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SPECIES COMPOSITION AND SEASONAL DISTRIBUTION OF PHYTOPLANKTON IN THE EXPERIMENTAL LAKES AREA, NORTHWESTERN ONTARIO

by

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INTRODUCTION

This report summarizes the phytoplankton communities of 35 Canadian Shield lakes located within the Experimental Lakes Area (ELA) near Kenora, Ontario (Johnson & Vallentyne, 1971). The lakes are representative of the area and the phytoplankton communities are probably comparable to those in other Canadian Shield lakes. On the basis of size the lakes were grouped into three classes Schindler and Holmgren (1971) (Table 1). Four lakes representing the three classes were chosen for detailed analysis of seasonal variations in phytoplankton biomass and species composition.

HISTORICAL REVIEW

The most detailed study directly concerning the region in which the present survey was made was done by C.W. Lowe (1924). However, two of the lakes he studied, Lake Winnipeg and Lake of the Woods, receive some drainage from prairie regions. As a result, the waters have higher concentrations of most ions than typical Shield lakes and the phytoplankton may not be entirely typical. Lowe's species lists from these lakes and from Shoal Lake and Mud Lake, Kenora, are extensive and include both benthic and planktonic algae. He did not, however, describe his sampling procedure, and he omitted the small flagellates that are numerous in waters of the area. Moreover, the study was strictly qualitative. Smith's (1921) report of the Muskoka Region is a very detailed study of the desmids of the area, but contains little information on other algal groups.

Rawson's (1956, 1957, 1960a, 1960b, 1961) work on the northern Saskatchewan lakes, and lakes of the Churchill River drainage, were not primarily concerned with phytoplankton taxonomy. His quantitative data are difficult to use for comparative purposes, because they were based on the dry weight of samples taken with coarse-mesh tow net rather than direct cell counts and volume estimates. His most extensive taxonomic work on phytoplankton and benthic algae was reported in a study of Great Slave Lake (1956), which only lies partially on the Shield. Koshinsky (1964, 1965, 1968) in his studies of north central Saskatchewan lakes, identified only a few forms to the species level and omitted the Chrysophyceae, Euglenophyta, and Dinoflagellata. The absence of several major genera of the above classes which are common in Shield lakes from Koshinsky's lists may be due to the relatively coarse No. 20 plankton net which he used for collections. Some of the missing forms are important components of the Shield phytoplankton community, for example, small Chrysophyceae, Cryptomonas species, Peridinium and Gymnodinium species. Lund's (1962) study of the phytoplankton from northern Saskatchewan lakes and Great Slave Lake was restricted to the Bacillariophyceae and Cyanophyta, and he concentrated on differences between species. Again, these waters do not lie entirely in the Shield. Bourrelly's (1966) report of the eastern Ontario and northern Quebec lakes is extensive with major emphasis on the desmids. Christie's (1969) taxonomy was quite detailed, although he did not mention a number of small flagellates that are numerous during the ice-covered period in Shield lakes. Sparling and Nalewajko (1970) presented a species list for some southeastern Ontario lakes, which is correlated with chemical analysis. Their list, however, is based on only a single sampling from each lake, taken in November. Schindler and Nighswander (1970) presented a species list along with biomass, production and chemical data accumulated over the span of a complete year from a southern Ontario lake. This is also the only study using the Utermöhl method as modified by Nauwerck (1963) for enumeration. Stockner and Armstrong (1971) and Evans and Stockner (1972) are concerned entirely with periphyton and benthic algae. Studies dealing with the phytoplankton taxonomy of Shield areas in the United States are those of Smith, 1916, 1918, 1920, 1924, (Wisconsin lakes, those located on Shield are the northeastern lakes); Drouet, 1954, (northwestern Minnesota lakes); and Meyer and Brook, 1969 (algae of Itasca State Park, Minnesota). The recent paper by Schindler and Holmgren (1971) contains some information on algae from the Experimental Lakes Area.

METHODS

The phytoplankton work at ELA was done in conjunction with an extensive limnological program which included experimentation as well as general lake surveys (e.g. see papers in J. Fish. Res. Bd Canada Vol. 28, No. 2 and also Schindler *et al*. 1971). Samples of lake water (150 ml) were collected with a van Dorn sampler, for quantitative counts and identification. They were obtained from 5-7 depths in the euphotic zone of the lakes, depending upon light penetration. A net haul was also taken using a 10μ mesh nannoplankton net, in order to allow examination of live algae to facilitate the later identification of preserved material. All quantitative samples were immediately preserved with Lugol's solution[2]. A portion of the net sample was also preserved and stored.

Live identification as well as counts were generally made from 1-10 ml of sample depending on the density of the phytoplankton. Phytoplankton were sedimented in a settling chamber, then examined on a Wild model m 40 inverted microscope. Most of the identifications and counts were made using magnifications of 100x, 400x and 1000x with phase contrast illumination. The counting procedure was according to the Utermöhl technique as modified by Nauwerck (1963). This procedure is also described by Vollenweider (1969). In order to convert the cells/l to biomass values it was necessary to approximate the volume of cells of the various species. Volume estimates were made by approximation using geometric shape or shapes that most closely resembled the shape of the cell (Vollenweider 1969). See Table II.

RESULTS

Biomass

Vollenweider (1968) classified lakes according to maximum live biomass values:

Ultra-oligotrophic	1000 mg/m^3
Mesotrophic	3000 - 5000 mg/m^3
Highly eutrophic	10000 mg/m^3

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2. KI in 20 mls H_2O + 5 gm I_2. Completely dissolve. Add 50 mls H_2O + 5 gm Na acetate. Dissolve.

According to the Schindler & Holmgren (1971) classification most of the ELA Class A lakes (large deep exposed lakes) are ultra-oligotrophic. Experimentally eutrophied Lake 227 ranged from eutrophic in 1969 to highly eutrophic in 1971. ELA Class B lakes (small deep protected lakes) and Class C lakes (small shallow lakes) are mesotrophic (Table 1). In the three "type" lakes studied (Figs. 1, 2, 3, 4, 5) considerable biomass fluctuation occurred from season to season as well as from year to year.

Class A lakes

In the large, deep, exposed lakes the biomass values usually ranged from winter minima of approximately 70 mg/m^3 to summer maxima of around 1200 mg/m^3.

In Lakes 239 and 305 minimum values of 70 mg/m^3 occurred in February and March in 1969 and 1970 (Fig. 1 and 2). During the spring of 1969 there was a rapid increase in the phytoplankton biomass of these lakes, with maxima of 1200 mg/m^3 in Lake 239 during late May and 1000 mg/m^3 in Lake 305 in early June. However the 1970 spring maximum was much lower in Lake 239 - only 860 mg/m^3. (Lake 305 was not sampled in 1970). Further, the maximum (920 mg/m^3) occurred in late July 1970. Both Lakes 239 and 305 showed declines in biomass (Lake 239 to 500 mg/m^3 and Lake 305 to 300 mg/m^3) throughout the summer of 1969 until September when there was a small autumn maximum (740 mg/m^3 in Lake 239 and 480 mg/m^3 in Lake 305). The 1970 fall increase for Lake 239 was approximately 100 mg/m^3 lower than the 1969 value and occurred in October rather than in September. Unlike 1969, there occurred an early winter increase (approximately 800 mg/m^3 in early November 1970, just after freeze-up).

Class B and C lakes

In the smaller lakes, the winter counts from 1969-1970 indicate concentrations of about 1000 mg/m^3 (Figs. 4 and 5). In late June and early July, Lake 304 (Class B) exhibited a comparatively small late maximum of 2000 mg/m^3. In Lake 303 (Class C) a maximum of 1300 mg/m^3 occurred in late May (Fig. 5). In Lakes 304 and 303 the summer maxima (2800 mg/m^3 and 5000 mg/m^3 respectively) did not occur until late July and mid-August, respectively (Figs. 4 and 5). Following the July maximum, the biomass of Lake 304 decreased rapidly. However, that of Lake 303 remained more or less constant until after the middle of October when it then declined to a value of 1000 mg/m^3.

Species Composition

Table III lists the species found in the various classes of lakes and indicates the time of year in which each was most common. The following is a general account of the seasonal variation of the major groups and the predominant species in these groups for the three classes of ELA lakes. For detailed information refer to Table III and Figures 1 through 5.

Class A lakes

The Chrysophyceae were in general the predominant group in Class A lakes throughout the year. During the winter the flagellates were dominant, for example *Chrysococcus* spp., *Chromulina* spp.; the Heterokontae, especially *Botryococcus braunii*. *Mallomonas* spp. and *Dinobryon* spp. were the major spring species. In the summer colonial and loricate species such as *Synura* spp., *Chrysosphaerella longispina*, *Uroglena americanum*, *Mallomonas* spp., and *Dinobryon* spp. were abundant. During the autumn, both typical summer and winter species were present in abundance; for example summer species of Dinobryon, Synura and Mallomonas were still present in relatively large numbers in early fall while the winter species Ochromonas and Chromulina dominated later in the fall.

Other significant but less predominant groups include the Cryptophyceae, Peridineae, Diatomeae, Cyanophyta, and Chlorophyta. The Euglenophyta were of no importance in Class A lakes.

Cryptophyceae occurred in largest numbers during the spring. Major species were Cryptomonas obovata, C. rostratiformis, C. pusilla, Rhodomonas minuta, and Katablepharis ovalis. Following this cryptomonad maximum the members of the Peridineae increased slightly, with dominance by Peridinium willei, P. aciculiferum, P. inconspicum, P. pusillum, Gymnodinium mirablis, G. palustre, and G. uberrimum. The only Chlorophyta that were of any significance were Chlamydomonas spp. which occurred in the spring and a small summer population of Oocystis sp., Quadrigula spp., Elakatothrix sp., Gloeococcus schroeteri, Ankistrodesmus spp. and Crucigenia spp. Diatomeae maxima in late spring and early summer, the major species being Tabellaria fenestrata, T. flocculosa, Asterionella formosa, Synedra acus v. radians, S. nana, Cyclotella comta, C. stelligera, C. comensis, Melosira islandica, M. italica, M. distans, and Rhizosolenia eriensis. The Diatomeae peak was usually followed by an increase in Cyanophyta after the lakes were well stratified thermally. The predominant forms were species of Aphanocapsa spp., Aphanothece spp., Radiocystis geminata, Gomphosphaeria lacustris, G. aponina, Coelosphaerium keutzingianum, Rhabdoderma spp., Dactylococopsis spp., Chroococcus spp., and Merismodpedia spp.

Class B lakes

Chrysophyceae were also the predominant group in Class B lakes. During the winter the small flagellates and Heterokontae predominated. The major species were Chrysochromulina parva var., Chromulina spp., Chrysococcus spp., Kepherion spp., Pseudokepherion spp., and Botryococcus braunii. The spring plankton was dominated by species of Dinobryon, Chrysochromulina parva var., Mallomonas pumilio var., Chrysoikos skujai, Pseudokepherion spp. and Kepherion spp. The spring species and the major summer species were similar, for in summer Chrysochromulina was still present along with a number of species of Mallomonas, Synura spp., Kepherion spp. and Pseudokepherion spp. Like Class A lakes the dominant fall species were a mixture resulting from the simultaneous persistence of summer forms and the advent of winter forms.

