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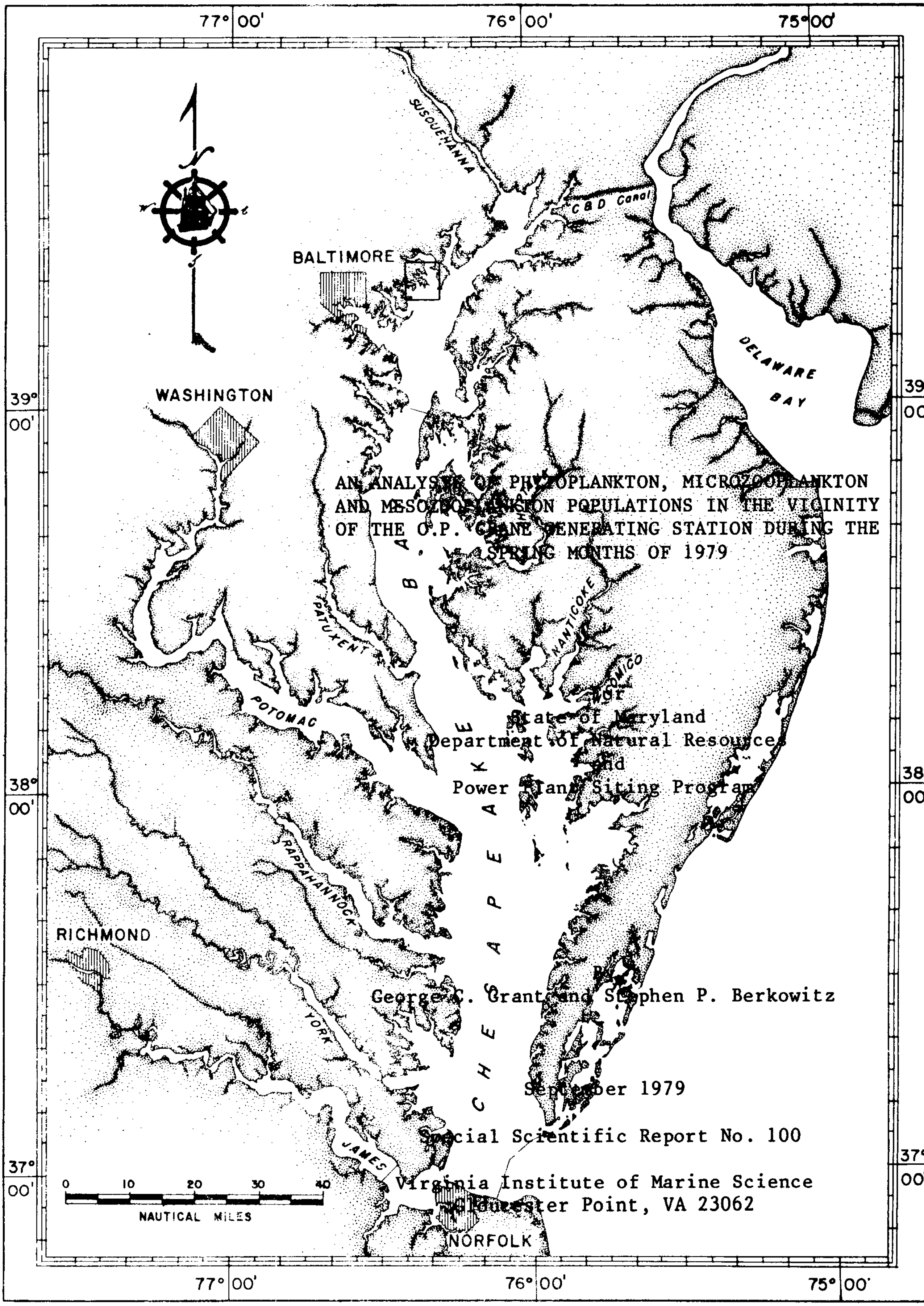
An analysis of phytoplankton, microzooplankton and mesozooplankton populations in the vicinity of the C. P. Crane generating station during the spring months of 1979

George C. Grant
Virginia Institute of Marine Science

Stephen P. Berkowitz
Virginia Institute of Marine Science



AN ANALYSIS OF PHYTOPLANKTON, MICROZOOPLANKTON AND MESOZOOPLANKTON POPULATIONS IN THE VICINITY OF THE C.P. CRANE GENERATING STATION DURING THE SPRING MONTHS OF 1979

for

State of Maryland
Department of Natural Resources
and
Power Plant Siting Program

By
George C. Grant and Stephen P. Berkowitz

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Grant & Berkowitz 1979b (p. 52)

Table 5. Frequency of occurrence (%) and average abundance (total numbers per total sampled volume in 0.1 m^3) of the more common zooplankton species occurring near the C. P. Crane generating station, spring 1979. Based on collections made with a submersible pump and filtered through a #20 (76 μm) net. Horizontal collections excluded.

Species		March		April		May		June	
		%	no./0.1m^3	%	no./0.1m^3	%	no./0.1m^3	%	no./0.1m^3
Eurytemora affinis	(N)*	100	960.0	100	6,762.7	100	2,028.4	100	2,127.2
" "	(C)	100	352.4	100	1,056.9	70	47.2	90	258.4
" "	(A)	100	81.8	56	90.7	0	0	20	6.4
Acartia tonsa	(N)	0	0	0	0	0	0	20	147.2
" "	(C)	0	0	0	0	0	0	30	60.0
" "	(A)	0	0	0	0	20	4.8	20	14.4
Unid. copepod nauplii		100	28.9	100	243.6	100	228.8	100	2,118.4
Ectinosoma curticorne		100	607.6	56	23.1	0	0	10	8.0
Cyclops bicuspidatus		100	106.7	56	154.7	0	0	20	4.8
Keratella cochlearis		67	244.4	100	2,780.4	50	17.6	0	0
Brachionus calyciflorus		78	7.6	100	307.6	100	1,385.6	90	607.6
Brachionus plicatilis		0	0	0	0	90	513.2	60	36.0
Notholca marina		0	0	78	361.8	80	341.6	90	1,268.0
Moina micrura		0	0	0	0	0	0	90	71.2

* N = nauplii, C = copepodites, A = adults.

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ABSTRACT

Sampling of spring 1979 plankton populations at the C.P. Crane site was conducted at 15 stations during six sampling periods for phytoplankton, at 5 stations monthly from March to June for microzooplankton and monthly at 14 stations for mesozooplankton. Ancillary physical data were collected at all the above stations, while nutrients were measured twice in April.

The spring 1979 physical conditions included uniformly low salinity (rarely over 1 °/oo), seasonally rising temperatures from ca. 8.5 in March to 21°C in May and June, field-measured Δt's from 3.7° to 7.3°C, gradually decreasing oxygen levels, and water transparency increasing from very low early spring levels (Secchi readings <0.2 m) to a maximum in early May. Nutrient measurements, made only in April, showed uniformly low ammonia, no nitrite, relatively high nitrate, moderate to moderately high phosphate and very high silicon.

Ambient productivity increased seasonally from a low less than 5 mg C/hr/m^3 to over 60 mg C in early May. During periods of low ambient productivity, rates increased along the intake, then abruptly declined in the immediate discharge; during high ambient productivity, intake rates declined, then increased in the discharge. A secondary peak usually occurred in the lower Saltpeter Creek. Chlorophyll-a distribution generally mirrored that of productivity.

Phytoplankton populations were dominated by a small (3 x 10 μm)

species of *Melosira*.

Important physical characteristics in similarity of phytoplankton stations included mean water temperature and bottom dissolved oxygen. Studies of productivity measured *in situ* at various depths indicate that populations may be strongly light-limited.

Microzooplankton collections were numerically dominated by nauplii of *Eurytemora affinis* in all four months and by *Ectinosoma curticorne* and several species of rotifers in successive months. Plant effect was evident from cluster analyses only in March, when near-discharge samples contained fewer numbers of dominant taxa and were devoid of several infrequent species. Diversity of collections was high in March, decreased in April and June, increased again in June. Water temperature was of primary importance in faunal dissimilarity of spring microzooplankton collections.

Mesozooplankton (>202 μm) collections showed a bracketed seasonal succession from cool-water fauna dominated by *Eurytemora affinis*, *Cyclops bicuspidatus* and *Eubosmina coregoni* to a warm-water fauna dominated by *Moina micrura* and *Acartia tonsa*. Distinction between near-discharge collections and those in other areas was lacking except during the transition period in late May. Diversity increased to a peak in May. Parasitic copepods of the genera *Ergasilus* and *Argulus*, found in abundance during a previous study of summer plankton at the C.P. Crane site, did not occur in the present collections until May. Surface dissolved oxygen and surface temperature were important

physical characteristics in separation of faunally similar clusters of spring mesozooplankton collections. Salinity, while not the primary factor in faunal differences, was of consistent secondary importance in the discriminant functions.

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1. INTRODUCTION

1.1 Introductory Remarks

This study is a continuation of a summer, 1978 study (Grant and Berkowitz 1979), with important modifications. The overall objective was the same: to provide seasonal information on abundance and composition of aquatic flora and fauna in waters surrounding the C.P. Crane generating station, with accompanying physical data, for use in recommendations to State agencies pursuant to Maryland Water Quality Regulations. Additions to the original study included: i) sampling beginning in March to assess the spring bloom period; ii) measurement of dissolved NH_4^+, NO_3^-, and $PO_4^{\equiv}$ during the bloom; iii) extension of previous sampling sites further up the Gunpowder River and toward Chesapeake Bay, and intensified sampling close to the plant; and iv) taking replicate stratified micro- and mesozooplankton samples to assess vertical distributions. Also, an effort was made to sample each station on the same part of the tidal cycle during each sampling trip. See Grant and Berkowitz (1979) for a brief description of the study area.

1.2 Other Studies in the Vicinity

Plankton studies in the area of the plant other than present investigations are few. Davies et al. (1976) studied micro-, meso-, and macrozooplankton distributions in the intake, discharge, and offshore (Channel Marker 1) waters from August 1974 to February 1975. However, their report concentrates on laboratory bioassay studies. Ecological Analysts, Inc. (1978) examined ichthyoplankton and fish eggs collected by pumps operated just outside the plant intake. Grant and Berkowitz (1979) listed plankton studies in other areas of the upper Chesapeake Bay.

1.3 Objectives and Limitations of the Present Study

The present study was designed to:

(1) Provide a seasonal data base for phytoplankton productivity and chlorophyll *a* (and phaeopigment) levels in the vicinity of the C.P. Crane Plant.

(2) Provide replicated samples of preserved phytoplankton, available for taxonomic analysis, ancillary to productivity and chlorophyll *a* measurements.

(3) Determine the composition, abundance and diversity of micro- and mesozooplankton monthly during spring and early summer of 1979.

(4) Measure dissolved NH_4^+, NO_3^-, and $PO_4^{\equiv}$ in the vicinity of the

C.P. Crane plant during the spring bloom.

(5) Extend previous sites of sampling further up the Gunpowder River and toward Chesapeake Bay, and to intensify sampling close to the plant.

(6) Provide ancillary data on salinity, temperature, dissolved oxygen and water transparency.

(7) Determine whether any of the above parameters are demonstrably affected by the operation of the generating station.

(8) Determine whether parasitic copepods, found in summer months, are also important components of the spring zooplankton.

Limitations of the study include the following: Sampling was conducted on an already altered environment and without benefit of comparable data from years prior to operation of the C.P. Crane generating station; the system's natural state is therefore obscure. Zooplankton sampling was conducted with pumps (76 μm nets) and 18.5 cm bongo samplers (202 μm nets) only during daylight hours. The more agile forms of zooplankton were, therefore, undersampled.

2. Methods and Materials

2.1 The Sampling Scheme

Zooplankton were sampled monthly from March through June. Phytoplankton were sampled biweekly from the last week in March through May, and once in late June. Nutrient data were collected during the two April sampling runs. The sampling sites were concentrated in the intake waters of Seneca Creek and the discharge waters of Saltpeter Creek, with additional stations in Dundee Creek, the upper and lower Gunpowder River, and in Chesapeake Bay (Fig. 1). Fifteen locations were sampled during each phytoplankton cruise (P01-P15); eleven of these same locations (excluding P02, 03, 13, 14), plus three additional sites (Z01-03) were sampled for mesozooplankton during the monthly zooplankton cruises. Microzooplankton were sampled at five stations each month (P02, 05, 06, 10, 15).

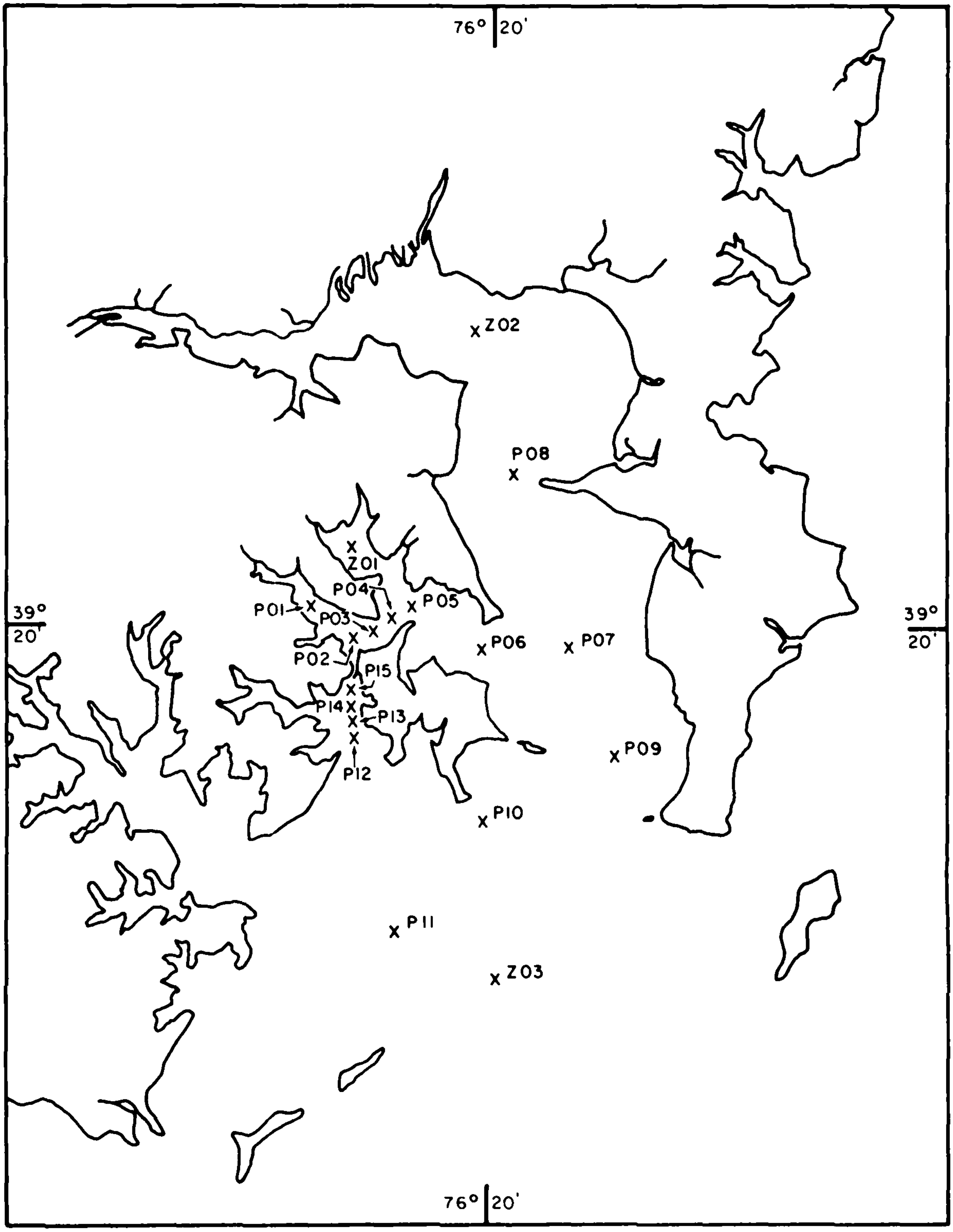


Figure 1 Location of stations sampled in the vicinity of the C.P. Crane generating station, March-June 1979. Station P02 was located in the immediate discharge (Saltpeter Creek); P15 was in the immediate intake (Seneca Creek).

2.2 Measurements and Methodology

2.2.1 Phytoplankton and Ancillary Measurements

Samples were obtained from the water column using a submersible pump at a known depth or from the surface (0-20 cm) using a plastic bucket and subsequently divided for different analyses. Water temperature was measured using either a mercury thermometer (-1 to 51°C graduated in tenths) [Fisher Scientific Co.] or a thermistor (0-50°C graduated in tenths) YSI Model 43T [Yellow Springs Instrument Co.]; salinity (to the thousandth) was measured in the laboratory using a Beckman RS-7B conductivity meter on samples brought back from the field. Dissolved oxygen was measured using the modified Winkler titration method with thiosulfate after fixation with manganous sulfate (Strickland and Parsons, 1972). Alkalinity was determined by titration to a pH of 4.6 using standardized 0.1589N sulfuric acid cartridges (Hach Chemical Co.).

Surface incident radiation (langleys h^{-1}) was measured with a solar meter (Dodge Products) previously calibrated against a pyroheliometer. Subsurface light penetration was measured with a Secchi Disc (10 cm increments) and a submarine photometer (G.M. Mfg. and Instrument Corp. Model #268WA-310).

Phytopigments were determined by fluorescence using a Turner 111 filter fluorometer equipped with a red-sensitive photomultiplier (Strickland and Parsons, 1972). Part of each water sample was filtered through a 20 μm screen for a determination of total vs.

screened chlorophyll. Twenty-five ml of water was filtered through a glass fibre filter (Whatman GF/A), which was then frozen on dry ice. After extraction with 90% acetone and centrifugation to remove the filter and particulate debris the sample was diluted to 10 ml and the fluorescence read before and after acidification with 2 drops of 2N HCl using the appropriate excitation window. The excitation filter was 430 nm (Filter 5-60) and the emission was >625 nm (Filter 2-64); calibration was previously made against known dilutions of chlorophyll _a_ extracts using the EPA Method Study 9, Chlorophyll Analyses.

Primary productivity was measured in an on-deck incubator at all stations, as well as _in situ_ at three selected stations; in both cases we used the light-dark bottle technique (Biological Methods Panel Committee on Oceanography, 1969). At each station a bucket surface sample was taken, and after 1.0 μCi of $NaH^{14}CO_3$ was added to each of five subsamples in glass tubes, two tubes were incubated in the dark and three in the light for two hours. The same procedure was used with water samples pumped from 1 and 2 m, if the station depth was sufficient. At stations P04, P07 and P15 a portion of each water sample was filtered through a 20 μm screen and treated in the same manner as described above, so that five additional tubes were incubated for each depth stratum sampled. The incubator was a modified 151 qt. cooler fitted with four Westinghouse 34 watt Econowatt® fluorescent bulbs. The water temperature in the incubator was monitored constantly and adjusted to within 1-2°C of ambient if necessary, with the sampling sequence arranged so that the upper

Gunpowder River samples were out of the incubator before the warmer water was added for incubating the samples from the stations in the plant discharge area. The uptake of the radioisotope was terminated by the addition of 0.2 ml of borate-buffered formalin. ^{14}C-labeled particulate matter was trapped on Millipore® EHWP-02500 0.5 μm filters and counted using Aquasol II® (New England Nuclear) counting solution in a Beckman LS-150 liquid scintillation counter (Pugh, 1973). When necesary, an internal standard was added to determine efficiency and quenching. Computation of productivity (mgC $m^{-3}h^{-1}$) was then completed using the stock of isotope added and the light, dark and alkalinity values.

Primary productivity was measured in situ at stations P04, P07, and P15. The method was as described above, except the 20 μm screened and total portions from bucket surface samples were incubated at depths of 0.5, 1 and 2 m (no 2 m sample at the shallow P04) at ambient temperature and light intensity for 2 hours at midday (between 10:00 a.m. and 3:00 p.m. EDT).

Phytoplankton were preserved with Lugol's iodine solution and identified and enumerated from selected samples with an inverted microscope according to the method of Utermohl (1958).

Water for nutrient analyses was drawn from the bucket surface samples and subsurface pump samples taken at 1 m intervals, and filtered through a 20 μm pore size Nalgene sterile filter unit. Two drops of concentrated sulfuric acid were added to each subsample which was then stored in a cooler or a refrigerator in sterile 50 ml centrifuge tubes pending analysis.

Reactive phosphate, reactive silicate, and ammonia were analyzed according to the respective methods in Strickland and Parsons (1972; pp. 49-52, 65-70 and 87-89), except for the ammonia determinations in which sodium dichloroisocyanurate was used instead of sodium hypochlorite. The procedure used for determining reactive nitrate was similar to the method in Strickland and Parsons (1972; pp. 71-76), with the following modifications: a Cd-Cu wire column was substituted for Cd-Cu filings (Gardner et al., 1976); sulfanilic acid (0.60 g + 20 ml conc. HCl per 100 ml solution) was used instead of sulfanilamide; and a buffer containing NH_4Cl, NaB_4O_7 and EDTA was used instead of a dilute NH_4Cl solution (Stainton, 1974).

2.2.2 Microzooplankton

Zooplankton smaller than those forms normally retained in 202 μm mesh nets were sampled by pump (Flotec's Tempest submersible pump Model S1400). Pumping was conducted while in motion in a 23 ft stern drive motor boat. Samples were integrated over the water column by raising and lowering the pump from near-bottom to near-surface during the operation, and quantified by pumping into carboys of known volume, which were then poured into a partially submerged #20 (76 μm) net to concentrate collected organisms. At each sampling site, two replicate samples of $0.1m^3$ each were obtained and preserved in 5% formalin. At station P15 two replicate samples of $0.04m^3$ each were taken from near-surface, mid-depth, and near-bottom, in addition to the two integrated samples.

Preserved samples were stained with rose bengal to aid in sorting and identification of collected organisms in the laboratory. Most counts were performed at 45-60X under a dissecting microscope and identifications at 100-1000X under a compound microscope. Separate counts were made of the naupliar, copepodid and adult stages of the dominant copepods.

2.2.3 Mesozooplankton

This size range of zooplankton has been defined (BMPCO, 1969) as those organisms retained in netting constructed of 202 μm mesh. Our previous study (Grant and Berkowitz, 1979) at the C.P. Crane site utilized this mesh size and the adults and later copepodid stages of the dominant copepods, as well as the other mesozooplankton forms were retained in the nets in an apparently quantitative way. Nets were mounted on bongo sampler frames with mouth openings of 18.5 cm and towed obliquely through the water column at each of 14 fixed stations each month. Tows were 15 min long, and the volume of water sampled during each tow was calculated from the number of revolutions registered on a General Oceanics, Inc. flowmeter mounted in the mouth of the collection net. At station P15, three sets of stratified tows were made, at near-surface, mid-depth and near-bottom, with flowmeters used in both bongo nets and both samples retained for analysis.

Collections, preserved in 5% formalin, were initially measured for displacement volume (Kramer, 1972), then sorted under dark-field microscopes (Olympus JM-100) into major categories such as copepods, barnacle larvae and decapod larvae, with the size of aliquot examined dependent upon the abundance and relative size of the sorted category. Larger and rarer organisms were sorted from whole samples; successively smaller aliquots were sorted for the smaller, more abundant taxa. Identification of sorted organisms was carried out to species whenever possible and resulting counts (total sample counts) were entered on data cards, one for each species occurrence.

2.3 Data Processing

Areal distributions of measured phytoplankton parameters (productivity and biomass) were examined graphically with respect to the sampling stations' distance from, and position relative to, the generating station. Phytoplankton stations from all six spring sampling trips were clustered (Boesch 1977, Grant 1979) on the basis of similarity in unweighted surface measurements of chlorophyll, phaeopigments and productivity; resulting clusters were then used as predesignated groups in a discriminant function analysis (Nie et al. 1975) of eight, standardized physical variables. This sequential technique of analysis has been recommended by Green and Vascotto (1978), and all variables were included in the discriminant analysis, following their reservations in using a stepwise analysis.

Micro- and mesozooplankton collections from each month were clustered by samples and species (normal and inverse clusters), with relationships of sample to species clusters examined by nodal analysis (Boesch 1977). The so-called "fidelity" index was used for nodal analysis, as defined earlier (Grant and Berkowitz 1979). The two sets of spring data for pumped and towed net collections were then, respectively, combined in a normal cluster analysis. Resulting clusters, as in the treatment of phytoplankton data, were used as preassigned groups in a discriminant function analysis of eight physical variables obtained at each station as ancillary data.

Also calculated for each zooplankton collection were diversity

(H'), evenness (J') and species richness (d) (Pielou 1975, Margalef 1961). More descriptive analyses of zooplankton collections included frequency of occurrence, mean abundance and determination of dominance.

3. PHYTOPLANKTON BIOMASS, PRODUCTIVITY AND ANCILLARY MEASUREMENTS

At each station sampled for phytoplankton and/or zooplankton, data were also collected from the surface and at 1 meter depth intervals to the bottom for temperature and salinity; dissolved oxygen was measured from surface and near-bottom waters. The surface incident radiation was measured and a Secchi disc reading made, in addition to measurements of light penetration with a transmissometer (submarine photometer). These measurements are included in Appendix Table A-1 and will be summarized below.

3.1 Plant Operation Data and Other Physical Measurements.

The C.P. Crane generating station operates at variable loads, up to a maximum or peak load of 400 megawatts (MW). During peak demand periods the plant typically operates at reduced capacity during the night, increases generation to the maximum during morning hours and continues at capacity until nearly midnight. During our study period (late March - June 1979), the average output of the C.P. Crane plant was approximately half the peak load of 400 MW. Mean gross generated loads were 221 MW for March 15-31, 234 MW for April, 216 MW for May and 164 MW for June. The low mean load for June was at least partly due to plant shutdowns (Fig. 2). Figure 2 also shows a consistent reduction in output during weekends. All of our sampling was conducted during days of moderate or relatively high generating load and was unaffected by plant shutdowns on June 2, 9 and 10.

Waters around the C.P. Crane plant were essentially fresh at the

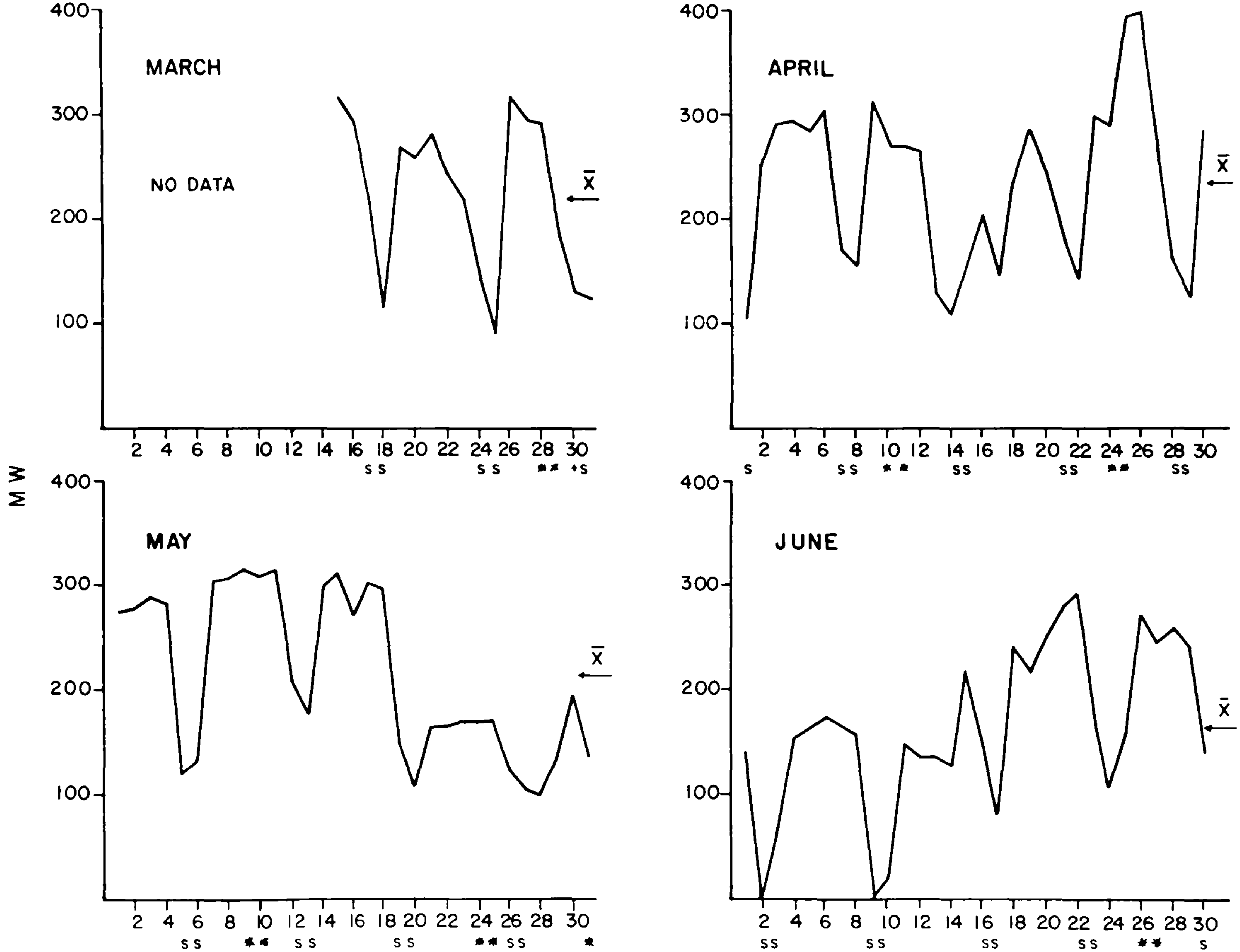


Figure 2 C.P. Crane daily mean gross generated load (in megawatts with weekends (S), sampling dates (*) and monthly means (arrows) indicated. Plant was shut down on June 2, 9, 10 (from data supplied by Baltimore Gas and Electric Company).

beginning of our sampling period (Table 1 and Appendix Table A-1). Salinities increased slightly at the end of April and again at the end of May, but never approached the upper limit of the oligohaline range. The highest salinities observed occurred on May 31, when stations missed because of a vessel breakdown on May 25 were sampled on a different tidal cycle. Lowest salinities occurred at the farthest upstream station (Z02) in the Gunpowder River, always essentially fresh. Although the observed range of salinity was always small in the study area, the immediate discharge stations (P01-P05) were always closely similar in salt content to those of Seneca Creek. This is considered to be a direct effect of the transfer of relatively large volumes of water from Seneca Creek to Saltpeter Creek by the C. P. Crane plant. This effect extending to the mouth of Saltpeter Creek (including station P06) during the late April and early May sampling periods. It was less extensive (limited to immediate discharge stations P01-P05) during other sampling periods.

Highest temperatures occurred at stations closest to the plant discharge, as expected in this season of cooler ambient temperatures. Using Station P12 as a reference station for intake temperatures (it is sufficiently removed from the plant to be unaffected by the "hole in the wall") and P02 or P03 as a source for temperatures closest to the discharge, the following ΔT's due to passage of water through the plant were estimated:

Dates	ΔT(°C)
Mar 28-30	4.3
Apr 10-11	7.0
Apr 24-25	7.3
May 9-10	5.6
May 24-25	4.3
June 26-27	3.7

Table 1. Ranges of surface salinity, temperature, and dissolved oxygen at the study site, spring 1979.

Sampling Dates (1979)	Salinity ($^{o}/oo$)	Temp. (°C)	DO (mg/l)
Mar 28-30	0.12 - 0.46	8.5 - 14.1	9.6 - 10.6
Apr 10-11	0.20 - 0.38	7.7 - 16.2	7.1 - 11.1
Apr 24-25	0.12 - 0.98	13.0 - 22.3	10.6 - 13.3
May 9-10	0.21 - 0.79	19.5 - 27.2	7.6 - 10.0
May 24-25	0.14 - 0.92	20.6 - 25.4	7.4 - 9.2
May 31*	1.27 - 2.63	19.9 - 20.3	8.0 - 8.6
June 26-27	0.28 - 1.09	20.2 - 27.3	7.1 - 8.9

* lower stations only (P09, P10, P11, P12, Z03) sampled on different tidal cycle

As was the case in the summer of 1978 (Grant and Berkowitz 1979), there was no evidence of oxygen depletion in the spring of 1979, but this may, in large part, be due to restriction of sampling to daylight hours. A separate study of oxygen balance in the area is now underway (P.L. Zubkoff, VIMS), which will provide more definitive information on oxygen than can be gained from our ancillary measurements.

Light penetration, as measured by Secchi disk visibility, was even lower than noted for summer 1978 (0.2 m at one July 1978 station). The majority of Secchi readings were below 0.2 m in late March and early April, averaged 0.39 in late April, 0.52 in early May, 0.46 in late May and dropped back to 0.34 in June. As measured by transmissometer, the sea cell/deck cell ratio at 1 meter depth ranged from <0.001 to 0.028 in March, <0.001 to 0.009 in early April, 0.005 to 0.070 in late April, 0.009 to 0.124 in early May, 0.022 to 0.133 in late May, and <0.001 to 0.042 in June. On the basis of the above observations on light penetration, there is a strong indication that phytoplankton populations in the study area may be light-limited.

3.2 Nutrient Measurements

Nutrients were measured at the C.P. Crane site during the two April sampling periods (see Appendix Table A-2). Zero readings among nitrate and phosphate measurements made on April 11 do not accurately reflect nutrient levels at the site, since replicate samples to which known amounts of standard had been added also failed to develop color in the reaction. Apparently, unknown interfering substances were present in these water samples. Nitrite was never detected in our sampling.

Ammonia was decreased in discharge waters on the first sampling dates (April 10-11), from approximately 2 μg-at/l at the mouth of Seneca Creek to less than 1 μg-at/l at stations P03-P05. However, in the second sampling period, highest concentrations of ammonia (just over 1 μg-at/l) occurred in the immediate discharge.

Nitrate, excluding those questionably low and zero readings referred to above, was generally high. Some reduction in nitrate concentrations in discharge waters was evident in the second sampling period (from about 35 μg-at/l in intake waters to less than 30 μg-at/l at stations P01-P06). Highest levels of nitrate were measured during the April 10-11 sampling period (over 50 μg-at/l at two stations).

