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A study of changes in algal population density diversity and distribution and changes in physical and chemical characteristics of Lake Elsinore

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A STUDY OF CHANGES IN ALGAL POPULATION DENSITY DIVERSITY AND DISTRIBUTION AND CHANGES IN PHYSICAL AND CHEMICAL CHARACTERISTICS OF LAKE ELSINORE

A Thesis

Presented to the

Faculty of

California State

University, San Bernardino

In Partial Fulfillment

Of the Requirements for the Degree

Master Of Science

in

Biology

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by

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ABSTRACT

From June through December of 1982 a study of the phytoplankton and water chemistry of Lake Elsinore was conducted. The Lake is a eutrophic lake of approximately 25 square kilometers and a shallow depth reaching 8 to 9 meters. It was found that the lake exhibits the characteristics of a monomictic eutrophic lake forming a summer thermocline near 7 meters and having a summer clinograde oxygen distribution. Due to an abundance of phosphate, nitrate was found to be absent or in very low concentration in the lake during most of the year. Members of most of the algal phyla were present with major populations found in the green algae, blue green algae and diatoms. Significant populations of pollution tolerant algal species were identified including seven found to be most frequently present; *Dactylococcopsis* sp., *Chlorella ellipsoidea, Melosira varians, Kirchneriella* sp., *Stephanodiscus* sp., *Ankistrodesmus convolutus* and *Golenkinia radiata*. The diversity index for the lake was found to be 3.2. A near shore pollution index of 18 and midlake index of 15 were calculated.

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I. INTRODUCTION

Hutchinson (1957 & 1967), Reid (1961), Russel-Hunter (1970), and Palmer (1969) have described methods for studying and classifying lake trophic conditions based on their physical shape, oxygen content, level of organic pollution and algal community. While lakes exhibit many intermediate stages, two basic classifications exist, oligotrophic and eutrophic. The truly oligotrophic lake is characterized by a physical shape where the depth is several times the width and has sharp vertical sides. Oxygen concentration is nearly uniform from the surface to the bottom (orthograde). The water is clear and contains a sparse community. There is little or no organic pollution. Eutrophic lakes, on the other hand, are shallower in depth than they are in width and length. During stratification the hypolimnion in the eutrophic lake exhibits oxygen depletion (clinograde), and the water lacks clarity due to high density of the algal community and concentration of organic pollutants.

The diversity among and density of algal populations can be used to determine eutrophic conditions without actually examining the lake's physical and chemical characteristics. Hutchinson (1967) and Palmer (1969) both have defined algal species and genera which are indicators

of eutrophic lakes. Palmer has also developed a quantification system whereby assignment of points based on the composition of the algal community indicates the existence of eutrophic waters.

Not only is it advantageous to understand the lake's degree of eutrophy, but it is desirable to know what factor or factors are controlling the primary productivity of the lake and how changes in chemical constituents of the lake may affect its productivity. In some cases, such as Astotin Lake (Lin 1972), algal population growth may be nutrient limited by nitrogen. However, in the presence of a nitrogen-fixing bloom of Cyanophyta, which assures adequate amounts of usable nitrogen, the growth becomes limited by other factors such as phosphate, micronutrients, temperature, solar radiation or whole lake mixing due to wind. Gordon *et. al.* (1981) found that nutrients in general and phosphorous in particular were the growth limiting factors within the lakes they studied. These observations were made in summer climates with warm temperatures and high solar radiation. During winter months temperature and solar radiation generally become the limiting factors. Schwartzkopf and Hergenrader (1978), studying four eutrophic reservoirs, found no correlation between the day of the year and the concentration of chlorophyll-*a* (biomass) indicating that season and

possibly solar radiation have no effect on biomass. However, this lack of correlation is most probably due to the summer-only time span of their investigation.

THE STUDY SITE

Lake Elsinore, a naturally occurring lake formed by a geologic slump between two fault lines, lies in the Santa Ana River basin. The lake is the southern terminus of the San Jacinto River, with a 198,100 hectare drainage basin, and forms the head of the Temescal Wash. Unlike most lakes studied by other investigators, Lake Elsinore has only intermittent inflows from its tributary basin. Between 1900 and 1982 the lake has filled to overflowing only twice: once during the floods of 1916, and a second time during the floods of 1980. A water reservoir, built in the early 1930's, nine kilometers upstream, prevents water flows in the San Jacinto River from reaching Lake Elsinore during years having normal rain fall, such that inflows occur only during flood-level storms . Table 1, from The Lake Elsinore Lake Stabilization and Land Use Plan (1974), shows San Jacinto River water flows in excess of 1000 acre feet between 1930 and 1973. From 1969 to 1976 no flows came from the stream and the lake receded to a depth of about 3 to 4

meters. In 1977, during floods, the lake rose seven meters to the 379.5 meter elevation and again rose in 1978 by two meters to near the 381.0 meter elevation. In 1980 the lake rose seven meters to the 381.2 meter level and, for the first time since 1916, overflowed downstream through the Temescal Wash.

YEAR	ACRE FEET
1932	10,000
1937	82,340
1938	58,140
1939	9,430
1940	46,090
1943	7,480
1952	16,600
1959	8,720
1969	58,140

Table 1: San Jacinto River water flows exceeding 1000 acre feet per year between 1930 and 1973. (From Lake Elsinore Lake Stabilization and Land use Plan)

As can be seen from the above discussion the lake changes greatly in level and water quality depending on the local weather patterns. The lake evaporates at a rate of one to one and a half meters in height per year depending on the severity and duration of the summer weather. During the period of the study the lake elevation was between 380.0 and 381.6 meters above sea level.

The only published data for Lake Elsinore are contained in the Lake Elsinore Lake Stabilization and Land Use Plan

(1974). These data show some water quality information such as total dissolved solids, chloride, nitrate and conductance, but do not provide any detail on algal communities, algal blooms, thermoclines, oxygen concentrations or other information necessary to understand how the chemical and physical characteristics of the lake are affecting the algal populations in the lake.

The purpose of this study is to provide a base line of information on the algal community in the lake and its succession and the chemical and physical nature of the lake. From this information conclusions are drawn as to the eutrophic nature of the lake and what may be the limiting nutrients in the lake.

II MATERIALS AND METHODS

MONITORING LOCATIONS AND FIELD SAMPLES

A temporary laboratory was established in a residence on the southwest shore near the middle of the length of the lake. Two sampling locations were chosen, one near shore and a second near the center of the lake (Plate 1, in pocket inside rear cover). Both stations were directly off shore from the field station.

Station One was about 200 meters from shore where the water was a depth of seven meters. Station Two was about 1.5 kilometers from shore where the water was a depth of nine meters. The location of each station was determined at sampling time by triangulation using specified points on shore. From April 13, 1982 to July 5, 1982 water samples were taken at Station One only and reviewed for algal community characteristics. From July 5, 1982 to September 17, 1982, algal populations and water chemistry were monitored, on a weekly bases, with samples taken from both stations at depths of 0, two, five and seven meters. Subsequent samples were taken and analyzed on October 27 and December 20, 1982.

Oxygen and temperature depth profiles were taken *in situ* at 0.6 meter intervals.

Incident light energy, on the roof of the field station, was monitored by spectroradiometry, daily, at half

hour intervals, between 5:00 A.M. and 8:30 P.M.

METHODS of DATA COMPILATION

Data compilation will be discussed in four different categories: 1) incident light energy; 2) temperature and oxygen; 3) algal populations and 4) water chemistry. Each category requires a specific type of equipment and a different location for analysis.

Light energy was monitored using a spectroradiometer controlled by the time clock on a recorder-scanner. The readings from the spectroradiometer were interfaced to an Apple II Computer using a variable resistor and recorded on floppy disk.

The spectroradiometer is a Model SR Spectroradiometer (Instrumentation Specialties company, Lincoln, Nebraska) capable of monitoring light quantities from 750 *mu* to 1550 *mu* in the IR range and 380 *mu* to 750 *mu* in the visible range. The accuracy of the instrument is in the range of ±10% and is capable of monitoring both infra-red and visible spectra. Only the visible light spectrum was monitored for this study. To keep the signal on scale during the brightest part of the day the instrument was set on the 300X position. Thus, there was a lack of sensitivity during sunrise and sunset measurements. However, light at these times represents less than 1% of the total incident daily light and errors generated by lack of sensitivity at these

times were also less than the errors from the accuracy of the spectroradiometer.

The light energy measured by this spectroradiometer is expressed in microwatts per square centimeter per millimicron of wave length ($\mu Wcm^{-2}m\mu^{-1}$). The energy data were then evaluated as the average spectral energy per second for the day in μWcm^{-2}, or multiplied by the total time over which readings are taken and expressed as Joules per square centimeter per day ($J/cm^2/day$).

The spectroradiometer was located on the roof of the field station in a location to minimize the shadow effects from any surrounding trees. Only during the late fall was there any shadow on the spectroradiometer and this only after 3:00 P.M. (shortly before shadow intrusion from local mountains).

The ISCO Model SRR Spectroradiometer Recorder-Scanner was used to control the spectroradiometer. This unit contains a 24-hour time clock and chart recorder for running the spectroradiometer and recording the measurements of light energy. The recorder also has an automated wave length scanner which mounts on the spectroradiometer to turn it on and drive the spectroradiometer through the infra-red and visible spectra. The time clock is adjustable to collect spectral readings as desired with a shortest interval of once every 15 minutes. For this experiment

readings were taken every 30 minutes starting at 5:00 A.M. and ending at 8:30 P.M.

The chart paper holder was removed from the chart recorder and the drive for the chart needle modified to include a linear variable resistor with resistance from 0 to 100 k ohms. The resistance of the variable resistor changed as the needle on the chart recorder moved. This resistor then served as the interface between the spectroradiometer recorder and the computer which calculated total incident light energy in the visible spectrum.

An Apple II Plus (Apple Computer Inc.) was used to interpolate the energy readings taken by the spectroradiometer. After calibrating the computer to read the chart recorder needle position, via a variable resistor, from 0 to 100 ±1%; a program was written to read the incident energy every 5 $m\mu$ of wave length. The actual computation was as follows:

EQUATION #1:

RA x 3 x 5 x CF = R in watts per 5 $m\mu$ of wave length

RA = spectral radiation from spectroradiometer (0 - 100)
3 = multiplication coefficient for spectroradiometer setting (300)
5 = 5 $m\mu$ of wave length between readings
CF = calibration factor for the 5 $m\mu$ bandwidth being read (see discussion under calibration).

Equation #1 calculates the incident energy every 5 *mu* of wave length from 380 *mu* to 750 *mu*. RA was read from the variable resistor and lay between 1 and 100. Because the spectroradiometer was set so that full scale deflection represented a reading of 300, it was necessary to multiply by 3 to get a reading between 0 and 300. As each reading was 5 *mu* removed from the previous wavelength it was necessary to multiply by 5 (representing 5 *mu* band width). Finally the spectroradiometer had been calibrated in 5 *mu* increments against a known standard and the correction factor (CF) for each 5 *mu* was multiplied by the result to yield an R value for each 5 *mu* of wave length.

EQUATION #2:

$$RT = R_1 + R_2 + R_3 + \ldots + R_{74}$$

RT = total radiation in visible spectrum (380 - 750 *mu*).
R_1 to R_{74} = individual R values from (1) above for each 5 *mu* of wave length.

Equation #2 summates each of the 5 *mu* R values to obtain the total radiation (RT) in the visible spectrum for each half-hour interval.

Calibration of the system was performed using the entire system in operation reading a known light intensity from an ISCO calibrated incandescent bulb mounted in an ISCO Model

SRC Spectroradiometer Calibrator. For a detailed discussion of the calibration technique see ISCO Instruction Manual Model SRC Spectroradiometer Calibrator. The radiation (RC) of ISCO lamp No. 370 was calculated at a distance of 12 cm from the filament for every 5 *mu* interval between 380 and 750 *mu* at the specified setting of 15.790 amps. This was then divided by the actual reading (AR) to give the correction factor CF (see equation 3).

EQUATION #3:

$$CF = AR / RC$$

CF = correction factor
AR = actual reading
RC = radiation calculated
= wave length

Temperature and oxygen levels were monitored *in situ* using a Precision Scientific Co. Galvanic Cell Oxygen Analyzer (Cat. No. 68850). Both the temperature and oxygen sensors were capable of operating at depths in excess of 15 meters, greater than the depth at either station. Therefore temperature and oxygen levels were monitored for the entire water column at both stations. The temperature probe is a standard thermister-type probe with a calibration knob built into the instrument to allow calibration of the instrument to a mercury thermometer during use.

The oxygen probe is a galvanic cell consisting of a set

of concentric electrodes, a central rod-shaped silver cathode surrounded by a cylindrical shaped lead anode. The electrodes are insulated from each other with their ends exposed to a thin layer of KOH electrolyte trapped under a thin plastic, semipermeable membrane. The membrane serves as a gas permeable membrane which is impermeable to ionic species and to surface active compounds. The lead electrode is sufficiently electronegative to cause spontaneous oxygen reduction without any external electrical voltage and in KOH has no residual electron flow without oxygen.

Probe calibration was accomplished using a standard Winkler titration, as described in the Hach Chemical Company's DR-EL/2 Bulletin and from APHA Standard Methods For Examination Of Water and Waste Water (Franson, 1976). For the calibration oxygen content of a control water sample was determined using the probe and the Winkler titration . Correction factors were determined for the probe reading against the Winkler titration by dividing the titration value by the probe reading.

EQUATION #4:

$$CO = OT/OP$$

CO = correction oxygen
OT = oxygen concentration from titration
OP = oxygen concentration from probe

An analysis based on temperature correction charts

provided by Precision Scientific showed that the temperature correction coefficient was a function of the seventeenth power of the temperature in degrees Kelvin. The correction factor for temperature was the lake temperature to the 17th divided by the sample temperature raised to the 17th. This is algebraically represented in equation #5.

EQUATION #5:

$$CT = (TL)^{17} / (TC)^{17}$$

CT = correction coefficient for temperature
TL = lake water temperature in degrees Kelvin
TC = calibration temperature in degrees Kelvin

It is not known if this equation was used by Precision Scientific Co. to develop their table of temperature correction coefficients. However, it can be used to generate that table and thus allows direct use of the equation for numerical analysis with a computer rather than hand calculations using the published tables. The computer was given the value for CO (from Equation #4), the calibration temperature and the water temperature and meter reading and directly calculated the actual oxygen concentration by multiplying corrected oxygen concentration (CO) times the correction coefficient for temperature (CT) . The first oxygen readings were taken August 25, 1982.

Algal populations were counted with a Leitz Model

716917 Phase Contrast Microscope. A sample of the water was placed into a Neubauer Hemacytometer and five 0.1 x 0.1 mm squares counted under oil immersion. Each algal species present was counted and a record kept of each square and the numbers of each species found. Data are reported in cells per milliliter after correcting for volume.

Identification of the more difficult algal species was aided by Kodachrome and Ektachrome photomicrographs of living cells and cells stained with IKI, safranin or Toluidine Blue-O from laboratory stock preparations. The photomicrographs were taken with a Leitz 301-184-001 No. 2254 camera with automatic exposure control mounted on a Leitz Ortholux model 837257 microscope. While the IKI and Toluidine Blue-O were used for separation of algal groups, it was found that safranin stain made the external morphological characteristics more distinct, especially for the diatoms, thus allowing identification to genus or species.

The IKI and Toluidine Blue-O were administered to living cells in solution and the cells were then photographed in the presence of the stain. However, the safranin was applied using the bacteriological technique of drying, fixing, staining and washing the water sample. Safranin stained the cell walls of diatoms well enough to show valvular overlaps, setae and in some cases punctae. In

particular, safranin helped with positive identification of *Melosira*, thereby allowing verification of valvular features, filamentous detail and cellular separations.

The Fresh-Water Algae of the United States (Smith, 1950), Diatomaceae of North America (Wolle, 1894), Algae of the Western Great Lakes Area (Prescott, 1951), How to Know the Freshwater Algae (Prescott, 1978) and Diatoms of North America (Vinyard, 1979) were used as reference material to identify the algae to genus and species.

In addition to dissolved oxygen, which has already been discussed, water chemical analyses for pH, ammonia, nitrate, nitrite, phosphate (total and ortho), silica, sulfate and hardness were conducted during the study.

An Analytical Measurements Redox Meter, model # 707 mV standard pH meter was used to monitor pH. The meter was standardized at pH 9.0 with one capsule of buffer dissolved in 100 milliliters of deionized water. The remainder of the analyses were conducted using the Hach Model DR-2 Water Analysis Spectrophotometer Kit. All analyses, except for the hardness test, were done spectrophotometerically.

The Hach DR-2 is a full scale spectrophotometer capable of measuring between 410 and 700 *mu*. Each procedure has an insertable scale which, when in place behind the meter, allows for direct readings of chemical concentration for the chemical being determined. This scale also specifies a wave

length setting for these readings. In the case of phosphate, where no scale was available, known concentrations were tested and an absorbency profile determined for 700 *mu* to 410 *mu*. The maximum absorbency was located at 410 *mu* and a calibration scale constructed as described under phosphate in this section.

Ammonium determinations were accomplished with the HACH Nessler Method (0 - 3 mg/l). A standard series of four concentrations were run using the ammonium scale supplied in the kit. All readings from lake water samples were then corrected in accordance with this calibration. The data reported have an accuracy of ±10%.

Nitrate was determined using the cadmium reduction method with NitraVer VI Nitrate Reagent (0 - 0.5 mg/l). First the Nitra Ver VI reagent reduces nitrate to nitrite, then Nitri Ver III Nitrite Reagent is added and a test is conducted for nitrite (both nitrate and nitrite register). When no nitrite is present in the water a direct reading of nitrate is taken. Otherwise the nitrite must be subtracted to yield nitrate. It should also be noted that a negative test here indicates that neither nitrate nor nitrite is present.

Nitrite tests were accomplished using the HACH Diazotization Method with NitriVer III Nitrite Reagent (0 - .3 mg/l). Results of this test are influenced only by

conversion of small amounts of nitrate to nitrite, which occurs in the presence of high concentrations of nitrate. As nitrate was not present in large concentrations, the results are considered to be accurate in determining the presence of small amounts of nitrite.

Ortho-phosphate tests were performed by two different methods. In the early tests ortho-phosphate was measured using PhosVer III Phosphate Reagent (HACH Ascorbic Acid Method). The reagents for the Ascorbic Acid Method became exhausted and the test was changed to the Stanna Ver Method using ammonium molybdate and Stana Ver Powder Reagent. Both of these methods were very sensitive to contamination, especially from the cadmium reduction test for nitrate. Second and third tests were run to check concentrations which appeared to be erroneous. It was found to be necessary to wash each sample bottle with the ammonium molybdate or other acid prior to the test in order to remove all contamination. For the Stana Ver test maximum absorbency was found to be at 410 *mu*. As no scale was available, standards were run at 14, 7, 3.4, 1.7, 0.85 and 0.43 mg/l and a scale was constructed on a blank transmittance card.

The same tests were run for total inorganic phosphate as those for *ortho*-phosphate except that the samples were boiled for 30 minutes in the presence of acid (ammonium

molybdate or hydrogen sulfate) to convert poly-phosphates to ortho-phosphates. The same contamination problems existed for these as for the ortho-phosphate tests and the same scales were used to read concentrations.

The HACH Heteropoly Blue (powder) Method was used to determine silica concentration (0 - 3 mg/l). Measurements were done strictly against the scale provided with the DR-2 Kit.

Sulfate concentrations were determined turbidimetrically using the HACH Sulfa Ver IV Reagent (0 - 200 mg/l). Standardization tests indicated the scale in the kit to be accurate within 10% and no corrections were made from scale readings. No special problems were encountered in this determination as the lake water was not highly colored nor turbid. The colorimeter bottles though were found to cause considerable variance so one bottle was marked and used for all readings. After each test it was necessary to repeatedly scrub, with soap and water, each bottle to assure cleanliness for subsequent tests.

Tests were conducted for both calcium hardness and total hardness using titration techniques described in the HACH DR-EL/2 Handbook. Calcium hardness titration with Cal Ver II was determined by a titration of 10 ml samples to an achromic end point. For total hardness a 10 ml sample was titrated by the ManVer II Procedure. Magnesium hardness was

then calculated as the difference between calcium hardness and total hardness.

III. RESULTS

The tables of raw data for chemical and phycological portion of the study appear in appendix A. The data in appendix A is presented in tabular form by date collected starting with April 13, 1982 and ending December 20,1982.

LIGHT

While light was monitored daily at 30 minute intervals, except during power failures and equipment malfunctions, the data presented are the average of the incoming radiation during an entire week expressed as *micro*watts per centimeter squared. The values, shown for each week,

WEEK ENDING	AVERAGE INTENSITY $\mu w/cm^2$	WEEK ENDING	AVERAGE INTENSITY $\mu w/cm^2$
7/10/82	22000	10/9/82	16800
7/17/82	27100	10/16/82	13100
7/24/82	23300	10/23/82	13000
7/31/82	26300	10/30/82	11000
8/7/82	27700	11/6/82	10700
8/14/82	28800	11/13/82	8000
8/21/82	27100	11/20/82	7900
8/28/82	20500	11/27/82	6400
9/4/82	23800	12/4/82	7500
9/11/82	17700	12/11/82	7000
9/18/82	12300	12/18/82	5600
9/25/82	15600	12/25/82	5500
10/2/82	16500	1/1/83	6200

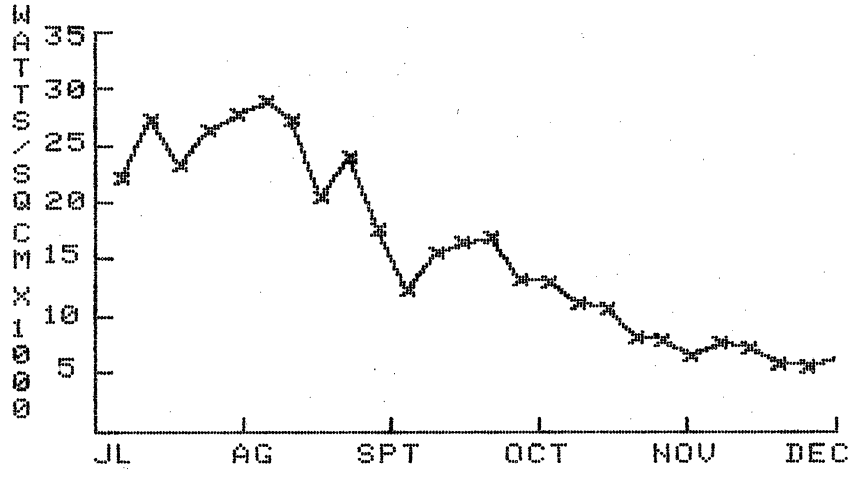
Table 2. Light (solar radiation in the visible spectrum) in microwatts per square centimeter averaged over each week.

represent the weekly average of the daily data collected. Table #2 lists the average solar radiation for each week from July 10 through January 1.

July and August experienced the highest intensities with an average of 22000 $\mu w/cm^2$ and a maximum of 28800 $\mu w/cm^2$ during the week of august 14. The fall intensities fell gradually to an average of 6300 $\mu w/cm^2$ during the month of December with a weekly low of 5500 $\mu w/cm^2$ for the week of December 25. The data are displayed graphically in Figure 1.

FIGURE 1

SOLAR RADIATION IN WATTS PER SQUARE CENTIMETER



WATER CHEMISTRY

Water chemistry graphs are presented in figures 2 through 37. Figures 2 through 25 are graphs of temperature and oxygen concentration *versus* depth for each sample day and these appear in appendix B. Figures 26 through 37 in appendix C are graphs of the concentration of each chemical at each sample depth for each station (8 graphs for each figure) *versus* time.

Nitrate (Fig. 26, Appendix C)

Only during the month of June was nitrate detectable with a maximum value of 1.8 ppm. During the remainder of the study nitrate was not detectable. The October sampling was not tested for nitrate because of the appearance of nitrite in the lake. Nitrate concentration (0.1 ppm) was not significantly greater than nitrite. Nitrate levels were very low in the lake during the summer (less than 0.05 ppm). The test used here would have detected nitrate levels as small as 0.05 ppm.

Nitrite (Fig. 27, Appendix C)

Nitrite concentration reveals two active periods. The first in late July and early August and a second extending from mid September into October. The maximum value occurred at the end of July (0.19 ppm, at a depth of 5 meters at

Station 2). This station also had a high concentration at that time at a depth of 7 meters.

Ammonia (Fig. 28, Appendix C)

Ammonia concentration is shown to be relatively constant from July through late August. In late August all depths at both stations, except the surface at Station 2, show increases in ammonia concentration apparently preceding a decrease in total algal population density (Fig. 81) and following the maximum summer water temperatures reached in early August (Fig. 35).

Ortho - Phosphate (Fig. 29, Appendix C)

Ortho-Phosphate concentrations at Station 2 increased with depth consistently throughout the study. Station 1, however, showed a diversion from this with the concentration at 5 and 7 meters dropping to 0.92 ppm in August, while the concentration at two meters remained above 0.04 ppm. General trends for *ortho*-phosphate were toward greater concentrations in early July with a decrease to nearly 0.02 ppm in mid August, followed by a generally sharp rise in late August and early September, and these slowly decreased again through December.

Total Inorganic Phosphate (Fig. 30, Appendix C)

Inorganic phosphate had three maxima for the summer; one in mid July at 1.0 ppm, one in early August at 0.4 ppm and a third in late August-early September at 1.0 ppm. From early September through December little fluctuation was evident, with concentrations ranging from 0.11 to 0.15 ppm. The maxima in late June (0.9 - 1.3 ppm) are suspect of being caused by contamination as in later tests it was found necessary to acid wash all glassware prior to phosphate tests to eliminate contamination from chemicals used in previous tests.

Sulfate (Fig. 31, Appendix C)

Sulfate usually ranged between 100 - 120 ppm, but maxima and minima of 180 ppm and 70 ppm were recorded as well. Only small peaks occurred during June and July and most sample readings showed a slow steady decrease of sulfate through October. The higher concentrations of sulfate were generally found at the deepest sample points. It should be noted here that during the periods of strong thermocline, the samples brought from the bottom contained noticeable odors of hydrogen sulfide.

Silicate (Fig. 32, Appendix C)

Each sample point for silica determination shows a maximum concentration in August and a minimum concentration of zero during October, followed by a second maximum during December. With some exceptions at Station 1 (depths of 5 and 7 meters), the general trends were low concentrations (0.5 ppm) in the early summer, higher concentrations in mid summer (1.1 ppm), falling to 0.00 ppm in October and increasing to 1.2 ppm in December.

Hardness (Figs. 34 and 35, Appendix C)

Total hardness and calcium hardness were monitored during the study,(see fig. 34 and fig. 35 respectively). Calcium hardness, with two exceptions, remained constant at 50 ppm. The two exceptions occurred on July 12, when calcium hardness at Station 1, two meter depth was 60 ppm and Station 1, seven meter depth was 55 ppm.

Total hardness also showed little variation, remaining near 120 ppm throughout the study. Exceptions to this occurred on July 19, for Station 1 at the surface and 7 meter depth (70 and 75 ppm respectively). The minor transitions shown at Station 2 (surface, 2 and 7 meter depths) are from 110 ppm to 120 ppm at the surface and at 2 meter depths; and from 130 to 120 ppm at 7 meters.

pH (Fig. 36, Appendix C)

During the study the pH remained fairly constant near 9 and showed little fluctuation. Only a gradual tendency was apparent for pH to decrease as winter set in.

OXYGEN AND TEMPERATURE

Oxygen (Fig. 33, Appendix C)

Oxygen concentrations are presented for each sample day from August 26 to December 20 in two different ways. The concentrations are reported at 0.6 meter depth increments from the surface to the bottom. The oxygen concentrations at 0, 2, 5 and seven meters are also shown in the water chemistry tables (tables 2 through 25). Plots of oxygen concentration *versus* depth for each day are then shown in figures 19 through 25 while figure 33 shows changes in concentration at each sample depth (0, 2, 5 and 7 meters) with time.

August 25 (fig. 19) was the first day oxygen data was collected. On August 26 (fig. 20) Station 2 exhibited thermoclines and oxyclines at 7 - 8 meters which resulted in an orthograde oxygen graph. Station 1, being in shallower water only displayed a temporary shallow late afternoon thermocline and oxycline at 0.6 to 1.2 meters. Station 2

developed this same shallow temperature and oxygen variation only to a more exaggerated extent with the maximum oxygen concentration of 7.8 ppm occurring at 0.6 meters. With the exception of August 31st Station 1 oxygen concentrations showed only the small oxycline near the surface and remained above 1 part per million while at Station 2 below 6 meters the oxygen concentration fell below 0.5 parts per million below 7 meters.

During the fall (October 27 and December 20) only shallow (at or above 3 m.) oxyclines were evident indicating the effects of whole lake mixing on oxygen concentration. As can be seen in figures 15 and 16, when the 6 - 7 meter thermocline was broken in the fall, oxygen concentrations at depths below four meters rose and were generally maintained above 3 parts per million.

Figure 33 shows changes in oxygen concentration with time for each of the eight sampling depths. The four highest peaks, one at each station at 0 meters and 2 meters, and a fifth smaller peak at Station 1, 5 meters were all taken on September 7 at 4:30 P.M. The time of day here may be the single most significant cause of this high peak. Photosynthesis having taken place throughout the day drove the dissolved oxygen up to its highest levels of 14 parts per million. With a water temperature at Station 1 of

29.2° C. at a depth of 0.6 meters the water was super saturated with oxygen by a total of 6.8 parts per million (solubility of oxygen at 29° C. = 7.8 ppm) or 180% saturation. Super saturation existed to a depth of 2.4 meters where dissolved oxygen was 8.4 parts per million, the water temperature was 26.4° C. and solubility was 8.2 ppm. September 7, September 17 and December 20 all exhibited oxygen concentrations in excess of saturation from 0 meters to at least 0.6 meters. On these days sampling was conducted at 4:30 P.M., 5:00 p.m. and 2:30 p.m. The other days when oxygen concentrations were monitored the sampling times were 12:30 p.m. or earlier and no super saturation was found.

Temperature (Fig. 37, Appendix C)

Temperature data are also shown graphically in two forms. Figures 2 through 25 plot temperature *versus* depth at Stations 1 and 2 for each sample day from April 13 to December 20. Figure 37 is a graphical representation of temperature changes with time at each sampling depth (0, 2, 5 and 7 meters) for Stations 1 and 2.

Temperature plots from April 13 through July 13 show little or no thermocline. Those which do show a thermocline have no continuity from one sample date to the next. The thermocline varied from 1 meter (April 13) to 4 meters

(April 19) to 5 meters (May 20) to none (May 25, June 3 and June 17) to 2 meters (June 24) one meter and six meters (June 30) to none (July 5) to two meters and six meters (July 12) and finally on July 13, the first day of Station 2 monitoring, a mild thermocline at two meters for Station 1, and 2 thermoclines, one at 1 meter and a second between 5 and 6 meters, for Station 2.

Beginning July 19 more permanent tendencies were evident in thermal stratification. This sampling, conducted at 6:30 A.M., shows two thermoclines at both stations, one at two meters and a second at five meters. This trend toward two thermoclines continued throughout the summer at Station 2 while at Station 1 the lower thermocline sank so deep that only the shallow stratification was observed after July 27. The depth and strength of the shallow stratification was dependent on two variables. First surface winds causing mixing and second daily incident light energy prior to the reading. Two factors influenced incident light energy: First actual solar radiation, which is dependent on season and cloud cover, and second and most important the time of day at which the temperatures were recorded.

Station 1 surface temperature peaks occurred on four dates: June 24, with a reading time of 3:00 P.M.; July 27, with a reading time of 2:30 P.M.; August 17, with a reading

time of 1:15 P.M.; and September 7 with a reading time of 4:30 P.M. With one exception these dates represent the only days when data was collected after 12:30 P.M. The exception to this was a low reading of 24.0° C. on September 17 read at 5:00 P.M. However, solar radiation for this day was only 20% of average for this month and the field notes indicate that it was cloudy and raining on this day.

Late July all of August and early September were the warmest periods with temperatures between 1.2 meters and 6 meters staying in the range of 26° to 27° C. The cloudy and rainy weather of September 17 reduced temperatures to the point of no perceivable thermocline. However, the dissolved oxygen concentrations indicate that whole lake mixing was not yet taking place.

PHYCOLOGICAL DATA

Graphs of algal population size *versus* time are presented in figures 38 through 83, appendices D and E. Appendix D (figs. 38 - 78) presents each of the 39 species observed during the study, while appendix E (figs. 79 - 83) presents graphically total count data by phyla and for all planktonic alga.

CHLOROPHYTA

Figure 79 (Appendix E) shows the sum of all the Chlorophyta that appeared during the study. While there were significant amounts of Chlorophyta in most samples minima occurred during early July and early August at all sample points. and the highest densities occurred during October and December after whole lake mixing had been reestablished.

Ankistrodesmus convolutus (Fig. 38, Appendix D)

Ankistrodesmus convolutus ranges from highs of 16,000 cells per milliliter to none observed. When present the abundance was higher at Station 1, near shore. For Station 1 populations were highest during the spring and fall at the surface and at 2 meters. While at the 7 meter depth the highest values were recorded during the summer months and dropped to zero in December.

In contrast to Station 1, the most consistent population densities at Station 2 were recorded through the summer, with populations densities ranging from 2,000 to 14,000 cells per milliliter. At all depths *A. convolutus* fell to zero in September, but 0, 2 and 7 meters recovered to previous densities by October. Station 2 at 5 meters maintained a low count throughout the summer and fall with late August, September and October counts at zero, but in

December the population rose to 12,000 cells per milliliter, the highest count for December.

Chlorella ellipsoidea (Fig. 39, Appendix D)

Chlorella ellipsoidea shows Station 1 concentrations at 0 meters to be higher than Station 2 concentrations at 0 meters and to be fluctuating throughout the summer. The major peaks for Station 1, 0 meters and 2 meters, occurred in June, July and August with the highest peak occurring June 30 at a density of 38,000 cells per milliliter. The first counts at Station 2 were taken July fifth, after the maximum peak at Station 1, and presented the highest Station 2 total for *C. ellipsoidea* for the summer, 30,000 cells per milliliter. Had counts for *C. ellipsoidea* been taken before July 5. Station 2 may have also shown higher counts in June. The abundance of *C. ellipsoidea* was greatest for the 0 meter and 2 meter depths during the summer and 5 and 7 meters in late spring and early winter.

Chodatella longiseta (Fig. 40, Appendix D)

Chodatella longiseta was not found at all depths on any one sampling and only appeared occasionally. During late August and early September *C. longiseta* was observed in its highest numbers (6 - 8,000 cells per milliliter) during late August at Station 1.

Cosmarium sp. (Fig. 41, Appendix D)

Cosmarium, shows no sign of regular occurrence with *Cosmarium* only occurring in eight samples; twice at Station 1 at 2 meters, early July and early August, twice at Station 1 at 7 meters, October and December, three times at Station 2 at 0 meters, September, October and November, and once at Station 2 at 7 meters, December. December was the heaviest occurrence with 4,000 cells per milliliter.

Diacanthos sp. and Echinosphaerella sp. (Figs. 42 and 43, Appendix D)

Diacanthos and *Echinosphaerella* were found only rarely with *Diacanthos* being counted nine times and *Echinosphaerella* only twice.