The Cyanophyta in Class B lakes (Lake 304) exhibited a number of pulses during spring and summer. The major spring species found in the epilimnion were Aphanocapsa spp., Aphanothece spp. and Chroococcus spp., in the hypolimnion the dominant Cyanophyta were the species Lyngbya pseudospirulina. During the summer in addition to the above-mentioned species Merismopedia spp. appeared in the epilimnion, and Oscillatoria sp. in the hypolimnion. A brief pulse of Peridineae was observed in the summer, the predominant species being Peridinium wisconsiense, Gymnodinium mirablis, G. palustre, and G. cf. varians. Summer increases in Cryptophyceae and Euglenophyta occurred at approximately the same time. Cryptophyceae species included Cryptomonas marsonii, C. obovata, C. platyuris, C. pusilla, Rhodomonas minuta, and Katablepharis ovalis. The predominant species of Euglenophyta were Euglena acus, E. viridis, Euglena spp., and Lepocinclis ovum. Chlorophyta were most abundant in the fall. The predominant species were Ankistrodesmus acicularis, Chlamydomonas spp., Arthrodesmus incus, Spondylosium planum, Staurastrum spp., Scenedesmus spp., Oocystis submarina v. variablis, and Ocystis spp. At no time did the Diatomeae compose more than 5 per cent of the population. The major species in the group were Synedra acus, S. nana and Melosira distans.

Class C lakes

In the Class C lakes the predominant algal group in the spring, fall and winter was Chrysophyceae, while in the summer this group was largely displaced by Diatomeae. In the winter Botryococcus braunii, Chrysochromulina sp., Chromulina spp. and Ochromonas spp. were of major importance. During spring Chrysochromulina parva var. and Ochromonas spp. remained important until the Diatomeae increase in late spring and summer. The major species of Diatomeae was Synedra acus v. angustissima. The diatoms declined with the onset of fall and species of the chrysophyceaen genera Synura, Uroglena, Dinobryon, Mallomonas and Pseudokepherion dominated.

The Chlorophyta peaked in the spring and the fall. The important spring species were Chlamydomonas spp., Oocystis sp., Ankistrodesmus falcatus, and Arthrodesmus incus. These same species were also observed in relatively large numbers in the fall in addition to Spondylosium planum, Sphaerozosma granulatus and Quadrigula closterioides. The Peridineae were of minor importance in the summer. Peridinium willei, P. wisconsiense, and Gymnodinium spp. were most abundant. The Cyanophyta and Cryptophyceae appeared to be of little or no importance in this type of lake.

Sphagnum Bogs

Net samples were obtained from two of the Sphagnum bogs in the area. The phytoplankton of these bogs was comprised mostly of Desmidiaceae of the Chlorophyta. Other groups were of minor abundance.

DISCUSSION

Very few all-year studies have been made on the phytoplankton of Precambrian Shield lakes. Of those that have described seasonal change, the majority have been European, in particular Finnish and Swedish. Järnefelt (1952) made perhaps the most comprehensive study, on a number of Finnish lakes. He found these lakes to be dominated by diatoms rather than Chrysophyceae as in the ELA lakes. Willen (1969), however, in a study of a small culturally undisturbed lake in southern Sweden found a predominance of diatoms during the first year of his two year study and a predominance of Chrysophyceae and Cryptophyceae during the second year. Holmgren (1968) in a three year study of a sub-arctic lake in Lapland also found considerable variation from year to year. Schindler and Nighswander (1970) in a one year study of a southeastern Ontario lake found the major components of the phytoplankton community to be Chrysophyceae, with Pyrrophyta and Diatomeae of secondary importance. In the ELA lakes the only significant departure from a dominance of Chrysophyceae for any length of time was in Lake 303 (a Class C lake). In this lake diatoms were the dominant group during the summer. In the Class A lakes (Lake 239 and Lake 305) Cryptophyceae and Diatomeae were next in abundance to

Chrysophyceae, while in the Class B lake (Lake 304) the Cryptophyceae and Cyanophyceae followed in importance. Considering the two years 1969 and 1970 for Lake 239 there were no major departures from the pattern of succession that was found in 1969 although the maximum average biomass appeared later in the summer than in 1970 and was somewhat lower. This was probably due to the late spring breakup in 1970. It appears that small environmental changes are capable of causing these fluctuations in biomass and species composition throughout the seasons.

Maximum average biomass values for Shield lakes of other areas seem to be somewhat lower than those found in the ultra-oligotrophic lakes in the ELA area. Willen (op. cit.) recorded a maximum of 400 mg/m^3 in his study. Clear Lake (Schindler and Nighswander, 1970) had a maximum average biomass of approximately 300 mg/m^3 and a Shield lake of Labrador (Duthie pers. comm.) had a value of 164 mg/m^3. The ELA values were around 1000 mg/m^3. Willen (op. cit.) concluded that the biomass of an uninfluenced Shield lake seldom exceeded 1000 mg/m^3 in the epilimnion during any time of the year. This applies to the ELA Class A lakes where the Chrysophyceae are the most important phytoplankton group.

A comparison of the phytoplankton assemblages (Table III) in the different classes of lakes may be found in Table IV. Here the percentage composition is based on the total number of different species found in the different classes of lakes rather than on biomass as in Figures 1-5. The predominance of Chrysophyceae is seen here as well, but the Cyanophyta and Chlorophyta appear to be much more important than is shown by their contribution to biomass. The proportion of desmids in comparison to

Euchlorophyta increases rather abruptly as the size of the lake decreases, with the greatest percentage of desmids occurring in the bogs (less than 1 m, Table III). Hilliard (1959) and Prescott (1963) have indicated similar findings in the Alaskan lakes of similar size.

Effects of eutrophication on phytoplankton species and standing crop

When the environment of a Shield lake is altered in any way, a change in standing crop and species composition of the lake is observed. The maximum biomass for a small Swedish lake surrounded by farms (Willen 1969) was found to be 2000 mg/m^3 compared to 400 mg/m^3 in the culturally undisturbed lakes of the area. The dominant algae were found to change to Cyanophyta and Diatomeae from a predominance of Chrysophyceae and Diatomeae. In Lake 227, a typical Class B lake with a maximum summer biomass of approximately 3000 mg/m^3, and a species composition of predominantly Chrysophyceae and Cryptophyceae before experimental fertilization was begun in 1969, the biomass rose to 7000 mg/m^3 in the summer of 1969, (Schindler *et al.*, 1971), to 15000 mg/m^3 in 1970 and 8000 mg/m^3 in 1971 (unpublished data). Throughout these years there was a progressive change to a predominance of Cyanophyta and Chlorophyta. The species dominating the Cyanophyta were not the typical 'bloom' species such as *Aphanizomenon*, *Anabaena* or *Microcystis*, although these are present in limited numbers in unfertilized lakes of the area, but species of Oscillatoria and Lyngbya. Lake 304, which also was experimentally fertilized in 1971 (P, N and C) responded similarly to Lake 227. There was a change from Chrysophyceae to Cyanophyta and Chlorophyta, with dominant species different from those in Lake 227, for example *Merismopedia* *tenuissima* became abundant, then *Scenedesmus* spp. became important (Kling, unpublished data). The biomass values are not yet available, but from the result of the other studies it would appear that average standing crop values together with the predominance of various algal groups are more valid indicators of the trophic state of a lake than individual 'indicator' species, at least in early stages of eutrophication.

The phytoplankton assemblage is very sensitive to small changes in the environment and i.e. pollution of different types can be revealed by its species composition long before it is possible to measure it by conventional physical-chemical methods.

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Table I. A list of the lakes of Class A, B and C, plus the Sphagnum bogs and the pond that were sampled during the period 1969-1971. Lake locations and a brief summary of major physical and chemical characteristics are presented by Cleugh and Hauser 1971.

Lake	Seasonal samples collected	Samples counted	Occasional samples examined
Class A lakes - large deep exposed lakes - A >20 ha, Zmax >7 m			
468			
668			
228	1970 - 1971	1971	1970-1971
161	1969	1969	1969-1970
305	1969 1971	1969	1969-1970-1971
239	1969 - 1971	- 1971	1969-1970-1971
259			1970
310			1970
317			1970
385			1970
302	1971		1970-1971
240	1969 - 1971	- 1971	1969-1970-1971
257			1970
Class B lakes - small deep protected lakes - A <13 ha, Zmax >6 m			
226	1971		1971
265	1971		1969-1970-1971
320	1971		1969-1970
120	1969 - 1971	- 1970	1969-1970-1971
298			1970
268			1970
230	1971		1970-1971
122			1970

241			1969-1970-1971
227	1969 - 1971	- 1971	1968-1969-1970-1971
261	1971		1970-1971
383			1970
314			1969-1970
132			1970
296			1970
99	1969		1969-1970
304	1969 - 1971	- 1970	1969-1970-1971
Class C lakes - small shallow lakes - Zmax <5 m			
114	1971		1969-1970-1971
303	1969 - 1971	- 1969	1969-1970-1971
Sphagnum bogs Zmax <1 m			
118			1969-1970
116			1969-1970
Pond			
470			1969-1970

TABLE II. Volumes of major species or genera encountered in ELA phytoplankton.

		Volume μ^3
1.	Cyanophyta	
	"small blue-greens"	
	Aphanocapsa spp. (col)	50-100
	Aphanothece spp. (col)	
	Chroococcus spp. (col)	
	Merismopedia spp. (col)	
	Gomphosphaeria lacustris (col)	2000
	Coelosphaerium kuetzingianum	2000
	Coelosphaerium naegelianum	10000
	Microcystis spp. (col)	2000
	Rhabdoderma spp. (col)	2000
	Anabaenea spp. (cell, col)	100, 50000
	"filementous blue-greens" (strips of 100)	
	Aphanizomenon spp.	300
	Oscillatoria spp.	
	Lyngbya spp.	
2.	Chlorophyta	
	Pyramidomonas tetrarhychnes	500
	Chlamydomonas spp.	200,300,500,1000,1500
	"small green algae"	50-150
	Gonium sociale	2000

Chlorogonium maximus	750
Gloeococcus schroeteri (cells)	100
Chlorella spp.	50
Oocystis spp.	50-300
Lagerheimia sp.	100
Tetraedron spp.	50-100
Scenedesmus spp. (cells)	50-500
Dictyosphaerium spp. (cell & col)	50,2000
Crucigenia spp.	50-100
Coelastrum spp.	10000
Selenastrum sp.	50-100
Kirchnerella sp.	50-100
Ankistrodesmus spp.	50-150
Quadriqula sp. (cells)	50-100
Elakotothrix sp. (cells)	50-100
Coccomyxa spp.	5
Stichococcus spp.	5
Planetonema lauterbornii (cell)	100
Closterium spp.	500-5000
Cosmarium spp.	50-3000
Xanthidium spp.	10000-50000
Euastrum spp.	5000-10000
Arthrodesmus spp.	1000
Staurastrum spp.	1000-10000
Spondylosium planum	300

Spaerozosma granulatum	300
Gymnozyga moniliformis	1500
Groenbladia sp.	1500-3000
Desmidium sp.	1500-3000

3. Euglenophyta

Euglena spp.	5000-9000-20000
Phacus spp.	5000-9000
Trachelomonas spp.	1000-2000
Lepocinclis sp.	3000
Distigma sp.	750
Astasia sp.	750

