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NOTES ON THE PHYTOPLANKTON OF KARLUK LAKE, KODIAK ISLAND, ALASKA

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DURING the period June 20, 1956, to November 22, 1957, a biological investigation was conducted at Karluk Lake, Kodiak Island, Alaska, to determine the local occurrence of coracidia hatched from the ova of the fish tapeworm *Diphyllobothrium ursi* Rausch, 1954.

This investigation required an intensive sampling program in which plankton were gathered with a No. 20 silk net at approximately weekly intervals during the ice-free seasons and once a month following the formation of ice cover (December through April). Collecting was done at two stations: one near the mouth of the Thumb River, and at the No. 2 station established by Juday, Rich, Kemmerer, and Mann (1932); these are shown in Figure 1.

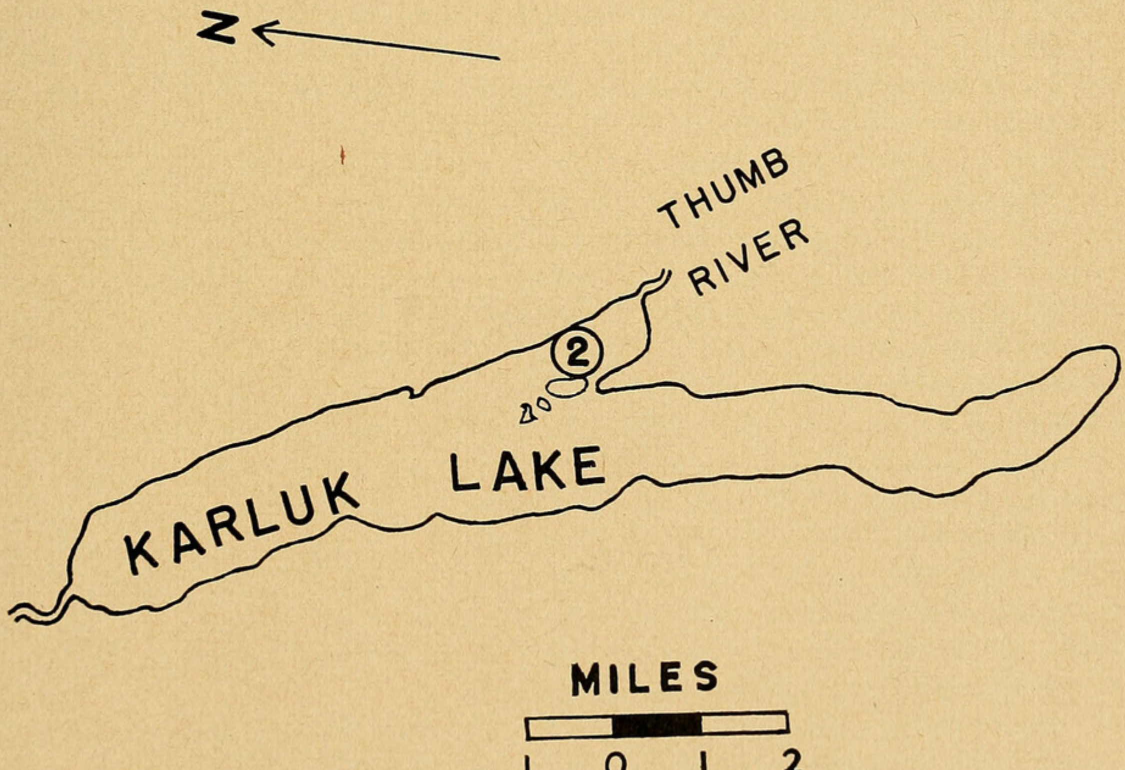

FIGURE 1.—Map of Karluk Lake showing Station No. 2 where plankton samples were gathered.

Mailing date of this number: 10 August 1959

Sampling methods were similar to those used by Juday (1932). All of the material reported on herein was collected from the No. 2 station. There were, in all, 46 collections made.

In addition to the regular gathering of invertebrate material, considerable quantities of phytoplankton were obtained. It is the purpose of this paper to give an account of the phytoplankton and, when applicable, to compare it with the collections made by Juday (1932).

