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The Plankton of Some Sink Hole Ponds in Southern Illinois

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THE PLANKTON OF SOME SINK HOLE PONDS IN SOUTHERN ILLINOIS

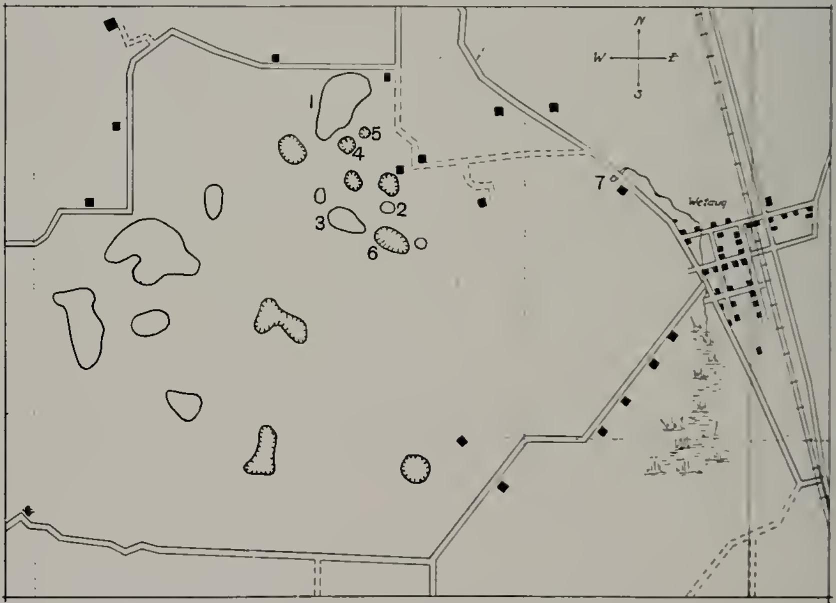
Samuel Eddy

Sink holes are abundant in various parts of Illinois, especially in the extreme southern portion of the state. Their circular or oval funnels are common in areas underlain with limestone. The general conception of their origin is that water moving through the limestone dissolves away part of it so as to form underground chambers, the roofs of which settle and cause surface depressions that become filled with water draining from the surrounding land. Cummings (1905) advanced the idea that the majority of sink holes, particularly those of southern Indiana, were only enlarged funnels produced by the penetration of surface waters into the limestone, and according to this idea such bodies of water have been referred to sometimes as "solution ponds." The sink holes studied in this paper, however, were probably produced by the first method, which is the more generally accepted among geologists.

All such sinks originally have no other drainage than a vertical pit in the center extending to the subterranean outlet. The younger sinks are usually small and deep with steep sides extending to the pit. In the older sinks drainage from the pit is obstructed by falling rocks and eroded soil, so that the water accumulates to form a pond, though drainage is frequently maintained to some extent through the pit. As a result of further erosion of the sides and deposition of the silt washed in after each rain, the pond gradually fills and becomes only a low place containing water in wet seasons.

The water from these sinks is generally considered as a source of supply to underground streams and springs. Kofoid (1899) states that the sink holes in the vicinity of Mammoth Cave, Kentucky, supply the water for the cave streams and the surrounding surface springs. All of the twenty organisms that he found in the water of Echo River in Mammoth Cave seemed to be characteristic of the surface waters and to originate from ponds in connected sink holes. Plankton organisms were rare in Echo River, and only six of those found were true pond forms. Scott (1909) found that the underground streams in the vicinity of Shawnee Cave in southern Indiana were similarly fed by water from sink holes and that the plankton of these streams originated in the ponds on the surface. Scott (1911) observed the fauna of a sink hole pond in southern Indiana over a period of several years and reported a faunal list containing a few plankton organisms.

A study of the plankton of such ponds is of interest because of the additional information thus obtained regarding pond organisms and because of the possibilities of their relation to cave fauna. Also, as the ponds may be the sources of the large springs for which these regions are noted and often popular, the contents of their waters are important as possible sources of pollution.



Sketch map showing location of ponds (1-6) and spring (7). Scale: 2½ inches equals 1 mile.

The ponds studied by the writer are located three-fourths of a mile northwest of Wetaug, Illinois, on the farm of Mr. R. Wiard in Pulaski County. The Lower Mississippian limestone which underlies this region contains many caves, and the numbers of its subterranean passages are indicated by the numbers of springs in the valleys. More than a dozen large sinks filled with water and many others small and empty are to be found within a radius of one-half mile from the ponds studied. The larger sinks contain water at all seasons of the year. During the rainy seasons the level rises a few feet but soon drops to normal.