Franceia sp. (Fig. 44, Appendix D)

Franceia occurred with some regularity at Station 1 at 2 meters during June, July and August but did not appear in concentrations above 4000 cells per milliliter. Figure 42 shows single peaks only for all other depths at Station 1 and 2 except for two peaks at 7 meters for Station 2.

Golenkinia radiata (Fig. 45, Appendix D)

Golenkinia radiata occurred regularly throughout the study and in higher numbers at Station 1 than at Station 2, with major peaks occurring in early July and late August. The maximum cell density occurred, August 26 at Station 1 at 0 meter, with a count of 20,000 cells per milliliter. Peaks of 18,000 cells per milliliter occurred at other depths during August with a lesser peak occurring at Station 1 in early July. Except for the peak at 18,000 cells per milliliter for 2 meters on July 5 the fluctuations of Station 2 were much reduced from those at Station 1 resulting in lower average densities at Station 2 than Station 1.

Kirchneriella sp. (Fig. 46, Appendix D)

Kirchneriella maintained densities between 6,000 and 14,000 cells per milliliter with the highest peaks at Station 1 and Station 2 reaching as many as 20,000 cells per milliliter. The most consistent densities occurred at the surface with many small peaks occurring between 6,000 and 8,000 cells per milliliter throughout the spring and summer, and a large increase to 20,000 cells per milliliter in October. With the exception of 7 meters at both stations the October and December densities were rising to peaks at or above 8,000 cells per milliliter indicating a fall or

winter bloom for *Kirchneriella*.

Palmella sp. and *Pediastrum sp.* (Figs. 47 and 48, Appendix D)

Palmella and *Pediastrum* both occurred sporadically during the study with no apparent trends or consistency.

Scenedesmus abundans (Fig. 49, Appendix D)

Except for a large peak, 12,000 cells per milliliter, at the surface of Station 1 during July and early August, *Scenedesmus abundans* maintained a population around 6,000 cells per milliliter during the spring and summer. However a fall/winter bloom brought the population density to totals between 10,000 and 12,000 cells per milliliter for most depths at both stations. A large deviation from the other sample points occurred at the surface of Station 2, which showed no *S. abundans* until september.

Scenedesmus dimorphus (Fig. 50, Appendix D)

Except for a December bloom of 4,000 cells per milliliter, *Scenedesmus dimorphus* was not abundant nor consistent and did not appear regularly.

Scenedesmus incrassatulus (Fig. 51, Appendix D)

Scenedesmus incrassatulus occurred only at the surface of Station 2 and only for the October and December

observations.

Scenedesmus quadricauda (Fig. 52, Appendix D)

Scenedesmus quadricauda revealed four peaks all reaching the maximum study densities of 6,000 cells per milliliter. Three of these peaks occurred at the surface of Station 1 with the fourth occurring at the surface of Station 2. *S. quadricauda* was found more often and in higher numbers at the surface and near the bottom of both stations, and Station 1 populations were higher than Station 2.

Scenedesmus perforatus (Fig. 53, Appendix D)

Scenedesmus perforatus was found only in two sample depths prior to mid August, at Station 2 at 2 meters and 7 meters. However, a late bloom of *S.perforatus* occurred beginning in late August and reached its peak in October at a density of 20,000 cells per milliliter at a depth of 2 meters at Station 1. The Station 2 densities did not show this same increase and only experienced mild increases from September through December.

Figure 77 summarizes the Total *Scenedesmus* spp. populations found during the study, including *S. abundans, S. incrassatulus, S. quadricauda and S. perforatus.* The major population bloom occurred in the fall during the

October and December samplings.

Tetraedron minimum (Fig. 54, Appendix D)

Except for September 7, *Tetraedron minimum* was present in at least one of the samples for each sample day during the study. While at no time the density of *T. minimum* was observed above 10,000 cells per milliliter, its appearance was regular and on two occasions the maximum density was observed: July 5, 2 meters at Station 2; and July 27, surface at Station 1. While some higher individual counts were observed, figure 52 shows that December had the highest overall occurrence. On that date 8,000 cells per milliliter was the maximum and 2,000 cells per milliliter was the minimum for the 8 sample points.

Tetraedron trigonum (Fig. 55, Appendix D)

The maximum sample density for *Tetraedron trigonum* at 10,000 cells per milliliter occurred at the 2 meter depth of Station 2 on October 27. One sample counting density was found at 8,000 cells per milliliter and one at 6,000 cells per milliliter with four at 4,000 cells per milliliter and the remainder at 2,000 or zero cells. Except at the surface of Station 2, fig. 53 shows a bloom during October.

Tetrastrum heterocanthum (Fig. 56, Appendix D)

Tetrastrum heterocanthum was scarce during most of the summer appearing in only 11 of the samples from June through September. Fig. 54 does show the highest peak, 20,000 cells per milliliter, in October which occurred at the surface of Station 1. In December all sample depths showed the presence of *T. heterocanthum* with a 10,000 cells per milliliter maximum occurring this time at Station 1, 7 meters.

Figure 78 (Appendix d) shows the sum of the three species of *Tetraedron* spp. found during the study.

Treubaria setigerum (Fig. 57, Appendix D)

T. setigerum shows no consistency or predictability. The surface and 2 meters at Station 1 during September and October are the only sample points which revealed more than one occurrence of *T. setigerum* and these only at 2,000 cells per milliliter. The maximum density was Station 2 at 7 meters on July 27 with a density of 4,000 cells per milliliter. On this date Station 1, 2 meters, and Station 2, surface samples also show the presence of *T. setigerum* at a density of 2,000 cells per milliliter.

Trochiscia sp. (Fig. 58, Appendix D)

Trochiscia only appeared in the samples a total of 12 times during the study, and not at all in the surface samples from Station 1. The maximum frequency of occurrence was August and September during which it occurred in ten different samples.

Green Flagellates

Chlamydomonas (Fig. 59, Appendix D)

Chlamydomonas occurred regularly at Station 1 and only occasionally at Station 2. The highest densities occurred at Station 2 on August 17, with a surface population density of 16,000 cells per milliliter and a density of 8,000 cells per milliliter at 2 meters representing a small localized bloom of *Chlamydomonas*. The surface and 2 meter densities at Station 1 showed several peaks between 4,000 and 8,000 cells per milliliter while the 5 and 7 meter depth peaks were between 2,000 and 4,000 cells per milliliter.

Nislouchiella planktonica (Fig. 60, Appendix D)

Although the maximum densities occurred in other sample points, *Nislouchiella planktonica* occurred most regularly at the surface of Station 2 having been found there a total

of seven times. Five meters at Station 1 was the next highest frequency of occurrence, having appeared a total of four times at this sample point. The highest density, only 4,000 cells per milliliter, occurred five times during the study: twice at Station 2, 2 meters; and Station 1 at the surface and 7 meters.

Cyanophyta

Total Cyanophyta population densities are shown in Figure 80 (Appendix E). A maximum appeared a most sample points in mid to late August and a minimum at most sample points occurred in early September. During most of the study Cyanophyta densities fluctuated around 40,000 cells per ml.

Anabaena sp. (figure 61, Appendix D)

Anabaena was scarce throughout the summer, only having been found four times from June through August: June 30, Station 1 at the surface, 2,000 cells per milliliter; July 27, Station 2 at 2 meters, 2,000 cells per milliliter; August 17, Station 2, at the surface, 2,000 cells per milliliter; and August 31, Station 1, at the surface, 2,000 cells per milliliter.

Anabaenopsis ellenkinii (figure 62, Appendix D)

Anabaenopsis ellenkinii appeared only at Station 1 before August 26, when a bloom initiated at both stations resulting in a maximum population density of 12,000 cells per milliliter during September. These blooms disappeared rapidly with the last indications, below 2 meters, disappearing before the October sampling. Only minor occurrences of *A. ellenkinii*, densities of 2,000 cells per milliliter, were recorded from June through August.

Dactylococcopsis sp. (figure 63, Appendix D)

Dactylococcopsis was the most frequently encountered algae during the study. Only in three samples, Station 2, 7 meters July 5, Station 1, 2 meters and Station 2, 7 meters August 26, was no *Dactylococcopsis* found. The major occurrence of *Dactylococcopsis* peaked on August 17 with Station 1 at the surface and 2 meters and Station 2 at the surface and 2 meters having population densities of 90,000, 86,000, 104,000 and 46,000 cells per milliliter respectively. This peak was followed immediately by low densities at all sample points on August 26 between 0 and 8,000 cells per milliliter except at the surface of Station 1 which was 26,000 cells per milliliter and reached its subsequent low of 14,000 cells per milliliter on August 31.

Merismopedia sp. (figure 64, Appendix D)

Merismopedia's most frequent appearance was at the surface of Station 1 and 7 meters at Station 2 having been recorded on 5 separate sampling dates with the maximum density for Station 1 sample point being 20,000 colonies (16 to 30 cells per colony) per milliliter recorded on September 17. The maximum density of *Merismopedia* was recorded August 12 at Station 2, 7 meters, where *Merismopedia* was recorded on four other occasions not exceeding 8,000 colonies per milliliter. *Merismopedia* was found on two different dates at both the 2 meter and 5 meter depths at Station 2.

Microcystis sp. (figure 65, Appendix D)

Microcystis appeared in higher concentrations both early in the study, June and July, and late in the study September through October. The summer counts and appearance of *Microcystis* were of small, 2 - 3 individuals per colonies while later in the year colony size increased to 50 or more individuals per colony. The highest peak of 28,000 colonies per milliliter in June represents fewer individuals than the peaks in September and October between 10 and twelve thousand colonies per milliliter. For late July and August the observed populations of *Microcystis* fell to

zero at all sample points representing the lowest levels during the study.

Oscillatoria sp. (figure 66, Appendix D)

Oscillatoria was present in the limnoplankton throughout the study, except during early July when all sample points revealed none. While *Oscillatoria* was more prevalent at Station 1 the highest density, 26,000 cells per milliliter was recorded at a depth of 2 meters at Station 2 on August 10. On this same date the surface of Station 2 revealed a density of 18,000 cells per milliliter and 2 meters at Station 1 was counted at 10,000 cells per milliliter with the remaining sample points showing no occurrence of *Oscillatoria*. The June occurrences, when Station 1 only was being monitored, showed a maximum density of 10,000 cells per milliliter at the surface decreasing with depth to zero at 7 meters.

The occurrence of *Oscillatoria* at station 1 after July 27 was distributed throughout all sample depths with the highest densities occurring at 2 meters and 7 meters. During this period the two meter depth most consistently maintained its population, with peaks ranging between 10,000 and 18,000 cells per milliliter, and the highest peak of 18,000 cells per milliliter occurring October 27.

Station 2 populations occurred on two separate

occasions. The first occurrence, at the end of July and beginning of August, resulted in the highest recorded density of *Oscillatoria* (26,000 cells per milliliter). The high peak occurred at 2 meters with smaller peaks occurring at all depths during this time. The second occurrence was late August through September with all depths showing no *Oscillatoria* during the October sampling. The high peaks occurred August 31 and September 17 with densities ranging between 4,000 and 20,000 cells per milliliter. During this last bloom at Station 2 the surface samples showed no occurrence of *Oscillatoria*.

Chrysophyta : Bacillariophyceae

Figure 81 (Appendix E) shows total Bbacillariophyceae populations during the study. Maxima appeared during both June and November indicating the occurrance of major blooms during the spring and late fall.

Biddulphia sp. (figure 67, Appendix D)

Biddulphia occurred in a total of 8 samples during the study. The maximum frequency and density of occurrence was on October 27 when it occurred in four samples and at a total density of 8,000 cells per milliliter for the surface of Station 2. A large bloom of diatoms, including *Biddulphia*, occurred during October and can be credited

to the increased density and frequency of occurrence of *Biddulphia* on October 27. The highest population density was also observed on this date at the seven meter depth of Station 1 with 8,000 cells per milliliter.

Melosira varians (figure 68, Appendix D)

Melosira varians populations showed two high density counts. The first at Station 1 during late May and early June and the second during September and October. The highest peak during the first bloom, also the highest during the study, occurred June 3 when 70,000 cells per milliliter were observed at a depth of 2 meters. The surface, five meter and seven meter densities on this date were 56,000, 46,000 and zero cells per milliliter respectively. Except for a peak occurring in August the density of *M. varians* remained near 4,000 cells per milliliter during the summer and rose to a fall peak with the other diatoms, at both stations in October. The highest fall density, like the spring bloom, occurred at two meters of depth at Station 1. This time with 42,000 cells per milliliter.

Stephanodiscus sp. (figure 69, Appendix D)

Stephanodiscus populations had bloomed in the early summer and again in October. The summer bloom came in late June and early July and was evidenced at both Station 1 and

2. The high peak, for both the summer bloom and the study, occurred at the surface of Station 1 with a density of 66,000 cells per milliliter with densities of 20,000, 14,000, 24,000, 6,000, 18,000, 30,000, and zero cells per milliliter for Station 1, 2 meters, 5 meters, and 7 meters and Station 2 at the surface, 2 meters, 5 meters and 7 meters respectively.

The fall bloom shown by the October peak showed lower densities than the early summer bloom, with a maximum at 2 meters at Station 1 of 34,000 cells per milliliter. The fall bloom was no longer in evidence during the December sampling.

Tabellaria sp. (figure 70, Appendix D)

Tabellaria was observed only once, this at a depth of 7 meters at Station 1 with a population density of 4,000 cells per milliliter.

Pennate Diatoms (figure 71, Appendix D)

Pennate diatoms were found only occasionally, with a large bloom occurring at Station 1 on August 31. The highest density occurred on this day with 26,000 cells per milliliter being observed at the surface of Station 1. The remaining densities at Station 1 were 4,000, 6,000 and 2,000 cells per milliliter for 2, 5 and 7 meters respectively.

The second highest density 10,000 cells per milliliter, occurring on September 7 at 5 meters for Station 2, occurred during a small bloom which, like the first peak, was concurrent with the pennate diatoms being found at three other sample points.

While the two maximum densities occurred at Station 1 at the surface and Station 2 at 5 meters, the highest frequencies of occurrence were at Station 1 2 meters, 5 meters and 7 meters with 4, 3 and 5 occurrences at each sample point respectively.

Chrysophyta : Chrysophyceae

Chrysochromulina sp. (figure 74, Appendix D)

Chrysochromulina appeared to have no preference for any one sample point over another, except that it did not appear at all at the 7 meter depth of Station 2 and only appeared twice at the seven meter depth of Station 1. The remaining sample points all showed the presence of *Chrysochromulina at* least three times during the study. The highest population density was observed at Station 1 two meters deep on June 30 when a density 28,000 cells per milliliter was observed. The sample taken the following week, July 5 had the highest daily rate of occurrence with six of the eight sample points having *Chrysochromulina* present and densities higher than most other sample

densities. The densities in cells per milliliter found here for station 1 were 6,000 at the surface, 6,000 at 2 meters, 2,000 at 5 meters, and for station 2 were 4,000 at the surface, 4,000 at 2 meters and 8,000 at 5 meters.

Euglenophyta

Euglena sp. (figure 72, Appendix D)

Both the highest frequency and density of occurrence of *Euglena* occurred at the surface of Station 1. *Euglena* was seen in four samples taken during the study with the highest density, 32,000 cells per milliliter, being counted on September 17, the next highest counts of 6,000 cells per milliliter on August 10 and August 31 were also at this sample point. The highest frequency of occurrence for any one day was August 10 when four sample points showed the presence of *Euglena*. Station 1 at the surface and seven meters and Station 2 at the surface and two meters recorded 6,000, 2,000, 2,000 and 2,000 cells per milliliter respectively.

Trachelomonas sp. (figure 73, Appendix D)

Trachelomonas showed no preference for any one sample point over another appearing three times at the surface, once at 2 meters, twice at 5 meters, and twice at seven meters for Station 1 and zero times for the surface,

two times for 2 meters, one time for 5 meters and twice for seven meters at Station 2. The maximum frequency of occurrence for any observation was twice which occurred May 25, July 13, September 17 and October 27. The highest density, 10,000 cells per milliliter, was recorded on May 25 for both 5 meters and 7 meters of depth at Station 1.

Pyrrophyta

Exuviaella sp. (figure 75, Appendix D)

Exuviaella was found only once during the study. The one occurrence was at a density of 2,000 cells per milliliter at a depth of 5 meters at Station 2.

Gymnodinium .sp (figure 76, Appendix D)

Gymnodinium was found only on 12 occasions with each occurrence being at a density of 2,000 cells per milliliter. The occurrence of *Gymnodinium* provided no pattern.

IV. DISCUSSION

The lake basin, having very gradual sloping sides, a depth of not more than 17 meters, about 8 meters during the study, a width of 3 km and a length of 12 km, has the physical shape Hutchinson (1957) attributes to an eutrophic lake.

Light, solar radiation in the visible spectrum, appeared to effect temperature most consistently. A comparison of figure 35 (temperature) and figure 1 (light) show temperature changing with solar radiation. As solar radiation peaked in the middle of August (the week of August 14) temperatures were at their maxima and began to descend constantly with the readings in September. The indication is that temperature, as expected, is dependent on solar radiation and appears to react to the radiation with a lag of up to 14 days. Total algal population (figure 83) and solar radiation show no direct correlation. The lack of correlation is shown most by the algal population size in late october reaching its maximum while solar radiation was approaching its minimum intensity. Although temperatures were not at a maximum in June, solar radiation may have actually peaked during late June prior to the first solar readings.

The chemical analysis of the lake indicates a possible-nitrogen limited lake. During the length of the study the nutrient least present was consistently nitrate

with little or no nitrite detectable. Ammonia levels remained relatively constant throughout the study indicating that the algal biomass was probably maintaining itself by recirculating the ammonia which they excreted. Thus, as Axler *et. al.* (1982) found for a sub-alpine lake, inorganic nitrogen concentrations remain extremely low due to a dynamic balance between ammonium sources and sinks. This study is consistent with their finding, suggesting that when nitrogen is the limiting factor the algae will assimilate ammonia as a nitrogen source in place of nitrate nitrogen.

Total phosphate and *ortho*-phosphate concentrations indicate that the lake has an over supply of phosphate and that it does not become the limiting factor for this lake. With many residences in the vicinity of the lake it is suspected that laundry soaps are the source of phosphate. Excess phosphorous leads to nitrate depletion by algae that form blooms in response to phosphate.

Sulfate levels within the lake remained relatively constant throughout the study around 80 to 100 parts per million and are accredited to the practice of pumping warm sulfur bearing water into the lake from deep wells during times of low water levels.

The concentration of silicate fell to zero at all eight sample locations on October 27 indicating that silicate was

the limiting nutrient for the expansion of the diatom population. Figure 84 presents a plot of both silicate and total diatom population versus time. As can be seen the silicate concentration is inversely proportional to the diatom population. As the diatom population grew the silicate concentration fell. As the diatom population fell the silicate concentration increased indicating that there is an inverse proportionality between silicate and diatom populations.

During the study pH remained fairly constant between 8.0 and 9.0. There was little change in pH even with the time of day. The calcium hardness was high enough that even with carbonate depletion from photosynthesis during the day there was little or no change in pH with day light. The low pH can be expected to restrict the lake to organisms which can tolerate high alkalinity.

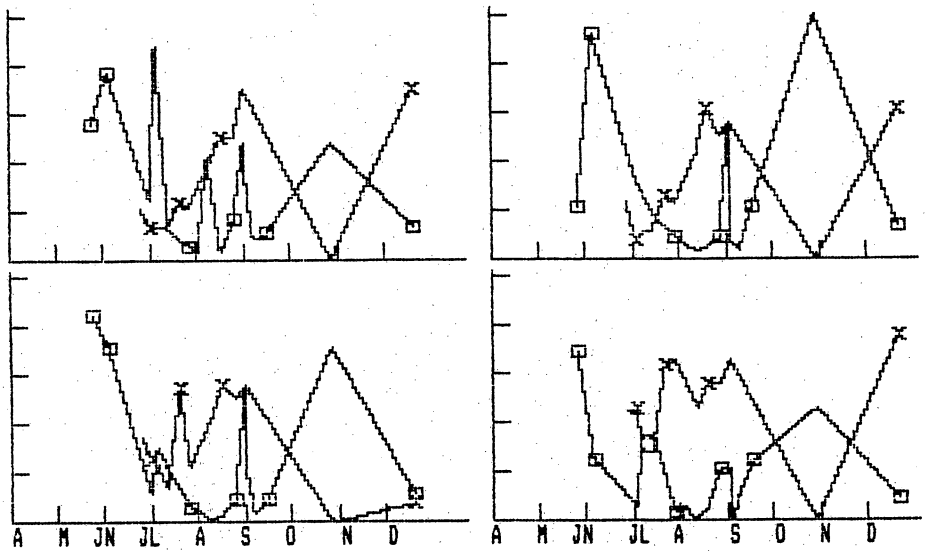
Calcium hardness and total hardness changed little during the study. Other than eliminating organisms which cannot tolerate a calcium hardness in excess of 50 ppm or total hardness in excess of 100 ppm, this level of hardness is not a factor in the lake dynamics and is indicative of the basin which contains large areas of sedimentary rocks.

Temperature data indicate the possible presence of stratification during most of the year. However the long term deep thermocline did not appear until July when the

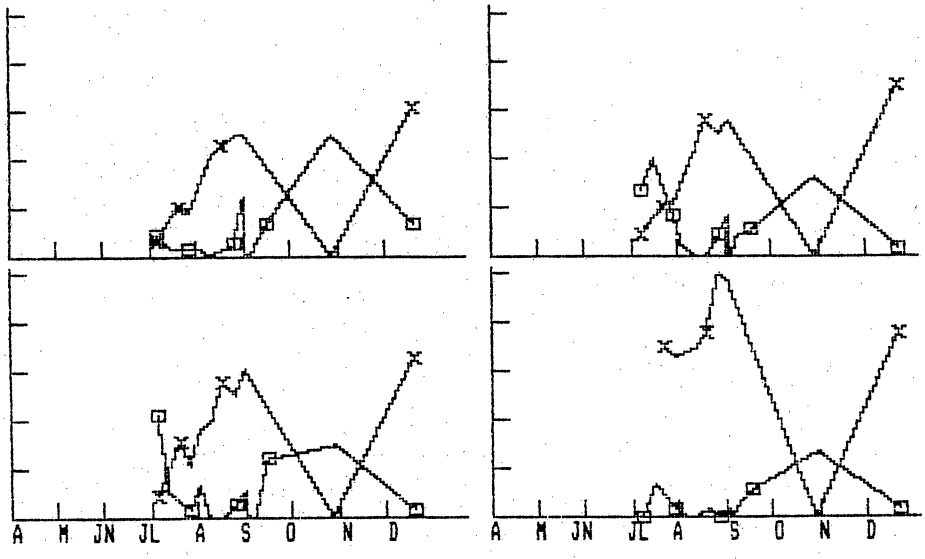
FIGURE 84

SILICATE (X) AND DIATOM POPULATION (O) VS. TIME
NO SCALE SHOWN FOR COMPARISON ONLY

STATION 1



STATION 2



thermocline started a descent from the daily established 1 - 3 meter level to a long term stable stratification at 7 meters. By late July and early August a permanent thermocline, 1 1/2o C, established itself between six and seven meters. A strong and relatively shallow thermoclines (less than 10 meters) is indicative of eutrophic waters which preclude light energy from penetrating more than several meters. Lake Elsinore can then be classified as a monomictic subtropical lake never reaching temperatures at or below 4o C.

Temperature plots against time (fig. 37) have the highest peaks during the end of the summer (August and September) when temperatures reached maxima of 28 to 29 C. This also corresponds with the highest oxygen concentrations and the smallest algal population (fig. 83). The indication being that oxygen production may be more closely related to temperature and solar radiation than to algal population.

Oxygen concentrations, first taken on August 26, are typical clinograde curves when concentration is plotted against depth for each sampling day through September 7, indicating a eutrophic type lake. The oxycline became more severe at each sampling until a maximum gradient of 9 parts per million per .6 meters was recorded on September 17 between 0.6 and 1.2 meters at Station 1. This gradient was due to oxygen production by algae in the upper limnion while

below the deep thermocline (7m.) the oxygen concentration fell to 0.5 ppm.

During the sampling of October 27 and December 20 the clinograde curve and oxycline were much less severe, along with a reduced thermocline, indicating that the summer thermocline had dissipated and that whole lake mixing had returned. The small oxycline and thermoclines present during October and December were from temporary gradients which would establish and dissipate on a daily basis.

Oxygen concentration in the upper limnion on several occasions became super saturated resulting in concentrations 3 to 4 ppm in excess of saturation. Supersaturation occurred 3 times. The first record was September 7 when Station 1 was super saturated from the surface to a depth of 2.4 meters and Station 2 was super saturated from the surface to 1.8 meters. Super saturation was still taking place on September 17 with both stations being super saturated at the surface and 0.6 meters. The third day super saturation was recorded on December 20. This super saturation is another indication of an eutrophic lake with an algal population and productivity so high that oxygen is unable to diffuse from the water as fast as it is being produced.

Oxygen concentrations with time plotted from August through December (Fig. 33) show two peaks above five meters

and one peak at or below five meters. The first peak for the 0 and two meter depths is a result of increased oxygen production above the thermocline while the peak (somewhat less visible at the surface) on October 27 is caused by whole lake mixing and loss of the thermocline.

	Pollution Index		Pollution Index
Anacystis	1	*Micractinium*	1
Ankistrodesmus	2	*Navicula*	3
Chlamydomonas	4	*Nitzchia*	3
Chlorella	3	*Oscillatoria*	5
Closterium	1	*Pandorina*	1
Cyclotella	1	*Phacus*	2
Euglena	5	*Phormidium*	1
Gomphonema	1	*Scenedesmus*	4
Lepocinclis	1	*Stigeoclonium*	2
Melosira	1	*Synedra*	2

Table 3. Algal Genus Pollution Index (from Palmer 1969)

Palmer (1969) reviewed the publishing of 165 authors to develop an indices of algae tolerating organic pollution. In developing the indices he assigned either 1 or 2 points to each algae considered by an author to be pollution tolerant, with 2 points being assigned to those algae which the authors felt were most significant in their study. Using Palmers data shown in Table 2 (from Palmer 1969) a pollution index was calculated for each station on each sample day. The daily index, shown in Table 3 is the sum of the pollution index for each genera present in the table for that day and station without regard to sample depth (see table B)

The average pollution index for each station during the sampling period was 18 for Station 1 and 16 for Station 2

Date	Station 1	Station 2
May 25, 1982	19	--
June 3, 1982	19	--
June 30, 1982	19	--
July 5, 1982	14	10
July 13, 1982	10	10
July 27, 1982	14	23
August 2, 1982	24	15
August 10, 1982	24	18
August 17, 1982	14	14
August 26, 1982	20	19
August 31, 1982	22	17
September 7, 1982	17	13
September 17, 1982	24	20
October 27, 1982	19	14
December 20, 1982	15	14

Table 4. Pollution indices for stations 1 and 2 on each sample day at Lake Elsinore. Indices are based on Palmer's (1969) Algal pollution index.

providing a strong indication of the existence of organic pollution within the lake. A small sample T-test done on the pollution indices found and the calculation shows that with 95% confidence these two represent different population bases. It may then be inferred that the near shore station represented a population of algae from more enriched waters than Station 2 in the middle of the lake. This is probably due to the influence of the bottom on the near shore water where the thermocline is not separating the bottom from the mixed layer.

A diversity index was calculated for each station on each day using the Shannon-Wiener information expression

shown in equation #6 (Hutchinson 1967). Table 3 shows the

EQUATION #6:

$$D = \frac{N_1}{N_s}\log_2\frac{N_1}{N_s} + \frac{N_2}{N_s}\log_2\frac{N_2}{N_s} + \cdots + \frac{N_I}{N_s}\log_2\frac{N_I}{N_s}$$

D = diversity
N_I = cells counted for any one species
N_s = total cells counted for the station
I = number of species found

result of the calculation for each day at each station. The average diversity at both Station 1 and Station 2 was 3.2 with a standard deviation of 0.5. The identical diversity indices indicate that the population variations were similar

Date	Station 1	Station 2
May 25, 1982	2.9	--
June 3, 1982	3.0	--
June 30, 1982	3.6	--
July 5, 1982	2.7	3.2
July 13, 1982	3.2	2.9
July 27, 1982	3.7	3.0
August 2, 1982	3.2	2.6
August 10, 1982	2.5	2.5
August 17, 1982	2.0	2.2
August 26, 1982	3.4	3.8
August 31, 1982	4.0	3.5
September 7, 1982	3.0	2.9
September 17, 1982	3.9	3.8
October 27, 1982	3.7	3.7
December 20, 1982	3.5	3.9

	# of samples	Total Cells	Ave./count
Station 1	15	4838	320
Station 2	12	3316	276

Table 5. Diversity indices for Stations 1 and 2 on each sample day and total cell counts and average population densities in 1,000's of cells per ml.

between Station 1 and Station 2. As a further check on population differences the total cells counted at both stations and the average number of cells per count were calculated.

The average population density was 16% higher at Station 1 than at Station 2. This reduced population density may have been due to the increased depth of the mixed layer. As the depth to the bottom at Station 1 was just over 6 meters and the depth to thermocline (bottom of the mixing layer) at Station 2 was usually 7.2 meters allowing the population to be mixed through 16% more water. While most species appeared at both stations *Ankistrodesmus convolutus, Chodatella longiseta, Franceia* sp., *Golenkinia radiata, Scenedesmus quadricauda, Chlamydomonas* sp. and *Oscillatoria* sp. occurred most often or in the largest numbers at Station 1 near shore. There was no apparent water chemistry activity which would account for the higher rates of inshore occurrence for these species. If these species have faster settling rates than other species, then the fact that the bottom is shallower than the thermocline could allow them to accumulate on the bottom and be mixed back into the surface waters by the mixed layer after they settle. A second explanation could be that there is a higher supply of chemical nutrients near shore which one or more of thesespecies require and assimilate rapidly. If the

assimilation is rapid enough then the chemical analysis would not pick up a higher concentration of the nutrient even though a near shore supply is there. Two possible sources are the benthos, which is stirred by both boats and the wind, and nutrients carried into the lake from the urban uses surrounding it. A third factor here is temperature, as the temperatures, at least during stratification, were about one to two degrees higher at Station 1 than at Station 2.

Table 5 lists in order the seven most prevalent algae. The table lists for each day the maximum density for the alga and number of sample locations in which the sample was found. That is, for *Dactylococcopsis* sp. on may 25, 1982 the highest density was 14,000 cells per milliliter and it appeared in all 4 of the Station 1 sample depths. On July 5, 1982 *Dactylococcopsis* sp. had a maximum density of 54,000 cells per milliliter and appeared in several of the 8 samples for the two stations. The last column gives the average maximum density during the study (the sum of the densities divided by 15) and the total number of occurrences of each alga. Again looking at *Dactylococcopsis* sp., the average density was 42,000 cells per milliliter and it was found in 105 for the total 108 samples taken.

Genus/species	Month / Day	MAY 2	JUN 3	JUN 30	JUL 5	JUL 13	JUL 27	AUG 2	AUG 10	AUG 17	AUG 26	AUG 31	SEP 7	SEP 17	OCT 27	DEC 20	AVE tot
Dactylococcopsis	density	14	8	34	40	54	38	38	90	104	28	20	30	28	42	60	42
# of positive sample points		4	4	4	7	8	8	8	8	8	8	6	8	8	8	8	105
Chlorella ellipsoidea	density	6	20	38	14	26	20	38	26	10	6	16	12	12	18	22	19
# of positive sample points		3	4	4	7	8	7	6	8	7	7	7	7	8	8	8	99
Melosira varians	density	60	70	4	8	6	2	4	32	4	12	28	6	12	42	10	20
# of positive sample points		4	3	2	4	5	2	4	1	5	7	8	6	8	8	7	74
Kirchneriella sp.	density	6	22	0	2	14	8	14	12	10	6	26	20	22	22	26	14
# of positive sample points		4	3	0	1	4	5	6	6	7	4	2	7	6	8	7	70
Stephanodiscus sp.	density	0	18	24	66	28	12	8	0	2	4	6	2	4	34	6	14
# of positive sample points		0	2	4	7	8	8	3	0	1	3	5	1	5	8	3	58
Ankistrodesmus convolutus	density	10	16	10	4	10	6	6	10	8	4	2	6	8	16	12	9
# of positive sample points		4	4	3	2	6	5	6	6	6	5	4	4	6	7	7	75
Golenkinia radiata	density	0	4	4	18	18	4	4	12	6	20	16	8	10	8	6	9
# of positive sample points		0	2	4	7	7	3	3	5	4	6	8	5	7	5	6	72

Table 6. Frequency and Density of occurrence for the seven most abundant genus/species observed during the study. For each alga the density in 1,000's of cells per ml. is given over the number of sample points it occurred, with the final column on the right displaying the average density over the total occurrences during the study. During May and June there were only four sample points all at Station 1, while the remainder of the study shows 8 sample points 4 at each of Stations 1 and 2.

Dactylococcopsis sp., *Chlorella ellipsoidea*, *Melosira varians* and *Kirchneriella* sp. were the four most common species present during the study. *C. Ellipsoidea* and *Dactylococcopsis* sp. were both present during each sample day with normal populations in excess of 10,000 cells per milliliter. *Kirchneriella* sp. was absent only on one sample day and showed early summer densities near 4,000 cells per milliliter and late summer

surface densities over 10,000 cells per milliliter. *M. varians* was present throughout the year but the larger populations were late spring and fall.

Lake Elsinore can be described as an eutrophic monomictic lake. The lake is nitrogen-limited rather than phosphate-limited probably due to use of phosphate detergents used by residents around the lake. The diversity index for the two stations 3.2 indicates similar variations in populations close to shore and at the middle of the lake. However, the pollution index shows the near shore population (Station 1) to be more influenced by pollution than the algal population near the center of the lake (Station 2).

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VI. APPENDICES

APPENDIX A

TABLES 7 THROUGH 28

WATER CHEMISTRY AND

PHYCOLOGICAL DATA

DEPTH (METERS)	STATION 1 0	2	5	7	STATION 2 0	2	5	7	STATION 1 DEPTH METERS	T °C	DO PPM	STATION 2 T °C	DO PPM
TEMPERATURE (°C)	17.2	15.4	14.6	14.3					0.0	17.2			
									0.6	16.6			
									1.2	15.5			
									1.8	15.4			
									2.4	15.1			
									3.0	14.9			
									3.6	14.8			
									4.2	14.6			
									4.8	14.6			
									5.4	14.5			
									6.0	14.4			
									6.6	14.3			

Table 7. Water chemistry and phycology, 10:30 AM, April 13, 1982

DEPTH (METERS)	STATION 1 0	2	5	7	STATION 2 0	2	5	7	STATION 1 DEPTH METERS	T °C	DO PPM	STATION 2 T °C	DO PPM
TEMPERATURE (°C)	19.8	18.9	16.5	15.8					0.0	19.8			
									0.6	19.4			
									1.2	19.2			
									1.8	18.9			
									2.4	18.8			
									3.0	17.5			
									3.6	17.1			
									4.2	16.6			
									4.8	16.4			
									5.4	16.2			
									6.0	16.0			

Table 8. Water chemistry and phycology, April 19, 1982, no time recorded

	STATION 1				STATION 2				STATION 1			STATION 2	
DEPTH (METERS)	0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM
TEMPERATURE (°C)	22.6	22.5	22.1	20.8					0.0	22.6			
									0.6	22.5			
									1.2	22.5			
									1.8	22.5			
									2.4	22.4			
									3.0	22.4			
									3.6	22.5			
									4.2	22.5			
									4.8	21.5			
									5.4	21.1			
									6.0	20.8			
									6.6	20.5			

Table 9. Water chemistry and phycology, 6:45 AM, May 20, 1982.