PREVIOUS WORK

Although Karluk Lake drainage is one of the world's most important red salmon systems, very little has been published on its phytoplankton, and of this virtually nothing on species composition. Juday (1932) did a comprehensive study of the physical and chemical aspects of the lake, including quantitative estimates of the plankton during the summer months of 1926-1930. Their studies revealed 49 genera of algae from the plankton catches, but the species were not indicated. Mann (*in* Juday and others, 1932) cited 26 genera and 67 species of diatoms found in bottom deposits from the lake, though no references were made to planktonic forms. More recently Croasdale (1958) described as new several forms and varieties of desmids from material provided by the writer. The above-cited publications constitute the only contributions to knowledge of phytoplankton in Karluk Lake.

DESCRIPTION AND CLASSIFICATION OF THE LAKE

Certain limnological features of Karluk Lake, described in detail by Juday (1932), are briefly summarized as follows. The lake is situated in south-central Kodiak Island, at 57° 24′ N 154° 5′ W. Its long axis (12.2 miles) is oriented in a north-south direction and has a maximum width of two miles. The lake covers an area of 14.8 square miles, has a maximum depth of 413 feet and a mean depth of 159 feet. The elevation above sea level is about 350 feet. Geologically, the lake basin is of recent glacial origin. The shore is composed of a ledge of shale with poorly developed subaqueous terraces which drop sharply away from the littoral zone. This rocky substrate does not foster the growth of the larger aquatic plants as is evidenced by a few patches of *Potamogeton* sp. and *Vallisneria* sp. in the shallow, protected coves.

Chemical analysis of the lake water, according to Juday (1932), showed the surface water to be alkaline (pH 7.2-8.6) and the water at the lower depths neutral. Dissolved oxygen was abundant at all levels (8.8-12.1 mg/l), approaching within 90 percent of saturation. Bound carbon dioxide was not particularly high, with 9-10 mg/l. Nitrate nitrogen varied from .012-.05 mg/l, with the higher concentrations being found at the 40-meter level. Soluble phosphorus ranged from .002 mg/l at the surface to .018 mg/l at the lower levels, while the calcium content varied slightly from 5.0-6.0 mg/l. Secchi disc readings ranged from 4.5 to 8.6 meters.

From the standpoint of lake typology, the physical and chemical data gained from the Juday expedition indicate that Karluk Lake is a classic example of an oligotrophic lake (namely, low in electrolytes, a homogeneously high dissolved oxygen content, deep lake basin, etc.). Since, however, no biological indices have been used for establishing the trophic status of this lake, it seemed pertinent to apply the recent hypothesis of Nygaard (1949) as a means of determining its trophic level. This hypothesis, referred to as the phytoplankton, or compound coefficient, holds that the ratio between the total numbers of Desmidiae and those of other discrete phytoplankton groups can be used as an index to trophic types. It states that if the ratio, or compound coefficient, is one or less, oligotrophy is indicated, while values of one or more generally show an eutrophic situation. The quotient may be derived from the following formula:

$$\text{Compound quotient} = \frac{\text{Myxophyceae} + \text{Chlorococcales} + \text{Centrales} + \text{Euglenales}}{\text{Desmidiae}}$$

Quotients were determined from 28 collections of phytoplankton; one or more for each month of the year. In general, it was found that the spring values were lower, with a mean of 0.44, while those of the late fall and winter were slightly higher with a mean of 0.75. During the summer the coefficients were somewhat erratic, varying from 0.07 to 11.0. The latter figure, which indicates an advanced degree of eutrophy, was brought about by a slight pulse of *Cyclotella bodanica*. Most of the coefficients, however, were well within the limits of oligotrophy as defined, and the median value for the 28 collections was 0.74. From available knowledge it would appear that this method of lake classification is valid for Karluk Lake.

The Phytoplankton

The total number of species and varieties of algae found in these collections was 255, representing 84 genera. The percentage composition of these according to plant groups is as follows:

Algal groups	*Species and varieties*	*Percent of the total*
Diatomaceae	166	65.1
Chlorophyta	56	21.9
Cyanophyta	19	7.5
Chrysophyta	10	3.9
Pyrrophyta	4	1.6