Phosphate was moderately high (0.42-1.73 μg-at/l) on the first sampling dates, excluding those samples in which the color reaction failed. It was reduced on April 24-25, with most measurements below

0.50 μg-at/l. No plant effect was evident.

Silicate levels in this shallow, turbid system were very high, 62-110 μg-at/l on April 10-11 and 26-65 μg-at/l on April 24-25. Lowest concentrations on each sampling date occurred at station P01, just upstream from the immediate discharge. Little information can be gained from the above observations on nutrients as to plant effects, due to inconsistencies from the first to second sampling dates (as in the case of ammonia), difficulties in measurement (zero readings for nitrite, nitrate and phosphate) and limited seasonal sampling.

3.3 Phytoplankton Pigments, Productivity and Taxonomy

Chlorophyll-a (as a measure of phytoplankton biomass), phaeopigments and productivity were measured at each of 15 phytoplankton stations during six individual sampling periods from late March through June 1979. Resulting data are listed in Appendix Table A-3. Counts and identification of phytoplankton species (Appendix Tables A-4 through A-9) were also performed on a more limited number of samples.

Results are summarized below within the six individual sampling periods, and following methodology of our first report (Grant and Berkowitz 1979) with stations aligned according to their position relative to the C.P. Crane plant location. In the present report, two stations not directly in line with intake or discharge are omitted from this treatment (stations P01 in upper Saltpeter Creek and P08 in the upper Gunpowder River).

3.3.1 March 29-30

In the initial sampling period, productivity was very low (less than 5 mg C/hr/m^3) at the lower reference station P11 and in the lower Gunpowder River, peaked at nearly 15 mg C in the upper intake creek, decreased in immediate discharge (P02 and P03), recovered at P04, then declined to the low levels of lower Gunpowder River (Fig. 3). Since chlorophyll-a levels generally varied directly with productivity, the assimilation ratio followed the same trend as its two components. Highest chlorophyll-a was measured at station P04, however, rather than in intake waters.

Fairly constant amounts of phaeopigment resulted in a generally inverse relationship between chlorophyll-a levels and phaeopigment expressed as a percentage of chlorophyll. An exception occurred at the peak chlorophyll station P04, where phaeopigments rose to over 75% of chlorophyll-a. This high percentage of degraded pigment could account for the lowered peak of productivity at this station.

Cell counts and identifications were made for 22 samples from stations P11, P15, P02, P04, P07, P09 and P10 (Appendix Table A-4). Total cell counts varied from 1650/ml at P11 to 10,500 at P04, corresponding to lows and highs in chlorophyll measurements (Fig. 3). Dominant species included a 5 μm cryptophyte, a species of Melosira, an 8 μm Chroomonas sp. and a 5 μm biflagellate. The cryptophyte and biflagellate were among the dominant species at P04, but absent at the low chlorophyll station P11.

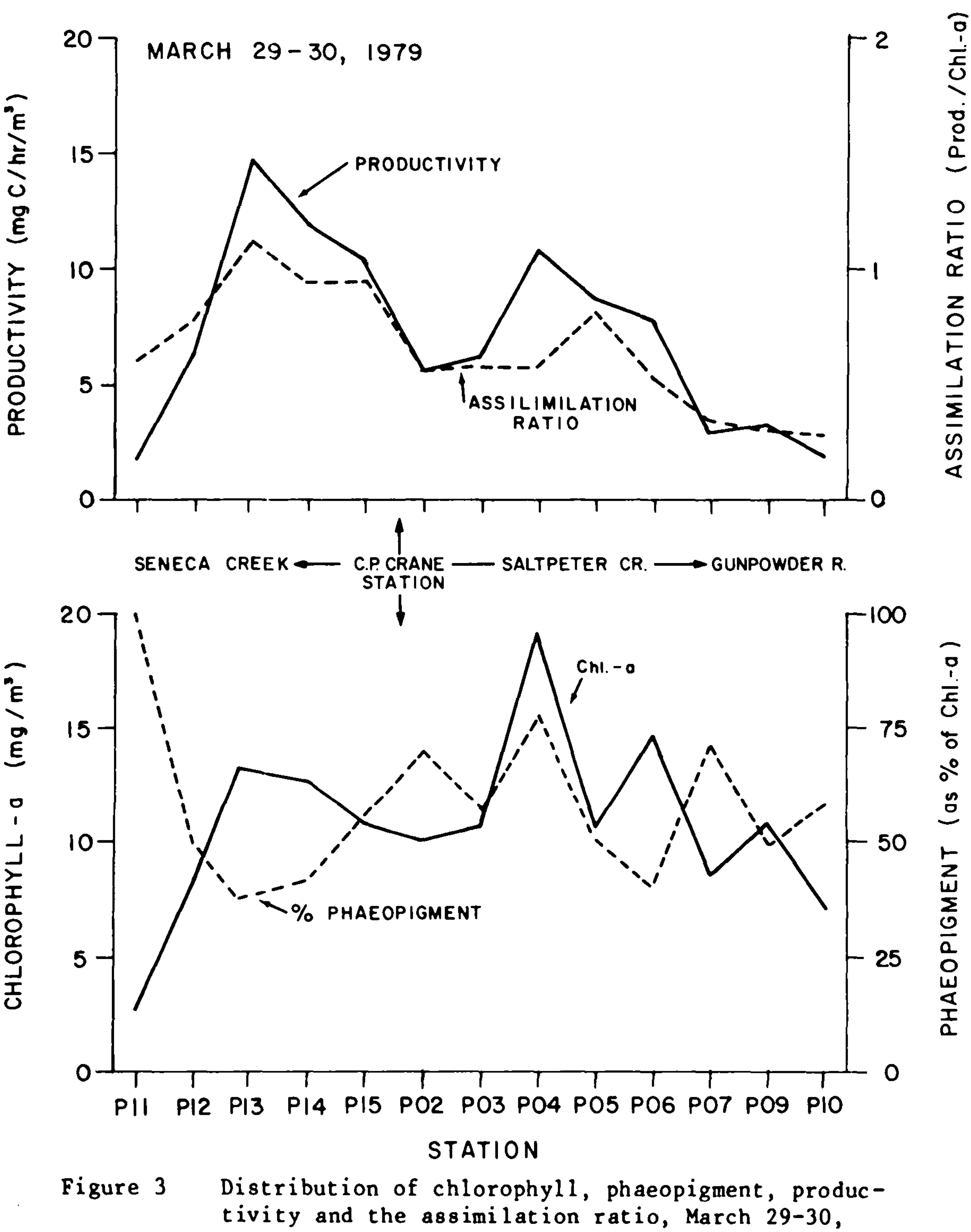


Figure 3 Distribution of chlorophyll, phaeopigment, productivity and the assimilation ratio, March 29-30, 1979. Stations are aligned according to their position relative to plant location, omitting those stations not in intake or directly in path of effluent.

3.3.2 April 10-11

Productivity in early April was less than 5 mg C/hr/m^3 only at the reference station P11 and at station P12 (lower Seneca Creek); increased to fairly constant levels of 8.5-9.0 mg C at the immediate intake and near discharge stations P15, P02, P03 and P04; reached a peak of less than 13 mg C at P06, the mouth of Saltpeter Creek, then decreased to intermediate levels in the lower Gunpowder River (Fig. 4). The assimilation ratio followed similar trends except in the immediate discharge, where it peaked at P02 and P04 (constant productivity, but lowered chlorophyll).

Chlorophyll-a increased from a low of less than 5 mg/m^3 at station P11 to a peak of over 18 mg at P05. Lower Gunpowder chlorophyll levels remained relatively high. Phaeopigment percentages were nearly always inverse to chlorophyll amounts, with lowest percentages at stations P05 and P06 matching peak chlorophyll and productivity at those stations.

Cell counts and identifications are available for 18 samples from stations P15, P02, P04 and P07 (Appendix Table A-5). Total cell counts had increased from late March to a range of from 6100 (station P04 at the surface and P15 at 2 meters) to 19,500/ml at station P07, corresponding to differences in chlorophyll concentration seen in Fig. 4. A 3 x 10 μm *Melosira* sp. was predominant in all samples, accounting for over half of the total cells counted. Other important species included a small

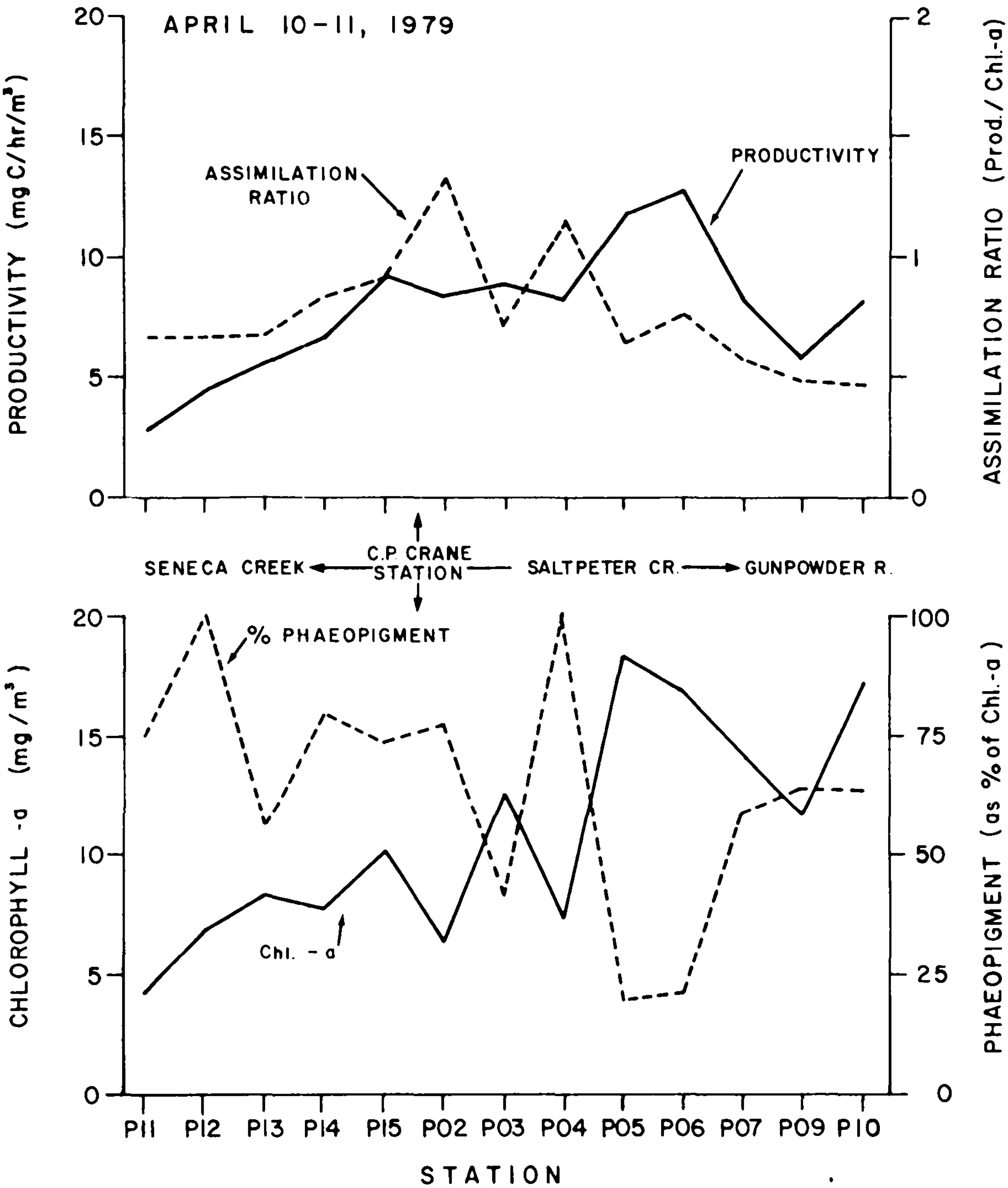


Figure 4 Distribution of chlorophyll, phaeopigment, productivity and the assimilation ratio, April 10-11, 1979.

(15-20 μm) Ankistrodesmus sp., an unidentified 5 μm centric diatom and a 15-17 μm Nitzschia sp.

3.3.3 April 24-25

Productivity in late April was considerably higher (note scale change in Fig. 5), at about 28 mg $C/hr/m^3$ in the intake waters, increased to a peak of 20 mg C in the immediate discharge, declined to a minimum of just over 10 mg C at station P04, and increased to a maximum over 33 mg C in the lower Gunpowder.

Chlorophyll-a was also considerably elevated over early April measurements, with no values below 20 μg-at/l. Lowest biomass occurred in intake waters, then increased irregularly to peaks of about 35 μg in the lower Gunpowder. The assimilation ratio generally followed the trend of productivity measurements.

Phaeopigment estimates at all stations in discharge and Gunpowder River waters were all negative. Reasons for this are unknown, but may be related to inadequacy in fresh water or oligohaline samples of the equation for calculation of phaeopigments.

Cell counts in late April had greatly increased compared with earlier sampling trips. In 18 samples from stations P15, P02, P04 and P07 (Appendix Table A-6) total cell counts varied from 37,000 at station P02 to 100,000/ml at P07 (where peak

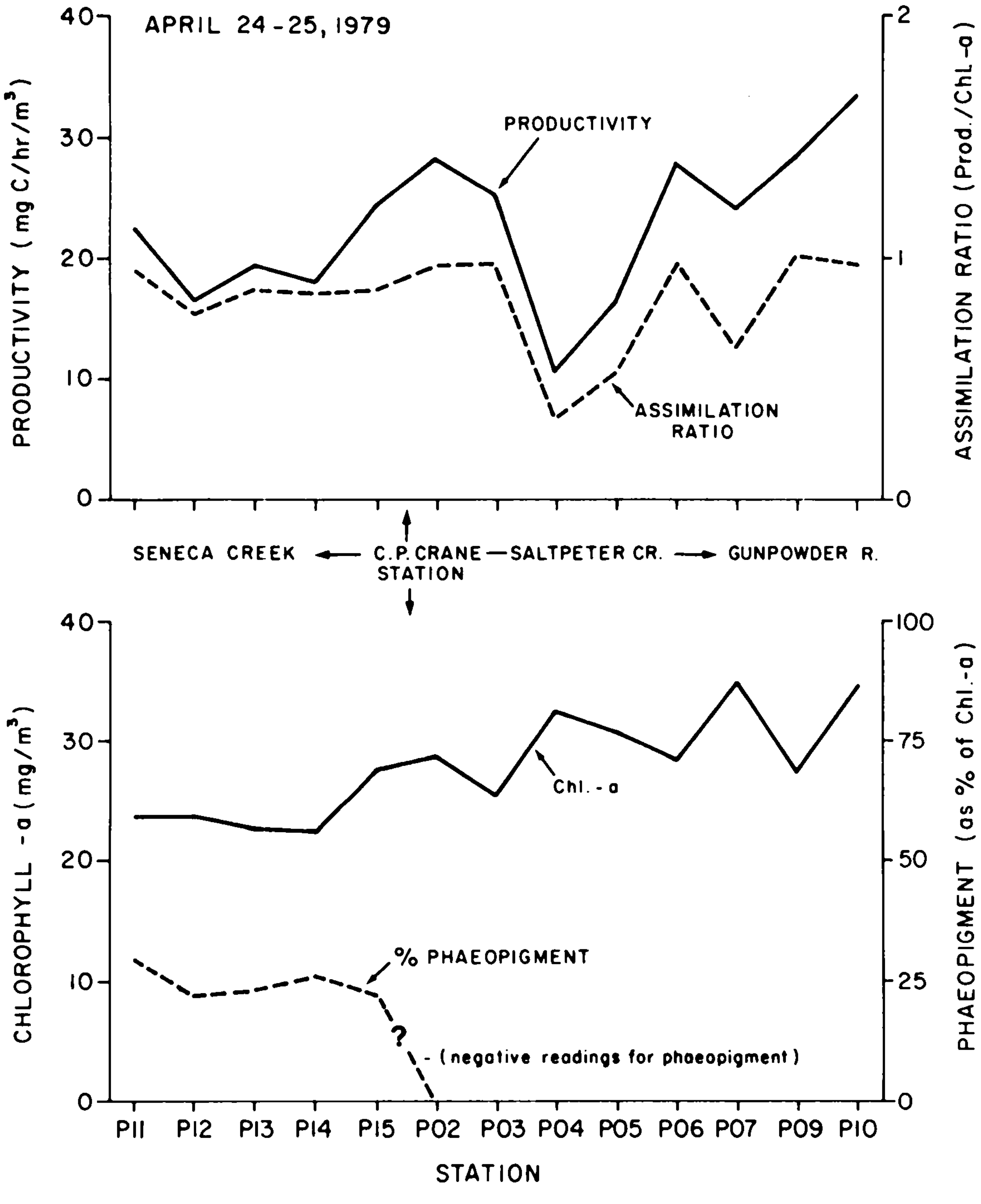


Figure 5 Distribution of chlorophyll, phaeopigment, productivity and the assimilation ratio, April 24-25, 1979.

chlorophyll was measured). The dominant species in all samples was the 3 x 10 μm Melosira sp. that also dominated the early April collections. The subdominants found in early April were also important in this later period.

3.3.4 May 9-10

Highest measurements of productivity were obtained in early May (Fig. 6), with a maximum rate of over 60 mg C/hr/m^3 measured in the mouth of Seneca Creek (station P12). Rates declined to the immediate intake, increased sharply in the immediate disharge, declined to a minimum under 30 mg C at P04, then fluctuated between 35 and 50 mg C in the lower Saltpeter Creek and Gunpowder River stations.

Chlorophyll was also highest in early May with a minor peak of over 40 mg/m^3 at the immediate intake, a decrease to the minimum of about 25 mg at P04, a maximum of nearly 50 mg at P07 and a decline to intake levels in the lower Gunpowder River. The assimilation ratio followed the trend of productivity except at the peak chlorophyll station P07. Phaeopigments were a consistently low percentage of chlorophyll (mostly less than 15%).

Cell counts from 17 samples (stations P15, P02, P04 and P07) were somewhat reduced from those of late April with a range of 36,000 to 90,000/ml. Dominant species included the 3 x 10 μm

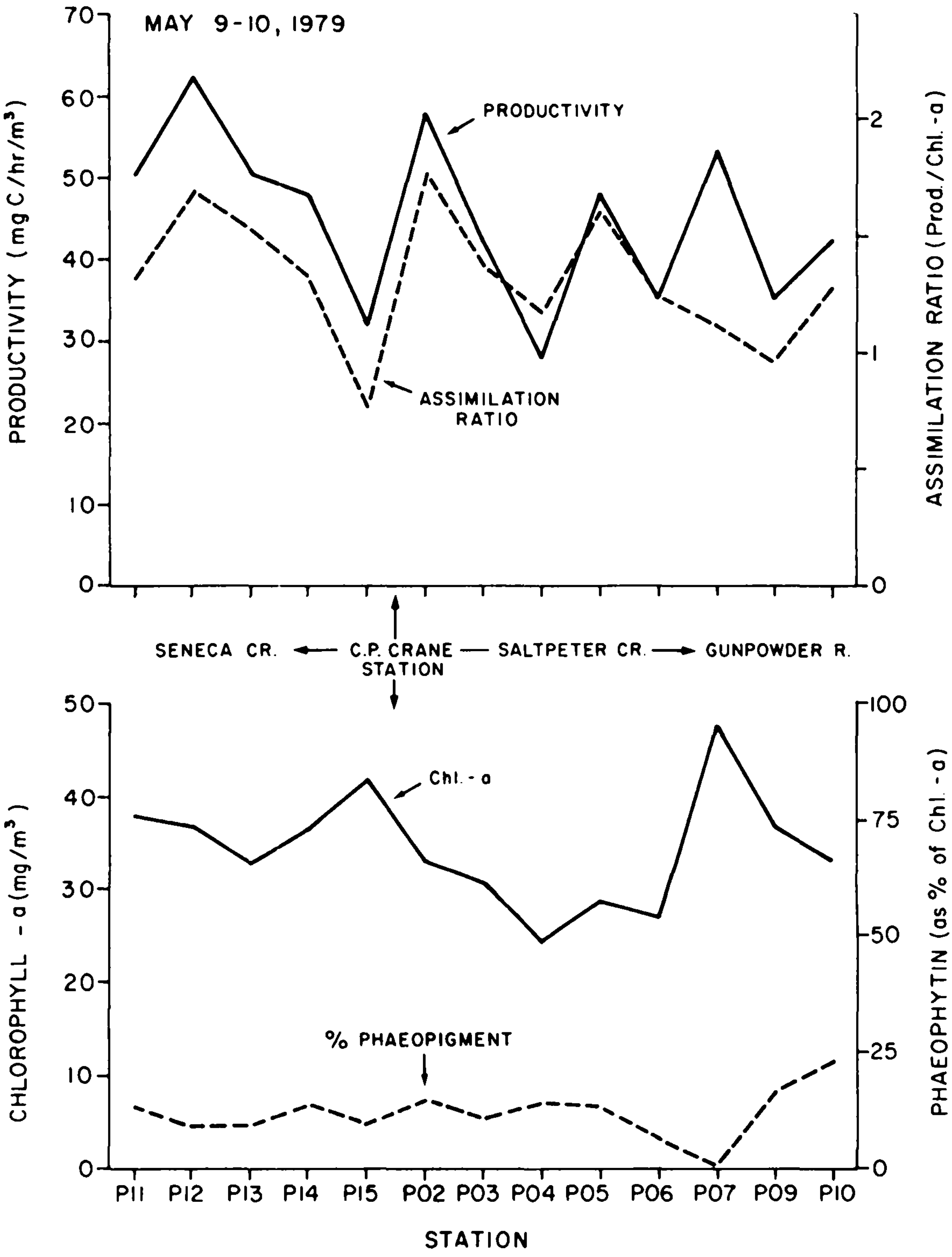


Figure 6 Distribution of chlorophyll, phaeopigment, productivity and the assimilation ratio, May 9-10, 1979.

Melosira sp., an 8 μm *Chroomonas* sp. near the plant, a 15-17 μm *Nitzschia* sp. and a 5 μm flagellate (Appendix Table A-7). Peaks in chlorophyll at stations P15 and P07 corresponded, respectively, with high total cell counts and large numbers of *Nitzschia*.

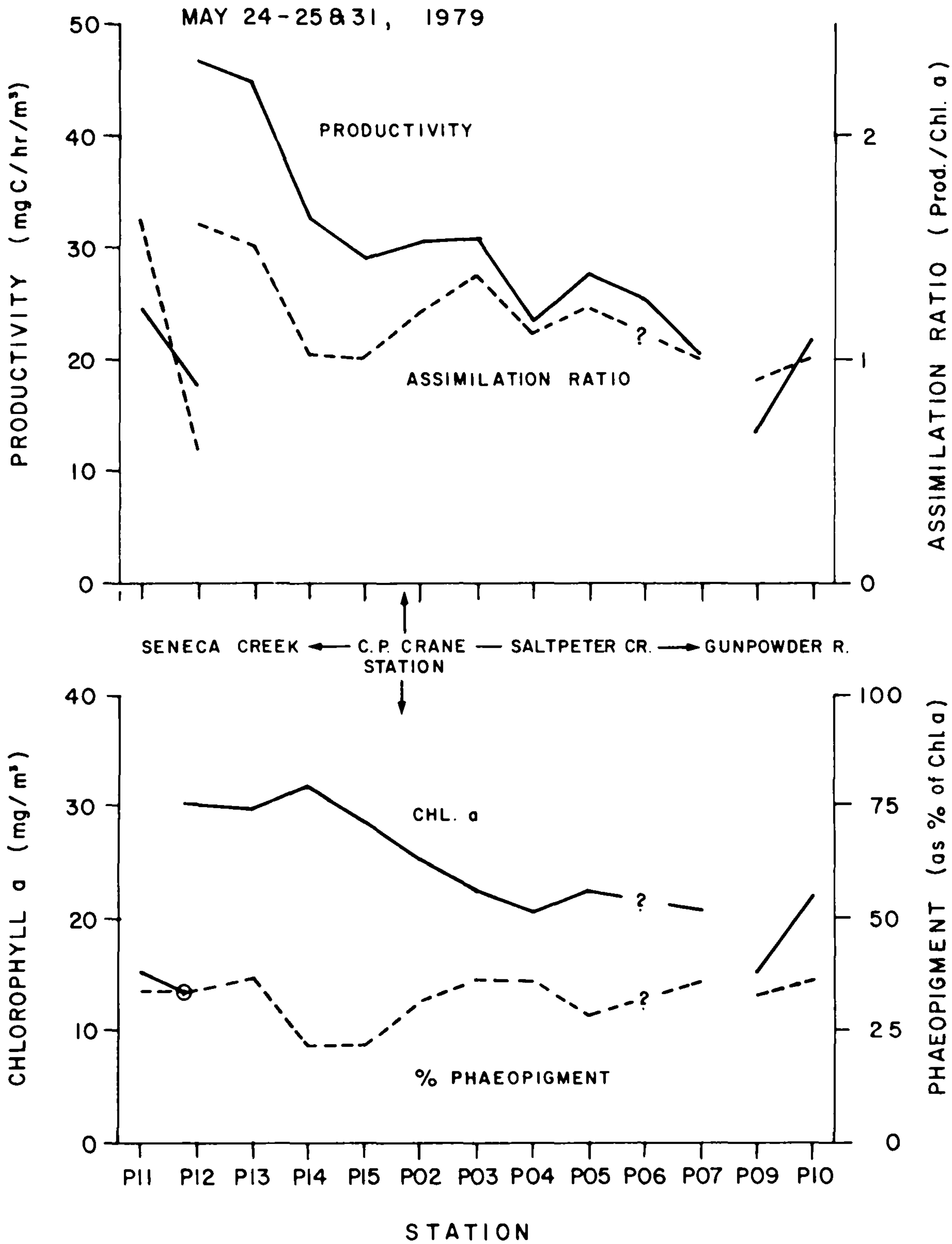
3.3.5 May 24-25 & 31

In late May, sampling was interrupted by a vessel breakdown, but the data are useful in showing the rapidity of seasonal changes or possible tidal effects on phytoplakton populations. Productivity on April 24-25, the planned sampling period, declined from a high of over 46 mg C/hr/m^3 at the mouth of Seneca Creek to a low of just over 20 mg C in the Gunpowder River. Just six days later, but in a different tidal regime, productivity at the mouth of Seneca Creek (the repeated station P12) had dropped from over 46 mg C to less than 20 mg C.

Chlorophyll-a had also decreased from early May levels, and declined 30 mg/m^3 in Seneca Creek to just over 20 mg at Saltpeter Creek and Gunpowder River stations. On the May 31 sampling date, the repeat of station P12 showed a drop of 16 mg/m^3 in chlorophyll-a concentration (from 30 to less than 14 mg/m^3). The assimilation ratio varied directly with productivity (Fig. 7), while the percent phaeopigment varied inversely with chlorophyll.

All samples selected for cell counts and identification were obtained during the regular May 24-25 sampling period. The 18 samples (stations P15, P02, P04, P07) showed a further seasonal decline in total cell counts, ranging in densities of 18,000 to 52,000/ml. The 3 x 10 μm Melosira sp. was still the dominant species in every sample, with subdominants including the 15 x 17 μm Nitzschia sp., Merismopedia sp. (especially below

Figure 7 Distribution of chlorophyll, phaeopigment, productivity and the assimilation ratio, May 24-25 & 31, 1979. Data missing for station P06; stations P09, P10, P11, P12 (second time) were sampled on May 31, 1979.



surface waters), a 15-20 μm Ankistrodesmus sp. and Scenedesmus quadricauda (Appendix Table A-8). Chlorophyll levels were not obviously related to cell counts or taxonomic differences.

3.3.6 June 26-27

In the final spring 1979 sampling period, productivity (Fig. 8) decreased sharply from over 30 mg $C/hr/m^3$ at the reference station P11 and mouth of Seneca Creek to less than 10 mg C at the immediate intake, increased to between 21 and 29 mg C in discharge and Saltpeter Creek waters, then decreased again to a minimum of less than 7 mg C in the lower Gunpowder River.

Chlorophyll-a was low (just over 5 mg/m^3) at P11, increased in Seneca Creek to nearly 20 mg, dipped to less than 10 at the immediate intake, rose sharply in near-discharge waters to a maximum of nearly 35 mg at station P04, then declined sharply through lower Saltpeter Creek and Gunpowder River stations to a minimum less than 5 mg at P10. The curve for assimilation ratio mirrored that of productivity except at the mouth of Seneca Creek, the generating station location and the mouth of Gunpowder River. The curve for phaeopigment, as a percentage of chlorophyll-a was inverse to that of chlorophyll concentration.

Cell counts from 18 samples (P15, P02, P04, P07) were further and seasonally decreased to a range of from 10,000 to 27,000/ml. All samples continued to be dominated by the

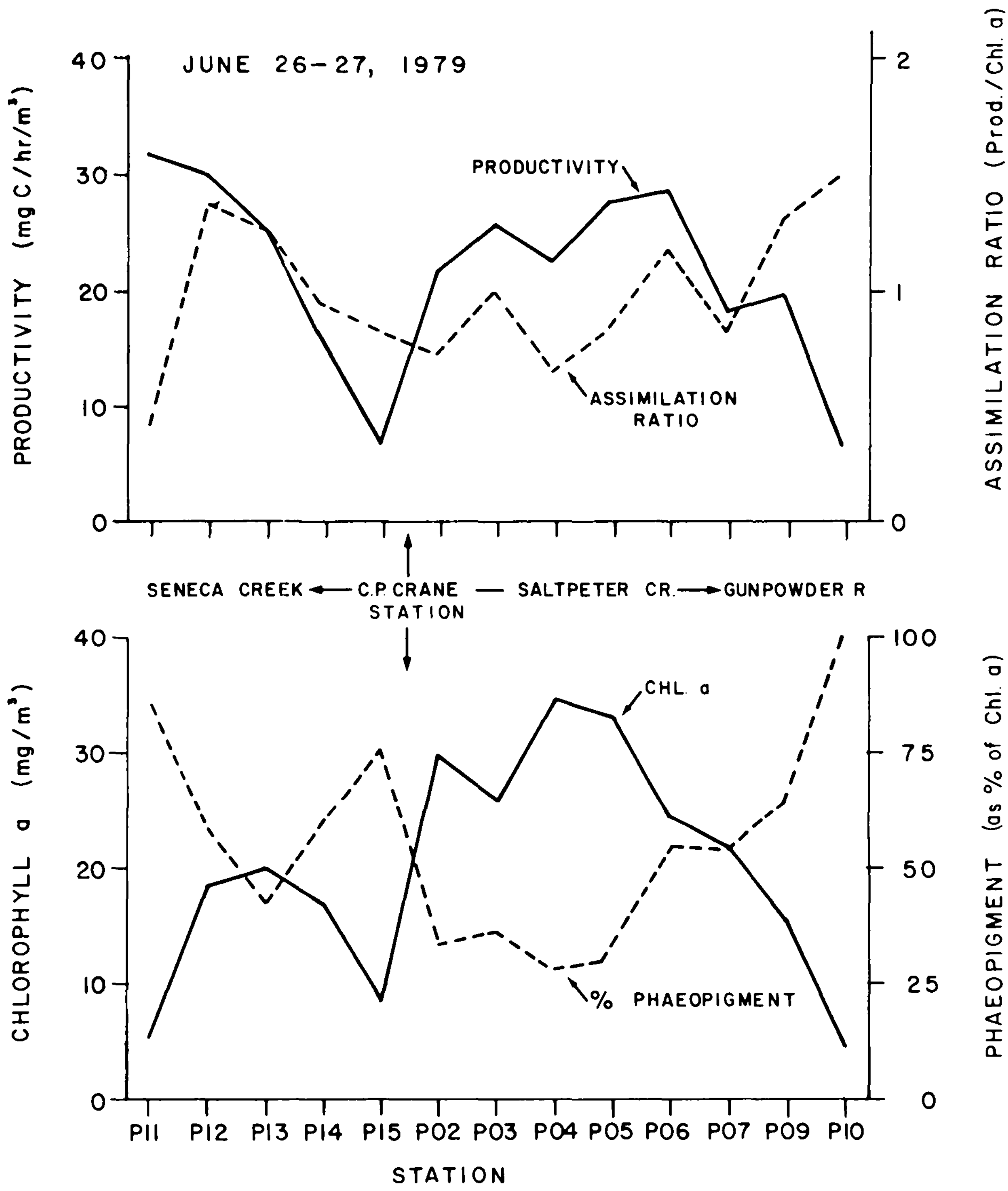


Figure 8 Distribution of chlorophyll, phaeopigment, productivity and the assimilation ratio, June 26-27, 1979.

3 x 10 μm Melosira sp. (Appendix Table A-9). Subdominants included an unidentified 5 μm centric diatom, an 8 x 5 μm Melosira sp., an 8 μm Chroomonas sp. and a 15-17 μm Nitzschia sp. Highest cell counts at stations P02 and P04 corresponded to peak measurements of chlorophyll in the immediate discharge and were attributed to larger numbers of the dominant Melosira sp.