4. Chrysophyceae

"small Chrysophyceae"	50-100
Chrysococcus spp.	50
Chromulina spp.	150
Pseudokepherion spp.	50-100
Stenokalyx sp.	50-100
Mallomonas caudata	3000-8000
Mallomonas acaroides	1500
Mallomonas elongata	1000-3000
Mallomonas pumilio	1500
Mallomonas pumilio var.	500-1000

Mallomonas spp.	500-3000
Erkenia sp.	100-200
Synura spp. (cell, col)	300-30000
Dinobryon spp.	200,500,750,1000
Chrysoikos Skuja	100-200
Chrysolkos sp.	100-200
Epiphyxis spp.	200
Ochromonas spp.	300-500
Uroglena americana (cells, col)	300,50000
Chrysosphaerella spp. (cells, col)	300,50000
Bitrichia spp.	200
Chrysochromulina sp.	300
Sticogloea spp.	300
Bicoeca spp.	150-200
Isthmochloron trispinatum	200
Gleobotrys limneticus	300
Ophiocytium cochleare	2000
Botryococcus braunii	15000,30000

5. Diatomeae

Melosira spp. (cell)	200-1500
Cyclotella comta	2000
Cyclotella spp.	50-200
Rhizosolenia spp.	200

Tabellaria fenestrata	2000-3000
Tabellaria flocculosa	1000
Fragillaria crotenensis	650
Fragillaria contruens	200
Asterionella formosa (cells, col)	100,750,800
Synedra acus v. radians	200-650
Synedra acus var. angustissima	650
Synedra nana	200

6. Cryptophyceae

Gonyostomen semens	50000
Rhodomonas minuta	150-200
Rhodomonas spp.	100-500
Chroomonas spp.	100-200
Cryptomonas pusilla	300,500,750
Cryptomonas ovata	3000-8000
Cryptomonas obovata	3000-5000
Cryptomonas marsonii	1500-2500
Cryptomonas erosa	1500-5000
Cryptomonas playturis	5000
Cryptomonas rostratiformis	8000
Katablepharis ovalis	100-150
Cryptaulax spp.	100-150

7. Peridineae

Amphidinium spp.	3000-5000
Gymnodinium spp.	10000,20000,30000

Gymnodinium mirabile	5000-15000
Gymnodinium cf. lacustris	500-750, 100,2500
Gymnodinium helveticum	20000
Glenodinium spp.	1000-9000
Peridinium cinctum	
Peridinium willei	30000-50000
Peridinium palustre	
Peridinium limbatum	
Peridinium aciculiferum	7000-9000
Peridinium inconspicum	1000-3000
Ceratium spp.	50000

TABLE III. A list of the 131 genera and 458 taxa in ELA lakes during 1969-1971.

			Habitat				Season	Comments
			A	B	C	Others		
Cyanophyta								
I	1.	Microcystis flos-aquae (Wittrock) Kirchner	+				July-September	
	2.	Microcystis aeruginosa (Kützing)	+				July-September	
	3.	Microcystis viridis (A. Braun) Lemmermann		+			July-September	
	4.	Microcystis sp.	+	+			July-September	
II	1.	Aphanocapsa biformis A. Braun?		+			July-September	
	2.	Aphanocapsa elachista W. et G.S. West	+	+			July-September	
	3.	Aphanocapsa elachista var. planctonica G.M. Smith	+				July-September	
	4.	Aphanocapsa delicatissima W. et G.S. West	+	+	+		All year	
	5.	Aphanocapsa Grevillei (Hassall) Rabenhorst	+	+			July-September	
	6.	Aphanocapsa pulchra [Kützing] Rabenhorst	+	+			July-September	
III	1.	Aphanothece clathrata W. et G.S. West	+	+	+		All year	
	2.	Aphanothece clathrata var. brevis Bachmann	+	+	+		All year	
	3.	Aphanothece gelatinosa (Hennings) Lemmermann?		+			July-March	Species of Microcystis, Aphanocapsa, Aphanothece, Chroococcus,
	4.	Aphanothece microscopia Naegeli	+	+			July-March	Radiocystis, Gomphosphaena, Coelosphaereum and Merismopedia
	5.	Aphanothece microspora (Meneghini) Rabenhorst?	+	+			July-March	usually occupy the upper epilimnion of the lakes in mid-summer.
	6.	Aphanothece nidulans P. Richt	+	+			July-March	
	7.	Aphanothece stagnina (Spreng.) A. Braun		+			July-March	
IV	1.	Pelogoea bacillifera Lauterborn		+			June-August	Pelogloea species were found only in Lake 227 and Lake 304
	2.	Pelogoea chlorina Lauterborn		+			June-August	after artificial enrichment experiments were begun.
V	1.	Chroococcus limneticus Lemmermann	+	+	+		July-March	
	2.	Chroococcus turgidus (Kützing) Naegeli	+	+			July-March	
	3.	Chroococcus minatus (Kützing) Naegeli	+				July-March	
	4.	Chroococcus minimus (Keissler) Lemmermann	+				July-March	
	5.	Chroococcus dispersus (Keissler) Lemmermann	+	+	+		July-November	
	6.	Chroococcus dispersus var. minor G.M. Smith	+	+	+		July-November	
	7.	Chroococcus Westii [W. West] Boye-Petersen			+		July-March	
VI	1.	Radiocystis geminata Skuja	+				July-March	

		A	B	C	Others	Season		Comments
VII	1. Gomphospaeria lacustris Chodat	+	+	+		July-March		
	2. Gomphospaeria lacustris var. compacta Lemmermann	+				June-August		
	3. Gomphospaeria aponina Kützing	+	+	+		June-August		
VIII	1. Coelosphaerium Kuetzingianum Naegeli	+	+	+		July-March		
	2. Coelosphaerium Naegelianum Unger	+				July-August		
IX	1. Merismopedia elegans A. Braun		+			May-August		
	2. Merismopedia tenuissima Lemmermann	+	+L.304*			July-March	*July 1971	
	3. Merismopedia punctata Meyen	+	+			July-March		
	4. Merismopedia minima Beck	+		+		May-August		
	5. Merismopedia glauca (Ehrenberg) Naegeli		+			July-March		
X	1. Synechococcus aeruginosa Naegeli	+	+			May -October		Synechococcus sp. - found in the lower hypolimnion of these lakes.
	2. Synechococcus sp.		+					
XI	1. Gloeothece linearis var. composita G.M. Smith	+	+	+		July-October		
	2. Gloeothece linearis Naegeli	+	+	+		July-October		
XII	1. Rhabdoderma lineare Schmidle et Lauterborn	+	+			July-March		
	2. Rhabdoderma Gorskii Woloszynska	+	+	+		July-March		
	3. Rhabdoderma sigmoidea Moore et Carter ?	+	+			July-March		
	4. Rhabdoderma irregulare [Naumann] Geitler ?	+				July-March		
XIII	1. Dactylococcopsis lineare Geitler	+				July-October		
	2. Dactylococcopsis Smithii R. et F. Chodat	+	+			July-October		
XIV	1. Eucapsia alpina Clements et Schantz		+			July-September		
		+	+					
XV	1. Gloeocapsa sp.	+	+			July-September		
XVI	1. Phormidium sp.		+			July-September		
XVII	1. Aphanizomenon flos-aquae (Linneaus) Ralfs	L. 310		L. 303		August		Very seldom present in ELA lakes - More frequently found in Shield lakes receiving drainage from the prairies.

		A	B	C	Others		
XVIII	1. Anabaena planctonica Brunnthaler	+	+			July-April	Most abundant in mid-summer
	2. Anabaena flos-aquae [Ryngbye] Brébisson	+	+	+		July-April	
	3. Anabaena circinalis Rubenhorst	+	+	+		July-April	
	4. Anabaena sotitaria var. planctonica		tubes in L. 227			August	
	5. Anabaena sp.	+	+			July-September	
XIX	1. Spirulina laxa G.M. Smith		+			July-September	Present in the lower hypolimnion
XX	1. Oscillatoria limosa Agardh	+	+			July	
	2. Oscillatoria Agardhii var. isothrix Skuja	+	+			July-March	The species of this genera found in L. 227 were dominant in late summer of 1970 and spring of 1971.
	3. Oscillatoria Utermoehlii (Utermöhl) J. de Tini	+	+			July-August	
	4. Oscillatoria Lauterbornii Schmidle	+	+	+		July-October	
	5. Oscillatoria Redekei Van Goor		L. 227*			May-October	
	6. Oscillatoria tenuis Agardh		L. 230*-114			May-October	
	7. Oscillatoria limnetica Lemmermann		L. 227*			May-October	
	8. Oscillatoria geminata (Meneghini) Gomont		L. 227*			May-March	
	9. Oscillatoria amphigranulata Van Goor		L. 227*			May-March	
	10. Oscillatoria ornata Kreiger		+ L. 230			July	
XXI	1. Lyngbya limnetica Lemmermann	+	+	+		May-October	
	2. Lyngbya pseudospirulina Pascher		L. 304			All year	Present in lower hypolimnion and sediment surface of Lake 304
	3. Lyngbya vericolor (Wartmann) Gomont		+			July-October	
	4. Lyngbya endophytica Elenkin et Hollerbach		+			July-October	
XXII	1. Pelonema sp.		L. 227			July-October	
XXIII	1. Peloploca pulchra Skuja	+	+			June -September	
XXIV	1. Gloeotrichia echinulata (J.E. Smith) P. Richt	+				September	Only one specimen was found in a bay in Lake 161.

2. Chlorophyta

Protoblepharidinae

Protoblepharidales

Protoblepharidaceae

			A	B	C	Others		
I	1.	Scourfieldia cordiformis Takeda	+				January-May	
II	1.	Pyramidomonas tetrarhynochus Schenarda	+				January-May	Occasionally found throughout the summer and fall
Euchlorophyinae								
volvocales								
Chlamydomonadaceae								
III	1.	Carteria spp.	+	+	+		May-August	
IV	1.	Chlamydomonas sagittula Skuja	+	+	+		February-May	
	2.	Chlamydomonas cf. vernalis Skuja	+				February-May	
	3.	Chlamydomonas frigida Skuja	+				February-May	
	4.	Chlamydomonas spp.	+	+	+	P, Sb	February-May	
V	1.	Chlorogonium sp.	+	+			July-October	
	2.	Chlorogonium maximum Skuja	+	+			February-June	
	3.	Chlorogonium parvula Skuja	+	+			September-October	
Volvocaceae								
VI	1.	Gonium pectorale Müller	+	+			June-September	
	2.	Gonium sociale [Dujardin] Warming	+L310		+L303		June-September	
VII	1.	Pandorina morum (Müller) Bory	+			P	June-September	
VIII	1.	Eudorina elegans Ehrenberg	+	+	+	P	March-October	
IX	1.	Volvox aureus Ehrenberg				P	July-September	
Characiochloridaceae								
X	1.	Chariochloris incrassata Skuja	+			P	July-August	
	2.	Chariochloris epizootica [Korschikow] Pascher	+			P	July-August	

