

CRYSTAL LAKE REVISITED

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A comparison of the algal flora of Crystal Lake, Cleveland County, Oklahoma observed by Leake in 1938 is made with that found by the authors forty years later. One hundred-two algal taxa previously unobserved in the state of Oklahoma are reported. Preserved collections are stored in the Department of Botany-Microbiology at the University of Oklahoma.

INTRODUCTION

Prior to the year 1929 almost nothing was known about the algae of Oklahoma. In that year Dr. C. E. Taft began a survey resulting in a number of papers on algae common to the state (1-8). Since then publications on the algae of Oklahoma have been sporadic, correlating understandably with the presence in the State of those interested in "lower" plants (9-30; 41). The first extensive examination of the algae of one body of water in Oklahoma was that by Leake (11) in which she studied the algae of Crystal Lake from 1938 to 1943. The present study, which revisited the algae of Crystal Lake forty years later, compares the algal flora found in 1978 with that observed by Leake in her study and in the process adds 102 new taxa to the state record (Table 1).

MATERIALS AND METHODS

Crystal Lake is approximately 800 m long from north to south and 250 m at its widest point. Its deepest basin measures 3 m. The lake lies on the southwest corner of the intersection of Porter and Rock Creek Road in Norman, Oklahoma. The area surrounding the lake is covered by mixed short-grass prairie with a few scattered trees. Flowering plants in the lake were *Polygonum lapathifolium* L., *Myriophyllum spicatum* L., many sedges and rushes, and a few cattails.

Ten sampling sites were chosen to correspond to various microhabitats in the lake area. A total of 690 samples were collected at each of these stations on each of 31 sampling dates from Oct. 20, 1977 to Oct. 13, 1978. Plankton tows, rock scrapings, plant squeezings, and log scrapings were taken at each station. In addition collections were made between sampling stations when different specimens were observed.

Algal samples were examined fresh when possible and preserved in Transeau's solution when delayed examination necessitated. All algae exclusive of the diatoms were identified.

RESULTS AND DISCUSSION

Three hundred twenty-three taxa were collected and identified over the one-year period with most of the algal divisions represented. A breakdown of these 331 taxa into divisions is shown in Table 1:

| | |
|-----------------|---------------|
| Chlorophyta 179 | Pyrrhophyta 9 |
| Cyanophyta 96 | Xanthophyta 1 |
| Euglenophyta 45 | Chrysophyta 1 |

A comparison of algal taxa collected in 1977-1978 with Leake's results reveals a number of similarities and differences (Table 2). Chlorophyta populations tended to be similar while Cyanophyta and Euglenophyta populations differed. Lake identified 155 taxa while 165 were identified in our study. Diversity increased among Chlorococcales and decreased in Zygnematales (Table 2). Diversity in the Euglenophyta populations rose from 8 taxa reported by Leake to 45 taxa found in our study. Most of this increase was in species of *Euglena* and *Trachelomonas*, both of which are very abundant today. The most striking change was in the Cyanophyta. We were able to identify 92 taxa while Leake only reported 8 in her study. Although we feel certain that more than 8 taxa were present during Leake's study and that the low number merely represents the most commonly occurring species, we believe the population in this division has increased greatly.

It would be very difficult to pinpoint a cause for the changes in the algal flora that have taken place over the last 40 years. The chemistry of the lake has changed considerably since Leake's time and this

TABLE 1. Taxa identified, their seasonal occurrence and relative abundance as indicated by F (rare), O (occasional), C (common), A (abundant). *Indicates new state record.

