six o'clock in the afternoon and at four o'clock in the morning. Most of them were found in the filter paper catch.

10. *Difflugia pyriformis* Perty. A very few were taken in one tow from Terwilliger's Pond.

11. *Euglypha ciliata* Ehr. Two individuals were recorded from Terwilliger's Pond.

12. *Heterophrys* (?). Numerous in one net tow from Fishery Bay.

13. *Heterophyrys myriapoda* Archer. One was taken in a collection made under the bridge connecting Terwilliger's Pond with Fishery Bay.

14. *Raphididiophrys viridis* Archer. One taken in Fishery Bay.

MASTIGOPHORA.

15. *Anthophysa vegetans* Muller. Numerous in filter paper catches from Terwilliger's Pond.

16. *Ceratium longicorne* Perty. A considerable number in one tow from the open lake. A few individuals in each of three collections from Fishery Bay. An occasional one from Terwilliger's Pond.

17. *Cryptomonas ovata* Ehr. Numerous in one filter paper catch from Terwilliger's Pond. A few others in another catch from the same station.

18. *Dinobryon sertularia* Ehr. A very few in one tow from the open lake. Somewhat more numerous in scattered collections from Terwilliger's Pond.

19. *Distigma proteus* Ehr. One from Terwilliger's Pond.

Eudorina elegans Ehr. Common in all collections from Fishery Bay and the open lake. Abundant at all times from Terwilliger's Pond, but increasing in numbers greatly toward the latter part of July. The greatest number occurred in filter paper catches.

Euglena spp. A few in one tow from Fishery Bay. Very abundant throughout the period of study in Terwilliger's Pond.

Euglena sp (?). A few in one tow from the open lake. Abundant in filter paper collections, fewer numbers in the silk net, in all tows made throughout the period of study.

Euglena acus Ehr. Only a few individuals in scattered collections from Terwilliger's Pond. None recorded during the last few days in July.

Euglena deses Ehr. One specimen from Terwilliger's Pond.

Euglena spirogyra Ehr. One specimen from Fishery Bay. One from the open lake. Frequent in several tows from Terwilliger's Pond.

Euglena viridis Ehr. Frequent in scattered tows from Terwilliger's Pond.

Gonium pectorale Mull. Four colonies recorded from Terwilliger's Pond.

Pandorina morum Bory. Very frequent in two tows made in the open lake and Fishery Bay. Moderately abundant during the first part of July in Terwilliger's Pond. Exceedingly abundant in the same place during the latter part of July. In tows made on July 16, 24 and 26, a very large number of young colonies was noted, after which, the number of this species reached its height on July 27. Young colonies occurred frequently in one tow from Fishery Bay.

Peranema trichophorum Ehr. One specimen from Terwilliger's Pond.

Peridinium sp. (?). Numerous once in surface tow from Terwilliger's Pond on July 28.

Peridinium tabulatum Ehr. An occasional one from the open lake and Fishery Bay. Frequent irregularly during the latter part of July in Terwilliger's Pond.

Phacus longicaudus Ehr. Frequent in two filter paper catches from Terwilliger's Pond.

Phacus pyrum Ehr. Frequent irregularly in Terwilliger's Pond during the first part of July.

Phacus triqueter Ehr. Frequent in Terwilliger's Pond during the latter part of July.

Platydorina caudata Kofoid. A few colonies in all tows from Terwilliger's Pond during the latter part of July.

Trachelomonas acuminata Schmarda. One specimen from Fishery Bay. Numerous in nearly all of the tows from Terwilliger's Pond, increasing greatly in numbers during the latter part of July.

Trachelomonas armata Ehr. A few in three filter paper catches from Terwilliger's Pond.

Trachelomonas caudata Ehr. Three from Terwilliger's Pond.

Trachelomonas hispida Stein. A very few in two tows from Fishery Bay. Abundant during the first part of July in filter apper catches and increasing in numbers past the middle of the month. Decreasing somewhat in number toward the end of July.

Trachelomonas volvocina Ehr. Numerous in two filter paper catches from Terwilliger's Pond.

Volvox aureus Ehr. One colony from the open lake. Numerous colonies throughout the period of study in Terwilliger's Pond. Most of them were taken in the silk net.

CILIATA.

Amphileptus anser Ehr. One specimen taken in Terwilliger's Pond.

