SPECIES COMPOSITION AND DIVERSITY OF PHYTOPLANKTON IN THE GRAND RIVER DAM AREA, OKLAHOMA

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A total of 245 phytoplankton taxa were collected with a plankton net from the Grand River, Chouteau Creek, Pryor Creek, and ponds located on GRDA property in Mayes County, Oklahoma, from February 1977 to August, 1977. Several of these taxa represent new state records. On the basis of species diversity Chouteau Creek, Pryor Creek and the Grand River are said to be lightly to moderately polluted.

INTRODUCTION

Considerable taxonomic work has been completed on the algal flora of Oklahoma including that of Gabel (1), Taft (2-9), Transeau et al. (10), Leake (11-13), Booth (14, 15), Maloney (16), Jenkins (17), Ophel (18-20), Vinyard (21-22), Cooper (23), Schlicting and Gearhart (24), Bermudez (25), Koch and Risser (26), Pfiester (27, 28), Pfiester and Felkner (29), Pfiester and Terry (30), Pfiester et al. (31), Wright (32, 33), Taylor (34), Wilhm et al. (35, 36), Seyfer and Wilhm (37), and Troeger (38, 39). The purpose of this paper is to report on changes in phytoplankton assemblage from February, 1977 to August, 1977 in Chouteau Creek, Pryor Creek, Grand River, and three ponds located on the Grand River Dam Authority (GRDA) property in Mayes County, Oklahoma.

MATERIALS AND METHODS

Study Area

Seven sampling stations were studied monthly (Fig. 1). Three were located on the Grand River. Station G-1 was at the present intake for the GRDA Generating Station, G-2 below the inflow of Pryor Creek where Highway 33 crosses the Grand River, and G-3 below the inflow of Chouteau Creek. Stations C-2 and C-3 were located on Chouteau Creek, C-2 near Highway 33 above where it converges with Grand River. Station P-1 was located on Pryor Creek north of where it joins Grand River and P-2 on Pryor Creek where it converges with Grand River. Three ponds located on GRDA property near the Highway 33 Bridge were sampled once in May.

Collection

Three samples were collected at each station by towing a No. 20 plankton net through 38.97 l of water on each sampling date. The plankton was concentrated into a 25-ml container. Samples were stored in an ice chest and 25 ml Transeau's solution (6 parts water, 3 parts ethanol, 1 part formalin) added upon return to the laboratory. These samples were used for identification of the algae exclusive of diatoms.

Identification and Diversity

Species identification of phytoplankton (exclusive of diatoms) was made by plac-
ing a drop on a glass slide which was then examined with an oil immersion lens. After species identification was accomplished at this magnification, a Sedwick-Rafter counting chamber was filled with 1 ml of the sample and organisms in the entire field counted at 10 × magnification.

Samples used for diatom identification and counts were cleaned by adding potassium dichromate and concentrated H₂O₂ to each sample. The contents were concentrated to 50 ml and permanent slides were prepared by adding a 1-ml aliquot to a cover slip which was dried and mounted permanently with Hyrax onto a slide. All algal samples are in the University of Oklahoma Bebb Herbarium.

Species diversity (d) was determined by using the formula of Shannon and Weaver (40).

RESULTS

Two hundred and forty-five taxa of phytoplankters were collected from the Grand River Dam Study Area (Table 1). Of this number 136 were diatoms (Bacillariophyta-