		A	B	C	Others	
Chlorodenoraceae						
XI	Chlorangium polychlorum Skuja	+				August
Tetrasporales						
Palmellaceae						
XII	Gemellicystis neglecta Teiling cm. Skuja	+				July-October
XIII 1.	Gloecystis planctonica [W. et G.S. West] Lemmermann	+				July-October
2.	Gloeocystis planctonica var. Subarctica Skuja?	+				July-October
XIV	Phacomyxa sphagnophila Skuja	+	+			July-August
XV	Gloeococcus Schroeteri [Chodat] Lemmermann	+	+	+		May-October
Tetrasporaceae						
XVI	Paulschulzia pseudevolvox [Schulz, Teiling] Skuja	+	+			July-August
Characiacea						
Hydrodicxyaceae						
XVII 1.	Pediastrum duplex Meyen	+			P	June-August
2.	Pediastrum Boryanum [Turpin] Meneghini	+	+			June-August
3.	Pediastrum tetras [Ehrenberg] Ralfs	+	+	+		June-October
Oocystaceae						
XVIII 1.	Chlorella vulgaris Beyer	+				April-August
2.	Chlorella pyrenoidosa [Chick]	+				April-August
XIX 1.	Oocystis submarina var. variablis Skuja	+	+	+		All year
2.	Oocystis lacustris Chodat	+				April-August
3.	Oocystis solitaria Wittrock	+				All year
4.	Oocystis borgei Snow	+				June-September

		A	B	C	Others		
XX	1. Nephrocytium limneticum (G.M. Smith) Skuja	+				July-December	
	2. Nephrocytium lunatum W. West				P	August	
	3. Nephrocytium Agardhianum Naegeli	+			Sb	July-September	
XXI	1. Lagerheimia ciliata (Lagerheim) Chodat	+				April-August	
XXII	1. Tetraëdron limneticum Borge	+	+			May-August	
	2. Tetraëdron caudatum (Corda) Hansgirg	+				July-September	
	3. Tetraëdron minimum (A. Braun) Hansgirg	+	+	+		All year	Found in Lake 227 in 1969 in great abundance
	4. Tetraëdron minimum v. tetralobulatum Reisch	+	+	+		All year	
Coelastraceae							
XXIII	1. Scenedesmus acuminatus (Lagerheim) Chodat	+	+			March	
	2. Scenedesmus incrassatulus Bohlin	+				September	
	3. Scenedesmus serratus f. minor Chodat	+				February-August	
	4. Scenedesmus quadricauda Chodat				P	May-October	
	5. Scenedesmus quadricauda var. longispina (Chodat) G.M. Smith	+				April-August	
	6. Scenedesmus denticulatus Lagerheim	+	+			July-September	Lake 304
	7. Scenedesmus platydiscus (G.M. Smith) Chodat	+				July-September	
	8. Scenedesmus pannonicis Hortobagyi			+		July-September	
	9. Scenedesmus brevispina (G.M. Smith) Chodat		+			July-September	Lake 304 after artificial enrichment
XXIV	1. Dictyosphaerium pulchellum Wood	+	+			July-October	
	2. Dictyosphaerium simplex Skuja	+				July-October	
XXV	1. Dimorphococcus lunatus A. Braun	+			P	May-August	
XXVI	1. Dispora crucigenoides Printz ?	+				August	
XXVII	1. Crucigenia quadrata Morren	+				June-August	
	2. Crucigenia rectangularis (A. Braun) Gay	+				June-August	
	3. Crucigenia rectangularis var. irregularis (Wille) Brunnthal	+				June-August	

		A	B	C	Others	
	4. Crucigenia tetrapedia (Kirchner) W. et G.S. West	+	+	+		All year
	5. Crucigenia apicutata (Lemmermann) Schmidle	+	+			July-October
XXVIII	1. Coelastrum cambricum Archer			+	P	May-August
	2. Coelastrum morus W. et G.S. West			+		May-August
	4. Coelastrum microporum Naegeli	+	+			May-September
	5. Coelastrum cubicum Naegeli		+			May-September
XXIX	1. Selenastrum minutum (Naegeli) Collins		+			May-August
	2. Selenastrum capricornutum Printz		+			May-August
XXX	1. Kichnerella lunaris (Kirchner) Moebius	+				May-August
XXXI	1. Ankistrodesmus falcatus (Corda) Ralfs	+	+	+		All year
	2. Ankistrodesmus falcatus var. mirabilis W. et G.S. West	+				April-October
	3. Ankistrodesmus falcatus var. spiralis (W.B. Turner) G.S. West	+	+			All year
	4. Ankistrodesmus acicularis A. Braun	+	+			April-October
	5. Ankistrodesmus setigerus (Schröder) G.S. West	+				April-October
XXXII	1. Quadrigula closteroides (Baulin) Printz	+	+	+		July-October
	2. Quadrigula Pfitzeri Schroeder	+	+			July-September
XXXIII	1. Elakatothrix gelatinosa Wille	+	+	+		May-October
XXXIV	1. Coccomyxa minor Skuja		+			November-December
	2. Coccomyxa sp.	+	+	+		All year
XXXV	1. Planctonema Lauterbornii Schmidle	+				August
XXXVI	1. Stichococcus atomus Skuja	+	+	+		September-May
	2. Stichococcus minutissimus Skuja	+	+			September-May

			A	B	C	Others	
Desmidiaceae							
XXXVII	1.	Closterium kutzingii Brebisson		+	+	Sb	July-September
	2.	Closterium pronum Brebisson		+	+	Sb	July-September
XXXVIII	1.	Pleurotaenium gladosum			+	Sb	July-October
	2.	Pleurotaenium trabeula (Ehrenberg) Naegeli			+	Sb	July-October
	3.	Pleurotaenium sp.	+				July-October
XXXIX	1.	Cosmarium depressum var. achondrum (Boldt) W. et G.S. West	+				July-October
	2.	Cosmarium Comminsurale var. crassum Nordsted		+	+		July-October
	3.	Cosmarium spp.	+	+	+	Sb	July-October
XL	1.	Euastrum sinuosum Lenorm			+	Sb	June-October
	2.	Euastrum sinuosum var. Ceylanicum W. et G.S. West			+	Sb	June-October
	3.	Euastrum bitendatum Naegeli (inkl. E. nostratum Ralfs)			+	Sb	June-October
	4.	Euastrum denticulatum (Kirchner) Gay			+	Sb	June-October
	5.	Euastrum sp.				Sb	June-October
XLI	1.	Micrasterias pinnatifida (Kützing) Ralfs			+	Sb	June-October
	2.	Micrasterias muricata (Bailey) Ralfs			+	Sb	June-October
	3.	Micrasterias foliacea var. ornata Nordstedt			+	Sb	June-October
	4.	Micrasterias truncata (Corda) Brebisson			+	Sb	June-October
XLII	1.	Xanthidium subhastiferum West				Sb	June-October
	2.	Xanthidium antilopaeum (Brebisson) Kützing		+	+	Sb	June-October
	3.	Xanthidium armatum (Brebisson) Rabenhorst				Sb	June-October
	4.	Xanthidium cristatum var. cf. uncinatum Gütwinski				Sb	June-October
	5.	Xanthidium cristatum Brebisson				Sb	June-October
	6.	Xanthidium perissacanthum Scott et Prescott					June-October
XLIII	1.	Arthrodesmus incus (Brebisson) Hasslow	+	+	+		All year

			A	B	C	Others		
	2.	Arthrodesmus incus var. validus West	+	+	+		All year	
	3.	Arthrodesmus incus var. Ralfsii W. et G.S. West	+				April-October	
	4.	Arthrodesmus triangularis Lagerheim	+			Sb	March	
	5.	Arthrodosmus convergens Ehrenberg	+	+			June-October	
	6.	Arthrodesmus cf. sachlanii Scott et Prescott				Sb	June-October	
XLIV	1.	Staurastrum curvatum W. West	+	+	+	Sb	August-October	
	2.	Staurastrum cuspidatum Brebisson				Sb	July-October	
	3.	Staurastrum cuspidatum var. divergens Wordstedt		+		Sb	July-October	
	4.	Staurastrum lunatum var. planctonicum W. et G.S. West	+	+		Sb	July-October	St. paradoxum, St. paradoxum var. parvum, and St. lunatum var. planctonicum were abundant in L. 227 in the summer of 1969. They formed a large proportion of the total biomass of Chlorophyta, dominating the plankton at this time.
	5.	Staurastrum paradoxum Meyen		+		Sb	July-October	
	6.	Staurastrum paradoxum var. parvum W. West				Sb	July-October	
	7.	Staurastrum pseudopelagicum W. et G.S. West				Sb	July-October	
	8.	Staurastrum cerastes Lund	+	+	+	Sb	July-October	
	9.	Staurastrum clevei (Wittrock) Roy et Bisset		+		Sb	July-October	
	10.	Staurastrum leptocladum Nordstedt				P, Sb	July-October	
	11.	Staurastrum leptocladum var. cornutum Wille				Sb	July-October	
	12.	Staurastrum leptocladum sinuatum Wolle				Sb	July-October	
	13.	Staurastrum longimum var. spiniferum Scott et Groenblade				Sb	July-October	
	14.	Staurastrum longiradiatum W. et G.S. West				Sb	July-October	
	15.	Staurastrum bullardii G.M. Smith	+	+	+		July-October	St. bullardii is the predominant staurastrum species in L. 240
	16.	Staurastrum setigerum Cleve				Sb	July-October	
	17.	Staurastrum actiscon (Ehrenberg) Lundell	+	+		Sb	July-October	
	18.	Staurastrum arachne Ralfs	+	+	+		July-October	
	19.	Staurastrum arachne var. arachnoides W. et G.S. West				Sb	July-October	
	20.	Staurastrum ophiura Lund		+		Sb	July-October	
	21.	Staurastrum cf. anatinium Cooke et Wills		+		Sb	July-October	
	22.	Staurastrum cf. anatinium ja. denticulatum G.M. Smith		+		Sb	July-October	
	23.	Staurastrum elongatum Barker				Sb	July-October	

			A	B	C	Others	
	24.	Staurastrum rugosum Irenee-Marie				Sb	July-October
	25.	Staurastrum pentacerum (Wolle) G.M. Smith		+		Sb	July-October
	26.	Staurastrum brachiatum Ralfs.				Sb	July-October
	27.	Staurastrum longibrachiatum (Borge) Gutwinski				Sb	July-October
	28.	Staurastrum jaculiferum West		+		Sb	July-October
	29.	Staurastrum protectum West et West var. planctonicum G.M. Smith		+		Sb	July-October
	30.	Staurastrum hystrix Ralfs		+		Sb	July-October
	31.	Staurastrum cf. hexacerum (Ehrenberg) Wittrock				Sb	July-October
	32.	Staurastrum apiculatum Brébisson				Sb	July-October
	33.	Staurastrum inconspicum Nordstedt				Sb	July-October
	34.	Staurastrum gracile var. nanum Wille				Sb	July-October
	35.	Staurastrum subgracillimum W. et G.S. West				Sb	July-October
	36.	Staurastrum pachyrhynchum Nordstedt				Sb	July-October
	37.	Staurastrum vestitum Ralfs				Sb	July-October
	38.	Staurastrum quadrispinatum Turner				Sb	July-October
	39.	Staurastrum gladiosum Turner				Sb	July-October
	40.	Staurastrum longipes (Nordstedt) Teiling	+			Sb	July-October
	41.	Staurastrum lacustre G.M. Smith	+			Sb	July-October
	42.	Staurastrum brasiliense var. Lundelii W. et G.S. West				Sb	July-October
	43.	Staurastrum brevispinum Brébisson		+			July-October
	44.	Staurastrum subcuriatum Cooke and Wille		+			July-October
	45.	Staurastrum gemillisparum Nordstedt		+			July-October
	46.	Staurastrum Freemanii West et West				Sb	July-October
	47.	Staurastrum Wildemanii Gutwinski				Sb	July-October
	48.	Staurastrum Johnsonii W. et G.S. West		+		Sb	July-October
	49.	Staurastrum avirula Brebisson		+			July-October
	50.	Staurastrum orbiculare Ralfs		+		Sb	July-October
XLV	1.	Hyalothece dissiliens (Smith) Brebisson	+			Sb	July-October
	2.	Hyalothece mucosa (Dillwanger) Ehrenberg			+	Sb	July-October
	3.	Hyalothece neglecta Raciborski			+	Sb	July-October
XLVI	1.	Desmidium quadratum Nordstedt			+	Sb	July-October

Most of the Staurastrum species were found in sphagnum bogs where desmids composed the highest percentage of the phytoplankton.