	STATION 1				STATION 2				STATION 1			STATION 2	
DEPTH (METERS)	0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM
TEMPERATURE (°C)	22.4	22.1	21.7	21.4					0.0	22.4			
									0.6	22.4			
CELLS PER MILLILITER TIMES 1000									1.2	22.4			
ANKISTRODESMUS CONVOLUTUS	4	6	10	4					1.8	22.1			
CHLORELLA ELLIPSOIDEA	0	4	6	2					2.4	21.9			
KIRCHNERIELLA SP.	6	2	6	2					3.0	21.8			
SCENEDESMUS ABUNDANS	0	0	4	2					3.6	21.7			
SCENEDESMUS DIMORPHUS	2	0	0	0					4.2	21.7			
SCENEDESMUS QUADRICAUDA	0	4	0	0					4.8	21.6			
TETRAEDRON MINIMUM	0	6	6	4					5.4	21.5			
TETRAEDRON TRIGONUM	0	2	0	0					6.0	21.4			
CHLAMYDOMONAS SP.	6	0	2	2									
WISLOUCHIELLA PLANCTONICA	4	0	0	0									
ANABAENAOPSIS ELENKINII	2	0	0	0									
DACTYLOCOCCOPSIS SP.	14	12	10	4									
MICROCYSTIS SP.	8	8	6	6									
OSCILLATORIA SP.	0	0	2	0									
MELOSIRA VARIANS	42	16	60	52									
PENATE DIATOM	0	0	4	0									
TRACHELOMONAS SP.	0	0	10	10									
CHRYSOCHRONULINA SP.	8	0	6	0									
TOTAL CELLS	96	60	132	88									
TOTAL SPECIES/GENERA	10	9	13	10									

Table 10. Water chemistry and phycology, May 25, 1982, no time recorded.

DEPTH (METERS)	STATION 1 0	2	5	7	STATION 2 0	2	5	7
TEMPERATURE (°C)	22.4	20.6	20.1	20.1				
	CELLS PER MILLILITER TIMES 1000							
ANKISTRODESMUS CONVOLUTUS	16	16	6	4				
CHLORELLA ELLIPSOIDEA	14	20	6	4				
FRANCEIA SP.	0	4	0	0				
GOLENKINIA RADIATA	2	4	0	0				
KIRCHNERIELLA SP.	8	22	8	0				
SCENEDESMUS ABUNDANS	0	4	0	0				
SCENEDESMUS DIMORPHUS	2	0	0	2				
TETRAEDRON MINIMUM	2	2	2	2				
TETRAEDRON TRIGONUM	0	4	0	0				
TETRASTRUM HETEROCANTHUM	0	0	0	4				
CHLAMYDOMONAS SP.	2	4	0	0				
ANABAENAOPSIS ELENKINII	0	2	0	0				
DACTYLOCOCCOPSIS SP.	8	8	6	6				
MERISMOPEDIA SP.	8	0	0	0				
MICROCYSTIS SP.	4	0	0	2				
OSCILLATORIA SP.	0	0	2	0				
MELOSIRA VARIANS	56	70	46	0				
STEPHANODISCUS SP.	0	0	8	18				
PENATE DIATOM	2	0	0	0				
TOTAL CELLS	124	160	84	42				
TOTAL SPECIES/GENERA	12	12	8	8				

STATION 1 DEPTH METERS	T °C	DO PPM	STATION 2 T °C	DO PPM
0.0	21.0			
0.6	20.8			
1.2	20.7			
1.8	20.6			
2.4	20.4			
3.0	20.5			
3.6	20.4			
4.2	20.3			
4.8	20.2			
5.4	20.1			
6.0	20.1			
6.6	20.1			
7.2	20.1			

Table 11. Water chemistry and phycology, June 3, 1982, no time recorded.

DEPTH (METERS)		STATION 1 0	2	5	7	STATION 2 0	2	5	7
TEMPERATURE	(°C)	22.6	22.8	22.6	22.4				

STATION 1 DEPTH METERS	T °C	DO PPM	STATION 2 T °C	DO PPM
0.0	22.6			
0.6	22.6			
1.2	22.7			
1.8	22.8			
2.4	22.7			
3.0	22.7			
3.6	22.7			
4.2	22.6			
4.8	22.6			
5.4	22.5			
6.0	22.4			

Table 12. Water chemistry and phycology, 9:15 AM, June 17, 1982.

DEPTH (METERS)		STATION 1 0	2	5	7	STATION 2 0	2	5	7
NITRATE	(PPM)	0.00	0.00	0.00	0.00				
AMMONIA	(PPM)	1.10	0.58	0.84	0.88				
SILICATE	(PPM)	0.40	0.45	0.68	0.88				
PHOSPHATE (ORTHO)	(PPM)	1.30	0.40	0.85	0.50				
SULFATE	(PPM)	76.0	74.0	79.0	79.0				
pH		9.1	8.8	8.6	8.5				
TEMPERATURE	(°C)	27.5	23.0	21.4	21.3				

STATION 1 DEPTH METERS	T °C	DO PPM	STATION 2 T °C	DO PPM
0.0	27.5			
0.6	26.3			
1.2	23.9			
1.8	23.0			
2.4	22.4			
3.0	21.8			
3.6	21.5			
4.2	21.5			
4.8	21.4			
5.4	21.3			
6.0	21.3			
6.6	21.3			

Table 13. Water chemistry and phycology, 3:00 PM, June 24, 1982.

DEPTH (METERS)		STATION 1 0	2	5	7	STATION 2 0	2	5	7
NITRATE	(PPM)	1.40	1.00	0.60	1.80				
AMMONIA	(PPM)	0.20	0.38	0.44	1.00				
SILICATE	(PPM)	0.25	0.14	0.50	0.90				
PHOSPHATE (ORTHO)	(PPM)	0.14	0.02	0.23	0.40				
SULFATE	(PPM)	95.0	100.0	100.0	120.0				
TEMPERATURE	(°C)	23.2	22.6	22.2	21.5				
		CELLS PER MILLILITER TIMES 1000							
ANKISTRODESMUS CONVOLUTUS		2	10	2	0				
CHLORELLA ELLIPSOIDEA		38	8	8	8				
FRANCEIA SP.		2	0	0	0				
GOLENKINIA RADIATA		4	4	4	4				
PALMELLA SP.		2	0	0	0				
SCENEDESMUS ABUNDANS		0	2	2	2				
SCENEDESMUS DIMORPHUS		2	0	2	2				
SCENEDESMUS QUADRICAUDA		6	0	0	2				
TETRAEDRON MINIMUM		2	6	2	2				
TETRAEDRON TRIGONUM		0	0	2	2				
TETRASTRUM HETEROCANTHUM		0	0	2	4				
CHLAMYDOMONAS SP.		6	4	2	0				
NITSCHIELLA PLANCTONICA		0	0	0	4				
ANABAENA SP.		2	0	0	0				
DACTYLOCOCCOPSIS SP.		34	28	4	14				
MICROCYSTIS SP.		28	0	0	0				
OSCILLATORIA SP.		10	2	0	0				
MELOSIRA VARIANS		4	0	4	0				
STEPHANODISCUS SP.		14	24	4	4				
CHRYSOCHROMULINA SP.		0	28	0	6				
GYMNODINIUM SP.		2	2	0	0				
TOTAL CELLS		158	118	38	54				
TOTAL SPECIES/GENERA		16	11	12	12				

DEPTH METERS	STATION 1 T °C	DO PPM	STATION 2 T °C	DO PPM
0.0	23.2			
0.6	23.2			
1.2	22.6			
1.8	22.6			
2.4	22.5			
3.0	22.5			
3.6	22.5			
4.2	22.5			
4.8	22.4			
5.4	22.0			
6.0	21.6			
6.6	21.5			

Table 14. Water chemistry and phycology, 11:45 AM, June 30, 1982.

		STATION 1				STATION 2				STATION 1			STATION 2	
DEPTH (METERS)		0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM
NITRATE	(PPM)	0.50	1.80	1.00	0.50	0.00	0.00	0.00	-	0.0	23.1			
NITRITE	(PPM)	0.00	0.00	0.00	0.00	-	-	-	-	0.6	23.0			
AMMONIA	(PPM)	0.25	0.23	0.48	0.60	0.15	0.13	0.20	-	1.2	22.9			
SILICATE	(PPM)	0.25	0.22	0.44	0.55	0.13	0.17	0.16	-	1.8	22.7			
PHOSPHATE (ORTHO)	(PPM)	0.40	0.21	0.49	0.40	0.13	0.16	0.25	-	2.4	22.7			
PHOSPHATE TOTAL	(PPM)	2.80	1.30	1.60	1.50	0.43	0.68	1.50	-	3.0	22.6			
SULFATE	(PPM)	90.0	90.0	93.0	98.0	75.0	65.0	75.0	-	3.6	22.6			
pH		8.8	8.8	8.7	8.7	-	-	-	-	4.2	22.4			
TEMPERATURE	(°C)	23.1	22.7	22.4	22.0	24.0	24.1	23.1	22.8	4.8	22.4			
										5.4	22.4			
		CELLS PER MILLILITER TIMES 1000								6.0	22.2			
										6.6	22.0			
ANKISTRODESMUS CONVOLUTUS		0	0	4	0	0	0	2	0					
CHLORELLA ELLIPSOIDEA		10	6	6	14	6	30	14	0					
COSMARIUM SP.		0	2	0	0	0	0	0	0					
GOLENKINIA RADIATA		8	6	6	10	10	18	6	0					
KIRCHNERIELLA SP.		0	0	2	0	0	0	0	0					
PALMELLA SP.		0	0	0	0	0	2	0	0					
PEDIASTRUM SP.		0	0	0	2	0	0	0	0					
SCENEDESMUS ABUNDANS		4	0	0	0	0	2	8	0					
SCENEDESMUS QUADRICAUDA		0	0	0	0	2	4	4	0					
TETRAEDRON MINIMUM		0	0	0	0	2	10	4	0					
TETRAEDRON TRIGONUM		2	0	0	0	0	2	0	0					
TETRASTRUM HETEROCANTHUM		0	0	0	0	0	4	0	0					
TROCHISCHIA SP.		0	0	2	0	0	0	0	0					
CHLAMYDOMONAS SP.		0	0	0	4	0	0	0	0					
NISLOUCHIELLA PLANCTONICA		0	0	0	0	0	4	0	0					
BACTYLOCOCCOPSIS SP.		40	12	2	8	16	44	18	0					
MERISMOPEDIA SP.		0	0	0	0	0	2	0	0					
MICROCYSTIS SP.		4	0	0	0	14	8	0	0					
MELOSIRA VARIANS		0	0	8	2	0	2	2	0					
STEPHANODISCUS SP.		66	20	14	24	6	18	30	0					
TRACHELOMONAS SP.		4	0	0	0	0	0	0	0					
CHRYSOCHROMULINA SP.		6	6	2	0	4	4	8	0					
EXUVIELLA SP.		0	0	0	0	0	0	2	0					
TOTAL CELLS		144	52	46	64	60	154	98	0					
TOTAL SPECIES/GENERA		9	6	9	7	8	15	11	1					

Table 15. Water chemistry and phycology, 9:15 AM, July 5, 1982.

DEPTH (METERS)		STATION 1 0	2	5	7	STATION 2 0	2	5	7	STATION 1 DEPTH METERS	T °C	DO PPM	STATION 2 T °C	DO PPM
NITRATE	(PPM)	0.00	0.00	0.00	0.00	-	-	-	-	0.0	24.2			
NITRITE	(PPM)	0.00	0.00	0.00	0.00	-	-	-	-	0.6	24.2			
AMMONIA	(PPM)	0.38	0.37	0.45	0.45	-	-	-	-	1.2	24.2			
SILICATE	(PPM)	0.23	0.22	0.25	0.55	-	-	-	-	1.8	24.0			
PHOSPHATE (ORTHO)	(PPM)	0.26	0.33	0.37	0.48	-	-	-	-	2.4	23.6			
PHOSPHATE TOTAL	(PPM)	0.61	0.61	1.22	0.74	-	-	-	-	3.0	23.6			
SULFATE	(PPM)	95.0	92.0	87.0	91.0	-	-	-	-	3.6	23.5			
HARDNESS CALCIUM	(PPM)	50.0	60.0	50.0	55.0	-	-	-	-	4.2	23.4			
HARDNESS TOTAL	(PPM)	120.0	120.0	120.0	120.0	-	-	-	-	4.8	23.4			
FLOURIDE	(PPM)	0.8	0.8	0.8	0.8	-	-	-	-	5.4	23.2			
pH		8.9	8.8	8.7	8.6	-	-	-	-	6.0	22.8			
TEMPERATURE	(°C)	24.2	24.0	23.4	22.7	-	-	-	-	6.6	22.7			
										7.2	22.7			

Table 16. Water chemistry and phycology, 6:00 PM, July 12, 1982.

	STATION 1				STATION 2				STATION 1			STATION 2		
DEPTH (METERS)	0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM	
pH	8.8	8.7	8.7	8.7	8.9	8.8	8.7	8.6	0.0	23.9		25.0		
TEMPERATURE (°C)	23.9	23.6	22.9	22.7	25.0	23.9	23.4	22.6	0.6	23.7		25.0		
									1.2	23.8		24.5		
	CELLS PER MILLILITER TIMES 1000								1.8	23.6		23.9		
ANKISTRODESMUS CONVOLUTUS	10	6	2	8	0	14	0	6	2.4	23.2		23.6		
CHLORELLA ELLIPSOIDEA	26	4	6	6	18	8	2	6	3.0	23.0		23.6		
DIACANTHOS SP.	2	0	2	0	0	0	0	0	3.6	23.0		23.5		
FRANCEIA SP.	0	2	0	0	0	0	0	0	4.2	22.9		23.5		
GOLENKINIA RADIATA	6	4	0	18	2	4	6	2	4.8	22.9		23.1		
KIRCHNERIELLA SP.	8	0	0	0	14	4	8	0	5.4	22.9		22.9		
PALMELLA SP.	0	0	0	2	0	0	0	0	6.0	22.8		22.7		
SCENEDESMUS ABUNDANS	10	2	0	4	0	0	2	0	6.6	22.7		22.6		
SCENEDESMUS DIMORPHUS	0	2	0	0	0	0	0	0	7.2			22.6		
SCENEDESMUS QUADRICAUDA	0	0	0	4	2	0	0	2	7.8			22.6		
SCENEDESMUS PERFORATUS	0	0	0	0	0	4	0	2						
TETRAEDRON MINIMUM	0	2	0	0	0	4	2	2						
TETRAEDRON TRIGONUM	0	2	0	4	4	2	0	0						
TETRASTRUM HETEROCANTHUM	0	0	0	0	0	4	2	0						
NISLOUCBIELLA PLANCTONICA	0	0	0	0	2	0	0	2						
ANABAENAOPSIS ELENKINII	0	0	0	2	0	0	0	0						
DACTYLOCOCCOPSIS SP.	40	42	20	32	54	46	34	26						
MERISMOPEDIA SP.	10	0	0	4	0	0	0	2						
MICROCYSTIS SP.	0	2	4	4	2	2	4	8						
BIDDULPHIA SP.	0	0	0	0	0	2	0	2						
MELOSIRA VARIANS	6	2	4	2	0	0	0	2						
STEPHANODISCUS SP.	2	10	10	22	2	28	6	6						
TRACHELOMONAS SP.	0	2	0	0	0	0	0	2						
CHRYSOCHROMULINA SP.	2	2	0	0	2	0	0	0						
TOTAL CELLS	122	84	48	112	102	122	66	70						
TOTAL SPECIES/GENERA	11	14	8	13	10	13	9	14						

Table 17. Water chemistry and phycology, 6:00 AM, July 13, 1982.

		STATION 1				STATION 2				STATION 1			STATION 2	
DEPTH (METERS)		0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM
NITRATE	(PPM)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	25.5		26.9	
NITRITE	(PPM)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.6	25.4		26.8	
AMMONIA	(PPM)	0.23	0.27	0.82	0.95	0.30	0.25	0.25	1.19	1.2	25.4		26.8	
SILICATE	(PPM)	0.45	0.50	1.08	1.25	0.40	0.40	0.60	1.40	1.8	25.4		26.8	
PHOSPHATE (ORTHO)	(PPM)	0.19	0.23	0.43	0.50	0.16	0.13	0.17	0.67	2.4	24.9		26.8	
PHOSPHATE TOTAL	(PPM)	1.35	0.36	0.78	0.80	0.67	0.84	0.50	1.15	3.0	24.8		25.8	
SULFATE	(PPM)	-	-	-	-	70.0	125.0	110.0	180.0	3.6	24.5		25.5	
HARDNESS TOTAL	(PPM)	70.0	120.0	120.0	75.0	109.0	-	-	-	4.2	24.2		25.4	
FLOURIDE	(PPM)	0.8	0.7	0.7	0.7	0.7	0.8	0.7	0.8	4.8	23.9		25.0	
pH		8.9	8.9	8.6	8.6	9.0	9.1	8.7	8.6	5.4	23.6		24.2	
TEMPERATURE	(°C)	25.5	25.4	24.1	23.3	26.9	26.8	25.2	23.3	6.0	23.6		23.6	
										6.6	23.3		23.3	
										7.2			23.2	
										7.8			23.2	

Table 18. Water chemistry and phycology, 6:30 AM, July 19, 1982.

		STATION 1				STATION 2				STATION 1			STATION 2	
DEPTH (METERS)		0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM
NITRATE	(PPM)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	30.0		29.2	
NITRITE	(PPM)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.6	29.9		29.0	
AMMONIA	(PPM)	0.20	0.40	0.35	1.70	0.53	0.50	0.40	1.85	1.2	27.5		27.5	
SILICATE	(PPM)	0.40	0.43	0.43	1.30	0.35	0.40	0.42	1.30	1.8	27.1		26.7	
PHOSPHATE (ORTHO)	(PPM)	0.05	0.05	0.05	0.07	0.04	0.03	0.03	0.60	2.4	26.8		26.6	
PHOSPHATE TOTAL	(PPM)	0.08	0.24	0.16	0.50	0.07	0.12	0.12	0.60	3.0	26.5		26.5	
SULFATE	(PPM)	90.0	80.0	80.0	80.0	100.0	90.0	95.0	90.0	3.6	26.3		26.2	
pH		9.0	8.9	8.6	7.9	9.0	9.0	8.8	8.0	4.2	26.1		26.2	
TEMPERATURE	(°C)	30.0	27.1	25.8	23.1	29.2	26.7	26.1	22.8	4.8	25.5		26.0	
										5.4	23.3		25.7	
		CELLS PER MILLILITER TIMES 1000								6.0	23.2		23.4	
ANKISTRODESMUS CONVOLUTUS		6	0	0	2	2	4	2	0	6.6			22.8	
CHLORELLA ELLIPSOIDEA		6	2	2	0	4	20	6	2	7.2			22.7	
CHODATELLA LONGISETA		2	0	0	0	0	2	0	0	7.8			22.5	
FRANCEIA SP.		0	0	2	0	0	0	0	4					
GOLENKINIA RADIATA		0	2	2	2	0	4	0	0					
KIRCHNERIELLA SP.		4	0	0	8	4	0	6	4					
PEDIASTRUM SP.		2	0	0	0	0	0	0	0					
SCENEDESMUS ABUNDANS		12	0	2	6	0	2	6	0					
SCENEDESMUS DIMORPHUS		4	0	0	0	0	2	0	2					
SCENEDESMUS QUADRICAUDA		0	2	0	0	0	0	2	0					
TETRAEDRON MINIMUM		10	2	0	2	2	0	4	8					
TETRAEDRON TRIGONUM		0	0	2	2	0	0	0	2					
TETRASTRUM HETEROCANTHUM		0	0	2	0	0	0	0	0					
TREUBARIA SETIGERUM		0	2	0	0	2	0	0	4					
CHLAMYDOMONAS SP.		6	0	0	0	0	2	0	0					
NISLOUCHIELLA PLANCTONICA		0	2	2	0	0	0	0	0					
ANABAENA SP.		0	0	0	0	0	2	0	0					
ANABAENAOPSIS ELENKINII		0	2	0	0	0	0	0	0					
DACTYLOCOCCOPSIS SP.		16	16	18	6	20	38	36	10					
MERISMOPEDIA SP.		4	0	0	0	0	0	0	6					
MICROCYSTIS SP.		0	0	0	2	2	0	0	4					
OSCILLATORIA SP.		0	0	0	0	2	0	0	0					
BIDDULPHIA SP.		0	2	0	0	0	0	0	0					
MELOSIRA VARIANS		2	2	0	0	0	0	0	0					
STEPHANODISCUS SP.		2	2	4	2	2	12	2	2					
EUGLENA SP.		0	0	0	0	0	0	2	0					
TOTAL CELLS		76	36	36	32	40	88	66	48					
TOTAL SPECIES/GENERA		13	11	9	9	9	10	9	11					

Table 19. Water chemistry and phycology, 2:30 PM, July 27, 1982.

DEPTH (METERS)		STATION 1 0	2	5	7	STATION 2 0	2	5	7	STATION 1 DEPTH METERS	T °C	DO PPM	STATION 2 T °C	DO PPM
NITRATE	(PPM)	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.04	0.0	28.0		28.6	
NITRITE	(PPM)	0.02	0.02	0.03	0.06	0.01	0.03	0.19	0.13	0.6	27.7		27.8	
AMMONIA	(PPM)	0.40	0.50	0.55	0.65	0.40	0.45	0.52	0.48	1.2	27.6		27.5	
SILICATE	(PPM)	-	-	-	-	-	-	0.70	-	1.8	27.5		27.4	
PHOSPHATE (ORTHO)	(PPM)	0.11	0.15	0.11	0.11	0.00	0.05	0.05	0.11	2.4	27.3		27.3	
PHOSPHATE TOTAL	(PPM)	0.35	0.20	0.30	0.20	0.35	0.30	0.30	0.20	3.0	27.2		27.0	
HARDNESS TOTAL	(PPM)	120.0	120.0	120.0	110.0	110.0	110.0	120.0	130.0	3.6	27.2		26.8	
pH		8.9	8.8	8.8	8.8	8.9	8.9	8.7	8.5	4.2	27.1		26.7	
TEMPERATURE	(°C)	28.0	27.5	27.1	27.0	28.6	27.4	26.6	26.0	4.8	27.1		26.6	
										5.4	27.0		26.0	
		CELLS PER MILLILITER TIMES 1000								6.0	27.0		26.0	
ANKISTRODESMUS CONVOLUTUS		0	2	0	6	2	2	6	6	6.6	27.0		26.0	
CHLORELLA ELLIPSOIDEA		12	38	4	4	0	2	4	0	7.2			23.9	
CROOATELLA LONGISETA		0	0	0	0	0	0	0	2	7.8			23.2	
COSMARIUM SP.		0	2	0	0	0	0	0	0					
FRANCEIA SP.		0	0	0	2	0	2	2	0					
GOLENKINIA RADIATA		0	4	2	4	0	0	0	0					
KIRCHNERIELLA SP.		8	14	6	8	0	0	10	2					
SCENEDESMUS ABUNDANS		4	2	0	0	0	2	0	0					
SCENEDESMUS DIMORPHUS		0	0	0	2	2	0	0	0					
SCENEDESMUS QUADRICAUDA		2	0	0	2	0	0	0	0					
TETRAEDRON MINIMUM		0	0	2	0	2	0	4	4					
TROCHISCHIA SP.		0	2	0	0	0	0	2	0					
CHLAMYDOMONAS SP.		0	2	4	4	0	0	0	0					
WISLOUCHIELLA PLANCTONICA		0	0	2	0	2	2	0	0					
BACTYLOCOCCOPSIS SP.		22	20	20	32	26	14	38	14					
MERISMOPEDIA SP.		0	0	0	0	0	0	0	2					
MICROCYSTIS SP.		2	8	0	0	0	0	0	0					
OSCILLATORIA SP.		2	0	8	18	6	8	8	16					
MELOSIRA VARIANS		2	4	0	2	0	0	2	0					
STEPHANODISCUS SP.		0	0	0	0	2	2	8	0					
PENATE DIATOM		0	0	2	2	0	0	0	0					
EUGLENA SP.		0	0	4	2	0	0	0	0					
TRACHELOMONAS SP.		0	0	0	0	0	2	0	0					
CHRYSOCHROMULINA SP.		0	0	0	0	0	2	0	0					
GYMNODINIUM SP.		2	0	0	2	0	0	0	2					
TOTAL CELLS		56	98	54	90	42	38	84	48					
TOTAL SPECIES/GENERA		9	11	10	14	7	10	10	8					

Table 20. Water chemistry and phycology, 10:40 AM, August 2, 1982.

		STATION 1				STATION 2				STATION 1			STATION 2	
DEPTH (METERS)		0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM
NITRATE	(PPM)	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.0	26.4		26.8	
NITRITE	(PPM)	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.05	0.6	26.2		26.8	
AMMONIA	(PPM)	0.30	0.40	0.35	0.30	0.40	0.40	0.40	0.60	1.2	26.2		26.8	
SILICATE	(PPM)	0.80	0.85	0.85	0.90	0.80	0.85	0.80	1.40	1.8	26.1		26.7	
PHOSPHATE (ORTHO)	(PPM)	0.05	0.04	0.02	0.05	0.03	0.03	0.04	0.23	2.4	26.3		26.6	
PHOSPHATE TOTAL	(PPM)	0.40	0.30	0.30	0.25	0.45	0.45	0.45	0.70	3.0	26.2		26.6	
SULFATE	(PPM)	100.0	85.0	85.0	100.0	90.0	110.0	90.0	80.0	3.6	26.1		26.6	
HARDNESS TOTAL	(PPM)	110.0	120.0	120.0	120.0	120.0	110.0	120.0	120.0	4.2	26.0		26.6	
pH		8.9	8.8	8.8	8.8	9.0	9.0	8.9	8.6	4.8	26.0		26.6	
TEMPERATURE	(°C)	26.4	26.1	26.0	25.7	26.8	26.7	26.6	25.3	5.4	25.9		25.8	
										6.0	25.8		25.5	
		CELLS PER MILLILITER TIMES 1000								6.6			25.3	
ANKISTRODESMUS CONVOLUTUS		4	2	2	0	10	2	6	2	7.2			25.3	
CHLORELLA ELLIPSOIDEA		6	6	4	0	26	14	10	8	7.8			24.2	
FRANCEIA SP.		0	2	0	0	0	0	0	0					
GOLENKINIA RADIATA		8	0	0	0	12	4	6	4					
KIRCHNERIELLA SP.		0	4	0	4	14	6	12	6					
SCENEDESMUS ABUNDANS		0	6	0	0	0	0	0	2					
SCENEDESMUS DIMORPHUS		0	0	0	2	0	0	0	0					
TETRAEDRON MINIMUM		0	0	0	0	0	6	0	2					
TETRAEDRON TRIGONUM		0	0	0	0	0	0	0	4					
TROCHISCHIA SP.		0	0	0	2	0	0	0	0					
CHLAMYDOMONAS SP.		8	0	0	0	2	6	0	0					
NITSCHIELLA PLANCTONICA		0	0	0	0	2	4	2	0					
ANABAENAOPSIS ELENKINII		0	0	0	0	0	2	0	0					
DACTYLOCOCCOPSIS SP.		16	6	2	12	90	42	30	24					
MERISMOPEDIA SP.		0	0	0	0	0	0	0	60					
MICROCYSTIS SP.		0	0	0	0	0	8	0	0					
OSCILLATORIA SP.		0	10	0	0	18	26	0	0					
MELOSIRA VARIANS		32	0	0	0	0	0	0	0					
PENATE DIATOM		0	2	0	0	0	0	0	0					
EUGLENA SP.		6	0	0	2	2	2	0	0					
GYMNODINIUM SP.		0	0	0	0	2	0	0	0					
TOTAL CELLS		80	38	8	22	178	122	66	112					
TOTAL SPECIES/GENERA		7	8	3	5	10	12	6	9					

Table 21. Water chemistry and phycology, 9:00 AM, August 10, 1982.

	STATION 1				STATION 2			
DEPTH (METERS)	0	2	5	7	0	2	5	7
NITRATE (PPM)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NITRITE (PPM)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AMMONIA (PPM)	0.21	0.10	0.25	0.30	0.25	0.25	0.35	0.59
SILICATE (PPM)	1.00	1.20	1.10	1.10	0.90	1.10	1.10	1.50
PHOSPHATE (ORTHO) (PPM)	0.03	0.20	0.02	0.02	0.03	0.12	0.02	0.02
PHOSPHATE TOTAL (PPM)	0.20	0.40	0.20	0.22	0.30	0.20	0.20	0.23
HARDNESS CALCIUM (PPM)	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
HARDNESS TOTAL (PPM)	115.0	120.0	120.0	115.0	120.0	120.0	120.0	120.0
pH	9.2	9.0	8.8	8.7	9.3	8.9	8.8	8.7
TEMPERATURE (°C)	28.1	9.3	26.2	26.1	28.0	26.3	25.9	25.4
	CELLS PER MILLILITER TIMES 1000							
ANKISTRODESMUS CONVOLUTUS	2	4	4	4	2	8	0	0
CHLORELLA ELLIPSOIDEA	4	0	6	6	4	4	10	6
CHODATELLA LONGISETA	0	2	0	2	0	0	2	0
DIACANTHOS SP.	0	0	0	0	4	0	0	0
FRANCEIA SP.	0	2	0	0	0	0	0	0
GOLENKINIA RADIATA	0	2	6	0	4	0	2	0
KIRCHNERIELLA SP.	6	0	10	8	6	6	2	4
PALMELLA SP.	2	0	0	0	0	0	0	0
SCENEDESMUS ABUNDANS	2	0	0	4	0	4	0	0
SCENEDESMUS DIMORPHUS	0	0	0	0	2	0	0	0
SCENEDESMUS QUADRICAUDA	2	0	2	0	0	0	0	0
TETRAEDRON MINIMUM	0	0	2	2	6	0	0	0
TETRAEDRON TRIGONUM	0	0	0	2	2	0	0	0
TREUBARIA SETIGERUM	0	0	2	0	0	0	0	0
TROCHISCHIA SP.	0	0	0	2	0	2	0	0
CHLAMYDOMONAS SP.	0	6	0	0	16	8	0	0
ANABAENA SP.	0	0	0	0	2	0	0	0
BACTYLOCOCCOPSIS SP.	90	86	26	30	104	46	32	20
MELOSIRA VARIANS	2	4	2	4	2	0	0	0
STEPHANODISCUS SP.	0	0	0	0	0	0	0	2
TRACHELOMONAS SP.	0	0	0	0	0	0	2	0
GYMNODINIUM SP.	0	0	0	0	0	0	2	0
TOTAL CELLS	110	106	60	64	154	78	52	32
TOTAL SPECIES/GENERA	8	7	9	10	12	7	7	4

DEPTH METERS	STATION 1 T °C	STATION 1 DO PPM	STATION 2 T °C	STATION 2 DO PPM
0.0	28.1		28.0	
0.6	28.1		26.7	
1.2	27.4		26.5	
1.8	26.7		26.3	
2.4	26.4		26.3	
3.0	26.3		26.3	
3.6	26.3		26.2	
4.2	26.2		26.1	
4.8	26.2		25.8	
5.4	26.1		25.6	
6.0	26.1		25.5	
6.6			25.4	
7.2			25.0	
7.8			24.5	

Table 22. Water chemistry and phycology, 1:15 PM, August 17, 1982.

		STATION 1				STATION 2				STATION 1			STATION 2	
DEPTH (METERS)		0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM
NITRATE	(PPM)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	27.5	7.5	27.7	7.3
NITRITE	(PPM)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.6	27.1	7.1	27.0	7.8
AMMONIA	(PPM)	0.50	0.60	0.70	0.70	0.60	0.90	0.70	3.00	1.2	26.8	5.8	26.4	4.2
SILICATE	(PPM)	1.00	1.00	1.00	1.10	1.00	1.00	1.00	2.00	1.8	26.7	4.8	26.4	3.1
PHOSPHATE (ORTHO)	(PPM)	0.10	0.15	0.10	0.05	0.04	0.04	0.50	0.80	2.4	26.5	3.6	26.3	2.8
PHOSPHATE TOTAL	(PPM)	0.50	0.40	0.40	0.45	0.75	0.40	0.45	1.60	3.0	26.5	3.5	26.1	2.7
DISSOLVED OXYGEN	(PPM)	8.5	5.4	3.4	3.5	8.3	3.5	2.2	0.2	3.6	26.4	3.4	26.1	2.5
pH		9.2	9.0	8.9	8.9	9.0	8.9	8.8	8.1	4.2	26.4	3.1	26.0	2.0
TEMPERATURE	(°C)	27.5	26.7	26.3	26.4	27.7	26.4	26.0	24.5	4.8	26.3	2.9	26.0	1.8
										5.4	26.4	3.1	25.9	1.4
		CELLS PER MILLILITER TIMES 1000								6.0			25.6	0.3
ANKISTRODESMUS CONVOLUTUS		0	2	4	0	2	2	0	2	6.6			24.5	0.2
CHLORELLA ELLIPSOIDEA		6	4	4	2	0	6	4	4	7.2			24.4	0.1
CHODATELLA LONGISETA		4	0	0	2	0	0	0	0	7.8			24.3	0.0
GOLENKINIA RADIATA		20	12	18	16	0	6	4	0					
KIRCHNERIELLA SP.		4	2	6	0	0	0	0	2					
SCENEDESMUS ABUNDANS		0	2	2	0	0	0	4	0					
SCENEDESMUS QUADRICAUDA		0	0	2	0	0	0	0	2					
SCENEDESMUS PERFORATUS		0	2	0	0	0	0	0	0					
TETRAEDRON MINIMUM		2	0	0	0	2	0	2	2					
TETRAEDRON TRIGONUM		2	0	0	0	0	0	0	0					
TREUBARIA SETIGERUM		0	0	0	0	0	0	2	0					
TROCRISCHIA SP.		0	4	0	0	0	0	0	2					
CHLAMYDOMONAS SP.		0	0	0	0	0	4	0	0					
NISLOUCHIELLA PLANCTONICA		2	2	0	0	2	0	2	0					
ANABAENAOPSIS ELENKINII		0	0	0	0	2	6	0	0					
DACTYLOCOCCOPSIS SP.		28	0	8	8	6	0	4	6					
MERISMOPEDIA SP.		8	0	0	0	0	0	0	0					
OSCILLATORIA SP.		12	12	18	8	0	0	0	0					
BIDDULPHIA SP.		0	0	0	0	2	0	0	0					
MELOSIRA VARIANS		8	4	4	12	2	6	4	0					
STEPHANODISCUS SP.		4	2	0	2	0	0	0	0					
PENATE DIATOM		0	0	2	2	0	0	0	0					
EUGLENA SP.		0	4	0	0	2	0	0	0					
CHRYSOCHROMULINA SP.		0	0	0	0	4	4	4	0					
GYMNODINIUM SP.		0	0	2	0	0	0	0	0					
TOTAL CELLS		100	52	70	52	24	34	30	20					
TOTAL SPECIES/GENERA		12	12	11	8	9	7	10	7					

Table 23. Water chemistry and phycology, 12:30 PM, August 26, 1982.

