PHYTOPLANKTON OF THE TITTABAWASSEE RIVER, MIDLAND, MICHIGAN

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ABSTRACT

Phytoplankton samples were collected from June 1977 to January 1979. Low and high occurrences were in the winter (January, 1979) and spring-summer (May, 1978) respectively. Twenty-three taxa were dominant (> 5% occurrence at any station) among the 301 taxa observed. The dominant species were representatives of the divisions Chlorophyta, Bacillariophyta, Cyanophyta, and Cryptophyta.

INTRODUCTION

The Tittabawassee River is one tributary of the Saginaw River, a system which drains the majority of the east central region of Michigan. The Tittabawassee drains approximately 678,577 hectares of flat to slighly rolling terrrain in central Michigan (6). The city of Midland is the only major population or industrial center located on the river.

The Michigan Department of Natural Resources conducted biological surveys of the Tittabawassee River in 1971 and 1972 (1) and 1974 (7), to determine water quality conditions. Phytoplankton identifications in those studies were to the generic level only. Sixty genera were distinguished in 1971-72, and 45 genera in 1974.

SITE DESCRIPTION

Five transects were established in the vicinity of Midland, Midland County, Michigan in a major industrial section of the Tittabawassee River (Fig. 1). Three stations were established at each transect. Facing upstream, station 1 was one-third the distance form the left bank, station 2 in the middle of the river, and station 3 one-third across from the right bank.

Transect A (67 m across) was located 175 m above Dow Chemical Company's Tertiary Treatment Pond effluent. Transect B was directly upstream of the Midland Nuclear Power Plant, Consumer's Power Company. Transect C was located directly below the tertiary treatment discharge, while transect D was 1 km below the tertiary outfall and immediately below the city of Midland's sewage treatment effluent. Transect E was 84 m across, and was located 12 km below the power plant site, and 0.5 km above the Freeland Road bridge near the town of Freeland, Michigan.

MATERIALS AND METHODS

Whole water grab samples were collected at two transects (A and E) in June, August and October 1977, and at four transects (B, C, D, E) in April, May, July, August, September and November 1978, and January 1979. Triplicate samples were taken at each station in a transect.

In the laboratory, Lugol's Iodine was added to a 0.5 or 1 liter aliquot of each sample, and the phytoplankton concentrated by sedimentation. A second aliquot (45 ml) of the original sample was preserved when phytoplankton density was sufficient for enumeration without concentration.

Phytoplankton were enumerated at a magnification of 450X (1977) or 400X (1978). A 0.1 ml aliquot of sample was placed in a Palmer-Maloney counting chamber, and every other row observed across the counting chamber. All soft bodied algal cells encountered were identified to the lowest possible taxon. Diatoms were grouped into growth forms.

Strewn burnt Hyrax mounts were made from the concentrated samples for diatom species identification and enumeration. Percent composition of each species of the growth forms were calculated from the Hyrax slide counts as 1000X.

Occurrence (cells/ml) and percent occurrence were calculated for individual taxa and major algal divisions.

PHYTOPLANKTON ABUNDANCE

Phytoplankton abundance was lowest in January 1979, and highest in May 1978 (Fig. 2). Most maximum abundances occurred during the summer months, while lows were generally noted in April 1978 and January 1979. In the Sandusky River during 1973 and 1974, the lowest abundances were also recorded in the winter and early spring (4).

During sampling in 1977, phytoplankton occurrence was usually greatest at transect E, the transect located farthest downstream and at that time the sampling site most directly effected by the city of Midland's discharge. In 1978 however, occurrence in 1978 was greatest at transect D, downstream of Dow Chemical Company's tertiary treatment discharge. The standing crops observed were much higher than those observed by the earlier Department of Natural Resources studies (1,7).

A total of 301 taxa in 96 genera, representing eight divisions were observed during the sampling period (Table 1). Ninety-five taxa were observed in both 1977 and 1978, while only 10 additional taxa were present in 1977only, and 196 taxa were observed only in 1978. This difference was due to the more intensive sampling design in 1978.