PERENNIAL PONDS

Three perennial ponds of different sizes were selected for study. They are indicated by the numbers 1, 2, and 3 on the accompanying map. Mr. Wiard stated that by probing through the ice he had found a pit in the center of each. The largest pond (No. 1), located one-eighth mile north of Mr. Wiard's house, is probably the oldest of the group studied. The sides have eroded, enlarging the boundaries of the pond until it covers about five acres, and the deposition of the eroded clay has filled the bottom so that it slopes very gradually to a depth of 20 feet in the center. No vegetation is apparent except a few small willows. The next largest pond (No. 2), about 150 feet in diameter, lies about 300 feet south of the house. Clay has washed in until the bottom slopes gradually to a depth of about 20 feet in the center. There is no vegetation about this pond. The smallest and deepest, and therefore youngest, pond (No. 3) lies southwest of the house. It is about 75 feet in diameter with a steep mud bottom sloping to a reported depth of about 40 feet. Half of this pond is shaded by oak trees on the west bank.

Silk-net collections were made from Pond No. 1 on April 17, 1927, and again on April 16, 1928. In these preliminary collections the following forms were found:

Lysigonium varians (Ag.) D. T.............occasional
Synedra ulna (Nitz.) Ehr..................occasional
Coelosphaerium kuetzingianum Näg.........rare
Spirogyra spp. ....common
Netrium digitus (Ehr.) Itz. & Roth.........very abundant
Closterium acerosum (Schrank) Ehr........very abundant
Pleurotaenium sp. ....common
Micrasterias americana (Ehr.) ....common
Difflugia urceolata Carter..................occasional
Difflugia globulosa Duj.....................occasional
Dinobryon sertularia Ehr..................common
Eudorina elegans Ehr......................common
Volvox globator Leeuwenhoek..............common
Rotaria neptunia (Ehr.) ....rare
Conochiloides dossuarius (Hudson)..........occasional
Polyarthra trigla Ehr......................common
Trichocerca multicrinis (Kellicott).........common
Lecane ungulata (Gosse)...................occasional
Keratella cochlearis (Gosse) ....abundant
Notholca longispina (Kellicott).............rare
Diaphanosoma brachyurum (Liéven)........occasional
Bosmina longirostris (O. F. M.)............abundant
Alona sp. ....rare
Chydorus sphaericus (O. F. M.)............common
Diaptomus mississippiensis Marsh ....common
Cyclops bicuspidatus Claus ....abundant
Copepods (immature) ....common

Table IV shows the results obtained from collections made from Ponds Nos. 1, 2, and 3 in July, September, and December, 1928, and in April, 1929. Usually filter-paper collections were made simultaneously with the silk-net collections and used to furnish data on the smaller planktonts. The abundance of the organisms was determined by the usual counting method in a Sedgwick-Rafter slide.

Some of the chemical conditions of the ponds were determined in an effort to find any differentiating factors which might influence plankton distribution. Water samples collected December 1, 1928, were submitted to the Illinois State Water Survey for determination of the chlorine in chlorides and of alkalinity; determinations of the dissolved oxygen content were made September 12 and December 1, 1928; and temperature and pH readings were taken on several occasions (Table I). From these limited data on chemical and physical conditions, there seems to be little difference in the waters of the various ponds. Some variations occur, but they are not as great as those often found between two streams with the same type of fauna. The dissolved salt content is partially indicated by the determination of the chlorine in chlorides. This factor was negligible in Ponds No. 2 and No. 3 but quite noticeable in Pond No. 1. It is obvious that the origin of the dissolved salts is in the soil washed by the water draining into the ponds, since the only apparent source of the water of the ponds is rain water from the surrounding basins or slopes. Pond No. 1 not only occupies a larger area but has a much larger drainage basin in proportion than the other ponds studied. Consequently, as the water of this pond was subject to more soil wash, it would be expected to have a greater dissolved salt content.

TABLE I

PHYSICAL AND CHEMICAL DATA ON PONDS NOS. 1, 2, AND 3

Date 1928	Determination	No. 1	No. 2	No. 3
Dec. 1	Chlorine in chlorides, p. p. m.	16	0	1
Dec. 1	Alkalinity, phenolphthalein, p. p. m.	0	0	0
Dec. 1	Alkalinity, methyl orange, p. p. m.	24	10	10
July 20	Temperature, C.	29	29	28
Sept. 2	Temperature, C.	26	26	26
Dec. 1	Temperature, C.	9	9	9
July 20	Hydrogen ion concentration, pH	6.6	6.6	6.8
Sept. 3	Hydrogen ion concentration, pH	7.1	7.6	7.4
Sept. 3	Dissolved oxygen, cc. per liter	4.443	4.998	3.605
Dec. 1	Dissolved oxygen, cc. per liter	6.424	6.118	5.659