		STATION 1				STATION 2				STATION 1			STATION 2		
DEPTH (METERS)		0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM	
NITRATE	(PPM)	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.0	25.5	6.6	27.3	7.5	
NITRITE	(PPM)	0.00	0.03	0.00	0.00	0.00	0.03	0.00	0.00	0.6	26.3	6.1	26.0	6.7	
AMMONIA	(PPM)	0.40	0.60	1.20	1.50	0.30	0.35	1.20	3.50	1.2	25.8	4.7	25.8	5.8	
SILICATE	(PPM)	1.40	1.10	1.10	1.30	1.00	1.10	1.20	1.90	1.8	25.7	3.7	25.7	4.5	
PHOSPHATE (ORTHO)	(PPM)	0.15	0.05	0.11	0.15	0.03	0.03	0.15	0.40	2.4	25.3	0.8	25.6	3.5	
PHOSPHATE TOTAL	(PPM)	0.45	0.70	0.70	0.80	1.30	0.80	0.70	1.60	3.0	25.2	0.6	25.5	1.7	
DISSOLVED OXYGEN	(PPM)	6.6	3.7	0.4	0.2	7.5	4.4	0.7	0.4	3.6	25.1	0.4	25.5	0.8	
HARDNESS CALCIUM	(PPM)	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	4.2	25.0	0.4	25.3	0.7	
HARDNESS TOTAL	(PPM)	120.0	120.0	120.0	120.0	120.0	120.0	120.0	120.0	4.8	25.0	0.3	25.2	0.6	
pH		9.1	8.9	8.7	8.6	9.1	8.9	8.6	8.6	5.4	25.0	0.3	25.2	0.5	
TEMPERATURE	(°C)	25.5	25.7	25.0	24.9	27.3	25.7	25.3	24.8	6.0	24.9	0.2	25.0	0.4	
										6.6			24.8	0.4	
		CELLS PER MILLILITER TIMES 1000								7.2			24.8	0.3	
ANKISTRODESMUS CONVOLUTUS		0	2	2	0	0	2	0	2	7.8			24.6	0.3	
CHLORELLA ELLIPSOIDEA		4	8	4	4	10	16	10	0						
CHODATELLA LONGISETA		0	6	6	8	0	0	0	0						
DIACANTHOS SP.		0	0	0	0	4	2	0	0						
FRANCEIA SP.		0	0	0	0	2	0	0	0						
GOLENKINIA RADIATA		4	6	6	16	10	4	4	4						
KIRCHNERIELLA SP.		0	26	0	0	0	0	0	2						
PEDIASTRUM SP.		0	2	0	0	0	0	0	0						
SCENEDESMUS ABUNDANS		0	4	2	0	0	0	2	0						
SCENEDESMUS DIMORPHUS		0	2	0	0	0	0	0	0						
SCENEDESMUS QUADRICAUDA		6	0	0	0	0	0	2	2						
SCENEDESMUS PERFORATUS		0	4	4	2	0	0	0	0						
TETRAEDRON MINIMUM		4	4	2	2	4	4	0	2						
TETRAEDRON TRIGONUM		2	0	0	0	0	0	0	0						
TETRASTRUM HETEROCANTHUM		0	0	14	0	0	0	0	0						
TREUBARIA SETIGERUM		0	2	0	0	0	0	0	0						
TROCHISCHIA SP.		0	0	0	0	0	0	2	0						
CHLAMYDOMONAS SP.		0	0	0	2	0	2	0	0						
NISLOUCHIELLA PLANCTONICA		4	0	2	0	2	0	2	0						
ANABAENA SP.		2	0	0	0	0	0	0	0						
ANABAENAOPSIS ELENKINII		0	12	2	6	12	2	6	2						
DACTYLOCOCCOPSIS SP.		14	20	2	4	16	4	20	6						
MERISMOPEDIA SP.		0	0	0	0	0	0	4	0						
MICROCYSTIS SP.		0	2	2	0	0	2	0	0						
OSCILLATORIA SP.		0	0	4	0	0	20	4	4						
MELOSIRA VARIANS		10	28	28	12	14	10	8	2						
STEPHANODISCUS SP.		0	8	6	2	4	2	0	0						
PENATE DIATOM		26	4	6	2	0	0	0	0						
EUGLENA SP.		6	0	0	0	0	0	0	0						
CHRYSOCHROMULINA SP.		2	0	0	0	0	0	0	0						
TOTAL CELLS		84	140	92	60	78	70	64	26						
TOTAL SPECIES/GENERA		12	17	16	11	10	12	11	9						

Table 24. Water chemistry and phycology, 11:00 AM, August 31, 1982.

		STATION 1				STATION 2				STATION 1			STATION 2	
DEPTH (METERS)		0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM
NITRITE	(PPM)	0.01	0.00	0.01	0.01	0.02	0.01	0.01	0.01	0.0	29.2	14.4	28.5	13.3
AMMONIA	(PPM)	0.70	0.70	1.30	1.30	0.60	0.50	0.90	0.90	0.6	29.2	15.2	28.6	14.6
PHOSPHATE TOTAL	(PPM)	0.05	0.20	0.10	0.11	0.03	0.02	0.03	0.15	1.2	28.6	12.9	28.5	14.8
DISSOLVED OXYGEN	(PPM)	14.4	11.1	2.8	1.3	13.3	14.6	1.1	0.7	1.8	27.3	11.1	28.2	14.6
TEMPERATURE	(°C)	29.2	27.3	25.9	25.6	28.5	28.2	26.2	25.6	2.4	26.4	8.4	27.3	7.5
										3.0	26.2	5.3	26.5	5.4
		CELLS PER MILLILITER TIMES 1000								3.6	26.0	4.8	26.5	3.4
ANKISTRODESMUS CONVOLUTUS		2	0	2	6	2	0	0	0	4.2	26.0	3.7	26.4	3.3
CHLORELLA ELLIPSOIDEA		12	0	6	8	12	10	4	4	4.8	25.8	2.8	26.0	1.1
GOLENKINIA RADIATA		4	0	2	8	0	0	8	2	5.4	25.7	2.2	25.8	0.9
KIRCHNERIELLA SP.		4	8	0	12	20	12	10	0	6.0	25.6	1.3	25.6	0.7
SCENEDESMUS ABUNDANS		0	0	0	0	2	0	0	0	6.6			25.6	0.7
SCENEDESMUS DIMORPHUS		0	0	0	2	0	0	0	0	7.2			25.4	0.5
SCENEDESMUS QUADRICAUDA		0	0	0	2	2	0	0	0	7.8			25.3	0.5
SCENEDESMUS PERFORATUS		0	2	2	0	0	0	4	0					
TETRASTRUM HETEROCANTHUM		0	0	0	2	0	0	0	12					
CHLAMYDOMONAS SP.		0	6	2	0	0	0	0	0					
ANABAENAOPSIS ELENKINII		10	4	2	0	0	0	2	2					
DACTYLOCOCCOPSIS SP.		30	18	14	12	2	6	4	16					
OSCILLATORIA SP.		4	16	0	0	0	0	0	0					
MELOSIRA VARIANS		4	0	2	8	2	6	0	4					
STEPHANODISCUS SP.		2	0	0	0	0	0	0	0					
PENATE DIATOM		0	2	0	0	0	0	0	0					
EUGLENA SP.		0	0	0	0	0	0	2	0					
CHRYSOCHROMULINA SP.		0	0	0	0	0	2	0	0					
GYMNODINIUM SP.		2	2	0	0	0	0	0	0					
TOTAL CELLS		74	58	32	60	42	36	34	40					
TOTAL SPECIES/GENERA		10	8	8	9	7	5	7	6					

Table 25. Water chemistry and phycology, 4:30 PM, September 7, 1982.

	STATION 1				STATION 2				STATION 1			STATION 2	
DEPTH (METERS)	0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM
NITRITE (PPM)	0.02	0.02	0.02	0.01	0.04	0.02	0.04	0.04	0.0	24.0	11.8	23.9	9.6
DISSOLVED OXYGEN (PPM)	11.9	2.5	1.2	1.2	9.6	3.0	1.3	0.8	0.6	24.2	12.3	23.9	9.1
TEMPERATURE (°C)	24.0	23.2	23.1	23.1	23.9	23.3	23.0	23.0	1.2	23.2	3.2	23.5	5.1
									1.8	23.2	2.5	23.3	3.0
	CELLS PER MILLILITER TIMES 1000								2.4	23.2	1.8	23.2	2.3
ANKISTRODESMUS CONVOLUTUS	6	2	2	2	8	0	0	4	3.0	23.1	1.3	23.1	1.7
CHLORELLA ELLIPSOIDEA	6	4	6	10	6	12	10	12	3.6	23.2	1.1	23.1	1.5
COSMARIUM SP.	0	0	0	0	2	0	0	0	4.2	23.1	1.1	23.1	1.5
DIACANTHOS SP.	0	0	0	0	0	0	4	0	4.8	23.1	1.1	23.0	1.3
GOLENKINIA RADIATA	10	2	4	4	0	2	2	4	5.4	23.1	1.1	23.0	1.2
KIRCHNERIELLA SP.	10	0	4	22	4	0	18	4	6.0	23.1	1.1	23.0	1.0
SCENEDESMUS ABUNDANS	0	4	4	0	2	0	2	2	6.6			23.0	0.8
SCENEDESMUS DIMORPHUS	0	0	0	0	0	0	2	0	7.2			23.0	0.5
SCENEDESMUS QUADRICAUDA	0	2	0	0	2	0	0	0	7.8			22.9	0.3
SCENEDESMUS PERFORATUS	0	2	0	0	0	0	4	4					
TETRAEDRON MINIMUM	0	2	0	0	0	0	0	2					
TETRAEDRON TRIGONUM	0	0	0	2	2	2	2	0					
TETRASTRUM HETEROCANTHUM	0	0	2	0	0	0	0	0					
TREUBARIA SETIGERUM	2	0	0	2	0	2	0	0					
TROCHISCHIA SP.	0	0	0	0	2	0	0	0					
CHLAMYDOMONAS SP.	8	0	0	0	0	0	0	0					
NISLOUCHIELLA PLANCTONICA	0	0	2	0	0	0	0	0					
ANABAENA SP.	0	0	18	8	0	0	0	0					
ANABAENAOPSIS ELENKINII	2	0	2	2	0	0	4	0					
DACTYLOCOCCOPSIS SP.	28	4	16	28	16	12	12	28					
MERISMOPEDIA SP.	20	0	0	0	0	0	8	8					
MICROCYSTIS SP.	0	2	12	2	2	0	0	4					
OSCILLATORIA SP.	0	8	0	20	0	4	8	14					
MELOSIRA VARIANS	8	12	2	10	8	4	8	6					
STEPHANODISCUS SP.	0	0	4	4	2	2	0	2					
PENATE DIATOM	0	4	0	4	0	2	10	0					
EUGLENA SP.	32	0	0	0	0	4	4	0					
TRACHELOMONAS SP.	2	0	2	0	0	0	0	0					
CHRYSOCHROMULINA SP.	0	0	2	0	0	0	0	0					
TOTAL CELLS	138	48	82	120	56	46	98	94					
TOTAL SPECIES/GENERA	13	12	15	14	12	10	15	13					

Table 26. Water chemistry and phycology, 5:00 PM, September 17, 1982.

		STATION 1				STATION 2				STATION 1			STATION 2		
DEPTH (METERS)		0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM	
NITRITE	(PPM)	0.13	0.13	0.13	0.14	0.12	0.12	0.13	0.12	0.0	20.4	8.0	20.0	7.8	
AMMONIA	(PPM)	0.30	0.33	0.35	0.40	0.31	0.33	0.39	0.37	0.6	20.2	8.1	20.0	7.4	
SILICATE	(PPM)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.2	19.5	7.6	19.4	5.8	
PHOSPHATE (ORTHO)	(PPM)	0.15	0.10	0.10	0.10	0.14	0.10	0.10	0.11	1.8	19.3	6.8	19.2	5.2	
PHOSPHATE TOTAL	(PPM)	0.30	0.23	0.30	0.40	0.30	0.23	0.23	0.23	2.4	19.2	6.0	19.1	4.6	
SULFATE	(PPM)	80.0	80.0	80.0	90.0	80.0	80.0	85.0	85.0	3.0	19.0	5.5	19.0	4.4	
DISSOLVED OXYGEN	(PPM)	7.9	6.8	4.6	4.2	7.7	5.1	3.7	3.5	3.6	19.0	5.1	19.0	4.2	
FLOURIDE	(PPM)	0.9	0.9	0.8	0.8	0.9	0.9	0.8	0.9	4.2	19.0	4.8	19.0	4.2	
pH		8.9	8.8	8.8	8.7	8.9	8.7	8.7	8.7	4.8	19.0	4.6	19.0	4.0	
TEMPERATURE	(°C)	20.4	19.3	19.0	19.0	20.0	19.2	19.0	18.9	5.4	19.0	4.4	19.0	3.8	
										6.0	19.0	4.2	19.0	3.8	
		CELLS PER MILLILITER TIMES 1000								6.6			18.9	3.6	
ANKISTRODESMUS CONVOLUTUS		8	12	16	2	12	8	0	4	7.2			18.9	3.6	
CHLORELLA ELLIPSOIDEA		8	4	8	18	6	6	6	16	7.8			19.0	2.1	
COSMARIUM SP.		0	0	0	2	2	0	0	0						
DIACANTHOS SP.		6	4	0	0	0	0	2	0						
GOLENKINIA RADIATA		4	0	2	0	0	8	2	2						
KIRCHNERIELLA SP.		20	12	10	6	8	14	22	22						
SCENEDESMUS ABUNDANS		6	2	8	0	12	2	2	2						
SCENEDESMUS DIMORPHUS		2	0	0	0	2	0	0	0						
SCENEDESMUS INCRASSATULUS		0	0	0	0	12	0	0	0						
SCENEDESMUS QUADRICAUDA		6	4	2	0	6	2	0	0						
SCENEDESMUS PERFORATUS		8	20	12	2	0	2	0	2						
TETRAEDRON MINIMUM		2	0	2	0	4	0	0	0						
TETRAEDRON TRIGONUM		2	2	6	2	0	10	4	2						
TETRASTRUM HETEROCANTHUM		20	0	0	0	8	8	0	0						
TREUBARIA SETIGERUM		2	0	0	0	0	0	0	0						
CHLAMYDOMONAS SP.		0	0	0	0	0	4	0	0						
NISLOUCHIELLA PLANCTONICA		0	2	0	2	2	0	0	0						
ANABAENA SP.		0	44	6	0	6	32	0	0						
DACTYLOCOCCOPSIS SP.		22	36	38	32	42	34	34	32						
MERISMOPEDIA SP.		0	0	0	0	0	8	0	0						
MICROCYSTIS SP.		2	10	0	2	6	6	2	2						
OSCILLATORIA SP.		8	20	6	0	0	0	0	0						
BIDDULPHIA SP.		0	0	2	8	0	2	2	0						
MELOSIRA VARIANS		24	42	38	14	18	16	12	2						
STEPHANODISCUS SP.		12	34	14	8	20	4	8	18						
TABELLARIA SP.		0	0	0	4	0	0	0	0						
PENATE DIATOM		0	0	0	0	0	2	0	0						
EUGLENA SP.		2	0	2	0	0	0	0	0						
TRACHELOMONAS SP.		0	0	0	2	0	4	0	0						
CHRYSOCHROMULINA SP.		0	0	2	4	0	0	2	0						
GYMNODINIUM SP.		0	0	0	0	2	0	0	0						
TOTAL CELLS		164	248	174	108	168	172	98	104						
TOTAL SPECIES/GENERA		19	15	17	15	17	19	12	11						

Table 27. Water chemistry and phycology, 12:45 PM, October 27, 1982.

		STATION 1				STATION 2				STATION 1			STATION 2	
DEPTH (METERS)		0	2	5	7	0	2	5	7	DEPTH METERS	T °C	DO PPM	T °C	DO PPM
AMMONIA	(PPM)	0.35	0.35	0.45	0.45	0.50	0.50	0.55	0.55	0.0	14.0	12.8	14.0	12.0
SILICATE	(PPM)	1.40	1.20	0.15	1.50	1.20	1.40	1.30	1.50	0.6	13.4	13.0	12.0	12.3
PHOSPHATE (ORTHO)	(PPM)	0.09	0.03	0.04	0.04	0.01	0.03	0.03	0.04	1.2	11.7	11.2	11.4	9.6
PHOSPHATE TOTAL	(PPM)	0.13	0.12	0.15	0.15	0.13	0.11	0.14	0.13	1.8	11.5	10.2	11.3	8.4
DISSOLVED OXYGEN	(PPM)	3.9	3.3	2.1	2.0	3.7	2.5	2.0	1.7	2.4	11.5	9.6	11.2	7.5
pH		8.7	8.5	8.3	8.3	8.7	8.4	8.2	8.1	3.0	11.4	8.7	11.2	7.3
TEMPERATURE	(°C)	20.4	19.3	19.0	19.0	20.0	19.2	19.0	18.9	3.6	11.4	8.2	11.2	6.8
										4.2	11.4	7.9	11.2	6.5
		CELLS PER MILLILITER TIMES 1000								4.8	11.4	7.5	11.2	6.3
ANKISTRODESMUS CONVOLUTUS		12	10	4	0	4	8	12	4	5.4	11.3	7.1	11.2	6.2
CHLORELLA ELLIPSOIDEA		6	6	22	4	10	6	4	2	6.0	11.0	7.1	11.2	5.8
CHODATELLA LONGISETA		0	0	2	2	0	10	0	0	6.6			11.2	5.5
COSMARIUM SP.		0	0	0	2	2	0	0	4	7.2			11.2	5.3
ECHINOSPHAERELLA SP.		0	0	0	0	0	6	0	4	7.8			11.1	5.4
FRANCEIA SP.		0	0	0	0	0	0	0	4					
GOLENKINIA RADIATA		0	6	4	4	2	4	0	2					
KIRCHNERIELLA SP.		12	26	10	2	8	16	6	0					
PALMELLA SP.		0	20	8	0	4	0	0	0					
PEDIASTRUM SP.		0	0	0	0	0	2	0	0					
SCENEDESMUS ABUNDANS		8	2	8	4	4	10	8	4					
SCENEDESMUS DIMORPHUS		4	4	2	0	2	4	4	0					
SCENEDESMUS INCRASSATULUS		0	0	0	0	2	0	0	0					
SCENEDESMUS QUADRICAUDA		4	2	2	0	0	0	0	0					
SCENEDESMUS PERFORATUS		0	0	4	2	4	0	10	4					
TETRAEDRON MINIMUM		2	2	6	4	2	2	8	6					
TETRAEDRON TRIGONUM		0	0	2	8	0	4	2	4					
TETRASTRUM HETEROCANTHUM		6	4	2	18	12	4	8	2					
TROCHISCHIA SP.		0	0	0	0	2	0	0	0					
CHLAMYDOMONAS SP.		0	8	2	0	0	0	2	0					
NISLOUCHIELLA PLANCTONICA		0	0	0	0	2	0	0	0					
DACTYLOCOCCOPSIS SP.		18	60	38	34	28	32	24	22					
MICROCYSTIS SP.		2	0	0	2	0	0	0	2					
MELOSIRA VARIANS		10	8	8	6	4	0	2	2					
STEPHANODISCUS SP.		0	2	0	0	6	2	0	0					
EUGLENA SP.		0	4	0	2	0	0	0	0					
TRACHELOMONAS SP.		0	0	0	0	6	0	0	0					
CHRYSOCHROMULINA SP.		0	0	0	0	0	2	0	0					
GYMNODINIUM SP.		0	0	0	0	2	0	0	0					
TOTAL CELLS		84	164	124	94	106	112	90	66					
TOTAL SPECIES/GENERA		11	15	16	14	19	15	12	14					

Table 28. Water chemistry and phycology, 2:30 PM, December 20, 1982.