3.3.7 Summary of Possible Plant Effects on Productivity and Chlorophyll during Spring 1979.

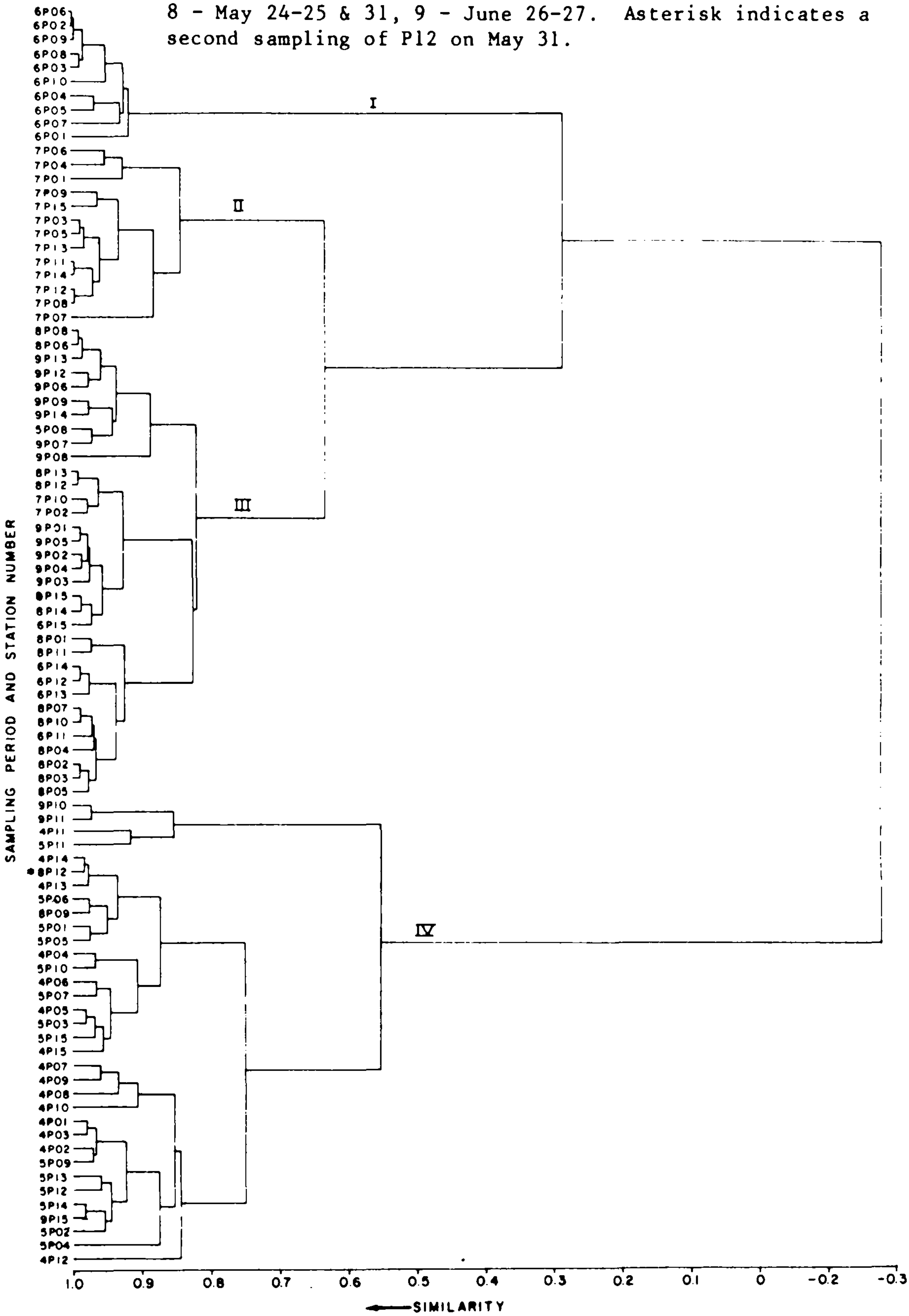
The previous examination of the spatial distribution of productivity and chlorophyll with respect to the C.P. Crane plant location showed a seasonal alteration in the direction of change (along a transect passing through the plant) that appears to depend on ambient conditions. In early spring, when temperatures and productivity were low in outside (or Chesapeake Bay) waters, productivity increased along Seneca Creek to the plant intake, sharply decreased in the immediate discharge, then recovered in lower Saltpeter Creek. In late spring, with ambient (Bay) waters warmed to above 19°C and highly productive, productivity decreased up Seneca Creek, then sharply increased in the immediate discharge.

3.4 Relationship of Spring Differences to Physical Characteristics

During a period of rapid seasonal change, especially spring months, and in an area, a portion of which is regularly heated above ambient conditions, one could reasonably hypothesize that productivity and phytoplankton biomass (or other parameters associated with the plant community) in the heated area might be more similar to such ambient measurements in successive sampling periods than to simultaneous measurements in unheated portions of the study area. In the present case, e.g., productivity in the immediate discharge in late March, might be more similar to ambient productivity in April than to that in intake waters in late March. A cluster analysis of all spring samples, using available surface measurements of phytoplankton parameters as input for similarity coefficients, should demonstrate whether such effluent effects predominate over strictly seasonal ones.

All 91 stations (including the second sampling of P12 on May 31) sampled for phytoplankton during the spring of 1979 were clustered on the basis of similarity in five measurements from surface waters. Parameters selected for inclusion in measures of similarity were available at every phytoplankton station regardless of depth and included chlorophyll-a and phaeophytin in both screened (<20 μm) and unscreened samples, and surface productivity (as estimated from box incubation). The cluster analysis yielded five clusters of stations at a similarity level of 0.7 or less. These clusters appeared

Figure 9 Clustering of spring 1979 phytoplankton stations on basis of surface chlorophyll and phaeopigment (screened and total samples) and surface productivity (box-incubated). Sampling periods (indicated by digits preceding station number): 4 - March 29-30, 5 - April 10-11, 6 - April 24-25, 7 - May 9-10, 8 - May 24-25 & 31, 9 - June 26-27. Asterisk indicates a second sampling of P12 on May 31.



"natural" in that they were basically seasonal in composition and grouped stations having much closer similarity; otherwise, choice of clusters was strictly subjective. These five clusters were used as pre-classified groups in a discriminant function analysis employing eight standardized, physical variables. The physical variables included incident radiation (ly/hr), secchi disc depth (cm), surface temperature (°C), mean temperature of the water column, surface salinity (°/oo), mean salinity of the water column, surface dissolved oxygen (mg/l) and bottom dissolved oxygen. The discriminant function analysis showed that half of the four stations in the originally-selected fourth cluster were misclassified, based on physical variables, so the last two clusters were recombined to form a single cluster (station Group IV, as shown in Fig. 9). The discriminant function analysis was repeated using only the four pre-classified groups. Results were similar to the first attempt, but with a slight improvement in correct classification (84.6 % of stations of stations correctly classified for 4 station groups vs. 83.5% for 5 station groups). Summary statistics of the latter analysis of four station groups are given in Table 2, where it can be seen that all three discriminant functions were highly significant, with the first two accounting for over 88% of the variance. Absolute values of the discriminant function coefficients show the most important physical variables to be mean water column temperature in Function 1 (1.766) and bottom dissolved oxygen in Function 2 (1.045). Surface salinity and mean salinity were the second most important variables in Functions 1&2, respectively.

The effectiveness of separation of the four groups using only the first two discriminant functions is depicted in Fig. 10, where Group III is shown to overlap widely with the other distinct groups of stations. This is the group of stations having the largest percentage of misclassified (according to physical variables) stations (cf. bottom of Table 2). Group IV, consisting mostly of stations sampled in late March and early April, is well separated from Group II, consisting of early May stations, along the first function (Fig. 10). This is the function strongly contributed to by temperature. The late April stations comprising Group I, however, would have overlapped both Groups II and IV without the addition of the second, or "bottom oxygen" function. The high levels of dissolved oxygen in Group I's late April stations occurred in calm conditions, but coincided with the highest phytoplankton cell counts observed during the spring survey. A second odd feature of Group I is that its original clustering was based largely on negative phaeopigment readings. Whether any relationship exists between these facts is not known.

The essentially strict seasonal nature of the clusters indicates that seasonal changes in phytoplankton parameters are more predominant in the study area than are observable effects from heated effluent. Looking at individual stations with which discharge samples clustered (Fig. 9), only those from the initial late March sampling period supported the hypothesis set forth at the beginning of this section.

Table 2. Summary statistics from discriminant function analysis of spring 1979 physical data, with groups of stations defined from cluster analysis based on phytoplankton community measurements of pigments and productivity.

Discriminant Function	Eigenvalue	Cumulative % of Variance	Canonical Correlation	After Function	Wilk's Lambda	Chi-Square	d.f.	Significance
				0	0.1024	191.43	24	0.0000**
1	2.85026	70.41	0.8604	1	0.3942	78.19	14	0.0000**
2	0.73926	88.68	0.6520	2	0.6857	31.70	6	0.0000**
3	0.45840	100.00	0.5606					

Standardized Discriminant Function Coefficients

Variable	Function 1	Function 2	Function 3
Radiation	-0.15592	-0.28053	0.44490
Secchi	0.58121	-0.56054	1.10434
Temp, surf.	-0.57669	0.47594	0.71060
Temp, mean	1.76644	0.39450	-1.26510
Sal, surf.	-0.74518	-0.49458	0.72454
Sal, mean	0.11085	0.58773	-1.23354
DO, surf.	0.37174	0.30673	-1.34332
DO, bottom	0.14875	1.04524	1.11866

Group Centroids

Station Group	Function 1	Function 2	Function 3
I	1.15533	2.30903	-0.17062
II	2.12577	-0.42243	1.33868
III	0.92515	-0.50509	-0.66247
IV	-2.07775	-0.01252	0.20080

Classification Results

Actual Group	Number of Stations	Predicted Group Membership (%) I	II	III	IV
I	10	90.0	10.0	0.0	0.0
II	13	0.0	84.6	15.4	0.0
III	34	2.9	14.7	79.4	2.9
IV	34	0.0	0.0	11.8	88.2

Percent of total (91) correctly classified: 84.62%

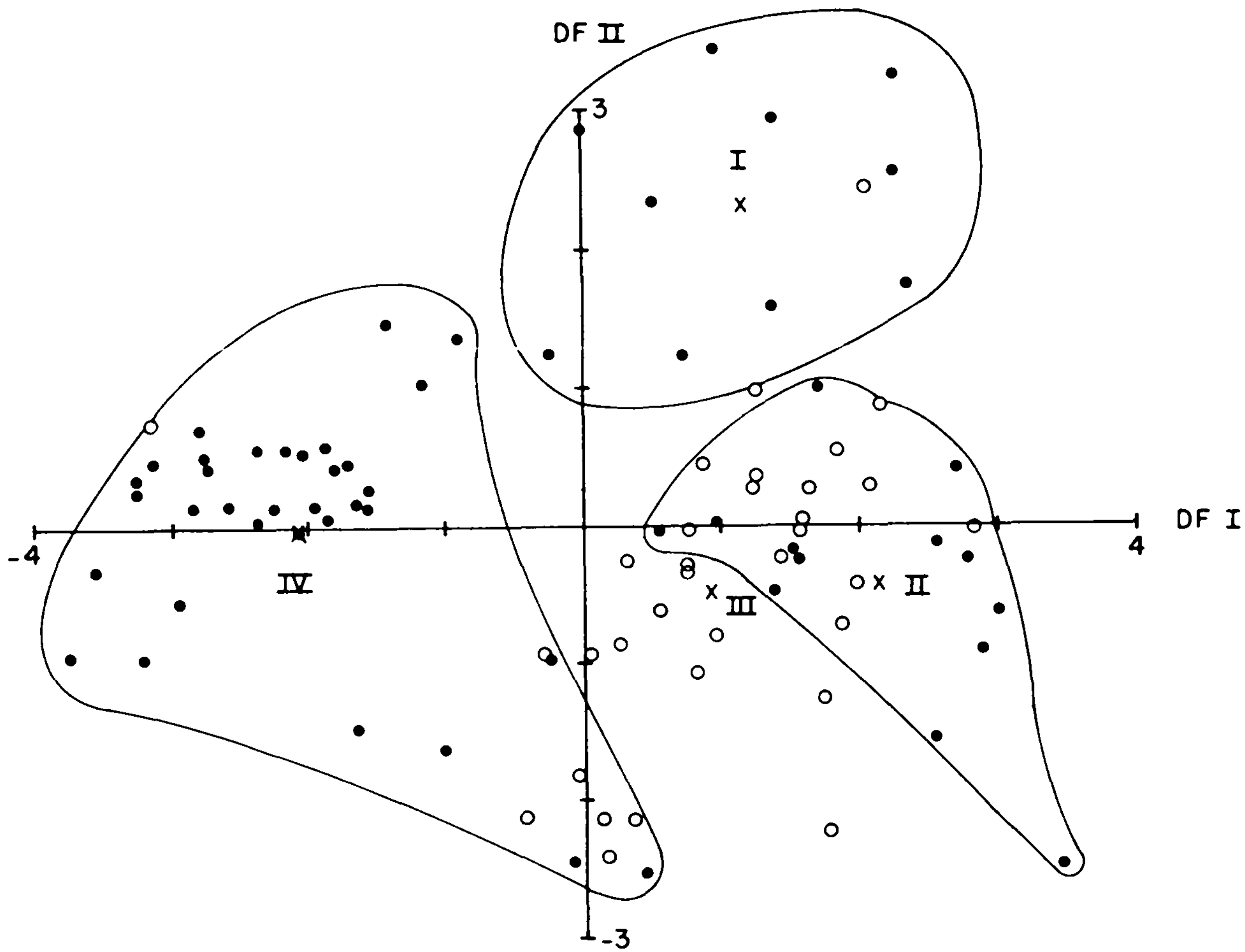


Figure 10 Separation of the sample groups obtained from phytoplankton biomass and productivity clustering on the first two discriminant functions of the eight environmental variables. Group centroids indicated with X's, open circles are samples in the poorly separated Group III.

According to clustering results late March discharge stations were more similar to ambient stations of early April. However, primary division of samples is seasonal.

If stations labelled as "misclassified" in the discriminant function analysis were reclassified according to highest probability of group membership in terms of physical characteristics, then the resultant groups would be more strictly seasonal (Table 3) as might be expected in a limited area. Individual stations labelled as "misclassified" were of both possible types: 1) those stations that are biologically similar and originally clustered together with stations occupied under different physical conditions and 2) stations that are similar in physical characteristics but differ biologically, so are separated in a cluster analysis based on biological characteristics.

Table 3. Distribution within sampling trips of stations within clusters, after reclassification of "misclassified" cases.

Station Cluster	Sampling Trip Late March	Early April	Late April	Early May	Late May	Late June
IV	15	15	0	0	0	0
I	0	0	10	0	0	0
II	0	0	1	12	3	1
III	0	0	4	3	12	14

3.5 A Comparison of Productivity Measurement by Box Incubation and In Situ Methods

Both in situ and box incubation methods of productivity estimation were employed at three stations (P04, P07, P15) during each sampling trip. Box-incubated samples were taken from the surface and one meter depth at all three stations and additionally from the two meter depth at the less shallow stations P07 and P15. In situ samples, on the other hand, were all taken from the surface and resuspended at the surface, one, and two meters. Resulting data are given in Table 4.

Surface samples provided a direct comparison of productivity estimates by the two methods. Except for the early spring period of low productivity, late March to April, all in situ surface measurements exceeded those obtained from box incubation, often by a factor of 2 to 3. Relatively low in situ measurements during the first three sampling trips were not the result of reduced incident radiation but were due to restricted light penetration (cf. Secchi disc readings, Appendix Table A-1). On the first three sampling trips, the Secchi disc often disappeared at depths above where "surface" samples were actually suspended.

Box-incubations of water samples from different depths provide estimates of potential productivity under constant light conditions and yield insight into vertical differences in phytoplankton populations. Table 4 shows very similar results in most cases among

Table 4. Productivity measurements (mg C/hr/m^3) at three stations where both box-incubation and *in situ* methods were used. Box-incubated samples obtained from indicated depths; *in situ* samples obtained from surface and suspended at indicated depths.

Sampling Dates (1979)	Depth (m)	Station P04 Box	P04 In Situ	P07 Box	P07 In Situ	P15 Box	P15 In Situ
March 29-30	0	10.87	7.70	2.86	1.62	10.26	5.60
	1	11.32	1.08	2.86	0.71	6.36	1.40
	2	-	-	2.48	0.94	7.26	-
April 10-11	0	8.40	10.32	8.17	6.33	9.09	3.45
	1	9.32	1.43	6.54	1.39	8.66	0.79
	2	-	-	7.21	-	7.23	-
April 24-25	0	10.82*	21.68	22.01	42.43	24.27	13.45
	1	15.38	8.16	22.64	16.30	22.45	5.32
	2	-	-	21.79	1.71	20.72	3.13
May 9-10	0	28.31	75.89	53.50	98.49	31.98	73.38
	1	32.30	71.86	54.76	50.54	36.03	47.63
	2	-	-	47.50	16.79	33.15	7.04
May 24-25	0	23.14	35.52	20.85	40.44	29.01	30.38
	1	19.26	9.35	28.87	27.16	33.13	12.68
	2	-	-	25.50	4.44	30.55	6.31
June 26-27	0	22.17	29.93	18.04	23.74	6.87	29.89
	1	19.91	3.95	19.13	2.94	11.10	8.13
	2	-	-	17.87	1.57	12.15	2.04

*inverter problems - intermittent light

samples from different depths at a given station. Exceptions were limited to the intake station P15, where early spring samples yielded a fairly consistent decline in potential productivity from surface to depth. Late June samples at P15 yielded the opposite results.

Suspension of surface water samples at various depths provides the best estimate of light limitation to phytoplankton production under field conditions. It is obvious from data in Table 4 that most of the phytoplankton production in waters around the C.P. Crane plant occurs within the upper 0.5 m of water (the depth at which "surface" samples were suspended). Except for the peak productivity period of early May, a sharp reduction of in situ productivity was evident below the surface. It would appear that in this shallow, turbid system, the phytoplankton population is severely light-limited.

3.6 Miscellanea

Observations from which no clear conclusions could be drawn also included vertical sampling of phytoplankton biomass (chlorophyll) and comparison of whole water samples in biomass and productivity with samples screened through a 20 μm filter.

As pointed out above, box-incubated samples from 0, 1 and 2 meters yielded very similar productivity measurements. Similarly, although there were differences between surface and subsurface measurements of chlorophyll and phaeopigments, the direction of increases or decreases varied among both stations and sampling trips (all data are included in Appendix Table A-3). The taxonomy of phytoplankton also was similar with depth as shown in Tables A-4 through A-9.

Productivity of samples screened through a 20 μm filter was usually very similar to that of whole samples (see Appendix Table A-3). In late spring, surface chlorophyll and phaeopigments were considerably lower in screened samples, but it is evident that the small size of dominant phytoplankters (above sections 3.3.1 - 3.3.6) permitted passage through the filter of most cells. Large differences in phytoplankton biomass and productivity would be unexpected in this community with the size fractions examined. Future studies should employ much smaller (perhaps 5 & 10 μm) filters.

4. Microzooplankton

Five stations (P02, P05, P06, P10, P15) were sampled monthly by pump for microzooplankton. Collections include all organisms retained on 76 μm netting. Complete listings of identifications and counts for these collections are provided in Appendix Table A-10. Dominants included *Eurytemora affinis* nauplii in all four months, *Ectinosoma curticorne* in March and several rotifers in succeeding months: *Keratella cochlearis* in April, *Brachionus calyciflorus* and *B. plicatilis* in April, and *Notholca marina* in June. The more frequent and abundant taxa and life stages of taxa are listed in Table 5.

Eurytemora affinis was, by far, the most consistently abundant zooplankter during spring months. The dominant copepod of summer months, *Acartia tonsa*, did not occur in abundance until June in this series of collections, and then almost entirely at station P10. Similarly, the dominant summer cladoceran, *Moina micrura*, first appeared in June, following a March-May abundance of diverse cladocerans.

4.1 Cluster and Nodal Analyses

Cluster analyses of each month's microzooplankton collections were undertaken, using the Bray-Curtis coefficient as a measure of similarity, and a flexible beta = -0.25. All species were included in the inverse analyses, with no elimination of infrequently occurring taxa. Normal and inverse analyses were related by use of a nodal

Table 5. Frequency of occurrence (%) and average abundance (total numbers per total sampled volume in m^3) of the more common zooplankton species occurring near the C.P. Crane generating station, spring and early summer 1979. Based on collections made with 18.5 cm bongo samples (202 μm mesh nets).

Species/Taxon	March %	March no./m^3	April %	April no./m^3	May %	May no./m^3	June %	June no./m^3
Eurytemora affinis	100	5166.0	100	7709.6	93	16.9	100	603.7
Cyclops bicuspidatus thomasi	100	1134.2	93	2200.6	47	0.6	36	0.1
Acartia tonsa	7	6.8	36	116.4	87	32.0	100	283.4
Eubosmina coregoni	100	233.9	93	1242.4	7	<0.1	29	0.2
Ostracoda	100	10.5	100	41.8	67	0.3	64	0.2
Bosmina longirostris	79	8.0	93	409.7	80	4.1	29	0.8
Acarina	21	<0.1	86	10.4	100	2.4	100	0.8
Leptodora kindti	14	1.2	64	<0.1	47	0.2	93	2.9
Chironomid larvae	93	1.6	79	2.6	53	5.7	43	<0.1
Moina micrura	0	—	0	—	87	2.0	100	57.5

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Grant & Berkowitz 1979b (p. 52)

Table 5. Frequency of occurrence (%) and average abundance (total numbers per total sampled volume in 0.1 m^3) of the more common zooplankton species occurring near the C. P. Crane generating station, spring 1979. Based on collections made with a submersible pump and filtered through a #20 (76 μm) net. Horizontal collections excluded.

Species	March		April		May		June	
	%	no./0.1m^3	%	no./0.1m^3	%	no./0.1m^3	%	no./0.1m^3
Eurytemora affinis (N)*	100	960.0	100	6,762.7	100	2,028.4	100	2,127.2
" " (C)	100	352.4	100	1,056.9	70	47.2	90	258.4
" " (A)	100	81.8	56	90.7	0	0	20	6.4
Acartia tonsa (N)	0	0	0	0	0	0	20	147.2
" " (C)	0	0	0	0	0	0	30	60.0
" " (A)	0	0	0	0	20	4.8	20	14.4
Unid. copepod nauplii	100	28.9	100	243.6	100	228.8	100	2,118.4
Ectinosoma curticorne	100	607.6	56	23.1	0	0	10	8.0
Cyclops bicuspidatus	100	106.7	56	154.7	0	0	20	4.8
Keratella cochlearis	67	244.4	100	2,780.4	50	17.6	0	0
Brachionus calyciflorus	78	7.6	100	307.6	100	1,385.6	90	607.6
Brachionus plicatilis	0	0	0	0	90	513.2	60	36.0
Notholca marina	0	0	78	361.8	80	341.6	90	1,268.0
Moina micrura	0	0	0	0	0	0	90	71.2

* N = nauplii, C = copepodites, A = adults.

analysis, employing an index of fidelity. These results are presented below, separately by month of collection.

4.1.1 March 1979

The normal cluster analysis of March pump samples, including 15 samples and 32 taxa, produced two distinct clusters of samples, the first a small group of three samples from the immediate discharge and station P05 (in this month the replicate sample from P05 was lost). Thus, the second group was comprised of all P15 samples (8) and those from P06 and P10 (Fig. 11). The species (inverse) analysis divided the taxa into four groups, which were linked at a rather low level of similarity. The discharge Sample Group I was best characterized by the absence of Species Group C, a group of rare and infrequent species of rotifers, cladocerans, copepods and unidentified insects. Species Group D, which contained all the dominant taxa, was of different (usually lesser) abundance or absent in the discharge stations, as follows:

	Occurrence in Sample Group I		
		Present in Numbers	
Taxa (Spp. Gr. D)	Absent	< Group II	> Group II
E. affinis, adults		X	
Cyclops bicuspidatus		X	
Bryocamptus sp.		X	
E. affinis, nauplii			X
E. affinis, copepodids		X	
Ectinosoma curticorne		X	
Keratella cochlearis	X		
Nematoda	X	X	
Ostracoda	X		
Eubosmina coregoni		X	
unid. nauplii			X
Brachionus calyciflorus			X

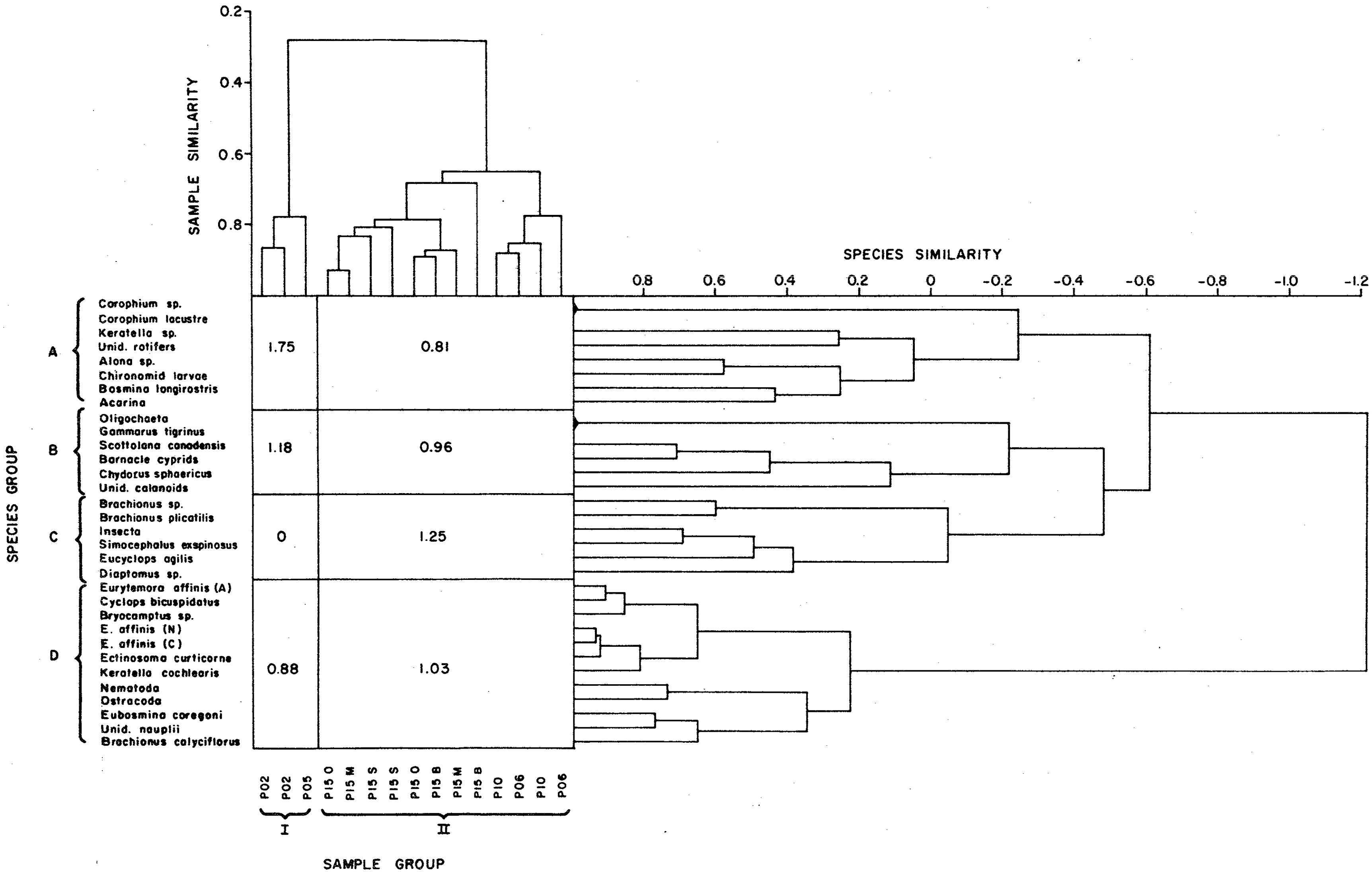


Figure 11 Sample and species clusters from March 1979 pumped microzooplankton collections, with the relationship of species clusters to sample clusters shown by indices of fidelity.

4.1.2 April 1979

Microzooplankton samples collected in late April, although clearly divided into two groups (Fig. 12), were all united at a higher level of similarity than in March. Fifteen samples and 27 taxa were employed in the analysis. The two sample groups also split replicate samples from given stations, which indicates that plant effects, if any, would be obscure. Sample Group I contains both horizontal, near-bottom samples from P15, both replicates from P02 and P10, and one replicate each from stations P05 and P06.

Species Group A consisted of three taxa found only in one replicate from P10, so is of little help in characterizing fauna from the sample groups. Sample Group I was best characterized by Species Group B, a rather infrequently occurring group of freshwater species (nematodes, cladocerans, ostracods, copepods and insects). Species Group C, also a collection of infrequent taxa, was largly restricted to P15, which station contributed 5 of the 7 samples in Sample Group II. Species Group D contained the more abundant and dominant taxa. Only slight differences (0.97 - 1.03) were shown in fidelity indices relating this species group to the sample groups. Taxa in Species Group D were somewhat less abundant and occasionally missing in samples from Sample Group I.

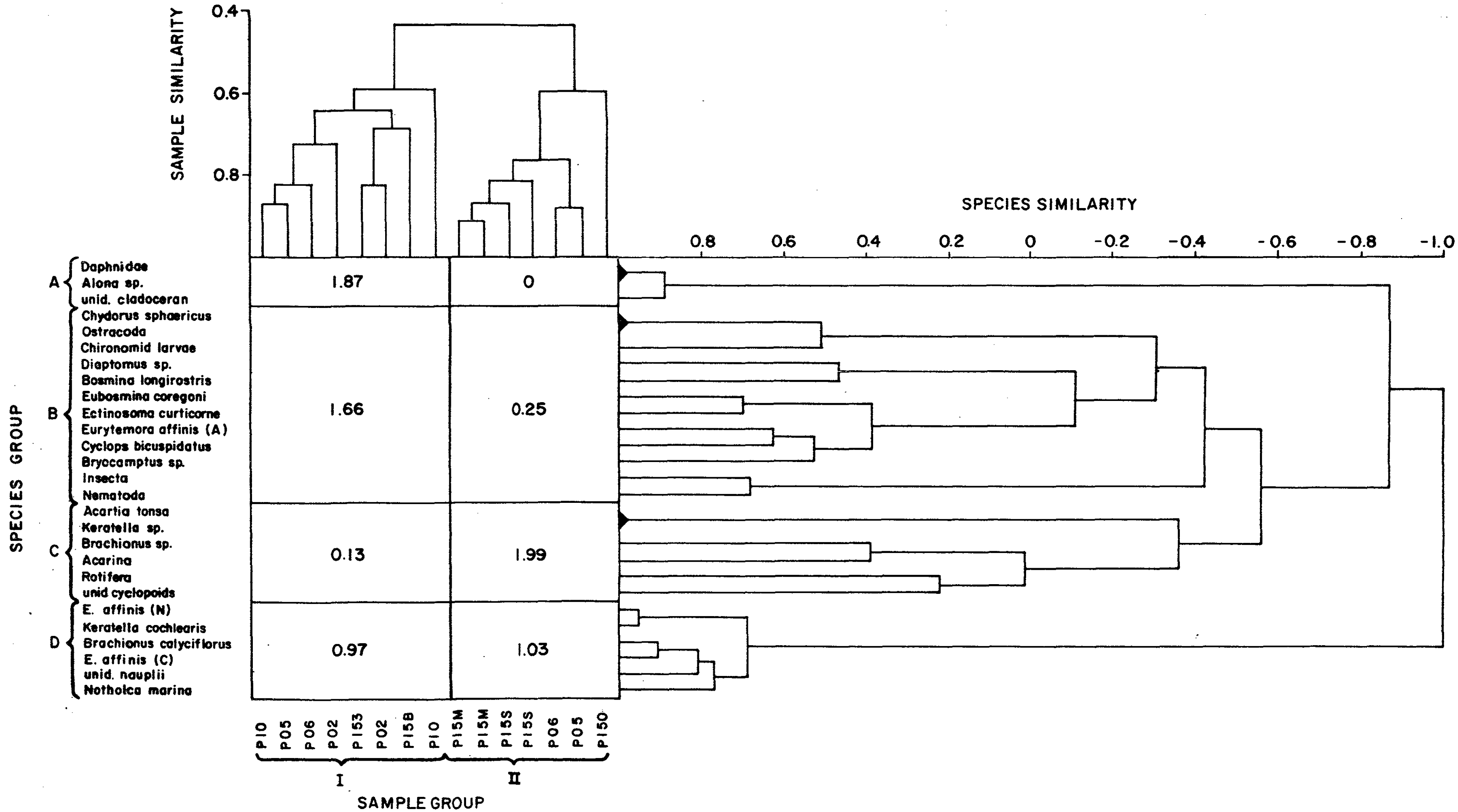


Figure 12 Sample and species clusters from April 1979 pumped microzooplankton collections, with the relationship of species clusters to sample clusters shown by indices of fidelity.

4.1.3 May 1979

Two distinct clusters of samples were evident among May microzooplankton collections (Fig. 13). The normal analysis, based on 16 samples and 23 taxa, linked all but two samples, replicates from P10, at a similarity level just over 0.5.

Faunal differences between the two sample groups included (1) presence or absence at P10 of species from Group A, a collection of infrequent taxa, (2) absence from P10 of Group B, the taxa of lesser abundance and (3) much lower abundance at P10 of the dominant taxa in Species Group C.

There is no evidence in this analysis of plant effect on the microzooplankton population. The distinctiveness of fauna at P10 is due to its being sampled at a later date (different tidal cycle and higher salinity) than other sampling locations (May 31 *vs*. May 24-25).

