Algal Records for Three Indiana Sewage Stabilization Ponds

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Abstract

Algal identifications have been recorded from 376 samples collected from three Indiana sewage stabilization ponds during a period from May 1962 to August 1968. Although certain genera were found frequently in all three ponds, each pond had a distinctive algal flora. Green algae were invariably the most abundant of the algal groups present. However, flagellates were also prominent. Of a total of 64 genera of the most significant and abundant algae there were 29 green algae, 19 flagellates, 10 blue-green algae, and 6 diatoms. Some genera were limited to the summr season, while others were most prominent in spring and fall or in the winter. The pollution-tolerant algae *Euglena* and *Nitzschia* were abundant and persistent in all three ponds.

Three sewage stabilization ponds in southeastern Indiana were among several throughout the United States selected for biological studies, with particular emphasis on the algal flora. The Indiana ponds serve the communities of Napoleon and Sunman in Ripley County and St. Paul in Decatur County. These ponds range from 2.9 to 7.9 acres and are from 3 to 4 feet deep. The respective populations served are approximately 300 to 800 with a pond area of about 0.01 acre per person. The biochemical oxygen demand (BOD) at the intakes has been ± 500 ppm and for the effluents less than 50 ppm. The Ripley County ponds were put into use in 1961 and the one in Decatur County three years later.

Information on one or more of these ponds has been reported by Kuwahara (2), Palmer (5), Safferman (6), and Safferman and Morris (7, 8). The first virus infecting a blue-green alga was isolated from one of the ponds in Ripley County (6).

Algal identifications were recorded from samples from the two Ripley County ponds on 43 different days during all seasons between May 1962 and August 1968. For the St. Paul pond, summer samples only have been available, these being obtained in 1966 and 1968, with collections on eight different dates. Four samples per pond were obtained on each date of collection making a total of 376 samples. Each set of four samples represented the following sites: A—Water, near influent; B—Sludge or floating mat, near influent; C—Water, near effluent; D—Sludge or floating mat, near effluent. Identification of the algae in each sample was to genus and the relative abundance of each was recorded.

Records of the microscopic analyses of samples for three dates for Napoleon and Sunman and two dates for St. Paul are given in Table 1. The data were selected to permit comparison of the algal flora in the three ponds and for each pond at different times of the year. Relative abundance of all genera is indicated using the figures from 1 through 5.

TABLE 1. *Microscopic Analyses of Indiana Stabilization Pond Samples for Three Collection Dates.*

	Napoleon												Sunman								St. Paul							
Collection Date	12/1/65				6/2/66				8/13/68				12/1/65				6/2/66				8/13/68				6/2/66				8/13/68			
Sample	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
GENUS																																
Achnanthes																									-	-	-	4				
Actinastrum									1	-	-	-																				
Anabaena					-	1	-	-																								
Anacystis									-	2	-	-									3	3	3	3					2	1	1	2
Ankistrodesmus	3	4	3	3	1	1	2	2	1	2	1	3	-	-	1	-	-	-	-	1					3	2	2	3	3	1	2	2
Chlamydomonas	2	-	-	-	1	1	-	-	-	1	-	-	3	1	1	1					4	3	1	-	-	-	-	2	3	3	2	2
Chlorella					1	1	1	-	4	3	4	4	4	5	4	4	3	3	3	3	5	5	5	5	3	3	2	4	4	5	4	4
Chlorococcum					-	3	1	3																	-	1	-	-				
Chlorogonium					1	-	-	-																	-	-	-	2	1	-	1	-
Chodatella	-	1	-	-	1	-	-	-																								
Chroomonas	1	-	2	-																												
Closteriopsis	1	2	1	2																												
Coelastrum																													1	-	1	1
Cryptomonas	4	3	4	4	2	-	-	-																	2	3	3	-				
Cyclotella																													2	2	2	1
Dictyosphaerium									1	-	1	1													1	2	2	3				
Eudorina					-	-	-	1																								
Euglena	-	4	-	2	-	2	2	2					1	2	1	-	2	4	2	3	4	4	5	5	5	5	2	3	2	1	1	1
Golenkinia					1	-	-	1					-	-	1	-													-	-	1	-
Gomphonema													-	2	1	-	-	-	-	1					-	-	-	1				
Johannesbaptistia																													-	1	-	-

Lepocinclis	–	2	–	1									1	–	–	1				
Micractinium									1	–	–	1								
Nannochloris																	5	5	5	5
Navicula	–	1	–	–									–	1	–	–				
Nitzschia	–	3	–	3	–	1	–	1	1	1	–	2	2	4	2	–	–	4	–	4
Oocystis									4	3	4	4	1	–	–	–	–	1	–	1
Oscillatoria	–	1	–	–					–	1	–	3					–	5	–	4
Pandorina	–	1	–	–	4	4	2	2	2	1	1	1								
Phacus																				
Planktosphaeria					–	–	2	2	3	2	3	2								
Pyrobotrys																				
Raphidiopsis									2	–	1	2								
Scenedesmus	–	2	–	1	3	3	2	3	–	–	–	1								
Schizothrix	–	2	–	1													–	–	–	2
Selenastrum													5	5	5	5	1	–	2	4
Stigeoclonium																				
Zoochlorella					–	1	–	–												
TOTAL GENERA	14				16				14				11				10			