Only the divisions Bacillariophyta, Cyanophyta and Chlorophyta were important in terms of percent composition during 1977 and 1978 (Fig. 3). In January 1979 however, the division Cryptophyta became important due to the extreme abundance of one species.

A total of 23 phytoplankton species were dominant (>5% occurrence at any station, during the sampling period, including six blue-green species (Cyanophyta), ten green species (Chlorophyta), six diatom species (Bacillariophyta) and one member of the division Cryptophyta (Table 1). Only six species were dominant in 1977, with three of those among the 20 dominant in 1978-79.

Occurrence (cells/ml) of members of the division Chlorophyta were greater than all others at all sampling dates except the spring date (April and May 1978). Green algae were the second most important group in the Sandusky River near Fremont, Ohio (4). Sixty-three taxa in 33 genera were observed and ten species were dominant. In 1977, Crucigenia tetrapedia and Scenedesmus quadricauda were domiant and in 1978 the dominant species included Ankistrodesmus falcatus, Chlamydomonas snowii, Chlamydomonas sp., Chlorella vulgaris, Coelastrum sphaericum, Cloeocystis vasiculosa, Pandorina morum, Scenedesmus quadricauda, and an unidentified green coccoid. The majority of these species peaked in occurrence in August and September.

The division Bacillariophyta was the most diverse group, but in 1977 was a minor contributor to the percent composition. In 1978, diatoms were the most abundant group in April and May. In the Arkansas River, 1975-76, maximum occurrence of plankton diatoms occurred in early spring (12). A total of 33 genera and 194 diatom taxa were observed. Only Cyclotella memeghiniana was dominant in both years. The other dominant species (1978) included Cyclotella michiganiana, Cyclotella pseudostelligera, Cyclotella stelligera, Stephanodiscus invisitatus and Stephanodiscus subtilis. Many of these centric forms are typical of alkaline rivers in themidwestern United States where they are often the most abundant group of river phytoplankton (4). This tendency has been observed in the Sandusky (4), Little Miami (10) Susquehana (9), and Mississippi Rivers (2). Stephanodiscus invisitatus peaked in occurrence in APril 1978. This species was also a spring dominant in the Sandusky River, Ohio (4). Cyclotella meneghiniana, C. pseudostelligera and C. stelligera were fall dominants here in the Tittabawassee River and in the Sandusky River (4). Cyclotella was also the most abundant phytoplankton genus in the Arkansas River (12).

The division Cyanophyta was never the largest contributor to the percent composition, but it was an important group in the summer months. Twenty-two taxa (12 genera) were observed, and seven taxa were dominant. Dactylococcopsis fascicularis and Dactylococcopsis raphidioides were dominant in 1977 only, Merismopedia tenuissima was dominant in both years, and Anabaena sp., Chroococcus dispersus and Chroococcus limneticus in 1978.

The division Cryptophyta was important in percent composition only in January 1979 samples. One species, Chroococcus nordstedtii, was extremely abundant at this time, with peak occurrence of 81.2% at one station. Chroococcus nordstedtii was not observed at any other time during the sampling period.

Spectral preference data were complied for the dominant species in the Tittabawassee River (3, 5, 8, 11). This tabula-

tion indicated a community which was acidophilous to indifferent in pH, mesosaprobic to oligosaprobic, indifferent to halobion spectrum, limnophilous, planktonic to tychoplanktonic, and eutrophic.

SUMMARY

1. Phytoplankton abundance in the samples taken at five transects in the Tittabawassee River from June 1977 to January 1979, was greatest in the summer and lowest in the winter. Overall peak high and low occurrences were in May 1978 and January 1979, respectively. Abundances were greatest at transects downstream of tertiary sewage treatment outfalls.

2. 301 taxa in 96 genera of 8 divisions were identified. The divisions Chlorophyta, Bacillariophyta and Cyanophyta were major contributors to percent composition of all sampling dates. Cryptophyta was also important in January 1979.

3. Twenty-three taxa were dominant (> 5% occurrence at any station). This total included six blue-green, ten green, one cryptophyte and six diatom taxa.