| Table 1. Phytoplankton collected from GRDA study area*

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<td>Pennales:</td>
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<tr>
<td>Acchnanthes affinis Grun. G, C, P</td>
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<tr>
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<tr>
<td>Amphora veneta Kuetz. P</td>
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<tr>
<td>Asterionella formosa Hass. G, C, P</td>
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<tr>
<td>Caloneis bacillaris (Greg.) Cleve Po</td>
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<tr>
<td>Caloneis bacillum (Grun.) Cl. C</td>
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<tr>
<td>Caloneis ventricosa (Ehr.) Mei. G, Po</td>
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<td>Cocconeis pediculus Ehr. G, C, P, Po</td>
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<td>Cocconeis placenta Ehr. G, C, Po</td>
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<td>Cymbella pleura sola (Bréb.) W. Smith P</td>
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<tr>
<td>Cymbella cymbiformis Ag. Po</td>
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<td>Cymbella minutula Hilde ex. Rabl. G, C, P, Po</td>
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<td>Diploneis sp. C</td>
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<td>Diploneis elliptica (Kuetz.) Cl. C</td>
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<tr>
<td>Epithemia sp. P</td>
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<tr>
<td>Eunotia curvata (Kuetz.) Lagerst. P, Po</td>
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* Fragilaria sp. P, Po
* Fragilaria laptonica Grun. Po
* Fragilaria vaucheriae (Kuetz.) Peters. C, P
* Frustulia vulgaris (Thwaites) DeT. G, P
* Gomphonema sp. Po
* Gomphonema affine Kuetz. G, C, P, Po
* Gomphonema angustatum (Kuetz.) Rabh. G, C, P, Po
* Gomphonema Auger Ehr. P
* Gomphonema consector Hohn. & Hellem. G, C, Po
* Gomphonema gracile Ehr. P
* Gomphonema olivaceum (Lynge.) Kuetz. G, C, P
* Gomphonema parvulum Kuetz. C, G, Po
* Gomphonema spumiferum Ehr. C.
* Gomphonema subclavatum (Grun.) Grun. G, C
* Gomphonema tenellum Kuetz. G, C
* Gomphonema tergestinum (Grun.) Fröcke G
* Gomphonema truncatum Ehr. C
* Gyrosigma sp. G
* Gyrosigma acuminatum (Kuetz.) Rabh. G, C, P, Po
* Gyrosigma eximium (Thwaites) Boyer G, P
* Hantzaebia ambigovox (Ehr.) Grun. C, P
* Meridion circulare var. constictum Ralfs G, C, P
* Navicula sp. G, C, P
* Navicula accommoda Hust. P
* Navicula capitata Ehr. G, C, P
* Navicula cryptobolum Kuetz. G, C, P, Po
* Navicula cuspidata Kuetz. Po
* Navicula decussis Destr. G
* Navicula gottlandica Grun. C, P, Po
* Navicula graciloides Mayer G
* Navicula jamaicensis Hust. P
* Navicula lanceolata (Ag.) Kuetz. G
* Navicula menisciulus Schum. G, C, P
* Navicula mima Grun. G
* Navicula mutica Kuetz. G, C, P
* Navicula mutica var. undulata (Hilse) Grun. G
* Navicula pseudoreinhardtii Patr. P
* Navicula papula Kuetz. G, C, P, Po
* Navicula pygmaea Kuetz. G
* Navicula radiosa Kuetz. Po
* Navicula rhynchocephala Kuetz. G, P
* Navicula subtilissima Cleve Po
* Navicula symetrica Patr. G, P, Po
* Navicula tricipitata (O.F.Muell.) Bory G, C, Po
* Navicula tripartitata var. schizonemoides (V.H.) Patr. C, Po
* Neidium affine (Ehr.) Pfitz. P
* Nitidula sp. C
* Nitidula aequalis Grun. P
* Nitidula acetata Hantzsche C, P
* Nitidula amphibia Grun. G, C, P, Po
* Nitidula apiculata (Greg.) Grun. C
* Nitidula capitellata Hust. C
* Nitidula Clausii Hantzsche C, P
* Nitidula diaphana (Kuetz.) Grun. G, C, P
* Nitidula filiformis (W. Smith) Hust. G, C, P
* Nitidula frustulum (Kuetz.) Grun. G, P
* Nitidula gracilis Hantzsche C, C, P
* Nitidula hungarica Grun. G, P
* Nitidula pilea (Kuetz.) W. Smith G, C, P, Po
* Nitidula parva Hust. P
* Nitidula sigma (Kuetz.) W. Smith G

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Nitzschia sublinearis Hust.
Nitzschia thermals Kuetz. C
Nitzschia thermals var. minor Hille G, C, P
Nitzschia tryblionella Hantsch C, G, C, P, Po
Pinnularia sp. C, P
Pinnularia ahuensis (Pant.) Ross G, Po
Pinnularia acrosphaeria W. Smith Po
Pinnularia acuminata W. Smith P
Pinnularia borealis Ehr. P
Pinnularia braunii var. amphiophala
(Mayer) Hust. Po
Pinnularia burkii Patr. Po
Pinnularia lagamen (Ehr.) Ehr. Po
Pinnularia maior (Kuetz.) Rabh. P
Pinnularia meigongylyla Ehr. Po
Pinnularia subatomophora Hust. Po
Rhoicosphera curvata (Kuetz.) Grun. G
Rhopalodia gibba (Ehr.) O. Muell. P, Po
Rhopalodia musculus (Kuetz.) O. Muell. C
Stauroneis nobilis Schum. Po
Surirella sp. Po
Surirella linearis W. Smith G, P
Surirella ovata Kuetz. G, C, P
Surirella robusta Ehr. F, Po
Symedra sp. P
Symedra delicatissima W. Smith Po
Symedra fasciculata (Ag.) Kuetz. G, C, P, Po
Symedra minuscula Grun. G
Symedra rumpens Kuetz. C, C, Po
Symedra ulna (Nitz.) Ehr. G, C, P, Po