Lepocinclis								
Micractinium					1	1	1	1
Nannochloris	2	3	2	2				
Navicula					–	1	–	1
Nitzschia					3	5	2	5
Oocystis					2	3	2	4
Oscillatoria					1	1	1	5
Pandorina					3	3	3	4
Phacus					1	–	–	–
Planktosphaeria					–	–	–	3
Pyrobotrys	2	2	2	1				
Raphidiopsis	–	1	–	–				
Scenedesmus					–	2	1	3
Schizothrix					–	–	–	5
Selenastrum								
Stigeoclonium					–	–	–	5
Zoochlorella								
TOTAL GENERA	7				21			

Lepocinclis								
Micractinium								
Nannochloris	2	–	–	–				
Navicula	–	1	–	1	2	–	1	–
Nitzschia	3	3	2	2				
Oocystis	–	–	–	1				
Oscillatoria	1	2	1	1				
Pandorina								
Phacus								
Planktosphaeria	3	2	2	3				
Pyrobotrys								
Raphidiopsis	1	–	–	–				
Scenedesmus	–	1	1	–				
Schizothrix	3	1	–	1				
Selenastrum								
Stigeoclonium								
Zoochlorella								
TOTAL GENERA	19							

Sample:
A—Near Influent, Water
B—Near Influent, Sludge or Mat
C—Near Effluent, Water
D—Near Effluent, Sludge or Mat

Relative Abundance
1—Rare
2—Occasional
3—Medium
4—Abundant
5—Very Abundant

Sludge or floating mat samples (B and D) often contained a larger number of algal genera than did the water samples from the same locations (A and B).

The number of genera of four algal groups recorded for each of the three ponds is listed in Table 2. In all three ponds the green and flagellate genera outnumbered those of blue-green algae and diatoms.

TABLE 2. *Number of Genera by Groups in Each Indiana Pond.*

Algal Group	Napoleon	Sunman	St. Paul
Green Algae	29	23	17
Blue-Green Algae	11	7	7
Flagellate Algae	23	19	12
Diatoms	4	4	5
TOTAL	67	53	41

The highest number of genera recorded for any pond for one day was 21. However, the averages differed for the three ponds, being 11 for Sunman, 14 for Napoleon, and 18 for St. Paul. The higher the number of genera, the more likely that wastes in the influent have been stabilized as algal ingredients. A number of industrial wastes, including those from dairies and food canneries are generally not as readily assimilated by algae as is typical household sewage. Variations in loading and in environmental factors can also affect the algal flora. A total of 83 algal genera was recorded. Table 3 lists the most abundant and significant of these, together with the number of sampling dates they were recorded for each pond. Among the 64 genera listed are 24 non-filamentous green algae, 19 pigmented flagellates, 10 blue-green algae, 6 diatoms, and 5 filamentous green algae.

Ankistrodesmus, Chlamydomonas, Chlorella, Euglena, Nitzschia, and *Oscillatoria* were persistent in all three ponds. All are among the top 12 algal genera most tolerant of pollution (4). Also fairly persistent in all three ponds were *Anacystis, Oocystis, Pandorina, Schizothrix,* and *Scenedesmus.* All but *Schizothrix* are among the top 35 pollution-tolerant genera (4). This genus would also be within the grouping if it were credited with the records of its synonyms as recognized by Drouet (1).

Anabaena, Chodatella, Chroomonas, Closteriopsis, Closterium, Cryptomonas, Spirulina, and *Zoochlorella* were present much more often in the Napoleon pond than in the other two ponds. *Arthrospira* and particularly *Pyrobotrys* are the only significant ones that were distinctive at Sunman. At St. Paul the diatom *Cyclotella* was the only distinctive genus that appeared more than once. The interesting forms *Achnanthes, Stigeoclonium,* and the blue-green alga *Johannesbaptistia* were reported once for that pond. *Navicula* and other diatoms (*Achnanthes, Gomphonema, Nitzschia*) were fairly consistent in the St. Paul flora.