4.1.4 June 1979

Again in June the normal analysis, based on 16 collections and 33 taxa, linked all but the two P10 replicates at a similarity level just over 0.5 (Fig. 14). The replicates from P10 were characterized by the nearly unique occurrence of Species Group A, including all stages of *Acartia tonsa* and a few adult *Eurytemora affinis*, the absence of the infrequent species in groups B and C, and a generally greater abundance of more

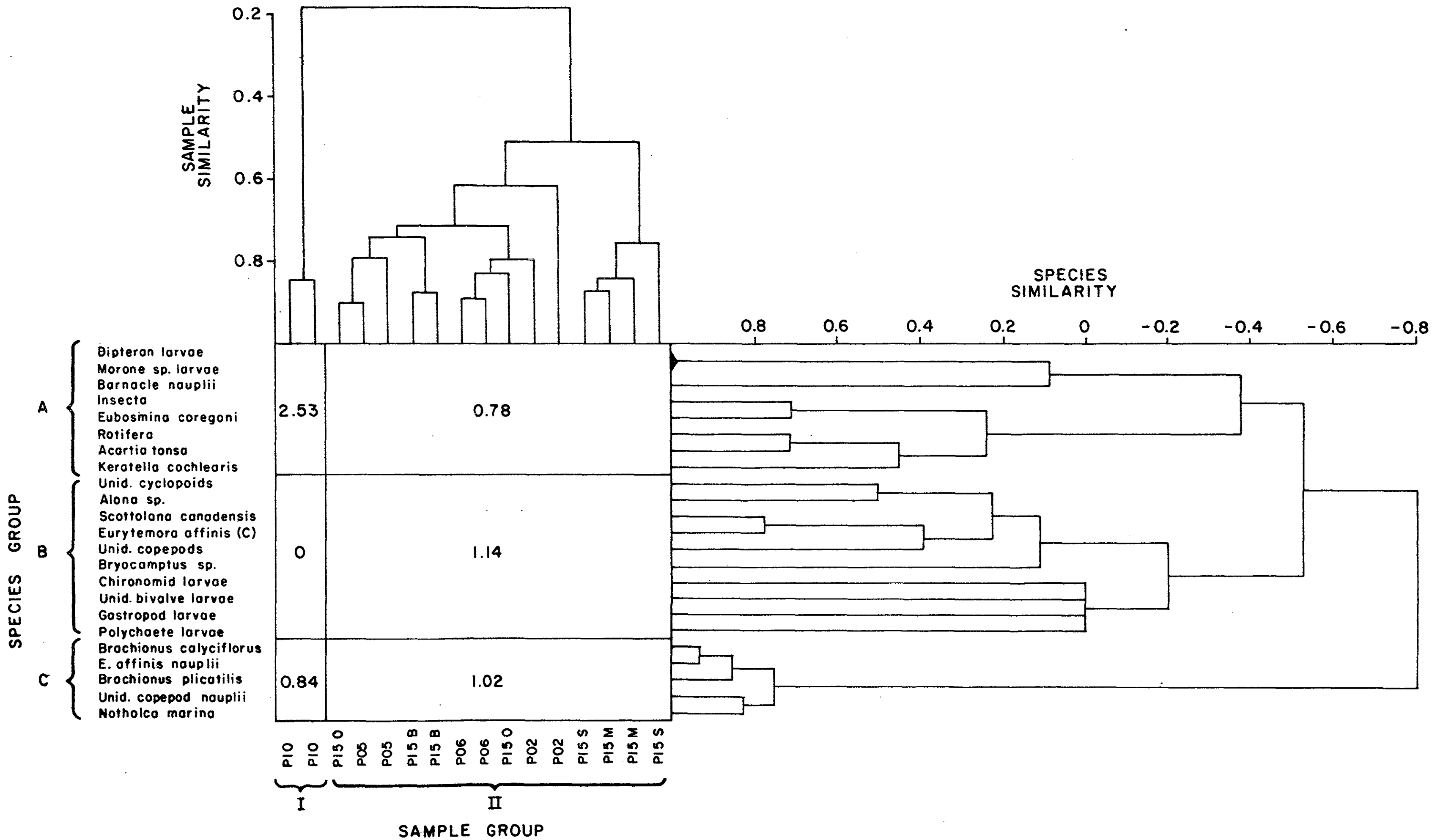


Figure 13 Sample and species clusters from May 1979 pumped microzooplankton collections, with the relationship of species clusters to sample clusters shown by indices of fidelity.

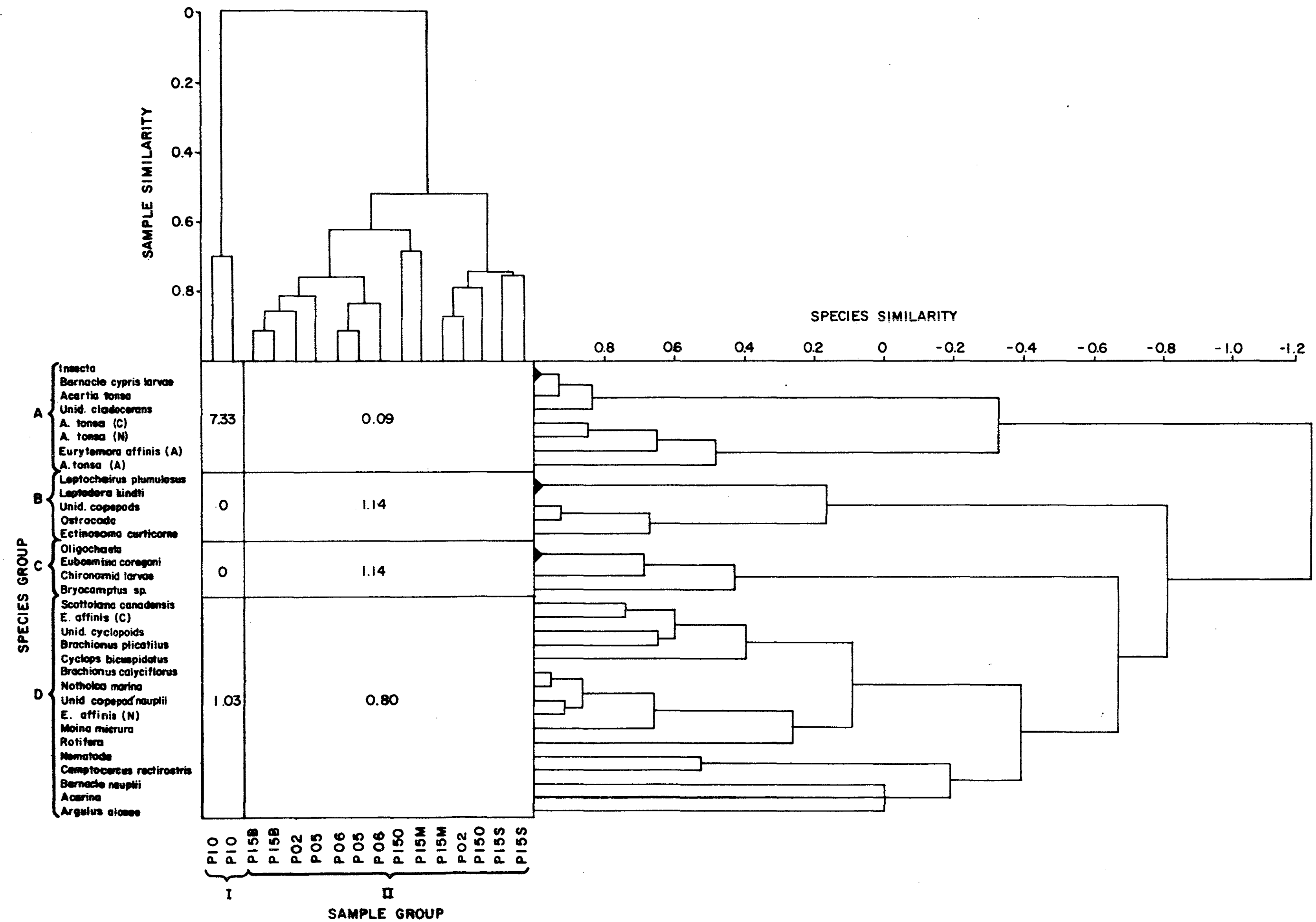


Figure 14 Sample and species clusters from June 1979 pumped microzooplankton collections, with the relationship of species clusters to sample clusters shown by indices of fidelity.

abundant and widespread species of group D.

4.2 Diversity

Measurements of diversity, evenness and species richness in microzooplankton collections included developmental stages of dominant copepods (nauplii, copepodids and adults of Eurytemora affinis and Acartia tonsa) as individual "species". Diversity was relatively high in March (H' > 2.38 except in the immediate discharge), decreased to a range of 1.45 - 1.98 in April and 1.43 - 2.10 in May, then increased in June with all diversities exceeding 1.81 (Table 6). Lowest diversity in March matched the distinctive cluster of discharge samples (stations P02 and P05). The late-sampled P10 which provided the only distinctive cluster of samples in May had lower diversity than any of the other oblique collections, but diversity was also low in the horizontal collections at P15. Diversities at P10 in June were not distinctively different from those at other stations. No relationship could be seen between diversity and clustering results in April.

Species richness followed the same seasonal trend as diversity, but lacked the definitiveness of relationship with clusters seen in March diversities. Ranges of species richness were 1.24 - 2.04 (March), 0.67 - 1.78 (April), 0.46 - 1.16 (May) and 0.59 - 2.10 (June).

Table 6. Diversity (H'), evenness (J') and species richness (d) of microzooplankton collections obtained by submersible pump and concentration with #20 netting (76 μm mesh). "Species" include counts of developmental stages of <u>Eurytemora affinis</u> and <u>Acartia tonsa</u> (nauplii, copepodids and adults) and of barnacles (nauplii and cypris larvae).

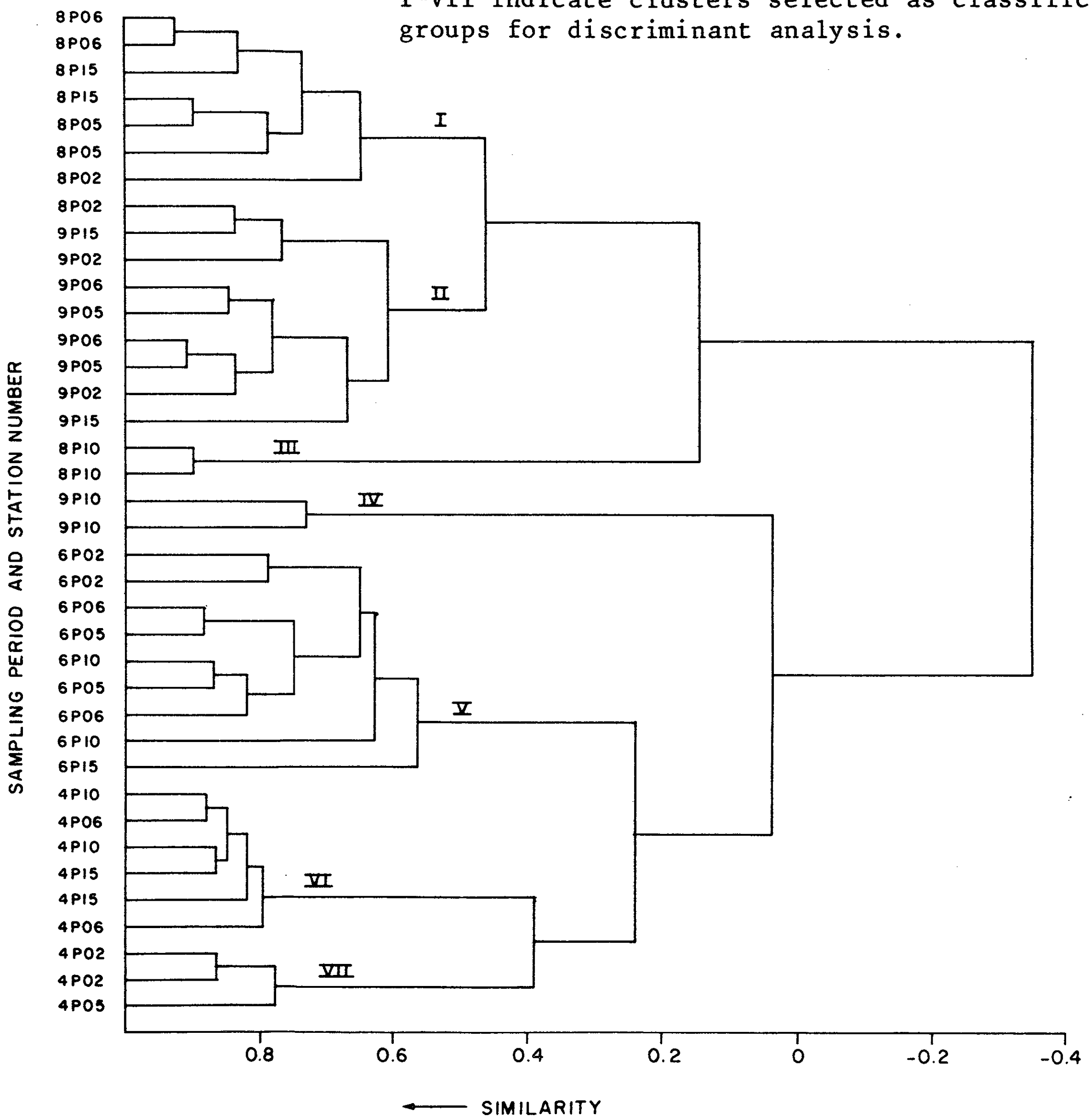
Station	March			April			May			June		
	H'	J'	d	H'	J'	d	H'	J'	d	H'	J'	d
					Discrete-depth Collections							
P15												
surface	2.6041	0.6510	1.8767	1.7738	0.5913	0.7311	1.5331	0.5931	0.6018	2.3261	0.6724	1.3237
surface	2.4179	0.6189	1.7271	1.8167	0.5713	0.8395	1.4306	0.6161	0.4591	2.0254	0.6751	1.0443
mid-depth	2.4629	0.6656	1.5533	1.9033	0.6780	0.6723	1.8852	0.6284	0.8156	2.4195	0.6355	1.7160
mid-depth	2.4942	0.6957	1.3640	1.9456	0.6485	0.7495	1.7091	0.6088	0.6910	2.1862	0.7287	0.9168
bottom	2.4088	0.6963	1.2904	1.6260	0.4895	0.9534	1.7784	0.5610	0.9281	1.9823	0.5730	1.1821
bottom	2.5347	0.6488	1.6982	1.4468	0.4823	0.7659	1.5266	0.4595	1.0139	2.0784	0.6257	1.0518
P15	2.6024	0.6835	1.6639	1.5280	0.5093	0.7843	2.0659	0.6219	1.0159	2.3108	0.7290	0.9888
P15	2.4069	0.6714	1.4453	--	--	--	2.1047	0.6084	1.1610	2.5319	0.6194	2.0958
P02	2.0571	0.5559	1.5331	1.9813	0.4953	1.7826	1.6859	0.5620	0.8322	2.0444	0.7909	0.5883
P02	1.7051	0.4929	1.2451	1.7991	0.5416	1.0125	1.7367	0.5228	1.0368	2.0387	0.6137	1.0581
P05	2.3878	0.6112	1.7822	1.8540	0.5581	0.9119	2.0123	0.6708	0.8591	2.1446	0.7149	0.8025
P05	--	--	--	1.8504	0.5349	1.0313	1.8938	0.5701	1.0528	2.4543	0.6846	1.2537
P06	2.3997	0.6485	1.5270	1.8263	0.5498	0.9560	1.9218	0.6406	0.7717	1.9476	0.5863	1.0001
P06	2.5015	0.5999	2.0388	1.6684	0.5561	0.7331	1.9785	0.6595	0.7765	1.8168	0.6471	0.6901
P10	2.4648	0.6309	1.7829	1.8469	0.5152	1.1695	1.5842	0.6823	0.6030	1.9756	0.5057	1.5956
P10	2.3889	0.6274	1.6298	1.7469	0.5259	0.9435	1.6500	0.5205	1.1581	2.0367	0.6131	1.0133

4.3 Relationship of Spring 1979 Microzooplankton to Physical Characteristics

As in the case of phytoplankton parameters, it is of interest to determine the relative strength of seasonal and plant effects on microzooplankton abundance and composition. Cluster analyses and diversity measurements in the previous sections of this report revealed effects of plant discharge only in March.

Whereas only one set of physical environmental measurements was available at each station, the six horizontal collections each month at station P15 were removed from this analysis. The remaining oblique tows (N=38) included replicates from each station, except for two lost samples. These combined spring samples were clustered (Fig. 15), providing seven sample groups with similarity of less than 0.5. The groups chosen were nearly identical to clusters obtained in month-by-month analyses, except for one May discharge sample linked with June samples and the lack of any separation among April samples. The principal division among spring microzooplankton samples was a seasonal one between early and late spring. The two replicates from P10 in June were linked at a low level of similarity to March and April samples, the sole exception to the split between early and late spring samples. The seven clusters, based on similarity in composition and abundance of microzooplankton, were used as pre-classified groups in a discriminant function analysis employing the same eight (8) physical variables used in the phytoplankton

Figure 15 Clustering of 38 spring 1979 microzooplankton samples according to similarity (Bray-Curtis) in species composition and abundance. Sampling periods: 4 - March 29-30, 6 - April 10-11, 8 - May 24-25 & 31, 9 - June 26-27. Roman numerals I-VII indicate clusters selected as classification groups for discriminant analysis.



analysis (section 3.4).

Summary statistics for the discriminant function analysis given in Table 7 show that the first four discriminant functions were highly significant and that the first two functions accounted for nearly 95% of the variance. Absolute values of the standardized discriminant function coefficients show the singular importance of temperature in the first few functions, which is reflected in the elongated group separation depicted in Fig. 16. Only sample groups I and II (May and June samples) show any overlap on this plot of the first two functions.

A remarkable 97.37% of the samples were correctly classified, with the single "misclassification" (based on physical data) being the replicate sample from P02 in May that was clustered with June samples on the basis of similarity of fauna. This represents the single instance of effluent effects overriding seasonal changes. The distinctive cluster of discharge samples in March analyses remained distinctive (as Sample Group VII) in the combined analysis.

4.4 Observations on Vertical Distribution at Station P15

In addition to the regular, replicated oblique pump collections taken at all stations, discrete-depth collections were also taken each month from near-surface, mid-depth and near-bottom at station P15. All of the counts and identifications from these horizontal collections are included in Appendix Table A-10. If the fauna at

Table 7. Summary statistics from discriminant function analysis of spring 1979 physical data, with groups of samples defined from cluster analysis of pumped microzooplankton collections (replicated oblique collections only).

Discriminant Function	Eigenvalue	Cumulative % of Variance	Canonical Correlation	After Function	Wilk's Lambda	Chi-Square	d.f.	Significance
				0	0.0000	337.32	48	0.0000**
1	107.48694	77.13	0.9954	1	0.0012	199.06	35	0.0000**
2	24.07324	94.41	0.9799	2	0.0294	104.02	24	0.0000**
3	4.23829	97.45	0.8995	3	0.1541	55.17	15	0.0000**
4	2.93498	99.55	0.8636	4	0.6064	14.75	8	0.0641n.s.
5	0.57886	99.97	0.6055	5	0.9575	1.28	3	0.7334n.s.
6	0.04442	100.00	0.2062					

Standardized Discriminant Function Coefficients

Variable	Function 1	Function 2	Function 3
Radiation	0.52559	1.39662	-0.88653
Secchi	0.29025	-0.24842	-0.44505
Temp, surf.	-10.38928	-10.31944	2.17033
Temp, mean	11.04438	9.04916	-2.32698
Sal, surf	4.38663	3.06705	2.31487
Sal, mean	-3.23732	-2.59217	-2.28114
DO, surf	1.43040	0.84844	0.89157
DO, bottom	-2.65449	-0.70130	-0.25257

Group Centroids

Station Group	Function 1	Function 2	Function 3
I	5.40	-3.05	-2.22
II	6.10	-2.40	-1.91
III	21.78	7.73	5.15
IV	13.24	3.09	-0.69
V	-9.50	-3.80	1.94
VI	-9.62	7.17	-1.29
VII	-6.49	4.16	0.03

Classification Results

Actual Group	Number of Samples	Predicted Group Membership (%) I	II	III	IV	V	VI	VII
I	7	100.0	0	0	0	0	0	0
II	9	11.1	88.9	0	0	0	0	0
III	2	0	0	100.0	0	0	0	0
IV	2	0	0	0	100.0	0	0	0
V	9	0	0	0	0	100.0	0	0
VI	6	0	0	0	0	0	100.0	0
VII	3	0	0	0	0	0	0	100.0

Percent of total (38) samples correctly classified: 97.37%

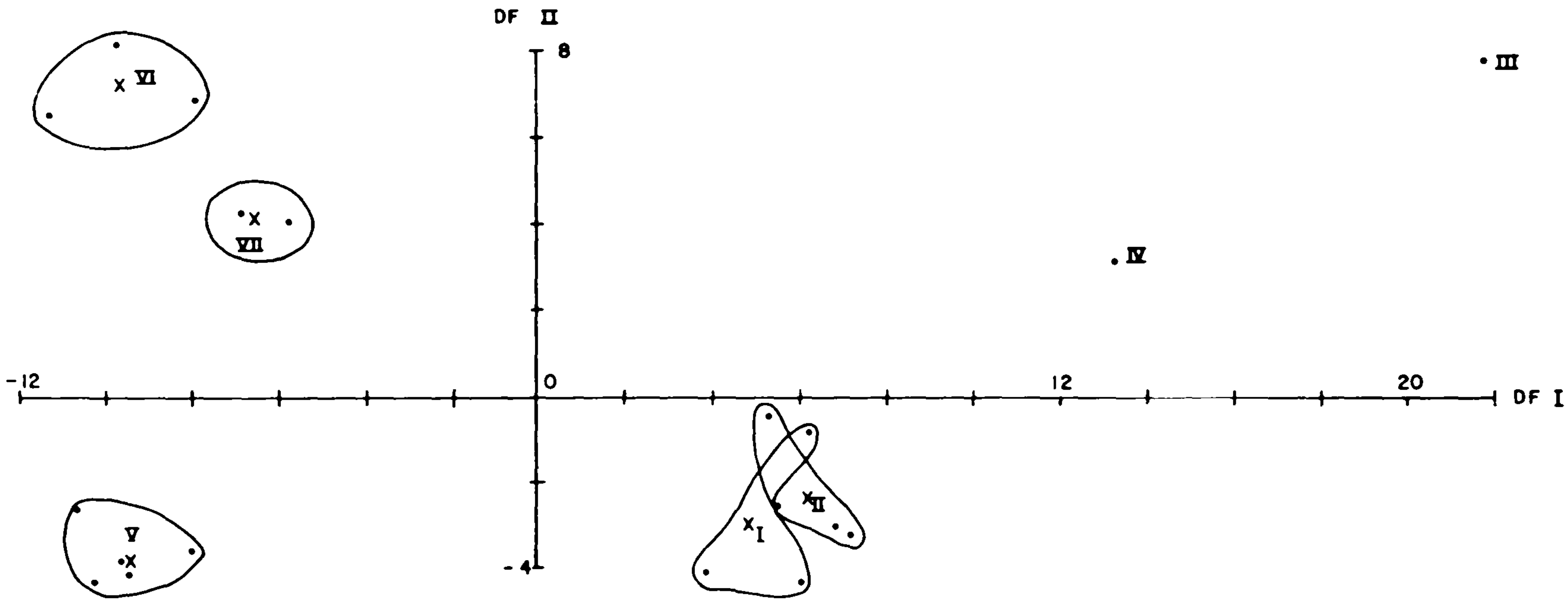


Figure 16 Separation of the sample groups obtained from microzooplankton sample clustering on the first two discriminant functions of the eight environmental variables. Each point represents two replicate samples, since only one set of physical measurements is available from each sampling site.

different depths was sufficiently distinct, then one could expect that cluster analyses would result in the separation of, e.g., P15 bottom samples from those at other depths. In march, all eight P15 collections (oblique and discrete-depth) were closely clustered. In April, P15 bottom collections were placed in a different sample group than other P15 samples, but as pointed out earlier separation of samples in April was rather poor (at a relatively high level of similarity). In May and June, only samples from P10 were found to be distinct, leaving all P15 samples clustered together.

Inspection of Appendix Table P15 under the April collections shows little difference between the fauna from P15 bottom collections and that of other P15 collections. Among the dominants, Eurytemora affinis nauplii were found in comparable numbers in surface and bottom collections, in lesser amounts at mid-depth. The rotifer, Keratella cochlearis was somewhat fewer in number in one of the two bottom samples, Notholca marina was considerably less abundant, but was absent in the oblique collection. Eurytemora affinis copepodids were considerably more abundant in near-bottom water. In summary, even in April where there was an indication of some faunal difference with depth, differences were slight. Greater stratification might be anticipated in summer months than during the season included in the present study.

5. Mesozooplankton

Zooplankton classified by size as mesozooplankton are those retained on 202 μm mesh netting (Biological Methods Panel Committee on Oceanography 1969). This size class was sampled in the present study with 18.5 cm bongo samplers towed obliquely through the water column at each of 14 stations monthly. Additional horizontal tows were also made at near-surface, mid-depth and near-bottom at station P15 each month. These 202 μm collections provided data on biomass, species occurrence and abundance, dominance, diversity and community structure.

5.1 Biomass

Unlike microzooplankton collections, mesozooplankton collections provided sufficient volumes of organisms to allow reasonably precise measures of displacement volume. Biomass was relatively high in March in these essentially fresh waters, exceeding 1 ml/m^3 in the intake stations P12 and P15 [the maximum displacement volume observed by Grant and Berkowitz (1979) in summer months was 0.89 ml/m^3 and intake biomass was consistently lower than that from the discharge side]. Except for stations in Dundee Creek and the upper reaches of Gunpowder River, displacement volume dropped in April to less than 0.60 ml/m^3 (Table 8) and to lower levels in May and June.

5.2 Species Occurrence, Dominance, and Relative Abundance

A checklist of species occurring in spring collections is

Table 8. Displacement volume (ml/m^3) of 18.5 cm bongo, 202 μm mesh net, collections at the C.P. Crane generating station, March-June, 1979.

Station	March	April	May	June
Z01	0.44	0.90	0.49*	0.13
Z02	0.71	1.43	0.09	0.19
P08	0.70	0.57	0.05	0.20
P01	0.73	0.11	0.07	#
P02	0.60	0.06	0.04	0.02
P05	0.46	0.04	0.06	0.06
P06	0.88	0.57	0.06	#
P07	0.43	0.35	0.03	0.02
P09	0.22	0.54	0.05	0.05
P10	0.57	0.40	0.05	0.03
P11	0.29	0.07	0.05	0.07
P12	1.09	0.36	0.11/0.02**	0.41
P15	1.21	0.04	0.11	0.02
sfc	0.82	0.02	0.29	#
	1.15	0.12	0.19	#
mid	1.31	0.02	0.20	#
	1.44	0.11	0.28	#
bot	1.07	0.02	0.33	0.04
	1.33	0.11	0.10	0.04
Z03	0.33	0.11	0.02	0.14

*Biomass mostly vegetation
**Station P12 sampled twice in May
#Volume too small to measure

provided in the appendix to this report (Appendix Table A-11). Unlike the relatively stable conditions sampled during the summer of 1978, the spring period revealed a transition from winter to spring fauna. As a result, there was a general lack of ubiquitous species, except for Eurytemora affinis, and the list of species was greatly lengthened. Especially diverse were the cladocerans in this period of cool, freshened water.

Seasonal succession was particularly evident among the cladocerans and copepods. Early spring cladocerans, such as certain Daphnia spp., Eubosmina coregoni and Bosmina longirostris, were gradually replaced by Leptodora kindti, Sida crystallina and Moina micrura. The early spring subdominant copepod Cyclops bicuspidatus was less frequent in May and June, when warm-water species such as Acartia tonsa and the parasitic Ergasilus spp. and Argulus alosae began appearing in greater abundance. Among the fishes, yellow perch eggs and larvae were collected in March and April, respectively, while Morone sp. (probably M. americana) larvae were abundant in April and May. Gobiosoma bosci did not appear in collections until June. The other important group of meroplankton, decapod larvae, was rare before May and was not frequent until June.

The more frequent and abundant species collected during spring 1979 are listed within months in Table 9. A rather sharp change in abundance and frequency is evident here between April and May, with the shift from cold-water to warm-water fauna. Average abundance of

Table 9. Frequency of occurrence (%) and average abundance (total numbers per total sampled volume in m^3) of the more common zooplankton species occurring near the C.P. Crane generating station, spring and early summer 1979. Based on collections made with 18.5 cm bongo samples (202 μm mesh nets).

Species/Taxon	March %	March no./m^3	April %	April no./m^3	May %	May no./m^3	June %	June no./m^3
Eurytemora affinis	100	5166.0	100	7709.6	93	16.9	100	603.7
Cyclops bicuspidatus thomasi	100	1134.2	93	2200.6	47	0.6	36	0.1
Acartia tonsa	7	6.8	36	116.4	87	32.0	100	283.4
Eubosmina coregoni	100	233.9	93	1242.4	7	<0.1	29	0.2
Ostracoda	100	10.5	100	41.8	67	0.3	64	0.2
Bosmina longirostris	79	8.0	93	409.7	80	4.1	29	0.8
Acarina	21	<0.1	86	10.4	100	2.4	100	0.8
Leptodora kindti	14	1.2	64	<0.1	47	0.2	93	2.9
Chironomid larvae	93	1.6	79	2.6	53	5.7	43	<0.1
Moina micrura	0	--	0	--	87	2.0	100	57.5

Eurytemora affinis in March and April and *Cyclops bicuspidatus* in April exceeded the highest estimate for the most abundant species (*Moina micrura*) in our previous study of summer plankton (Grant and Berkowitz 1979).

The numerical dominance of species in collections provides a rapid assessment of zooplankton community differences among stations and months. The dominance of *Eurytemora affinis* in March and April was evident throughout the study area (Table 10). Only three collections in March and two in April were numerically dominated by different species, *Cyclops bicuspidatus* at Gunpowder River stations in March and one of the April collections, and by *Eubosmina coregoni* at P01 in April. May dominants reflect the transition of fauna, with predominant species including *Eurytemora affinis* (5 collections), *Acartia tonsa* (6 collections, 5 of which were taken later on May 31), water mites (2 collections in the immediate discharge) and different cladocerans in the remaining two collecitons. In June, on the other hand, only two collections were dominated by *E. affinis*, but 8 and 4, respectively, by the warm-water species *Moina micrura* and *Acartia tonsa*.

5.3 Diversity

Diversity (H'), calculated for all bongo collections (Table 11), may be compared with results of similar calculations of summer 1978 collections. Most summer 1978 indices (Grant and Berkowitz 1979) were between 1.0 and 2.0 (H'), with a single higher index of 2.28 recorded

Table 10. Rank of numerical dominance of zooplankton species in 18.5 cm bongo, 202 μm mesh nets. Designations 1, 2, 3 represent first, second and third most abundant species in individual collections.

Month		Z01	Z02	P08	P07	P06	P05	P01	P02	P15	P12	P09	P10	P11	Z03
MAR	*Eurytemora affinis*	1	1	2	2	1	1	1	1	1	1	2	1	1	1
	Cyclops bicuspidatus thomasi	2	2	1	1	2	2	3	2	2	2	1	2	2	2
	Eubosmina coregoni	3	3	3	3	3	3	2	3	3		3	3	3	3
	Ostracoda										3				
APR	*Eurytemora affinis*	1	2	1	1	1	1	2	1	1	1	1	1	1	1
	Eubosmina coregoni		3	3	3	2	2	1	2		2	3	2		2
	Cyclops bicuspidatus thomasi		1		2		3				3	2		3	
	Brachionus calyciflorus			2						2			3	2	3
	Bosmina longirostris					3		3	3						
	Acarina									3					
	Chydorus sphaericus	2													
	Eucyclops agilis	3													
MAY	*Acartia tonsa*				1			2	3		1*	1	1	1	1
	Eurytemora affinis			1	2	1	1	3		1	1/3*	2	2	2	
	Acarina					3	2	1	1	3	3/2*	3	3	3	3
	Brachionus plicatilis			2	3					2	2				
	Bosmina longirostris		3												2
	Pseudochydorus globosus		1												
	Ilyocryptus spinifer		2												
	Moina micrura			3											
	Sida crystallina	1					3								
	Brachionus calyciflorus								2						
	Chironomid larvae	2													
	Chydorus sphaericus	3				2									
JUNE	*Moina micrura*	1	1	1	3	1	1	1	1	2	1	3	3	3	3
	Eurytemora affinis		2	2	1	3	2	2	2	3	3	2	2	2	1
	Acartia tonsa				2	2	3	3	3	1	2	1	1	1	2
	Disparalona rostrata		3												
	Leptodora kindti			3											
	Sida crystallina	2													
	Ceriodaphnia pulchella	3													

*Station P12 sampled twice in May

Table 11. Diversity (H'), evenness (J') and species richness (d) of 18.5 cm bongo collections (202 μm mesh nets) at the C.P. Crane generating station, March-June 1979. All collections from 15 min. oblique tows except those replicated, horizontal tows indicated under P15 (5 min. each).

Station	March			April			May			June		
	H'	J'	d	H'	J'	d	H'	J'	d	H'	J'	d
P11	0.8323	0.2774	0.6318	1.2169	0.3042	1.4814	0.4000	0.1204	1.1592	1.1556	0.3645	0.7722
P12*	0.4267	0.1422	0.5491	0.6385	0.1596	1.2964	1.2848	0.3288	1.6928	1.6270	0.4068	1.7251
							0.8553	0.2473	1.5592			
P15	0.3820	0.1150	0.7174	1.9592	0.5465	1.2678	2.3119	0.5443	2.4647	1.6828	0.4548	1.4435
P15 - surface	0.4415	0.1573	0.5468	1.7623	0.4511	1.8982	2.0098	0.5144	1.9714	1.2100	0.3642	1.5448
P15 - surface	0.3885	0.1295	0.7048	1.8128	0.5240	1.2753	2.2426	0.5486	3.0433	1.8515	0.6172	1.1146
P15 - mid depth	0.2775	0.0925	0.5999	1.7034	0.4752	1.7967	2.3131	0.5266	3.3059	1.7838	0.4820	1.6446
P15 - mid depth	0.3544	0.1118	0.6974	1.8515	0.5352	1.1590	2.4372	0.5845	2.8470	1.6712	0.4831	1.4660
P15 - bottom	0.2429	0.0766	0.6777	1.4598	0.3945	1.2145	1.7484	0.4045	2.3563	1.8845	0.4950	1.5244
P15 - bottom	0.2779	0.0877	0.6688	1.2114	0.4315	0.7512	1.3463	0.3446	2.0691	1.7681	0.5322	1.0962
P01	0.4190	0.1322	0.6839	2.2314	0.5711	1.4964	3.0572	0.6856	3.5416	2.5750	0.6438	2.3745
P02	0.4428	0.1333	0.6824	1.1291	0.2965	1.3747	3.4321	0.7814	3.3395	1.8006	0.4729	1.5255
P05	0.2816	0.0761	1.0091	1.8716	0.4791	1.2678	2.1706	0.5022	3.0613	2.4012	0.5384	2.7129
Z01	0.4894	0.1253	1.1094	1.2208	0.3052	1.1849	1.9580	0.4530	1.9835	2.8825	0.6372	3.1299
P06	0.9382	0.2464	1.0653	1.1733	0.2814	1.3681	2.9634	0.6747	3.2597	1.0306	0.2576	1.7906
Z02	1.6612	0.4489	1.0224	1.7573	0.4749	0.8986	2.6956	0.6237	2.1163	2.1903	0.4660	2.9492
P08	1.4505	0.4193	0.7551	2.1666	0.5545	0.9532	3.3553	0.7639	2.9247	2.0011	0.4424	2.6845
P07	2.0550	0.5397	1.1476	1.6650	0.4073	1.2274	2.4610	0.6152	2.3841	1.7747	0.4542	1.5364
P09	1.6479	0.4763	0.8671	0.7809	0.1999	1.0557	1.3241	0.3117	2.1829	1.1656	0.2577	1.9157
P10	1.2497	0.3486	1.0092	0.5079	0.1243	1.2837	0.9205	0.2488	1.5434	0.9421	0.2546	1.1596
Z03	1.1301	0.4372	0.4333	0.4481	0.1211	1.1963	0.4663	0.1404	1.0513	1.2428	0.3181	1.3774

*Station P12 sampled on two dates in May.

from the intake creek in July. March 1979 diversity was generally lower, below 1.0 except in Gunpowder River collections. Diversity increased in April to levels similar to summer 1978, peaked in May, then decreased in June, when indices were still generally higher than those observed during the previous summer. Three collections in May exceeded H' = 3.0, the maximum 3.4321 occurring at station P02 in the immediate discharge.