Quantitatively, the percentage values for the total numbers of phytoplankters from the 46 collections differed somewhat from those of the species and varieties composition. In order of dominance they are listed as follows: Diatomaceae 84.8%, Chlorophyta 12.4%, Chrysophyta 2.1%, Pyrrophyta 0.4%, and Cyanophyta 0.2%. The principal component of the phytoplankton, the diatoms, was represented most frequently by the following species, in order: *Asterionella formosa*, *Tabellaria flocculosa*, *Fragelaria crotonensis*, and *Cyclotella bodanica* and varieties. The Chlorophyta, second in abundance, were comprised mostly of *Dictyosphaerium pulchellum*, *Sphaerocystis Schroeteri*, and the desmids *Staurastrum* spp., *Staurodesmus* spp., and *Cosmarium* spp. Also present, though fewer in numbers, were *Ankistrodesmus falcatus* and *Scenedesmus* spp. The most frequently appearing member of the Chrysophyta was *Salpingoeca frequentissima*, a small epiphyte of *Asterionella formosa*. In this group were also found *Dinobryon* spp. and *Mallomonas* spp., the latter appearing mostly in the fall and winter catches. Both the Pyrrophyta and Cyanophyta were represented by two dominant genera; these were, respectively, *Ceratium* and *Peridinium*, and *Anacystis* and *Oscillatoria*.

Listed below is the catalogue of species compiled from the collections.

With the exception of those entities prefixed by an asterisk, all of these species are assumed to be new records for both Karluk Lake and Alaska. This assumption is based on previous algological work done in Alaska by Saunders (1903), Lowe (1923), Juday and others (1932), Hooper (1947), and Croasdale (1956, 1957, 1958).

An impression of average relative abundance is indicated, as suggested by Croasdale (1955), as follows: 'ccc' dominant in every slide; 'cc' present in nearly every low-powered field; 'c' many specimens seen; 'r' only a few specimens seen; and 'rr' only one or two specimens seen.

Catalogue of Species

CHLOROPHYCEAE

Chlorococcales

Actinastrum gracillimum G. M. Smith—rr
Ankistrodesmus falcatus (Corda) Ralfs—c
A. falcatus var. *mirabilis* (W. & W.) G. S. West—rr
Coelastrum cambricum Archer—r
C. microsporum Näg.—r
Crucigenia fenestrata Schmidle—rr
C. rectangularis (A. Br.) Gay—r
Dictyosphaerium Eherenbergianum Näg.—c
D. pulchellum Wood—c
Micractinium pussilum var. *elegans* G. M. Smith—rr
**Pediastrum Boryanum* (Turp.) Men.—c
Reported from Alaska by Hooper (1947).
P. Boryanum var. *brevicorne* A. Br.—c
P. Boryanum var. *longicorne* Rac.—c
P. Boryanum var. *undulatum* Wille—r
P. duplex Meyen—rr
P. duplex var. *clathratum* (A. Br.) Lagerh. —rr
Quadrigula lacustris (Chod.) G. M. Smith —rr
Scenedesmus armatus var. *major* G. M. Smith—r
S. bijuga (Turp.) Lagerh.—c
S. dimorphus (Turp.) Kütz.—r
S. ecornis (Ralphs) Chod.—r
S. helviticus Chod.—r
S. obliquus (Turp.) Kütz.—c
S. opoliensis Richter—r
S. quadrecauda var. *longispina* (Chod.) G. M. Smith—r
S. quadrispinus Chod.—c
S. Westii (Smith) Chod.—r
Tetraëdron minimum (A. Br.) Hansg.—rr
Tetradesmus elegans Playfair—rr

Desmidiales

Most of the species listed herein have been either described or identified by Dr. Hannah Croasdale of Dartmouth College. Those species prefixed by a single asterisk are listed in her earlier works (Croasdale, 1956; 1957), while those with a double asterisk were described or identified from specimens provided from Karluk Lake by the writer (Croasdale, 1958).

Closterium sp.—rr
***Cosmarium botrytis* Men. var. *paxillosporum* W. & G. S. West—r
***C. norimbergense* var. *Boldtii* Messik—r
***C. phaseolus* Bréb. var. *alaskana* Croasdale —c
**C. pyramidatum* Bréb.—rr
***C. subrenatum* Hansch—r
Gonatozygon Kinahani (Arch.) Rabh.—r
Pleurotaenium sp.—rr
***Spondylosium planum* (Wolle) W. & G. S. West—c
***S. planum* (Wolle) W. & G. S. West var. *alaskanum* Croasdale—r
**Staurodesmus cuspidatus* (Bréb.) Teiling f. *alsakanus* Croasdale—r
**S. dejectus* (Bréb.) Teiling—r
Staurastrum granulosum (Ehr.) Ralfs—rr
***S. lunatum* Ralfs var. *planctonicum* W. & G. S. West—cc
S. mucronatum Ralfs var. *subtriangulare* W. & G. S. West—rr
***S. pendulum* Nygaard var. *pinguiforme* Croasdale—c
***S. petsamoense* Järnfelt var. *minus* f. *karlukense* Croasdale—c
***S. sebaldi* Reinch var. *impar* Croasdale—r
S. alternans Bréb.—rr