			A	B	C	Others		
	2.	Desmidium Grevillei (Kützing) De Bary			+	Sb	July-October	
	3.	Desmidium Baileye (Ralfs) Nordstedt			+	Sb	July-October	
XLVII	1.	Groenbladia neglecta (Raciborski) Teiling			+	Sb	July-October	
XLVIII	1.	Bambusina Brebissonii Kützing			+	Sb	July-October	
XLIX	1.	Spirotaenia condensata Brébisson				Sb	July-October	
L	1.	Triplocera verticillatum Bailey				Sb	July-October	
LI	1.	Sphaerozosma granutatum Roy et Bisset		+	+	Sb	March-October	Sphaerozosma granulatum and Spondylosium planum were the dominant Chlorophyta forming the largest percentage of the biomass in July and August in L. 227 in 1970.
LII	1.	Spondylosium planum [Wolle] W. et G.S. West		+	+		March-October	
	2.	Spondylosium papillosum W. et G.S. West		+	+		March-October	

3. Euglenophyta

Euglenales

Euglenaceae

			A	B	C	Others	
I	1.	Euglena pisciformis Klebs	+	+		P	February-October
	2.	Euglena viridis Ehrenberg	+	+		P, Sb	February-October
	3.	Euglena acus Ehrenberg	+	+	+		February-October
	4.	Euglena spirogyra Ehrenberg	+	+			February-October
	5.	Euglena cf. gracilis Klebs	+	+		P	February-October
	6.	Euglena sp.	+	+		P	February-October
II	1.	Lepocinclis ovum [Ehrenberg] Lemmermann		+			May-August
III	1.	Phacus caudatus Hübner	+	+	+	P	May-October
	2.	Phacus longicauda (Ehrenberg) Dujardin	+	+	+		June-August
	3.	Phacus spp.	+	+	+		June-October
IV	1.	Trachelomonas volvocina Ehrenberg	+	+	+		All year

			A	B	C	Others		
	2.	Trachelomonas lacustris var. ovalis Drězepolski		+		L 227	May	
	3.	Trachelomonas hispida (Perty) Stein	+	+	+		All year	
	4.	Trachelomonas oblonga Lemmermann	+	+	+		All year	
	5.	Trachelomonas bacillifera Playfair	+	+	+		All year	
	6.	Trachelomonas cf. cylindrica E. sec. Playfair		+			All year	
	7.	Trachelomonas spinosa Stokes				Sb	July-October	
	8.	Trachelomonas spinulosum (Skŭ.) Deflandre				Sb	July-October	
	9.	Trachelomonas superba Suirenko	+	+	+		May -October	
	10.	Trachelomonas armata var. longispina				Sb	July-October	
	11.	Trachelomonas sp.	+	+	+		All-year	
V	1.	Colacium vesiculosum Ehrenberg	+				All year	
	2.	Colacium arbuscula Stein	+				All year	

4. Chrysophyta

a. Chrysophyceae

Chrysomonadidae

Chromulinales

Euchromulinaceae

			A	B	C	Others		
I	1.	Chromulina erkensis (Skuja)	+	+	+		All year	
	2.	Chromulina spp.	+	+	+		All year	
II	1.	Phaeaster aphanaster (Skuja) Bournelly	+	+	+		All year	The small chrysophyceae are most abundant in late fall through to late spring in most ELA lakes.
III	1.	Chrysococcus minutus [Fritsch] Nygaard	+				All year	
	2.	Chrysococcus rufescuns Klebs	+	+	+		All year	
	3.	Chrysococcus biporus Skuja	+	+	+		All year	
	4.	Chrysococcus cupiliformis			+		June-October	
	5.	Chrysococcus klebsianus			+		June-October	
IV	1.	Kephyrion littorale Lund	+				July-August	
	2.	Kephyrion spirale (Lackey) Conrad	+	+			May-August	
	3.	Kephyrion obliguum Hilliard		+			May-August	

			A	B	C	Others		
	4.	Kephyrion boreale Skuja	+	+	+		May-August	
	5.	Kephyrion rubri-claustri Conrad	+				February L. 120	
V	1.	Kephyriopsis elegans Hilliard	+				May-October	
	2.	Kephyriopsis gracilis Hilliard	+	+	+		April-August	
	3.	Kephyriopsis limnetica Hilliard	+	+			May	
	4.	Kephyriopsis cordata Hilliard	+	+			October	
VI	1.	Stenokalyx monilifera (Gerloff) Schmid.	+				May-October	
Mallomonadaceae								
VII	1.	Mallomonas globosa Schiller		+	+	Sb	March	
	2.	Mallomonas reginae Teiling	+	+	+		All year	
	3.	Mallomonas majorensis Skuja	+			P	May-August	
	4.	Mallomonas producta var. marchica Lemmermann	+				August	
	5.	Mallomonas caudata Iwanoff	+	+	+		All year	
	6.	Mallomonas acaroides Perty	+	+	+		All year	
	7.	Mallomonas elongata Reverdin	+	+	+		All year	
	8.	Mallomonas pseudocoronata Prescott	+	+	+		May-October	
	9.	Mallomonas pumilio Harris et Bradley	+	+		P	June-March	
	10.	Mallomonas pumilio var. Harris et Bradley	+	+	+		All year	M. pumilio var. is most abundant in the spring and fall in L. 227.
	11.	Mallomonas mangofera Harris et Bradley	+				June-August	
	12.	Mallomonas papillosa Harris et Bradley	+				June-August	
	13.	Mallomonas cf. cratis Harris et Bradley	+				June-August	
	14.	Mallomonas heterospina		+		Sb	June-September	
	15.	Mallomonas akrokomos Ruttner	+	+			June-September	
	16.	Mallomonas cf. rhapaloides Conrad.			+		July-September	
	17.	Mallomonas Teiling i (Teiling) Conrad.	+	+			July-October	
	18.	Mallomonas heterotricha Nygaard	+	+			July-September	
	19.	Mallomonas intermedia Kisselow	+	+	+		July-October	
	20.	Mallomonas oviformis Nygaard	+	+		Sb	July-September L. 227	
	21.	Mallomonas multiunca Asmund		+			July-October	
	22.	Mallomonas lelymene Harris et Bradley		+			July-October	

		Species	A	B	C	Others	Period		Remarks
	23.	Mallomonas coronata Pemain et Vinnikova		+			July-October		
Isochrysidales/Isochrysidaceae									
VIII	1.	Erkenia subaequiciliata Skuja	+	+			September-April	L. 227	
IX	1.	Synura uvella Ehrenberg et Korschikow	+	+	+		May-August		The Synura species found in the bogs often had red
	2.	Synura sphagnicola Korschikow	+	+	+	Sb	May-July		hematochrome pigment spots in the anterior end of
	3.	Synura petersenii Korschikow	+	+		P	June-August		the cell. The species S. biorete/Sphagnocoli were often observed
	4.	Synura adamsii G.M. Smith	+	+		P	July-September		clustered around the bodies of dead zooplankton.
	5.	Synura biorete Huber-pestalozzi	+	+	+	Sb	July-September		These may be nutrient sources.
X	1.	Dinobryon Borgei Lemmermann	+	+	+		All year		According to Hilliard 1967 the varieties of D. borgei
	2.	Dinobryon Borgei var. elongata Pascher	+	+	+		November		and suecicuim are cyclomorphic forms and are not valid
	3.	Dinobryon suecicum var. longispinum Lemmermann	+	+	+		May-August		taxa. The spine length and lorica shape vary with
	4.	Dinobryon suecicum Lemmermann	+	+	+		May-August		temperature and these varieties are probably intermediate
	5.	Dinobryon crenulatum W. et G.S. West	+	+		Sb	May-August		forms.
	6.	Dinobryon acuminatum Ruttner	+	+	+		May-October		
	7.	Dinobryon elegantissimum Bournelly	+		+	P Sb	August-December		
	8.	Dinobryon bavaricum Imhof	+	+	+		All year		
	9.	Dinobryon bavaricum vanhöffenii (Bachmann) Krieger	+	+	+		May-August		
	10.	Dinobryon divergens Imhof	+	+			All year		
	11.	Dinobryon divergens var. schauinslandii (Lemmermann) Brunnthaler		+	+	Sb	July-December		
	12.	Dinobryon cylindricum Imhof	+				All year		L. 305
	13.	Dinobryon cylindricum var. palustre Lemmermann	+	+	+		All year		
	14.	Dinobryon cylindricum var. Alpinum (Imhof) Zachmann	+	+			March-June		D. cylindricum var. alpinum is predominant species
	15.	Dinobryon sertularia Ehrenberg	+	+	+		May-August		of Duniobryon in L. 227.
	16.	Dinobryon sertularia var. protruberans (Lemmermann) Krieger	+	+	+		May-August		
	17.	Dinobryon pediforme (Lemmermann) Steineche	+	+			May-August		
	18.	Dinobryon sociale Ehrenberg	+	+			April-August		
	19.	Dinobryon sociale var. stipitatum (Stein)					April-August		
		Lemmermann		+	+		April-August		

			A	B	C	Others		
	20.	Dinobryon sociale var. Americanum (Brunnthaler) Bachmann	+	+	+		April-December	The Dinobryon species were classified according to Ahlstrom, 1937.
	21.	Dinobryon campanulastipitum Ahlstrom	+	+			June-September	
XI	1.	Chrysolykos planctonicus Mack		+			April-July	
XII	1.	Chrysockkos skujai {Nauwerck] Willén	+	+	+		All year	
XIII	1.	Ochromonas globosa Skuja	+		+		March	
	2.	Ochromonas verrucosa Skuja	+				June	
	3.	Ochromonas stellaris Doflein	+	+	+		June	
	4.	Ochromonas sparseverrucosa var. septentrionalis Skuja			L. 303		June-August	
	5.	Ochromonas spp	+	+	+		All year	
XIV	1.	Uroglena americana Calkins	+	+	+		May-October	
Chrysosphaerellaceae								
XV	1.	Chrysosphaerella Rodhei Skuja		+			May	
	2.	Chrysosphaerella longispina Lauterborn	+	+	+		May-October	
Lepochromonadaccae								
XVI	1.	Pseudokephyrion alaskanum Hilliard	+	+			May-October	
	2.	Psueudokephyrion attenuatum Hilliard	+				May-December	
	3.	Pseudokephyrion angulosum Hilliard				P, Sb	May-October	
	4.	Pseudokephyrion parvum Hilliard	+	+			February-June	
	5.	Pseudokephyrion hiemale Hilliard		+			February-June	
	6.	Pseudokephyrion minutissimum Conrad	+	+			May-October	
	7.	Pseudokephyrion spirale (Gerloff) Schmid	+	+			May-October	
	8.	Pseudokephyrion spp.	+	+	+	Sb	All year	
XVII	1.	Epiphyxis utriculus var. acuta {Schiller] Hilliard	+	+	+		All year	E. utriculus is epiphytic on D. divugens and E.