On the average, diversity increased through intake waters, then sharply increased to maximum H' in the immediate discharge. It decreased down the Gunpowder River and out into Chesapeake Bay.

The relationship of faunal similarity within monthly collections and measures of diversity and species richness is shown in Fig. 17. Clusters of stations separated at a similarity level below 0.5 (detailed below) were usually of similar diversity, species richness or a combination of the two measures.

5.4 Cluster and Nodal Analyses

Cluster analyses of bongo collections included a 5% frequency of occurrence cutoff for the inclusion of species, which were more numerous than in microzooplankton collections. Results of cluster analyses and the nodal analyses to show relationship between clusters of samples and species are given below, separated by month of collection.

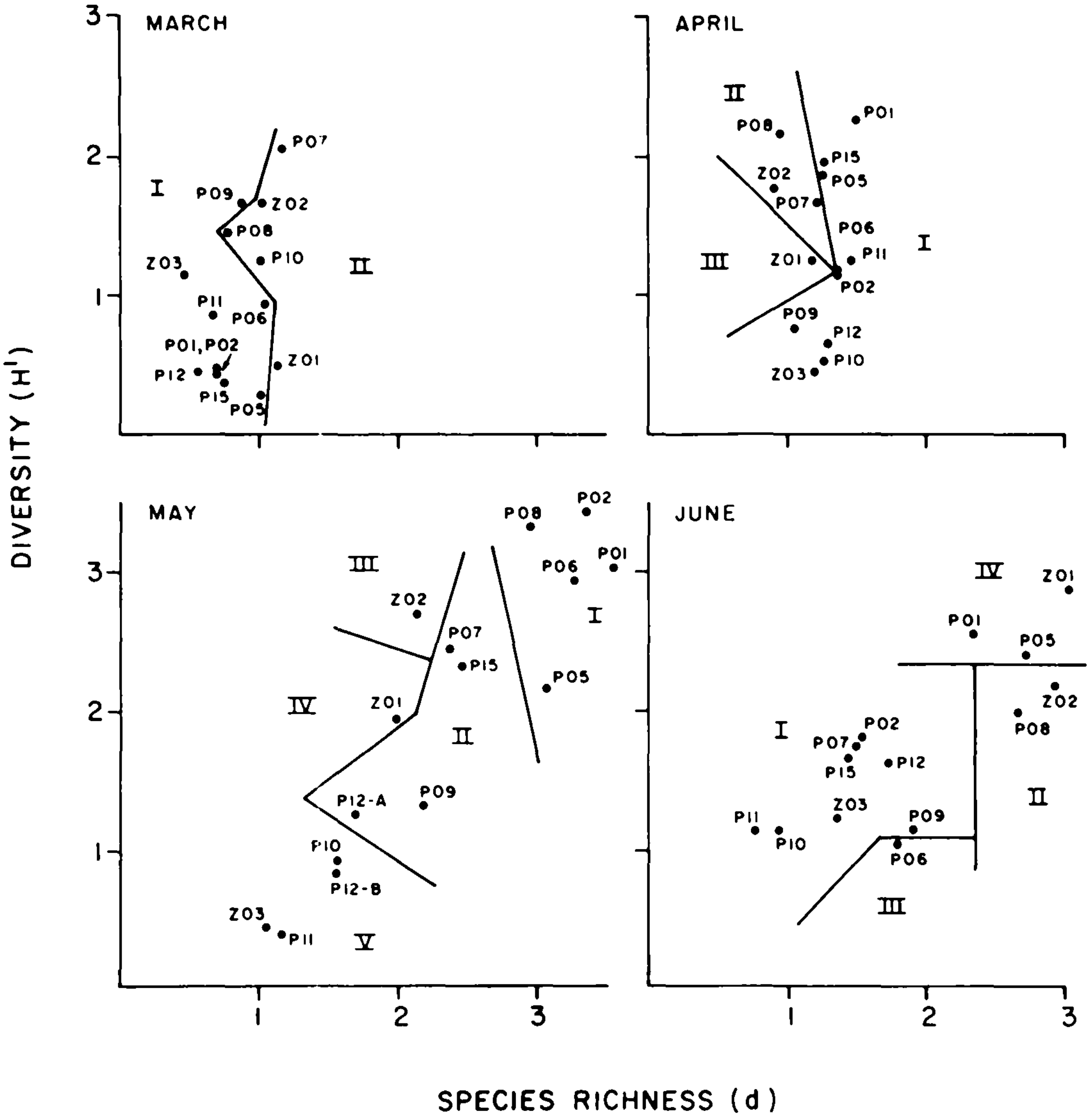


Figure 17 Relationship of diversity (H') to species richness (d) as calculated from 18.5 cm bongo collections, March-June 1979. Groups of stations separated at a similarity level below 0.5 are indicated by Roman numerals (cf. Figs. 17-20).

5.4.1 March 1979

The normal cluster analysis of March bongo collections, with 20 samples and 24 species occurring in more than 5% of samples, divided samples into two groups (Fig. 18), the first of somewhat lower salinity than the second, 0.123 - 0.408 ($\bar{x}$ = 0.245) vs. 0.220 - 0.456 ‰ ($\bar{x}$ = 0.351):

I: Upper Gunpowder River, lower Saltpeter Creek and Dundee Creek

II: Lower Gunpowder River, intake waters and near-discharge waters.

Dominant species were all within a single species group (F), which demonstrated its lack of "preference" for either sample group by fidelity indices of 1.00. Species Group A showed preference for the upstream station cluster, but consisted of infrequent taxa of low abundance. Species Group B was also in low abundance and distributed in both sample groups. Species Group C was somewhat more abundant, although of patchy distribution, with a slight preference for Gunpowder River locations. Species Group D included ubiquitous species of low abundance and moderately abundant species (especially *Eucyclops agilis*) that showed some preference for Sample Group I. Species Group E was very rare and of low abundance.

Of those species of particular interest to other studies in the area, both fish species were clustered in Species Group C. White perch eggs were found off Carroll Island at P09 and in Dundee Creek,

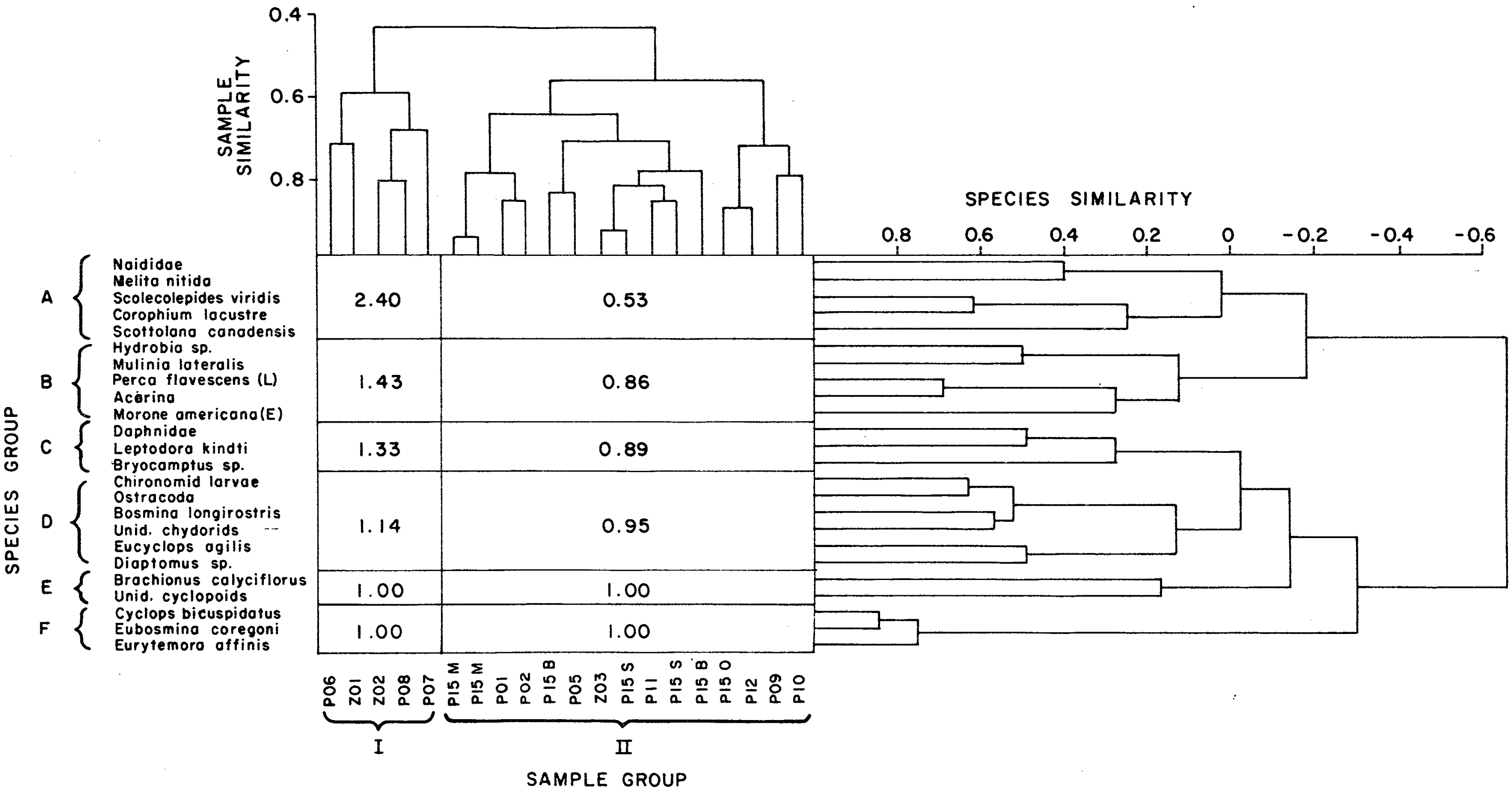


Figure 18 Sample and species clusters from March 1979 bongo collections, with the relationship of species clusters to sample clusters shown by indices of fidelity.

while yellow perch larvae were taken in Dundee and Saltpeter creeks (5 stations including the immediate discharge). Parasitic copepods were absent.

5.4.2 April 1979

The normal cluster analysis of April bongo collections was based on 20 samples and 27 species occurring in more than 5% of samples (Fig. 19) and yielded four sample groups:

I: Dundee Creek (Z01)

II: Intake waters, immediate discharge and lower Gunpowder River

III: Upper Gunpowder and lower Saltpeter

IV: One half of P15 horizontal tows

Except for the separation of groups I and IV, therefore, clustering of stations was the same as seen above in March. Surface salinities in the lower salinity Group III ranged from 0.125 to 0.323 $^{o}/oo$; in Group II the range was 0.323 - 0.984 $^{o}/oo$. The Dundee Creek collection differed from those in Sample Group III mostly in the absence of certain species, Brachionus calyciflorus, Eubosmina coregoni, Bosmina longirostris, Cyclops bicuspidatus and Acartia tonsa (Species Group E) that were abundant in Sample Group III and by a greater abundance of the cladoceran, Chydorus sphaericus (also Group E).

Distinctiveness of the three horizontal samples at P15

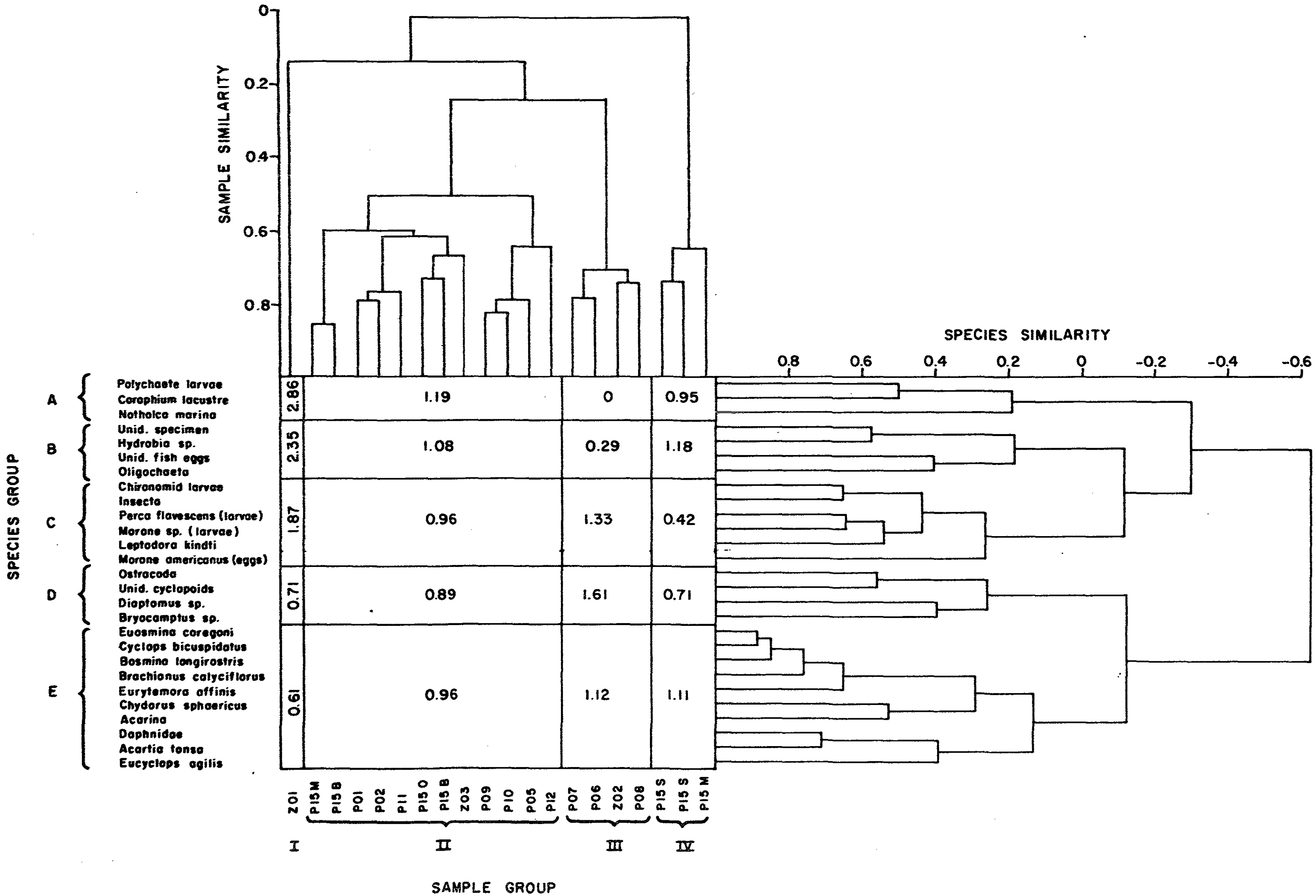


Figure 19 Sample and species clusters from April 1979 bongo collections, with the relationship of species clusters to sample clusters shown by indices of fidelity.

(Sample Group IV) from Sample Group II included an abundance of *Notholca marina* (Group A), absence of *Leptodora kindti* (Group C), and generally reduced abundance of the dominants in Group E.

Yellow perch larvae were found at all stations except P11, Z03, P15 and Z01, and were most numerous in the upper Gunpowder River. *Morone* eggs were found in the upper Gunpowder and in upper Saltpeter and Dundee creeks. White perch larvae were most abundant in the lower Saltpeter Creek, but occurred at all locations. Parasitic copepods were again absent.

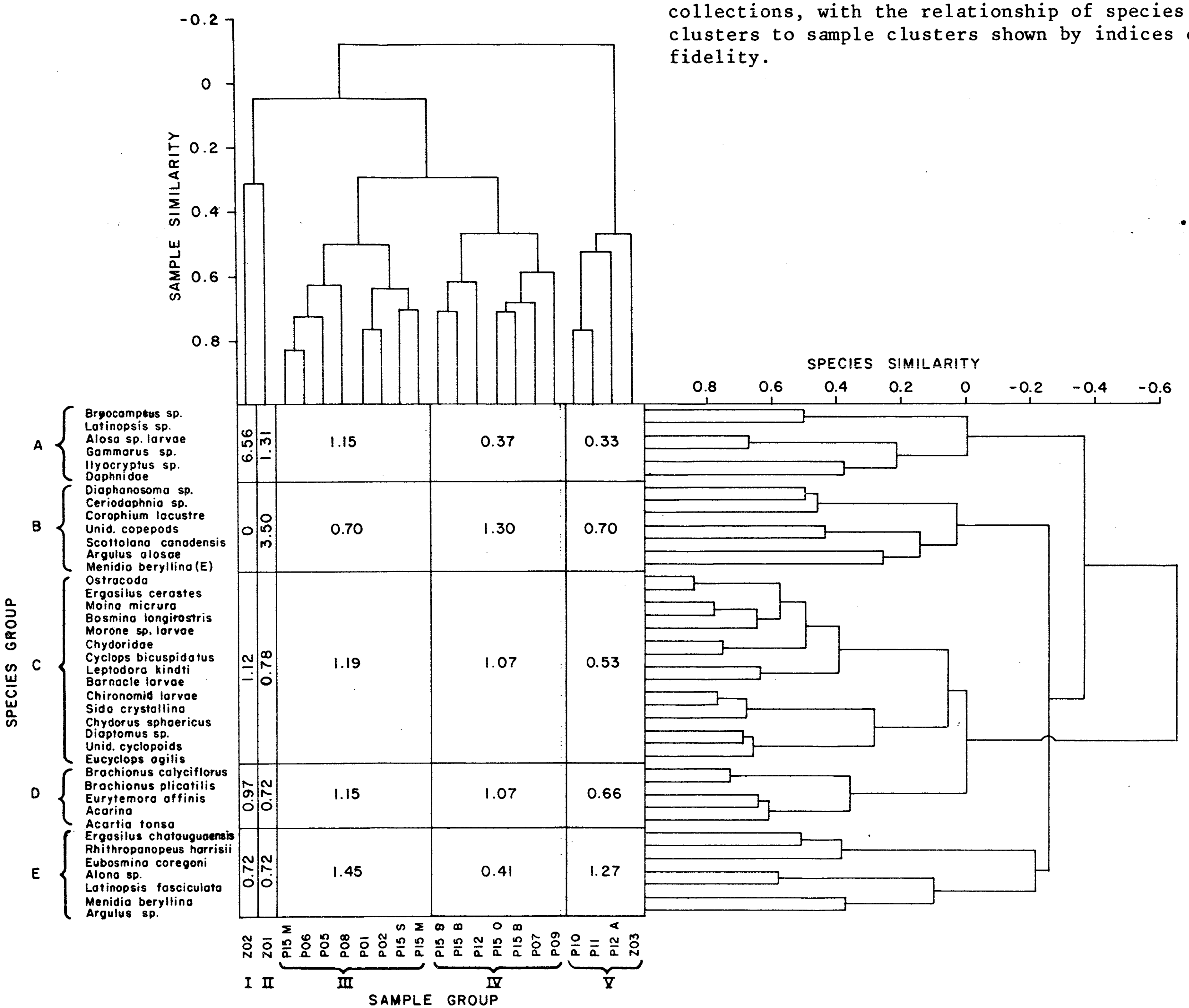
5.4.3 May 1979

The cluster analyses of May bongo collections (Fig. 20), based on 21 samples and 40 species occurring in more than 5% of samples, divided samples into 5 groups, two of them containing only a single sample:

- I: Uppermost Gunpowder R. (Z02)
- II: Dundee Creek (Z01)
- III: Saltpeter Creek, upper Gunpowder River (P08) and one-half of horizontal tows (P15)
- IV: Gunpowder River (P07, P09) and intake
- V: Outside stations (May 31)

Groups III, IV and V included stations with generally increasing surface salinity, with ranges of 0.253 - 0.919 ^{o}/oo, 0.542 - 1.780 ^{o}/oo and 1.275 - 2.631 ^{o}/oo, respectively. Z02 was the

Figure 20 Sample and species clusters from May 1979 bongo collections, with the relationship of species clusters to sample clusters shown by indices of fidelity.



freshest station, with surface salinity of 0.145 $^{o}/oo$. The most distinctive cluster was Sample Group V (P10, P11, Z03 and the second visit to P12), sampled in a different tidal cycle on May 31. Collections were characterized by the absence of *Brachionus plicatilis* and an abundance of and dominance by *Acartia tonsa*, associated with the increased salinity in this delayed sampling. Station Z02 (Sample Group I) was distinctive in the occurrence of certain rare taxa, especially *Ilyocryptus* of Species Group A, and in the absence of species in Species Group B, containing occurrences unique to the single station (Z01) in Sample Group II (*Diaphanosoma* sp., *Ceriodaphnia* sp., *Corophium lacustre*, etc.).

Sample Group III differed from Group IV primarily in the presence of the infrequent taxa of Species Group E (*Ergasilus chatauguaensis*, *Rhithropanopeus harrisii*, *Alona* sp.) and in containing fewer numbers of *Eurytemora affinis* and *Acartia tonsa*, members of Species Group D.

Among the fishes, *Alosa* sp. larvae were found in the upper Gunpowder River (Z02 and P08); eggs of *Menidia beryllina* at Z01 and P12 and larvae at Z01-Z03, P10, P11 and P15, and white perch larvae several stations scattered throughout the study area. Among the parasitic group of copepods, *Argulus alosae* occurred only on the Bay side of the study area (seasonal recruitment from Bay waters?), *Ergasilus cerastes* occurred in all locations except the uppermost Gunpowder River and the outermost stations P11 and

Z03. E. chatauguaensis (probably free-living) was found principally at the immediate intake and in discharge waters of Saltpeter Creek.

5.4.4 June 1979

Cluster analysis of June bongo collections were based on 20 samples and 37 species found in more than 5% of samples. The normal analysis divided samples into 4 clusters:

- I: Uppermost Gunpowder River (Z02, P08)
- II: Dundee and upper Saltpeter Creeks
- III: Lower Saltpeter Creek and P15 (partial)
- IV: Lower Gundpowder, intake (partial P15) and immediate discharge

The two upper Gunpowder River stations (low surface salinity, 0.279 - 0.373 °/oo) were most distinctive, preferentially inhabited (fidelity index = 6.07) by holdovers from the cool weather freshwater fauna, including an abundant and fairly unique supply of Ilyocryptus sp. and Alona sp. (Species Group A). This fauna was also important in Sample Group II, which differed from the upper Gunpowder collections in the occurrence of Species Group B and higher surface salinity (0.613 - 0.860 °/oo). Highest salinities occurred at stations in Group IV (range of 0.605 - 1.094 °/oo at the surface). The summer complement of dominants were included in the small Species Group E, the most

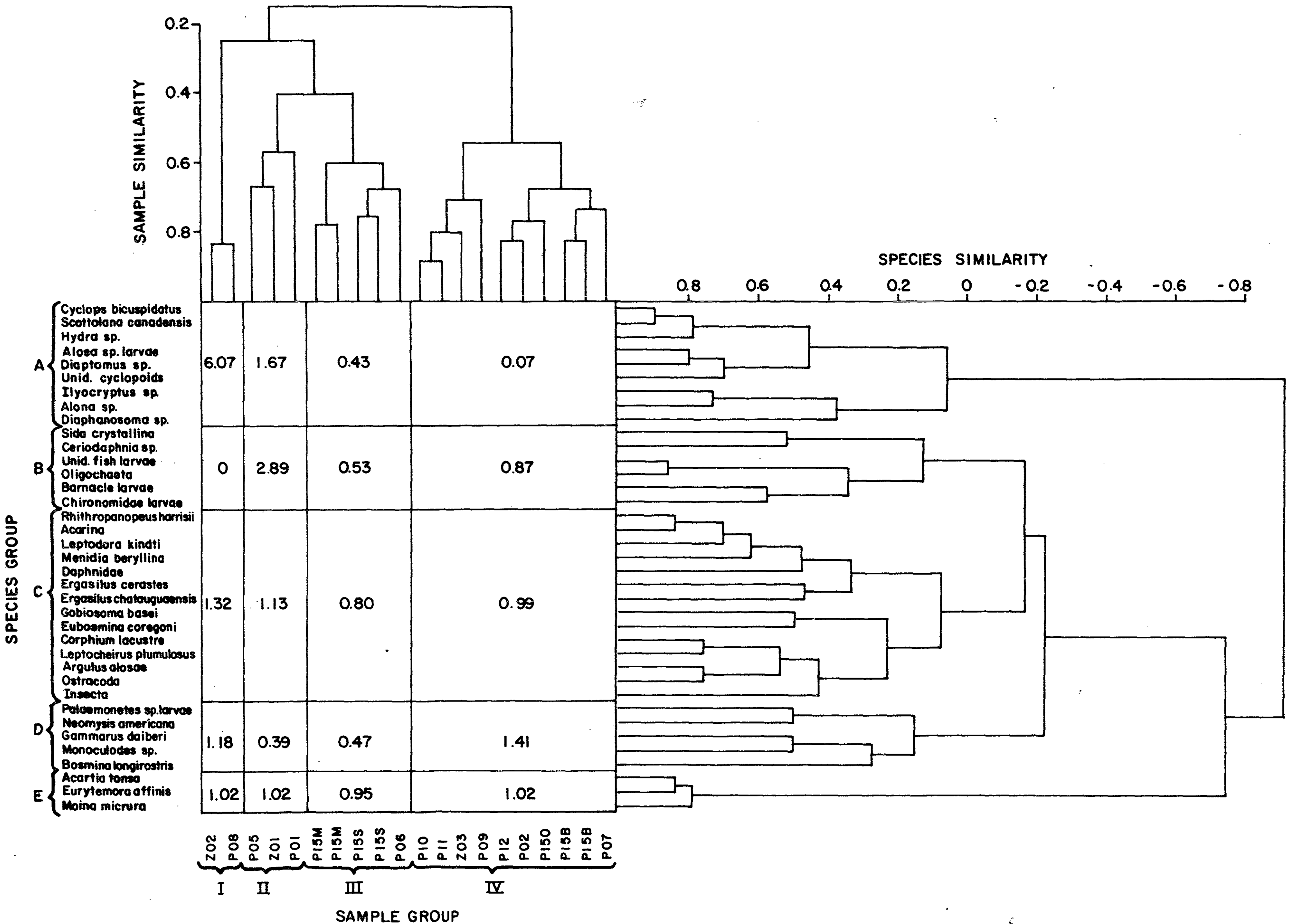


Figure 21 Sample and species clusters from June 1979 bongo collections, with the relationship of species clusters to sample clusters shown by indices of fidelity.

distinctive cluster of the inverse analysis (Fig. 21). Fidelity indices close to unity reflect a general lack of "preference" or "avoidance" by this group for subareas, although a somewhat lower abundance in Sample Group III was instrumental in its separation.

Alosa sp. larvae were restricted to the upper Gunpowder (Sample Group I); unidentifiable fish larvae were found at P09 and in discharge waters; *Menidia beryllina* occurred everywhere except P12, P02 and P08; and *Gobiosoma bosci* was found in the upper Gunpowder (Z02, P08, P07), the intake (P15) and station Z03. Mudcrab larvae (*R. harrisii*) were found at every station except P05, while *Palaemonetes* sp. larvae were limited to P12, P15, P06, P09 and P10. *Argulus alosae* was present in all collections except those from P10 and P11; *Ergasilus cerastes* occurred in the immediate intake, in all Saltpeter and Dundee creek stations and at P10; *E. chatauguaensis* occurred mostly in freshest water (Z01, P08, P06, P01 and P15).

5.5 Relationship of Spring 1979 Mesozooplankton to Physical Characteristics

The relative importance of seasonal plant effects on mesozooplankton populations was, as in previous sections dealing with phytoplankton and microzooplankton, examined by use of a combined cluster analysis.

As in the combined cluster analysis of microzooplankton collections, replicated horizontal bongo collections were excluded from this analysis. The remaining oblique tows (N = 57), including the repeated sampling of P12 on May 31, were clustered according to similarity in composition and abundance of collected organisms (Fig. 22), yielding seven sample groups. The primary division of samples, as in microzooplankton analyses, was a seasonal split between March-April and May-June collections. Within these primary clusters, were secondary divisions of samples, essentially by month. The March cluster (Sample Group VI) was subdivided in a similar manner to our previous analysis of March collections (Fig. 18), except for inclusion of the April sample from P12 and a subsequent shift between March clusters of the sample from Z01. The April cluster (Group VII), on the other hand, was quite different from that seen earlier (Fig. 19). With the removal of the P12 sample, the subcluster of April samples from P05, P09, P10 was more similar to the Gunpowder River cluster and was linked to them. Removal of the dissimilar Z01 sample to the May cluster further simplified April clustering. May clusters (Sample

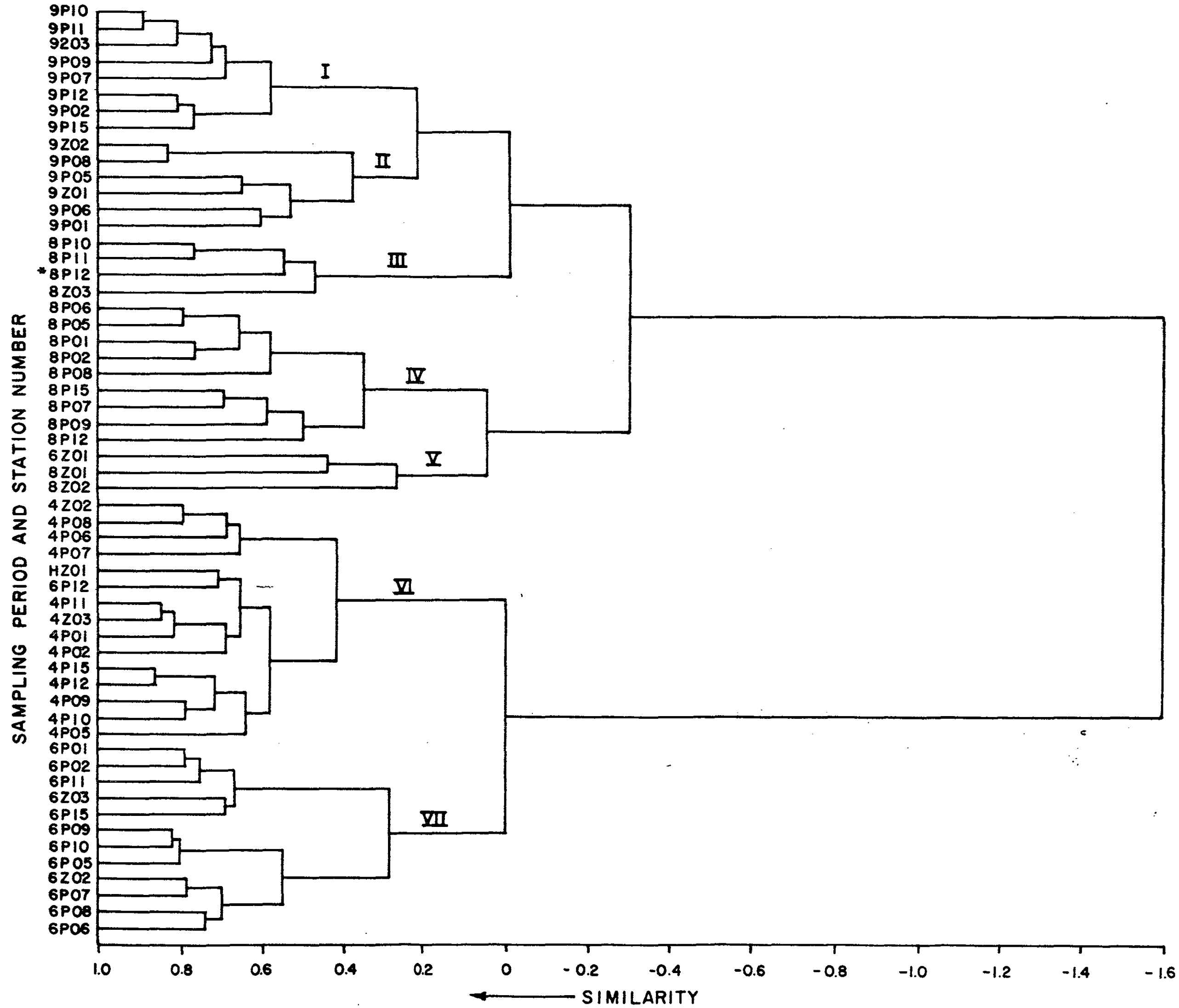


Figure 22 Clustering of 57 spring 1979 mesozooplankton (bongo) samples according to similarity (Bray-Curtis) in species composition and abundance. Sampling periods: 4 - March, 6 - April, 8 - May, 9 - June. Roman numerals I-VII indicate clusters selected as classification groups for discriminant analysis.

Groups IV and V) were again similar to the single-month analysis (Fig. 20), except that, in the present analysis, four of the five collections taken on May 31 (Group III) were found to be more similar to June collections and linked to them. June samples (Groups I and II) were clustered as in the one-month analysis (Fig. 21), after discounting the removed horizontal collections. In no case were discharge samples from one month found to cluster preferentially with those from ambient conditions in the next month, as rarely seen in analyses of phytoplankton and microzooplankton.

The seven selected clusters (I-VII) were used as pre-classified groups in a discriminant function analysis employing the same eight (8) physical variables used in phytoplankton and microzooplankton analyses. Summary statistics for the discriminant function analysis in Table 12 show the first three functions to be highly significant, the fourth significant ($p < 0.05$). The first two functions accounted for over 88% of the variance. According to absolute values of the standardized function coefficients, important physical variables included surface dissolved oxygen (Function I) and surface temperature (functions II and III). Over 87% of the 57 samples were correctly classified, based on physical data. Misclassifications (N=7) occurred among sample groups I, II, IV and V. Separation of the seven pre-classified groups, using only the first two discriminant functions, is shown in Figure 23. The clear separation of those groups with 100% correct classification (III, VI, VII) is apparent. Group IV, on the other hand, with the largest number (4) of misclassifications, overlaps three other groups.