These three ponds contained a rich plankton. Many more species were found than were recorded by Scott (1911). A total of 128 species was found in the plankton of the three ponds. With slight differences in the lists, 81 species occurred in the north pond (No. 1) the same number in the south pond (No. 2), while the southwest pond (No. 3) had 90 species (Table II). As far as volume was concerned, there was little difference between the total amount of plankton in each pond. The silk-net collections for July and September averaged 18 cc. per cubic meter, and the filter-paper collections for the same dates averaged 183 cc. per cubic meter. The species which were common to all the ponds usually were those which were abundant in each. The exceptions to this will be discussed later. There were no greater differences in species or in their abundance in the collections of the same date from the three ponds than often occur in collections made simultaneously at short distances from each other in the same pond or stream. Thirty-seven species were common to the three ponds, and there may have been others which were overlooked because of small numbers. All of these were species characteristic of pond plankton. The most abundant were *Trachelomonas volvocina*, *Peridinium cinctum*, *Codonella cratera*, *Polyarthra trigla*, *Keratella cochlearis*, *Bosmina longirostris*, *Cyclops viridis*, and *Cyclops bicuspidatus*. These are cosmopolitan forms, commonly found in nearly all bodies of fresh water. The plankton thus was characterized by the presence of certain species abundantly distributed in all the ponds and by the absence or scarcity of other species.

TABLE II

NUMBERS OF SPECIES FOUND IN PONDS NOS. 1, 2, AND 3

Organisms	No. 1	No. 2	No. 3
Algae	33	30	31
Protozoa	21	16	25
Nematoda	0	1	1
Rotatoria	17	20	20
Cladocera	5	9	9
Copepoda	4	3	4
Ostracoda	0	1	0
Insecta	1	1	0
Total	81	81	90

Diatoms, usually so abundant in pond and stream plankton, were noticeably rare. *Synedra ulna* was the only diatom found in all the ponds. *Synedra tenuissima* and species of *Fragilaria* and *Lysigonium*, usually found in bodies of fresh water, were either absent or relatively scarce. Pearsall (1923) has noted that a lack of essential mineral elements may be responsible for the decreased diatom population in the plankton of ponds, and that an increase in mineral content usually occurred after rains and was accompanied by an increase in diatoms. It is interesting to note that two common species of the typical plankton genus *Lysigonium* occurred in Pond No. 1, which was the only pond with an appreciable dissolved salt content as indicated by the determination of the chlorine in chlorides, and bottom diatoms were particularly abundant in the small temporary pools occupying the basins of the filled sinks, where the water was generally greatly reduced by evaporation and it is possible that the dissolved salt content may have been rather large.

Algae, especially the blue-green forms, were usually abundant. In July and September, Ponds No. 1 and No. 2 contained a rich population of blue-greens. Pond No. 3, which was deeper and ecologically younger, did not have these forms in any abundance. *Coelosphaerium naegelianum, Anabaena planktonica*, and *A. spiroides* formed a bloom on the first two ponds in July and September. The total number of species of algae found in the three ponds was 52.

The common phytoplanktonts of the genera *Scenedesmus* and *Pediastrum* were never as abundant as in rivers and in ponds generally.

Most of the species of rotifers are those which are quite common in rivers and ponds generally, but several were noted which were characteristic of these sinks. *Trichocerca multicrinis* occurred in all the ponds but was much more abundant in the north pond (No. 1) most of the time. Although occasionally found elsewhere in Illinois, this species does not usually occur as abundantly or as uniformly as it did here. It was seldom absent from a collection and was always abundant in one or more of the ponds.

Rotifers of the genus *Synchaeta* were entirely absent, and those of the genus *Brachionus* were very scarce with the exception of *Brachionus patulus*, which is hardly a typical species. Both of these genera usually form a characteristic part of the plankton of ponds and large rivers, and their scarcity here constitutes a negative character of the plankton. This may be due in part to a lack of necessary mineral elements or to a slight temporary acidity of the water (Harring and Myers, 1928). As collections were made from three ponds, it is hardly possible that these rotifers could have been abundant in any pond between the dates of collections. In many southern waters in the State of Mississippi, in Reelfoot Lake in Tennessee (Eddy, 1930), and in the floodplain lakes a few miles to the south of the sink holes under discussion, the writer has found most species of the genus *Brachionus* to be rare. In many ponds and lakes in the central part of Illinois and in the Illinois and Rock rivers, these forms are very abundant and often are characteristic of the plankton. Information on the geographical distribution of these circum-polar and supposedly cosmopolitan rotifers is not sufficient to establish their range definitely, but their rarity in southern collections makes it seem possible that they have a southern limit.

Thirty-one species of Protozoa were found in the three ponds. The common pond types, such as *Ceratium hirundinella* and *Codonella cratera*, were well distributed. The plankton was further characterized by the rather unusual abundance of various species of *Trachelomonas* and of *Peridinium cinctum*. *Trachelomonas volvocina* was abundant at all times. An unusually interesting form was found in *Trachelomonas magdaleniana*, which was described by Deflandre (1926) from a single specimen from Venezuela, but never reported, as far as is known, from any other place. This species was found commonly in Ponds No. 2 and No. 3 in the summer of 1928, and in various other waters of the southern part of Illinois during the same season.