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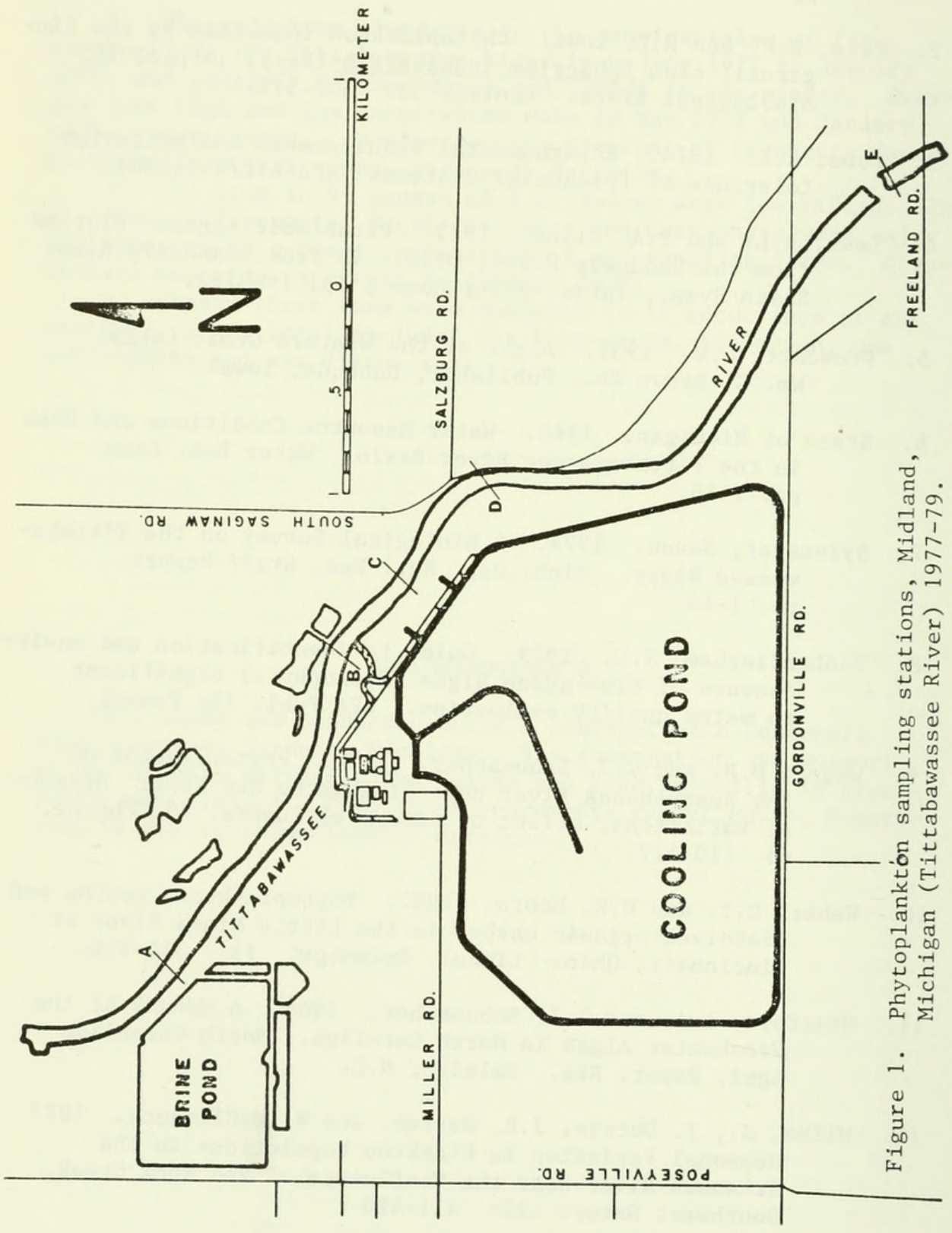

Figure 1. Phytoplankton sampling stations, Midland, Michigan (Tittabawassee River) 1977-79.