Reclassification of "misclassified" cases according to highest probability of group membership (based on physical data) did not, as in the case of phytoplankton data clusters, reorder clusters along more seasonal lines. In fact, clusters of samples based on mesozooplankton composition were more strictly seasonal than those rearranged to satisfy a physical classification. Mesozooplankton communities may be more seasonally predictable than the physical measurements utilized in this study. This could be related to the importance of temperature and the effect on that parameter of the C.P. Crane discharge. While increasing seasonal temperatures and associated parameters during spring such as decreasing oxygen are influential in community changes, they vary widely at the sampling site during any given sampling period with, e.g., discharge temperatures in one month equalling or even exceeding ambient intake temperatures in the next month. The affected area of increased temperature is apparently too small to produce, within a sampling period the magnitude of faunal change represented by seasonal succession. This is in agreement with the conclusions of Grant and Berkowitz (1979) that while small-scale effects are observable near the plant discharge for phytoplankton and microzooplankton, effects on mesozooplankton are large-scale and essentially historical in nature, related to displacement of the freshwater community from receiving waters of Saltpeter Creek.

Table 12. Summary statistics from discriminant function analysis of spring 1979 physical data, with groups of samples defined from cluster analysis of oblique 18.5 cm bongo collections (202 μm mesh nets).

Discriminant Function	Eigenvalue	Cumulative % of Variance	Canonical Correlation	After Function	Wilk's Lambda	Chi Square	d.f.	Significance
				0	0.0061	247.41	48	0.0000**
1	13.22092	77.31	0.9642	1	0.0866	118.66	35	0.0000**
2	1.87119	88.25	0.8073	2	0.2486	67.50	24	0.000**
3	1.31836	95.96	0.7541	3	0.5764	26.72	15	0.0311*
4	0.62302	99.60	0.6196	4	0.9355	3.23	8	0.9189n.s.
5	0.04433	99.86	0.2060	5	0.9770	1.13	3	0.7699n.s.
6	0.02357	100.00	0.1517					

Standardized Discriminant Function Coefficients

Variable	Function 1	2	3
Radiation	-0.36958	0.55464	0.32610
Secchi	0.43846	-0.53381	-0.05935
Temp, surf.	0.12900	-2.89519	-0.82889
Temp, mean	0.87521	2.38974	0.70734
Sal, surf.	-0.67202	1.08416	0.15765
Sal, mean	0.80749	-0.07258	-0.72987
DO, surf.	-1.03504	0.76316	0.00319
DO, bottom	0.37724	-1.06343	-0.68042

Group Centroids

Station Group	Function 1	2	3
I	2.36	0.93	0.81
II	2.70	-0.65	0.77
III	3.49	2.93	-2.30
IV	3.29	-0.47	-0.41
V	3.99	-0.64	2.50
VI	-4.84	0.80	0.44
VII	-1.51	-1.75	-1.03

Classification Results

Actual Group	Number of Samples	Predicted Group Membership (%) I	II	III	IV	V	VI	VII
I	8	87.5	0	0	12.5	0	0	0
II	6	16.7	83.3	0	0	0	0	0
III	4	0	0	100.0	0	0	0	0
IV	9	11.1	11.1	11.1	55.6	11.1	0	0
V	3	0	0	0	33.3	66.7	0	0
VI	15	0	0	0	0	0	100.0	0
VII	12	0	0	0	0	0	0	100.0

Percent of total (57) samples correctly classified: 87.72%

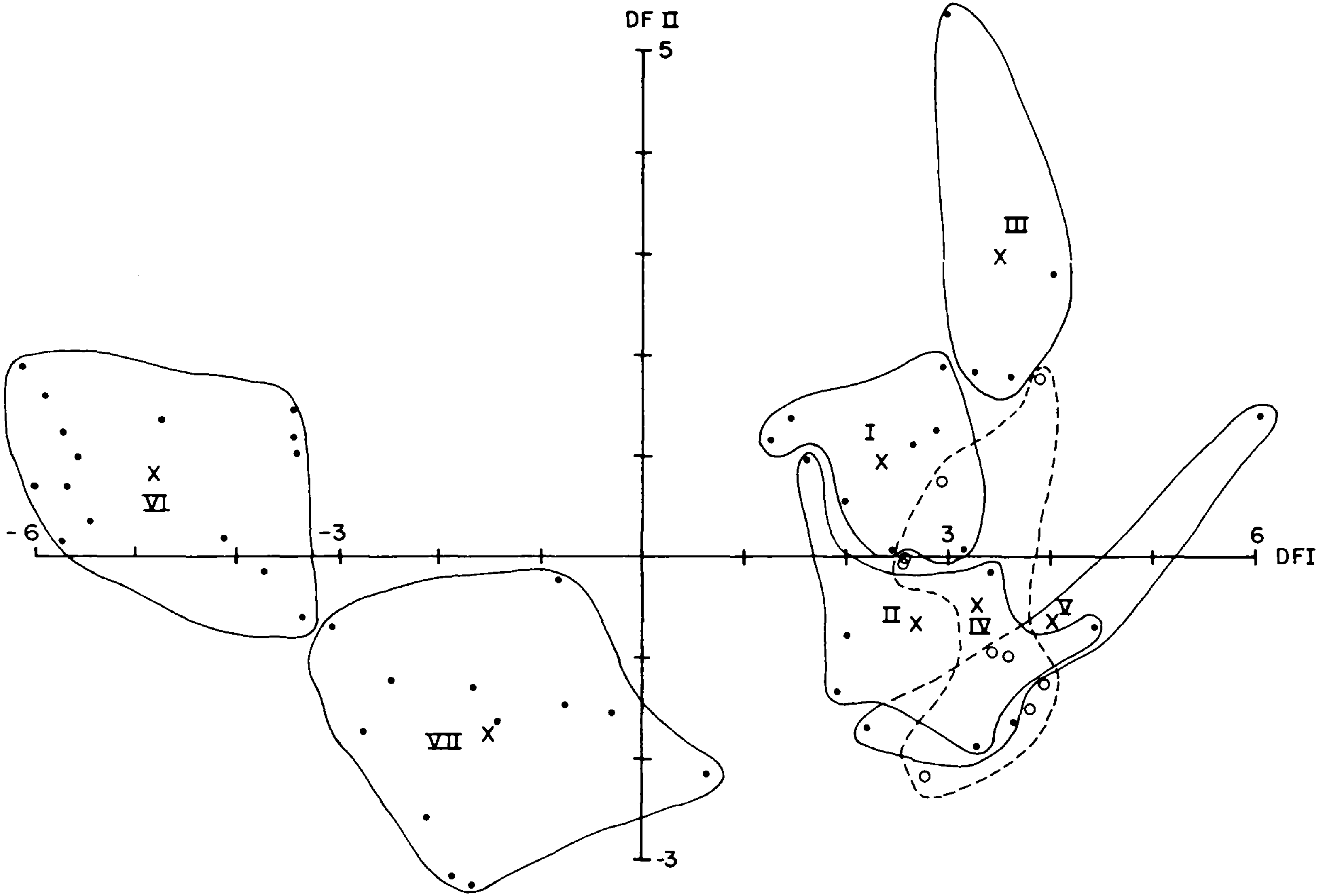


Figure 23 Separation of the sample groups obtained from mesozooplankton sample clustering on the first two discriminant functions of the eight environmental variables. X's indicate group centroids. Open circles represent samples of the poorly separated Group IV.

5.6 Observations on Vertical Distribution at Station P15

Discrete-depth tows at near-surface, mid-depth and near-bottom at station P15 were taken each month to explore the possibility that entrained organisms might be drawn from particular levels of the intake and if faunistically different with depth, might be differentially affected by plant operation. Occurrence of species in these various tows is included in Appendix Table A-11 and abundance was incorporated in the monthly cluster analyses of these tows together with oblique tows. The March sample cluster analysis combined all P15 samples within a single group. In April, the two near-surface and one mid-depth sample were in a distinct cluster; other P15 samples were combined with all intake and lower stations plus those in the immediate discharge. One surface and both mid-depth May samples were in a cluster with the immediate discharge; others all in a second cluster. In June, both bottom samples and the oblique tow at P15 were clustered with lower Gunpowder, intake and immediate discharge samples; other P15 samples were in a separate cluster. Thus, cluster analyses show possible vertical differences in fauna in three months (all but March), but varying possibilities for sources of discharge water. Bottom collections were more similar to those in the near discharge in April and June; mid-depth and (one) surface collections were more similar in May.

Densities of the dominant species were examined for vertical differences and were found to, in the case of *Eurytemora affinis*, consistently increase with depth. Ratios of near-bottom to near-surface abundance for this species were 2.6 (March), 23.8 (April), 7.0 (May) and 15.1 (June). The near-bottom samples also contained greater numbers of _E. affinis_ than the integrated oblique tows, reinforcing the possibility that this species is actually concentrating near the bottom at station P15. A second possible explanation for these results, however, is that lower light levels near the bottom might reduce net avoidance. Among the more seasonally restricted dominants, _Cyclops bicuspidatus_, _Acartia tonsa_ and _Moina micrura_ were also caught in greater numbers near the bottom. Densities of these organisms in P02 (immediate discharge) collections, relative to those at P15, were too variable to allow even speculative conclusions as to whether a specific depth stratum is selectively introduced into the plant intake.

6. Summary of Results

(1) Sampling for phytoplankton, micro- and mesozooplankton at the C.P. Crane site during spring months of 1979 was conducted during weekdays of moderate to high generating load and was unaffected by plant shutdowns in early June.

(2) Salinity throughout the sampling period was low, ranging from continually fresh at the uppermost Gunpowder River station to slightly brackish at lower stations. Maximum salinity was observed on May 31 (< 3.0 ^{o}/oo) when delayed sampling was conducted on a different tidal cycle.

(3) Ambient water temperatures at the site seasonally increased from about 8.5°C in late March to about 21.0°C in early May, remaining at that level through the unseasonably cool month of June. Highest temperatures always occurred in discharge waters, with field estimates of temperature increase due to plant operation ranging from 3.7° to 7.3°C.

(4) Dissolved oxygen declined with increasing temperature from early spring concentrations over 10 mg/l to a minimum of about 6.5 mg/l in late spring, while water transparency (light penetration) increased to a maximum average of about 0.5 m in early May, then declined. The coincidence of maximum light penetration and productivity in early May indicates that the phytoplankton population at the site may be light-limited.

(5) Nutrients were measured on two sampling dates in April and showed consistently low amounts of ammonia, no nitrite, generally high nitrate (over 50 μg-at/l at maximum) moderately high phosphate and very high silicate (26-110 μg-at/l).

(6) Productivity at lower control stations (P11, P12) seasonally increased from less than 5 mg $C/hr/m^3$ in March to over 60 mg C in early May. Possible generating station effects were masked by wide fluctuations in measurements and variable trends in the data, e.g. along the Seneca Creek transect leading to the plant, productivity increased in March and early April, was fairly constant in late April and decreased in May-June. These directions of change, although changes were generally of smaller magnitude, were consistently reversed in the immediate discharge. A secondary peak (primary in early April) generally occurred in the lower Saltpeter Creek.

(7) Chlorophyll-a distribution generally mirrored that of productivity throughout the study period, resulting in assimilation ratios that followed the trend of productivity. Maximum chlorophyll, as in the case of productivity occurred in early May (over 48 mg/m^3). Phaeopigments, at fairly constant levels within sampling trips were therefore inverse to chlorophyll distribution, when expressed as a percentage of chl-a.

(8) Phytoplankton populations were dominated by a small (3 x 10 μm) species of Melosira, which increased in numbers and importance until the bloom peak in early May.

(9) All 91 spring phytoplankton stations were clustered on the basis of similarity in surface measurements of chlorophyll-a, phaeopigments and productivity, yielding four clusters used as preclassified groups in a discriminant function analysis using physical variables. Three of the four biological station groups were well separated on the basis of physical characteristics (84% of stations correctly classified). Important physical variables in the first two functions were mean water temperature and bottom dissolved oxygen.

(10) *In situ* measurement of productivity showed that most phytoplankton production at the C.P. Crane site occurs in the upper 0.5 m of the water column. Under conditions of higher productivity *in situ* measurements exceeded those obtained by box incubation.

(11) Incubation of water samples from 0, 1 and 2 m depths yielded similar productivity estimates, indicating the lack of stratification in phytoplankton populations. Homogeneity with depth was also evident in the taxonomy of samples taken at different depths.

(12) Screening water samples through a 20 μm filter yielded productivity estimates similar to those from whole water samples. The generally small size of phytoplankters at the site will require use of finer filters if effective partitioning of the population is desired.

(13) Microzooplankton dominants included nauplii of *Eurytemora affinis* in all four months, the harpacticoid *Ectinosoma curticorne* in March and several rotifers in succeeding months: *Keratella*

cochlearis, *Brachionus calyciflorus*, *B. plicatilis* and *Notholca marina*.

(14) Clustering of microzooplankton produced two distinct groups of samples in March, one of which consists of near discharge samples, characterized by an absence of several infrequent species and lesser abundance of the dominants. Separation into two groups in April was less effective, splitting replicates from several stations. In both May and June, replicates from station P10 were separated as a distinct cluster, characterized by lower abundance of dominant taxa or (in June) by the nearly unique occurrence of summer fauna.

(15) Diversity of microzooplankton collections was relatively high in March, decreased in April and May, then increased in June. Low diversity was evident in the distinctive March cluster of near-discharge samples.

(16) A clustering of all spring, oblique microzooplankton collections yielded seven groups that were nearly identical to those obtained in monthly analyses. These were used as pre-classified groups in a discriminant function analysis using the same set of physical variables employed in phytoplankton analyses. All but two of the seven groups were well separated on a physical basis (95% of samples correctly classified), with water temperature providing most of the separation.

(17) Analysis of horizontal pump collections showed little if any

vertical stratification of microzooplankton populations.

(18) Bongo collections of mesozooplankton showed a seasonal succession from fresh, cool-water fauna dominated by Eurytemora affinis, Cyclops bicuspidatus and Eubosmina longirostris to a warm-water fauna dominated by Moina micrura, Acartia tonsa and E. affinis. Distinctive clusters of samples in March, April and June were those of upper Gunpowder River and Dundee Creek, rather than discharge stations. Discharge stations in the complex transition period of May were separate from other samples.

(19) Unlike microzooplankton collections, diversity in bongo samples increased to a peak in May.

(20) Parasitic copepods of the genera Ergasilus and Argulus were rare until May and June. Yellow perch occurred in March and April, white perch as eggs in April and larvae in May, Alosa sp. larvae in May and June.

(21) Discriminant function analysis of physical variables, using groups of bongo samples obtained from a cluster analysis of all spring collections as pre-classified groups showed clear separation of only 3 of 7 groups, although more than 87% of the samples were correctly classified. A single group having the largest number of misclassifications overlapped three of the poorly separated groups. Important physical variables were surface dissolved oxygen and surface temperature. Results indicate that seasonal succession of

mesozooplankton species might be more reliably predicted than any of the physical variables used in these analyses.

(22) Discrete-depth collections at station P15 showed possible vertical differences in fauna in 3 of the 4 months, but varying possibilities for sources of discharge water. Densities of *Eurytemora affinis* were consistently greater near the bottom than at surface waters at P15. The effect of differential veritcal distribution in intake waters on entrainment and passage through the plant requires a detailed and combined physical and biological study for full understanding.

7. Summary of Observed Plant Effects

As observed in the summer of 1978 (Grant and Berkowitz 1979) the principal physical effects of the C.P. Crane generating station included, in the spring of 1979, the transfer of large volumes of slightly brackish water into Saltpeter Creek, which in its natural state would be significantly fresher, and a sharp increase in temperatures of the upper Saltpeter Creek area. No significant acceleration of reproduction of fauna in the heated effluent, as suggested as a possibility for spring months in our previous report, was evident. Typical summer fauna, including parasitic copepods and developmental stages of decapod crustaceans, did not occur in abundance until May. This may be due to the continuous renewal of water pumped into Saltpeter Creek and flushing of the shallow receiving system into cooler ambient waters, of any developmental stages that might benefit from the heated effluent.

Observed effects on the biota are listed below:

<u>Phytoplankton</u>

1. A consistent change in productivity and chlorophyll concentration at the plant outfall that changed in direction (from decrease to increase) as outside Bay waters became highly productive. The latter response may be limited to bloom conditions, since results from summer 1978 showed a sharp decrease at the plant discharge.

2. Heating of water passed through the plant in late March resulted

in productivity and phytoplankton biomass in discharge waters that was more similar to early April than late March ambient conditions.

3. In combined seasonal analyses of productivity and chlorophyll levels, seasonal effects generally override those of the plant's operation.

Microzooplankton

1. Direct effect of the plant was obvious only in late March, resulting in lower diversity (absence of rarer taxa) and a decrease in abundance of the dominant copepods *Eurytemora affinis*, *Ectinosoma curticorne* and *Cyclops bicuspidatus*. In other spring months microzooplankton at discharge stations was similar to that at other locations, with (in May and June) the most distinctive populations present at P10, well removed from the plant.

2. In a combined analysis of microzooplankton samples (March-June), only a single discharge sample (May) was found to be more similar to ambient samples in an advanced month than to samples collected concurrently. Thus, a seasonal progression of populations generally outweighed any observable plant effect.

Mesozooplankton

1. Effects on the larger size fraction of zooplankton are generally absent in the immediate discharge during spring months. There is a close similarity in composition and abundance of mesozooplankton populations from intake and discharge waters.

2. The principal effect of the C.P. Crane plant on mesozooplankton is tied to a continual (and now historical) displacement of a highly diverse freshwater community from receiving waters of Saltpeter Creek. This was evident in clustering of spring 1979 collections, despite the small range of salinity.

General

The observations of plant effects in late March (in both phytoplankton and microzooplankton) in contrast to later months suggest that small-scale direct effects of plant operation may be more evident in winter months.

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Table A-1. Physical data from the spring 1979 plankton study of waters around the C.P. Crane generating station.

CRUISE CPC-04 (March 28, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-09	surf	1045				60	.15	62790	4485.0	.071	9.1	.248	10.05
	1.0								179.0	.002	8.9	.243	
	2.0							(1.5m)	9.0	.0001	8.8	.238	
	3.0										8.7	.235	9.92
P-10	surf	1155				60	.15	65032	5157	.079	8.5	.227	10.18
	1.0								291	.004	8.5	.225	
	2.0							(1.5m)	15	.0002	8.5	.225	
	4.0										8.5	.240	10.01
P-11	surf	1250				60	.18	67275	15249	.227	9.7	.363	10.18
	1.0								1345	.020	8.5	.391	
	2.0							(1.5m)	134	.002	8.1	.553	
	3.0							(2.0m)	22	.0003	7.9	.561	10.36
Z-03	surf	1325				60	.18	65032	6503	.1	9.4	.220	10.58
	1.0								448	.007	8.6	.271	
	2.0							(1.5m)	44	.0007	8.3	.365	
	4.0										8.1	.429	10.17
P-15	surf	1425				50	.25	53820	3588	.067	9.6	.402	10.11
	1.0								1121	.021	9.6	.537	
	2.0							(1.5m)	291	.0054	9.6	.402	10.09
								(2.0m)	134	.0025			
P-12	surf	1720				7.0	.25	8073	897	.111	9.8	.456	10.15
	1.0								224	.028	9.5	.453	
	2.0								44	.005	9.5	.458	
	3.0										9.4	.458	10.01

Table A-1. (Cont.)

CPC-04 (March 29, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
Z-02	surf	0805	NW 15	choppy	clearing	15	.10	24667	448	.012	8.5	.123	10.64
	1.0				ptly cldy				4	.0001	8.5	.145	
	2.0										8.5	.138	10.52
P-08	surf	0850	NW 15	choppy	clearing	30	.10	35880	448	.0125	8.8	.185	10.34
	1.0				slight haze				4	.0001	8.8	.185	
	2.0										8.8	.182	10.38
P-07	surf	1032	NW 15	choppy	partly	33	.10	47092	67	.0014	9.1	.271	10.42
	1.0				cloudy				6	.0001	9.1	.263	
	2.0										9.1	.261	10.50
P-06	surf	1048	NW 10	slight	partly	50	.15	58305	5382	.092	9.2	.240	10.42
	1.0			chop	cloudy				358	.0061	9.2	.240	
	1.5							(1.5m)	31	.0005	9.1	.253	10.42
P-01	surf	1144	slight	calm	clear	60	.15	58305	Broke Down		13.5	.408	9.63
	1.0										13.4	.416	9.55
P-02	surf	1220	slight	calm	clear	57	.12	65032	Broke Down		14.1	.426	9.79
	1.0										13.6	.424	9.81
P-03	surf	1345	slight	calm	clear	55	.15	58305	Broke Down		13.7	.418	10.03
	1.0										13.2	.416	10.03
P-04	surf	1351	slight	calm	clear	50	.20	56062	Broke Down		13.6	.416	9.85
	1.0										13.5	.413	9.85
P-05	surf	1430	slight	calm	clear	40	.15	56062	Broke Down		13.4	.413	9.95
	1.0										13.2	.408	9.69
Z-01	surf	1518	slight	calm	clear	32	.25	32292	Broke Down		13.3	.408	10.24
	1.0										11.6	.391	9.89
P-09	surf	1615	calm	calm	clear	15	.20	17940	Broke Down		13.5	.737	10.40
	1.0										9.5	.240	
	2.0										9.4	.225	
	3.0										9.4	.225	
	4.0										9.4	.225	10.18

Table A-1. (Cont.)

CPC-04 (March 29, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-10	surf	1635	calm	calm	clear	7.0	.12	8970	Broke	Down	10.0	.182	10.30
	1.0										9.7	.182	
	2.0										9.4	.210	
	3.0										9.4	.233	
	4.0										9.4	.258	10.03

Table A-1. (Cont.)

CPC-04 (March 30, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-11	surf	0810	slight	calm	partly cloudy	17	.15	22425	Broke	Down	9.0	.276	10.44
	1.0										9.0	.274	
	2.0										9.0	.271	
	3.0										9.0	.271	
	4.0										9.0	.271	10.30
Z-03	surf	0830	slight	calm	partly cloudy			24667	Broke	Down	9.2	.120	-
P-15	surf	0850	slight	calm	partly cloudy	20	.25	27807	Broke	Down	11.8	.376	10.52
	1.0										11.4	.410	
	2.0										11.1	.445	
	3.0										10.6	.442	9.89
P-12	surf	0925	calm	calm	overcast	15	.25	29152	Broke	Down	11.2	.368	10.48
	1.0										10.7	.389	
	2.0										10.0	.373	10.30
P-13	surf	0935	calm	calm	overcast	22	.23	31395	Broke	Down	11.5	.350	10.50
	1.0										10.5	.386	
	2.0										10.1	.429	
	3.0										10.0	.445	9.87
P-14	surf	1050	calm	calm	slightly overcast	17	.15	26910	Broke	Down	11.7	.350	10.52
	1.0										11.6	.350	
	2.0										10.6	.418	
	3.0										10.2	.445	9.83

Table A-1. (Cont.)

CRUISE CPC-05 (April 10, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-09	s	1102	NW 15-20	choppy	clear	65	.10	67275	1794	.0270	7.7	.235	10.71
	1								45	.0007	7.7	.197	
	2							(1.5m)	2	.00003	7.7	.253	10.77
P-10	s	1155	NW 15-20	choppy	clear	71	.10	69517	2242	.0323	7.8	.222	9.83
	1								45	.00064	7.8	.230	
	2										7.8	.256	
	3										7.6	.253	10.35
P-11	s	1225	NW 20	choppy	clear	73	.15	69517	6279	.0903	8.4	.202	9.71
	1								650	.0094	8.4	.235	
	2							(1.5m)	31	.00045	8.4	.253	
	3										8.4	.253	9.91
P-15	s	1325	NW 15	slight	clear	72	.15	65032	2691	.041	9.3	.318	10.15
	1			chop					112	.0017	9.3	.310	
	2								5	.00006	9.3	.326	10.05
P-14	s	1535	NW 15	slight	clear	40	.15	33637	291	.0087	9.3	.321	7.06
	1			chop					9	.0003	9.4	.297	
	2										9.0	.313	10.03
P-13	s	1605	NW 10-15	slight	clear	35	.12	33637	291	.0087	9.2	.302	10.19
	1			chop					9	.0003	9.2	.300	
	2										9.1	.297	
	3										9.1	.313	10.13
P-12	s	1635	NW 10-15	slight	clear	35	.10	24667	291	.0118	9.2	.292	9.53
	1			chop					4	.0002	9.2	.279	
	2										8.9	.297	10.51

Table A-1 (Cont.)

CPC-05 (April 11, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-08	s	0855	NE-10	calm	clear	40	.10	47092	1121	.0238	8.0	.384	11.12
	1								18	.0004	8.1	.147	
	2							(1.5m)	2	.0000	7.9	.135	10.91
P-07	s	0920	NE-10	calm	clear	56	.15	51577	2915	.0565	8.5	.248	10.77
	1								156	.0030	8.5	.245	
	2							(1.5m)	1	.0002	8.2	.253	10.79
P-06	s	1015	NE-10	calm	clear	53	.20	60547	4709	.0778	10.1	.253	10.93
	1								291	.0048	9.2	.253	
	2							(1.5m)	22	.0004	9.3	.253	10.45
P-01	s	1115	NE-10	calm	clear	63	.20	65032	4709	.0724	13.1	.323	10.39
	1								448	.0069	12.5	.321	10.11
P-02	s	1130	NE-10	calm	clear	63	.15	67275	4485	.0667	13.9	.289	10.05
	1								269	.0040	12.7	.302	9.63
P-03	s	1220	S-10	calm	clear	52	.15	42607	2691	.0632	16.2	.326	10.23
	1								179	.0042	15.4	.310	10.15
P-04	s	1354	S 5-10	calm	clear	57	.15	60547	4036	.0667	16.1	.313	9.81
	1								246	.0041	14.9	.339	9.99
P-05	s	1537	S-10	calm	clear	34	.15	44850	2691	.0600	14.3	.323	10.69
	1								224	.0050	14.3	.328	
	2							(1.5m)	20	.0004	11.2	.323	10.35

Table A-1. (Cont.)

CRUISE CPC-06 (April 24, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-09	s	0812	calm	calm	overcast	8	.25	15697	1569	.100	14.0	.426	12.12
	1							15697	469	.027	14.0	.550	
	2							15697	14	.0009	14.0	.569	
	3										13.7	.629	
	4										13.7	.635	11.29
P-10	s	0904	calm	calm	overcast	7	.4	13455	897	.067	14.3	.651	11.23
	1							13455	179	.013	13.3	.795	
	2							13455	15	.001	13.3	.902	
	3										13.3	.899	
	4										13.0	1.212	10.38
P-11	s	1025	calm	calm	overcast	10	.5	15697	2242	.143	15.0	.437	12.81
	1							15697	605	.039	14.3	.416	
	2							15697	56	.004	14.0	.910	
	3							15697	9	.0006	13.0	1.212	10.13
Z-03	s	1115	calm	calm	fog	10	.7	17940	3363	.188	13.0	.984	11.19
	1				overcast			17940	1121	.063	13.0	1.091	
	2							17940	89	.005	12.8	1.163	
	3							17940	9	.0005	12.8	1.304	
	4										12.3	1.344	10.20

Table A-1. (Cont.)

CPC-06 (April 24, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-15	s	1245	calm	calm	fog	7	.5	15697	1569	.100	16.0	.336	12.51
	1				overcast			15697	269	.017	16.0	.313	
	2							15697	4	.0003	15.3	.334	
	3										15.0	.360	11.84
P-14	s	1530	calm	calm	overcast	12	.6	20182	3363	.167	15.3	.341	12.81
	1							20182	897	.044	15.3	.339	
	2							20182	89	.004	15.0	.363	
	3							20182	2	.0001	14.3	.458	
	4										13.3	.499	9.55
P-13	s	1545	calm	calm	overcast	5	.6	8970	1345	.15	15.5	.344	12.69
	1							8970	246	.028	15.0	.341	
	2							8970	7	.0008	14.5	.429	
	3										14.0	.437	
	4										13.3	.523	9.16
P-12	s	1600	calm	calm	overcast	4	.5	8970	897	.100	15.0	.370	13.28
	1							8970	358	.040	15.0	.363	
	2							8970	7	.0008	14.0	.416	
	3										14.0	.550	9.36

Table A-1. (Cont.)

CPC-06 (April 25, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
Z-02	s	0835	calm	calm	overcast	21	.3	29152	1569	.054	16.8	.125	11.37
	1				hazy			29152	179	.006	16.2	.116	
	2							29152	5	.0001	16.0	.116	10.78
P-08	s	0910	slight	slight	fog	10	.4	15697	1794	.114	16.0	.140	11.33
	1		<5					15697	358	.023	15.6	.142	
	2							15697	20	.001	15.3	.140	10.89
P-07	s	1025	slight	slight	hazy	50	.25	65032	8970	.138	16.5	.192	11.29
	1		<5					66826	784	.012	16.0	.177	
	2							66826	8	.0001	15.5	.172	11.27
P-06	s	1125	slight	calm	slight	60	.3	78487	10046	.128	19.8	.323	10.85
	1		<5		haze			78487	1569	.020	18.3	.321	
	2							78487	179	.002	17.8	.321	9.97
P-01	s	1222	slight	calm	clear	69	.45	78487	20631	.263	20.0	.323	11.47
	1		<5					80281	5606	.070	19.8	.323	10.95
P-02	s	1356	slight	calm	clear	40	.30	65032	8073	.124	22.3	.373	11.13
	1		<5					65032	740	.011	22.0	.357	11.01
P-03	s	1440	slight	calm	clear	25	.30	56062	5382	.096	22.0	.352	11.07
	1		<5					49335	897	.018	22.0	.352	10.20
P-04	s	1500	slight	calm	clear	34	.25	49335	4485	.091	21.0	.352	10.62
	1		<5					49335	897	.018	20.2	.350	10.82
P-05	s	1630	slight	calm	clear	15	.15	22425	1345	.060	20.0	.331	10.78
	1		<5					22425	224	.010	20.0	.323	
	2							22425	18	.0008	20.0	.365	10.62
Z-01	s	1735	slight	calm	clear	6	.2	5382	206	.038	20.0	.326	
	1		<5					5382	26	.005	20.0	.331	

Table A-1. (Cont.)

CPC-07 (May 10, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-08	s	0800	S 10-15	slight	ptly cldy	8	.5	11212	1121	.100	21.7	.210	9.03
	1							11212	650	.058	21.8	.210	
	2							11212	112	.010	22.0	.445	8.68
P-07	s	0830	S 10-15	slight	ptly cldy	12	.5	17940	2466	.1375	21.5	.274	9.20
	1							17940	1345	.075	21.3	.271	
	2							17940	201	.0112	21.3	.271	9.05
P-06	s	0930	S 10-15	slight	ptly cldy	17	.8	31395	3139	.100	23.8	.756	7.88
	1							31395	717	.023	23.8	.734	7.86
P-01	s	0955	S 10-15	slight	ptly cldy	34	.6	47092	17940	.381	25.1	.787	7.58
	1							47092	5830	.124	25.1	.784	7.78
P-02	s	1055	S 10-15	calm	ptly cldy	57	.5	74002	4709	.064	27.2	.784	8.32
	1							74002	1569	.021	27.1	.781	8.36
P-03	s	1110	S 10-15	calm	ptly cldy	67	.6	89700	18837	.210	26.8	.792	8.44
	1							89700	5382	.060	26.0	.784	8.60
P-04	s	1130	S 10-15	calm	ptly cldy	65	.6	89700	6503	.073	26.0	.784	8.64
	1							89700	3812	.043	25.6	.779	8.40
P-05	s	1220	S 10-15	calm	ptly cldy	45	.5	67275	4036	.060	26.6	.776	9.29
	1							67275	2466	.033	25.8	.776	8.74

Table A-1. (Cont.)

CRUISE CPC-07

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-09	s	0820	S-15	slight	clear	25	.4	35880	9367	.275	20.0	.575	9.15
	1			chop				35880	2018	.056	19.8	.531	
	2							35880	179	.005	19.8	.528	
	3							35880	13	.0004	20.0	.526	
	4										20.0	.526	9.09
P-10	s	0900	S-15	slight	slight	35	.4	44850	2242	.050	19.5	.660	9.55
	1			chop	haze			44850	426	.0095	19.4	.668	
	2							44850	31	.0007	19.5	.679	
	3							44850	45	.0001	19.3	.676	
	4										19.3	.676	9.13
P-11	s	0930	S-15	slight	clear	40	.4	53820	6279	.117	20.4	.784	9.35
	1			chop				53820	1345	.025	19.9	.784	
	2							53820	89	.002	19.7	.784	
	3							53820	5	.0001	19.6	.784	8.99
P-15	s	1005	S-15	slight	slight	50	.5	65929	12558	.190	21.2	.784	9.17
	1			chop	haze			65929	1794	.027	21.0	.784	
	2							65929	156	.002	21.2	.779	
	3							65929	5	.0001	20.6	.779	8.99
P-14	s	1130	S-15	slight	slight	58	.5	80730	14352	.178	21.7	.776	9.89
	1			chop	haze			80730	3588	.044	21.3	.776	
	2							80730	269	.003	21.1	.776	
	3							80730	29	.0004	21.1	.776	10.27
P-13	s	1155	S-15	slight	clear	60	.5	82524	8970	.109	21.6	.770	9.91
	1			chop				82524	1569	.019	21.5	.770	
	2							82524	448	.005	21.2	.770	
	3							82524	25	.0003	20.7	.776	9.19
P-12	s	1215	S-15	slight	slight	60	.5	85215	14352	.1684	21.6	.767	10.05
	1			chop	haze			85215	3812	.045	21.4	.765	
	2							85215	493	.006	20.9	.765	9.09

Table A-1. (Cont.)

CRUISE CPC-08 (May 24, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-15	s	1230	S-20	choppy	cloudy	20	.35	35830	4485	.1250	21.2	.862	8.38
	1							35880	897	.0250	21.1	.888	
	2							35880	35	.0010	21.1	.868	
	3										21.1	.868	8.26
P-14	s	1540	W 10-15	slight	cloudy	15	.4	26910	4036	.1500	21.3	.812	8.54
	1							26910	941	.0350	21.2	.882	
	2							26910	47	.0017	21.2	.902	
	3							26910	2	.0000	21.1	.927	
	4										21.1	.952	8.97
P-13	s	1555	W 10-15	slight	cloudy	15	.4	20182	2018	.1000	21.2	.885	9.23
	1							20182	269	.0133	21.0	.882	
	2							20182	7	.0003	21.0	.952	
	3										21.0	.941	
	4										21.0	.961	8.18
P-12	s	1615	W 10-15	slight	cloudy	10	.4	24667	2691	.1090	21.1	.888	8.73
	1							24667	538	.0218	21.0	.874	
	2							24667	9	.0003	21.0	.967	
	3										20.6	.910	8.02

Table A-1. (Cont.)