Aspidisca costata (Duj). Several in a few tows from Terwilliger's Pond.

Blepharisma musculus Ehr. Synonymous with *Uroleptus musculus* Ehr. of Butschli. A few scattered ones from Terwilliger's Pond.

Cinetochilum margaritaceum (Ehr.) Three recorded from Terwilliger's Pond.

Codonella cratera (Leidy). A few from the open lake during the first two weeks of July. More numerous in tows from Fishery Bay, mostly in filter paper catches. Abundant in Terwilliger's Pond collections. Considerably more numerous in the tows made at night.

Coleps hirtus Ehr. Few in the silk net and numerous in filter paper catches from Terwilliger's Pond. This form occurred more or less spasmodically.

Colpoda sp (?). Frequent in one tow made in the first part of July in Terwilliger's Pond. An occasional individual after that and frequent again during the latter part of July.

Cyclidium glaucoma Ehr. Two from the open lake. Numerous in one filter paper catch from Terwilliger's Pond.

Dileptus gigus C. & L. One from Fishery Bay. One in a night tow from Terwilliger's Pond.

Frontonia sp. (?). A few specimens in a filter paper catch from Terwilliger's Pond.

Frontonia acuminata Ehr. A few in one tow from Terwilliger's Pond.

Glaucoma scintillans Ehr. A few in two tows from the open lake. More frequent in Fishery Bay.

Halteria grandinella O. F. Mull. An occasional individual in Terwilliger's Pond until the latter part of July, when the filter paper catches contained a few more.

Holophrya lieberkuhnii . A few in one Terwilliger's Pond tow.

Loxodes rostrum Ehr. Numerous individuals in one filter paper catch made at night from Terwilliger's Pond, during the first part of July. No more were seen again until the latter part of July when a few were noted from the same place in a night tow.

Oxytricha sp (?). Conn. A few occurred in two collections from Terwilliger's Pond.

Pleurotricha grandis Stein. One specimen in a night tow from Terwilliger's Pond.

Prorodon armatus C. & L. One specimen from Terwilliger's Pond.

Rhabdostyla sphæroides From. One was taken in a tow from Fishery Bay.

Stentor cæruleus Ehr. Frequent in one tow from Fishery Bay.

Trachelius ovum Ehr. A few specimens from Terwilliger's Pond.

Vorticella sp (?). An occasional specimen in night tows from Terwilliger's Pond.

Vorticella brevistyla D'Udk. One from the open lake.

Vorticella convallaria Linn., (Kent). A single specimen was recorded from Terwilliger's Pond.

Vorticella microscopica From. A single specimen occurred in a night tow made in Terwilliger's Pond.

PLANKTON TABLES.

FISHERY BAY Surface Plankton Protozoa Numbers are per cubic meter	Sky black, water very rough. Transp. 3′ 5″ Temp. 22° July 7 9 A. M.		Sky clear, water calm, slight breeze. Temp. 24° July 12 11 P. M.		Bright sunlight, water rippled. Preceding day, heavy rainstorm. Transp. 3′ 5″ Temp. 24° July 15 9 A. M.		Bright sunlight. Preceding day very rough. Transp. 3′ 6″ Temp. 24° July 16 4 P. M.		Heavy clouds, Water rough. Much rain preceding day. Transp. 2′ Temp. 22° July 19 11 A. M.		Bright sunlight, water rippled. Preceding day calm. Transp. 3′ Temp. 24° July 21 11 A. M.	
	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper
Ameboid forms, minute	324000	825600	1200	24000	13200	10200	2040	.....	.....	.....	.....	.....
Arcella vulgaris Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Centropyxis aculeata Stein	30	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cyphoderia ampulla Leidy	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Difflugia acuminata Ehr.	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	11520
Difflugia corona Wallich	.....	.....	.....	.....	.....	.....	120	.....	.....	.....	1	.....
Difflugia lobostoma Ehr	1020	2400	10200	25000	3190	.....	13080	.....	2600	14400	1430	8000
Euglypha ciliata Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Heterophrys (?) developmental forms(?)	.....	.....	.....	.....	.....	.....	120960	.....	.....	.....	.....	.....
Raphidiophrys viridis Archer	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Ceratium longicorne Perty	.....	1	100	100	.....	.....	.....	.....	.....	.....	720	.....
Eudorina elegans Ehr	.....	2400	500	1000	110	.....	1560	.....	.....	.....	.....	3840
Euglena spp.	60	19200	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Euglena spirogyra Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Pandorina morum Bory	.....	.....	.....	9600	.....	.....	2040*	.....	.....	.....	110	19200
Peridinium tabulatum Ehr.	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
Trachelomonas acuminata Schmarda	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Trachelomonas hispida Stein	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	110	.....
Codonella cratera Leidy	60	9600	700	19200	110	.....	120	.....	.....	.....	330	.....
Dileptus gigus C. & L.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Glaucoma scintillans Ehr.	360	4800	500	52800	.....	.....	600	.....	.....	.....	.....	.....
Rhabdostyla sphaeroides From.	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Stentor caeruleus Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	200	.....	.....	.....