| Organism | Relative Abundance | Seasonal Occurrence |
|---|--------------------|-----------------------|
| Chlorophyta: | | |
| Chaetophorales: | | |
| <i>Aphanochaete repens</i> A. Braun | O | A,My,Ju,N |
| <i>Coleochaete orbicularis</i> Prings. | O | My,Ju,Jy |
| <i>Stigeoclonium tenue</i> (Ag.) Kuetz. | O | O,N,Mr,Ap |
| Charales: | | |
| <i>Chara globularis</i> var. <i>virgata</i> (Kuetz.) R. D. W. Wood | A | My,Ju,Jy,Ag,S |
| <i>Chara vulgaris</i> L. | A | My,Ju,Jy,Ag,S |
| Cladophorales: | | |
| <i>Cladophora insignis</i> (C. A. Ag.) Kuetz. | O | Ap,My,Ju,Jy |
| <i>Pithophora oedogonia</i> (Mont.) Wittrock | O | Ap,My,Ju,Jy |
| <i>Rhizoclonium crassipelatum</i> West and West | C | O,N,Ap,Ju |
| <i>Rhizoclonium fontanum</i> Kuetz. | C | O,N,Ju,Ju,Jy |
| <i>Rhizoclonium hieroglyphicum</i> (C. A. Ag.) Kuetz. | C | O,N,Ap,My,Ju |
| <i>Basicladia crassa</i> Hoffman and Tilden | C | O-O |
| Chlorococcales: | | |
| <i>Acanthosphaera Zachariae</i> Lemm. | O | Ag |
| * <i>Ankistrodesmus convolutus</i> Corda | C | My,Ju |
| <i>Ankistrodesmus falcatus</i> var. <i>tumidus</i> West and West | C | O,N,Ap,My,Ju,Jy,Ag |
| <i>Ankistrodesmus spiralis</i> (Turner) Lemm. | O | O,N |
| <i>Characium sieboldii</i> A. Braun | R | O,N |
| <i>Coelastrum cambricum</i> Archer | O | Ag |
| <i>Coelastrum sphaericum</i> Naegeli | O | Ju,Jy,Ag,S,O,N |
| <i>Coelastrum microporum</i> Naegeli | C | Ju,Jy,Ag,O,N |
| <i>Crucigenia rectangularis</i> (A. Braun) Gay | C | My,Ju,Jy,N |
| * <i>Crucigenia lauterbornei</i> Schmidle | A | My |
| <i>Crucigenia truncata</i> Smith | O | Ju,Jy,Ag |
| * <i>Crucigenia apriculata</i> (Lemm.) Schmidle var. <i>truncata</i> (G. M. Smith) Ahlstrom and Tiffany | C | My,Ju,Jy,Ag,S |
| <i>Crucigenia irregularis</i> Wille | C | Ap,My |
| <i>Dictyosphaerium pulchellum</i> Wood | R | My |
| <i>Dictyosphaerium ebrenbergianum</i> Naegeli | R | My,Ju |
| * <i>Dimorphococcus lunatus</i> A. Braun | R | Ap |
| * <i>Gloeotaenium loitelsbergianum</i> Hansg. | C | Ju,Jy,Ag,S |
| <i>Lagerheimia citrififormis</i> (Snow) G. M. Smith | R | Ag |
| <i>Micractinium pusillum</i> Fresenius | R | Ag |
| <i>Nephrocytium limneticum</i> (G. M. Smith) G. M. Smith | O | Jy |
| <i>Oocystis borgei</i> Snow | O | O,N,My |
| <i>Oocystis crassa</i> Witttr. | C | Ap,My,Ju,Jy,Ag |
| <i>Oocystis elliptica</i> W. West | C | O,N,D,My,Ju,Jy,Ag,S |
| <i>Oocystis eremosphaeria</i> G. M. Smith | O | O,N,D,Ap,Ju,Jy |
| <i>Oocystis parva</i> West and West | C | Ap,My,Ju,Jy |
| <i>Oocystis pusilla</i> Hansg. | O | My,Ju,Jy |
| <i>Oocystis solitaria</i> Witttr. in Witttr. and Norstedt | C | O,N,D,My,Ju,Jy,Ag,S |
| <i>Oocystis lacustris</i> Chodat | R | Ju,Jy |
| <i>Pediastrum Boryanum</i> (Turp.) Menegh. | A | Ap,My,Jun,Jy,Ag,S,O,N |
| <i>Pediastrum duplex</i> var. <i>reticulatum</i> Lagerheim | O | N |
| <i>Pediastrum simplex</i> var. <i>duodenarium</i> (Bailey) Rabenhorst | O | N,O,My,Ju |
| <i>Pediastrum tetras</i> (Ehr.) Ralfs. | A | O,N,Mr,Ap,My |
| <i>Pediastrum tetras</i> (Ehr.) Ralfs, var. <i>tetraodon</i> (Corda) Rabenhorst | C | O,N,My |
| <i>Planktosphaeria gelatinosa</i> G. M. Smith | R | Jy |
| <i>Scenedesmus acutiformis</i> Schroeder | R | S |
| <i>Scenedesmus arcuatus</i> Lemm. | C | N,Ap,My |
| <i>Scenedesmus arcuatus</i> Lemm. var. <i>platydiscus</i> G. M. Smith | O | O,N,My |
| <i>Scenedesmus armatus</i> var. <i>chodatii</i> G. M. Smith | O | N |
| <i>Scenedesmus basiliensis</i> Bohlin | C | Ap,My,Ju,Jy |
| <i>Scenedesmus denticulatus</i> Lagerheim | A | My,Ju,Jy,Ag |
| <i>Scenedesmus quadricauda</i> (Turp.) de Breb. | A | O-O |
| <i>Selenastrum minutum</i> (Naeg.) Collins | R | N |
| * <i>Selenastrum Bibrianum</i> Reinsch | R | S |
| * <i>Selenastrum Westii</i> G. M. Smith | R | N |

TABLE 1. (continued)