Copepods were very common. *Cyclops viridis* was observed in most of the collections. *Cyclops bicuspidatus* occurred as a spring form in the April collections. *Diaptomus mississippiensis*, generally regarded as a southern species, appeared as a spring form in Pond No. 1 in 1928 and in all the ponds in April, 1929.

Temporary Ponds In Old Sink Holes

Random collections were made also from three small sink holes (see 4, 5, and 6 on the map) which contained shallow temporary pools having an abundance of vegetation, chiefly grasses and cat-tails. These were old sinks that had filled with clay until they had become very shallow. There was no longer any evidence of any pit or underground drainage. Such pools, therefore, have no influence on the subterranean waters.

A small pool (No. 5), near Pond No. 1, contained a heavy red bloom of *Euglena sanguinea* July 29, 1928. As the water was only about six inches deep, the plankton was highly concentrated. Bottom diatoms constituted half of the bulk of the forms present. Protozoa, especially the chlorophyl-bearing forms, constituted the other half. This aggregation of organisms can hardly be called plankton, because the pool was so shallow that they were practically living on the bottom. Nevertheless, except for the bottom diatoms, they were forms which are found normally in plankton. Algae were scarce. The plankton here included six forms not found at this time in Pond No. 1: two rotifers (*Monostyla quadridentata* and *Lepadella acuminata*), three protozoans *(Euglena sanguinea, Euglena viridis,* and *Pleodorina illinoisensis),* and one alga *(Cosmarium depressum).* This pool was dry September 3, 1928.

Another similar pool (No. 6), near Pond No. 3, also had a heavy red bloom of *Euglena sanguinea* and contained an abundance of diatoms. Only a few other species, however, were found here. *Arcella vulgaris,* usually a bottom form, was abundant, though it did not appear in the collections from the nearby perennial pond (No. 3).

Another small sink hole (No. 4), near Pond No. 1, contained a temporary pool 2 feet deep and 20 feet in diameter in April and July, 1928. This sink was dry in September, 1928. At the time of collecting, the organisms were not as concentrated as in the other temporary pools but represented many more species. The data of this pool are not listed, as they are very similar to those of Pond No. 1 for the same date. They comprise 35 species, all of which occurred in the nearby pond (No. 1) at the same times. It is interesting to note that this temporary pool was slightly deeper than the other temporary pools and that the plankton here resembled that of the larger perennial ponds rather than that of the smaller temporary pools.

TABLE III

COUNTS OF ORGANISMS PER CUBIC METER FROM TEMPORARY PONDS NOS. 5 AND 6

Organisms	Pond No. 5 July 20, 1928	Pond No. 6 Sept. 3, 1928
Undetermined diatoms	12,000,000,000	20,000,000,000
Cosmarium depressum (Näg.)	3,000,000	....
Spirogyra sp.	10,000,000	....
Arcella vulgaris Ehr.	10,000,000	10,000,000
Difflugia lobostoma Leidy	2,000,000	....
Euglena sanguinea Ehr.	1,000,000,000	10,000,000,000
Euglena spirogyra Ehr.	80,000,000	....
Trachelomonas ensifera Daday	3,000,000	....
Trachelomonas volvocina Ehr.	1,000,000	50,000,000
Trachelomonas hispida (Perty)	....	30,000,000
*Pleodorina illinoisensis Kofoid	50,000,000	....
Peridinium sp.	40,000,000	....
Polyarthra trigla Ehr.	....	1,000,000
Lepadella acuminata (Ehr.)	....	6,000,000
Monostyla quadridentata Ehr.	2,000,000	....
Brachionus patulus O. F. M.	1,000,000	....

* Colonies.

The plankton of all these temporary remnants of old ponds contained the same species of organisms as were found at some time or other in the younger and deeper permanent ponds, with the exception of *Euglena sanguinea* and *E. spirogyra,* which formed the bloom.

Relation of Sink Hole Ponds to Springs

As Scott and Kofoid found that underground waters in the regions of sink holes were contaminated by surface pond organisms, an attempt was made to ascertain if there was any evidence that the springs of this locality were connected with the surface ponds. The most accessible spring (No. 7 on the map) was located on the road one-fourth mile from Wetaug and one-half mile from the sink holes. Plankton collections were made from this spring on October 12, 1928. Only a few organisms were found, twelve of which were identified. These are listed below, with average counts of their abundance per cubic meter:

Surirella robusta Ehr.	800
Undetermined diatoms	400
Oscillatoria sp. (filaments)	40,000
Arcella vulgaris Ehr.	2,400
Difflugia acuminata Ehr.	320
Nematodes	16
Cyclops viridis Jurine	1,600
Cyclops serrulatus Fischer	3,200
Immature copepods	4,800
Chironomid larvae	160
*Filinia longiseta (Ehr.)	16
*Brachionus angularis Gosse	15
*Keratella cochlearis (Gosse)	18

Nine of these were living and, with the exception of *Cyclops serrulatus* (a temporary pond copepod), could occur naturally in either the spring or in the sink hole ponds. The other three, which were rare and partly disintegrated, were rotifers: *Filinia longiseta*, *Brachionus angularis*, and *Keratella cochlearis*, all of which also occurred in the collections from the sink hole ponds. None of these three forms would be expected to live under normal conditions in a spring. It would be difficult to determine whether this spring was connected with the particular ponds studied. The use of dyes in the ponds could not be attempted in this brief study. The presence of the three battered rotifers mentioned may be accepted as probable evidence of the origin of the water from these or similar ponds. The other species were either typical of springs or tolerant of the conditions under which they were found.