Centrales:
Biddulphia laevis Ehr. C
Coreniciosdiscus sp. G
Coreniciosdiscus lineatus Ehr. Po
Coreniciosdiscus Rothii (Ehr.) Grun. G
Cyctolleta atomus Hust. G, C, P
Cyctolleta comta (Ehr.) Kuetz. G, P
Cyctolleta Menegheniana Kuetz. C, G, C, P, Po
Cyctolleta stelligera Cl. & Grun. G, C
Cyctolleta striata (Kuetz.) Grun. G, C, C, Po
Melosira ambigua (Grun.) O.F.Muell. G, C, P, Po
Melosira distans (Ehr.) Kuetz. G, C, C, Po
Melosira granulata (Ehr.) Raes G, C, P, Po
Melosira italic (Ehr.) Raes G, C, C, P
Melosira varians Ag. G, C, C, Po
Stephanodiscus aster (Ehr.) Grun. G, C, C, Po
Stephanodiscus Hantzschii Grun. G, C

CHLOROPHYLLA
Chlorococcales:
Ankistrodesmus falcatus (Corda) Raes G, C, P
Ankistrodesmus fractus (West & West)
Brunthaller G, C, Po
Chlorococcom sp. G, P
Coelastrium microorum Naeg. in Braun C
Coronarustea aestivale Thompson G
Crucigenia rectangularis (A. Br.) Gay Po
Crucigenia tetraedra (Kirch.) West & West C
Crucigenia truncata Smith G, C, P
Dictyosphaerium pulchellum Wood P
Dityosphaerium Ehrenbergianum Naeg. C
Fracella Drosecheri (Lemm.) Smith C
Golenkinia radiata (Chod.) Wille P, Po
Kirchneriella elongata Smith P
Kirchneriella obesa (West) Schmide P
Kirchneriella subsolitaria West C
Lagerheimia sp. C

Micractinium pusillum Fresenius G, C, P
Nephrocytum obesum West & West P
Oocystis pusilla Hangg. G, C, P, Po
Pedotrassum duplex var. reticulatum Lager. C, P
Pedotrassum tetrac. (Ehr.) Raes P
Scenedesmus sp. P
Scenedesmus acuminatus (Lag.) Chod. C
Scenedesmus anomalous (Smith) Ahlstr.
T & Tiffany P
Scenedesmus arcuatus var. platydiscus Smith G
Scenedesmus brasilienis Bohlin Po
Scenedesmus dimorphus (Turr.) Kuetz. C, P
Scenedesmus quadricauda (Turr.) Brab. G, C, P
Scenedesmus serratus (Corda) Bohlin
Schroederia Judayi Smith G
Schroederia setigera (Turr.) Brab. P
Tetraedron constrictum Smith P
Tetraedron trigonum (Naeg.) Hangg. C, P
Tetraedron elegans Playfair C

Oedogoniales:
Oedogonium sp.

Tetrasporales:
Sphaerocystis Schroeteri Chod. G, P, Po

Ulotrichales:

Ulothrixiales:

Volvocales:
Chlamydomonas sp. G, C, P
Chlamydomonas Cienkowskii Schmidle P
Chlamydomonas Snovitzi Printz C, P
Pteromonas sp. C

Zygometales:
Arthrodoreus convergens Ehr. Po
Arthrodoreus michiganensis Johnson C, Po
Closterium acerosum (Schr.) Ehr. C
Closterium calosporum Witt. G, P
Closterium leibnitii Kuetz. Po
Closterium moniliforme (Bory) Ehr. P
Cosmarium sp. G, Po
Cosmarium denatum Wolfe P
Cosmarium nobile (Turner) Kriger P
Cosmarium porrectum Nordst. Po
Desmidium sp. Po
Desmidium Aptogonum Brab. G
Desmidium Baileyi (Raes) Nordst. Po
Desmidium Greivilli (Kuetz.) B. By. Po
Euastrum sp. G, C, Po
Microstrixia radiata Hass. Po
Mongeobia sp. Po
Onychomma filiforme (Ehr.) Roy & Biss. Po
Pleurosigma Tracheala (Ehr.) Naeg. Po
Piregynia sp. G, P, Po
Spondylosium sp. Po
Staurastrum sp. Po
Staurastrum quadrivicipitator Turner Po
Staurastrum turgescens de Wok Po
Xantidium sp. Po

CHRYSOPHYLLA
Heterotrichales:
Trichonema affine West C

CYANOPHYLLA
Chroococcales:
Aphanocapsa muscicola (Meneg.) Wolfe Po
Chroococcus sp. G, Po
Chroococcus immotilis Lemm. P
Chroococcus minor (Kuetz.) Naeg. Po
Coelosphaerium confortum G. S. West Po
ta), 62 green algae (Chlorophyta), 23 bluegreens (Cyanophyta), 19 euglenophyts, 3 pyrrhophyts, 1 chrysophyty, and 1 unidentified red alga. Several of these represent new state records.