Oedogoniales

Bulbochaete spp. sterile—c
Oedogonium spp. sterile—r

Tetrasporales

Chlorangium stentorinum (Ehr.) Stein—rr
Gloeocystis gigas (Kütz.) Lagerh.—r
Sphaerocystis Schroeteri Chod.—c
Tetraspora cylindrica (Wahl.) Ag.—c
T. gelatinosa (Vauch.) Desv.—r
T. lacustris Lemm.—c

ULOTRICHALES

Microspora stagnorum (Kütz.) Thur.—c

Ulothrix variabilis Kütz.—c

VOLVOCALES

Chlamydomonas pseudopertyi Pascher—rr

Gonium pectoral Muell.—rr

ZYGNEMATALES

Mougeotia sp.—r

Zygnema sp.—r

Spirogyra sp.—r

CHRYSOPHYCEAE

HETEROTRICHALES

Tribonema spp.—c

CHRYSOMONADALES

Dinobryon bavaricum Imhof—r

D. social var. *americanum* (Brun.) Bachm. —r

Euroglena volvox Ehr.—rr

Hyalobryon mucicola Pascher—c

This species occurred in the fall and winter plankton, attached to other algae.

Mallomonas caudata Iwanoff—c

M. gracillima Conrad—c

M. producta (Zach.) Iwanoff—c

Salpingoeca frequentissima (Zach.) Lemm. —c

Sphaeroeca volvox Ltb.—rr

On the basis of available data (cf. Smith, 1950), the above two genera have hitherto not been reported from the United States and, presumably, North America.

Synura uvella Ehr.—rr

DINOPHYCEAE

The following listed *Peridinium* were identified by Dr. Rufus H. Thompson of the University of Kansas.

Ceratium hirundinella (O.F.M.) Schrank—c

Peridinium aciculiferum (Lemm.) Lemm.—c

P. volzii Lemm.—r

P. willei Huift.—Kaas—c

MYXOPHYCEAE

With the exception of *Chroococcus* and *Merismopedia*, all other coccoid forms listed were identified by Dr. Francis Drouet of the Chicago Natural History Museum. Those prefixed by an asterisk have been previously reported from Alaska by Drouet and Daily (1956) from specimens provided by the writer.

Anacystis incerta (Lemm.) Dr. & Daily—r

**A. montana* f. *minor* (Wille) Dr. & Daily —c

A. nidulans (Richt.) Dr. & Daily—r

A. thermalis f. *major* (Lagerh.) Dr. & Daily —r

Chroococcus limneticus Lemm.—r

C. minutus (Kütz.) Näg.—r

**Clastidium setigerum* Kirchner—r

Coelosphaerium Kuetzingianum Näg.—c

Gomphospheria lacustris Chod.—r

Lyngbya Diguetii Gom.—r

L. purpurea (Hook. & Harv.) Gom.—r

Merismopedia glauca (Ehr.) Näg.—r

M. punctata Meyen—r

M. thermalis Kütz.—rr

Oscillatoria rubescens DC.—r

O. sancta (Kütz.) Gom.—r

O. tenuis Ag.—c

Spirulina sp.—r

A preliminary examination of this alga suggests that it might be *S. Corakiana* Playfair.

Tolypothrix distorta Kütz.—rr

T. lanata Wartm.—rr

DIATOMACEAE

The following list of diatoms was prepared by Dr. Emile Manguin of the Muséum National, Paris, France. In addition, he has added a few notes on the restricted geographic occurrence of some of the Old World species indigenous to Karluk Lake. Missing from the list are 15 species and varieties which Dr. Manguin will describe in a subsequent publication. The writer has assigned a relative abundance to the various species based on information provided by Dr. Manguin. Species prefixed by an asterisk have been cited previously from Karluk Lake by Juday (1932); those with a double asterisk were observed by Saunders (1903) from Kodiak Island.

Achnanthes affinis Grun.—rr

A. austriaca Hust.—rr

Alpine and north-alpine of Europe.

A. calcar Cleve—r

North-alpine of Europe.