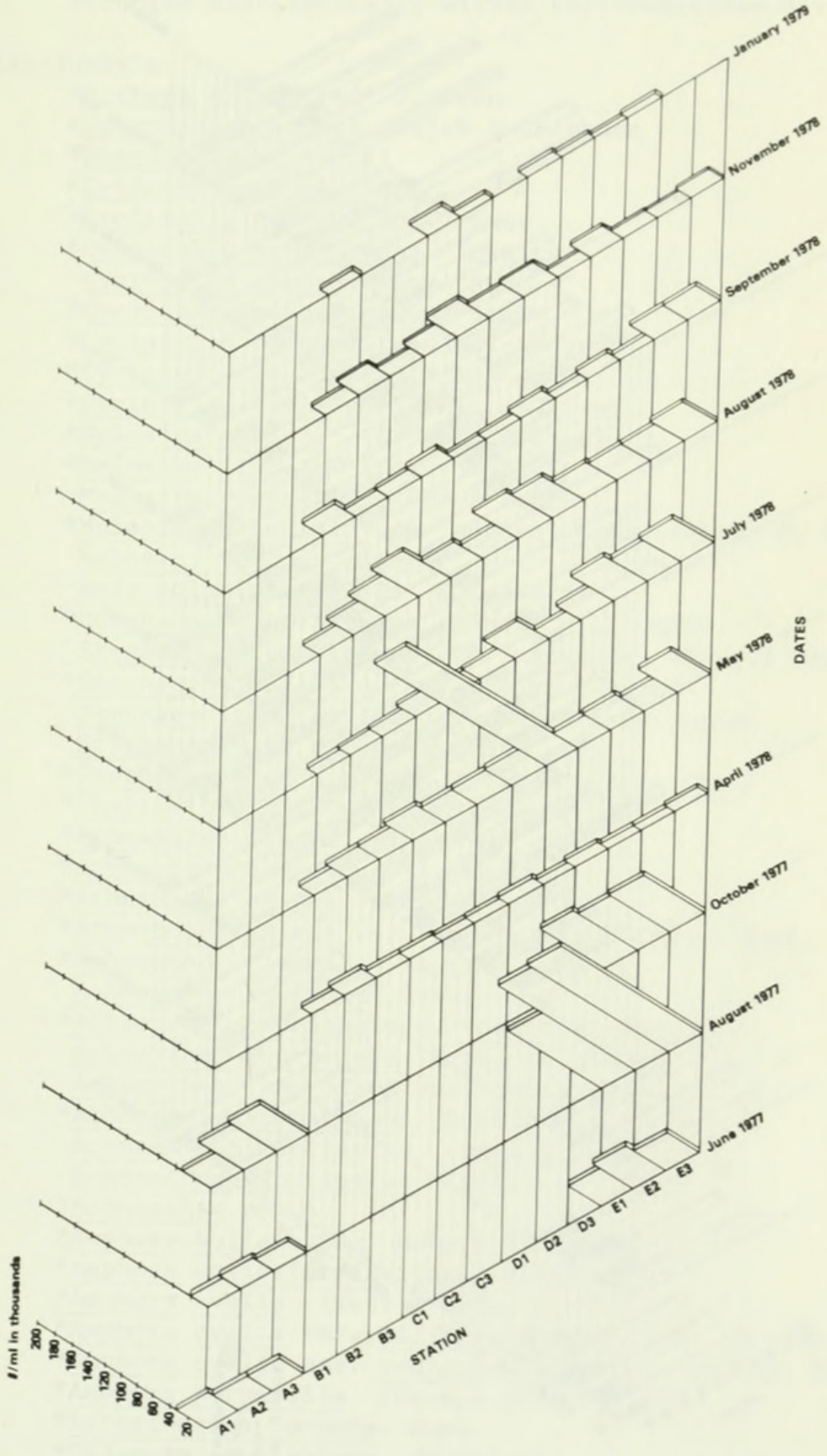

Figure 2. Seasonal variation of phytoplankton, Tittabawassee River, Midland, Michigan, 1977-79