Species diversity in the Grand River ranged from 0.49 at Station G-1 in March to 3.44 in August (Table 2). Number of taxa present at any one sampling time ranged from 5 at G-3 in May to 27 at G-2 in June. The diatoms *Melosira granulata* and *Cymbella minuta* were the most abundant algae in the Grand River during this study. Other important algae include *Ankistrodesmus falcatus*, *Oocystis pusilla*, and *Gymnodiunm* sp.

Species diversity in Chouteau Creek ranged from 1.56 in March at Station C-3 to 3.82 in May at the same station. The lowest number of taxa present at any one sampling time was in March at C-3 and the highest was 45 at the same station in June. *Melosira granulata* and *Chlamydomonas Snowii* were the most abundant algae at Chouteau Creek. *Cymbella minuta*, *Crucigenia truncata*, and *Trachelomonas volvocina* were also common.

Species diversity ranged from 0.30 at station P-1 in February in Pryor Creek to 3.40 at the same station in March. The number of taxa present varied from four in August at P-2 to 41 in June at P-1. *Euglena gracilis* was the most abundant alga observed in Pryer Creek with *Melosira granulata* the second most abundant. Other common algae were *Trachelomonas volvocina*, *Ankistrodesmus falcatus*, and *Scenedesmus quadricauda*.

Species diversity in the ponds ranged from 2.52 in Pond 3 to 4.10 in Pond 2. Taxa present varied from 42 in Pond 1 to 53 in Pond 3. All three ponds had large numbers of desmids such as *Desmidium Baileyi*, *Cosmarium* sp., *Arthrodesmus convergens*, and *Pleurotaenium Trabecula* as well as filamentous members of the *Zygnematales* such as *Mougeotia* and *Spirogyra*.

**DISCUSSION**

The Grand River is typical of larger rivers in that the plankton was composed mainly of diatoms. Diatoms were also the dominant planktonic algae in Pryor and Chouteau creeks with the exception of Station P-1 in February.

Planktonic diatoms found in this study include the genera *Melosira*, *Asterionella*, *Fragilaria*, *Cyclotella*, and *Stephanodiscus* (41). Benthic diatoms found include the genera *Synedra*, *Nitzschia*, *Navicula*, *Diatoma*, and *Surirella*. As the water became warmer Chlorophycean phytoplankters such as *Scenedesmus*, *Ankistrodesmus*, and *Dictyosphaerium* became common. Numbers of benthic algae in the open water generally
vary with the composition of the stream bed. As populations attached to the substrate mature, layers become unstable, are detached, and float away. Shallower streams tend to have larger numbers of benthic algae. This is true of Chouteau and Pryor creeks.

Species diversity values in the Grand River ranged from 0.49 to 3.44. Using the categories of Staub (42) the Grand River would range from slightly to heavily polluted at all three stations. The present intake appears to have a decided effect on the phytoplankton population. This probably occurs in several ways: 1) large numbers of plankters are removed from the open water through the intake, 2) decay of fish and other animals trapped by the intake and low water dam contribute to organic pollution and thus abundance of pollution-tolerant algal genera to the exclusion of less tolerant taxa, and 3) frequent and severe fluctuations in water level affect the number and kinds of organisms capable of thriving. Station G-2 is most likely affected by organic pollutants coming from Pryor Creek, an industrialized stream.

The greatest variety of phytoplankton taxa occurred in Chouteau Creek in February, while the lowest occurred in March. As in the Grand River, diatom taxa are common in Chouteau Creek. According to Staub's (42) classification system, species diversity values for Chouteau Creek indicate that it is only moderately to lightly polluted. The lowest value for species diversity in Pryor Creek occurred in February at P-1 (0.30). The potential for such a low species diversity indicates substantial pollution. The presence of cattle at Station P-1 and industrial wastes add considerable organic nitrogen to the water and contribute to heavy pollution found there in some months, which increases the pollution found at Station P-2.

The algae found in the three ponds are those typically found in quiet, acid environments.

CONCLUSIONS

Two hundred and forty-five taxa of phytoplankters were collected from the Grand River Dam Study area. Of this number 136 were diatoms, 62 green algae, 23 bluegreens, 19 euglenophytes, 3 pynrmphytes, 1 chrysophytes, and 1 unidentified red alga. The sites on the GRDA Study Site indicate some potential problem areas such as in P-1. In general, however, the study indicates that Chouteau Creek, Pryor Creek, and the Grand River are lightly to moderately polluted.

LITERATURE CITED


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<th>Stream (Station)</th>
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<th>3/26</th>
<th>4/30</th>
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