APPENDIX B

FIGURES 2 THROUGH 25

TEMPERATURE AND OXYGEN VS. DEPTH

FIGURE 2

TEMPERATURE
APRIL 13, 1982

STATION 1

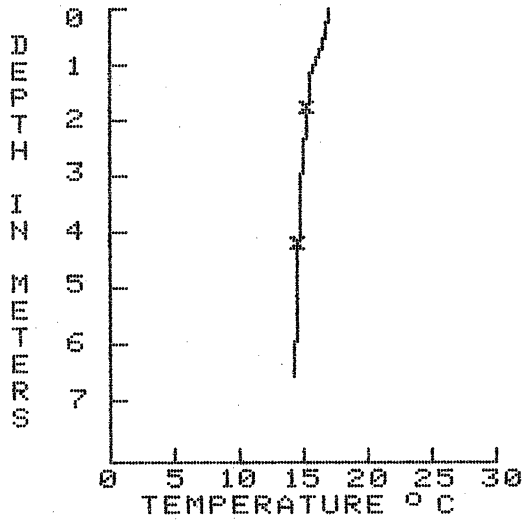


FIGURE 3

TEMPERATURE
APRIL 19, 1982

STATION 1

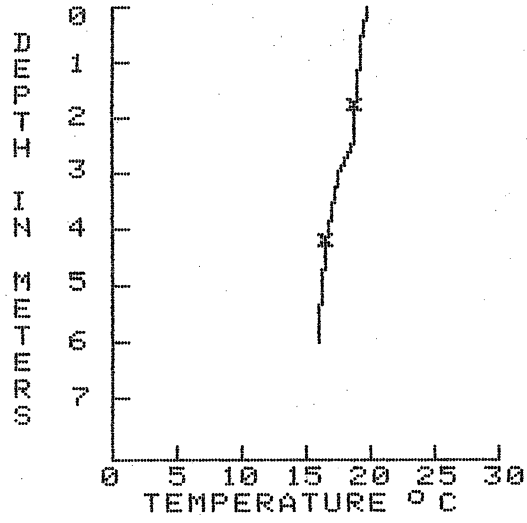


FIGURE 4

TEMPERATURE
MAY 20, 1982

STATION 1

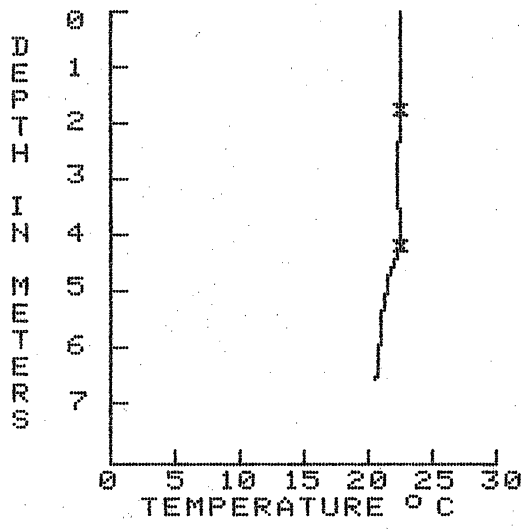


FIGURE 5

TEMPERATURE
MAY 25, 1982

STATION 1

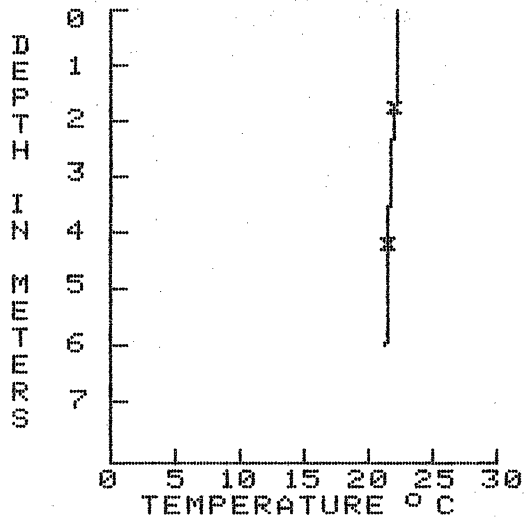


FIGURE 6

TEMPERATURE
JUNE 3, 1982

STATION 1

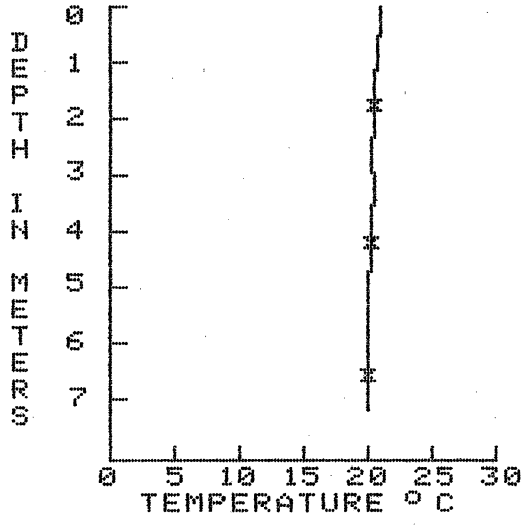


FIGURE 7

TEMPERATURE
JUNE 17, 1982

STATION 1

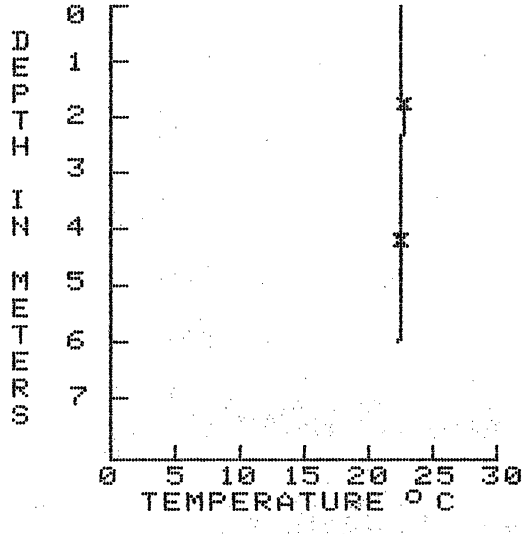


FIGURE 8

TEMPERATURE
JUNE 24, 1982

STATION 1

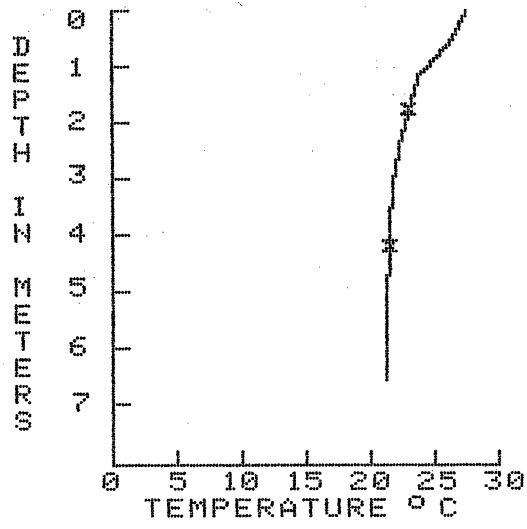


FIGURE 9

TEMPERATURE
JUNE 30, 1982

STATION 1

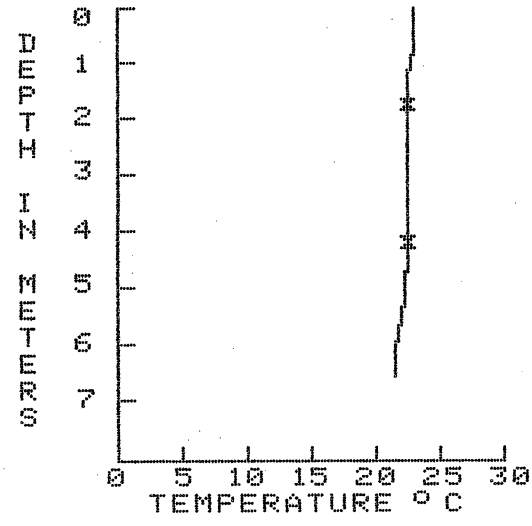


FIGURE 10

TEMPERATURE
JULY 5, 1982

STATION 1

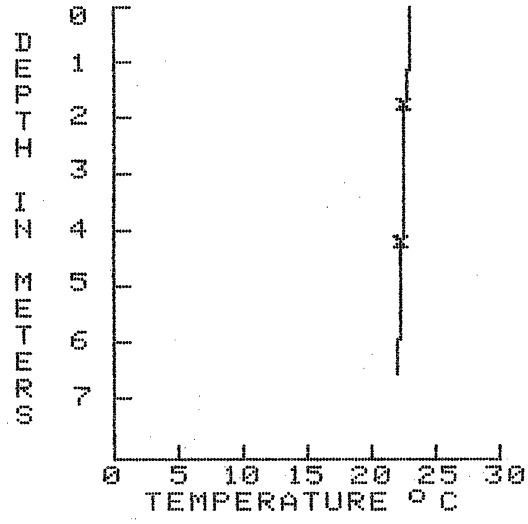


FIGURE 11

TEMPERATURE
JULY 12, 1982

STATION 1

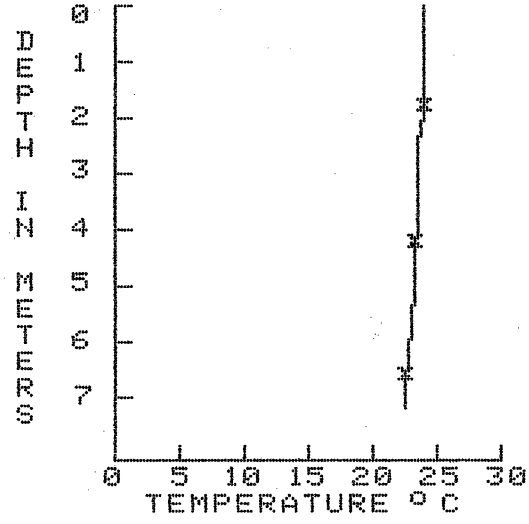


FIGURE 12

TEMPERATURE
JULY 13, 1982

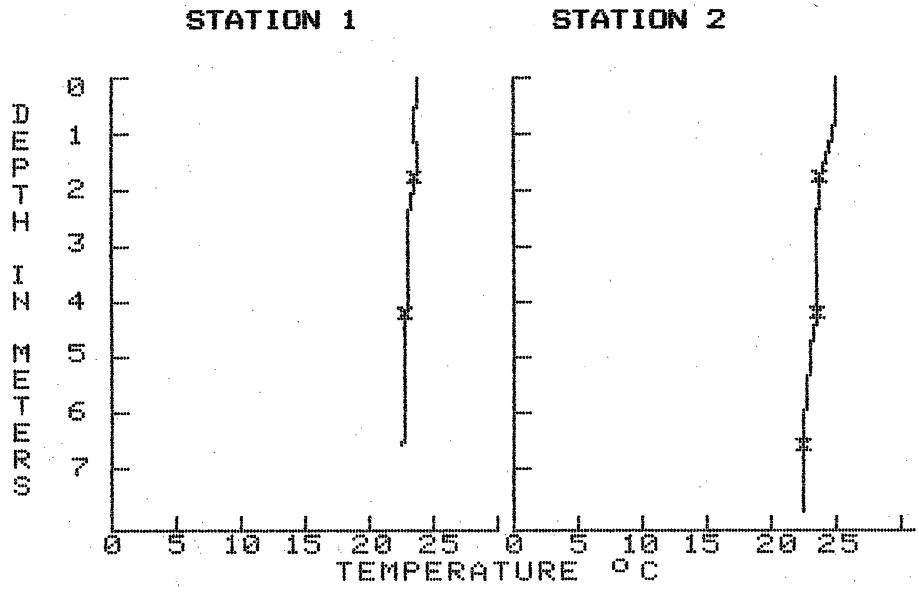


FIGURE 13

TEMPERATURE
JULY 19, 1982

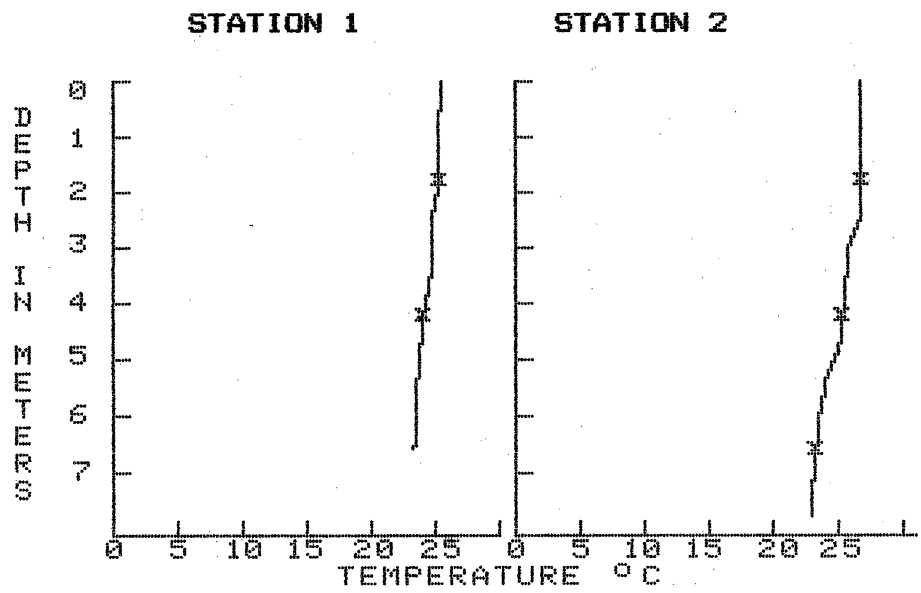


FIGURE 14

TEMPERATURE
JULY 22, 1982

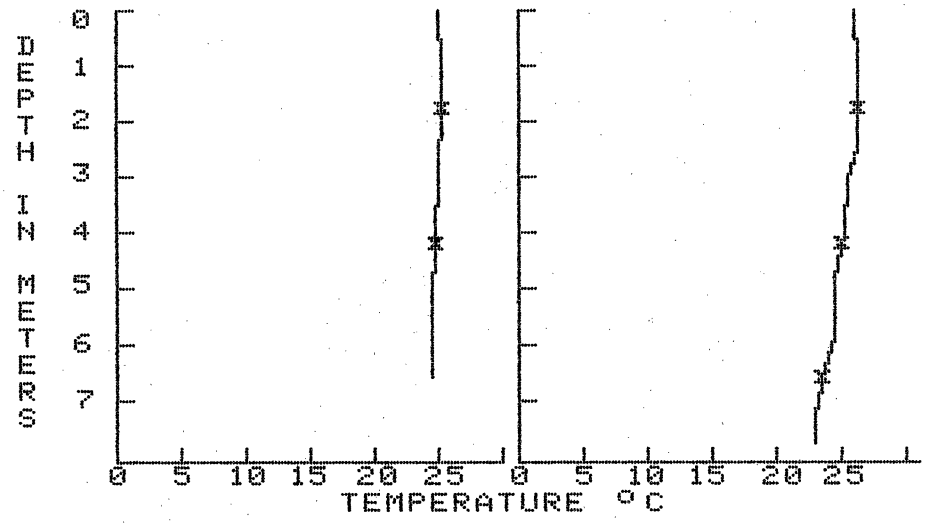


FIGURE 15

TEMPERATURE
JULY 27, 1982

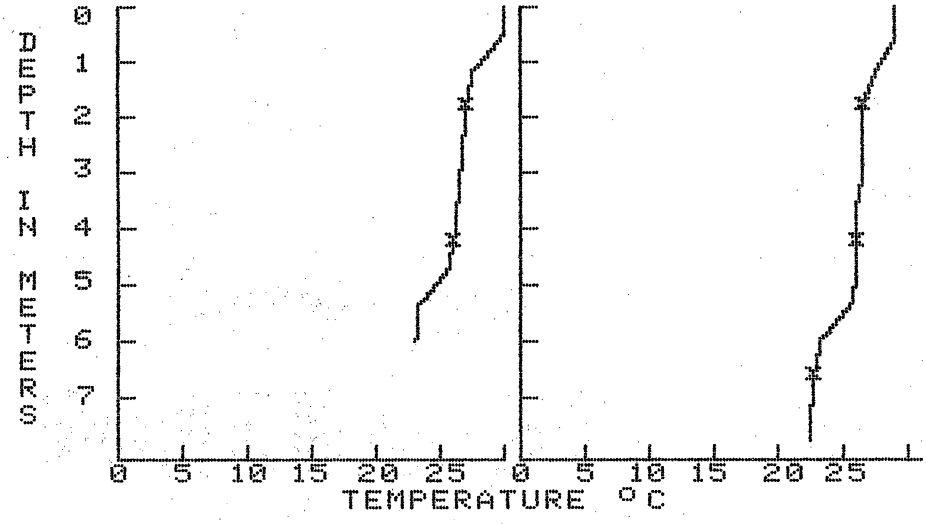


FIGURE 16

TEMPERATURE
AUG. 2, 1982

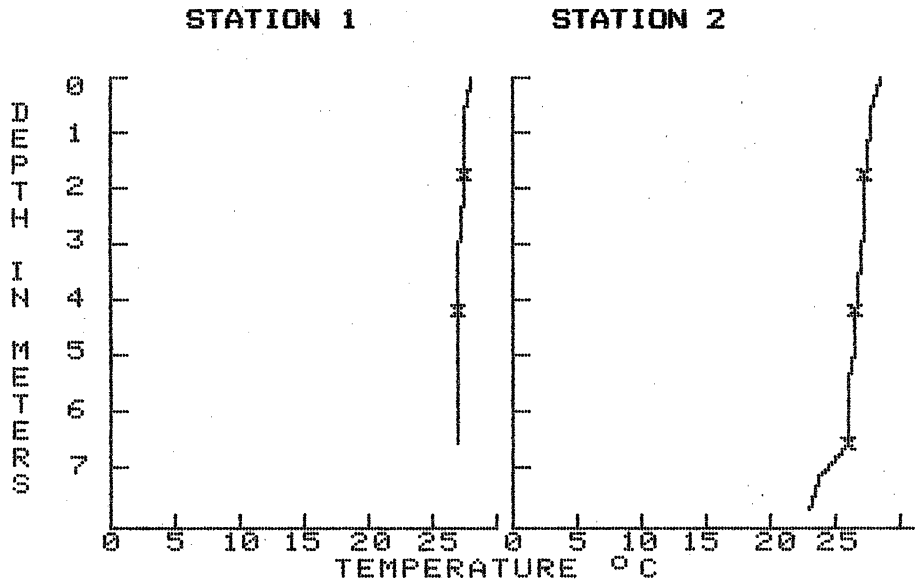


FIGURE 17

TEMPERATURE
AUG. 10, 1982

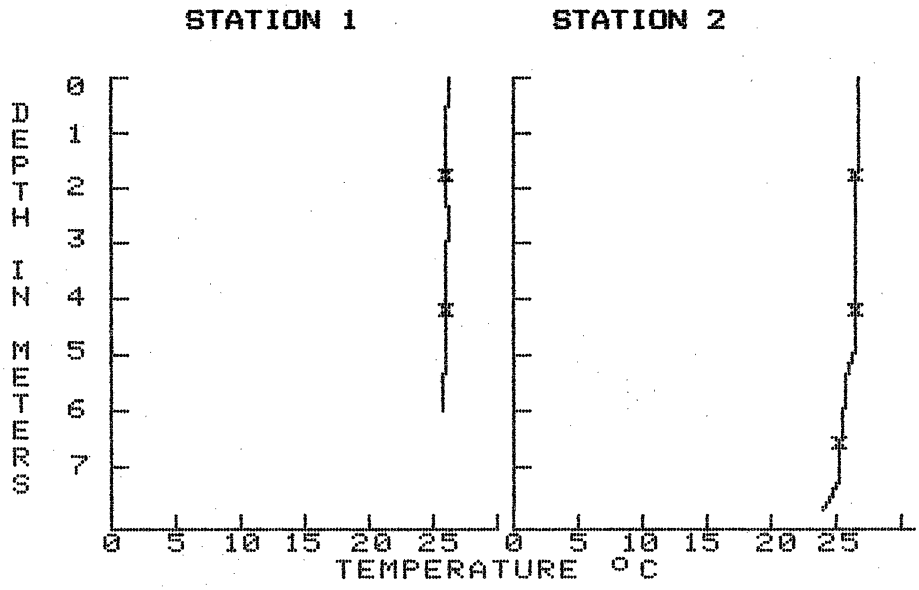


FIGURE 18

TEMPERATURE
AUG. 17, 1982

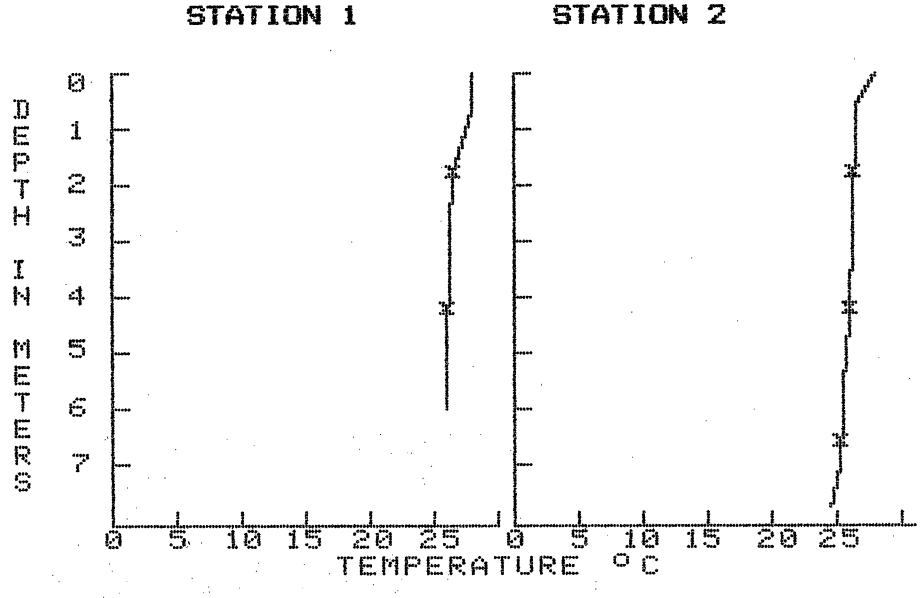


FIGURE 19

TEMPERATURE (X) OXYGEN (O)
AUG. 25, 1982

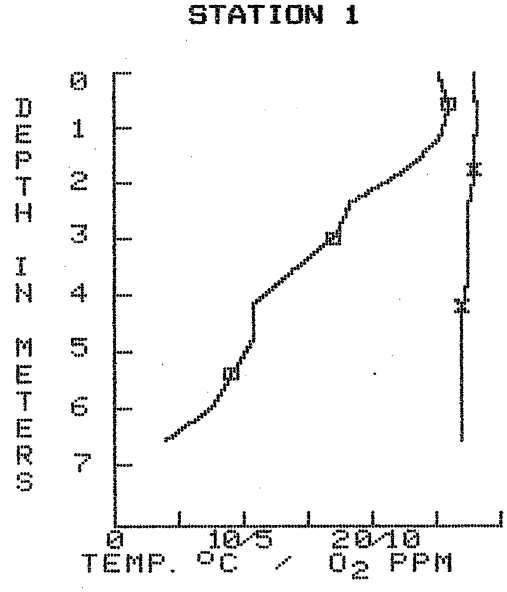


FIGURE 20

TEMPERATURE (X) OXYGEN (O)
AUG. 26, 1982

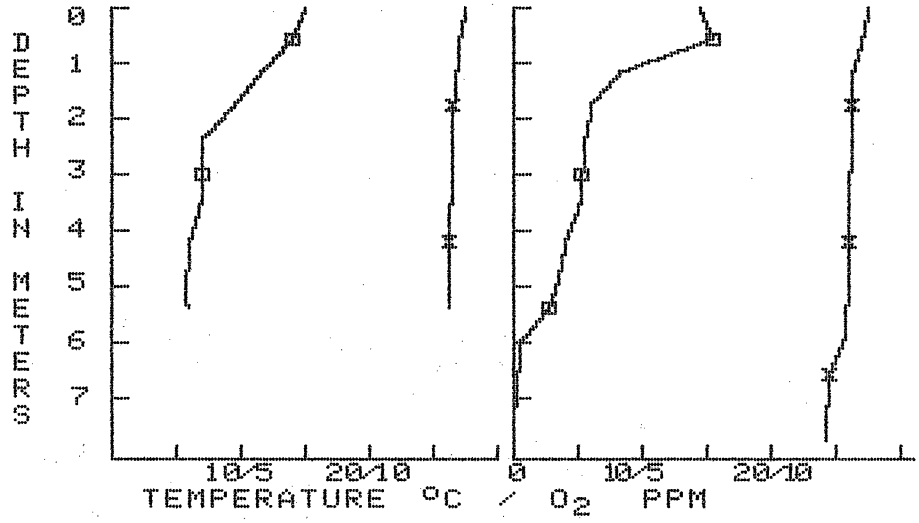


FIGURE 21

TEMPERATURE (X) OXYGEN (O)
AUG. 31, 1982

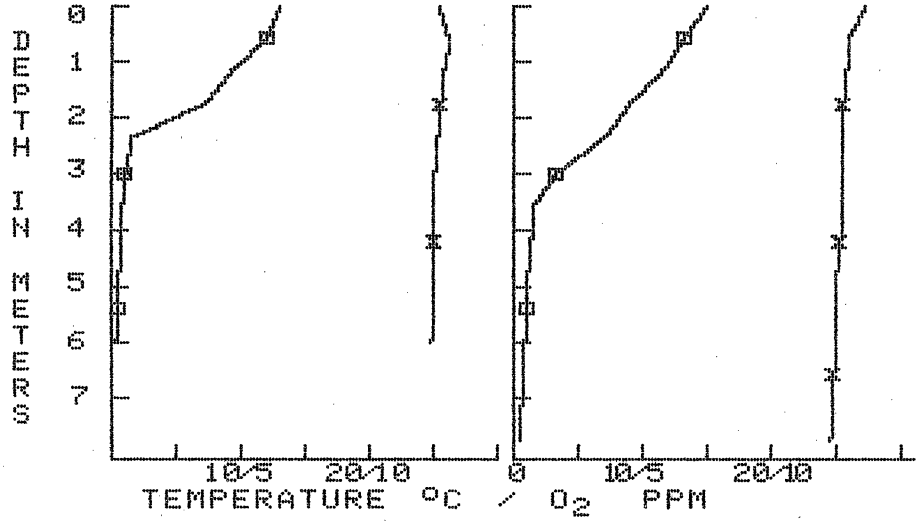


FIGURE 22

TEMPERATURE (X) OXYGEN (O)
SEPT. 7, 1982

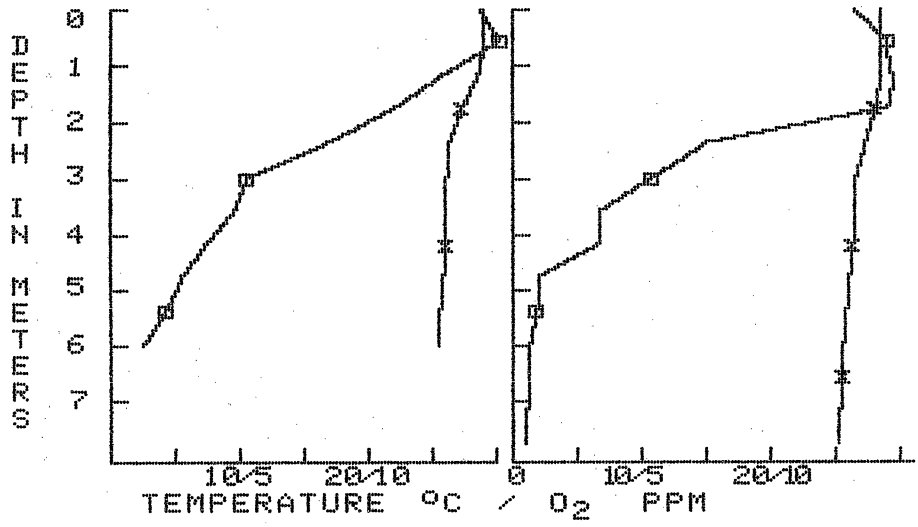


FIGURE 23

TEMPERATURE (X) OXYGEN (O)
SEPT. 17, 1982

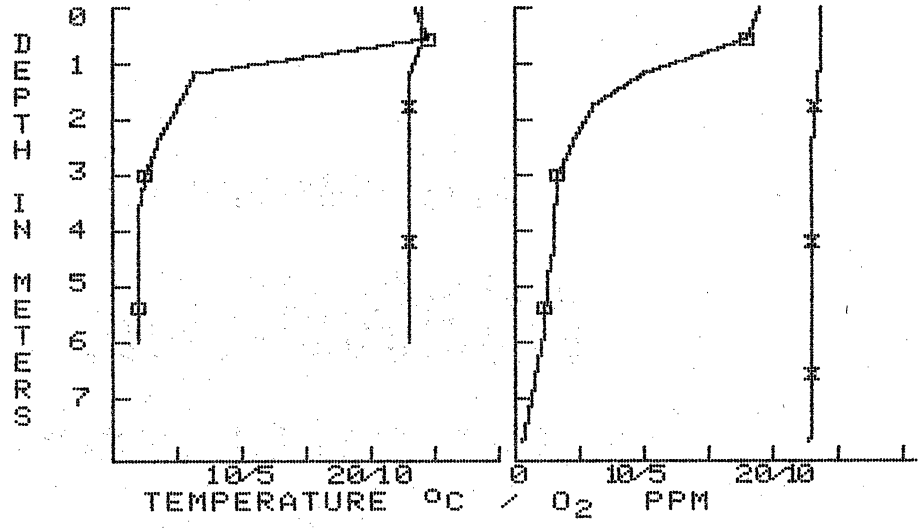


FIGURE 24

TEMPERATURE (X) OXYGEN (O)
OCT. 27, 1982

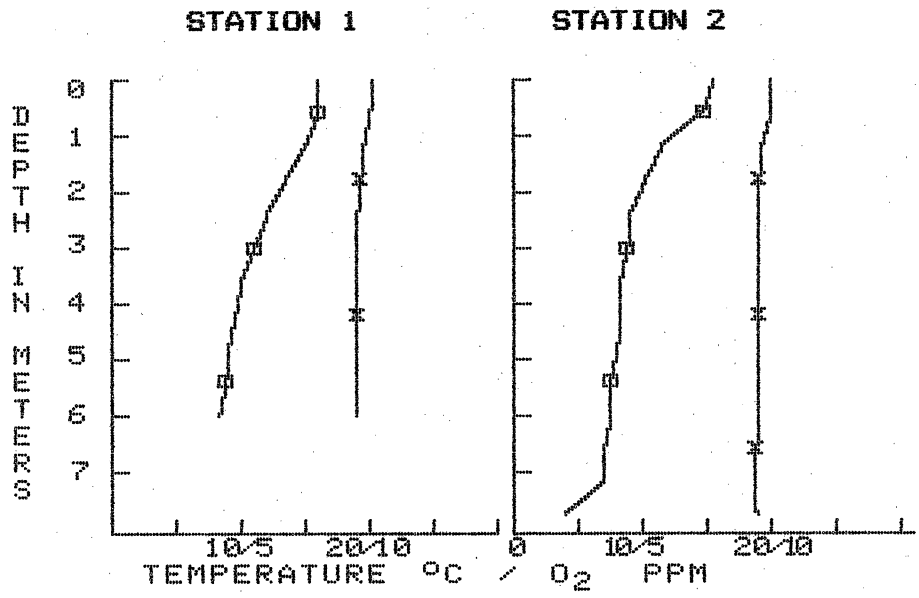
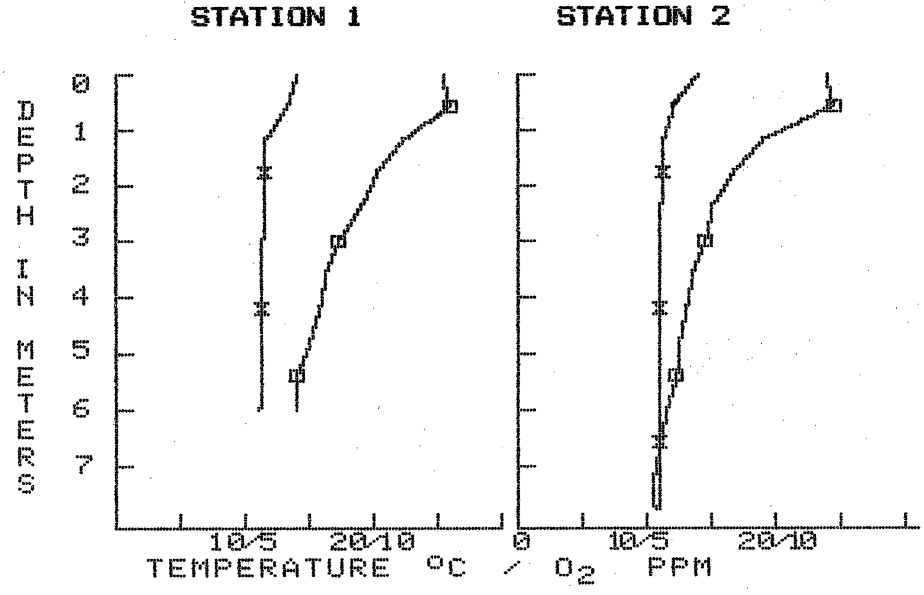


FIGURE 25

TEMPERATURE (X) OXYGEN (O)
DEC. 20, 1982



APPENDIX C

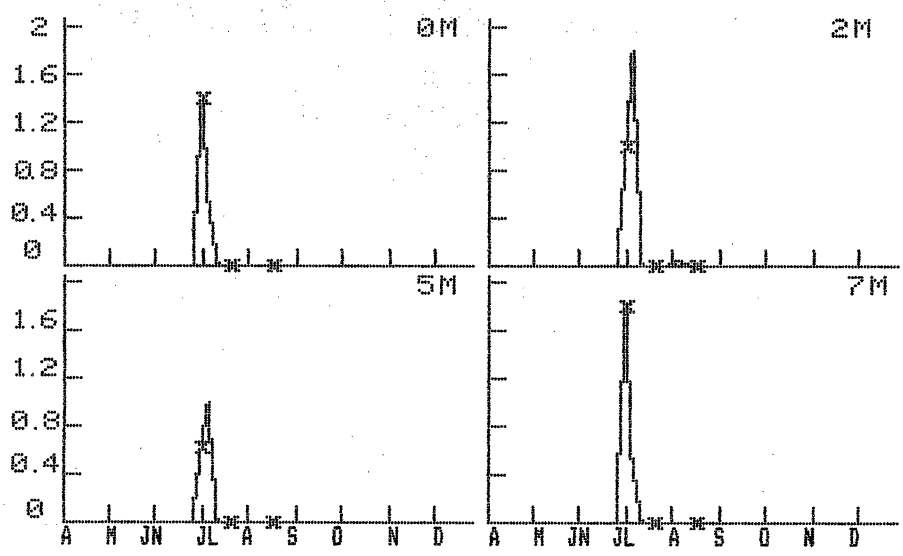
FIGURES 26 THROUGH 37

WATER CHEMISTRY VS. TIME

FIGURE 26

NITRATE (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
PARTS PER MILLION VS. TIME

STATION 1



STATION 2

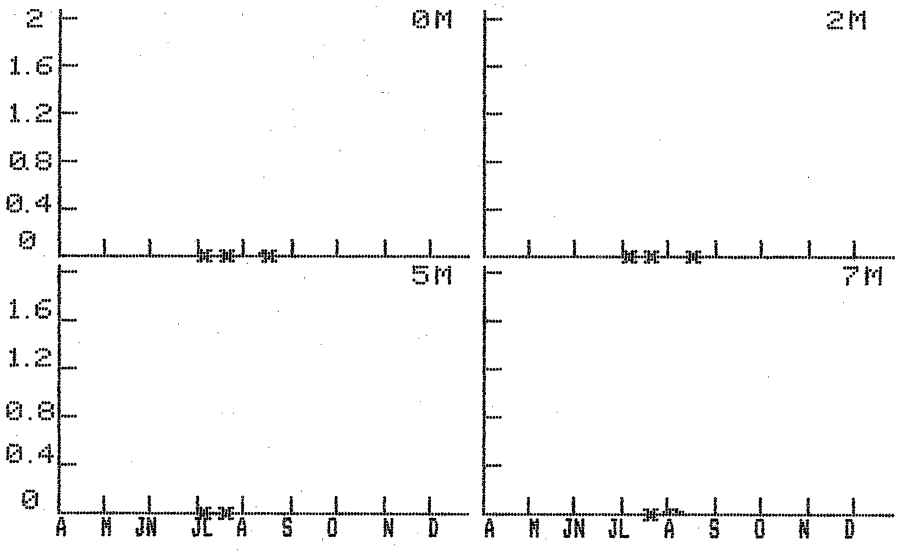
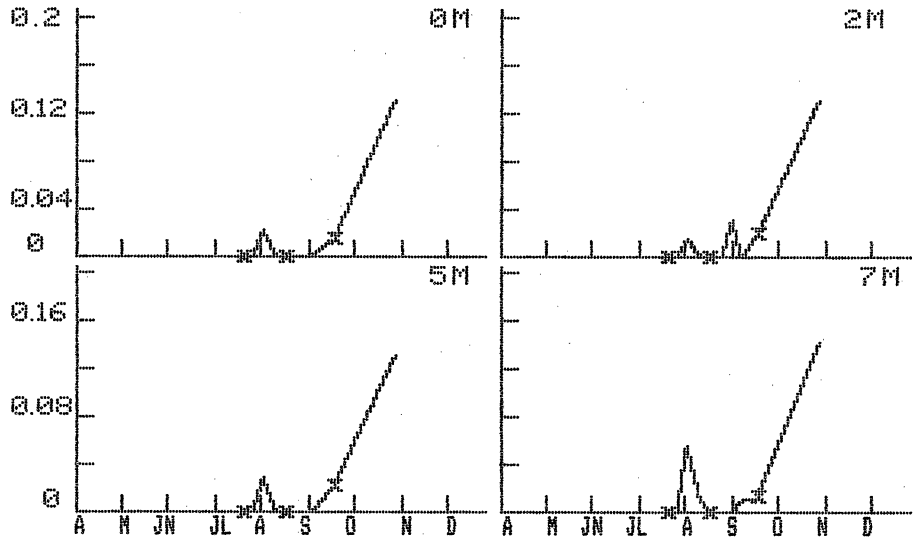


FIGURE 27

NITRITE (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
PARTS PER MILLION VS. TIME

STATION 1



STATION 2

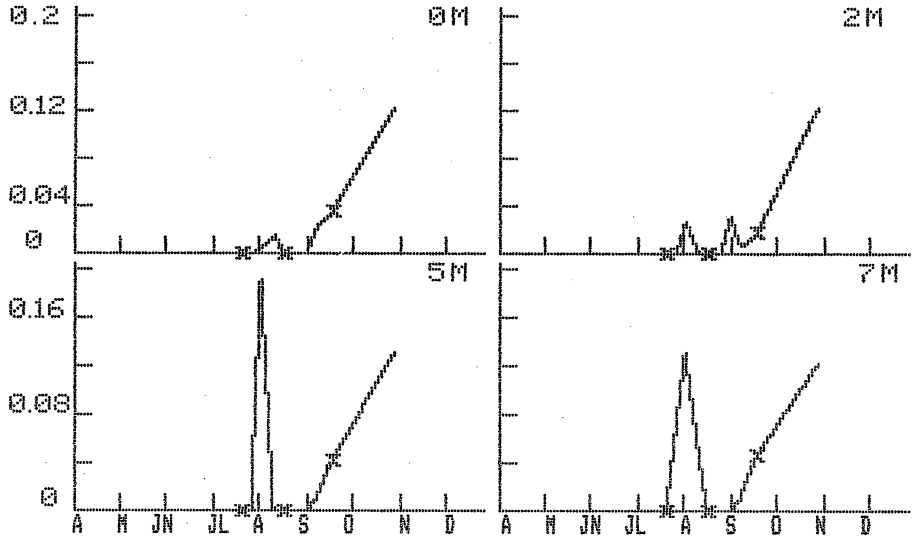
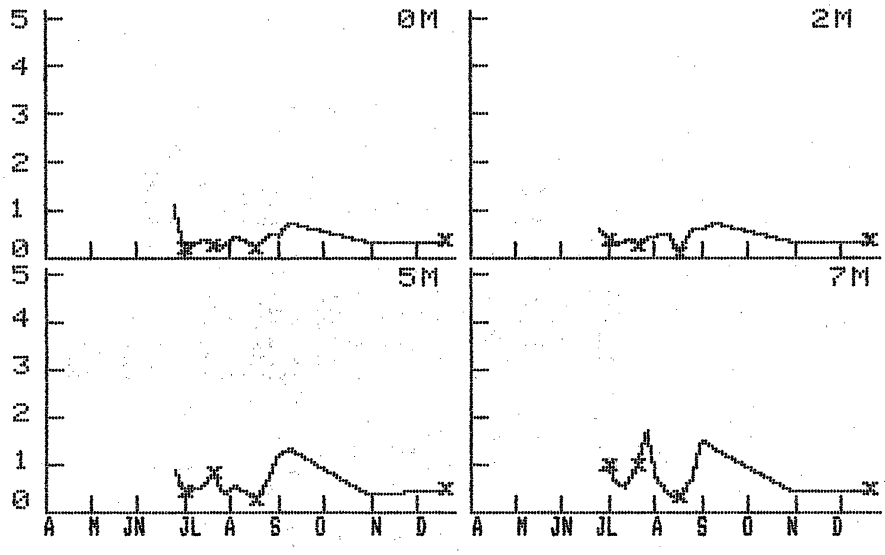


FIGURE 28

AMMONIA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
PARTS PER MILLION VS. TIME

STATION 1



STATION 2

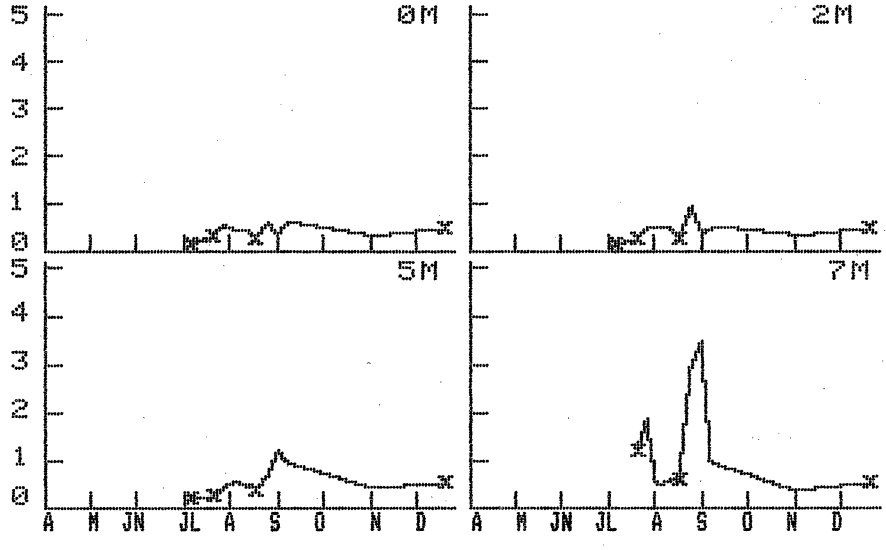
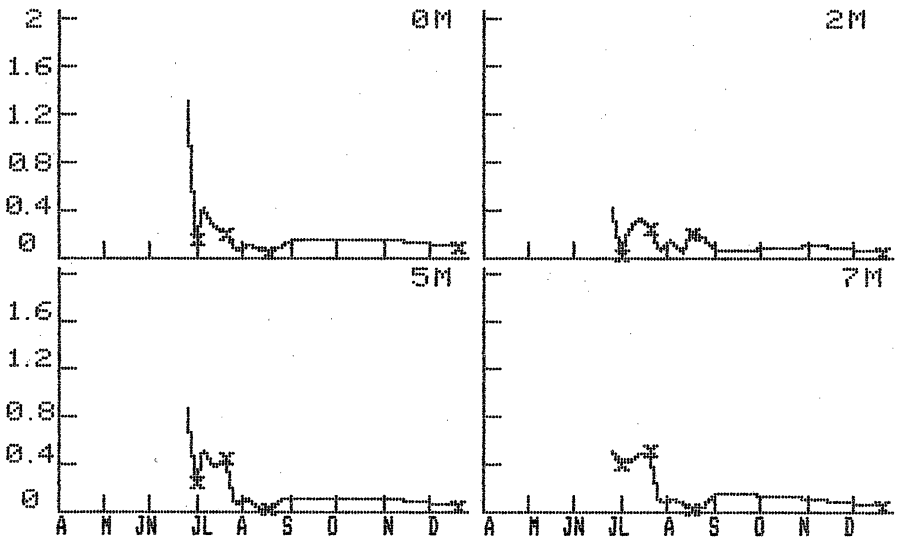


FIGURE 29

PHOSPHATE (ORTHO) (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
PARTS PER MILLION VS. TIME

STATION 1



STATION 2

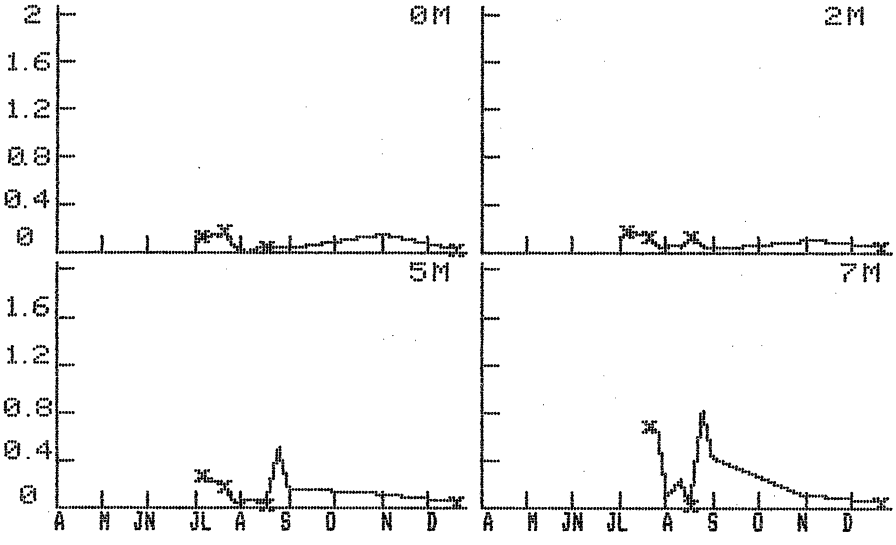
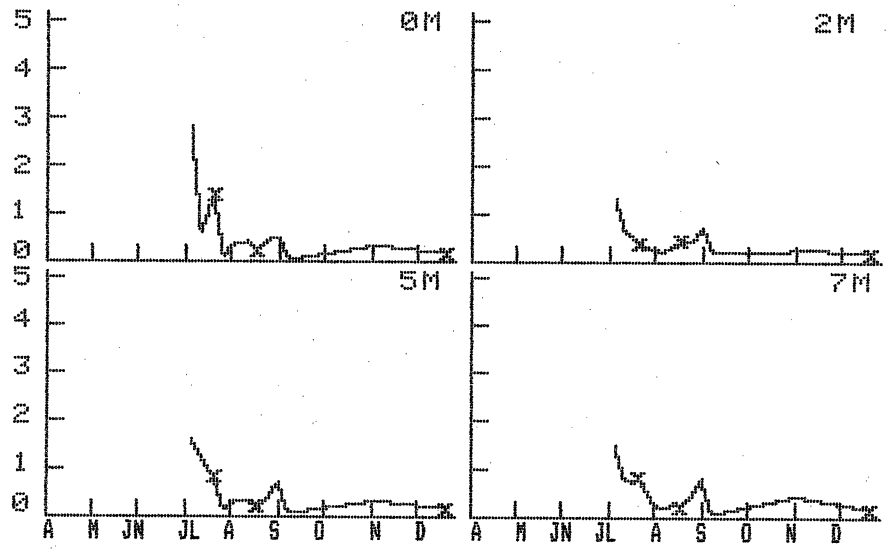


FIGURE 30

PHOSPHATE TOTAL (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
PARTS PER MILLION VS. TIME

STATION 1



STATION 2

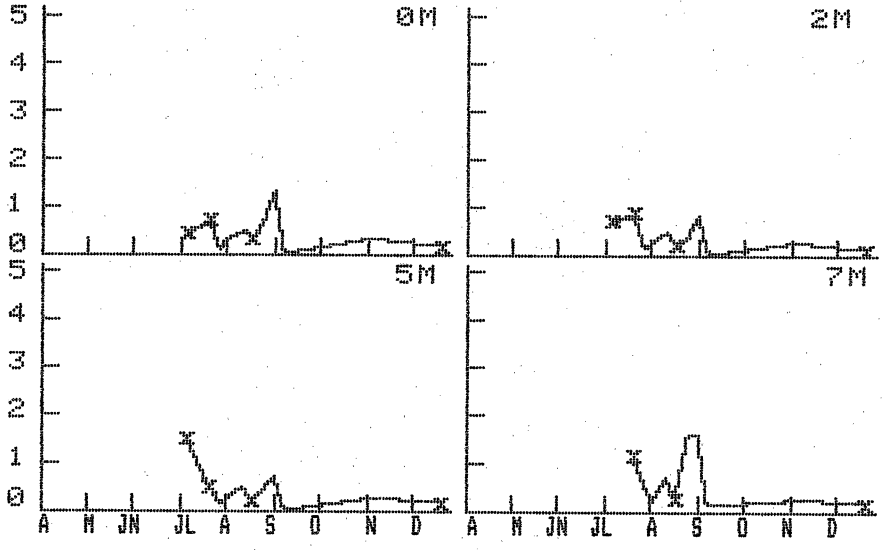
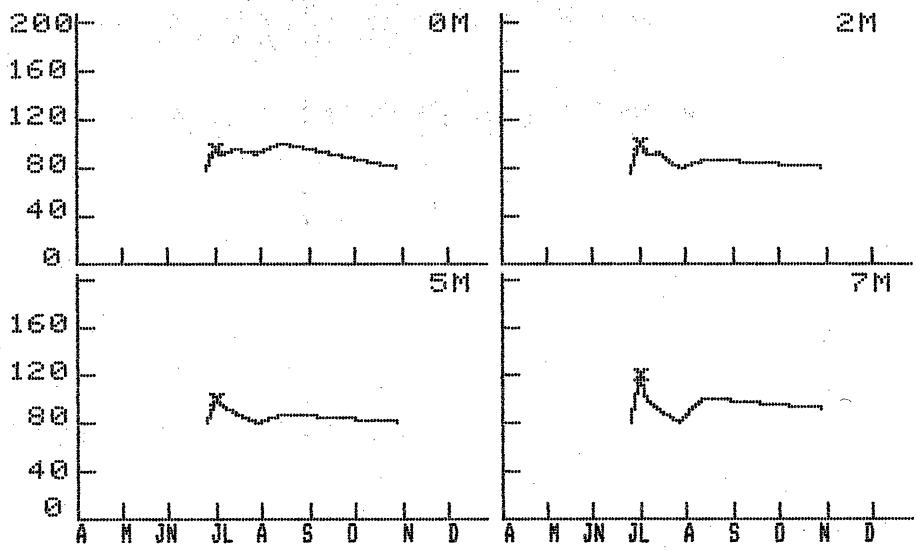