* Young colonies

PLANKTON TABLES—Continued.

TERWILLIGER'S POND Surface Plankton Protozoa Numbers per cubic meter	Sky black, water very rough. Transp. 15.5″ Temp. 22.5° July 8 9 A. M.		Sky clear, water calm. Temp. 26° July 12 10 P. M.		Bright sunlight, water disturbed by a stiff breeze. Transp. 9″ Temp. 25° July 15 9 A. M.		Bright sunlight, water calm. Transp. 10″ Temp. 25° July 16 4 P. M.		Sky clouded, preceding day stormy with heavy rains. Water full of silt and disturbed slightly. Transp. 9″ Temp. 22° July 19 11 A. M.	
	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper
Actinophrys sol Ehr.										
Amebold forms, minute.	12000	1300000			235	10000				
Arcella vulgaris Ehr.									280	
Centropyxis aculeata Stein.	33								1	
Difflugia acuminata Ehr.										
Difflugia corona Wallich.			200		1		240		280	
Difflugia lobostoma Ehr.	1100	2600	1700	14400	2492	25000	23040	6000	4060	19400
Difflugia lucida Penard.										
Difflugia pyriformis Perty.							480			
Euglypha ciliata Ehr.									1	
Heterophrys myriapoda Archer.										
Anthophysa vegetans Mull.		13000								
Ceratium longicorne Perty.										
Cryptomonas ovata Ehr.										
Dinobryon sertularia Ehr.								6000	280	
Distigma proteus Ehr.									1	
Eudorina elegans Ehr.	19000	97500	600		4781	20000	2640	24000	1400	36000
Euglena spp.	800	227500					720	48000	4320	771840
Euglena sp. (?)	200	26000	100		8032	300000			5180	28800
Euglena acus Ehr.	33	3250			96					11520
Euglena deses Ehr.										
Euglena spirogyra Ehr.	66	6500			191	2	480		280	51840
Euglena viridis Ehr.	33	3250				1000				
Gonium pectorale Mull.									1	
Pandorina morum Bory.	1300	110500	200		5068	75000	25920	438000	2940	372000
Peranema trichophorum Ehr.										
Peridinium sp. (?)										
Peridinium tabulatum Ehr.										
Phacus longicaudus Ehr.						1000				11520
Phacus pyrum Ehr.		3250							140	11520
Phacus triqueter Ehr.		19500			287				280	66080
Platydorina caudata Kofoid.										
Trachelomonas acuminata Schmarda.	100	58500		15000			720	36000	7980	504000
Trachelomonas armata Ehr.						1000			140	5760
Trachelomonas caudata Ehr.									1	2
Trachelomonas hispida Stein.		39000		1	287	35000	240	18000	140	80640
Trachelomonas volvocina Ehr.										
Volvox aureus Ehr.	3				670	1	960		420	3
Amphileptus anser Ehr.										
Aspidisca costata (Duj.).										1
Blepharisma musculus Ehr.										
Cinetochilum margaritaceum Ehr.								3		
Codonella cratera (Leidy).	200	19500	10300	230000	1912	15000	960	18000	3920	132480
Coleps hirtus Ehr.			800	55000			240		280	149760
Colpoda sp. (?)	400	19500	300							
Cyclidium glaucoma Ehr.				15000						
Dileptus gigus C. & L.				1						
Frontonia sp. (?) Conn.										
Frontonia acuminata Ehr.										
Hatteria grandinella O. F. Mull.						1	1			1
Holophrya lieberkuhnii										
Loxodes rostrum Ehr.										
Oxytricha sp. (?) Conn.										
Pleurotricha grandis Stein.										
Prorodon armatus C. & L.	1									
Trachelius ovum Ehr.										
Vorticella sp. (?)										
Vorticella convallaria Linn.										
Vorticella microscopica From.				1						

PLANKTON TABLES—Continued.