			A	B	C	Others		
	2.	Epiphyxis tabellariae [Lemmermann] G.M. Smith	+				All year	tabellariae is epiphytic on T. fenestrata.
	3.	Epiphyxis alaskana Hilliard		+			June-October	
	4.	Epiphyxis gracilis Hilliard	+				June-October	
	5.	Epiphyxis spp.	+	+			All year	
Rhizochrypidae								
Rhizochrysidales								
Rhizochrysidaceae								
XVIII	1.	Rhizochrysis sp.	+	+	+		June-October	
XIX	1.	Chrysideastrum catenatum Lauterborn	+				June-October	
XX	1.	Chrysostephanosphaera globulifera Scherffel	+	+	+		June-October	
XXI	1.	Chrysocapsa planctonica (W.et G.S. West) Pascher		+	+		July-October	
Chrysocapsinae								
Chrysocapsales								
Bitrichiaceae								
XXII	1.	Bitrichia chodatii (Reverdin) Chodat.		+			May-June	Lake 227
	2.	Bitrichia longispina (Lund) Bourrelly	+	+	+		April-August	
Prymesiales								
Prymesiaceae								
XXIII	1.	Chrysochromulina cf. parva Lackey		+			May-December	The Chrysochromulina cf. parva is dominant in L. 304, L. 114 and present in large numbers in L. 303 during the period. During the winter months there is a rapid decline in numbers when rotifer populations increase. This species appears to be heterotrophic. It has been observed ingesting particles which it captures by means of the hapteron.
Chrysosphaerales								
Stichogloeaceae								
XXIV	1.	Stichogloea olivacea Chodat	+	+			August-November	
	2.	Stichogloea Doederleinii (Schmidle) Wille	+	+	+	Sb	August-November	

		A	B	C	Others		
Craspedomonadales							
Bicoecaceae							
XXV	1. Bicoeca lacustris Clark	+				June-November	Bicoeca lacustris is epiphytic on T. fenestrata and Asterionella formosa in L. 240.
	2. Bicoeca ainikkiae Jhrnefelt	+	+			February-June	
	3. Bicoeca De pucguesiana Bourrelly	+	+			July-November	
Craspemonadaceae							
XXVI	1. Salpingoeca Buetschlii Lemmermann	+				June-October	S. freguentissima is epiphytic on Asterionella formosa and tabellaria fenestrata in L. 240.
	2. Salpingoeca frequentissima (Zacharias) Lemmermann	+	+			July-November	
Heterokontae (= Xanthophyceae)							
Oleurochloridaceae							
XXVII	1. Isthomochloron trispinatum (West et West) Skuja	+	+			May-October	
Gloeobotrydaceae							
XXVIII	1. Gloeobotrys limneticus G.M. Smith] Pascher	+	+	+		May-August	
Ohlorotheciaceae							
XXIX	1. Ophiocytium cochleare A. Braun	+	+		P	May-August	Botryococcus braunii is the dominant alga in L. 120 in the spring.
Botryococcaceae							
XXX	1. Botryococcus Braunii Kützing	+	+	+		All year	
	2. Botryococcus protruberans W. et G.S. West	+	+			June-October	
	3. Botryococcus sudeticus Lemmermann	+	+			July-September	
XXXI	1. Ducelliera chodatii [Ducellier] Teiling	L 239				July-September	

			A	B	C	Others			
b. Bacillariophyceae									
centrales									
Coscinodiscaceae									
I	1.	Melosira granulata [Ehrenberg]							
	2.	Melosira islandica helvetica O. MUeller	+				August	L. 240	M. distens cells can be found in all lakes
	3.	Melosira ambigua [Grunow] O. MUeller'	+				July-October	L. 240	but never in any abundance.
	4.	Melosira italica subarctica O. MUeller	+				March	L. 382	
	5.	Melosira distans [Ehrenberg] Krieger	+	+	+		All year	L. 240	
II	1.	Cyclotella KUetzingiana Thwait	+				All year		
	2.	Cyclotella stelligera Cleue	+				All year		
	3.	Cyclotella comta Ehrenberg	+				All year		In L. 240 Cyclotella comta was infected with a species
	4.	Cyclotella glomerata Buchmann ?	+	+	+		All year		of Rhizophydium.
	5.	Cyclotella ocellata Pantocsele	+	+	+		All year		
Soleniaceae									
III	1.	Rhizosolenia eriense A.L. Smith	+	+	+		All year		Rhizosolinia eriense was most common in the larger class
	2.	Rhizosolenia longiseta Zacharias ?	+	+	+		All year		A lakes.
Pennales/Fragilariaceae									
IV	1.	Tabellaria fenestrata (Lyngbya) KUtzing	+	+			All year		
	2.	Tabellaria flocculosa [Rothest] KUtzing	+	+	+		All year		
V	1.	Fragilaria crotonensis Kitton	+	+	+		All year		Species of Fragellaria are seldom numerous in ELA lakes.
	2.	Fragilaria construens (Ehrenberg) Grunow	+	+	+		All year		
	3.	Fragilaria spp.	+	+	+		All year		
VI	1.	Synedra acus KUtzing	+	+	+		All year		Synedra acus var. angustissima composed 70-90 per cent
	2.	Synedra acus var. radians (KUtzing) Hustedt	+	+	+		All year		of the total biomass in L. 303 in midsummer.
	3.	Synedra acus var. angustissima Grunow			+	L 303*	All year		
	4.	Synedra nana Meister	+				June-October		

			A	B	C	Others		
VII	1.	Asterionella formosa Hassall	+	+	+		All year	Asterionella formosa was most abundant in the class A lakes.
	2.	Asterionella formosa var. acaroides Lemmermann	+				June-October	
	3.	Asterionella gracillima (Hantzsch) Hassall	+	+			June-October	
Pyrrophyta								
Chloromonadophyceae								
Chloromonadales								
Monomastigaceae								
I	1.	Monomastix opisthostigma Scherffel	+	+		P	June-July	
Chloromonadaceae								
II	1.	Gonyostomum semens (Ehrenberg) Diesing	+	+	+		May-September	
a. Cryptophyceae								
Cryptomonadales								
Cryptomonadaceae								
III	1.	Rhodomonas minuta Skuja	+	+	+		October-June	
	2.	Rhodomonas minuta var. nannoplanctica Skuja	+	+	+		May-November	
	3.	Rhodomonas lacustris Pascher et Ruttner	+	+			All year	
	4.	Rhodomonas tenuis Skuja	+	+			All year	
IV	1.	Chroomonas coerulea [Geitler] Skuja	+				February-April	
	2.	Chroomonas nordstedtii Hansgisg	+				February-April	
V	1.	Cryptomonas pusilla Bachmann	+	+	+		All year	
	2.	Cryptomonas erosa Ehrenberg	+	+	+		All year	In the spring the Cryptomonads composed about 30 per cent of the total phytoplankton biomass of the Class A lakes and a small percentage in the others. They usually formed a maximum about the end of April or early part of May.
	3.	Cryptomonas ovata Ehrenberg	+	+	+		All year	
	4.	Cryptomonas tenuis Pascher	+			P	August	
	5.	Cryptomonas obovata Skuja	+	+	+		September-June	
	6.	Cryptomonas reflexa Skuja	+	+			September-June	
	7.	Cryptomonas gracilis Skuja	+				February-April	

			A	B	C	Others		
	8.	Cryptomonas marssonii Skuja	+	+	+		All year	
	9.	Cryptomonas borealis Skuja	+				September-June	
	10.	Cryptomonas platyuris Skuja	+	+	+		April-October	
	11.	Cryptomonas rostratiformis Skuja	+	+			April-October	
VI	1.	Chilomonas paramaecium Entz		+ L.227			July-August	This genus was found in L. 227 in the summer of 1970 accompanied by a large number of ciliates, protozoa and rotifers.
	2.	Chilomonas sp.		+ L.227			July-August	
Katablysharidaceae								
VII	1.	Katablepharis ovalis Skuja	+	+	+		All year	
Senniaceae								
VIII	1.	Sennia parvula Skuja	+	+			April	
IX	1.	Cryptaulax vulgaris Skuja	+	+			All year	
	2.	Cryptaulax sp.	+				April	
b. Peridineae (Dinophyceae)								
Gymnodenales								
Gymnodiniaceae								
I	1.	Amphidinium sp.	+	+	+		All year	
	2.	Amphidinium luteum Skuja	+	+	+		All year	
II	1.	Gymnodinium fuscum [Ehrenberg] Stein			+ L.303		June-August	The peridineae usually have a small spring and fall maximum constituting from 10-25 per cent of the algal biomass. The predominant species are G. mirabile, G. palustre, G. uberrimuum, P. aciculiferum, P. inconspicum and P. willei. Peridinium Wisconsiense is the predominant peridinium species in L. 114 in the summer (July and August). It is a very red color in this lake which is shallow and relatively humic. In the class A or B lakes in which it is also present, but in smaller numbers, it has the typical brownish-yellow color of the group. Some of the other Gymnodinium species which are found in Class C lakes
	2.	Gymnodinium mirabile Penard	+	+	+		June-August	
	3.	Gymnodinium uberrimuum [Allman] Kotoid et Swezy	+	+		P	June-August	
	4.	Gymnodinium palustre Schilling	+	+			May-September	
	5.	Gymnodinium ordinatum Skuja	+	+			May	
	6.	Gymnodinium cf. limneticum Woloszynska	+			P	August	
	7.	Gymnodinium triceratium Skuja	+				May-August	
	8.	Gymnodinium cf. lacustre Schiller	+	+	+		May-September	
	9.	Gymnodinium helveticum Penard	+	+	+		All year	
	10.	Gymnodinium sp.	+	+	+		All year	

			A	B	C	Others	
Peridinales/Glenodiniaceae							
III	1.	Glenodenium Pascheri Suckland		L. 230			February
	2.	Glenodinium spp.	+	+	+		All year
Peridiniaceae							
IV	1.	Peridinium cinctum Ehrenberg	+	+			June-September
	2.	Peridinium Willei Huitfeldt-Kaas	+	+	+		All year
	3.	Peridinium palustre [Lindemann] Lefévre	+	+	+		June-September
	4.	Peridinium limbatum (Stokes) Lemmermann	+		+	P	July-September
	5.	Peridinium volzii Lemmermann		L. 320			July-September
	6.	Peridinium aciculiferrim Lemmermann	+	+	+		All year
	7.	Peridinium Wisconsiense Eddy	+	+	+	P	June-October
	8.	Peridinium africanum var. remotum fa. tatricum					July-September
		(Woloszynska) Lefévre	+	+			July-September
	9.	Peridinium inconspicum Lemmermann	+	+	+		June-October
	10.	Peridinium pusillum (Penard) Lemmermann	+	+	+		May-October
	11.	Peridinium goslaviense Woloszynska	+	+	+		June-September
	12.	Peridinium umbonatum Stein	+		+		July
V	1.	Ceratium hirundenella [Müller] Schrank	+	+	+		July-September
	2.	Ceratium cornutum [Ehrenberg] Claparede	+			P	July-September
	3.	Ceratium carolinianum [Bailey] Jörgensen	+			P	July-September

also have a red pigment spot in them which is not present in less humic waters. The pigment spot is hematochrome, the presence of which is a possible indicator of facultative heterotrophy as in the Synura species.