CPC-08 (May 25, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
Z-02	s	0900	S 10-15	slight	variable clouds	20	.3	29152	4485	.1538	20.6	.145	7.43
	1							29152	1121	.0384	20.7	.128	
	2							29152	52	.0017	20.8	.123	7.19
P-08	s	0930	S 10-15	slight	variable clouds	27	.5	40365	6279	.1555	20.8	.253	7.86
	1							40365	2915	.0722	20.9	.261	
	2							40365	314	.0077	21.0	.258	
	3							40365	45	.0011	21.0	.268	7.62
P-07	s	1015	S 10-15	slight	variable clouds	30	.4	47092	8073	.1714	21.4	.542	8.24
	1							47092	3363	.0714	21.0	.765	
	2							47092	269	.0057	20.8	1.565	7.58
P-06	s	1120	S 10-15	slight	variable clouds	10	.5	26910	2242	.0833	22.5	.687	8.16
	1							26910	807	.0300	22.4	.673	
	2							31395	112	.0035	21.6	.646	7.78
P-01	s	1200	S 10-15	slight	variable clouds	35	.4	44850	8073	.1800	23.1	.919	8.44
	1							44850	2691	.0600	22.9	.801	7.58
P-02	s	1335	S 10-15	slight	variable clouds	62	.45	85215	9867	.1157	25.2	.890	8.67
	1							85215	3812	.0447	23.4	.868	8.52
P-03	s	1425	S 10-15	slight	variable clouds	62	.45	82972	12558	.1513	25.4	.854	8.99
	1							82972	4036	.0486	25.2	.840	8.84
P-04	s	1436	S 10-15	slight	variable clouds	58	.4	78437	14352	.1828	24.5	.823	9.03
	1							78437	2466	.0314	25.2	.823	8.93
P-05	s	1515	S 10-15	slight	variable clouds	15	.4	40365	11661	.2888	24.0	.704	8.95
	1							40365	1344	.0333	24.6	.784	8.85
Z-01	s	1600	S 10-15	slight	cloudy	15	.5	31395	8970	.2857	22.4	.660	8.87
	1							31395	1569	.0500	23.2	.651	8.93

Table A-1. (Cont.)

CPC-08 (May 31, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-12	s	0810	S-10	slight	overcast	7	.6	6727	1121	.1667	20.2	2.631	8.63
	1							6727	470	.0700	20.2	2.083	
	2							6727	67	.0100	20.2	2.071	
	3							6727	18	.0026	20.2	2.071	8.38
P-09	s	0900	S-10	slight	overcast	10	.6	14352	1794	.1250	19.9	1.780	8.42
	1							14352	717	.0500	19.9	1.774	
	2							14352	112	.0078	19.8	1.792	
	3										19.8	1.806	
	4										19.8	1.804	8.61
P-10	s	0940	SE-10	slight	overcast	12	.5	24667	3139	.1272	20.2	1.522	8.40
	1							24667	1121	.0454	20.2	1.513	
	2							24667	89	.0036	20.2	1.525	
	3							24667	9	.0004	20.2	1.536	
	4										20.2	1.548	8.18
P-11	s	1030	SE-10	slight	overcast	17	.65	33637	5830	.1733	20.3	1.830	8.34
	1							33637	2691	.0800	20.3	1.845	
	2							33637	538	.0160	20.3	1.851	
	3							33637	112	.0033	20.3	1.913	
	4							33637	16	.0004	20.3	1.984	7.66
Z-03	s	1123	SE-10	slight	overcast	20	.5	33637	10764	.3200	20.1	1.275	7.96
	1							33637	4485	.1333	20.1	1.240	
	2							33637	470	.014	20.1	1.284	
	3							33637	89	.0026	20.1	1.706	
	4							33637	11	.0003	20.1	1.750	
	5										20.1	1.750	7.34

Table A-1. (Cont.)

CRUISE CPC-09 (June 26, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-09	s	0750	E-5	calm	clear	22	.3	26915	4485	.1667	21.2	.701	7.98
	1							26915	269	.0100	21.2	.701	
	2							26915	2	.0000	21.0	.729	
	3										20.4	.784	
	4										21.0	.840	
	5										21.0	.871	7.51
P-10	s	0845	E-5	calm	clear	35	.3	44850	4485	.1000	21.0	1.094	7.14
	1							44850	650	.0135	21.0	1.097	
	2							44850	18	.0004	21.0	1.097	
	3										21.0	1.097	
	4										20.8	1.097	7.18
P-11	s	0950	E-5	calm	clear	45	.4	59202	19734	.3333	21.2	.840	
	1							59202	1569	.0265	21.4	.826	
	2							59202	67	.0011	21.2	.829	
	3							59202	2	.0000	21.4	.905	
	4							-	-	-	21.2	.981	
Z-03	s	1035	E-5	calm	clear	62	.4	69517	13455	.1935	22.0	.858	7.36
	1							69517	2018	.0290	22.0	.871	
	2							69517	45	.0006	21.3	.896	
	3							69517	2	.0000	21.2	.924	
	4										21.2	.930	
	5										21.2	.947	6.87

Table A-1. (Cont.)

CPC-09 (June 26, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
P-15	s	1130	E-5	calm	clear	62	.35	78487	13455	.1714	23.0	.717	7.81
	1							78487	1345	.0171	22.3	.704	
	2							78487	47	.0006	21.8	.715	
	3							78487	3	.0000	21.4	.726	
	4										21.2	.754	6.63
P-14	s	1432	SE 5-10	slight	clear	63	.4	82972	17043	.2054	23.2	.737	8.45
	1							82972	1794	.0216	23.2	.734	
	2							82972	67	.0008	22.7	.723	
	3							82972	2	.0000	22.0	-	
	4										21.0	-	5.92
P-13	s	1442	SE 5-10	calm	clear	60	.35	82972	9867	.1189	23.5	.729	8.36
	1							82972	1345	.0162	22.5	.723	
	2							82972	29	.0003	22.0	.726	
	3										21.3	.756	6.45
P-12	s	1455	SE 5-10	calm	clear	59	.35	76245	8073	.1058	23.6	.742	8.94
	1							76245	1345	.0176	22.8	.740	
	2							76245	45	.0005	22.0	.731	
	3										21.0	.759	6.53

Table A-1. (Concluded)

CPC-09 (June 27, 1979)

Station	Depth (m)*	Time	Wind (knots)	Seas	Sky	Surface Incident Radiation (ly/hr)	Secchi (m)	Deck Cell Lux	Sea Cell Lux	Sea/Deck Ratio	Temp (°C)	Sal. (o/oo)	D.O. (mg/l)
Z-02	s	0817	SE 10-15	slight	clear	25	.3	33637	2915	.0866	20.2	.279	7.87
	1			chop				33637	112	.0033	20.2	.300	
	2								2	.0000	20.2	.368	7.89
P-08	s	0858	SE 10-15	slight	clear	40	.25	47092	1794	.0380	21.4	.373	7.69
	1			chop				47092	34	.0007	21.1	.370	
	2										21.2	.370	7.77
P-07	s	1000	SE 10-15	slight	clear	60	.25	65032	2242	.0344	21.0	.605	7.67
	1			chop				65032	156	.0024	21.1	.613	
	2										21.0	.607	
	3										21.0	.607	7.34
P-06	s	1055	S-10	slight	clear	63	.3	76245	4485	.0588	21.8	.599	7.94
	1							76245	448	.0058	21.7	.596	
	2							76245	7	.0000	21.1	.594	7.18
P-01	s	1245	S-10	calm	clear	68	.4	87457	12558	.1435	25.0	.613	8.91
	1							87457	1569	.0179	23.0	.610	8.89
P-02	s	1315	S-10	calm	clear	68	.3	89700	6279	.0700	26.2	.759	8.55
	1							89700	560	.0062	25.1	.762	8.10
P-03	s	1406	S-10	calm	clear	67	.3	87457	10764	.1230	27.0	.756	8.47
	1								560	.0064	25.0	.756	8.10
P-04	s	1417	S-10	calm	clear	66	.3	85215	8073	.0947	27.3	.910	8.85
	1								560	.0065	24.0	.806	7.38
P-05	s	1450	S-10	calm	clear	61	.35	69517	2018	.0290	26.6	.779	8.81
	1							69517	156	.0022	26.0	.779	
	2							69517	8	.0001	25.0	.779	7.94
Z-01	s	1557	S-10	calm	clear	47	.6	69517	14352	.2064	25.0	.860	8.34
	1							69517	2915	.0419	24.2	.854	7.45

* - surface depth is 0.5m for temperature, salinity, dissolved oxygen and sea cell reading of the submarine photometer.

Table A-2. Nutrient measurements from waters of the C.P. Crane study site, April 1979.

CPC-05 (April 10, 1979)

Station	Depth	Ammonia NH_3 (µg-at N/ℓ)	Nitrite NO_2^- (µg-at N/ℓ)	Nitrate NO_3^- (µg-at N/ℓ)	Phosphate $PO_4^{=}$ (µg-at P/ℓ)	Silicate $Si(OH)_4^{=}$ (µg-at Si/ℓ)
P-09	Surface	1.58	0	47.43	.73	94.1
	Bottom	1.45	0	45.29	.65	98.9
P-10	Surface	1.30	0	36.56	.58	83.4
	Bottom	1.33	0	54.87	.42	90.6
P-11	Surface	1.61	0	42.17	.65	95.3
	Bottom	1.45	0	38.71	.65	98.9
P-15	Surface	1.36	0	3.20	.58	96.5
	1m	1.20	0	6.66	.81	97.7
	2m	1.52	0	8.64	.50	94.1
P-14	Surface	1.33	0	13.26	.81	90.6
	Bottom	1.26	0	28.58	.73	88.2
P-13	Surface	1.58	0	31.21	.73	89.4
	Bottom	1.52	0	33.55	.65	95.3
P-12	Surface	2.21	0	34.16	.77	96.5
	Bottom	1.90	0	35.19	.65	93.0

Table A-2. (Cont.)

CPC-05 (April 11, 1979)

Station	Depth	Ammonia NH_3 (μg-at N/ℓ)	Nitrite NO_2^- (μg-at N/ℓ)	Nitrate NO_3^- (μg-at N/ℓ)	Phosphate $PO_4^{\equiv}$ (μg-at P/ℓ)	Silicate $Si(OH)_4^{\equiv}$ (μg-at Si/ℓ)
P-08	Surface	.95	0	2.66	0	103.7
	Bottom	2.91	0	8.65	0	109.6
P-07	Surface	1.30	0	14.0	0	81.0
	1m	1.25	0	1.09	0	89.4
	2m	1.25	0	0	0	95.3
P-06	Surface	1.00	0	0	0	83.4
	Bottom	.95	0	3.10	0	81.0
P-01	Surface	1.00	0	0	0	62.0
	Bottom	.90	0	0	1.73	69.1
P-02	Surface	1.30	0	0	.88	93.0
	Bottom	1.30	0	0	.84	97.7
P-03	Surface	1.00	0	0	0	93.0
	Bottom	.75	0	0	.76	93.0
P-04	Surface	.90	0	0	0	89.4
	Bottom	.70	0	0	0	96.5
P-05	Surface	.65	0	57.89	0	90.6
	Bottom	.57	0	48.26	0	87.0

Table A-2. (Cont.)

CPC-06 (April 24, 1979)

Station	Depth	Ammonia NH_3 (µg-at N/ℓ)	Nitrite NO_2^- (µg-at N/ℓ)	Nitrate NO_3^- (µg-at N/ℓ)	Phosphate $PO_4^{\equiv}$ (µg-at P/ℓ)	Silicate $Si(OH)_4^{\equiv}$ (µg-at Si/ℓ)
P-09	Surface	.80	0	34.08	.28	46.99
	2m	.84	0	38.11	.28	52.14
	4m-Bottom	.74	0	39.39	.57	50.37
P-10	Surface	.94	0	36.59	.28	41.85
	2m	.67	0	37.04	.11	64.52
	4m	.80	0	39.75	.45	58.33
P-11	Surface	.54	0	36.67	.19	46.99
	Bottom	.34	0	44.71	.19	63.48
P-15	Surface	.67	0	5.80	.28	54.21
	1m	.67	0	10.86	.19	49.05
	2m	.87	0	22.90	.11	50.08
	3m	.47	0	25.82	.61	51.11
P-14	Surface	.74	0	30.96	.36	46.99
	2m	.47	0	32.18	1.03	54.21
	4m	.74	0	34.35	.28	60.64
P-13	Surface	.54	0	33.97	.19	51.11
	2m	.60	0	35.84	.70	56.27
	4m	.54	0	36.74	.19	62.45
P-12	Surface	.74	0	34.31	.11	51.11
	Bottom	.74	0	36.97	.19	60.39

Table A-2. (Concluded)

CPC-06 (April 25, 1979)

Station	Depth	Ammonia NH_3 (μg-at N/ℓ)	Nitrite NO_2^- (μg-at N/ℓ)	Nitrate NO_3^- (μg-at N/ℓ)	Phosphate $PO_4^{\equiv}$ (μg-at P/ℓ)	Silicate $Si(OH)_4^{\equiv}$ (μg-at Si/ℓ)
P-08	Surface	.39	0	36.96	.29	51.11
	Bottom	.54	0	33.21	.29	48.02
P-07	Surface	.54	0	28.79	.25	44.93
	1m	.46	0	31.41	.25	38.74
	2m	.68	0	31.86	.25	39.77
P-06	Surface	.61	0	28.58	.29	45.96
	Bottom	.61	0	28.27	.21	44.93
P-01	Surface	.90	0	15.40	.45	31.71
	Bottom	.98	0	17.42	.45	26.37
P-02	Surface	1.05	0	27.38	.29	44.93
	Bottom	.61	0	11.88	.21	43.90
P-03	Surface	1.12	0	26.28	.29	46.99
	Bottom	1.05	0	28.71	.29	40.80
P-04	Surface	.54	0	28.57	.21	41.84
	Bottom	.61	0	28.27	.21	39.77
P-05	Surface	1.12	0	27.59	.29	45.96
	Bottom	.98	0	27.72	.29	41.84

Table A-3. Measurements of phytoplankton community parameters at the C.P. Crane study site, March-June 1979.

CRUISE CPC-04 (March 28, 1979)

Station	Depth (m)*	Total Chl a (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl a (<20 μm) (mg/m^3)	Screened Phaeophytin (<20 μm) (mg/m^3)	Alkalinity ($mgCO_2/l$)	Productivity ($mgC/hr/m^3$) Box Total	Box Screened	in situ** Total	in situ** Screened
P-09	surf	6.20	6.21	4.46	4.84		no productivity			
P-10	surf	6.51	5.34	7.87	6.23		no productivity			
P-11	surf	4.77	3.41	6.26	4.40		no productivity			
Z-03	surf	5.33	3.92	5.52	4.98		no productivity			
P-15	surf	10.48	5.60	10.54	5.82		no productivity			
P-12	surf	6.32	4.73	6.51	3.81		no productivity			

Table A-3. (Cont.)

CPC-04 (March 29, 1979)

Station	Depth (m)*	Total Chl a (mg/m³)	Total Phaeophytin (mg/m³)	Screened Chl a (<20 μm) (mg/m³)	Screened Phaeophytin (<20 μm) (mg/m³)	Alkalinity (mgCO₂/l)	Productivity (mgC/hr/m³) Box Total	Box Screened	in situ** Total	in situ** Screened
Z-02	surf	11.78	8.42	11.66	5.95					
P-08	surf	8.68	10.26	9.30	8.43	11.66	2.95	-	-	-
P-07	surf	8.54	6.06	8.30	5.25	12.11	2.86	3.29	1.62	1.22
	1	8.16	8.39	7.74	7.84	11.66	2.86	2.54	.71	.23
	2	8.59	7.96	8.07	7.23	11.66	2.48	2.40	.94	.36
P-06	surf	14.76	5.84	12.90	5.44	11.22	7.63	-	-	-
P-01	surf	11.16	5.77	10.17	5.80	11.22	4.77	-	-	-
P-02	surf	10.04	7.05	7.69	5.74	10.77	5.56	-	-	-
P-03	surf	10.66	6.15	10.04	5.08	11.66	6.07	-	-	-
P-04	surf	19.22	14.91	12.65	7.78	13.01	10.87	10.30	7.70	8.41
	1	9.18	6.62	12.40	8.81	14.36	11.32	9.92	1.08	1.03
P-05	surf	10.60	5.31	10.29	5.45	11.22	8.61	-	-	-
Z-01	surf	15.93	7.76	16.31	5.98					
P-09	surf	10.85	5.34	11.53	4.77	13.01	3.15	-	-	-
P-10	surf	7.13	4.15	7.19	4.60	10.77	1.89	-	-	-

Table A-3. (Cont.)

CPC-04 (March 30,1979

Station	Depth (m)*	Total Chl a (mg/m³)	Total Phaeophytin (mg/m³)	Screened Chl a (<20 µm) (mg/m³)	Screened Phaeophytin (<20 µm) (mg/m³)	Alkalinity (mgCO₂/l)	Productivity (mgC/hr/m³) Box Total	Box Screened	in situ** Total	in situ** Screened
P-11	surf	2.72	3.12	2.91	3.71	10.77	1.64	-	-	-
Z-03	surf	3.35	4.89	2.25	2.89		no productivity			
P-15	surf	10.91	5.96	12.25	7.78	12.11	10.26	10.76	5.60	6.34
	1	7.44	4.41	7.56	4.28	11.66	6.36	6.32	1.40	-
	2	6.20	5.65	5.77	4.16	12.11	7.26			
P-12	surf	8.21	4.06	25.41	9.63	11.66	6.31	-	-	-
P-13	surf	13.14	4.97	12.01	4.82	11.22	14.66	-	-	-
P-14	surf	12.67	5.25	13.93	5.26	12.56	11.85	-	-	-

Table A-3. (Cont.)

CRUISE CPC-05 (April 10, 1979)

Station	Depth (m)*	Total Chl a (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl a (<20 μm) (mg/m^3)	Screened Phaeophytin (<20 μm) (mg/m^3)	Alkalinity ($mgCO_2/l$)	Productivity ($mgC/hr/m^3$) Box Total	Productivity Box Screened	Productivity in situ** Total	Productivity in situ** Screened
P-09	s	11.78	7.59	9.61	7.03	13.01	5.81	-	-	-
P-10	s	17.20	11.01	13.43	8.66	13.01	8.06	-	-	-
P-11	s	4.24	3.19	4.34	4.49	13.01	2.80	-	-	-
P-15	s	10.02	7.37	9.61	5.25	13.01	9.09	7.85	3.45	3.22
	1	9.71	5.80	8.58	6.75	13.01	8.66	8.59	0.79	0.72
	2	10.13	10.00	10.75	9.00	13.01	7.23	7.96	-	-
P-14	s	7.75	6.17	8.06	5.10	13.01	6.52	-	-	-
P-13	s	8.27	4.62	6.61	6.18	13.01	5.57	-	-	-
P-12	s	6.82	6.82	6.82	5.59	13.01	4.50	-	-	-

Table A-3. (Cont.)

CPC-05 (April 11, 1979)

Station	Depth (m)*	Total Chl a (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl a (<20 μm) (mg/m^3)	Screened Phaeophytin (<20 μm) (mg/m^3)	Alkalinity ($mgCO_2/l$)	Productivity ($mgC/hr/m^3$) Box Total	Box Screened	in situ** Total	in situ** Screened
P-08	s	25.94	12.15	24.28	10.51	13.01	12.32	-	-	-
P-07	s	14.11	8.32	16.59	6.41	12.79	8.17	7.74	6.33	6.06
	1	17.21	5.22	14.42	5.61	12.56	6.54	6.65	1.39	0.87
	2	17.52	6.46	16.43	6.42	12.56	7.21	7.11	-	-
P-06	s	16.89	3.56	15.65	8.18	13.01	12.80	-	-	-
P-01	s	16.74	3.71	16.16	4.29	12.79	17.59	-	-	-
P-02	s	6.35	4.93	7.44	5.25	13.01	8.46	-	-	-
P-03	s	12.56	5.22	11.32	4.62	13.01	8.96	-	-	-
P-04	s	7.28	7.53	10.08	1.91	13.01	8.40	8.93	10.32	10.98
	1	11.94	6.12	10.23	6.56	12.56	9.32	10.13	1.43	1.51
P-05	s	18.29	3.57	14.73	4.32	12.56	11.88	-	-	-

Table A-3. (Cont.)

CPC-06 (April 24, 1979)

Station	Depth (m)*	Total Chl *a* (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl *a* (<20 µm) (mg/m^3)	Screened Phaeophytin (<20 µm) (mg/m^3)	Alkalinity (mgCO_2/l)	Productivity (mgC/hr/m^3) Box Total	Box Screened	in situ** Total	in situ** Screened
P-15	s	27.78	6.19	29.39	4.80	14.16	24.27	23.98	13.45	14.07
	1	31.99	5.47	33.84	5.89	13.98	22.45	24.88	5.32	5.24
	2	27.03	8.85	23.68	8.93	13.89	20.72	20.72	3.13	2.34
P-14	s	22.32	5.78	22.57	5.19	14.33	19.02	-	-	-
P-13	s	22.69	5.22	22.57	3.39	13.89	19.59	-	-	-
P-12	s	23.81	5.30	24.18	5.16	13.98	18.22	-	-	-

Table A-3. (Cont.)

CPC-06 (April 25, 1979)

Station	Depth (m)*	Total Chl a (mg/m³)	Total Phaeophytin (mg/m³)	Screened Chl a (<20 µm) (mg/m³)	Screened Phaeophytin (<20 µm) (mg/m³)	Alkalinity ($mgCO_2/l$)	Productivity ($mgC/hr/m^3$) Box Total	Productivity Box Screened	Productivity in situ** Total	Productivity in situ** Screened	
Z-02	s	38.44	8.95	39.68	3.76	-	-	-	-	-	
P-08	s	29.02	-1.93	26.29	-1.46	14.99	22.97	-	-	-	
P-07	s	34.97	-0.21	33.23	0.85	14.29	22.01	23.46	42.43	41.17	
	1	38.81	-1.46	39.06	1.00	14.51	22.64	19.45	16.30	16.42	
	2	41.17	-0.55	36.21	3.06	14.51	21.79	21.95	1.71	1.84	
P-06	s	28.52	-0.31	28.52	-1.44	13.63	27.95	-	-	-	
P-01	s	19.65	-1.43	19.47	-1.19	13.98	22.22	-	-	-	
P-02	s	28.89	-3.05	27.90	-4.20	13.81	28.09	-	-	-	
P-03	s	25.67	-0.84	27.28	-3.92	14.15	25.21	-	-	-	}
P-04	s	32.24	-1.77	27.28	-2.46	14.02	10.82	12.28	21.68	22.31	} inverter problems: intermittent light
	1	32.36	-2.24	31.00	-1.66	14.02	15.38	12.66	8.16	8.55	}
P-05	s	30.88	-0.97	33.48	-1.88	13.93	16.21	-	-	-	}
Z-01	s	28.02	7.97	26.04	8.94	-	-	-	-	-	

Table A-3. (Cont.)

CRUISE CPC-07 (May 9, 1979)

Station	Depth (m)*	Total Chl a (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl a (<20 μm) (mg/m^3)	Screened Phaeophytin (<20 μm) (mg/m^3)	Alkalinity ($mgCO_2/l$)	Productivity ($mgC/hr/m^3$) Box Total	Box Screened	in situ** Total	in situ** Screened
P-09	s	36.70	6.18	39.30	2.44	15.65	35.31	-	-	-
P-10	s	33.36	7.61	32.61	6.32	15.21	42.34	-	-	-
P-11	s	37.94	5.05	34.10	4.49	15.34	50.12	-	-	-
P-15	s	41.91	4.12	42.78	4.62	15.04	31.98	29.27	73.38	70.47
	1	43.28	6.15	42.16	2.98	14.91	36.03	34.16	47.63	50.24
	2	36.46	6.31	35.09	5.64	15.96	33.15	37.68	7.04	7.69
P-14	s	36.58	5.06	35.09	4.51	15.61	47.85	-	-	-
P-13	s	32.86	3.25	32.74	4.16	15.08	50.14	-	-	-
P-12	s	37.10	3.42	36.80	4.20	14.95	62.68	-	-	-

Table A-3. (Cont.)

CPC-07 (May 10, 1979)

Station	Depth (m)*	Total Chl a (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl a (<20 μm) (mg/m^3)	Screened Phaeophytin (<20 μm) (mg/m^3)	Alkalinity (mgCO$_2$/l)	Productivity (mgC/hr/m^3) Box Total	Productivity (mgC/hr/m^3) Box Screened	Productivity (mgC/hr/m^3) in situ** Total	Productivity (mgC/hr/m^3) in situ** Screened
P-08	s	39.06	3.26	35.59	4.47	16.14	60.01			
P-07	s	47.62	0.23	34.47	4.12	16.36	53.50	47.50	98.49	86.30
	1	50.35	0.43	41.29	6.44	16.05	54.76	55.30	50.54	55.67
	2	40.43	8.09	40.05	7.34	16.18	47.50	50.60	16.79	10.50
P-06	s	28.15	1.98	24.68	1.84	14.94	35.12	-	-	-
P-01	s	28.15	2.88	25.67	-0.28	15.61	36.75	-	-	-
P-02	s	32.86	4.94	31.87	6.32	14.91	57.86	-	-	-
P-03	s	30.88	3.31	28.52	3.64	15.17	41.88	-	-	-
P-04	s	24.18	3.47	27.28	3.19	14.73	28.31	21.63	75.89	68.79
	1	27.40	5.43	28.39	2.97	15.26	32.30	31.02	71.86	71.46
P-05	s	29.88	3.97	28.5	3.45	14.82	47.87	-	-	-

Table A-3. (Cont.)

CPC-08 (May 25, 1979)

Station	Depth (m)*	Total Chl a (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl a (<20 µm) (mg/m^3)	Screened Phaeophytin (<20 µm) (mg/m^3)	Alkalinity (mgCO_2/l)	Productivity (mgC/hr/m^3) Box Total	Box Screened	in situ** Total	in situ** Screened
Z-02	s	25.67	12.47	25.67	11.91	-	-	-	-	-
P-08	s	21.70	8.21	20.08	8.12	18.47	26.84	-	-	-
P-07	s	20.83	7.38	18.48	6.24	18.12	20.85	20.89	40.44	41.01
	1	26.78	7.75	26.04	7.25	18.02	28.87	28.13	27.16	23.75
	2	25.42	11.25	25.42	10.12	18.91	25.50	25.42	4.44	4.98
P-06	s	TUBE BROKE SAMPLE LOST		18.97	7.77	17.37	25.17	-	-	-
P-01	s	18.22	5.24	18.23	4.11	16.62	30.32	-	-	-
P-02	s	25.05	8.01	22.94	6.29	15.92	30.40	-	-	-
P-03	s	22.32	8.15	21.58	5.73	16.27	30.91	-	-	-
P-04	s	20.71	7.50	21.20	4.64	16.40	23.14	19.34	35.52	37.24
	1	19.47	5.92	20.09	4.51	16.36	19.26	18.45	9.35	11.33
P-05	s	22.32	6.23	20.09	6.43	16.40	27.69	-	-	-
Z-01	s	9.24	3.02	9.15	3.12	-	-	-	-	-

Table A-3. (Cont.)

CRUISE CPC-08 (May 24, 1979)

Station	Depth (m)*	Total Chl a (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl a (<20 μm) (mg/m^3)	Screened Phaeophytin (<20 μm) (mg/m^3)	Alkalinity ($mgCO_2/l$)	Productivity ($mgC/hr/m^3$) Box Total	Box Screened	in situ** Total	in situ** Screened
P-15	s	28.64	6.22	26.04	7.25	15.61	29.01	27.97	30.38	23.52
	1	27.28	11.09	29.26	9.10	16.27	33.13	35.66	12.68	10.63
	2	34.22	6.06	33.36	5.91	16.14	30.55	32.69	6.31	5.61
P-14	s	31.62	6.75	29.76	6.91	16.27	32.69	-	-	-
P-13	s	29.76	10.86	31.00	8.49	16.27	44.75	-	-	-
P-12	s	30.01	10.05	32.86	7.20	16.62	46.54	-	-	-

Table A-3. (Cont.)

CPC-08 (May 31, 1979)

Station	Depth (m)*	Total Chl a (mg/m³)	Total Phaeophytin (mg/m³)	Screened Chl a (<20 µm) (mg/m³)	Screened Phaeophytin (<20 µm) (mg/m³)	Alkalinity ($mgCO_2/l$)	Productivity ($mgC/hr/m^3$) Box Total	Box Screened	in situ** Total	in situ** Screened
P-12	s	13.39	4.66	11.53	5.62	17.28	11.96	-	-	-
P-09	s	15.13	4.96	15.13	7.44	18.91	13.69	-	-	-
P-10	s	21.95	8.07	19.96	5.99	18.25	21.87	-	-	-
P-11	s	15.06	5.09	14.76	4.54	18.42	24.38	-	-	-
Z-03	s	15.62	5.14	14.88	4.30	-	-	-	-	-

Table A-3. (Cont.)

CRUISE CPC-09 (June 26, 1979)

Station	Depth (m)*	Total Chl a (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl a (<20 μm) (mg/m^3)	Screened Phaeophytin (<20 μm) (mg/m^3)	Alkalinity ($mgCO_2/l$)	Productivity ($mgC/hr/m^3$) Box Total	Box Screened	in situ** Total	in situ** Screened
P-09	s	15.13	9.58	14.97	6.53	16.14	19.66	-	-	-
P-10	s	4.41	4.58	4.74	4.10	17.24	6.51	-	-	-
P-11	s	5.25	4.48	4.27	4.14	16.01	8.35	-	-	-
Z-03	s	5.68	4.06	5.16	4.11	-	-	-	-	-

Table A-3. (Cont.)

CPC-09 (June 26, 1979)

Station	Depth (m)*	Total Chl a (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl a (<20 μm) (mg/m^3)	Screened Phaeophytin (<20 μm) (mg/m^3)	Alkalinity ($mgCO_2/l$)	Productivity ($mgC/hr/m^3$) Box Total	Productivity ($mgC/hr/m^3$) Box Screened	Productivity ($mgC/hr/m^3$) in situ** Total	Productivity ($mgC/hr/m^3$) in situ** Screened
P-15	s	8.35	6.33	9.38	4.56	13.85	6.87	7.79	29.89	24.98
	1	9.10	5.02	10.70	4.49	13.71	11.10	12.54	8.13	6.94
	2	10.37	4.78	9.05	5.28	13.54	12.15	12.86	2.04	1.20
P-14	s	16.74	10.00	15.87	9.18	13.81	15.84	-	-	-
P-13	s	19.84	8.37	17.61	9.47	13.85	25.14	-	-	-
P-12	s	18.23	10.54	15.50	10.79	13.98	27.32	-	-	-

Table A-3. (Concluded)

CPC-09 (June 27, 1979)

Station	Depth (m)*	Total Chl a (mg/m^3)	Total Phaeophytin (mg/m^3)	Screened Chl a (<20 μm) (mg/m^3)	Screened Phaeophytin (<20 μm) (mg/m^3)	Alkalinity ($mgCO_2/1$)	Productivity ($mgC/hr/m^3$) Box Total	Box Screened	in situ** Total	in situ** Screened
Z-02	s	25.79	21.38	22.32	16.16	-	-	-	-	-
P-08	s	27.78	17.13	17.73	24.81?	19.78	34.04	-	-	-
P-07	s	21.70	11.59	19.84	9.27	16.80	18.04	17.03	23.74	23.03
	1	22.69	12.08	17.73	11.04	16.71	19.13	11.05	2.94	2.32
	2	20.58	13.83	18.23	13.71	16.36	17.87	12.53	1.57	1.37
P-06	s	24.06	13.07	19.59	11.33	15.96	28.15	-	-	-
P-01	s	33.98	7.77	30.50	7.86	14.16	27.47	-	-	-
P-02	s	29.88	9.84	26.66	7.64	14.03	21.46	-	-	-
P-03	s	25.92	9.18	25.79	7.16	14.16	25.66	-	-	-
P-04	s	34.60	9.52	31.37	8.46	13.98	22.17	25.02	29.93	33.89
	1	24.43	10.44	21.33	9.36	14.07	19.91	21.14	3.95	3.53
P-05	s	32.98	9.67	30.01	9.15	13.98	27.51	-	-	-
Z-01	s	4.97	3.36	5.49	2.73	-	-	-	-	-

* - water from a surface bucket sample was used for surface pigment analyses, alkalinity, productivity, and taxonomy determinations.
** - surface water was used for all 'in situ' incubations; bottles were suspended at .5m, 1.0m, and 2.0m.

Table A-4. Phytoplankton identifications and counts from selected stations, March 28-30, 1979.