TERWILLIGER'S POND Surface Plankton Protozoa Numbers per cubic meter	Sky clear, water calm. Eel grass surface of pond. Transp. 10″ Temp. 25° July 21 11 A. M.		Bright sunlight, atmosphere hazy, sultry, water rippled. Transp. 9″ Temp. 28° July 23 3 P. M.		Sky with heavy clouds, water rippled. Temp. 25° July 23 10 P. M.		Sky clear, water slightly rippled. Temp. 24° July 24 4 A. M.		Sky clear, a few white clouds. Atmosphere clear. Water rippled. Transp. 18″ Temp. 20.5° July 26 9 A. M.		Sky clear. Water placid. Temp 22° July 26 10 P. M.	
	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper
Actinophrys sol Ehr.	.....	.....	.....	.....	.....	19200	.....	.....	.....	800	.....	.....
Ameboid forms, minute.	1000	.....	.....	33600	.....	.....	.....	.....	.....	.....	.....	.....
Arcella vulgaris Ehr.	1	.....	200	.....	100	.....	.....	.....	.....	.....	.....	.....
Centropyxis aculeata Stein.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Difflugia acuminata Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Difflugia corona Wallich.	1000	.....	400	.....	400	.....	400	.....	.....	.....	600	1
Difflugia lobostoma Ehr.	5000	16500	2600	.....	1400	.....	2000	.....	3400	.....	1000	14400
Difflugia lucida Penard.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Difflugia pyriformis Perty.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Euglypha ciliata Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Heterophrys myriapoda Archer	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Anthophysa vegetans Mull.	.....	22000	.....	4800	.....	9600	.....	.....	.....	.....	.....	.....
Ceratium longicorne Perty.	.....	.....	1	.....	.....	.....	.....	.....	1	.....	1	.....
Cryptomonas ovata Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Dinobryon sertularia Ehr.	.....	1 col.	800	.....	.....	.....	.....	.....	.....	.....	.....	.....
Distigma proteus Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Eudorina elegans Ehr.	4200	27500	13800	67200	3400	28800	87800	28800	14200	129600	2400	139200
Euglena spp.	7800	577500	6400	105600	200	9600	.....	1	4200	307200	1	1
Euglena sp. (?).	6600	49500	7000	4800	1400	.....	.....	.....	400	4800	.....	.....
Euglena acus Ehr.	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Euglena deses Ehr.	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Euglena spirogyra Ehr.	.....	.....	.....	.....	.....	.....	1	.....	600	9600	.....	.....
Euglena viridis Ehr.	1800	16500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gonium pectorale Mull.	.....	.....	2	1	.....	.....	.....	.....	.....	.....	.....	.....
Pandorina morum Bory.	3200	275000	7600	86400	1200	48000	117800	76800	17800	129600	2400	158400
Peranema trichophorum Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Peridinium sp. (?).	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Peridinium tabulatum Ehr.	.....	.....	.....	1	.....	.....	.....	.....	.....	800	.....	.....
Phacus longicaudus Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	1	1	.....	.....
Phacus pyrum Ehr.	.....	5500	.....	4800	.....	.....	.....	.....	.....	.....	.....	.....
Phacus triqueter Ehr.	.....	5500	.....	4800	.....	.....	.....	.....	200	.....	.....	.....
Platydorina caudata Kofoid.	.....	.....	.....	.....	.....	.....	.....	.....	200	1	.....	.....
Trachelomonas acuminata Schmarda.	3600	77000	9800	33600	.....	9600	.....	.....	5200	100800	400	.....
Trachelomonas armata Ehr.	.....	61000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Trachelomonas caudata Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Trachelomonas hispida Stein.	2000	181500	600	4800	200	.....	.....	.....	200	4800	.....	960
Trachelomonas volvocina Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Volvox aureus Ehr.	6	.....	1600	.....	1200	.....	800	.....	800	.....	400	9
Amphileptus anser Ehr.	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aspidisca costata (Duj.).	.....	.....	1	.....	200	.....	.....	9600	.....	.....	.....	336
Blepharisma musculus Ehr.	.....	1	.....	.....	.....	.....	.....	96	.....	.....	.....	.....
Cinetoc hilummargaritaceum (E)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Codonella cratera (Leidy).	5400	11000	3000	4800	4800	28800	9000	76800	4200	43200	1000	72000
Coleps hirtus Ehr.	.....	.....	400	4800	400	.....	800	9600	.....	1	.....	.....
Colpoda sp. (?).	.....	1	.....	1	.....	9600	200	9600	.....	.....	.....	.....
Cyclidium glaucoma Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Dileptus gigus C. & L.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Frontonia sp. (?) Conn.	.....	.....	200	.....	.....	.....	.....	.....	.....	.....	.....	.....
Frontonia acuminata Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hatteria grandinella O. F. Mull.	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
Holophrya lieberkuhnii.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Loxodes rostrum Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	200	144
Oxytricha sp. (?) Conn.	.....	.....	.....	.....	.....	96	.....	.....	.....	.....	.....	.....
Pleurotricha grandis Stein.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Prorodon armatus C. & L.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Trachelius ovum Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....
Vorticella sp. (?).	.....	.....	.....	.....	.....	1	.....	1	.....	.....	.....	528
Vorticella convallaria Linn.	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....
Vorticella microscopica From.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