Conclusions

An abundant plankton was found in the sink hole ponds studied. It was of the same general composition in all of the perennial ponds.

* Partly disintegrated plankton organisms belonging to pond plankton.

exhibiting only minor variations, which consisted chiefly in the presence of a few species, usually inconspicuous, in one pond that were apparently absent in another.

The plankton of these ponds, though similar in some respects to that of rivers and of other ponds, is distinguished by the abundance of several characteristic species, such as *Trichocerca multicrinis*, and by the absence or scarcity of certain other species, notably rotifers of the genus *Brachionus* which normally occur in pond plankton.

The ponds ranged in age, both geologically and ecologically, from a deep perennial pond in an apparently recent sink hole to temporary ponds in old sink holes that had become nearly filled. Though differing in their depths and areas, the perennial ponds all contained the same type of plankton; that is, the predominant forms in each pond were largely of the same kinds. Two of the temporary ponds contained plankton which differed distinctly from that of the perennial ponds. In a third temporary pond, which was deeper and apparently younger, the plankton was more like that of the perennial ponds. Some of the species common to the perennial ponds were retained in all these temporary ponds, but they were mingled with bottom species to form a characteristic aggregation which may be called plankton only in a broad sense.

To a certain extent, this series shows developmental stages in the trend of the plankton community as the ponds grow old and gradually fill. As long as a pond remains in the perennial stage, containing water throughout the year, the plankton shows little change, but as the depth decreases and the pond reaches the temporary stage, containing water only in the rainy seasons, the plankton organisms mingle with those from the bottom in an aggregation characteristic of very shallow water. At this stage it is interesting to note how tenacious of their habitat certain pond planktonts are, for they persist almost as long as there is water left in which they can swim. Ultimately these aggregations disappear before an invasion of shore and vegetation organisms as the pond becomes merely a wet depression in a terrestrial habitat.

There is incomplete evidence that the plankton population of nearby springs is derived from ponds in sink holes. This is important because in many cases farm buildings are located on the slopes draining into the sink holes and could easily pollute the waters forming the source for nearby springs.

Each of the perennial ponds contained an abundance of algae of numerous species, which seemed to balance the heavy animal population. Thus the plankton community was apparently self-supporting with regard to producers and consumers.

Sink hole ponds, because of their relative stability in regard to water level and plankton content and because of their small size, should offer an interesting opportunity for further study on the dynamics of aquatic communities.

BIBLIOGRAPHY

Cummings, E. R.

1905. On the Weathering of the Subcarboniferous Limestones of Indiana. Proc. Ind. Acad. Sci., Vol. 15, pp. 85-100.

Deflandre, Georges.

1926. Monographie du Genre Trachelomonas Ehr. Thesis, University of Paris, pp. 1-162.

Eddy, S.

1930. The Plankton of Reelfoot Lake. Trans. Amer. Micro. Soc., Vol. 49, pp. 246-251.

Harring, H. K. and Myers, F. J.

1928. The Rotifer Fauna of Wisconsin. IV. The Dicranophorinae. Trans. Wisc. Acad. Sci., Vol. 23, pp. 667-808.

Kofoid, Chas. A.

1899. The Plankton of Echo River, Mammoth Cave. Trans. Amer. Micro. Soc., Vol. 21, pp. 113-126.

Pearsall, W. H.

1923. A Theory of Diatom Periodicity. Jour. of Ecol., Vol. 11, pp. 165-183.

Scott, Will.

1909. An Ecological Study of the Plankton of Shawnee Cave, with Notes on the Cave Environment. Biol. Bull., Vol. 17, pp. 386-406.

1910. The Fauna of a Solution Pond. Proc. Ind. Acad. Sci., Vol. 20, pp. 395-442.

Winkler, L. W.

1888. Die Bestimmung des im Wasser zelosten Sauerstoffes. Berichte der deutschen chemischen Gesellschaft, XXI, Bd. II, p. 2893.

TABLE IV

ABUNDANCE OF PLANKTON ORGANISMS PER CUBIC METER IN PONDS NOS. 1, 2, AND 3

Counts of organisms in filter-paper collections are given in italics; those in silk-net collections are given in roman type. All counts are of cells or unit organisms except those marked by the asterisk, which are of colonies or filaments.