| Organism | Relative Abundance | Seasonal Occurrence |
|---|--------------------|----------------------------------|
| <i>Sorastrum spinulosum</i> Naegeli | R | Jy,Ag |
| <i>Tetraedron constrictum</i> G. M. Smith | R | N |
| <i>Tetraedron gracile</i> (Reinsch.) Hansgirg | O | My,Ju,Jy |
| <i>Tetraedron minimum</i> (A. Braun) Hansgirg | C | Jy,Ag |
| <i>Tetraedron pusillum</i> (Wallich) West and West | O | Jy |
| * <i>Tetraedron quadratum</i> (Reinsch) Hansgirg | C | My,Ju,Jy |
| <i>Tetraedron regulare</i> var. <i>incus</i> Teiling | C | N,Ap,My |
| <i>Tetraedron trigonum</i> (Naeg.) Hansgirg | O | My,Ju,Jy,Ag |
| * <i>Tetrastrum heteracanthum</i> (Norstedt) Chodat | R | N |
| * <i>Trochiscia aspera</i> (Reinsch) Hansgirg | R | Ag |
| <i>Trochiscia reticularis</i> (Reinsch) Hansgirg | R | Ag |
| <i>Westella botryoides</i> (W. West) de Wildeman | R | Ju |
| <i>Westella linearis</i> G. M. Smith | R | Ju |
| Cylindrocapsales: | | |
| * <i>Cylindrocapsa conferta</i> W. West | O | My,Ju,Jy |
| Oedogoniales: | | |
| * <i>Bulbochaete mirabilis</i> Wittr. | C | Jy |
| <i>Bulbochaete pygmaea</i> Pringsheim | C | Jy |
| <i>Bulbochaete</i> sp. | C | O,N,Ap,My,Ju,Jy |
| <i>Oedogonium aerolatum</i> Lagerheim | O | Ag |
| <i>Oedogonium capitellatum</i> Wittr. | O | S |
| <i>Oedogonium cardiacum</i> (Hass.) Wittr. | O | Jy |
| <i>Oedogonium crassiusculum</i> Wittr. | O | My,Ju,Jy |
| * <i>Oedogonium globosum</i> Nordst. | O | Jy |
| <i>Oedogonium gracilius</i> (Wittr.) Tiffany | C | Jy |
| <i>Oedogonium Howardii</i> G. S. West | A | Ju,Jy,Ag |
| <i>Oedogonium irregulare</i> Wittr. | O | My |
| * <i>Oedogonium urceolatum</i> Nordstedt and Hirn in Hirn | O | Ag |
| <i>Oedogonium</i> spp. | A | O-O |
| Tetrasporales: | | |
| <i>Asterococcus limneticus</i> G. M. Smith | A | O,N,Ap,My,Ju,Jy |
| * <i>Elakatothrix viridis</i> (Snow) Printz. | R | S |
| <i>Gloeocystis ampla</i> (Kuetz.) Lagerheim | A | Ju,Jy,Ag |
| <i>Gloeocystis gigas</i> (Kuetz.) Lagerheim | C | My,Ju,Jy,Ag |
| <i>Gloeocystis vesiculosa</i> Naegeli | A | Ju,Jy,Ag |
| * <i>Palmodictyon viride</i> Kuetz. | R | Jy |
| <i>Sphaerocystis schroeteri</i> Chod. | A | O,N,D,Jn,F,Mr,Ap,My, Ju,Jy,Ag |
| <i>Tetraspora lacustris</i> Kenn. | A | O,N,Mr,Ap,My,S |
| Ulotrichales: | | |
| <i>Radiofilum conjunctivum</i> Schmidle | C | O,N,D,Ap,My,Ju |
| <i>Ulothrix subconstricta</i> G. S. West | O | My,Ju,Jy,Ag |
| <i>Ulothrix subtilissima</i> Rabenhorst | C | Jy,Ju,Jy,Ag |
| Volvocales: | | |
| * <i>Chlamydomonas globosa</i> Snow | O | Ap,My |
| * <i>Chlamydomonas polyphyrenoideum</i> Moew. | O | Ju |
| * <i>Chlamydomonas pseudopertyi</i> Pascher | O | N,D |
| <i>Chlamydomonas</i> spp. | C | O-O |
| <i>Eudorina elegans</i> Ehr. | O | Mr,Ap,My |
| * <i>Gonium formosum</i> Pascher | R | S |
| <i>Pandorina morum</i> (Muell.) Bory | C | My,Ju,Jy,Ag |
| <i>Phacotus lenticularis</i> Ehr. (Stein) | A | O-O |
| <i>Pleodorina californica</i> Shaw | C | Ju,Jy,Ag |
| <i>Volvox aureus</i> Ehr. | C | Mr,Ap,My,Ju,Jy,Ag |
| Zygnematales: | | |
| * <i>Aribrodesmus pbimus</i> var. <i>occidentalis</i> West and West | O | O,N,D |
| <i>Closterium eboracense</i> (Ehr.) Turner | C | Ap,My,Ju,Jy |
| <i>Closterium Leibleimii</i> Kuetz. | O | My,Ju,Jy,Ag |
| <i>Closterium parvulum</i> var. <i>maius</i> West f. <i>maius</i> | O | O,N,D,My,Ju |
| <i>Closterium venus</i> var. <i>apolloniensis</i> Croasdale | O | O,N |
| <i>Cosmarium angulare</i> Johnson | C | D,My,Ju,Jy |
| * <i>Cosmarium angulare</i> var. <i>canadensis</i> Irene-Marie | C | O,N,D |
| * <i>Cosmarium aphanichondum</i> Nordst. | O | O,N,D,My,Ju,Jy |

TABLE 1. (continued)