PLANKTON TABLES—Continued.

TERWILLIGER'S POND Surface Plankton Protozoa Numbers per cubic meter	Sky clear, water placid. Rays of sun not yet striking pond. Transp. 16″ Temp. 20.5° July 27 5:30 A. M.		Sun shining through white clouds. Atmosphere hazy. Transp. 16″ Temp. 24° July 28 11:30 A. M.		Sky with light clouds. Atmosphere hazy. Water placid. Transp. 17″ Temp. 26° July 28 6 P. M.		Sky clear, water undisturbed Temp. 24° July 29 4 A. M.		Sky clear, water slightly rippled. **Under bridge.** Current going out of pond. Transp. 16″ Temp. 23° July 30 10 A. M.		**Under bridge.** Current entering pond. July 30 10 A. M.	
	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper
Actinophrys sol Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ameboid forms, minute.	.....	.....	.....	.....	.....	96000	150	.....	.....	.....	.....	.....
Arcella vulgaris Ehr.	.....	.....	.....	.....	.....	.....	300	.....	39	.....	.....	.....
Centropyxis aculeata Stein.	.....	.....	.....	.....	.....	.....	225	.....	.....	.....	30	.....
Difflugia acuminata Ehr.	.....	.....	.....	.....	.....	.....	2	1	.....	.....	.....	.....
Difflugia corona Wallich.	400	.....	.....	.....	120	.....	300	.....	52	.....	120	.....
Difflugia lobostoma Ehr.	400	144	400	.....	5520	48	1800	96	1300	.....	1800	48
Difflugia lucida Penard.	.....	.....	.....	.....	2000	14400	525	10560	.....	.....	.....	.....
Difflugia pyriformis Perty.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Euglypha ciliata Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Heterophrys myriapoda Archer	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....
Anthophysa vegetans Mull.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Ceratium longicorne Perty.	.....	.....	.....	.....	.....	.....	1	.....	2	1	.....	.....
Cryptomonas ovata Ehr.	.....	.....	50	38400	120	.....	.....	.....	.....	.....	.....	.....
Dinobryon sertularia Ehr.	1	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....
Distigma proteus Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Eudorina elegans Ehr.	400	144	400	.....	5520	48	1800	96	1300	.....	1800	48
Euglena spp.	1	192	1000	7680	4000	388800	225	.....	260	28800	180	17280
Euglena sp. (?)	.....	.....	.....	.....	.....	48	.....	.....	.....	.....	.....	.....
Euglena acus Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Euglena deses Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Euglena spirogyra Ehr.	1	1	.....	.....	.....	.....	.....	.....	1	.....	.....	.....
Euglena viridis Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gonium pectorale Mull.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pandorina morum Bory.	15400	1103600	1600	48000	1800	940800	3300	227040	910	64900	480	30240
Peranema trichophorum Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Peridinium sp. (?)	.....	.....	.....	.....	1080	38400	.....	.....	.....	.....	.....	.....
Peridinium tabulatum Ehr.	.....	.....	200	9600	.....	.....	.....	.....	.....	.....	.....	.....
Phacus longicaudus Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Phacus pyrum Ehr.	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Phacus triqueter Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Platydorina caudata Kofoid.	.....	.....	20	.....	400	96	150	48	65	.....	.....	.....
Trachelomonas acuminata Schmarda.	800	19200	800	38400	.....	.....	150	.....	130	21600	.....	.....
Trachelomonas armata Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Trachelomonas caudata Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Trachelomonas hispida Stein.	200	9600	1000	43200	120	24000	150	.....	.....	48	.....	.....
Trachelomonas volvocina Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Volvox aureus Ehr.	600	.....	400	.....	1320	.....	75	.....	.....	.....	1	.....
Amphileptus anser Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aspidisca costata (Duj.)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Blepharisma musculus Ehr.	.....	.....	25	1	120	.....	.....	.....	1	.....	.....	.....
Cinetochilum margaritaceum (E)	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Codonella cratera (Leidy)	2200	38400	1600	14400	3600	192	5400	26400	130	.....	600	.....
Coleps hirtus Ehr.	.....	.....	.....	.....	.....	48	.....	.....	.....	.....	.....	.....
Colpoda sp. (?)	.....	.....	.....	.....	.....	624	150	.....	.....	.....	.....	.....
Cyclidium glaucoma Ehr.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Dileptus gigus C. & L.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Frontonia sp. (?) Conn.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Frontonia acuminata Ehr.	.....	.....	.....	.....	.....	100	.....	.....	.....	.....	.....	.....
Hatteria grandinella O. F. Mull.	.....	.....	.....	.....	.....	1776	.....	96	.....	48	.....	.....
Holophrya lieberkuhnii.	.....	.....	.....	.....	.....	144	.....	.....	.....	.....	.....	.....
Loxodes rostrum Ehr.	.....	.....	.....	.....	.....	.....	.....	48	.....	.....	.....	.....
Oxytricha sp. (?) Conn.	.....	.....	.....	.....	.....	.....	.....	.....	.....	48	.....	.....
Pleurotricha grandis Stein.	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
Prorodon armatus C. & L.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Trachelius ovum Ehr.	.....	.....	.....	.....	.....	96	.....	.....	.....	.....	.....	.....
Vorticella sp. (?)	.....	.....	1	.....	.....	48	.....	1	3	.....	.....	1
Vorticella convallaria Linn.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Vorticella microscopica From.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