FIGURE 31

SULFATE (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
PARTS PER MILLION VS. TIME

STATION 1



STATION 2

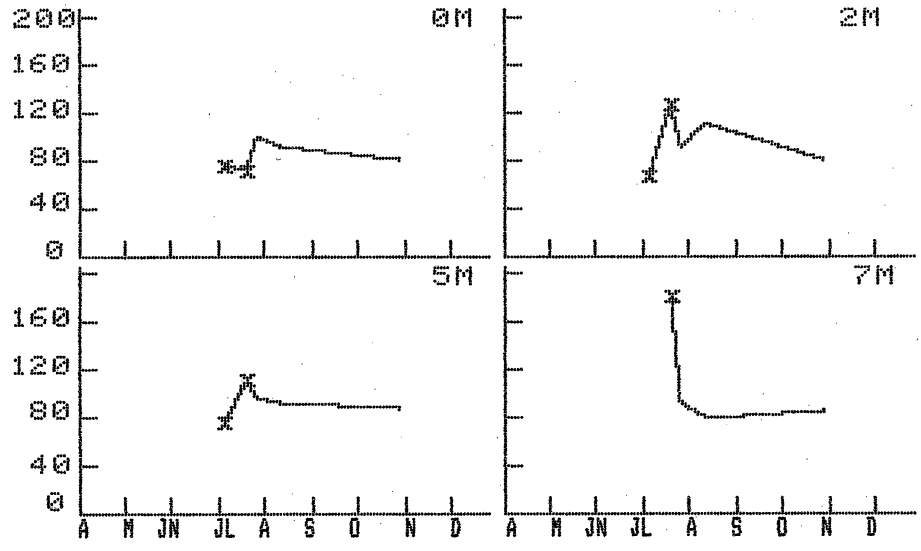
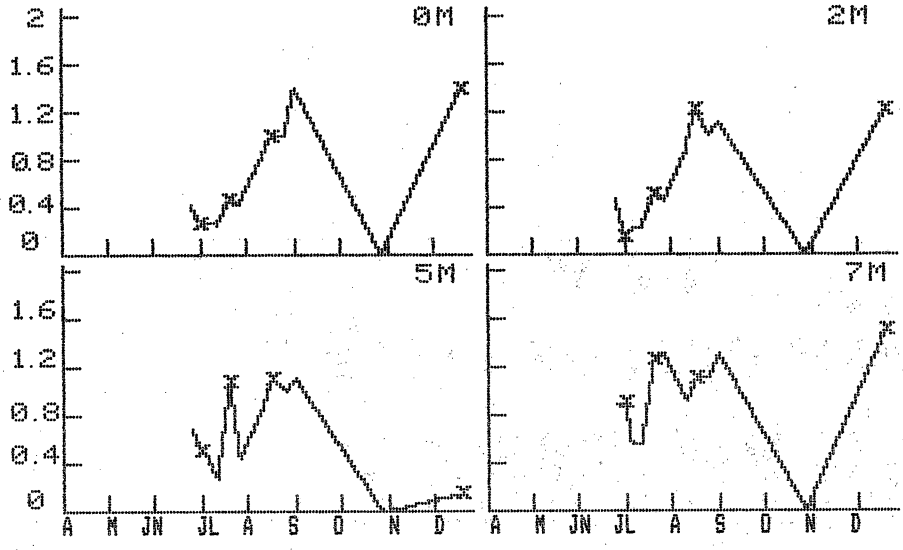


FIGURE 32

SILICATE (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
PARTS PER MILLION VS. TIME

STATION 1



STATION 2

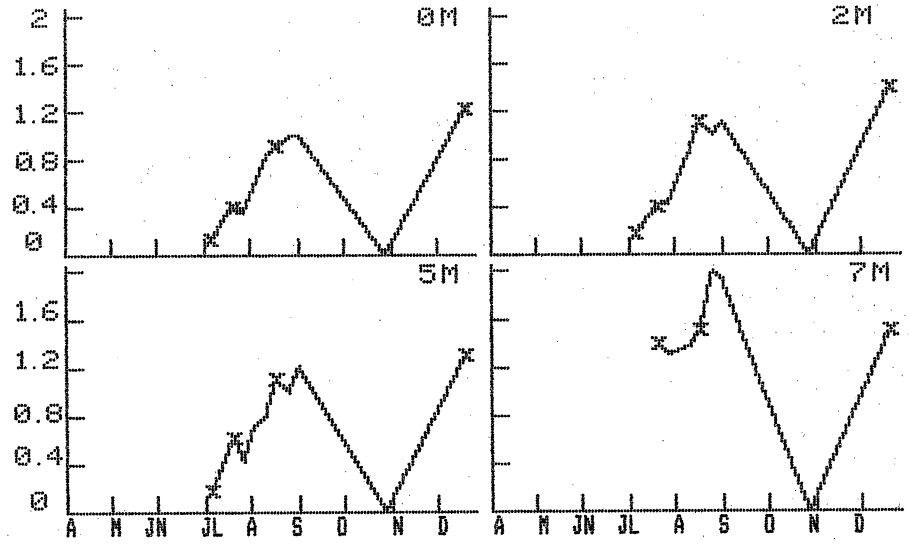
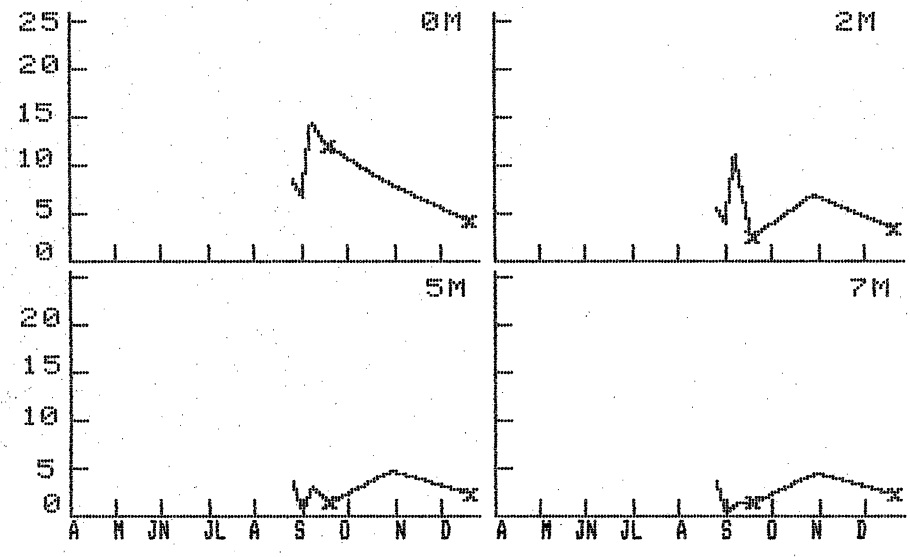


FIGURE 33

DISSOLVED OXYGEN (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
PARTS PER MILLION VS. TIME

STATION 1



STATION 2

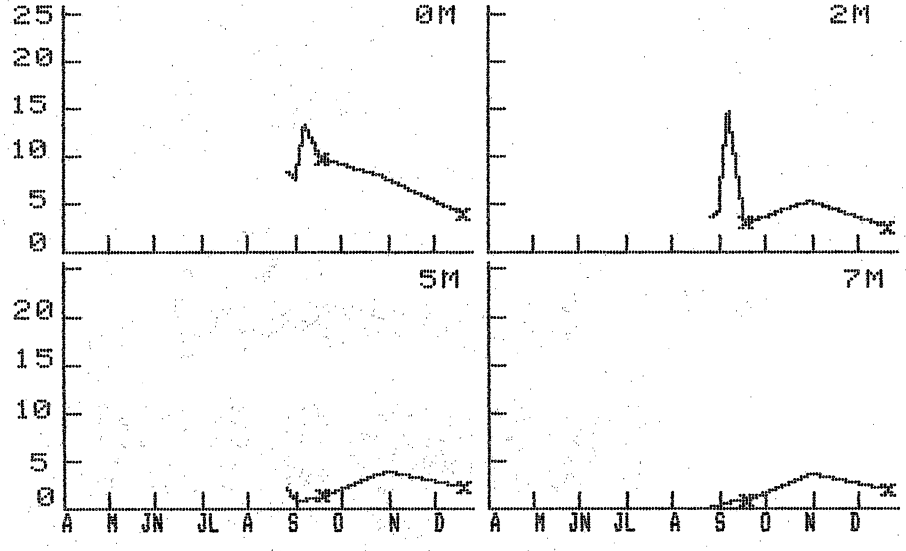
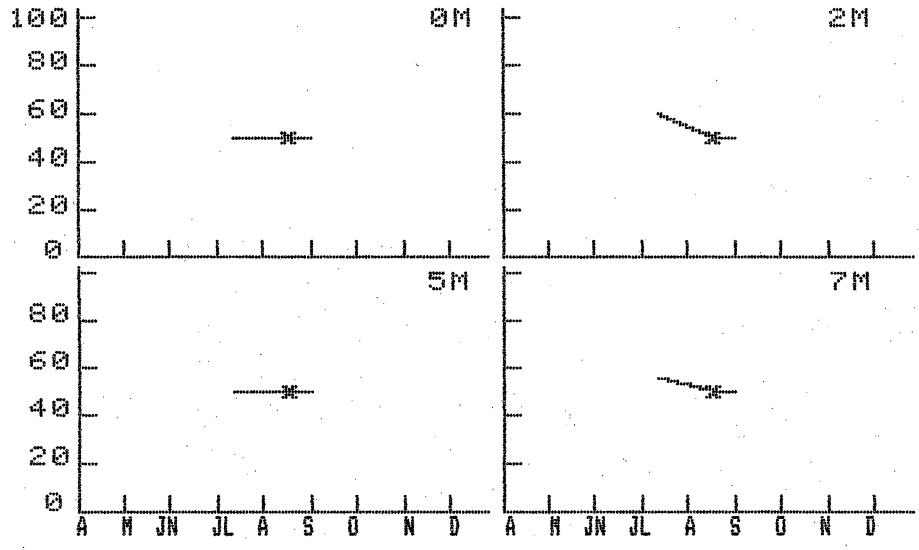


FIGURE 34

HARDNESS CALCIUM (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
PARTS PER MILLION VS. TIME

STATION 1



STATION 2

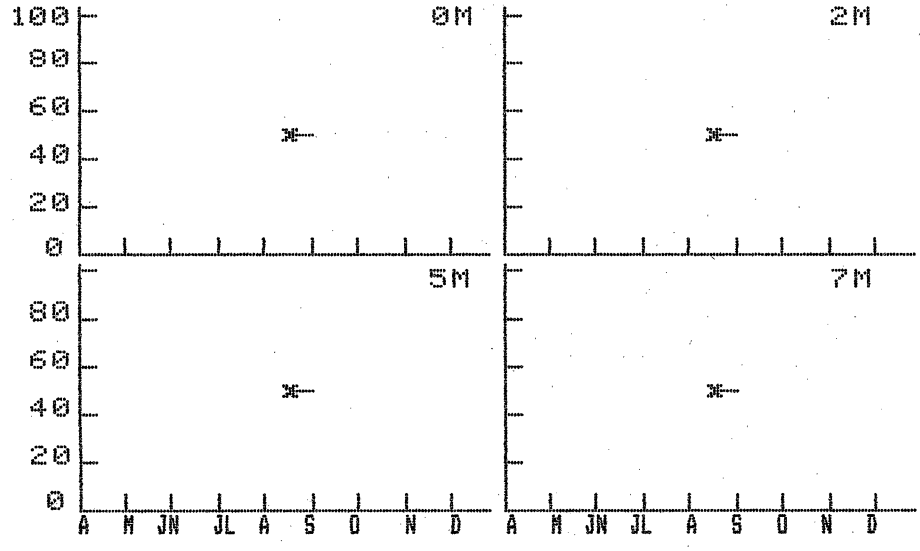
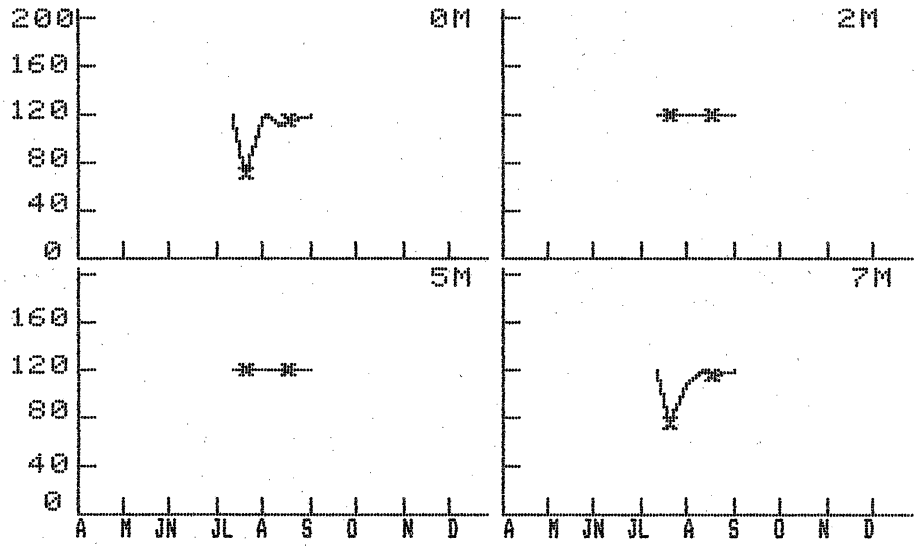


FIGURE 35

HARDNESS TOTAL (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
PARTS PER MILLION VS. TIME

STATION 1



STATION 2

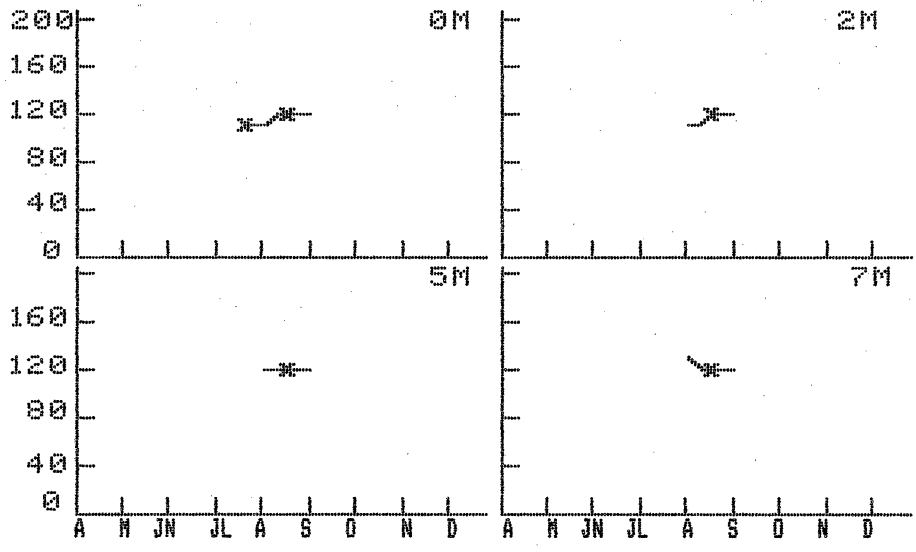
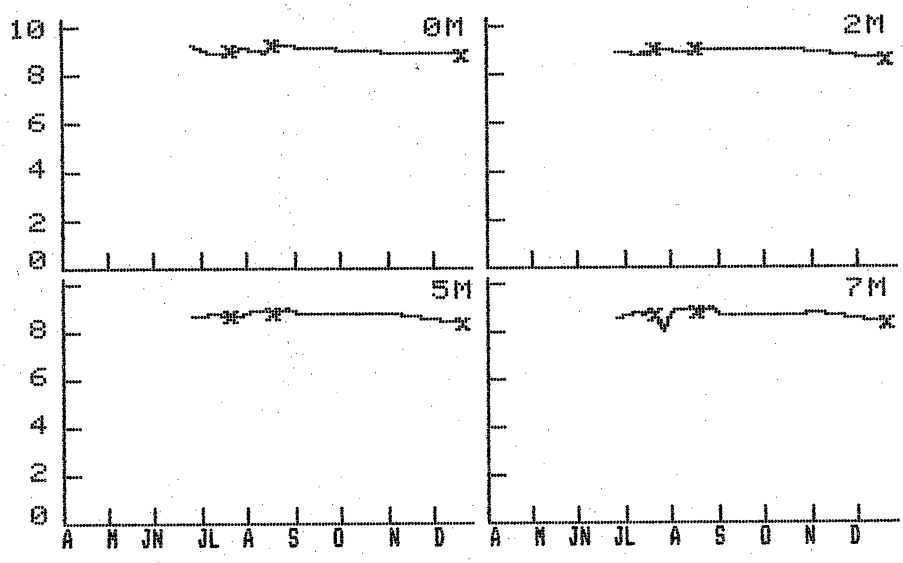


FIGURE 36

PH (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY

STATION 1



STATION 2

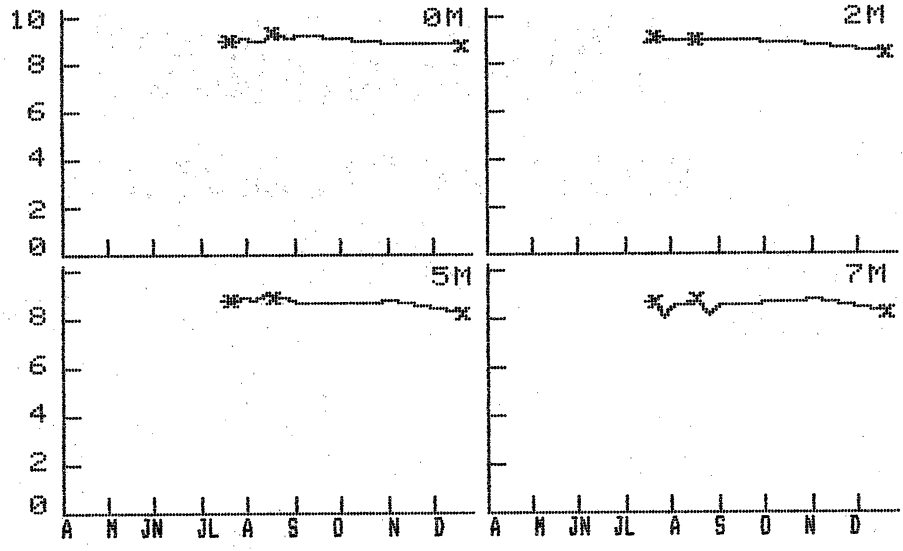
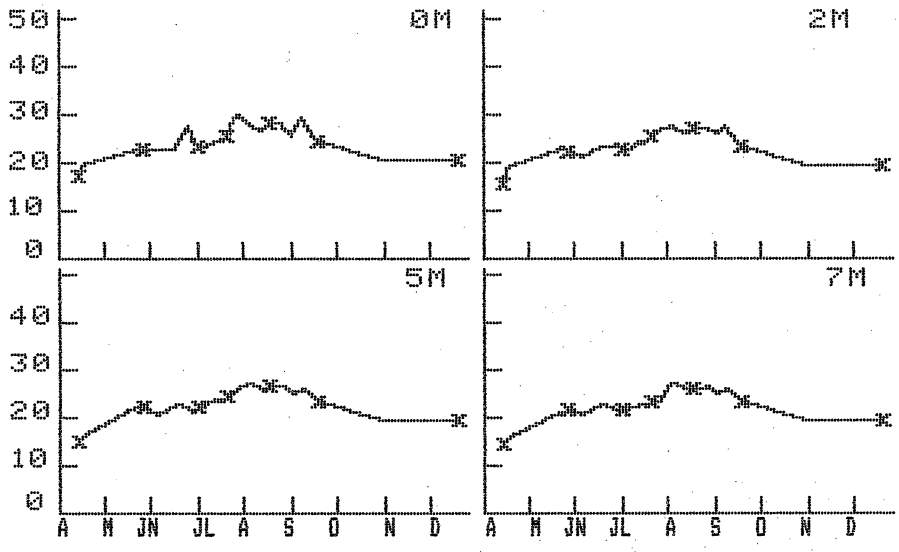


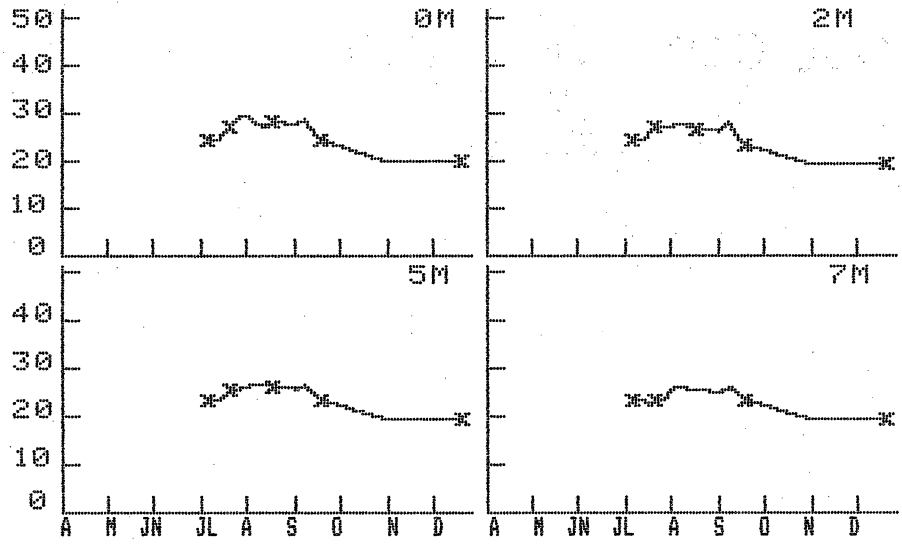
FIGURE 37

TEMPERATURE (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
DEGREES CENTIGRADE VS. TIME

STATION 1



STATION 2



APPENDIX D

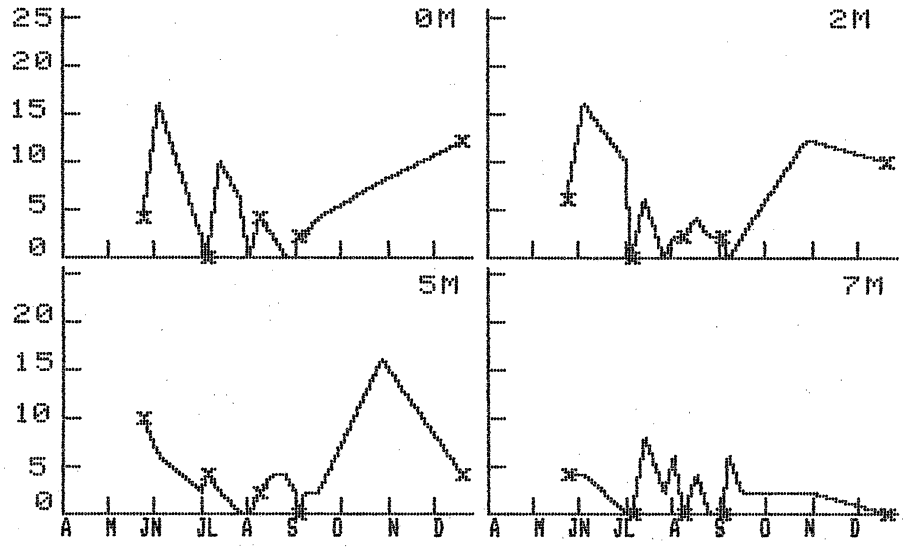
FIGURES 38 THROUGH 78

ALGAL DATA BY SPECIES / GENERA VS. TIME

FIGURE 38

ANKISTRODESMUS CONVOLUTUS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

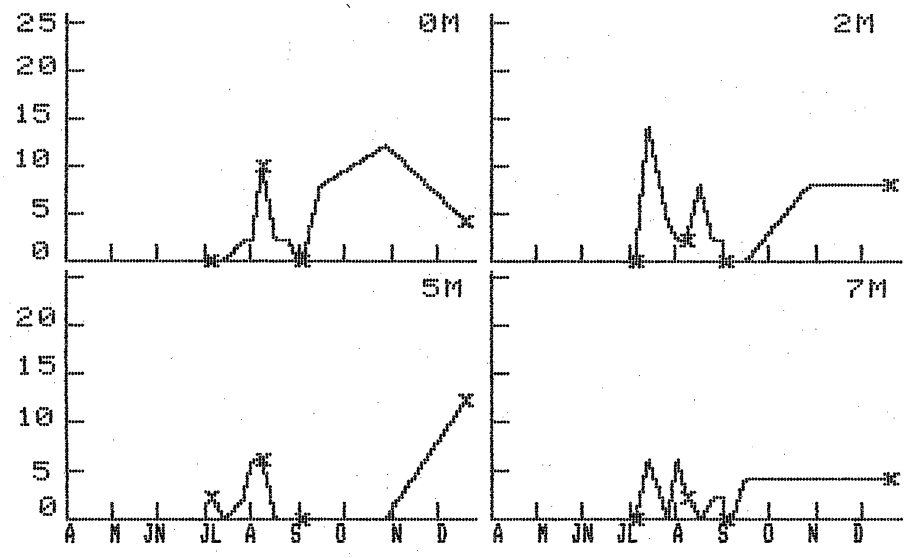
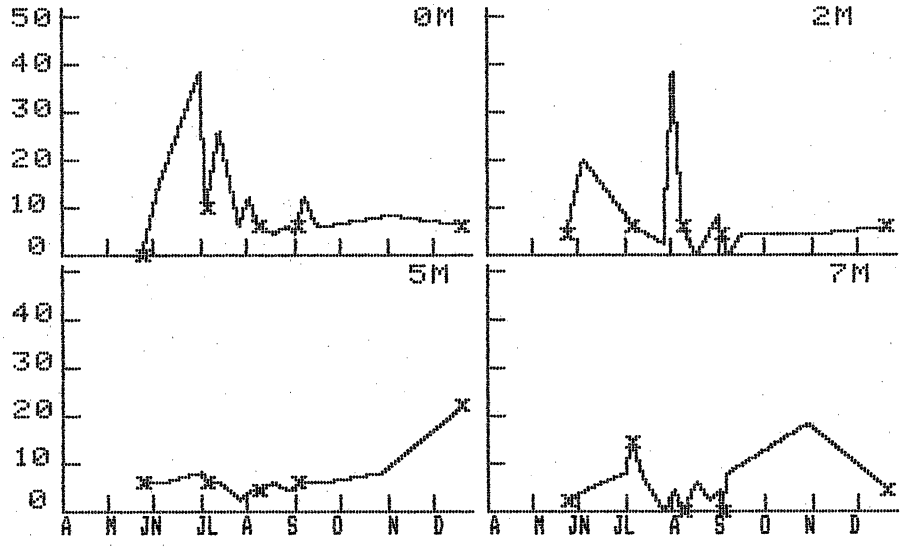


FIGURE 39

CHLORELLA ELLIPSOIDEA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

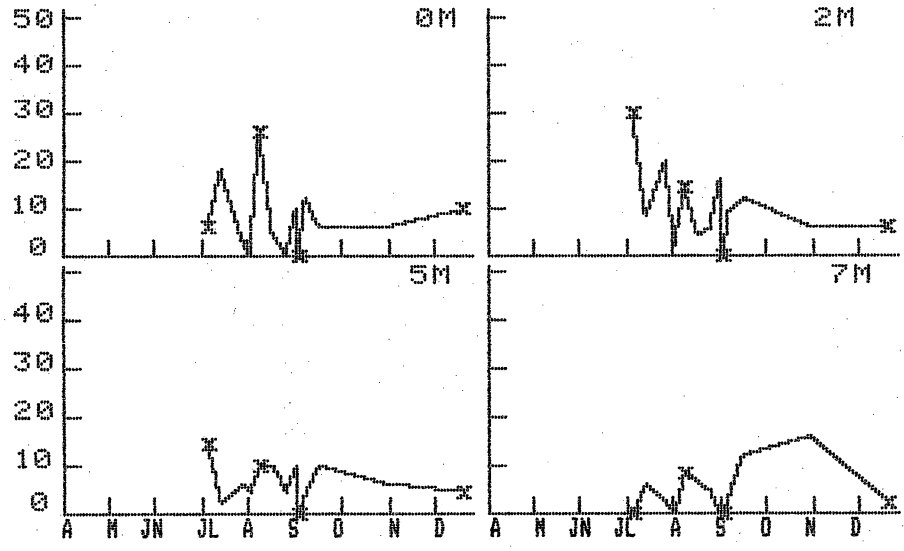
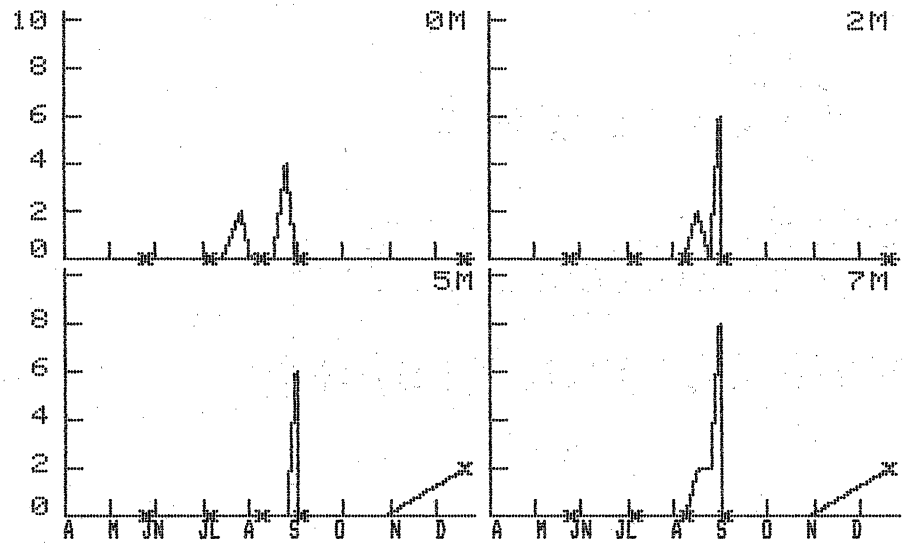


FIGURE 40

CHODATELLA LONGISETA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

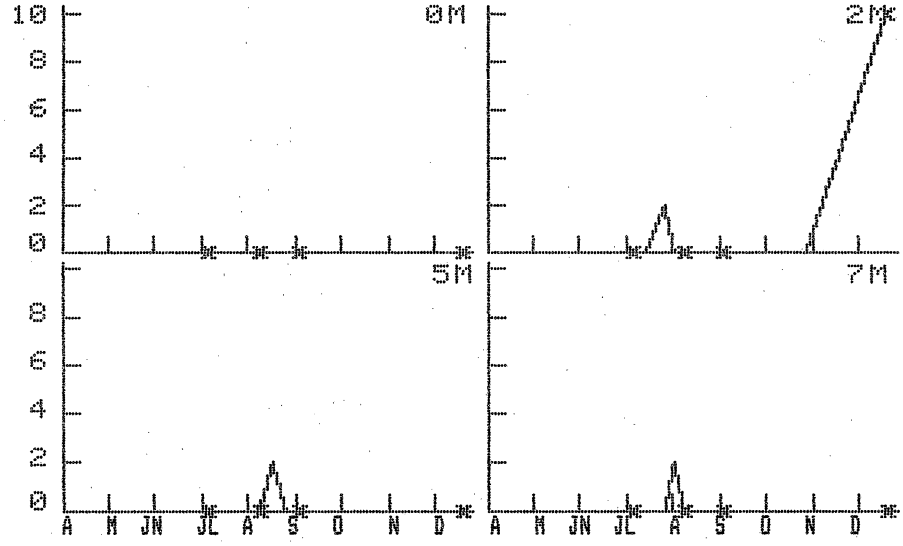
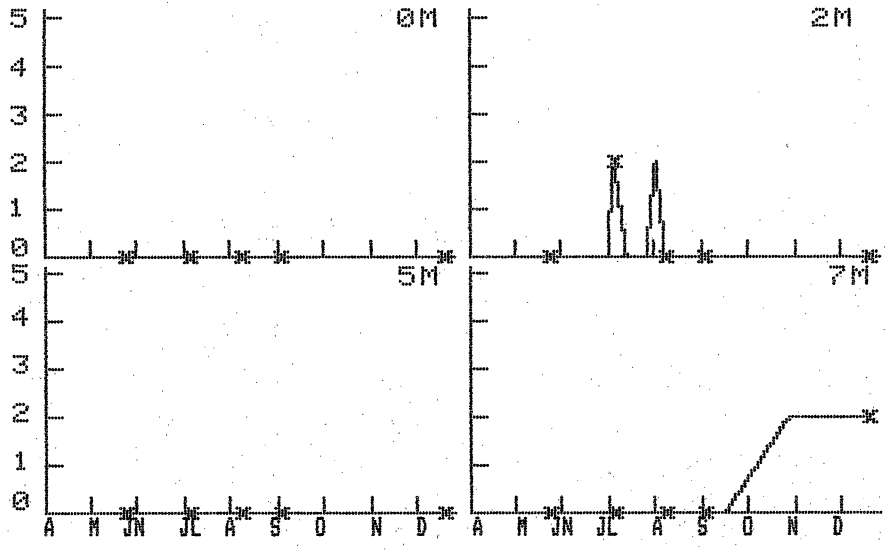