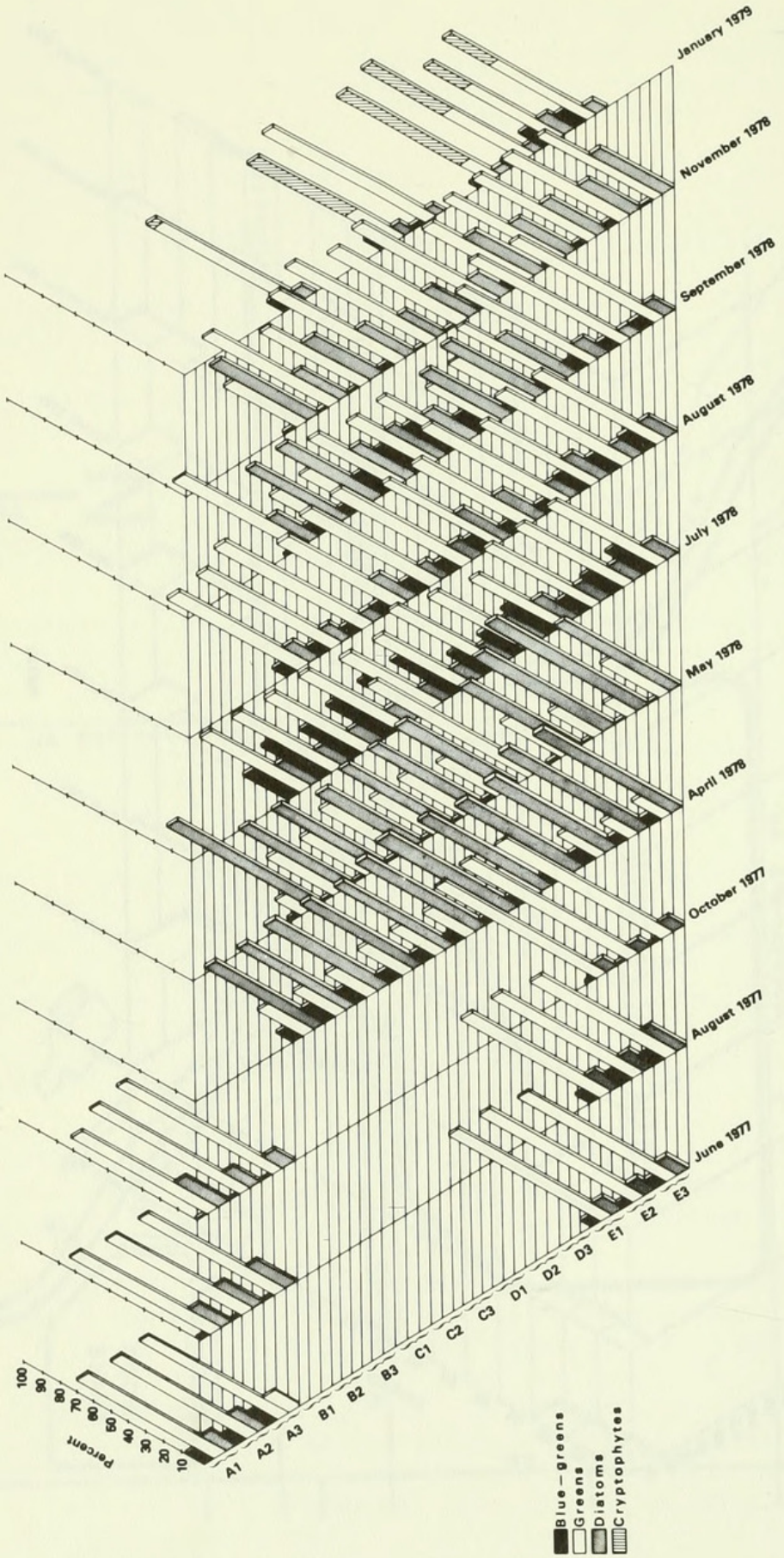

Figure 3. Percent distribution of phytoplankton, Tittabawassee River, Midland, Michigan, 1977-79.

Table 1. Summary of phytoplankton observed from the Tittabawassee River, Midland, Michigan, June 1977 - January 1979, arranged alphabetically within representative divisions.