Organisms	Pond	July 20, 1928	Sept. 3, 1928	Dec. 1, 1928	Apr. 3, 1929
BACILLARIACEAE					
Lysigonium granulatum (Ehr.) Kuntze	1	....	*165,000*	*1,000,000*	....
Synedra tenuissima Kütz	3	....	....	9,200	....
Synedra ulna (Nitz.) Ehr.	1	....	....	....	9,900
	2	....	....	....	*33,330*
	3	772	....	....	*72,000*
Navicula spp.	1	260	....	....	330
Surirella robusta Ehr.	1	130	....	....	....
	2	....	....	....	330
	3	....	....	920	....
CYANOPHYCEAE					
Chroococcus spp.*	1	....	*990,000*	....	....
	2	....	....	....	*367,700*
Coelosphaerium kuetzingianum Näg.*	3	....	7,722	....	....
Coelosphaerium naegelianum Unger*	1	*14,220,800*	*2,640,000*	*200,000*	*135,000*
	2	*13,332,000*	*477,730*	*14,670,000*	*666,600*
Microcystis flos-aquae (Wittrock) Kirchner*	1	*177,760*	*660,000*	*20,000*	....
	2	....	*2,400,000*	*144,400*	....
	3	11,583	....	....	....
Microcystis aeruginosa Kütz.*	2	*44,400*	3,200	....	....
	3	....	6,000	....	....
Microcystis incerta Lemm.*	2	*133,200*	....	....	....
Aphanocapsa spp.*	1	*1,066,510*	*330,000*	....	*27,000*
	2	465,000	*23,886,500*	....	....
	3	1,930	....	....	....
Anabaena planktonica Brunnthaler	1	*17,776,000*	*29,700,000*	*400,000*	....
	2	*22,220,000*	*7,105,950*	....	....
Anabaena spiroides var. crassa Lemm.	1	*1,777,600*	....	....	....
	2	*39,996,000*	*4,777,300*	....	....
Anabaena circinalis (Kütz.) Raben	2	620,000	*14,331,900*	....	....
Aphanizomenon flos-aquae (L.) Ralfs	1	*21,331,200*	*24,750,000*	*400,000*	....
	2	*20,300,200*	*1,433,190*	....	....

CHLOROPHYCEAE					
Botryococcus sudeticus Lemm.*	1	....	....	....	1,650
	2	....	....	....	3,300
	3	....	....	....	4,000
Dictyosphaerium pulchellum Wood*	1	....	*33,000*	....	....
	2	372,000	5,332,800	....	....
Treubaria crassispina G. M. S.	1	....	....	270	....
	2	....	....	320	....
	3	....	*46,662*	....	....
Tetraedron trigonum (Näg.) Hansgirg	1	260	*33,000*	....	....
	2	....	*95,546*	....	....
	3	1,544	*46,662*	*27,775*	....
Tetraedron gracile (Reinsch) Hansgirg	1	520	1,400	....	....
	3	772	....	....	....
Tetraedron lobulatum (Näg.)	1	....	*66,000*	....	....
	2	....	*47,773*	....	....
Lagerheimia sp.	2	....	*1,910,920*	....	....
Ankistrodesmus falcatus (Corda) Ralfs	1	....	*990,000*	*4,000,000*	....
	2	....	*477,730*	*888,800*	....
	3	....	*2,333,100*	*277,750*	....
Closteriopsis longissima Lemm.	3	....	*466,620*	*9,721,250*	....
Crucigenia irregularis Wille	3	386	....	....	....
Scenedesmus dimorphus (Turpin) Kütz.	2	....	320	....	....
Scenedesmus bijuga (Turpin) Lagerheim	3	....	*1,399,860*	*138,875*	....
Scenedesmus arcuatus Lemm.	3	7,722	*466,620*	....	....
Scenedesmus quadricauda (Turpin) Bréb.	2	....	640	....	....
	3	395	*139,986*	*277,750*	....
Coelastrum microporum Näg.*	2	....	*26,275,150*	....	....
	3	386	....	....	....
Coelastrum reticulatum (Dangeard) Senn.*	2	....	19,200	....	....
Pediastrum duplex Meyen	1	....	*660,000*	....	....
	2	....	320	320	....
Pediastrum tetras (Ehr.) Ralfs	3	380	....	....	....