A. flexella (Kütz.) Brun.—rr

A. kryophila B. Peterson var. *densestriata* Hust.—rr

This form is localized in alpine lakes of Europe.

A. lanceolata Bréb.—c
A. lapponica Hust.—r
Restricted to north-alpine in Europe.
A. laterostrata Hust.—c
Alpine lakes and Finland.
A. linearis W. Smith—r
A. linearis var. *pusilla* Grun.—r
A. minutissima Kütz.—cc
A. minutissima vra. *cryptocephala* Grun.—cc
A. obliqua (Greg.) Hust.—r
Occurs north of western Europe; also in Russian and Finnish lakes.
A. Suchlandtii Hust.—r
In alpine lakes of Europe.
**Amphora ovalis* Kütz.—c
A. ovalis var. *pediculus* Kütz.—c
A. perpusilla Grun.—r
Anomoenoeis exilis (Kütz.) Cleve—r
Asterionella formosa Hass.—ccc
Caloneis bacillum (Grun.) Meresch.—r
C. Schumanniana (Grun.) Cleve var. *biconstricta* Grun.—r
C. silicula (Ehr.) Cleve var. *tumida* Hust.—r
Campylodiscus noricus Ehr. var. *hibernica* (Ehr.) Grun.—r
**Ceratoneis arcus* Kütz.—cc
C. arcus vra. *amphioxys* Rabh.—cc
C. arcus var. *linearis* Holmboe—r
***Cocconeis pediculus* Ehr.—c
**C. placentula* Ehr.—c
**Cyclotella bodanica* Eulenst.—ccc
C. bodanica var. *lemanensis* O. Müll.—ccc
This particular form occurs in subalpine lakes of the northern regions of Europe; also in certain of the Canadian lakes.
C. comensis Grun.—cc
C. comta (Ehr.) Kütz.—c
C. Meneghiniana Kütz.—c
C. ocellata Pant.—c
C. pseudostelligera Hust.—c
C. stelligera Cleve & Grun.—r
Cymbella aequalis W. Smith—rr
C. affinis Kütz.—r
C. cistula (Hempt.) Grun.—c
**C. cistula* var. *maculata* (Kütz.) v. Heurk—r
C. Clericii Frenguel., forma—r
Indigenous to South America, probably Patagonia.
C. cymbiformis (Ag. ?Kütz.) v. Heurk—r
C. gracilis (Rabh.) Cleve—r
C. lanceolata (Ehr.) v. Heurk—r
C. microcephala Grun.—c
C. prostrata (Berk.) Cleve—r
C. prostrata var. *robusta* Cleve—r
C. sinuata Greg.—c
C. tumida (Bréb.) v. Heurk—c
C. tumidula Grun.—r
C. turgida (Greg.) Cleve—ccc
**C. ventricosa* Kütz.—c
C. ventricosa var. *silesiaca* (Bleisch) Cleve—r
Cymbellonitzschia diluviana Hust.—r
Characteristic of postglacial Quaternary alluvion in Europe.
Diatoma elongatum Ag.—r
D. hiemale (Lyngb.) Heib., var. *mesodon* (Ehr.) Grun.—c
D. vulgare Bory, var. *grandis* (W. Smith) Grun.—r
D. vulgare var. *producta* Grun.—r
Didymosphenia geminata (Lyngb.) M. Schmidt—c
North-alpine and alpine in Europe, North America, and Siberia (Kamchatka).
Diploneis elliptica (Kütz.) Cleve—c
D. ovalis (Hilse) Cleve—cc
D. Smithii (Bréb.) Cleve—c
Epithemia sorex Kütz.—r
**E. turgida* (Ehr.) Kütz.—r
E. turgida var. *granulata* (Ehr.) Grun.—r
**E. zebra* (Ehr.) Kütz., var. *saxonica* (Kütz.) Grun.—r
Fragilaria bidens Heiberg, f. *major*—cc
F. brevistriata Grun.—r
F. capucina Desmaz.—r
F. capucina var. *mesolepta* (Rabh.) Grun.—c
**F. construens* (Ehr.) Grun.—r
F. construens var. *biceps* Störe—r
F. construens var. *binodis* (Ehr.) Grun.—rr
F. construens var. *venter* (Ehr.) Grun.—r
F. crotonensis Kit.—ccc
Reported from Alaska by Hooper (1947).
F. leptostauron (Ehr.) Hust.—r
F. pinnata Ehr.—cc
F. pinnata var. *lancettula* (Schum.) Hust.—r
F. Vaucheriae (Kütz.) B. Petersen—c
F. Vaucheriae var. *capitellata* Grun.—c
F. virescens Ralfs—r
Gomphonema acuminatum Ehr., var. *coronata* (Ehr.) W. Smith—r
G. angustatum (Kütz.) Rabh.—r
G. angustatum var. *producta* Grun.—r
G. angustatum var. *sarcophagus* (Greg.) Grun.—r
**G. constrictum* Ehr.—c
G. constrictum var. *capitata* (Ehr.) Cleve—r