PLANKTON TABLES—Continued.

OPEN LAKE Surface Plankton Protozoa Numbers are per cubic meter	Sky black, water very rough. Transp. 3′ 5″ Temp. 22° July 7 8 A. M.		Sky clear, water calm, very slight breeze. Temp. 23° July 12 10:30 P. M.		Bright sunlight, water very rough. Transp. 3′ 5″ Temp. 23° July 15 9 A. M.		Bright sunlight, water very calm. Transp. 3′ 6″ Temp. 23° July 16 4 P. M.		Bright sunlight, long rolling Waves. Transp. 3′ Temp. 24° July 21 11 A. M.	
	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper	Silk Net	Filter Paper
Ameboid forms, minute	Abdt.	Abdt.	6000	.....	3000	145000	.....	.....	.....	.....
Arcella vulgaris Ehr.	.....	.....	1	.....	1	.....	.....	.....	.....	.....
Centropyxis aculeata Stein	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Difflugia corona Wallich	.....	.....	.....	.....	100	.....	.....	.....	.....	.....
Difflugia lobostoma Ehr	1120	24000	5200	.....	2700	15000	4060	.....	1200	6720
Ceratium longicorne Perty	70	1440	.....	.....	.....	.....	.....	.....	.....	.....
Dinobryon sertularia Ehr	6	.....	.....	.....	.....	.....	.....	.....	.....	.....
Eudorina elegans Ehr	210	14400	900	.....	.....	35000	960	.....	480	3360
Euglena sp. (?)	.....	6240	.....	.....	.....	.....	.....	.....	.....	.....
Euglena spirogyra Ehr	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Pandorina morum Bory	.....	2880	.....	.....	.....	.....	.....	.....	.....	20160
Peridinium tabulatum Ehr	.....	.....	.....	.....	2	.....	240	.....	.....	.....
Phacus pyrum Ehr	1	.....	.....	.....	.....	.....	.....	.....	.....	.....
Volvox aureus Ehr	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Codonella cratera (Leidy)	18	2880	100	.....	100	.....	240	.....	.....	.....
Cyclidium glaucoma Ehr	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
Glaucoma scintillans Ehr	.....	.....	300	.....	100	35000	.....	.....	.....	.....
Vorticella brevistyla D'Udk.	1	.....	.....	.....	.....	.....	.....	.....	.....	.....