Organisms	Pond	July 20, 1928	Sept. 3, 1928	Dec. 1, 1928	Apr. 3, 1929
Ulothrix sp.*	3	....	....	4,600	....
Spirogyra spp.*	1	520	....	270	....
	3	....	....	230	....
Netrium digitus (Ehr.) Itz. & Roth	1	260	350	270	3,300
	3	....	....	1,380	8,000
Closterium moniliferum (Bory) Ehr.	1	....	350	....	1,320
	2	....	....	....	660
	3	....	2,400	1,380	....
Closterium venus Kütz	3	193	....	....	....
Closterium acerosum (Schrank) Ehr.	1	260	360	....	3,300
	2	....	960	320	....
	3	....	1,200	9,200	4,000
Closterium gracile var. elongatum W. & G. S. West	2	....	....	320	....
Closterium strigosum Ehr.	1	....	....	*10,000*	....
	2	....	....	320	....
Closterium subtruncatum W. & G. S. West	3	....	....	460	....
Pleurotaenium sp.	1	....	....	....	1,650
	3	....	....	....	1,600
Spondylosium planum W. and G. S. West	1	....	....	....	33,000
Cosmarium depressum (Näg.) Lund	3	1,544	....	....	....
Cosmarium quinarium Lund	1	260	....	....	....
Cosmarium botrytis (Bory.) Menegh.	1	260	....	....	....
	3	....	600	....	....
Micrasterias americana (Ehr.)	1	....	....	....	330
Staurastrum gracile Ralfs	2	....	*191,092*	....	....
	3	775	....	....	400
Staurastrum cuspidatum Breb.	3	....	....	230	....
PROTOZOA					
Arcella vulgaris Ehr.	1	*533,280*	....	....	....
	3	....	....	230	....
Difflugia urceolata Carter	1	780	....	....	....
	3	1,158	*46,662*	....	....

Difflugia lobostoma Leidy	1	186,656	33,000	3,000	68,000
	2	666,690	95,460	44,440	33,800
	3	135,035	....	27,750	96,663
Difflugia globulosa Duj.	1	71,104	....	....	....
Difflugia acuminata Ehr.	3	....	....	240	....
Euglena viridis Ehr.	1	....	660,000	....	....
	2	11,110,000	955,460	44,440	....
	3	....	2,799,720	....	....
Euglena oxyuris Schmarda	1	35,552	3,500	....	....
	3	386	46,662	....	36,600
Euglena tripteris Duj.	3	386	....	....	....
Euglena acus Ehr.	1	....	4,800	....	....
Phacus longicaudus (Ehr.)	1	35,552	33,000	....	25,000
	2	133,320	95,546	10,000	16,665
	3	386	....	....	73,100
Phacus acuminata Stokes	2	33,560	66,000	....	....
	3	380	46,662	....	....
Trachelomonas volvocina Ehr.	1	711,040	16,500,000	8,000,000	1,350,000
	2	26,664,000	477,730,000	88,880,000	19,998,000
	3	38,610	74,659,200	7,443,750	3,666,300
Trachelomonas similis Stokes	1	1,066,560	330,000	....	....
	2	6,660,000	1,433,190	....	....
	3	772	....	....	....
Trachelomonas magdaleniana Defl.	2	....	3,821,840	....	....
	3	193	....	....	....
Trachelomonas tambowika Swir.	2	....	2,388,650	....	....
Trachelomonas armata (Ehr.)	1	....	1,650,000	....	....
	3	....	2,366,300	....	....
Trachelomonas hispida (Perty)	2	76,670,000	....	....	....
	3	19,444	34,996,500	277,750	....
Trachelomonas ensifera Daday	2	....	238,865	....	....
	3	772	1,399,860	....	....
Mallomonas producta (Zach.)	3	....	....	13,580	600,000

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Mallomonas caudata Iwanoff	1	*17,776*	*330,000*	*520,000*	*520,000*
	2	....	12,800	....	*300,000*
	3	*366,795*	....	*1,888,750*	....
Dinobryon sertularia Ehr.	1	....	*33,000*	*100,000*	*27,000*
	3	3,861	*22,333,100*	*11,110,000*	*966,630*
Chlamydomonas spp.	1	*35,552,000*	....	....	....
	3	....	*1,866,480*	....	....
Pandorina morum Bory*	2	....	1,600	....	....
	3	....	....	....	*18,000*
Eudorina elegans Ehr.*	1	*35,552*	....	....	....
	2	*22,220*	*953,460*	*44,440*	1,320
Pleodorina californica Shaw*	1	*35,552*	....	....	*12,000*
Pleodorina illinoisensis Kofoid*	2	*88,880*	*143,319*	....	....
Ceratium hirundinella (O. F. M.)*	1	*72,140*	*66,000*	*2,000*	*14,000*
	2	*22,220*	*477,730*	....	....
	3	5,792	*933,240*	*27,770*	*366,630*
Peridinium cinctum O. F. M.	1	*1,422,080*	*1,980,000*	....	*18,200*
	2	....	1,433,190	....	*33,300*
	3	*482,625*	*46,662,000*	*562,300*	*1,866,520*
Strombidium sp.	3	....	....	*555,500*	....
Codonella cratera (Leidy)	1	....	*495,000*	*1,800,000*	*710,000*
	2	*888,800*	*95,546*	....	*66,660*
	3	782	*933,240*	*2,499,740*	....
ROTATORIA					
Rotaria neptunia (Ehr.)	1	....	....	....	660
	2	....	....	....	330
Conochilus hippocrepis Schrk.	1	260	....	....	....
Conochiloides dossuarius (Hudson)	1	260	....	1,350	....
	2	3,100	1,280	....	....
	3	190	....	....	....
Asplanchna sieboldii (Leydig)	1	780	....	270	....
	2	....	9,600	144,000	412,500
	3	....	....	1,840	800