| Organism | Relative Abundance | Seasonal Occurrence |
|---|--------------------|-----------------------------------|
| <i>Cosmarium bireme</i> Nordst. | O | My, Ju |
| <i>Cosmarium biretum</i> de Breb. | O | O, N, D, Ap, My |
| <i>Cosmarium Blyttii</i> Wille | C | Ag, S |
| <i>Cosmarium crenulatum</i> var. <i>tumidulum</i> Insam and Krieger | O | Jy, Ag, S |
| <i>Cosmarium depressum</i> (Naegeli) Lundell | A | O, N, D, Jn, F, Mr, Ap |
| <i>Cosmarium formulosum</i> Hoffman | C | Ag, S |
| <i>Cosmarium Garrolense</i> Roy and Biss. | O | O, N, D |
| <i>Cosmarium granatum</i> de Breb. | A | Ap, My, Ju, Jy, Ag, S |
| <i>Cosmarium granatum</i> de Breb. var. <i>subgranatum</i> Nordst. | O | My |
| <i>Cosmarium humile</i> (Gay) Nordst. | C | O, N, My, Ju, Jy |
| <i>Cosmarium impressulum</i> Elfving | C | Ap, My, Ju, Jy, Ag |
| * <i>Cosmarium Lundellii</i> var. <i>ellipticum</i> West | C | O, N, D, Ap, My, Ju, Jy |
| <i>Cosmarium margaritatum</i> (Lund.) Roy and Biss. | A | S, O, N |
| <i>Cosmarium moniliforme</i> (Turp.) Ralfs. | O | Ap, My, Ju, Jy |
| <i>Cosmarium porrectum</i> Nordst. | A | My, Ju, Jy, Ag, S |
| <i>Cosmarium pseudoprotuberans</i> Kirchn. | O | N, My, Ju, Jy |
| <i>Cosmarium portianum</i> Archer | O | Jy |
| <i>Cosmarium Novae-Semliae</i> var. <i>sibericum</i> Boldt | O | S |
| <i>Cosmarium quadratum</i> Lundell var. <i>minus</i> Nordst. | O | My, Ju |
| <i>Cosmarium reniforme</i> (Ralfs.) Archer | C | O, N, D, Ap, My |
| * <i>Cosmarium rectangulare</i> var. <i>hexagonum</i> (Elf.) Nob. | O | My, Ju |
| * <i>Cosmarium regnellii</i> Wille | C | Ap, My, Ju, Jy, Ag |
| * <i>Cosmarium seelyanum</i> Wille | C | Ap, Ju, Jy |
| * <i>Cosmarium subochthodes</i> Schmidle | C | N, O, Ap, My, Ju, Jy |
| <i>Cosmarium subprotimidum</i> Nordst. | C | Ag, S |
| <i>Cosmarium umbiculatum</i> Lutkem | C | O, N |
| <i>Cosmarium turpinii</i> de Breb. var. <i>podolicum</i> Gutwinski | O | Jy |
| * <i>Cosmarium variolatum</i> Lendell var. <i>cataractum</i> Raciborski | C | Jy, Ag, S |
| <i>Euastrum binale</i> (Turp.) Ehr. f. <i>bians</i> W. West | C | My, Ju, Jy |
| <i>Euastrum dubium</i> Naegeli | C | O, N, D, Ap, My, Ju, Jy, Ag, S |
| <i>Euastrum insulare</i> (Wittr.) Roy | C | Ap, My, Ju, Jy |
| <i>Euastrum insulare</i> (Wittr.) Roy var.? | C | My |
| * <i>Euastrum turneri</i> West var. <i>turneri</i> f. <i>turneri</i> | C | O, N, My, Ju, Jy |
| <i>Micrasterias truncata</i> var. <i>truncata</i> f. <i>semiradiata</i> (Naeg.) Cleve | C | O, N, Ap, My, Ju |
| <i>Mougeotia</i> sp. | C | O, N, D, Mr, Ap, My, Ju, Jy |
| * <i>Netrium digitus</i> var. <i>rectum</i> (Turner) Kreiger | C | O, N, D, J, F, Mr, Ap, My, Ju, Jy |
| <i>Penium margaritaceum</i> (Ehr.) de Breb. | R | Jy |
| <i>Sirogonium stictum</i> (Engl. Bot.) Kuetz. | R | My |
| <i>Spirogyra communis</i> (Hass.) Kuetz. | A | Ap |
| <i>Spirogyra irregularis</i> Naegeli | A | Ap |
| <i>Spirogyra Juergenskii</i> Kuetz. | A | Ap, My, Ag, S, O |
| <i>Spirogyra punctata</i> Cleve | A | Ap, My |
| <i>Spirogyra spreeiana</i> Rabenhorst | A | Ju, Jy, Ag |
| <i>Spirogyra</i> spp. | A | O-O |
| * <i>Staurastrum bicornatum</i> Johnson var. <i>tridentatum</i> Taft | C | Ag, S |
| * <i>Staurastrum bineanum</i> var.? Rabenhorst | C | Mr, Mr, Ap, My, Ju, Jy |
| * <i>Staurastrum floriferum</i> W. & G. S. West | C | D, O, N |
| <i>Staurastrum gracile</i> var. <i>nanum</i> Wille | O | Ap, N, O |
| <i>Staurastrum polymorphum</i> var. <i>pusillum</i> West | O | N, D, My |
| <i>Staurastrum setigerum</i> Cleve | R | Jy, Ag |
| <i>Staurastrum striolatum</i> (Naeg.) Archer | C | Ju, Jy |
| * <i>Staurastrum turgescens</i> De Not. | C | My, Ju, Jy, Ag, S |
| * <i>Staurastrum vestitum</i> Ralfs. | C | O, N, Ju, Jy, Ag, S |
| * <i>Zygnemopsis americana</i> Transeau | A | S |
| Cyanophyta: | | |
| Chroococcales: | | |
| * <i>Aphanocapsa biformis</i> A. Braun | O | Jy, Ag |
| <i>Aphanocapsa delicatissima</i> West & West | O | Ju, Jy, Ag |
| * <i>Aphanocapsa elachista</i> West & West | R | Ag, S |
| <i>Aphanocapsa pulchra</i> (Kuetz.) Rabenhorst | C | Ju, Jy, Ag |
| * <i>Aphanocapsa rivularis</i> (Carm.) Rabenhorst | C | O, Ju, Jy, Ag |
| <i>Aphanothece nidulans</i> P. Richter | R | Jy |
| * <i>Aphanothece clathra</i> G. S. West | R | O |