OBSERVATIONS ON THE DIURNAL MIGRATION OF THE SURFACE PLANKTON PROTOZOA.

It is interesting to note that in the tow made at 10 P. M., July 12, at 11 P. M., July 23, at 4 A. M., July 29, and at 10 P. M., July 30, the predominating Protozoa were rhizopods and ciliates, in other words, they were mostly holozoic forms. A few colonial flagellates that were so abundant in the water during the day time were present only in small numbers in the night tow.

The ciliates, *Codonella cratera* (Leidy) and *Coleps hirtus* Ehr., occurred much more abundantly in night tows than in tows made during the day time.

I believe that it can be said that the chlorophyll bearing forms were present in greatest numbers at the surface between three and five o'clock in the afternoon.

It may be noted that in the collections made under the bridge connecting Terwilliger's Pond and Fishery Bay, the tow made while the water flowed out of the pond contained more than twice as many protozoan organisms as the tow made while the current flowed from Fishery Bay into the pond.

LITERATURE CONSULTED.

BIRGE, EDWARD A. and JUDAY, CHANCEY.
1921. Further Limnological Observations on the Finger Lakes of New York. Bulletin of the Bureau of Fisheries, Vol. 37.

BLOCHMANN, F.
1895. Die Mikroskopische Thierwelt des Susswassers. Abtheilung I; Protozoa. Hamburg.

BUTCHLI, O.
1883. Protozoa. In Bronns Klassen and Ordnungen des Thierreichs, Vol. I, Pt. 1–3. Leipzig.

CALKINS, G. N.
1901. The Protozoa, New York.
1909. Protozoology. New York.

CASH, J., and HOPKINSON, J.
1905–1909. The British Fresh-water Rhizopoda and Heliozoa. 2 parts. Ray Society, Vol. 75.

CONN, H. W.
1905 A Preliminary Report on the Protozoa of the Fresh-waters of Connecticut. State Geol. and Nat. Hist. Survey, Bull. 2.

JUDAY, CHANCEY.
1904. The Diurnal Movement of Plankton Crustacea. Trans. Wis. Acad. Sci. Arts. and Letters, 14:534–568, 2 Figs.
1915. Limnological Studies of Some Lakes in Central America. Trans. Wis. Acad., Vol. 18, Part I.
1916. Limnological Apparatus. Trans. Wis. Acad., 18:566–592, 5 Pl.

KENT, S.
1880–1882. A Manual of the Protozoa. 3 Vols. London.

KOFOID, C. A.
1897. Plankton Studies. I. Methods and Apparatus in use in Plankton Investigations at the Biological Experiment Station of the University of Illinois. Bull. Ill. Lab. Nat. Hist., 5:1–25, 7 Pl.
1903. Plankton of the Illinois River. 1894–1899. I, II, Bull. Ill. State Lab. Nat. Hist., 6:95–629, 50 Pl.; 8:1–360, 5 Pl.

LANDACRE, F. L.
1908. Protozoa of Sandusky Bay and Vicinity. Ohio Acad. Sci., 4:421–472.

LEIDY, JOS.
1879. Fresh-water Rhizopods of North America. U. S. Geol. Surv. Territ., Vol. 12; 324 pp., 48 Pl.

NEEDHAM, J. G. and LLOYD, J. T.
1915. The Life of Inland Waters. Ithaca. 438 pp., 244 Figs.

SHELFORD, V. E.
1913. Animal Communities in Temperate America. Chicago. 362 pp., 306 Figs.

STOKES, A. C.
1888. A Preliminary Contribution toward a History of the Fresh-water Protozoa of the U. S. Journ. of the Trenton Nat. Hist. Soc. I.

WALTON, L. B.
1915. A Review of the Described Species of the Order Euglenoidina Bloch. Ohio Biol. Survey, Bull. 4.

WARD, HENRY B.
1896. A Biological Examination of Lake Michigan in the Traverse Bay Region. Bull. of the Michigan, Fish Commission. No. 6.

WARD, HENRY B. and WHIPPLE, GEORGE C.
1918. Fresh-water Biology.