FIGURE 41

COSMARIUM (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

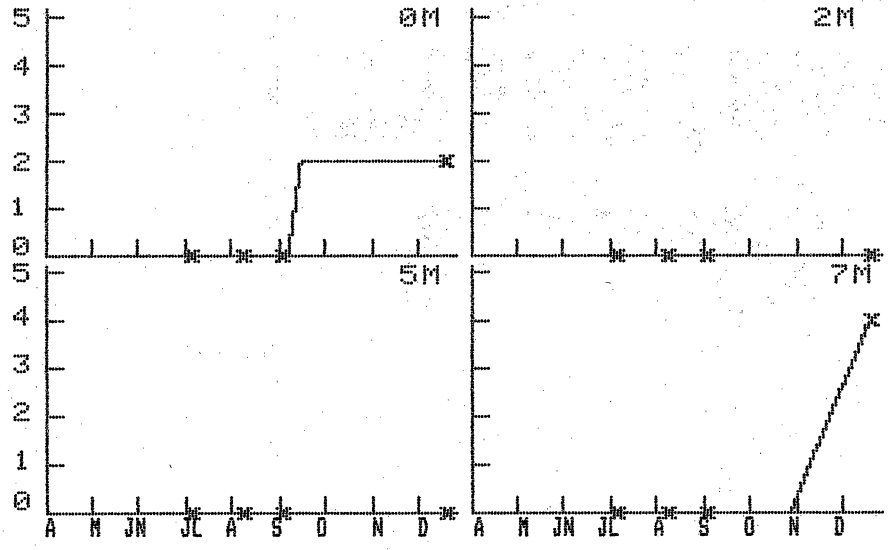
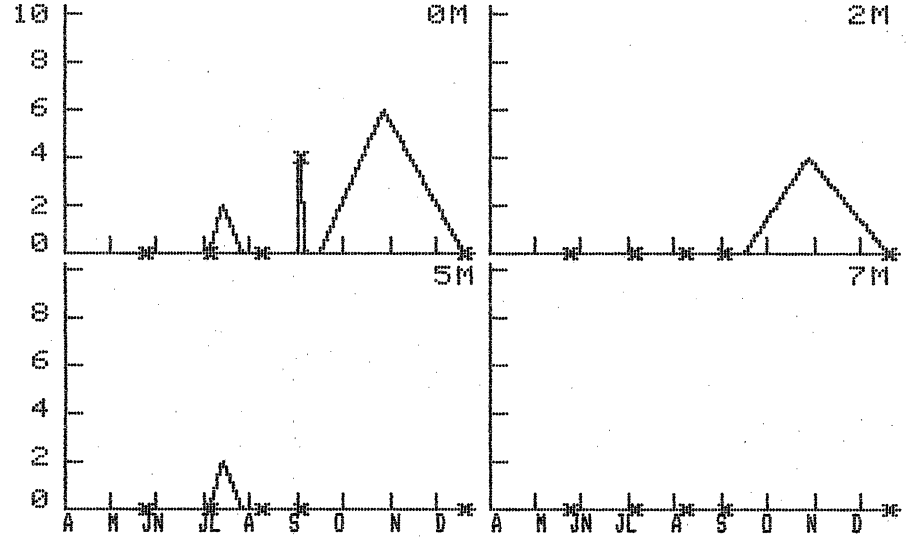


FIGURE 42

DIACANTHOS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

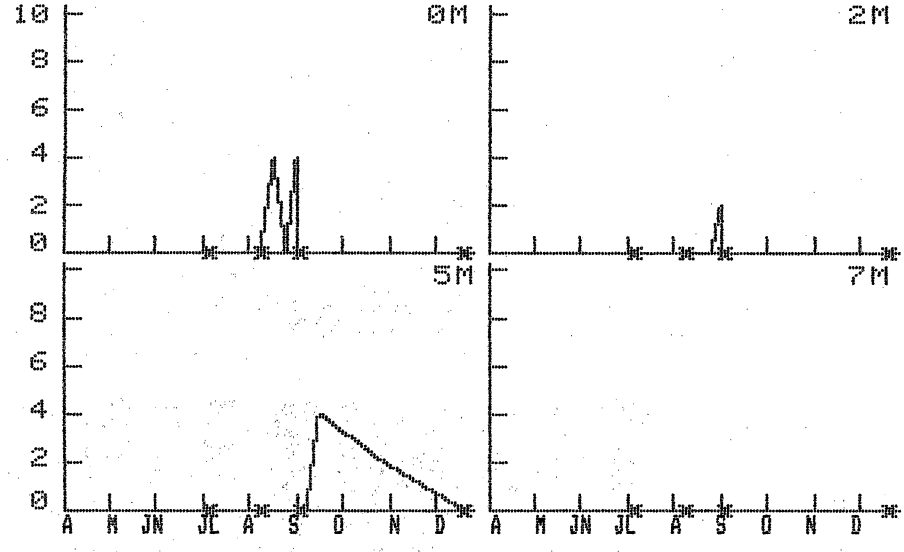
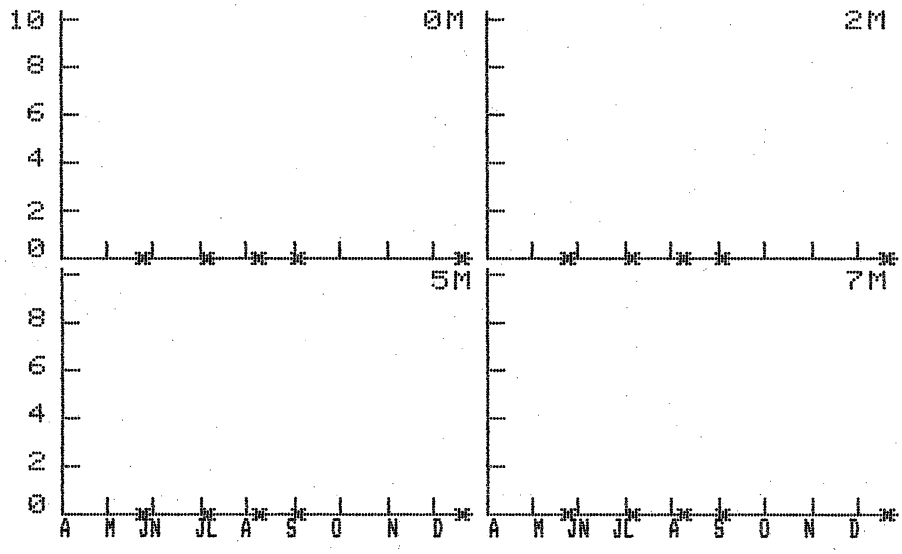


FIGURE 43

ECHINOSPHAERELLA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

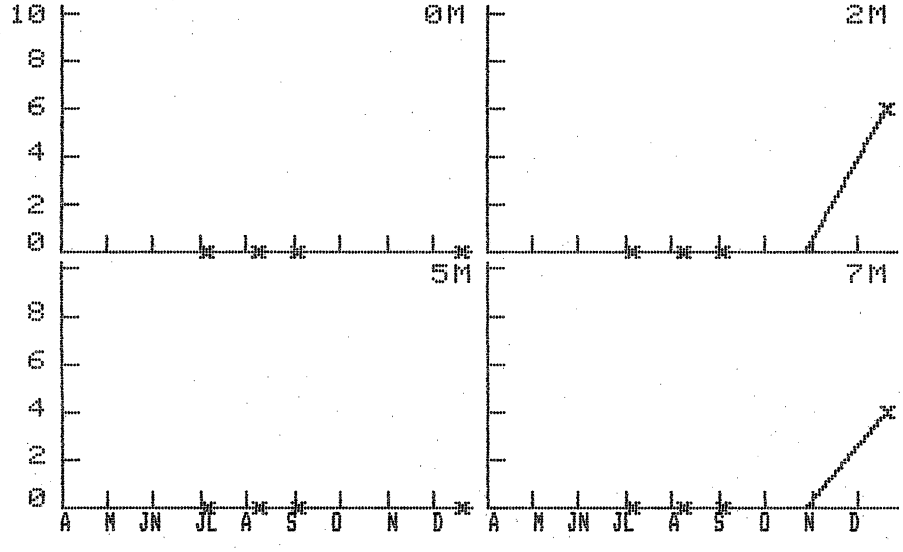
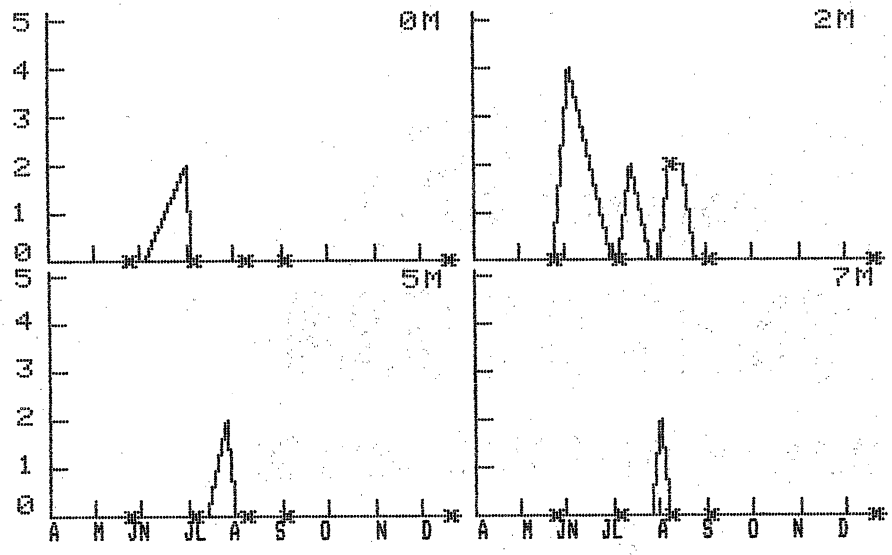


FIGURE 44

FRANCEIA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

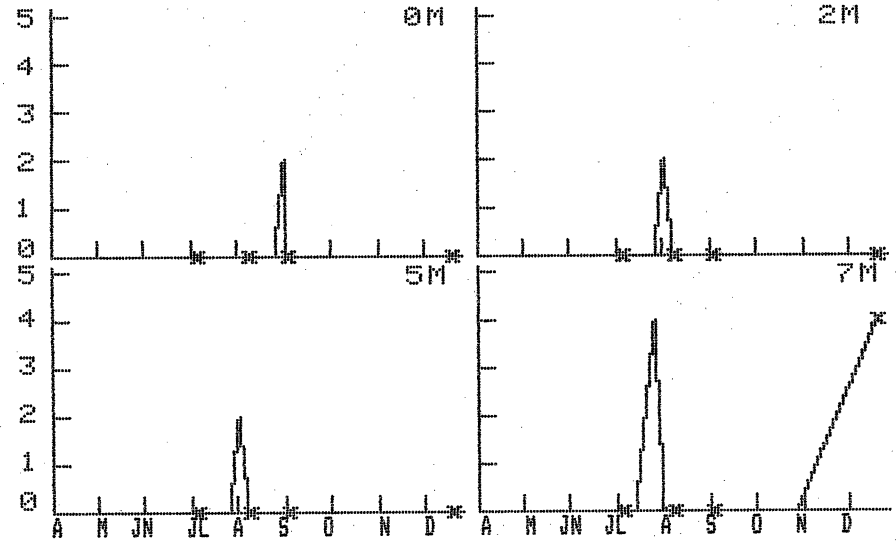
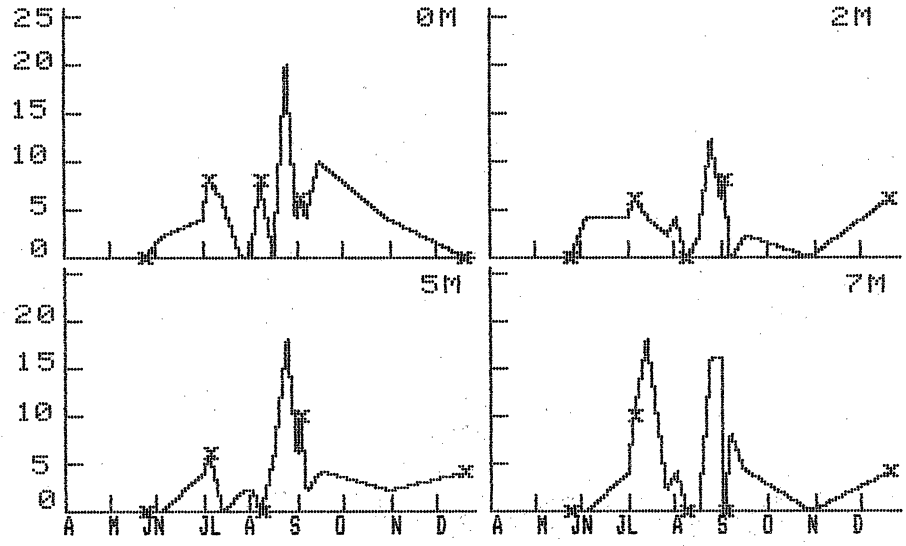


FIGURE 45

GOLENKINIA RADIATA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

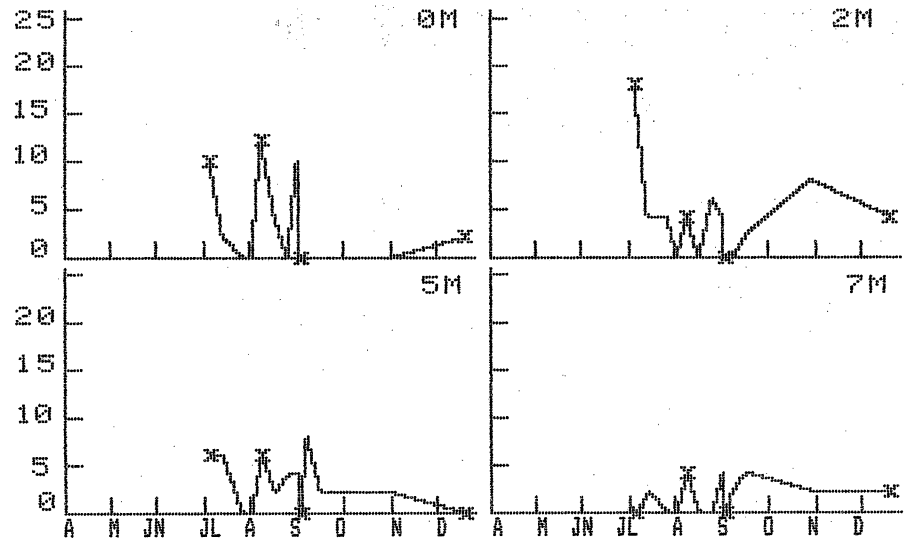
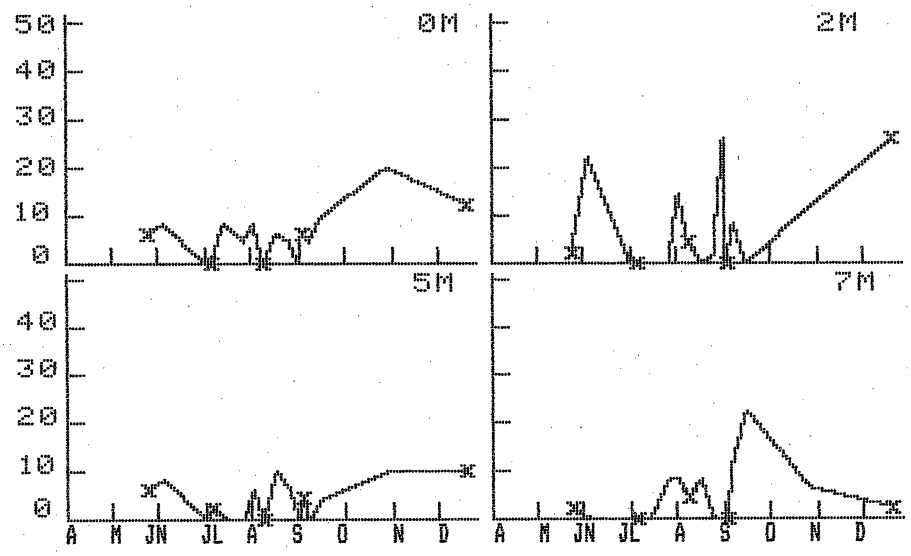


FIGURE 46

KIRCHNERIELLA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

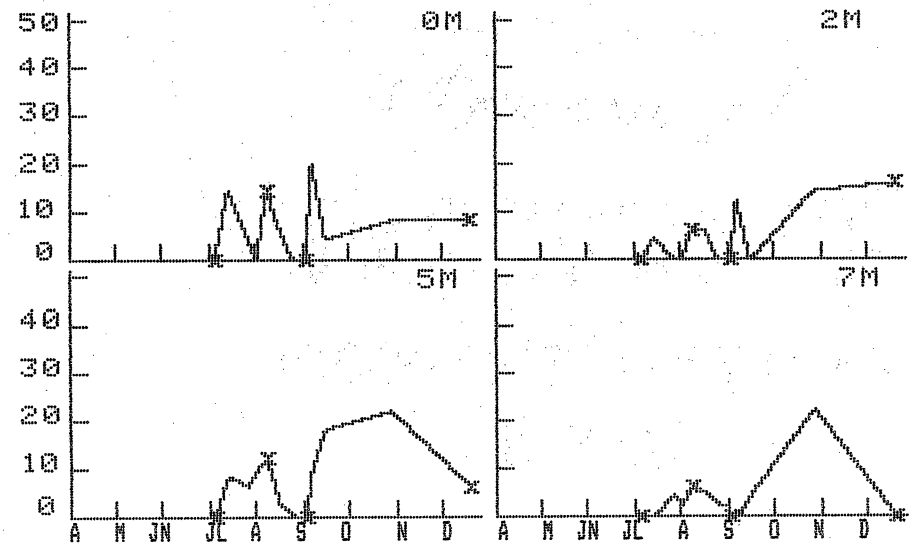
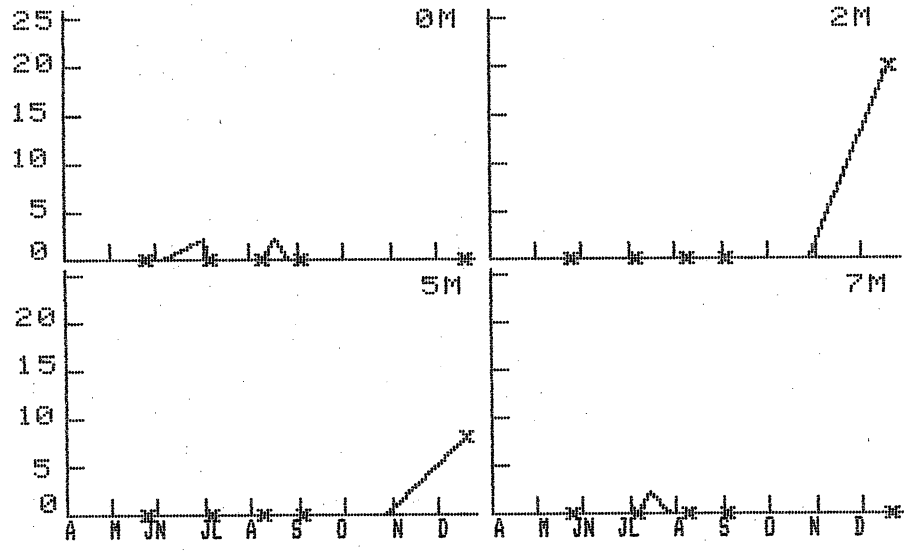


FIGURE 47

PALMELLA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

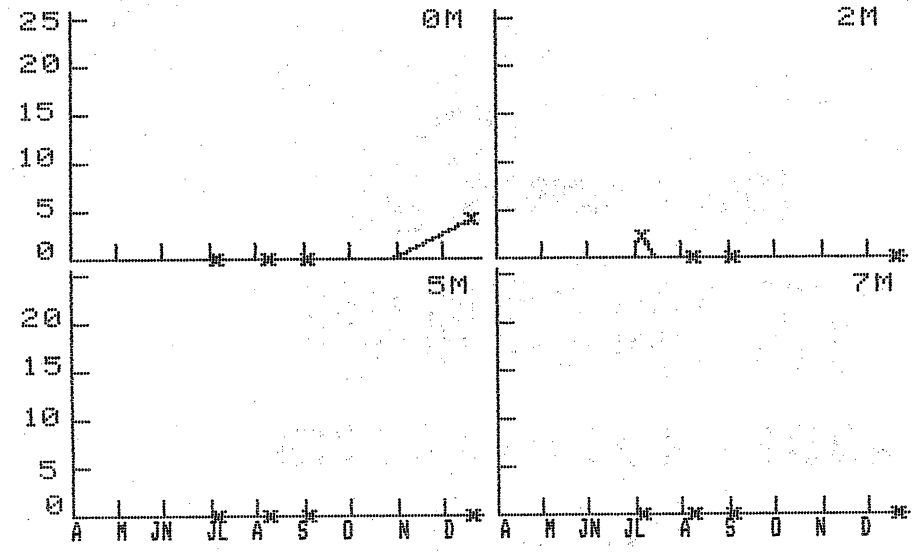
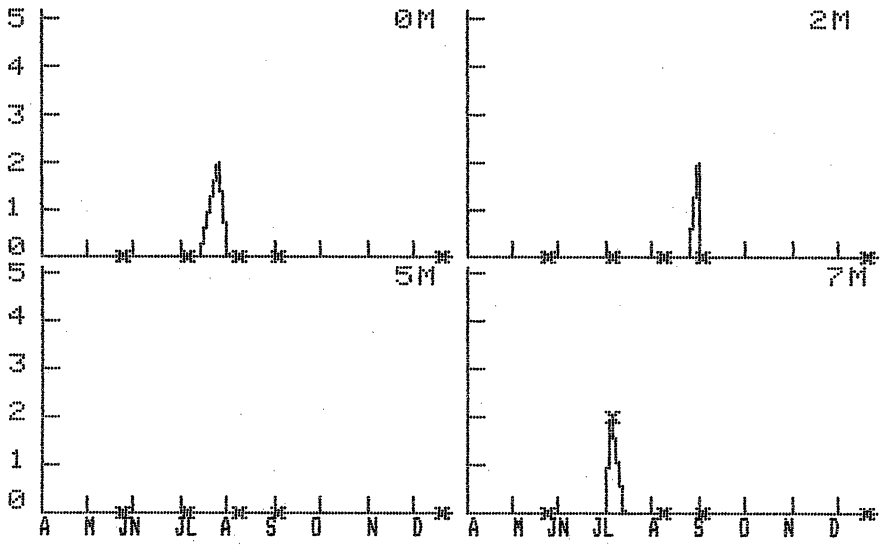


FIGURE 48

PEDIASTRUM (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

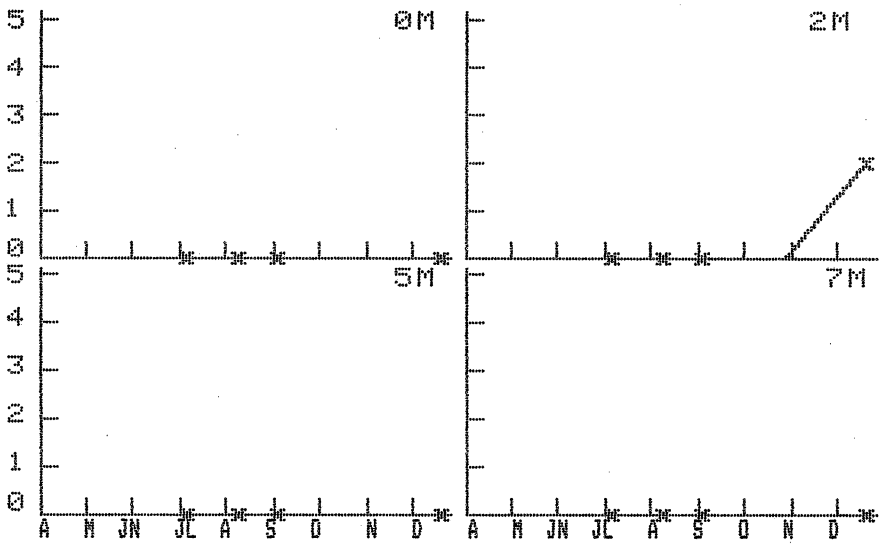
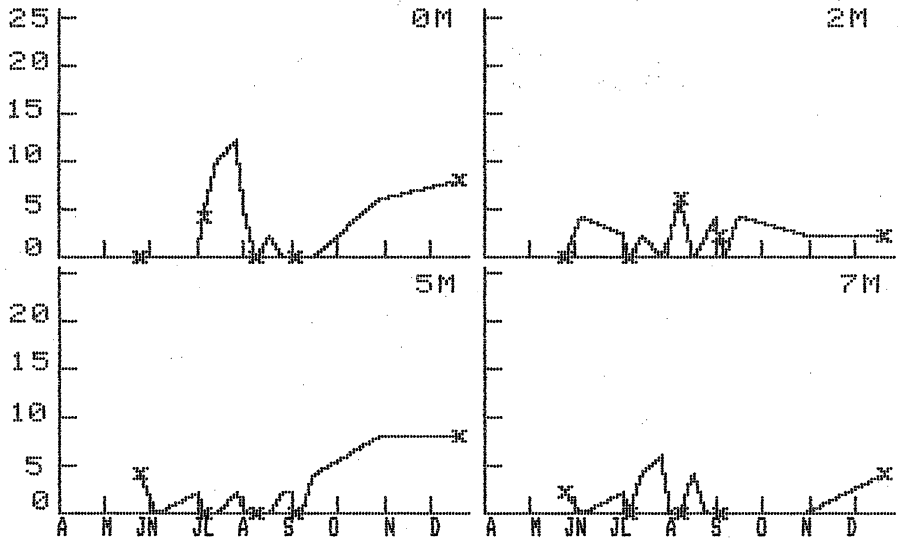


FIGURE 49

SCENEDESMUS ABUNDANS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

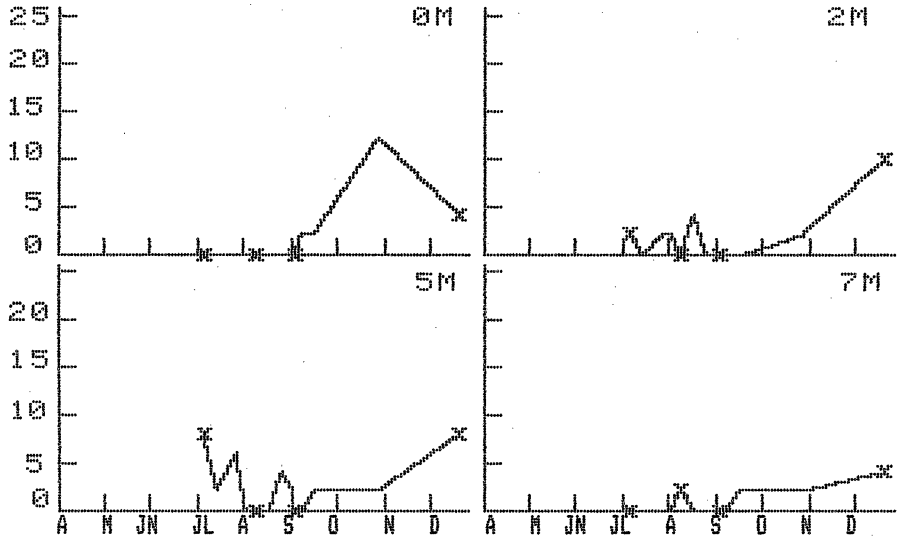
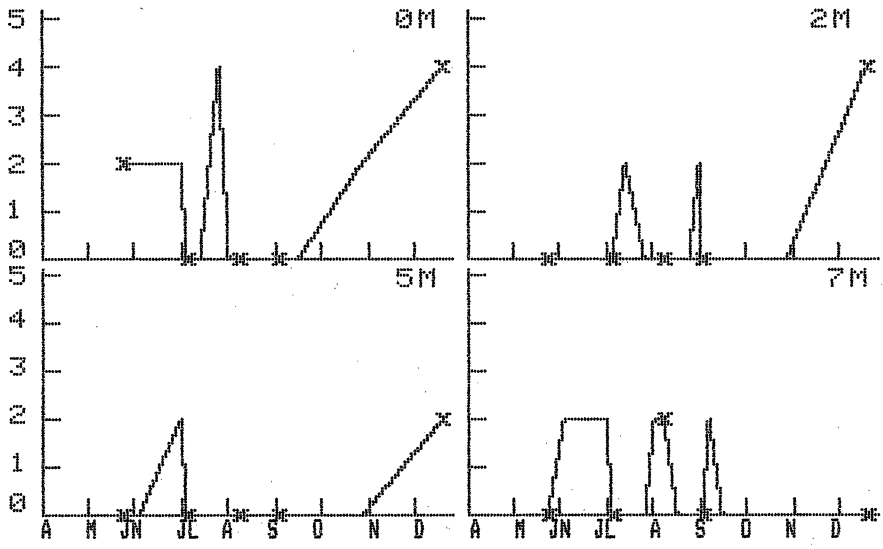


FIGURE 50

SCENEDESMUS DIMORPHUS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

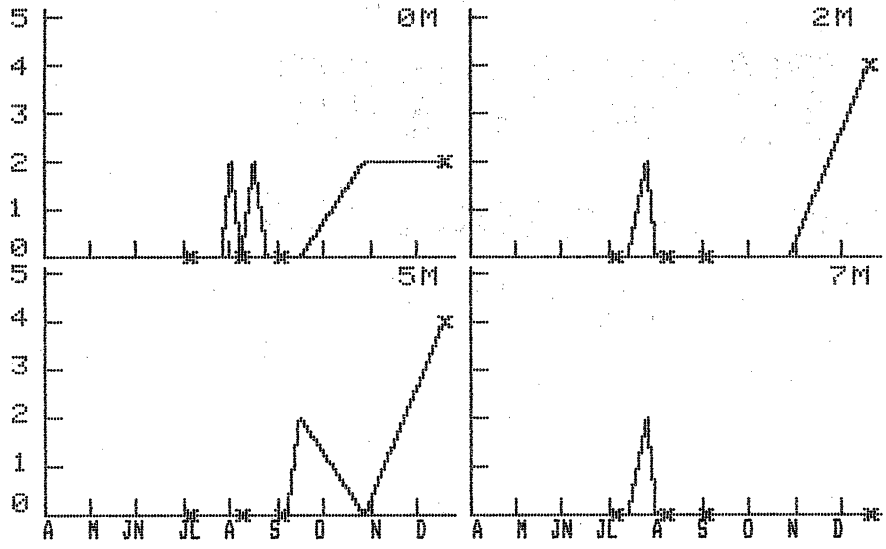
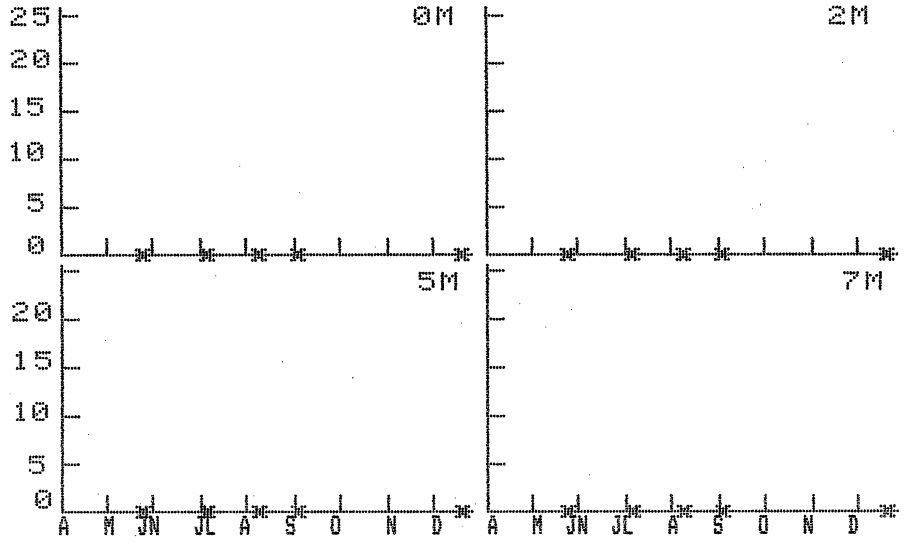


FIGURE 51

SCENEDESMUS INCRASSATULUS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

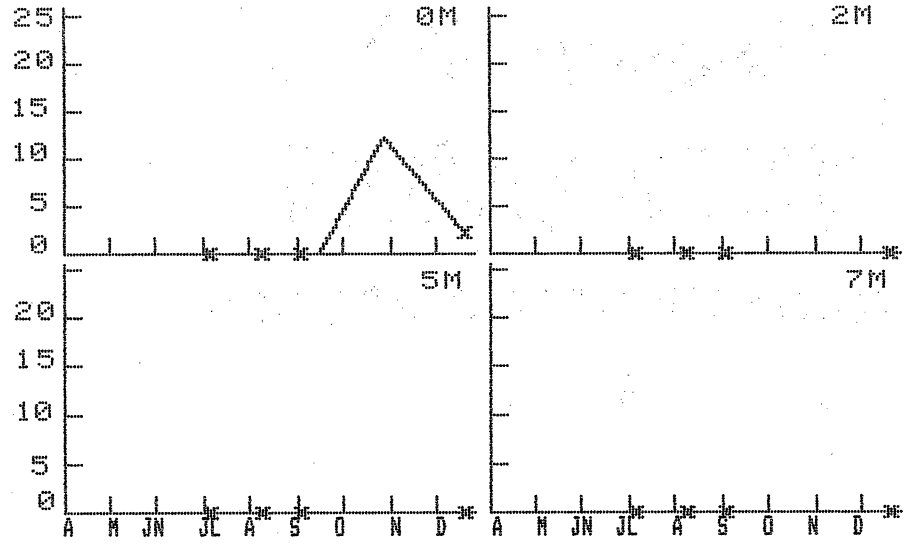
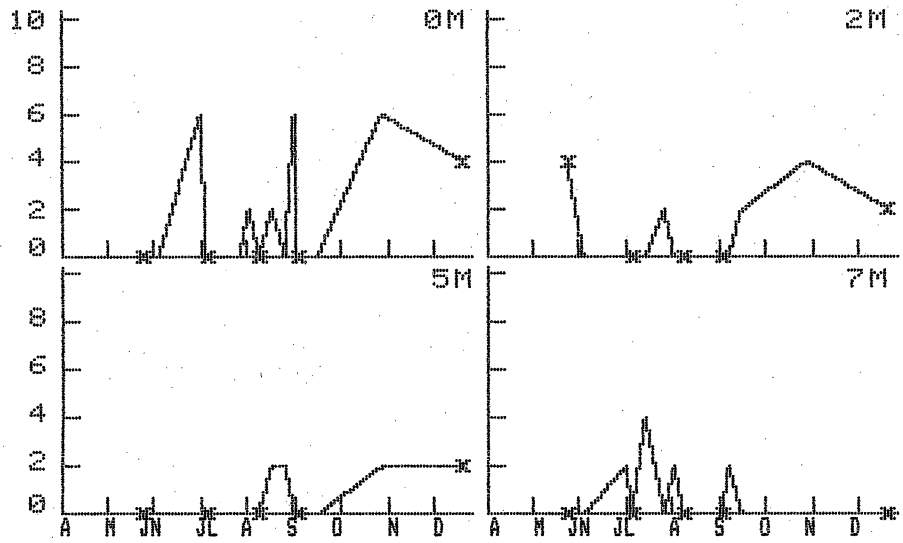