G. eriense Grun.—r
Regarded as a form of *G. herculeanum* in North America.
G. gracile Ehr.—r
**G. herculeanum* Ehr.—c
Found in both North America and Siberia (Kamchatka).
G. herculeanum var. *clavatum* Cleve—r
G. herculeanum var. *robustum* Grun.—r
G. herculeanum var. *septiceps* M. Schmidt —r
G. intricatum Kütz., var. *pumila* Grun.—r
G. olivaceoides Hust.—r
G. olivaceum (Lyngb.) Kütz.—r
G. parvulum Kütz—r
G. ventricosum Greg.—c
Found in North America, Kamchatka, and Scandinavia.
Gyrosigma attenuatum (Kütz.) Rabh.—r
**Hantzschia amphioxys* (Ehr.) Grun.—r
**Melosira arenaria* Moore—r
M. distans (Ehr.) Kütz.—cc
M. distans var. *lirata* (Ehr.) Bethge—r
**M. italica* (Ehr.) Kütz.—cc
**M. varians* Ag.—r
**Meridion circulare* Ag.—c
Navicula cocconeiformis Greg.—r
N. cryptocephala Kütz.—c
N. cryptocephala var. *intermedia* Grun. —c
N. cryptocephala var. *veneta* (Kütz.) Grun.—cc
N. cuspidata Kütz.—r
N. disjuncta ?Hust.—r
N. farta Hust.—r
N. hungarica Grun., var. *luneburgensis* Grun.—r
N. lanceolata (Ag.) Kütz.—r
N. menisculus Schum.—r
N. peregrina (Ehr.) Kütz., var. *meniscus* Grun.—r
N. pseudoscutiformis Hust.—r
N. pupula Kütz., var. *rectangularis* (Greg.) Grun.—rr
N. radiosa Kütz.—c
N. Reinhardtii Grun., var. *gracilior* Grun. —r
N. Reinhardtii var. *striolata* Mayer—r
N. Schonfeldii Hust.—r
N. semen Ehr.—r
Postglacial Quaternary alluvion.
N. vulpina Kütz.—c
Nitzschia acicularis W. Smith, var. *major* O. Müll.—r
N. angustata (W. Smith) Grun.—c.
N. fonticola Grun.—c
N. frustulum Kütz.—r
N. frustulum var. *perpusilla* (Rabh.) Grun.—c
N. gracilis Hantz.—r
**N. palea* (Kütz.) W. Smith—r
N. sigmoidea (Ehr.) W. Smith—r
Opephora Martyi Hérib.—rr
Pinnularia appendiculata (Ag.) Cleve—r
P. gibba Ehr.—r
P. microstauron (Ehr.) Cleve—r
P. streptoraphe ?Cleve—r
P. viridis f. (Nitz.) Ehr.—r
Rhizosolenia longiseta Zach.—r
**Rhoicosphenia curvata* (Kütz.) Grun.—cc
Stauroneis anceps Ehr.—r
***S. phoenicenteron* Ehr.—r
Stephanodiscus astraea (Ehr.) Grun., var. *intermedia* Fricke—r
S. astraea (Ehr.) Grun., var. *minutula* (Kütz.) Grun.—cc
**S. niagarae* Ehr.—ccc
Found in North America; planktonic form in certain large Canadian lakes.
S. niagarae var. *magnifica* Fricke—r
S. niagarae var. *magnifica* Fricke f. *minor* —r
Surirella biseriata Bréb.—r
S. biseriata Bréb., var. *bifrons* (Ehr.) Hust., f. *punctata* Meist.—r
S. linearis W. Smith., var. *constricta* (Ehr.) Grun.—r
S. linearis W. Smith., var. *helvetica* (Brun.) Meist.—r
**S. robusta* Ehr.—r
S. tenera Greg. f.—r
Synedra acus Kütz.—r
S. acus Kütz., var. *angustissima* Grun.—c
S. amphicephala Kütz., var. *austriaca* Grun. —r
S. nana Meist.—r
S. rumpens Kütz.—c
S. rumpens Kütz., var. *familiaris* Grun.—r
S. rumpens Kütz., var. *neogena* ?Grun.—r
S. rumpens Kütz., var. *scotica* Grun.—r
***S. ulna* (Nitz.) Ehr.—cc
S. ulna var. *danica* (Kütz.) Grun.—cc
Tabellaria fenestrata (Lyngb.) Kütz.—c
**T. flocculosa* (Roth) Kütz.—ccc