Bacillariophyta

*Attheya zachariasi J. Brun
*Chaetoceros hohnii Wujek & Graebner
*Coscinodiscus sp. 1
*Cyclotella atomus Hust.
Cyclotella comta (Ehr.) Kutz.
*Cyclotella kutzingiana Thwaites
Cyclotella meneghiniana Kutz.
*Cyclotella michiganiana Skv.
*Cyclotella operculata (Ag.) Kutz.
*Cyclotella pseudostelligera Hust.
*Cyclotella stelligera Cl. et. Grun.
*Melosira ambigua (Grun.) O. Mull
*Melosira distans (Ehr.) Kutz.
Melosira granulata (Ehr.) Ralfs
*Melosira granulata var. angustissima (Ehr.) O. Mull
Melosira varians Ag.
Rhizosolenia eriensis H.L. Smith
*Stephanodiscus astraea (Ehr.) H.L. Smith
Stephanodiscus astraea var. minutula (Kutz.) Grun.
*Stephanodiscus binderana (Kutz.) Round
Stephanodiscus invisitatus Hohn & Hellerman
Stephanodiscus niagarae Ehr.
*Stephanodiscus subtilis (Van Goor) A. Cl.
*Thalassiosira fluviatilis Hust.
*Achnanthes clevei Grun.
*Achnanthes conspicua A. Mayer
*Achnanthes exigua Grun.
*Achnanthes exigua var. constricta (Grun.) Hust.
*Achnanthes flexella (Kutz.) Brun.
Achnanthes haukiana Grun.
*Achnanthes haukiana var. rostrata Schultz
Achnanthes lanceolata Breb. ex. Kutz.
Achnanthes lanceolata var. dubia Grun.
*Achnanthes lemmermanni Hust.
Achnanthes linearis fo. curta H.L. Smith
Achnanthes minutissima Kutz.
*Achnanthes sp. 4
*Amphora bullatoides Hohn & Hellerman
*Amphora coffeiformis (Ag.) Kutz.
*Amphora ovalis (Kutz.) Kutz.
*Amphora ovalis var. affinis (Kutz.) V.H. ex. DeT.
*Amphora ovalis var. pediculus (Kutz.) V.H. ex. DeT.
*Amphora perpusilla (Grun.) Grun.
*Asterionella formosa Hass.
*Caloneis amphisbaena (Bory) Cl.

Table 1. con't.

*Caloneis bacillum (Grun.) Cl.
*Cocconeis diminuta Pant.
*Cocconeis disculus (Schum.) Cl.
Cocconeis pediculus Ehr.
*Cocconeis placentula Ehr.
Cocconeis placentula var. euglypta (Ehr.) Cl.
Cocconeis placentula var. lineata (Ehr.) V.H.
Cocconeis thumensis Mayer
*Cymatopleura elliptica (Breb.) W. Smith
Cymatopleura solea (Breb.) W. Smith
Cymbella affinis Kutz.
*Cymbella cistula (Ehr.) Kirchn.
*Cymbella microcephala Grun.
*Cymbella minuta Hilse ex. Rabhn.
*Cymbella muelleri var. ventricosa (Temp. & Perag.) Reim.
**Cymbella prostrata (Berk.) Cl.
*Cymbella tumida (Breb. ex. Kutz.) V.H.
Diatoma tenue Ag.
Diatoma tenue var. elongatum Lyngb.
*Diatoma vulgare Bory
*Diatoma vulgare var. breve Grun.
*Diploneis puella (Schum.) Cl.
*Epithemia adnata (Kutz.) Breb.
*Epithemia adnata var. minor (Perag. & Herib.) Patr.
*Eunotia praerupta var. bidens (Ehr.) Grun.
*Fragilaria brevistriata var. capitata Herib.
Fragilaria capucina Desm.
*Fragilaria capucina var. mesolepta Rabhn.
Fragilaria construens (Ehr.) Grun.
*Fragilaria construens var. subsalina Hust.
Fragilaria construens var. venter (Ehr.) Grun.
Fragilaria crotonensis Kitton
*Fragilaria leptostaurom (Ehr.) Hust.
*Fragilaria leptostaurom var. dubia (Grun.) Hust.
*Fragilaria pinnata Ehr.
*Fragilaria pinnata var. intercedens (Grun.) Hust.
*Fragilaria pinnata var. lanzettula (Schum.) Hust.
Fragilaria vaucheria (Kutz.) Peters
*Gomphonema ocuminatum (Ehr.)
*Gomphonema angustatum var. citera (Hohn & Heller.) Patr.
*Gomphonema gracile Ehr.
Gomphonema olivaceum (Lyngb.) Kutz.
Gomphonema parvulum (Kutz.) Kutz.
*Gomphonema sphaerophorum Ehr.
**Gomphonema tergestinum (Grun.) Fricke
*Gyrosigma attenuatum (Kutz.) Rabhn.
*Hantzschia amphyoxis (Ehr.) Grun.
*Meridon circulare (Grev.) Ag.
*Navicula anglica Ralfs