TABLE 1. (continued)

| Organism | Relative Abundance | Seasonal Occurrence |
|--|--------------------|------------------------|
| * <i>Aphanothece gelatinosa</i> (Henn.) Lemmermann | R | Jy,Ag |
| * <i>Chroococcus dispersus</i> (V. Keissler) Lemm. | O | My,Ju,Jy,Ag |
| <i>Chroococcus limneticus</i> var. <i>subsalsus</i> Lemm. | A | O,N,D,Jn,F,Ap,My |
| <i>Chroococcus minor</i> (Kuetz.) Naegeli | O | Ju,Jy,S |
| * <i>Chroococcus Prescottii</i> Drouet and Daily | C | My,Ju,Jy,Ag,S |
| <i>Chroococcus turgidus</i> (Kuetz.) Naegeli | C | N,D,Ap,My,Ju,Jy,Ag,S |
| <i>Chroococcus varius</i> A. Braun | O | Jy |
| <i>Coelosphaerium kuetzingianum</i> Naegeli | C | Ju,Jy,Ag |
| <i>Coelosphaerium pallidum</i> Lemm. | C | My,Ju,Jy,Ag,S |
| * <i>Dactylococcopsis acicularis</i> Lemm. | C | Jy |
| * <i>Dactylococcopsis fascicularis</i> Lemm. | O | My,Ju,Jy |
| * <i>Gloeocapsa polydermatica</i> Kuetz. | R | S |
| * <i>Gloeocapsa luteo-fusca</i> Martens | A | Ju,Jy |
| <i>Gloeothece rupestris</i> (Lyngb.) Borner in Wittr. & Norstedt | R | Ag |
| <i>Gomphosphaeria aponina</i> Kuetz | C | N,Mr,My,Ju,Jy,Ag,S |
| <i>Gomphosphaeria lacustris</i> Chod. | C | My,Ju,Jy,Ag |
| * <i>Marssonella elegans</i> Lemm. | O | My,Ju,Jy |
| <i>Merismopedia elegans</i> A. Braun | C | My,Ju,Jy |
| <i>Merismopedia glauca</i> (Ehr.) Naegeli | C | My,Ju,Jy |
| <i>Merismopedia punctata</i> Meyen | C | Jy |
| <i>Merismopedia tenuissima</i> Lemm. | O | Jy |
| <i>Microcystis aeruginosa</i> var. <i>major</i> (Wittr.) G. M. Smith | A | Ju,Jy,Ag,S |
| <i>Microcystis flos-aquae</i> (Wittr.) Kirchner | A | Ju,Jy,Ag |
| <i>Microcystis incerta</i> Lemm. | A | O,N,D,Ap,My,Ju,Jy,Ag,S |
| * <i>Rhabdoderma sigmoides</i> fa. <i>minor</i> Moorl & Carter | R | S |
| * <i>Synechococcus aeruginosa</i> Naegeli | R | Jy,Ag |
| Hormogonales: | | |
| <i>Anabena aequalis</i> Borge | O | My,Ju,Jy |
| * <i>Anabena ambigua</i> Rao, C. B. | C | Jy |
| <i>Anabena affinis</i> Lemm. | A | Ap,My,Ju |
| <i>Anabena circinalis</i> Rabenhorst ex. Born. et Flahault | A | Ju,Jy |
| * <i>Anabena fertilissima</i> Rao, C. B. | C | Ag |
| <i>Anabena flos-aquae</i> (Lyngb.) de Breb. | A | Ju,Jy,Ag |
| <i>Anabena planktonica</i> Brunthaler | A | Ju,Jy |
| * <i>Anabena oscillarioides</i> Bory ex. Born. et Flahault | O | S |
| * <i>Anabena sphaerica</i> Born. et Flah. | A | My |
| <i>Anabena spiroides</i> Klebahn | A | My,Ju,Jy |
| * <i>Anabena torulosa</i> (Carm.) Lagerh. ex. Born. et Flahault | O | Jy |
| * <i>Anabena vagnicola</i> Fritsch et Rich | O | Ag |
| <i>Anabena inaequalis</i> (Kuetz.) Borner et Flahault | O | My |
| * <i>Aulosira implexa</i> Born. et Flah. | A | Ju,Jy,Ag,S |
| * <i>Calothrix marchica</i> var. <i>intermedia</i> Rao, C. B. | C | My,Ju,Jy,Ag,S |
| * <i>Calothrix parietana</i> (Naeg.) Thuret | A | Jy,Ag,S |
| * <i>Calothrix scytonemicola</i> Tilden | R | S |
| * <i>Cylindrospermum stagnale</i> (Kuetz.) Born. et Flah. | A | Jy,Ag,S |
| * <i>Fortea bossei</i> (Fremy) comb. nov. | R | S |
| <i>Gloeotrichia echinulata</i> (J. E. Smith) P. Richter | A | Ju,Jy,Ag |
| * <i>Gloeotrichia pisum</i> Thuret ex. Born et Flah. | C | Jy,Ag |
| * <i>Hapalosiphon intricatus</i> West & West | R | S |
| * <i>Hydrocoleum homeotrichum</i> Kuetz. | R | S |
| <i>Lyngbya aerugineo-caerula</i> (Kuetz.) Gomont | O | Ag |
| * <i>Lyngbya kuetzingiana</i> Kirchner | O | Ag |
| <i>Lyngbya major</i> Meneghini | O | O-O |
| * <i>Lyngbya mesotrichia</i> Skuja | C | Jy,Ag |
| <i>Microcoleus</i> sp. | R | N |
| * <i>Nostoc carneum</i> Ag. ex. Born. et Flah. | O | Jy |
| <i>Nostoc hatei</i> Dixit | O | Ju,Jy |
| <i>Nostoc linckia</i> (Roth) Borner ex. Born. et Flah. | C | Ju,Jy,Ag |
| * <i>Nostoc paludosum</i> Kuetz. ex. Born. et Flahault | O | Ag |
| * <i>Nostoc punctiforme</i> (Kuetz.) Hariot | O | O,N,Ju,Jy |
| <i>Oscillatoria agardhii</i> Gomont | O | My,Ju |
| <i>Oscillatoria amphibia</i> C. A. Agardh | C | My,Ju,Jy |
| <i>Oscillatoria amphigranulata</i> van Goor | O | Jy |
| <i>Oscillatoria angustissima</i> West & West | O | My,Ju |
| <i>Oscillatoria formosa</i> Bory | R | Mr,Ap,Jy,Ju |
| * <i>Oscillatoria hamelii</i> Fremy | C | Ju,Jy,Ag |