Table IV   Percent by numbers of species of phytoplankton in different taxonomic groups

	*Class A	*Class B	*Class C	Peters & Schrader (Holmgren, unpub.)	N.Laksjon (Holmgren,1968)	Karluk (Hilliard) 1959	Prescott (1963)
CYANOPHYTA	16	19	11	10	15	7.5	11
CHLOROPHYTA						21.9	
Euchlorophyta	22	13	11	25	26		9
Desmidiales	5	12	19	5	17		75
EUGLENOPHYTA	5	6	5	4	5	-	1.23
CHRYSOPHYCEAE	29	31	30	22	16	3.9	2.51
DIATOMEAE	7	5	8	15	8	65.1	-
PYRROPHYTA						1.6	.99
Cryptophyceae	7	7	6	10	5		
Peridineae	8	8	11	9	8		

*Class A - ELA large deep Oligotrophic lakes.
Class B - ELA small deep protected lakes.
Class C - ELA small shallow lakes.

CAPTIONS FOR FIGURES

Figure 1. Average phytoplankton volume in the euphotic zone (15 m) in Lake 305 in 1969, and accumulative per cent composition.

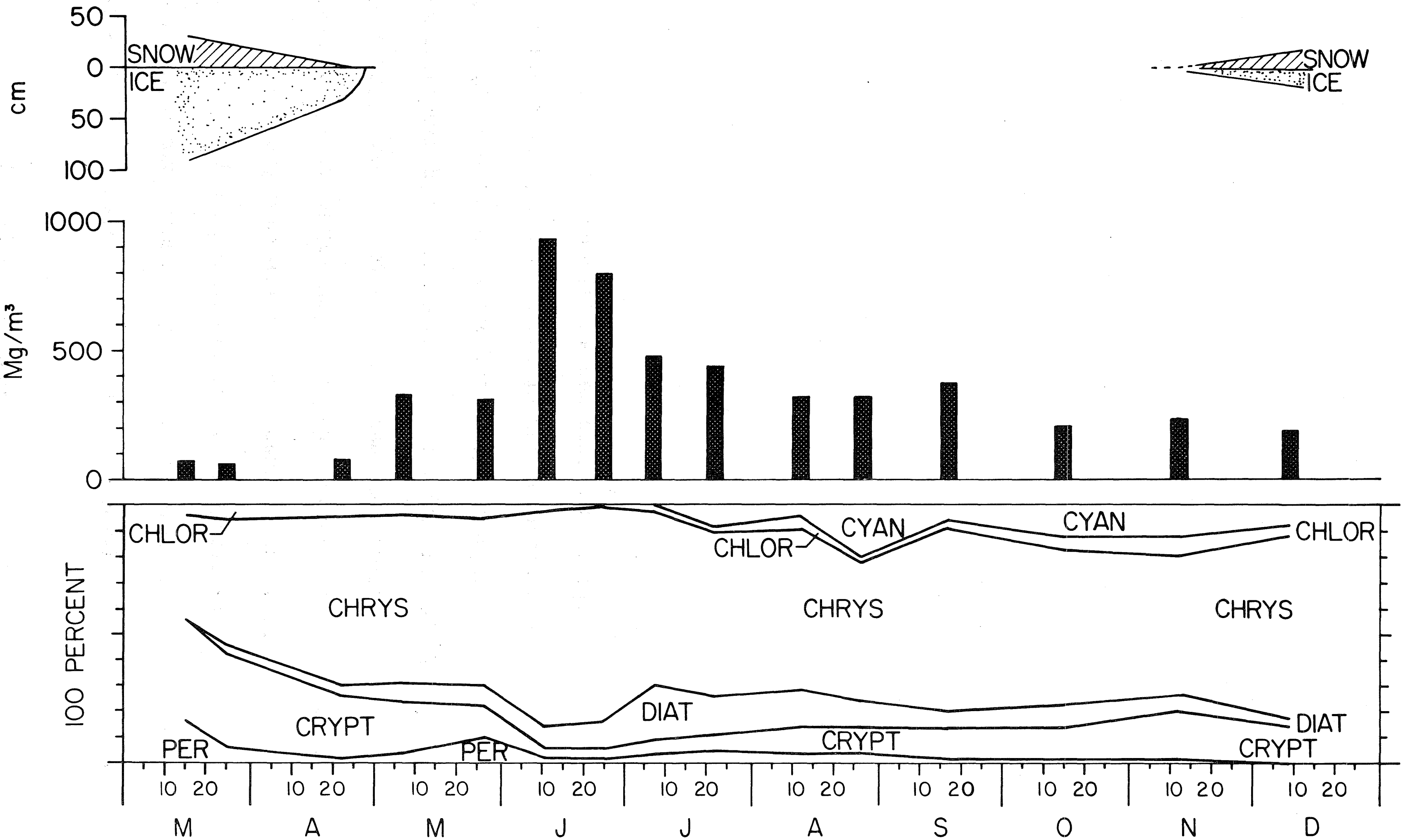
Figure 2. Average phytoplankton volume in the euphotic zone (10 m) in Lake 239 in 1969, and accumulative per cent composition.

Figure 3. Average phytoplankton volume in the euphotic zone (10 m) in Lake 239 in 1970, and accumulative per cent composition.

Figure 4. Average phytoplankton volume in the euphotic zone (6 m) in Lake 304 in 1969 and accumulative per cent composition.

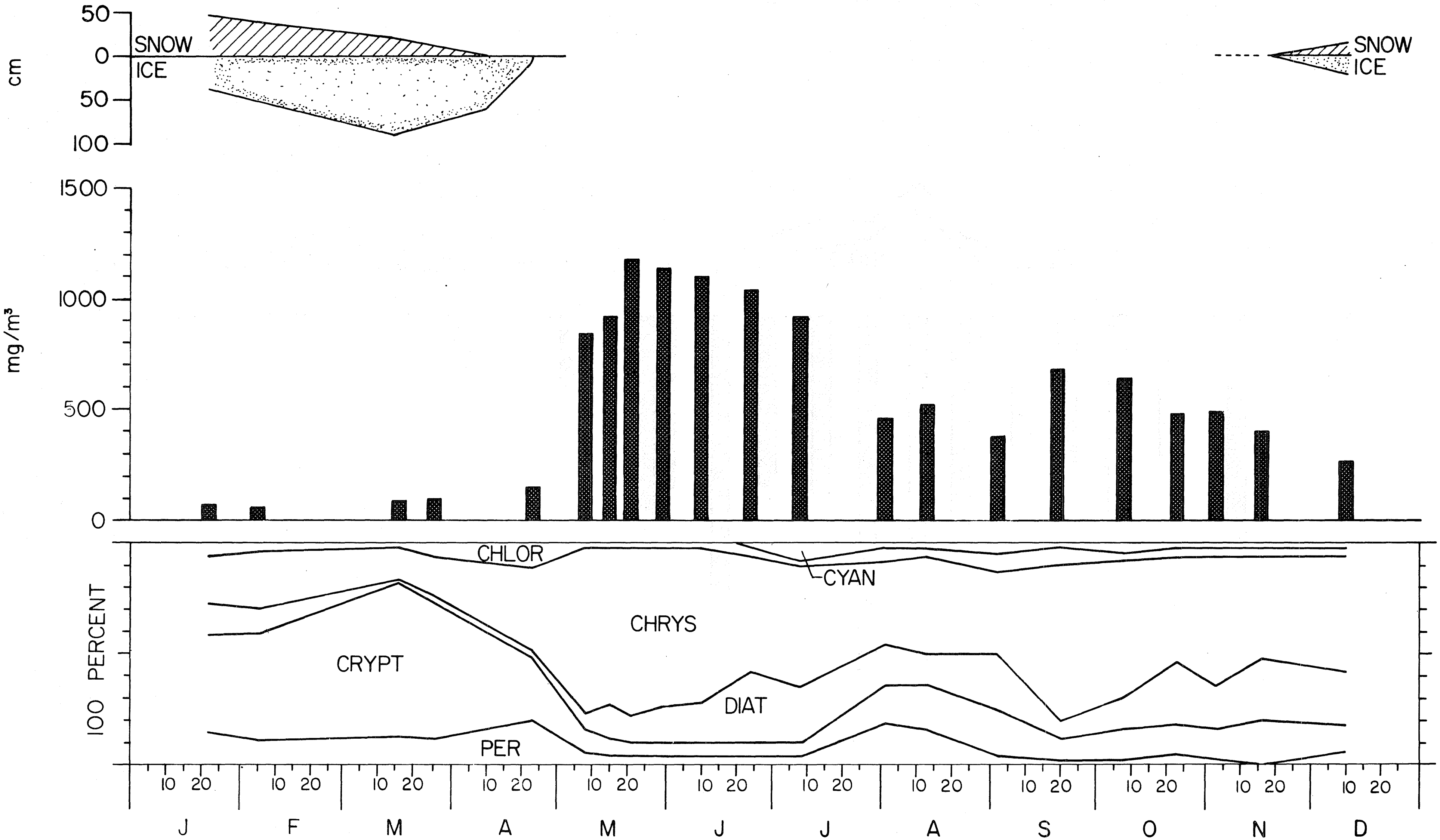
Figure 5. Average phytoplankton volume in the euphotic zone (2 m) in Lake 303 in 1969, and accumulative per cent composition.