Table 1. con't.

*Navicula anglica var. subsalsa Grun.
*Navicula arrensis Hust.
**Navicula atomus (Kutz.) Grun.
*Navicula biconica Patr.
Navicula capitata Ehr.
Navicula capitata var. hungarica (Grun.) Patr.
*Navicula cocconeiformis Greg. ex. Greg.
*Navicula cryptocephela Kutz.
Navicula cryptocephela var. veneta (Kutz.) Tabhn.
*Navicula cuspidata (Kutz.) Kutz.
Navicula decussis (Østr.) Kutz.
*Navicula exigua Greg. ev. Grun.
*Navicula gastrum (Ehr.) Kutz.
*Navicula graciloides A. Mayer
*Navicula gregaria Donkin
*Navicula heufleri Grun.
*Navicula heufleri var. leptocephela (Breb. ex. Grun.) Patr.
*Navicula integra (W. Smith) Ralfs
*Navicula lanceolata (Ag.) Kutz.
*Navicula menisculus var. upsaliensis (Grun.) Grun.
*Navicula minima Grun.
*Navicula minuscula Grun.
*Navicula muralis Grun.
*Navicula mutica Kutz.
*Navicula peregrina (Ehr.) Kutz.
*Navicula placentula Ehr.
*Navicula placentula fo. rostrata A. Amyer
*Navicula protracta fo. elliptica Hust.
*Navicula pupula Kutz.
*Navicula pupula var. rectangularis (Greg.) Grun.
*Navicula pupula var. rostrata (Kutz.) Hust.
*Navicula pygmaea Kutz.
*Navicula radiosa var. parva Wall.
*Navicula radiosa var. tenella (Breb.) Grun.
*Navicula reinhardtii (Grun.) Grun.
*Navicula rhyncocephela Kutz.
*Navicula salinarum Grun.
*Navicula salinarum var. intermedia (Grun.) Cl.
*Navicula scutelloides W. Smith ex. Greg.
*Navicula simplex Krasske
*Navicula tripunctata (O.F. Mull.) Bory
*Navicula viridula (Kutz.) Kutz.
*Navicula viridula var. rostellata (Kutz.) Cl.
*Navicula vulping Kutz.
*Nedium dubium (Ehr.) Cl.
*Nedium dubium var. constrictum Hust.

Table 1. con't.