TABLE 1. (continued)

| Organism | Relative Abundance | Seasonal Occurrence |
|---|--------------------|---------------------|
| <i>Oscillatoria limnetica</i> Lemm. | C | Mr,Ap,My |
| * <i>Oscillatoria proteus</i> Skuja | R | S |
| <i>Oscillatoria sancta</i> (Kuetz.) Gomont | R | Mr,Ap,Ag |
| <i>Oscillatoria subbrevis</i> Schmidle | C | O,Mr,Jn |
| <i>Oscillatoria tenuis</i> C. A. Agardh | C | N,My,Jn,F |
| * <i>Oscillatoria tenuis</i> var. <i>tergetina</i> (Kuetz.) Rabenh. | C | O,N |
| * <i>Phormidium inundatum</i> Kuetz. | O | Ju,Jy,Ag |
| * <i>Phormidium tenue</i> (Menegh.) Gomont | O | My |
| <i>Phormidium uncinatum</i> (Ag.) Gomont | C | Jy |
| * <i>Rivularia aquatica</i> De Wilde | R | My |
| * <i>Rivularia beccariana</i> (De Not.) Born. et Flahault | C | Ag |
| * <i>Rivularia globiceps</i> G. S. West | C | Ju,Jy,Ag |
| * <i>Scytonema hofmanni</i> Ag. ex. Born. et Flahault | R | S |
| * <i>Spirulina Norstedtii</i> Gomont | R | Ap |
| <i>Spirulina major</i> Kuetz. | R | Ap |
| Chamaesiphonales: | | |
| <i>Chamaesiphon incrustans</i> Grunow | O | My,Ju,O,N |
| Euglenophyta: | | |
| Euglenales: | | |
| <i>Colacium vesiculosum</i> Ehr. | O | Ap,My,Ju |
| <i>Euglena acus</i> Ehr. | C | N,Ap,My |
| <i>Euglena acus</i> var. <i>rigida</i> Huebner | C | O,N |
| * <i>Euglena convoluta</i> Korshikov | C | Ju,Jy,Ag,S |
| <i>Euglena gracilis</i> Klebs. | C | O,N,Ap,My,Ju,Jy |
| <i>Euglena proxima</i> Dangeard | O | N,Ju,Jy |
| <i>Euglena oxyuris</i> Schmarida | R | N,Ap |
| * <i>Euglena sanguinea</i> Ehr. | A | Jy,Ag |
| * <i>Euglena spadix</i> Gojdic | R | Ag |
| <i>Euglena spirogyra</i> Ehr. | O | Ag,S |
| * <i>Lepocinclis fusiformis</i> (Carter) Lemm. | O | N,S,O |
| * <i>Lepocinclis glabra</i> Orez. | R | S |
| * <i>Lepocinclis ovum</i> (Ehr.) Lemm. | C | Ju,Jy,Ag |
| * <i>Lepocinclis Playsfairiana</i> Defl. | O | N,My,Ju,Jy |
| <i>Phacus caudatus</i> Huebner | R | N |
| <i>Phacus longicauda</i> (Ehr.) Dujardin | C | N,Ap,My,Ju,Jy |
| <i>Phacus pseudoswirenkoi</i> Prescott | R | Jy |
| <i>Phacus pyrum</i> (Ehr.) Stein | O | N |
| <i>Phacus triquetus</i> (Ehr.) Dujardin | R | N |
| * <i>Trachelomonas acanthostoma</i> (Stokes) Deflandre | O | O,N |
| * <i>Trachelomonas acuminata</i> var. <i>ampthora</i> Playf. | O | My,Ju,Jy |
| <i>Trachelomonas armata</i> var. <i>longispina</i> (Playf.) Deflandre | C | Mr,My,Ju,Jy,Ag,S |
| * <i>Trachelomonas bacillifera</i> var. <i>minima</i> Playf. | R | Ap |
| <i>Trachelomonas charkowiensis</i> Swirenko | A | Jy,Ag |
| * <i>Trachelomonas dubia</i> (Swir.) Defl. | A | My,Ag,S |
| * <i>Trachelomonas gibberosa</i> Defl. | O | My,Ju,Jy |
| * <i>Trachelomonas gracillima</i> Balech.-Dast. | R | Ag |
| <i>Trachelomonas granulosa</i> Playfair | O | O,N,D,Jn,F |
| * <i>Trachelomonas globularis</i> var. <i>punctata</i> Skuja | R | Ag |
| <i>Trachelomonas hispida</i> (Perty) Stein | A | O-O |
| <i>Trachelomonas hispida</i> var. <i>coronata</i> Lemm. | C | N,My |
| * <i>Trachelomonas horrida</i> Palmer | C | Jy |
| * <i>Trachelomonas lacustris</i> Drez. | O | Jy |
| <i>Trachelomonas oblonga</i> Lemm. | C | Ju,Jy |
| * <i>Trachelomonas pulcherrima</i> var. <i>minor</i> Playfair | C | N,Ap |
| <i>Trachelomonas robusta</i> Swir. em. Defl. | C | N,D,F,Mr,Jn |
| * <i>Trachelomonas rotunda</i> (Playf.) Defl. | O | My,Ju,Jy |
| * <i>Trachelomonas scabra</i> Playf. aus Defl. | R | Jy |
| * <i>Trachelomonas schauinslandii</i> (Lemm.) Defl. | O | My,Ju |
| * <i>Trachelomonas triangularis</i> var. Defl. | O | Jy |
| * <i>Trachelomonas verrucosa</i> var. <i>zmiewika</i> (Swir.) Defl. | O | My,Ju,Jy |
| <i>Trachelomonas volvocina</i> Ehr. | A | O-O |
| <i>Trachelomonas superba</i> (Swir.) Difl. | R | Jy,Ag |