FIG. 1



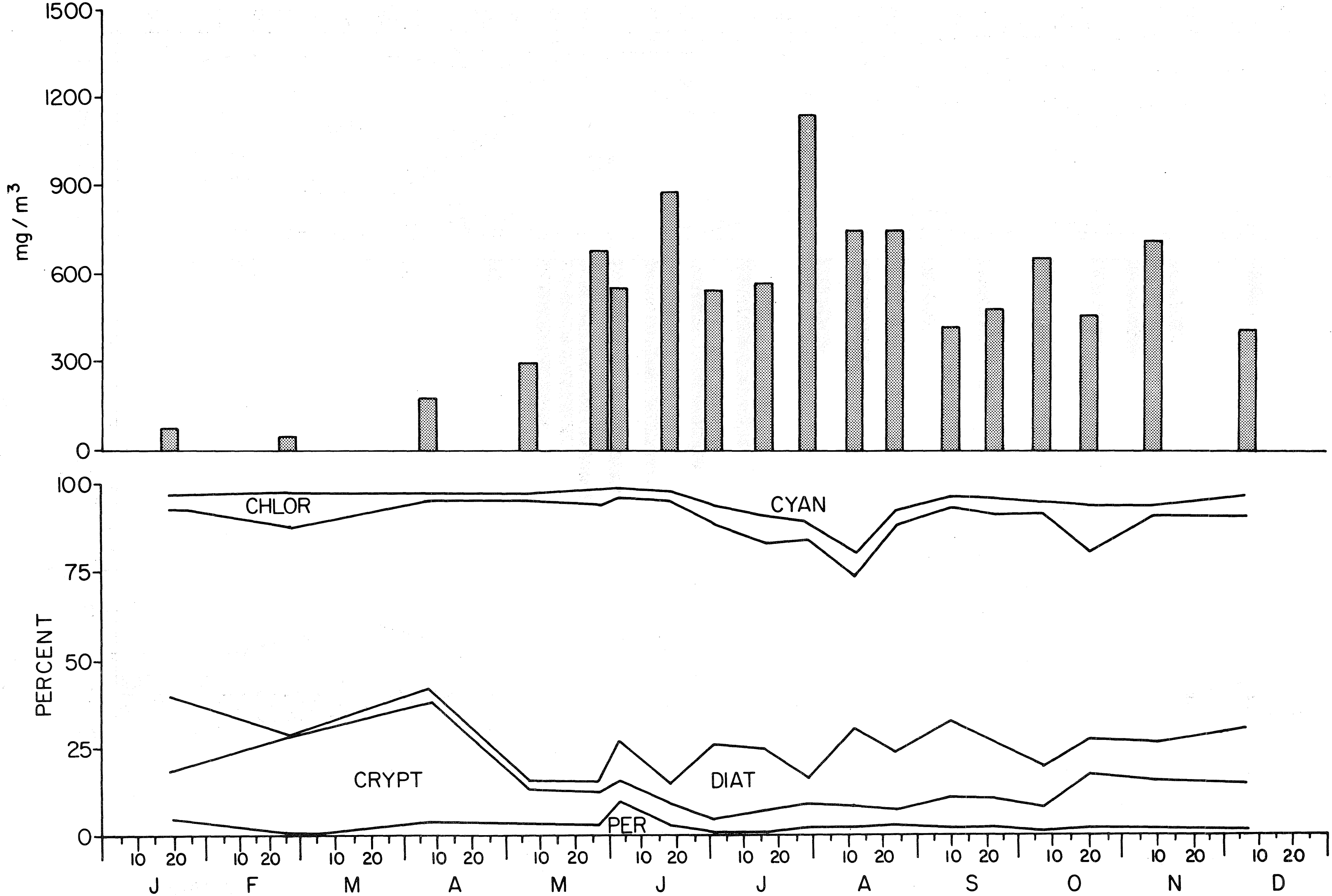
50
0
50
100
cm
SNOW
ICE
SNOW
ICE
1000
500
0
Mg/m³
CHLOR
CHLOR
CYAN
CYAN
CHLOR
CHRYS
CHRYS
CHRYS
DIAT
DIAT
CRYPT
CRYPT
CRYPT
PER
PER
100 PERCENT
10 20
M
A
M
J
J
A
S
O
N
D

FIG. 2



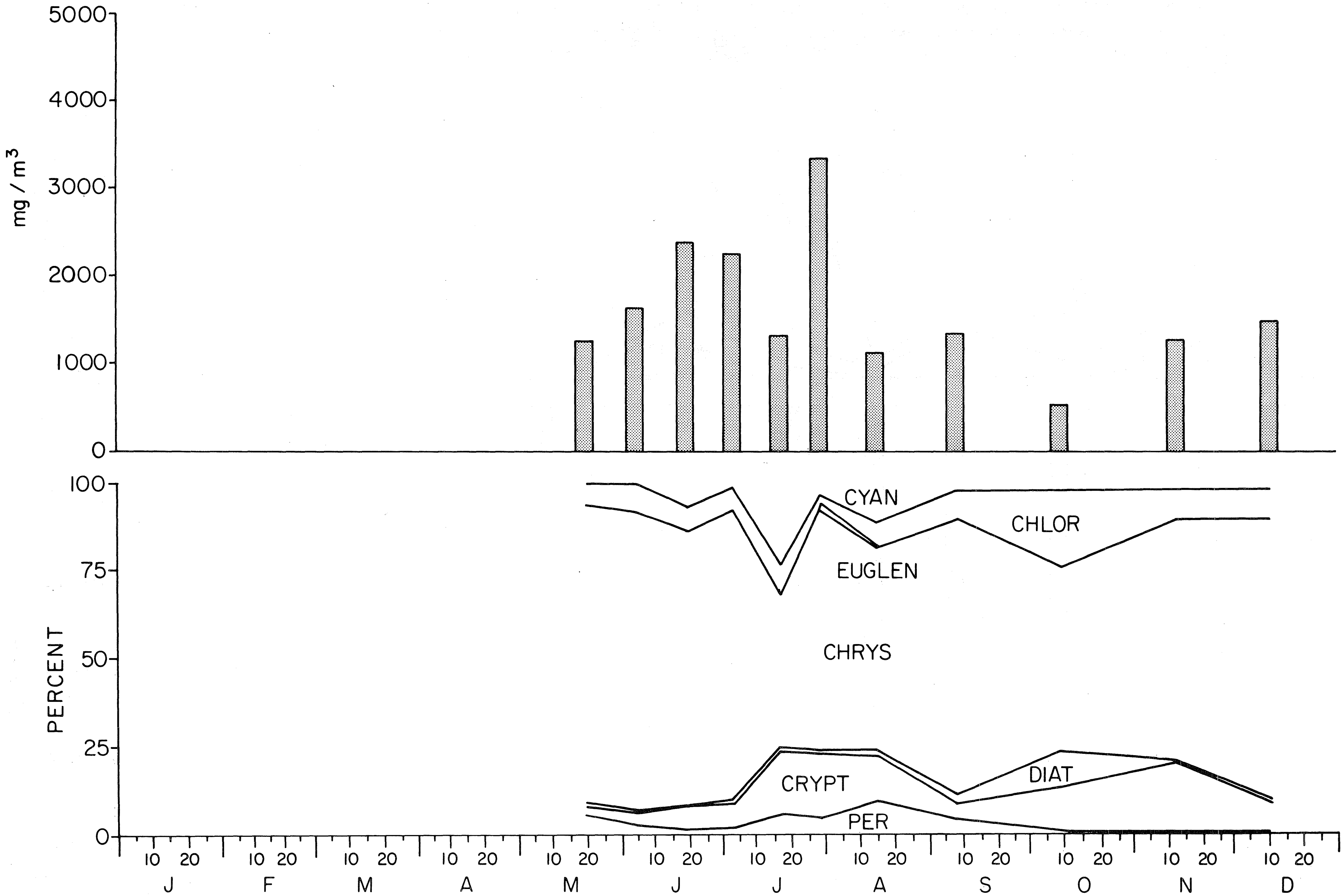
50
0
50
100
cm
SNOW
ICE
SNOW
ICE
1500
1000
500
0
mg/m³
CHLOR
CYAN
CHRYS
CRYPT
DIAT
PER
100 PERCENT
10 20
J
F
M
A
M
J
J
A
S
O
N
D

FIG. 3



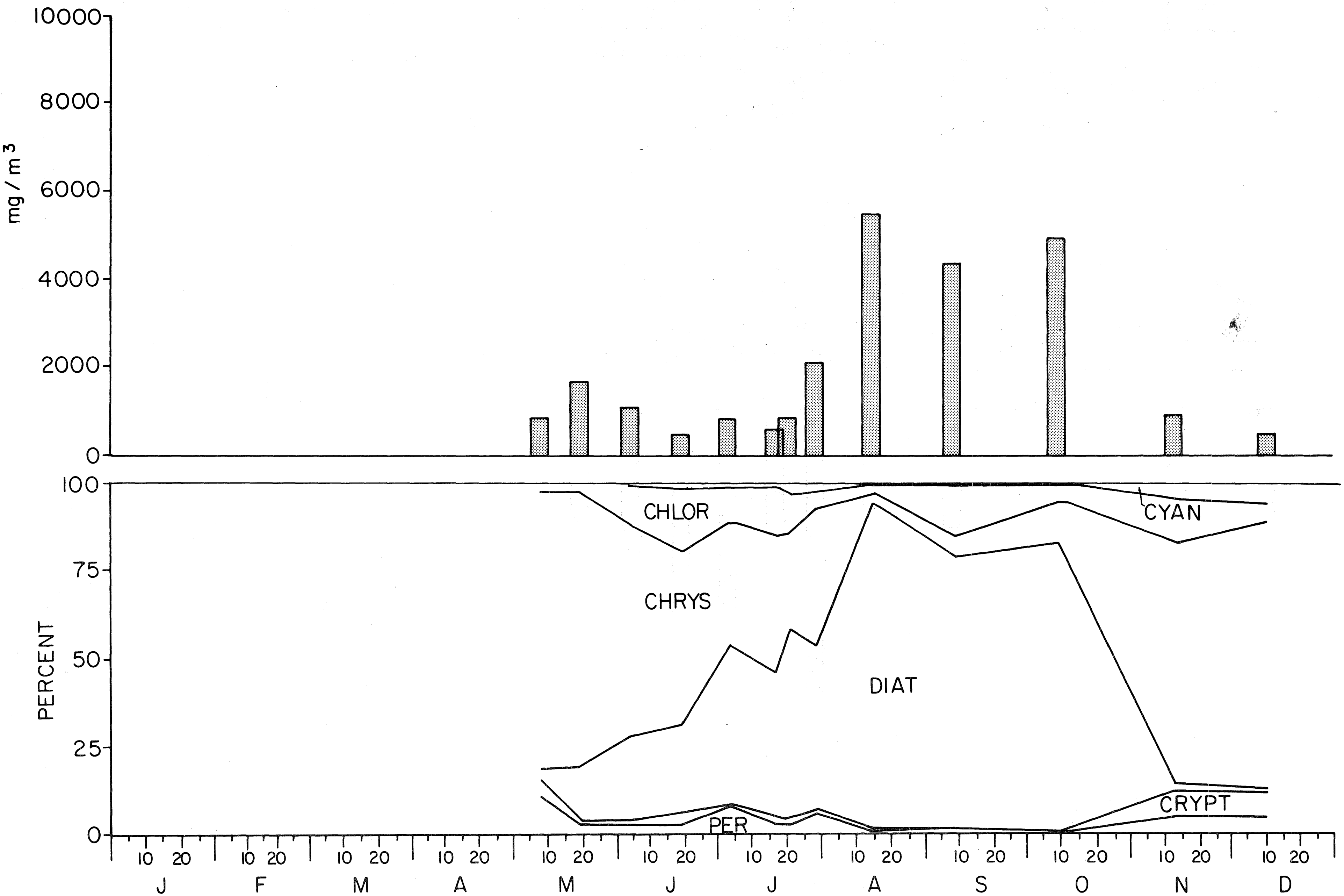
1500
1200
900
600
300
0
mg / m3
100
75
50
25
0
PERCENT
CHLOR
CYAN
CRYPT
DIAT
PER
10 20
J F M A M J J A S O N D

FIG. 4



5000
4000
3000
2000
1000
0
mg / m3
100
75
50
25
0
PERCENT
CYAN
CHLOR
EUGLEN
CHRYS
CRYPT
DIAT
PER
10 20 10 20 10 20 10 20 10 20 10 20 10 20 10 20 10 20 10 20 10 20 10 20
J F M A M J J A S O N D

FIG. 5



10000
8000
6000
4000
2000
0
mg / m3
100
75
50
25
0
PERCENT
CHLOR
CYAN
CHRYS
DIAT
CRYPT
PER
10 20
J
F
M
A
M
J
J
A
S
O
N
D