*Nitzschia acicularis W. Smith
*Nitzschia acicularis var. closteroides (Ehr.) W. Smith
*Nitzschia acuta Hantz.
*Nitzschia amphibia Grun.
*Nitzschia angustata (W. Smith) Grun.
*Nitzschia angustata var. acuta Grun.
Nitzschia apiculata (Greg.) Grun.
*Nitzschia capitellata Hust.
Nitzschia dissipata (Kutz.) Grun.
*Nitzschia filiformis (W. Smith) Hust.
Nitzschia fonticola Grun.
*Nitzschia frustulum Kutz.
Nitzschia frustulum var. perpusilla (Rabhn.) Grun.
Nitzschia gracilis Hantz.
Nitzschia hungarica Grun.
Nitzschia kutzingiana Hilse
*Nitzschia linearis W. Smith
*Nitzschia microcephela Grun.
Nitzschia palea (Kutz.) W. Smith
*Nitzschia paradoxa Kutz.
*Nitzschia parvula Levis
*Nitzschia recta Hantz.
*Nitzschia sigma (Kutz.) W. Smith
*Nitzschia sigmoideae (Ehr.) W. Smith
*Nitzschia sinuata var. tabellaria Grun.
*Nitzschia sublinearis Hust.
Nitzschia thermalis
*Nitzschia tryblionella Hantz.
*Nitzschia tryblionella var. levidensis (W. Smith) Grun.
*Nitzschia tryblionella var. victoriae Grun.
*Nitzschia sp. 1.
*Opephora martyi Herib
*Plagiotropis lepidoptera var. proboscidea (Cl.) Reim.
*Pleurosigma delicatulum W. Smith
Rhoicosphenia curvata (Kutz.) Grun. ex. Rabhn.
*Stauroneis smithii Grun.
*Surirella ovalis Breb.
Surirella ovata Kutz.
Synedra acus Kutz.
*Synedra delicatissima W. Smith
*Synedra delicatissima var. angustissima Grun.
*Synedra parasitica (W. Smith) Hust.
*Synedra parasitica var. subconstricta (Grun.) Hust.
*Synedra pulchella Ralfs ex Kutz.
*Synedra radians Kutz.
*Synedra rumpens Kutz.
*Synedra rumpens var. familaris (Kutz.) Hust.
*Synedra tenera W. SMith

Table 1. con't.

*Synedra ulna (Nitz.) Ehr.
*Synedra ulna var. oxyrhychus (Kutz.) V.H.
*Synedra ulna var. ramesi (Herib) Hust.

Chlorophyta

*Acanthosphaera "like"
*Actinastrum hantzschii var. fluviatile Lemm.
Actinastrum sp. 1.
Ankistrodesmus falcatus (Corda) Ralfs
Ankistrodesmus nannoselene Skuja
Ankistrodesmus spiralis (Turner) Lemm.
*Asteroccus "like"
Chlorella vulgaris Beyer
*Coelastrum microporum Naeg.
*Coelastrum proboscideum Bohlin
*Coelastrum sphaericum Naeg.
Crucigenia quadrata Morren
Crucigenia tetrapedia (Kirch.) West & West
Dictyosphaerium pulchellum Wood
Elakatothrix gelatinosa Wille
*Gloeocystis vesciculosa Naeg.
*Micractinium pusillum Fres.
Oocystis pusilla Hansg.
*Palmodictyon varium (Naeg.) Lemm.
Pediastrum boryanum (Turp.) Meneghini
*Pediastrum duplex var. clathratum (A. Brown) Lag.
Pediastrum duplex var. gracilimum West & West
*Pediastrum duplex var. reticulatum Lag.
Pediastrum tetras (Ehr.) Ralfs
*Pediastrum tetras var. tetraodon (Corda) Rabhn.
**Planktosphaeria gelatinosa G.M. Smith
*Polyedriopsis quadrispina G.M. Smith
**Quadrigula lacustris (Ched.) G.M. Smith
Scenedesmus abundans var. longicauda G.M. Smith
Scenedesmus acuminatus (Lag.) Chodat
*Scenedesmus armatus var. chodatii G.M. Smith
Scenedesmus bijuga var. alternans (Rein.) Hansg.
Scenedesmus bijuga (Turp.) Kutz.
*Scenedesmus denticulatus Lag.
*Scenedesmus dimorphus (Turp.) Kutz.
*Scenedesmus opoliensis P. Richter
Scenedesmus quadricauda (Turp.) Breb.
*SB (unknown green coccoid)
*Tetraedron gracile (Rein.) Hansg.
*Tetraedron incus (Teil.) G.M. Smith
*Tetraedron minimum (A. Brown) Hansg.
Tetraedron penaedricum W. & G. M. Smith
Tetraedron trigonum (Naeg.) Hansg.