TABLE 1. (continued)

| Organism | Relative Abundance | Seasonal Occurrence |
|---|--------------------|---------------------|
| Xanthophyta: | | |
| Heterosiphonales: | | |
| <i>Vaucheria gemineata</i> (Vauch.) de Candolle | C | O,N,Ap,My,Jn |
| Chrysophyta: | | |
| Heterococcales: | | |
| <i>Peroniella planktonica</i> G. M. Smith | O | My,Ju,Jy |
| Chryomonadales: | | |
| <i>Mallomonas caudata</i> var. <i>macrolepis</i> Conrad | O | Ju,Jy,Ag,S |
| Pyrrophyta: | | |
| Dinococcales: | | |
| * <i>Cystodinedria</i> sp. | C | Jy,Ag,S |
| * <i>Cystodinium bataviense</i> Klebs. | A | Ag,S |
| * <i>Stylodinium globosum</i> Klebs. | C | O,N,Ag,S |
| * <i>Tetradinium javanicum</i> Klebs. | O | Ag,S |
| Dinocapsales: | | |
| * <i>Gloeodinium montanum</i> Klebs. | A | Jy,Ag,S,O |
| Peridinales: | | |
| <i>Ceratium hirundinella</i> (O. F. Muell.) Dujardin | C | Jy,Ag |
| <i>Peridinium bipeps</i> Stein | O | Ag,S |
| <i>Peridinium gatunense</i> Nygaard | O | Ag,S |
| * <i>Woloszynskia reticulata</i> Thompson | C | Ag,S |

TABLE 2. Genera and numbers of species of algae identified.

| Chlorococcales | | Zygnematales | |
|----------------------------|---------------------------|---------------------------|---------------------------|
| 1978 | 1938-1943 | 1978 | 1938-1943 |
| <i>Acanthosphaera</i> (1) | <i>Ankistrodesmus</i> (1) | <i>Arthrodesmus</i> (1) | <i>Arthrodesmus</i> (1) |
| <i>Ankistrodesmus</i> (3) | <i>Characium</i> (1) | <i>Closterium</i> (4) | <i>Closterium</i> (14) |
| <i>Characium</i> (1) | <i>Coelastrum</i> (1) | <i>Cosmarium</i> (31) | <i>Cosmarium</i> (39) |
| <i>Coelastrum</i> (3) | <i>Kirchneriella</i> (2) | <i>Euastrum</i> (5) | <i>Cylindrocystis</i> (1) |
| <i>Crucigenia</i> (5) | <i>Oocystis</i> (2) | <i>Micrasterias</i> (1) | <i>Desmidium</i> (2) |
| <i>Dictyosphaerium</i> (2) | <i>Pediastrum</i> (5) | <i>Mougeotia</i> (1) | <i>Dichotomum</i> (1) |
| <i>Dimorphococcus</i> (1) | <i>Scenedesmus</i> (3) | <i>Netrium</i> (1) | <i>Euastrum</i> (5) |
| <i>Gloeotaenium</i> (1) | <i>Sorastrum</i> (2) | <i>Penium</i> (1) | <i>Hyalotheca</i> (2) |
| <i>Lagerheimia</i> (1) | <i>Tetraedron</i> (2) | <i>Sirogonium</i> (1) | <i>Mesotaenium</i> (1) |
| <i>Micractinium</i> (1) | <i>Trochiscia</i> (1) | <i>Spirogyra</i> (10) | <i>Miscrasterias</i> (1) |
| <i>Nephrocystium</i> (1) | (20 taxa) | <i>Staurastrum</i> (9) | <i>Netrium</i> (1) |
| <i>Oocystis</i> (8) | | <i>Zygnemopsis</i> (1) | <i>Onychonema</i> (1) |
| <i>Pediastrum</i> (5) | | (66 taxa) | <i>Penium</i> (2) |
| <i>Planktosphaeria</i> (1) | | | <i>Pleurotaenium</i> (5) |
| <i>Radiococcus</i> (1) | | | <i>Sirogonium</i> (2) |
| <i>Scenedesmus</i> (7) | | | <i>Spirogyra</i> (19) |
| <i>Selenastrum</i> (3) | | | <i>Spondylosum</i> (1) |
| <i>Sorastrum</i> (1) | | | <i>Staurastrum</i> (20) |
| <i>Tetraedron</i> (7) | | | (118 taxa) |
| <i>Tetrastrum</i> (1) | | | |
| <i>Trochiscia</i> (2) | | | |
| <i>Westella</i> (2) | | | |
| (57 taxa) | | | |
| | Oedogoniales | | Euglenales |
| <i>Bulbochaete</i> (3) | <i>Bulbochaete</i> (2) | <i>Colacium</i> (1) | <i>Cryptoglena</i> (1) |
| <i>Oedogonium</i> (11) | <i>Oedogonium</i> (1) | <i>Euglena</i> (9) | <i>Euglena</i> (1) |
| (14 taxa) | (15 taxa) | <i>Lepocinclis</i> (4) | <i>Phacus</i> (3) |
| | | <i>Phacus</i> (5) | <i>Trachelomonas</i> (3) |
| | | <i>Trachelomonas</i> (24) | (8 taxa) |
| | | (43 taxa) | |
| | Charales | | |
| <i>Chara</i> (2) | <i>Chara</i> (2) | | |
| (2 taxa) | (2 taxa) | | |