Filinia longiseta (Ehr.)	1	6,500	1,400	....	660
	2	9,300	....	....	....
	3	15,444	....	....	400
Polyarthra trigla Ehr.	1	15,600	35,000	18,900	165,000
	2	15,500	48,000	76,800	165,000
	3	7,822	3,600	27,600	260,000
Diurella tigris (O. F. M.)	3	....	....	230	....
Diurella stylata Eyferth	1	....	350	....	....
	3	386	2,400	....	....
Brachionus patulus O. F. M.	1	18,200	....	....	....
	2	....	25,600	....	....
	3	386	1,200	260	....
Trichocerca multicrinis (Kellicott)	1	520	3,600	2,700	....
	2	....	3,200	19,200	....
	3	46,432	48,000	8,050	400
Trichocerca pusilla (Jennings)	3	386	....	....	....
Euchlanis deflexa Gosse	1	2,600	....	....	....
	2	21,700	960	....	....
	3	770	....	....	....
Lecane ungulata (Gosse)	2	....	320	....	....
	3	....	....	....	400
Lecane ohioensis (Herrick)	2	350	....	....	....
Lepadella acuminata (Ehr.)	3	....	600	....	....
Monostyla lunaris (Ehr.)	2	350	....	320	....
	3	....	....	....	400
Monostyla bulla Gosse	2	....	1,280	....	....
	3	386	600	....	....
Monostyla quadridentata Ehr.	2	....	1,600	....	....
	3	....	600	....	....
Testudinella patina (Hermann)	3	3,861	....	....	....
Pompholyx complanata Gosse	1	....	....	....	330
	2	700	....	....	....
	3	386	....	230	....

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Brachionus calyciflorus Pallas	2	....	6,400	....	....
Brachionus angularis Gosse	1	260	....	....	....
	3	11,583	2,400	....	....
Schizocerca diversicornis Daday	1	....	700	....	....
	2	6,200	22,400	....	....
Keratella cochlearis (Gosse)	1	5,200	3,500	10,800	247,500
	2	15,500	3,200	6,400	132,000
	3	193,050	150,000	138,000	160,000
Notholca longispina (Kellicott)	1	....	700	810	660
	2	....	320	320	19,800
Pedalia mira Hudson	1	260	3,500	....	....
	2	....	12,800	....	....
	3	....	1,200	....	....
CLADOCERA					
Diaphanosoma brachyurum (Liéven)	1	31,200	1,750	....	....
	2	3,100	1,920	....	660
Daphnia longispina (O. F. M.)	2	....	....	1,920	1,650
	3	....	....	1,380	8,000
Scapholeberis mucronata (O. F. M.)	3	....	600	....	....
Ceriodaphnia lacustris Birge	1	15,600	1,050	....	....
	2	37,200	....	....	....
	3	78,220	1,200	....	....
Moina affinis Birge	2	6,200	640	....	....
Bosmina longirostris (O. F. M.)	1	39,000	10,500	8,100	26,400
	2	1,550	19,200	320,000	33,000
	3	11,583	60,000	55,200	320,000
Bosmina obtusirostris Sars	3	....	....	1,150	....
Alona sp.	1	260	....	....	....
	2	310	....	....	....
	3	1,930	....	....	....
Pleuroxus hamulatus Birge	3	....	....	460	....

Pleuroxus trigonella (O. F. M.)	2	....	....	160	....
Pleuroxus sp.	3	600	....	....	....
Chydorus sphaericus (O. F. M.)	2	9,300	....	....	....
	3	1,544	....	2,300	....
COPEPODA					
Diaptomus mississippiensis Marsh	1	2,600	....	4.050	39,600
	2	....	....	....	9,900
	3	....	....	....	400
Cyclops viridis Jurine	1	31,200	17,500	1,350	660
	2	96,100	67,200	400,000	6.600
	3	386,100	24,000	....	200,000
Cyclops bicuspidatus Claus	1	....	....	....	5,000
	2	....	....	....	82,500
	3	775	....	....	....
Cyclops leuckarti Claus	1	....	....	24,300	....
	3	190	....	177.500	....
Immature copepods	1	312,000	51,500	5,400	132,000
	2	170.500	112,000	176,000	99,000
	3	23,160	3,000	230,000	400,000
INSECTA					
Corethra larvae	1	260	....	....	....
	2	310	....	....	....
OSTRACODA					
Ostracods	2	....	....	640	....