		Station																					
		P02 surf		P04 surf		P04 1m		P07 surf		P07 1m		P07 2m		P09 surf		P10 surf		P11 surf		P15 surf		P15 1m	P15 2m
Size (μm)	Total Cells #/ml	7652	5843	9307	10,548	6877	6773	3154	3878	5688	3774	4395	3050	5584	5843	3568	3878	1654	1809	9824	7290	7083	5894
	Chlorophyta																						
15-20	Ankistrodesmus sp.	569	414	362	414	517	207	259	362	569	155	362	362	569	620	724	155	155	517	362	414	155	
30-50	Ankistrodesmus sp.													4					2	4		2	12
100-150	Ankistrodesmus sp.	4	2										2	2		2							
	Asterionella formosa		4	16	8		10	10	38		32		24		40	50	70	46	24	20	8	8	
	Crucigenia sp.		207				207			207					207							414	
	Kirchneriella sp.											52	52			103	52						
	Scenedesmus bijuga								103														
	Scenedesmus dimorphus									155							155		414			207	
	Scenedesmus quadracaudi	207	103	207				103		103	207	414	103	207	103	310		207		103			
	Scenedesmus quadracaudi var. alternans			207																			
	Tetastrum sp.	207				207			207	103		207				207		207					
	Sphaerocystis sp.	96		16																			
5	colonial Volvocalian																					517	
	Oscillatoria sp.						2																
	Cryptophyta																						
5	cryptophyte	1551	1138	2585	2895	2585	2327	517	258	517	155	155	52	672	724	258	207			3826	2430	776	879
8	Chroomonas sp.	465	207	310	931	517	827	103	258	414	259	310	258	776	776	155	155	155	207	620	362	569	465
16	Chroomonas sp.														103						103		
20	Cryptomonas sp.							52		52	52		52	103	155	52	52				52		
	Myxophyta																						
	Gomphosphaeria sp.																			620			
	Diatoms																						
3	centric																					52	155
5	centric	103	259	310	155	52	103	155	155	517	465	207	310	465	414	414	517	310	207	155	103	103	
8	centric	259	310	569	362	569	414	207	310	155		414	258						155	207	103	155	
15	centric									52												52	
30	centric							4	4	4		4		2			2	2					
30	Navicula sp.		52																				
60	Navicula sp.			2																			
15-17	Nitzschia sp.	310	52	207	155	207	259	310	310	362	155	414	103	103	52	258	465	155	103	207	207	155	310
5x2	Nitzschia longissima																						103
25x5	Nitzschia longissima	10	16	22	16	18	12	8	8	12	6		8	4		2	2	4	4	8		2	6
70x120	Nitzschia sp. (sigmoid)		4		2	2	2	4	2	2		2	2		2								

		Station																					
		P02 surf		P04 surf		P04 1m		P07 surf		P07 1m		P07 2m		P09 surf		P10 surf		P11 surf		P15 surf		P15 1m	P15 2m
	Diatoms (continued)																						
8x5	Melosira sp.	1396	931	1241	1706	517	879	569	1034	1293	1138	1034	931	982	258	724	414	310	1344	931	1861	1293	
8x5	Melosira sp.		207		414	259					310	155	103	52	827	517	310		207				
20x15	Melosira sp.											10							4				
	Surirella sp.		2						2										2				
30-40	Pennate	4	6		8	4		2	4			4		2			6	2	2	2	2		
60-110	Pennate		2		4	2	4		2	2		2		4	4				4		2		2
60	Synedra sp.									2													
	Other Flagellates																						
3	flagellates	620	207	517	414	103			52	155	103	103	155	103		103		52	155	258	310	207	310
5	flagellates				52																52	258	
3	biflagellates		207				52													362	362	207	155
5	biflagellates	931	776	1396	1293	724	776	465	207	672	465	362	155	569	310	207	310			1189	1034	827	1086
7	biflagellates	465	724	931	1241	569	569	414	362	310	259	52	155	982	620	103	207			362	569	362	465
9	biflagellates	569		414	362		52				52	103		207						52			

Table A-5. Phytoplankton identifications and counts from selected stations, April 10-11, 1979.

Size (µm)		Station																	
		P02 surf		P04 surf		P04 1m		P07 surf		P07 1m		P07 2m		P15 surf		P15 1m		P15 2m	
	Total Cells #/ml.	8480	6308	8790	6101	9100	9359	12,513	14,736	17,993	18,510	19,544	18,200	8531	8738	11,168	10,858	7342	6101
	Chlorophyta																		
15-20	*Ankistrodesmus* sp.	1499	1293	1396	1034	1965	1189	517	1086	724	1241	1551	1448	1448	982	776	1448	1499	827
30-50	*Ankistrodesmus* sp.	2		2		4	2	2	4								2	1	
100-150	*Ankistrodesmus* sp.					2		4	2	4	2		2		2				
	Asterionella formosa	14		4				2	16			14	4			2	2		
	Crucigenia sp.																207		
	Kirchneriella sp.							103					103		52				
	Oscillatoria sp.	2	2	2			2		2	2		2	2						
	Pedliastrum sp.							16			16				30	36	64		
	Scenedesmus abundans								103										
	Scenedesmus acuminatus	207																	
	Scenedesmus bijuga	207	103													103			
	Scenedesmus dimorphus						414		259					155					
	Scenedesmus quadricauda			414	207	103	517		155		414	1551	827	207	827		103		
	Scenedesmus quadricauda var. *alternans*					207											207		
	Tetrastrum sp.			414	414	207		724	1034	2068	1654	827	827		620	620	414	207	414
	Cryptophyta																		
5	Cryptophyte	207	207	155	259	52	259	52	465	207	103		103		155	103	155	52	103
8	*Chroomonas* sp.	310	155	569	414	465	569	207	52	518	310	310	103	517	259	620	259	259	207
16	*Chroomonas* sp.			207				52									52		52
20	*Cryptomonas* sp.			52										52		52		52	52
	Myxophyta																		
	Gomphosphaeria sp.								1344										
	Diatoms																		
3	Centric			103				52			103								
5	Centric	207	155	207	259	672	310	1603	1086	1344	1034	1758	1758	724	259	620	620	414	465
8	Centric	414																	
30	Centric	2			2			4		4	2	16	12		2		2		
15-17	*Nitzschia* sp.	569	414	310	155	414	569	517	1138	1344	1241		310	569	620	982	776	776	414
25x5	*Nitzschia longissima*					2	2	2	2	2	4	10	10	6		2			2
3x10	*Melosira* sp.	3516	3257	4292	2328	4498	5326	7601	6618	10,961	11,582	10,858	11,582	3878	3930	6360	5532	3102	3257
8x5	*Melosira* sp.	362			517			259	776		414	414	517	414	310	103	259	517	103
	Surirella sp.	2								4							2		
160	*Synedra* sp.		2										6	4					

Table A-5 (cont.)

		Station																	
		P02 surf		P04 surf		P04 1 m		P07 surf		P07 1m		P07 2m		P15 surf		P15 1m		P15 2m	
	Diatoms (continued)																		
30	Pennate		2						4			6	2		4			8	2
40-50	Pennate					4		2	2		2	2	2	4		2	4	6	2
80-100	Nitzschia (sigmoid)														4	4		2	2
20	Navicula															52	103		
3	Flagellate	103	155	207			207		207				207						
5	biflagellate	620	259	155	207	207	207	155	155		103	620	310	103		52			
7	biflagellate	259	259	155	103	310	259	103	207	207		310	103	155	465	569	517	465	
9	biflagellate		52	155	155		52	52		310				310	259	155	207	207	
3	biflagellate				52					310	310								

Table A-6. Phytoplankton identifications and counts from selected stations, April 24-25, 1979.

Size (µm)		Station																	
		P04 surf		P04 1 m		P07 surf		P07 1m		P07 2m		P15 surf		P15 1m		P15 2m		P02 surf	
	Total Cells #/ml	47,982	66,389	68,251	84,176	81,280	80,867	100,307	95,965	79,833	92,242	78,798	80,247	60,598	87,278	90,587	77,143	38,675	51,808
	Chlorophyta																		
15-20	Ankistrodesmus sp.	3309	3516	2275	2895	2689	2689	1241	3930	2689	2068	4136	3723	4136	2895	4757	2895	1758	2172
30-70	Ankistrodesmus sp.	6	4	6	10	8	2	4	6	4	2	2	2	6	4	10	2	1	4
90-160	Ankistrodesmus sp.				2	6	4	2	2	2	2		2				6	1	
	Kirchneriella sp.	207					207		207	620			207	207					310
50-100	Oscillatoria sp.	2	2	2								2	2		2				1
>250	Oscillatoria sp.		4							2									2
	Pediastrum sp.				16														
	Scenedesmus bijuga			414				414			827		414					207	931
	Scenedesmus dimorphus														1654		414		
	Scenedesmus quadricauda	414	1241	1241		1241	827			3309	827				827	414	827	414	1551
	Scenedesmus quadricauda var. alternans			1654	827		1448								827				
	Tetraedron sp.																	310	
	Tetrastrum sp.						414	827		827			827			827		414	414
30	colonial Ankistrodesmus						16												
	Asterionella formosa							6			4								
	Cryptophyta																		
5	Cryptophyte	414	414		207		414	207	207			207			414	620	414		
8	Chroomonas sp.	414	414	207	207	207	620	827	827	1448	414	1861	1861	414	827	207	414	1138	414
16	Chroomonas sp.																		103
20	Cryptomonas sp.			207				207									207		
	Diatoms																		
5	Centric	1241	1241	827	1034	1861	414	3102	2482	2275	2895	207	414	414	1241	207	1861	414	1551
20-30	Centric	2				10		6	6	2	6		2	2	2	2	4		
3x10	Melosira sp.	36,814	52,946	56,048	72,180	66,803	65,976	88,932	78,592	62,460	73,628	68,664	69,247	51,705	75,696	80,660	64,941	29,989	40,433
8x5	Melosira sp.				827	1034	620	414	2068	827	2482				414		827	517	
15-17	Nitzschia sp.	4136	5791	4757	5170	6205	6825	3930	7032	4964	9100	3309	2895	3516	1861	2689	3930	2895	3412
25x5	Nitzschia longissima	2				6	4		2	12	4	2			2	2	2	1	
20	Navicula sp.		207																
30-40	Pennate	6	4	2	2	4	2		2	4	2		4		2	2	2	3	1
50-70	Pennate	2	2	2			12	6	6	10	4			2	2	6	8		2
	Surirella sp.	2		2		2					2								
	Nitzschia (sigmoid)								2	2	2								
	Other Flagellates																		
3	flagellate	207	207	414	207		207	207	207	207			207		207		207	310	
5	biflagellate	827	414	207	827	1034	207		414	827		414	207	207	414	207	207	310	310

Table A-7. Phytoplankton identifications and counts from selected stations, May 9-10, 1979

Size (µm)		Station: P04 surf		P04 1m		P07 surf		P07 1m	P07 2m		P15 surf		P15 1m		P15 2m		P02 surf	
	Total Cells #/ml	40,123	36,814	43,846	36,194	48,603	37,848	39,916	48,603	45,707	53,980	60,185	71,766	89,760	59,771	44,880	70,732	68,871
	Chlorophyta																	
	Amphiprora sp.	2																
15-20	Ankistrodesmus sp.	3309	1654	4136	3516	3309	3516	2482	4757	5584	2068	2895	1448	1861	1861	2482	2482	3516
30-70	Ankistrodesmus sp.	18	38	16	10		28	40	56	44	24	22	26	24	8	8	4	12
100	Ankistrodesmus sp.					4	4	2	4									
	Asterionella formosa							2	2									
	Kirchneriella sp.	207	207		207	207		414	414	414					207		207	
	Merismopedia sp.					3309	3309		3309					16				
	Pediastrum sp.				32	32	16											16
	Pyramimonas sp.											414		207				
	Scenedesmus bijuga	1241			1241	2068	2275	2068	1654	1654		414			414			620
	Scenedesmus dimorphus			827	827	2275	827	1448	1448	1034		1654	827	414	827		1034	
	Scenedesmus quadricauda	2895	1654	1654	3723	3723	5377	2689	2482	3309	1241	827	3309	414	1241	414	414	2068
	Scenedesmus quadricauda var. alternans									827								827
	Tetrastrum sp.			1654					827									
	Scenedesmus abundans														827	414		
	Cryptophyta																	
5	Cryptophyte					620	620	414			2068	414	827	1241	207	1034	620	207
8	Chroomonas sp.	5170	3102	6618	2482	1448	1654	2275	1861	414	13,650	22,957	20,682	31,023	11,168	11,996	10,961	10,134
20	Cryptomonas sp.				207			207				207	207					207
16	Chroomonas sp.													207				
	Diatoms																	
5	Centric			207		207		827	207			207	827	620		207	620	1034
30	Centric				1		2		2	2	2	2	4	2		2		2
3x10	Melosira sp.	13,650	14,477	16,131	13,236	12,202	8893	13,236	15,305	12,823	29,575	24,198	35,366	45,087	36,194	22,750	28,748	28,334
8x5	Melosira sp.					827			414						414			
15-17	Nitzschia sp.	5998	4550	8066	6618	8893	8480	10,134	12,202	13,857	1241	3309	6205	6205	5170	4343	9514	9307
25x5	Nitzschia longissima					10	4	6		2								
90	sigmoid Nitzschia sp.			2							2							
30-70	Pennate		4	70	48	34	34	38	46	48	6	2	6	2	4	2	6	6
100	Pennate									2								
	Other Flagellates																	
3	flagellate	414	620	620	1241	1034		1241	1034	1448		207		207		207	2689	1034
5	flagellate	7239	10,548	3930	2895	8480	2895	2482	2689	4343	4136	2482	2068	2275	1241	1034	13,443	11,375

Table A-8. Phytoplankton identifications and counts from selected stations, May 24-25, 1979

Size (μm)		Station																	
		P04 surf		P04 1m		P07 surf		P07 1m		P07 2m		P15 surf		P15 1m		P15 2m		P02 surf	
	Total Cells #/ml	23,164	31,023	30,609	24,818	21,716	18,614	34,746	27,093	33,712	40,330	21,716	20,475	33,091	26,473	27,300	24,198	38,055	51,912
	Chlorophyta																		
	Anabaena sp.		2					4	2	2	8	4	2	2	4	4	2		4
15-20	Ankistrodesmus sp.	1034	1861	1241	620	2895	1861	1241	2275	1241	1861	654	1034	620	827	827	414	1034	620
30-50	Ankistrodesmus sp.		8	12	16	10	4	8	2	10	12	8	14	4	2	4	4	4	16
	Asterionella formosa						4								6				
	Katodinium sp.								414		207			207	207				
	Kirchneriella sp.			1034		207	620	414					207	414		207	207		
	Merismopedia sp.		827	4964				6618					1654	4964		3309	3309	3309	12,409
	Oscillatoria sp.	130	114	228	182	212	192	40	100	36	124	216	176	168	176	202	168	2	56
	Pediastrum sp.		32	16	14	32		8		16	46	16	32	16		16		48	
	Scenedesmus abundans																		414
	Scenedesmus bijuga		414			827							1654				414		414
	Scenedesmus dimorphus			620	207	1241		414	827	1654	3516	620							
	Scenedesmus quadricauda	1861	3309	2068		1654	827	2068	1241	827	3722	414	827	2275	3723	1654	207	207	
	Scenedesmus quadricauda var. alternans	3309	2068	827			1654												
	Tetrastrum sp.						827	827	1654		1654		827	827	1654				
	Cryptophyta																		
5	Cryptophyte							414										207	
8	Chroomonas sp.		207		414	620	620	207	414		207	620	207	620	1034	827	1241	414	414
16	Chroomonas sp.		207																
20	Cryptomonas sp.													207					
	Diatoms																		
5	Centric		414	414	827	207	207	620		414	827	827	827	207	1034		827	620	827
30	Centric		2		2	2	2	8	4		2	2		4				4	2
3x10	Melosira sp.	10,548	15,098	13,030	15,718	6204	7859	14,684	11,375	22,957	21,716	12,823	8066	14,684	11,789	13,650	13,030	22,543	26,473
15x17	Nitzschia sp.	5170	3516	4964	5998	5170	4136	7032	7859	6411	6618	3309	4550	7446	5377	5998	4343	8066	8686
100	Nitzschia (sigmoid)					2			2		2								
30-70	Pennate		6	16	14	92	76	110	96	62	88	30	34	34	30	26	30	18	16
70	Surirella sp.				2														
25x5	Nitzschia longissima		2	2			12	4	8			2	4	2	6	6	6		
8x5	Melosira sp.					1654			414										
	Other Flagellates																		
3	flagellate							207	620						414				
5	flagellate	1241	3102	1448	1034	1034				207		1448	620		414	827	207	1654	1654

Table A-9. Phytoplankton identifications and counts from selected stations, June 26-27, 1979.

Size (µm)		Station: P04 surf		P04 1m		P07 surf		P07 1m		P07 2m		P15 surf		P15 1m		P15 2m		P02 surf	
	Total Cells #/ml	27,300	20,062	16,959	17,993	19,234	19,855	20,062	21,716	19,027	22,750	17,993	18,200	12,616	15,718	9927	13,650	23,991	24,405
	Chlorophyta																		
15-20	Ankistrodesmus sp.	1034	827	620	620	827	1448	1654	1241	1241	414	1034	414	620	207	414	1241		1034
>30	Ankistrodesmus sp.		4	8		6	4	6	8	12	10								8
	Kirchneriella sp.	207										207	207				207		207
	Pediastrum sp.					32		32	78		16	14	16						
	Pyramimonas sp.		207											827				207	
	Scenedesmus abundans								827	414									
	Scenedesmus bijuga	414			414														
	Scenedesmus dimorphus					620				414									
	Scenedesmus quadricauda						827	620			827			827					
	Tetrastrum sp.					827			1654		827	827							
	Chryptophyta																		
5	Cryptophyte	620	414	207			620	620		207	414		827					207	827
8	Chroomonas sp.	3723	4964	1034		414		827			207	1654	2275		414		414	1861	1861
16	Chroomonas sp.	1654	414	207									414		414	207		620	207
20	Cryptomonas sp.	207	207									207						414	
	Diatoms																		
5	Centric	1034	1654	1861	1654	1241	827	1034	1654	1654	207	1448	1448	1241	1034	827	1241		2275
30	Centric	12	8	4		10	16	14	8	32	12	2	10	8	2	10	10	4	
	Anabaena sp.					2		2	2	6	12		2				2		
3x10	Melosira sp.	18,407	10,755	12,202	13,650	14,684	12,409	13,236	13,857	10,961	11,789	9307	11,996	7445	10,341	5791	8686	17,166	17,580
8x5	Melosira sp.						1861	827	620	1654	3309	2068	207	1241	2275	1448	1654		
15-17	Nitzschia sp.		620	827	1654	620	1861	1034	1034	2482	2275	620		207	620	1034		1034	414
25x5	Nitzschia longissima	2			2	4		2	2				2						
30-70	Pennate	8	4	6	16	40	50	32	56	26	60	4	6	6	6	14	2	8	6
90	sigmoid Pennate			2	4	16	24	18	28	30	28								
	Oscillatoria sp.					22	20	28	24	6	2	18	8	16	14	14	22		
	Flagellates																		
3	flagellates							207			414	207							
5	flagellates											414		207	414	207	207		
8	flagellates												414					620	

Table A 10. Identity and counts (per 0.1 m^3) of microzooplankton sampled by pump at the C. P. Crane generating station, March - June 1979.

	Station															
	P10		P15								P06		P02		P05	
			OBL		SFC		MID		BOT							
Taxa/Replicate	1	2	1	2	1	2	1	2	1	2	1	2*	1	2	1	2
							March									
ROTIFERA																
Brachionus calyciflorus	8	4	4			10		15			8		12	8	24	No sample
Brachionus plicatilis							5			10						
Brachionus sp.							5									
Keratella cochlearis	236	356	208	204	485	370	290	415	175	460	508	688				
Keratella sp.				4	10	5	10									
unid.					10	5							876	660	864	
NEMATODA																
unid.	28	16	20	28	25	5	5	20	10	100	20	136		4		
OLIGOCHAETA																
unid.												4				
HYDRACARINA																
unid.															4	
CLADOCERA																
Bosmina longirostris					10					5					4	
Eubosmina coregoni	20	32	8		20	5		5	15		28	20	4	8	20	
Daphnia parvula										5						
Alona diaphana						5									36	
Chydorus sphaericus	20	4		4							16	16			8	
OSTRACODA																
unid.	12		20	8	5		5	10	5	110		12				
COPEPODA																
Eurytemora affinis nauplii	996	740	788	612	805	1275	680	1050	640	475	1100	628	1072	1806	896	

Table A 10 (continued).

Taxa/Replicate	P10 1	P10 2	P15 OBL 1	P15 OBL 2	P15 SFC 1	P15 SFC 2	P15 MID 1	P15 MID 2	P15 BOT 1	P15 BOT 2	P06 1	P06 2*	P02 1	P02 2	P05 1	P05 2
March (continued)																
COPEPODA (cont.)																
Eurytemora affinis copepodids	224	224	540	412	510	580	370	535	440	645	308	332	268	436	428	No sample
adults	24	40	152	88	190	195	100	155	95	185	120	124	64	48	76	
Diaptomus sp.			4							5		4				
Scottolana canadensis	16	4	4									44	4			
Ectinosoma curticorne	720	1124	536	588	770	705	665	795	755	1620	380	1900	112	28	80	
Bryocamptus sp.	8	20	32	16	50	35	55	50	20	100	28	104	20	8	40	
Cyclops bicuspidatus thomasi	200	324	112	48	40	85	70	100	160	75	56	132	24	32	32	
Eucyclops agilis						10				5						
unid. nauplii	56	20	44	8	20	25	5	30	5		12	8	40	36	36	
unid. copepodids													8			
CIRRIPEDIA																
cyprid larva		4										20	4			
AMPHIPODA																
Corophium lacustre					5											
Corophium sp.					5											
Gammarus tigrinus												4				
INSECTA																
Chironomidae											4	4			32	
unid.	4								5							

*Pump reached bottom.

Table A 10 (continued).

	Station															
	P10		P15								P06		P02		P05	
			OBL		SFC		MID		BOT							
Taxa/Replicate	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
								April								
ROTIFERA																
Brachionus calyciflorus	128	192	112		240	200	210	280	160	160	448	448	200	152	544	544
Brachionus sp.					160			80					8			
Keratella cochlearis	2112	2208	3824		4240	3860	2480	4340	2640	1320	3104	2016	2448	2368	3072	3872
Keratella sp.						20										
Notholca marina		128			1160	1660	1420	2020	340		352	864	392	560	288	672
unid.			272													
NEMATODA																
unid.									20					16		
HYDRACARINA																
unid.					40											32
CLADOCERA																
Daphnia ambigua	32															
Bosmina longirostris										20	64		16			
Eubosmina coregoni	64	32									32	32	24			64
Alona sp.	32															
Chydorus sphaericus	32												8			
unid.	64															
OSTRACODA																
unid.													8			
COPEPODA																
Eurytemora affinis nauplii	7552	8832	3008		7720	7120	3060	4140	7880	6360	6656	9184	1088	3616	11872	9056
copepodids	960	1312	208		200	420	70	160	1220	1180	1440	1088	224	440	2176	1664
adults	192								20				8	8	576	32
Diaptomus sp.										20						
Ectinosoma curticorne	64	64									32		16		32	

Table A 10 (continued).

	Station															
	P10		P15								P06		P02		P05	
			OBL		SFC		MID		BOT							
Taxa/Replicate	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
April (continued)																
COPEPODA (cont.)																
Bryocamptus sp.		32	16						60	20	32		8		128	32
Cyclops bicuspidatus thomasi	352	640							220	240			32	48	320	
unid. cyclopoids			16			20	20	40				32				32
unid. nauplii	608	448	64		640	440	250	320			96	352	16	32	320	256
INSECTA																
Chironomidae													16	8		
unid.									20							
May																
ROTIFERA																
Brachionus calyciflorus	44	44	2848	1568	2380	3620	1760	3200	800	1260	3744	3296	1600	2208	912	1400
Brachionus plicatilis	44	40	1408	1888	1160	1820	2260	1520	1040	360	864	672	144	112	112	192
Keratella cochlearis			96	16							32			16		16
Notholca marina			192	224	160	280	300	360	180	220	640	992	176	288	416	488
unid.		8	32										16	16		
ANNELIDA																
unid. larvae						20										
MOLLUSCA																
unid. gastropod									20							
unid. bivalve												32				
CLADOCERA																
Eubosmina coregoni		4												16		
Alona diaphana				16											16	8

Table A 10 (continued).

	Station															
	P10		P15								P06		P02		P05	
			OBL		SFC		MID		BOT							
Taxa/Replicate	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
May (continued)																
CLADOCERA (cont.)																
Disparalona rostrata	16															
COPEPODA																
Eurytemora affinis nauplii	468	632	2112	1504	300	340	900	740	3240	4940	3184	2944	2320	2832	1632	2656
copepodids			64	32			40	20	40	120	144	96	48		48	40
Acartia tonsa adults			32											16		
Scottolana canadensis			32	16					20	60	32	96	32			16
Bryocamptus sp.										20						
unid. harpacticoids				16			20		40	40						
unid. cyclopoids				48				20		20						8
unid. nauplii	172	212	224	176	40		40	40	160	120	256	96	160	352	304	336
CIRRIPEDIA																
unid. nauplii	32	52													16	
INSECTA																
Diptera		4														
Chironomidae					20		20									
unid.														32		
PISCES																
unid. larvae		4														
June																
ROTIFERA																
Brachionus calyciflorus	64		608	444	480	250	480	440	870	680	544	528	640	848	1152	1248
Brachionus plicatilis				24			20		10	40	32	32		16	64	192

Table A 10 (continued).

		Station															
		P10		P15								P06		P02		P05	
				OBL		SFC		MID		BOT							
Taxa/Replicate		1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
								June (continued)									
ROTIFERA (cont.)																	
<u>Notholca</u> <u>marina</u>		16		544	316	500	360	230	440	500	680	3984	3376	1264	800	1056	1504
unid.			32	32		20	20	30	10	30		16		16			
NEMATODA																	
unid.					32							16					32
OLIGOCHAETA																	
unid.								10									
HYDRACARINA																	
unid.									10								
CLADOCERA																	
<u>Leptodora</u> <u>kindti</u>					4												
<u>Eubosmina</u> <u>coregoni</u>								10									
<u>Moina</u> <u>micrura</u>		16		32	72	190	35	40	50	50	20	160	144	80	16	128	64
<u>Camptocercus</u> <u>rectirostris</u>																	32
unid.		16															
OSTRACODA																	
unid.					4	20											
COPEPODA																	
<u>Eurytemora</u> <u>affinis</u>	nauplii	3920	3840	1280	872	600	110	710	690	2670	2360	1968	1040	1632	2208	2464	2048
	copepodids	704	1504	64	40	10		10	10	80	60	64	32		48	32	96
	adults	32	32														
<u>Acartia</u> <u>tonsa</u>	nauplii	640	832														
	copepodids	208	384		8												
	adults	48	96														
<u>Scottolana</u> <u>canadensis</u>		16	96	96	56	20	5	10		50	40	32					96
<u>Ectinosoma</u> <u>curticorne</u>					80	10											

Table A 10 (continued).

	Station															
	P10		P15								P06		P02		P05	
			OBL		SFC		MID		BOT							
Taxa/Replicate	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
June (continued)																
COPEPODA (cont.)																
Bryocamptus sp.							20							16		
Cyclops bicuspidatus thomasi									90	40				16		32
unid. harpacticoids				4	10											
unid. cyclopoids	32	64		4			10		20	20				16	32	32
unid. nauplii	688	320	576	100	50	30	360	420	350	1260	1280	816	1280	960	1216	1088
unid. copepodids	32															
Argulus alosae						5										
CIRRIPEDIA																
unid. nauplii			32													
AMPHIPODA																
Leptocheirus plumulosus				4												
INSECTA																
Chironomidae				4			10									
unid.	32															

Table A-11. Checklist of zooplankton identified from mesozooplankton collections, vicinity of C.P. Crane generating station, March-June 1979. Order of stations for each month is P09, P10, P11, Z03, P15 oblique, near-surface (2), mid-depth (2), near-bottom (2), P12, Z02, P08, P07, P06, P01, P02, P05, Z01. P12 was sampled twice in May.

Taxa	March	April	May	June
COELENTERATA				
Hydra sp.		X		XX X
ROTIFERA				
Brachionus calyciflorus	XX	XXXXXXXXXXXXXXXXXXX	XX XXX X XXXXXXX	
Brachionus plicatilis			X XX XXX X XXXXXXX	
Brachionus quadridentata		X		
Notholca marina		X X X		
NEMATODA			X	
ANNELIDA				
Naididae	X X X	X XXXX XX	X	X XX
Polychaete larvae		X X		
Scolecolepides viridis	XX X XXXX			
Hirudinea		X		
MOLLUSCA				
Hydrobia sp.	X X	XXX X	X	X
Mulinia lateralis	X X	X		
Rangia cuneata				X
Cladocera				
unid. cladocerans		X		
Leptodora kindti	X X	XX XX XXX XXXX	X XX XXX XXX	XXXXX XXXXXXXXXXXXX
Sida crystallina		X	X X XXXXXXX XXXXX	X X X XX
Latona setifera			X XX XX X	
Diaphanosoma sp.			X XX X	
Diaphanosoma brachyurum				X X
Daphnia spp.	XX XX X X	XX		XX X X
Daphnia ambigua	X X	XXXX X XXX XXXXX	X	
Daphnia parvula		XX	X	
Daphnia retrocurva				XXXX XXXXX XX
Daphnia catawba	X X			
Simocephalus sp.				X
Ceriodaphnia pulchella			X X XX X X	X X XX
Ceriodaphnia lacustris				XX
Moina micrura			XXX X XX XXXXXXXXXXX	XXXXXXXXXXXXXXXXXXX
Bosmina longirostris	XXX XXXXXXXXXX XXXX	XXXXXXXXXX XXXXXXXX	XXXXX XXXXX XXXXXXX	X X X X X
Eubosmina coregoni	XXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXXX	X X X	X X X X X
Ilyocryptus spinifer			X X XX	X X
Ilyocryptus sordidus				XX X
Macrothrix laticornis				X
unid. Chydorinae	XXX X X X XX X		X	
Camptocercus rectirostris			X	X X
Alonella sp.			X XX	X
Alona diaphana	X			

Cladocera (cont.)
- Alona sp.
- Alona rustica
- Disparalona rostrata
- Pleuroxus denticulatus
- Chydorus sp.
- Chydorus sphaericus
- Pseudochydorus globosus

Ostracoda (unid.)

Copepoda
- unid. copepods
- Eurytemora affinis
- Diaptomus sp.
- Pseudodiaptomus coronatus
- Acartia tonsa
- Bryocamptus sp.
- Cyclops bicuspidatus thomasi
- Eucyclops agilis
- Scottolana canadensis
- Ergasilus cerastes
- Ergasilus chatauquaensis
- Argulus alosae

Cirripedia (unid.)

Mysidacea
- Neomysis americana

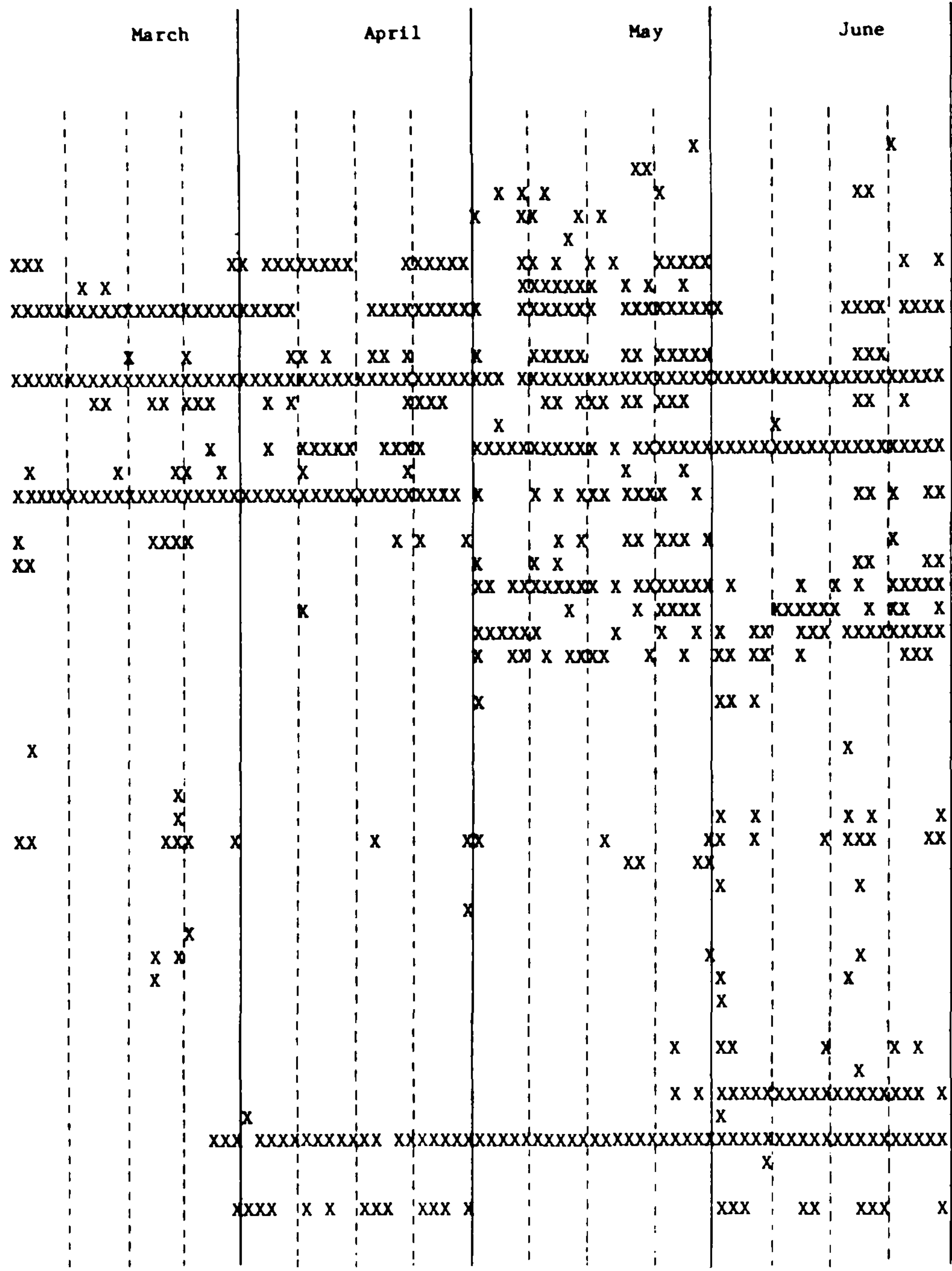
Isopoda
- Edotea triloba

Amphipoda
- unid. Gammaridean
- Leptocheirus plumulosus
- Corophium lacustre
- Gammarus sp.
- Gammarus daiberi
- Gammarus tigrinus
- Melita sp.
- Melita nitida
- Monoculodes sp.
- Parahaustorius holmesi

Decapoda
- Palaemonetes sp.
- Callinectes sapidus
- Rhithropanopeus harrisii

Arachnida (unid.)
- Hydracarina
- Pseudoscorpionida

Insecta
- unid. Insects



	March	April	May	June
Orthoptera				X
Coleoptera				X
PISCES				
unid. fish eggs		X X X		
unid. fish larvae	X		X	X XXX
Alosa spp.			XX	XX
Menidia beryllina			XX XX X XX	XXXXX XX XXX X XXX X
Morone americana			X	
Morone spp.		XXXX X X XXXXXXXXX	X X XX XXXXX X	
Lepomis sp.			X	
Perca flavescens	XXXXXXXX	XXXXX XXX		
Gobiosoma bosci				XX X XXX

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