(continued next page)

undoubtedly has been the major cause of change in the composition of the algal flora (31). Also, taxonomic classification of algae, especially at the species level, has been amended a great deal since Leake's time which could create artificial differences between the two studies.

Qualitatively Crystal Lake and the surrounding area have changed in many ways since Leake's study. The drainage basin of the lake, which was heavily grazed during Leake's study, is now covered heavily with grass and ungrazed. This undoubtedly has caused a change in the quality of solid runoff. Crystal Lake was formerly used extensively for boating, skiing and swimming, whereas now recreational use is limited to fishing. The lake has filled in 19-20 feet since Leake's study; this has resulted in reduced resistance to mixing. *Myriophyllum spicatum*, which has become the dominant plant in the lake, was not present when Leake did her study.

The presence of *Myriophyllum* has affected populations of algae in several ways. It provided a new habitat for many organisms resulting in greater algal diversity. Because of its presence, shoreline erosion and wave action in shallow areas was reduced, resulting in less sediment disturbance and clearer water. *Myriophyllum* also has an important effect on lake chemistry. Irwin and Stevenson (32) have shown that aquatic plants secrete substances into the water which combine with suspended particles and expedite their settling, thus reducing turbidity. Rooted submergent macrophytes such as *Myriophyllum* are important in the nutrient system of the lake as has been demonstrated by Gessner (33), Schwoerbel and Tillmans (34), and Wetzel (35). They function as "nutrient pumps" by bringing up nutrients from sediments and leaking them into the water through their leaves. Additional amounts of nutrients are released into the water when *Myriophyllum* dies in the fall. The nutrients added to the water by *Myriophyllum* are then utilized by algae and bacteria (36). While the Chlorophyta populations have remained relatively constant since Leake's study, the Cyanophyta and Euglenophyta populations have increased in diversity. Crystal Lake, therefore, seems to fit the hypothesis (35, 37) that established populations tend to remain constant. Palmer (38) has found that the green algae are the group most tolerant to changes in the environment, and this appears to be the case in Crystal Lake. The data also agree with the hypothesis (35, 39) that Euglenophytan and Cyanophytan populations tend to diversify with increased eutrophication.

Two factors besides the increase in Euglenophytan and Cyanophytan populations indicate that Crystal Lake is in an advanced state of eutrophication. One is that the surface area/volume ratio has increased greatly since the lake was built. Using the rate of filling in over the last 50 years, one can calculate that the lake will be filled in completely within 20-30 years. Whether or not this will happen is uncertain, but without a doubt, the lake will become shallower and thus will be more prone to eutrophication. The other factor is the heavy growth of *Myriophyllum*. Several authors (39, 40) indicate that a heavy growth of submerged macrophytes is a definite sign of advanced eutrophication and Crystal Lake certainly fits this description. We believe, therefore, that algal populations in Crystal Lake will continue to

Chroococcales

| 1978 | 1938-1943 |
|-----------------------------|---------------------------|
| <i>Aphanocapsa</i> (5) | <i>Coelosphaerium</i> (1) |
| <i>Aphanothece</i> (3) | <i>Gomphosphaeria</i> (1) |
| <i>Chroococcus</i> (6) | <i>Merismopedia</i> (1) |
| <i>Coelosphaerium</i> (2) | (3 taxa) |
| <i>Dactylococcopsis</i> (2) | |
| <i>Gloeocapsa</i> (2) | |
| <i>Gloeotheca</i> (1) | |
| <i>Gomphosphaeria</i> (2) | |
| <i>Marsoniella</i> (1) | |
| <i>Merismopedia</i> (4) | |
| <i>Microcystis</i> (3) | |
| <i>Rhabdoderma</i> (1) | |
| <i>Synechococcus</i> (1) | |
| (33 taxa) | |

Hormogonales

| | |
|----------------------------|--------------------------|
| <i>Anabena</i> (13) | <i>Anabena</i> (1) |
| <i>Aulosira</i> (1) | <i>Aphanizomenon</i> (1) |
| <i>Calothrix</i> (3) | <i>Lyngbya</i> (1) |
| <i>Cylindrospermum</i> (1) | <i>Oscillatoria</i> (1) |
| <i>Forsteia</i> (1) | (5 taxa) |
| <i>Gloeotrichia</i> (2) | |
| <i>Hapalosiphon</i> (1) | |
| <i>Hydrocoleum</i> (1) | |
| <i>Lyngbya</i> (4) | |
| <i>Microcoleus</i> (1) | |
| <i>Nostoc</i> (5) | |
| <i>Oscillatoria</i> (12) | |
| <i>Phormidium</i> (3) | |
| <i>Rivularia</i> (3) | |
| <i>Scytonema</i> (1) | |
| <i>Spirulina</i> (2) | |
| (54 taxa) | |

change but probably faster than over the last 40 years.

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