DISCUSSION

In recent years it has come to the writer's attention that surprisingly little has been published on arctic and subarctic fresh-water plankton as it exists during the winter seasons. The available reports stem principally from the efforts of European workers such as Olafsson (1918), Ström (1923, 1926), and Rhode (1955). In Alaska it would appear that biologists, principally those concerned with fisheries, are predisposed to *a priori* reasoning that biological productivity is nil during the late fall and winter. To illustrate, the party under Juday which investigated Karluk Lake over a four-year period (Juday and others, 1932), did so during the summer months, from mid-July to mid-September. This, in effect, represented two months or 16.7 percent of the year during which the plankton was taken into consideration. Presumably, such data as were gained during this brief period have been used as the sole basis for determining lake productivity as related to salmon fisheries. It is apparent from the available data that sampling over such a limited period can give misleading concepts of plankton populations.

During the course of their investigation, the Juday group found an average of 17,963 diatoms (all values given here are numbers of organisms per liter) at their No. 2 station, and a maximum count, taken July 21, 1927, of 67,424. They indicated further that optimal numbers of diatoms were found during July and that numbers usually decreased by the beginning of September. By comparison, the writer found during the summer of 1956 that the average number of diatoms was 14,420, a maximum of 27,800 occurring on July 25. The counts remained comparatively low, about 1,700, from August 16 until September 22. From that date until December 10, when the lake became completely covered with ice, the average number of diatoms rose to 34,500, and the maximum for the season was 70,975, observed on October 15. Concurrent with the late fall increase in phytoplankton productivity, the writer found that the Entromostracan population also showed a significant rise over that of the summer and early fall. For example, *Cyclops scutifer* Sars averaged 0.6 during the summer months through the middle of September, but from this time until the lake surface was frozen over, an average of 11 was sustained. Even more interesting was the fact that 48 hours before the freezing of the lake, the maximum number of 101 individuals was recorded. The Juday records show a copepod maximum, for the four-year period, of 37.6 occurring on September 7, 1929.

As an adjunct to observations made on the fall and winter plankton at Karluk Lake, another example of winter plankton abundance was demonstrated on February 28, 1958, when the writer visited an unnamed alpine lake, at 62° 41′ N 147° 48′ W. Here a hole was cut through about three feet of ice, and large numbers of copepods were observed in the overflow. To avoid the possibility that light attracted these organisms, another hole was made several hundred feet from the original opening at dusk, and a sample collected after dark. A quantitative examination of this sample revealed over 3,300 *Cyclops* sp. per liter. A re-examination of this lake in June showed that it was slightly dystrophic, and a plankton tow indicated a paucity of organisms. At this time the copepod count was about 12 per liter.

With reference to the aforementioned examples of late autumnal and winter maxima, it may be argued that these phenomena are a normal sequence of stenotopic (oligothermal) organisms making their appearance as the water temperatures decrease. However true this may be, there is a paucity of data on the seasonal biological rhythms of the plankton in Alaskan lakes. Until adequate information is available, it behooves biologists to exercise caution in making recommendations for lake management relating to fisheries in Alaska on the basis of existing published data on phytoplankton.

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ADDENDUM

In making a recent examination of the plankton from Karluk Lake, Dr. Berit Asmund of Snekkersten, Denmark, found, when using the electron microscope, that what the writer has listed as *Hyalobryon mucicola* Pascher may very well be *Hyalobryon polymorphum* Lund. In addition, she also observed *Mallomonas acaroides* var. *crassisquama* Asmund, *Mallomonas elongata* Reverdin, and *Mallomonas pseudocoronata* Prescott, all of which had not previously been recorded by the writer.

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