TABLE 3. *Relative Persistence of Algae in Indiana Sewage Ponds.* (No. Dates Recorded per Alga)

ALGAL GENUS	Napoleon	Sunman	St. Paul Equivalent*
Achnanthes	–	–	5
Actinastrum	3	5	–
Anabaena	9	3	5
Anacystis	10	18	20
Ankistrodesmus	41	33	40
Aphanizomenon	1	–	5
Arthrospira	–	3	–
Carteria	3	1	–
Characium	1	2	–
Chlamydomonas	39	30	40
Chlorella	35	40	40
Chlorococcum	3	5	10
Chlorogonium	16	6	25
Chodatella	15	–	–
Chromulina	8	2	5
Chroomonas	13	1	–
Cladophora	1	1	–
Closteriopsis	5	–	–
Closterium	5	–	–
Coelastrum	7	10	10
Cosmarium	–	1	–
Cryptomonas	22	1	10
Cyclotella	–	–	20
Dictyosphaerium	8	1	5
Eudorina	2	5	5
Euglena	41	42	40
Francea	1	–	–
Golenkinia	8	7	15
Gomphonema	3	4	10
Gonium	1	2	–
Hantzschia	1	–	–
Johannesbaptistia	–	–	5
Kirchneriella	7	9	–
Lepocinclis	3	4	5
Lobomonas	4	1	–
Massartia	2	–	5
Micractinium	14	7	20
Nannochloris	–	13	15
Navicula	14	15	35
Nitzschia	41	36	40
Oedogonium	–	2	–
Oocystis	11	22	30
Oscillatoria	37	35	40

TABLE 3. (*continued*)

ALGAL GENUS	Napoleon	Sunman	St. Paul Equivalent*
Palmella	3	2	5
Pandorina	16	16	30
Phacotus	2	–	–
Phacus	11	7	15
Phormidium	1	2	–
Planktosphaeria	14	3	20
Pleodorina	1	2	–
Pteromonas	5	–	15
Pyrobotrys	–	11	–
Raphidiopsis	4	4	10
Scenedesmus	39	15	35
Schizothrix	26	19	35
Selenastrum	1	8	5
Sphaerocystis	2	–	–
Spirogyra	–	1	–
Spirulina	4	–	–
Stigeoclonium	–	–	5
Tetraedron	1	–	5
Trachelomonas	8	1	5
Ulothrix	2	2	–
Zoochlorella	6	1	–

*No. of Dates recorded X5

Napoleon and Sunman ponds were sampled during all months of the year, making possible a study of seasonal distribution of the algae. While many algae can be recorded as abundant during the summer, a much more restricted flora is found during the winter. Of the flagellates, *Phacus* and *Chroomonas* were most abundant during the spring, *Pandorina* during the summer, and *Cryptomonas* during the autumn and winter. *Chalamydomonas* was abundant during all seasons and *Euglena*, while present in all seasons, was less abundant during the winter. The diatoms *Nitzschia* and *Navicula* were present in all seasons. The former was much more abundant and appeared in greatest numbers in spring and fall.

Most of the more common green algae tended to be primarily summer forms. These included *Actinastrum*, *Golenkinia*, *Kirchneriella*, *Oocystis*, and *Planktosphaeria*. During the test period, *Selenastrum* was absent in the fall and most abundant in winter. *Scenedesmus* and *Ankistrodesmus* remained high in numbers during fall as well as summer. *Oscillatoria* and *Schizothrix*, the two most prominent blue-green algae, were recorded during all seasons and were abundant from late spring until at least mid-autumn.

Some algae less common in sewage ponds, but present in one or more of the Indiana ponds, included the diatoms *Cyclotella* and *Hantzschia*,

the blue-green algae *Arthrospira, Johannesbaptistia,* and *Raphidiopsis,* the green algae *Actinastrum, Chodatella, Closterium, Dictyosphaerium, Selenastrum, Spirogyra,* and *Ulothrix,* and the flagellate algae *Chlorogonium, Chroomonas, Cryptomonas, Eudorina, Massartia, Phacotus, Pteromonas,* and *Pyrobotrys.*

On each collection date two samples were taken from the influent area and two from the effluent area of the pond. Microscopic analyses of these samples indicated very little difference between the algal flora of the influent and effluent areas. This could be the result of rapid mixing of the water throughout the pond. It could be the result of rapid oxidation and stabilization of the sewage, including that in the influent area.

At Napoleon and St. Paul the more abundant algae were generally present in each set of samples collected. This pattern indicates the constant quality and quantity of sewage entering the ponds. At Sunman, *Scenedesmus* was rare to absent after 1963 and *Ankistrodesmus* was rare to absent after 1965. *Chlorella* became more abundant in 1965 and the related genus *Nannochloris* appeared in large numbers in May 1966. Both persisted in abundance afterwards. Such a change in the flora has been considered elsewhere to be due to the development of partial anaerobic conditions (3).

The algal flora of three sewage stabilization ponds in Indiana was composed of an average of 11 to 18 genera of algae. The most abundant and persistent forms were all ones previously classified as highly tolerant to organic enrichment. In addition to the many green algae a large number of flagellate algae were present, some of these being seasonal. Blue-green algae and diatoms, with the exception of *Nitzschia,* were not common.

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