FIGURE 52

SCENEDESMUS QUADRICAUDA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

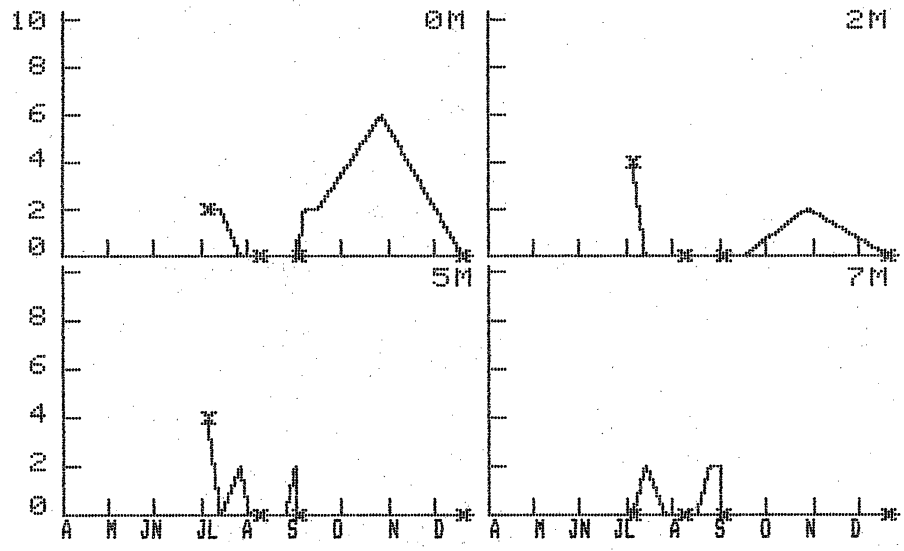
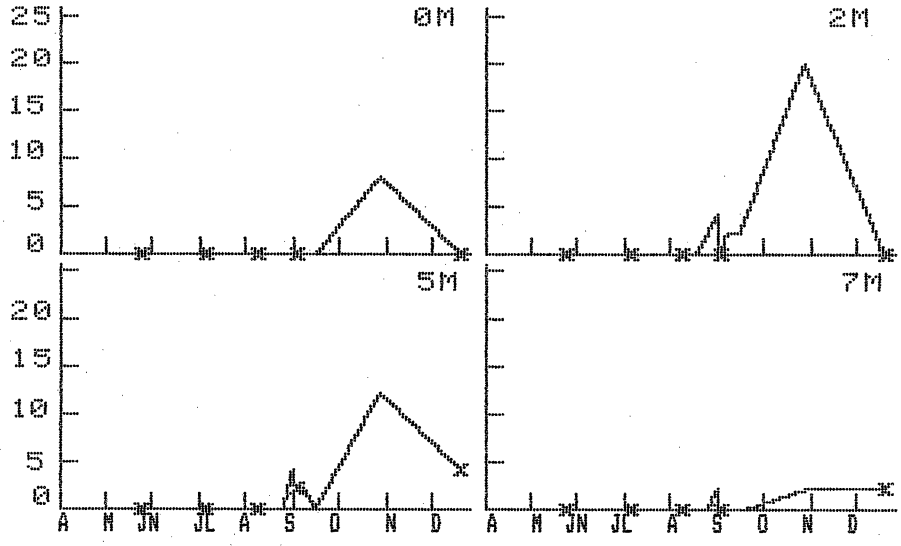


FIGURE 53

SCENEDESMUS PERFORATUS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

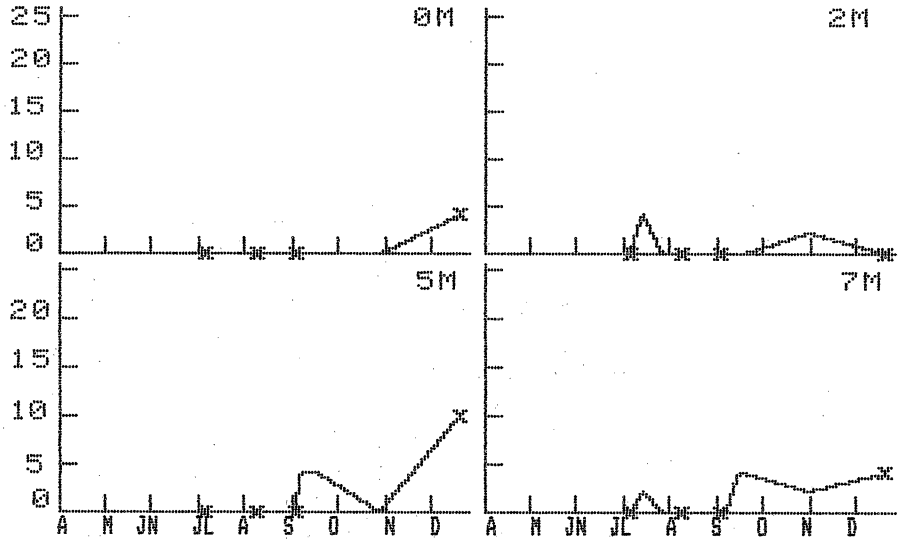
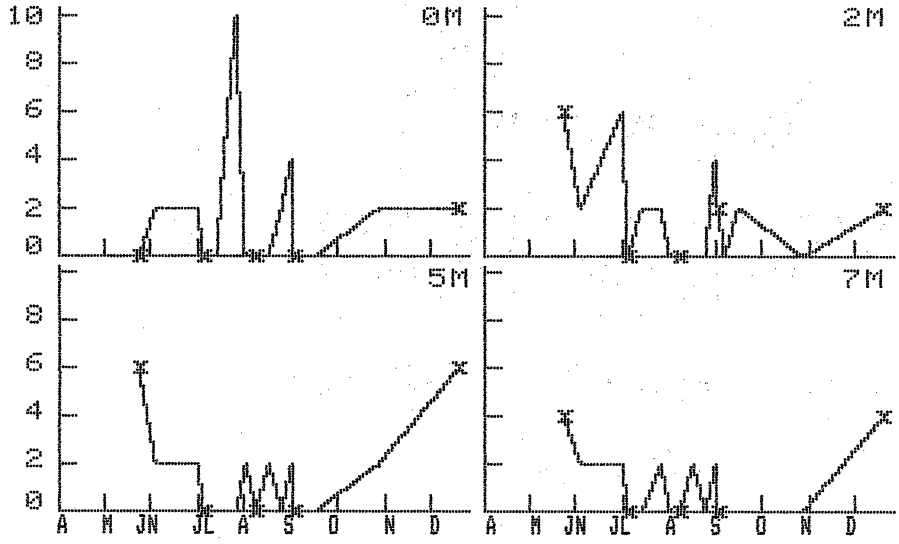


FIGURE 54

TETRAEDRON MINIMUM (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

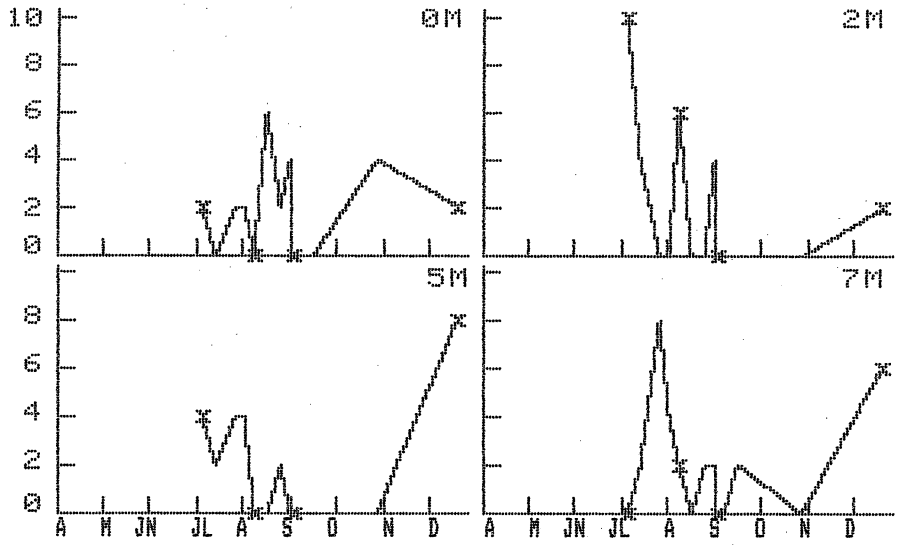
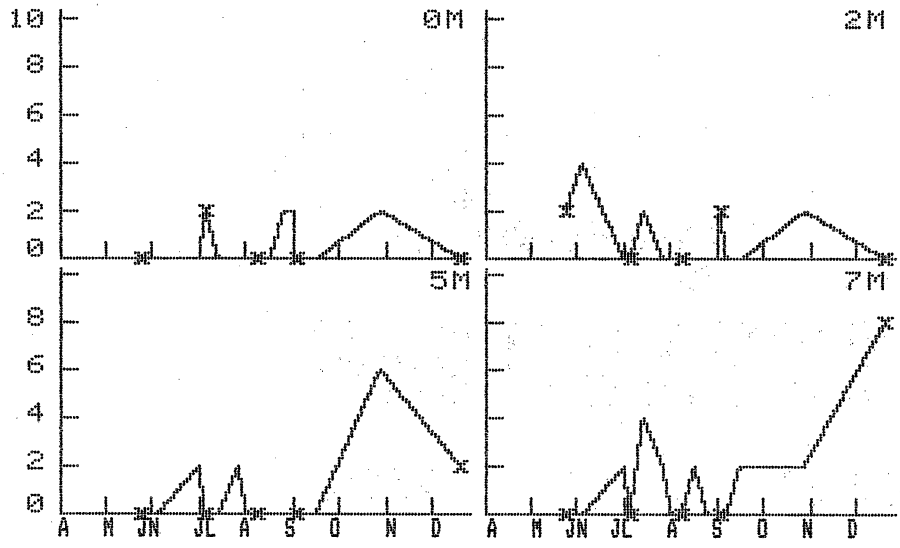


FIGURE 55

TETRAEDRON TRIGONUM (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

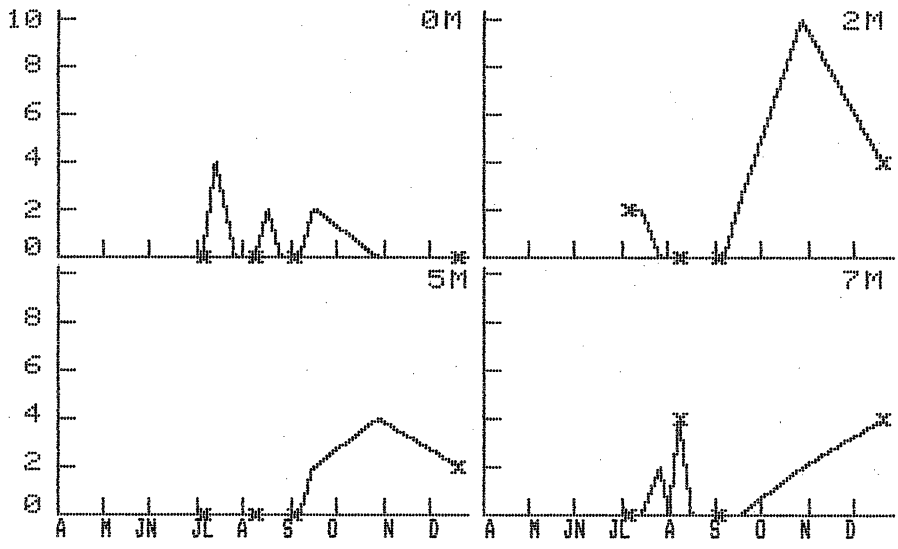
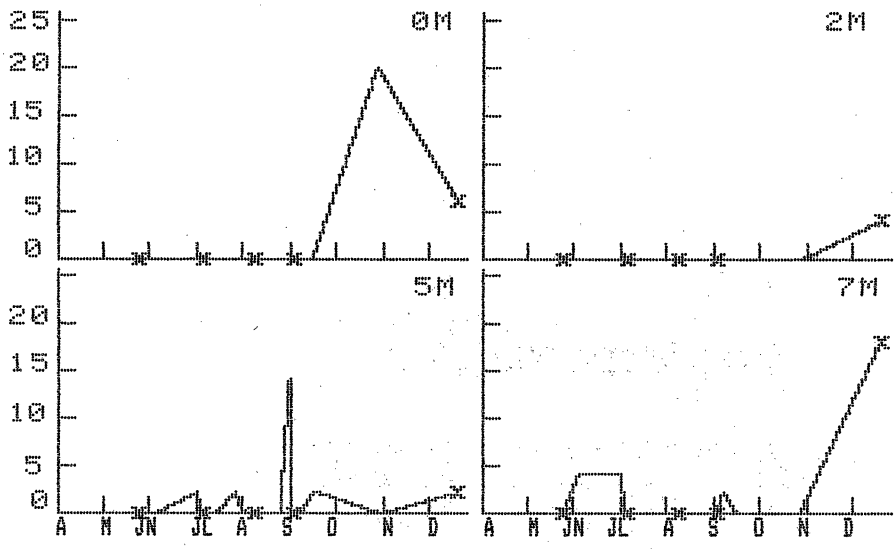


FIGURE 56

TETRASTRUM HETEROCANTHUM (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

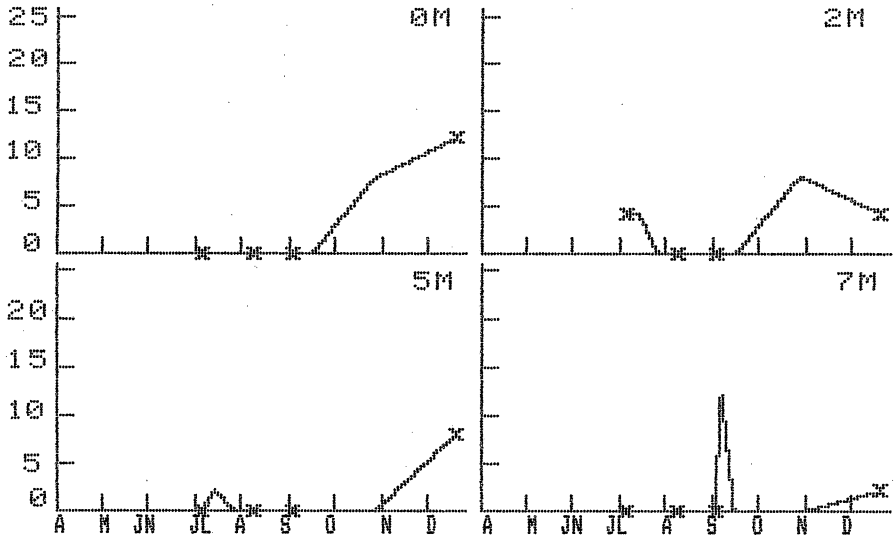
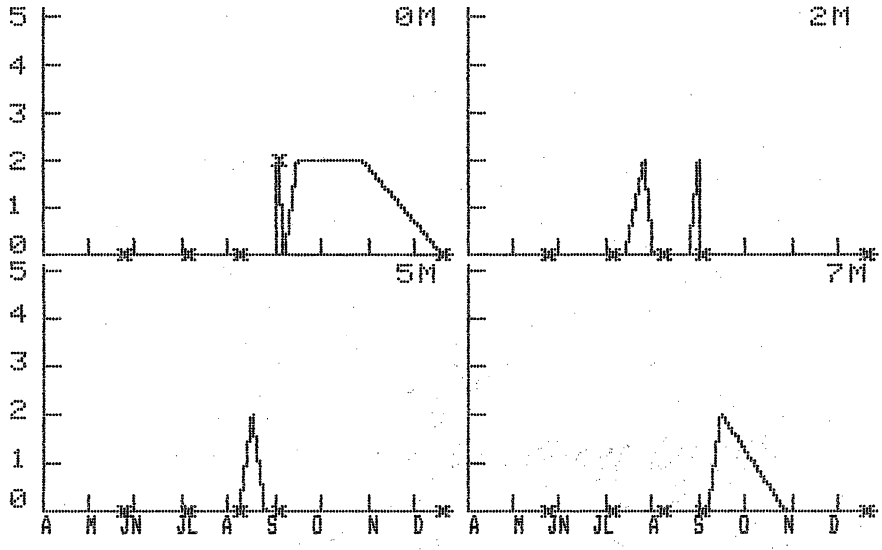


FIGURE 57

TREUBARIA SETIGERUM (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

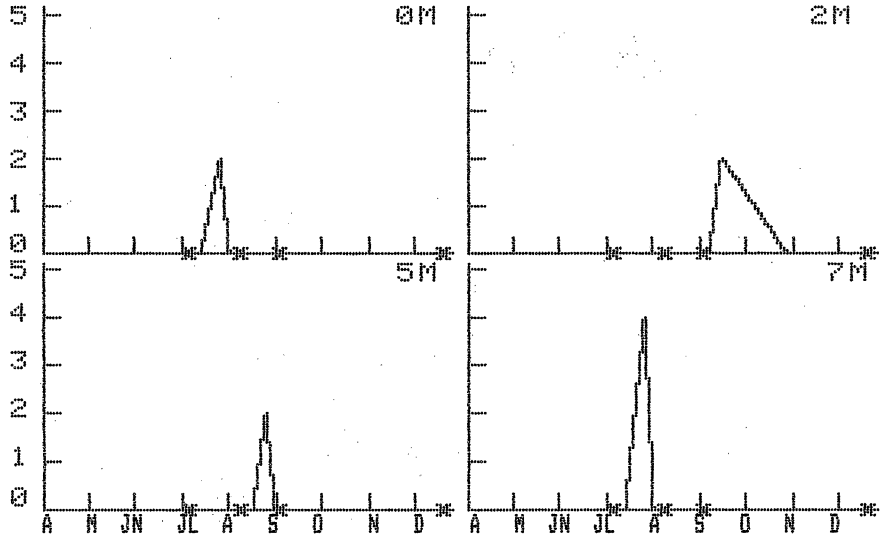
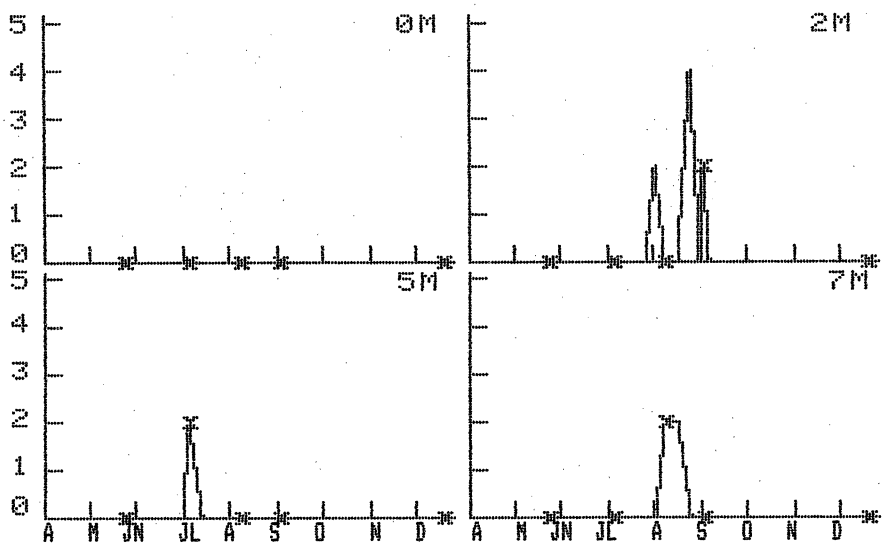


FIGURE 58

TROCHISCHIA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

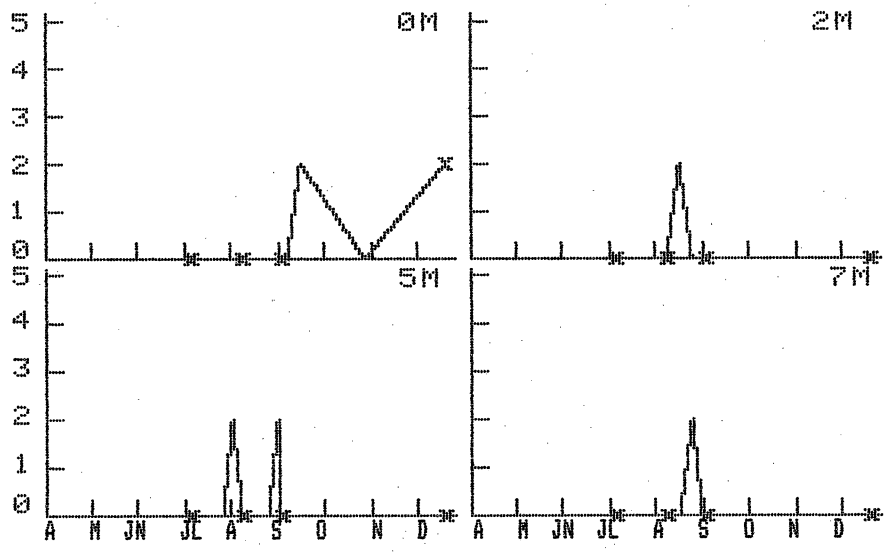
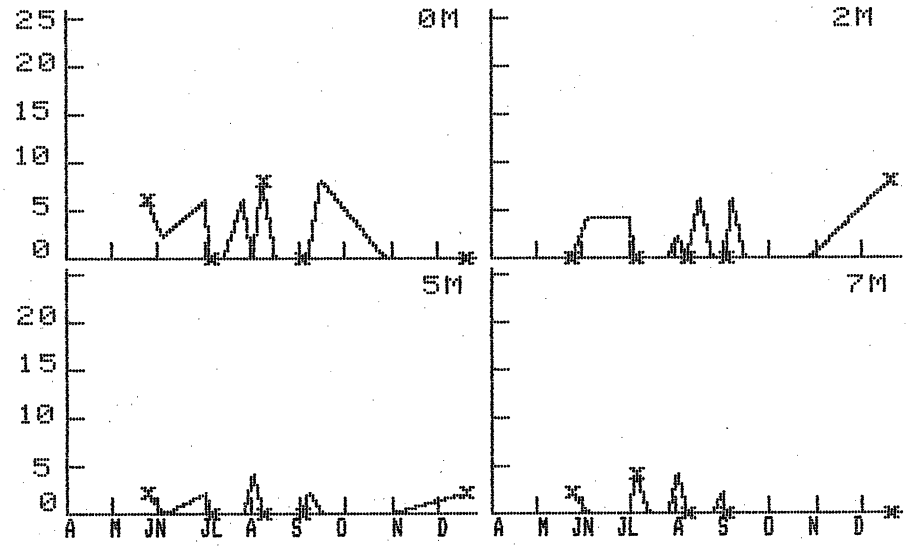


FIGURE 59

CHLAMYDOMONAS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

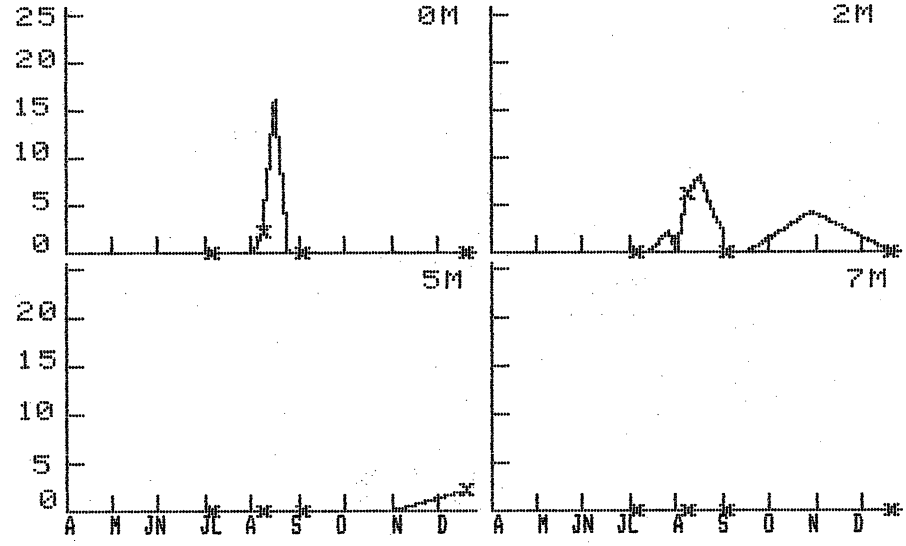
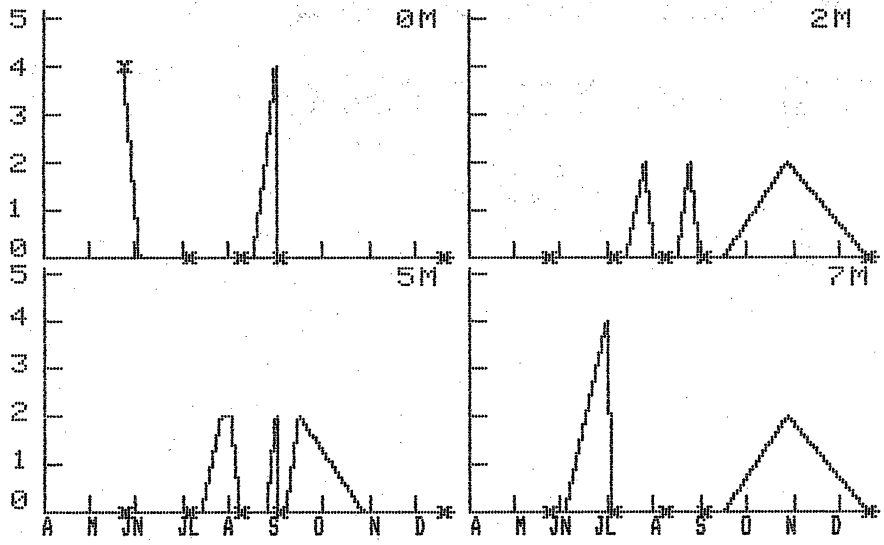


FIGURE 60

NISLOUCHIELLA PLANCTONICA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

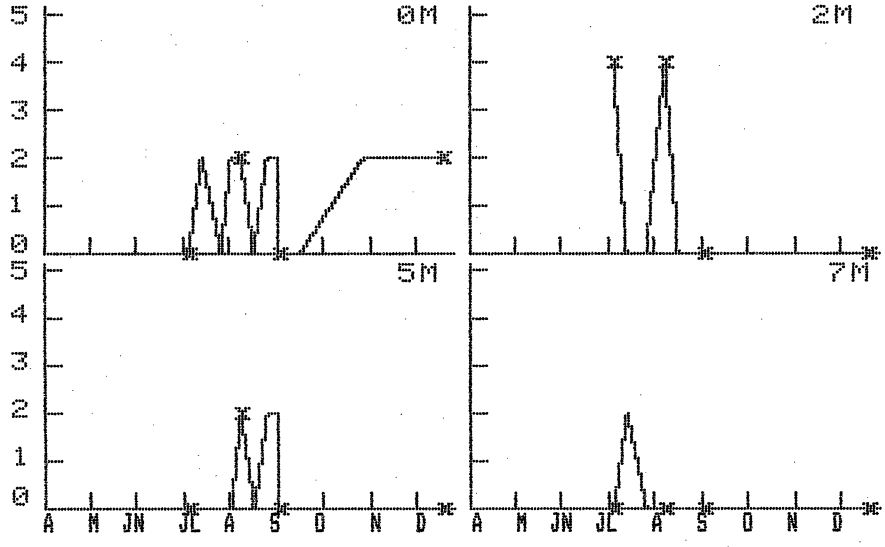
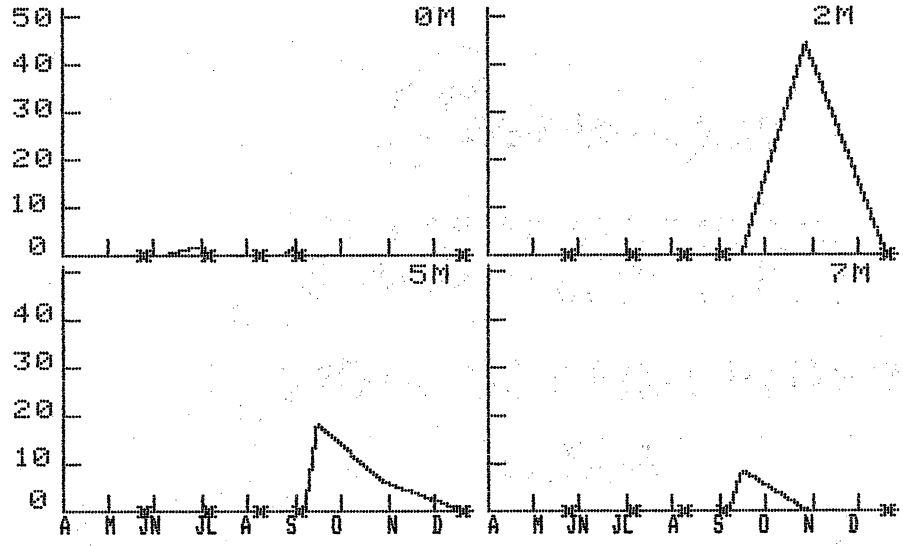


FIGURE 61

ANABAENA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

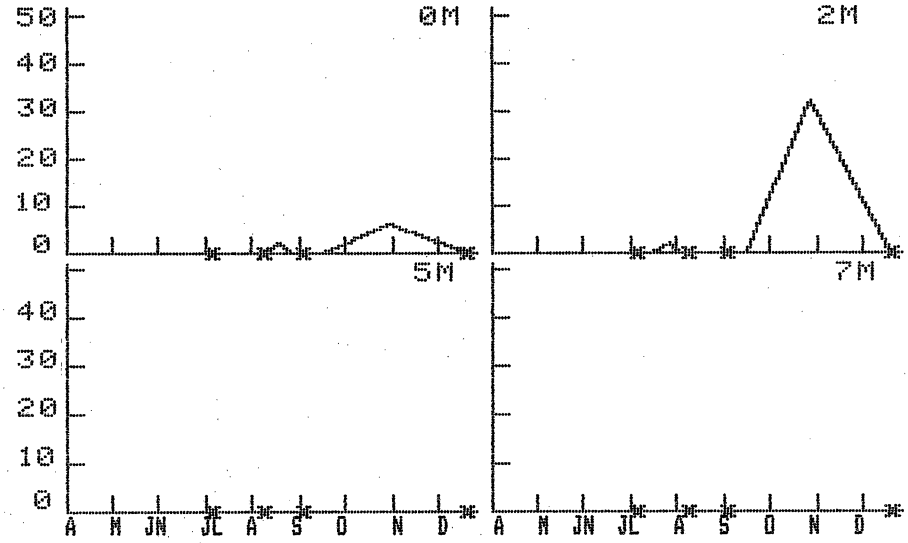
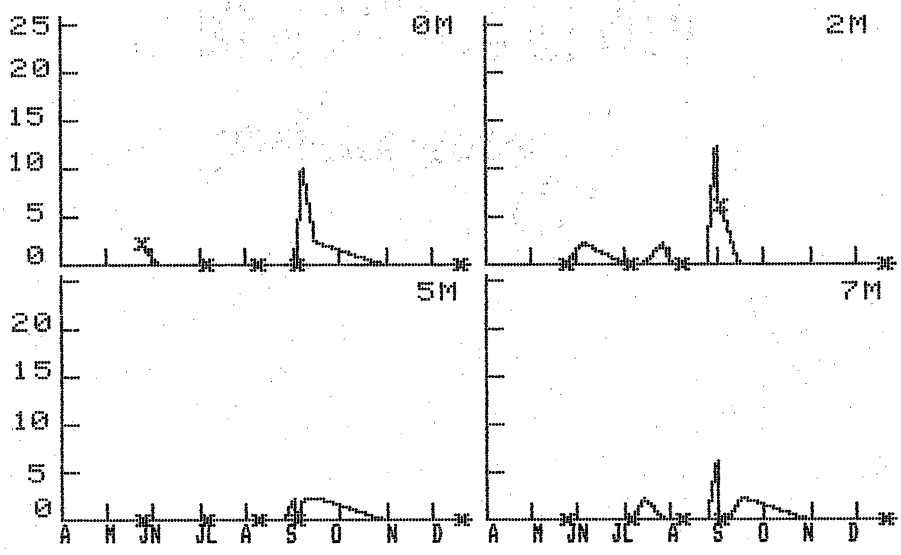


FIGURE 62

ANABAENAOPSIS ELENKINII (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

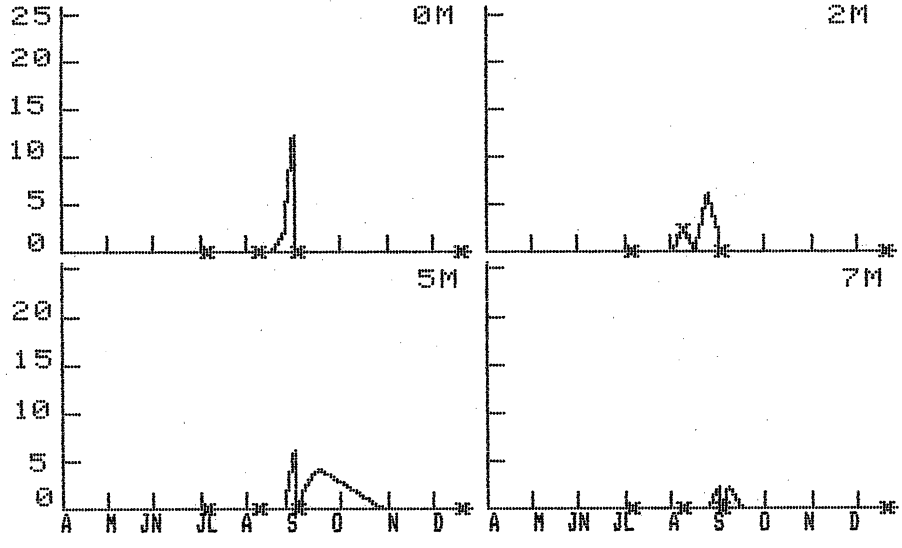
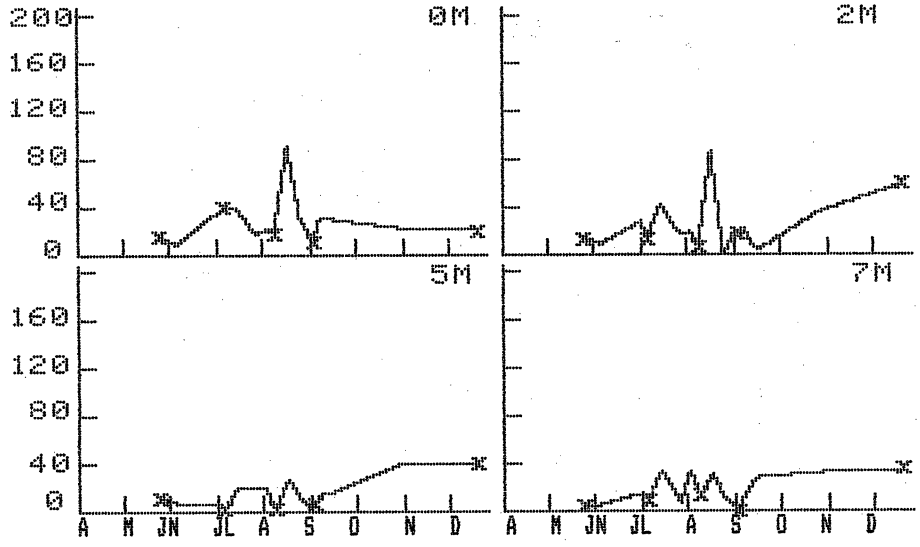


FIGURE 63

DACTYLOCOCCOPSIS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

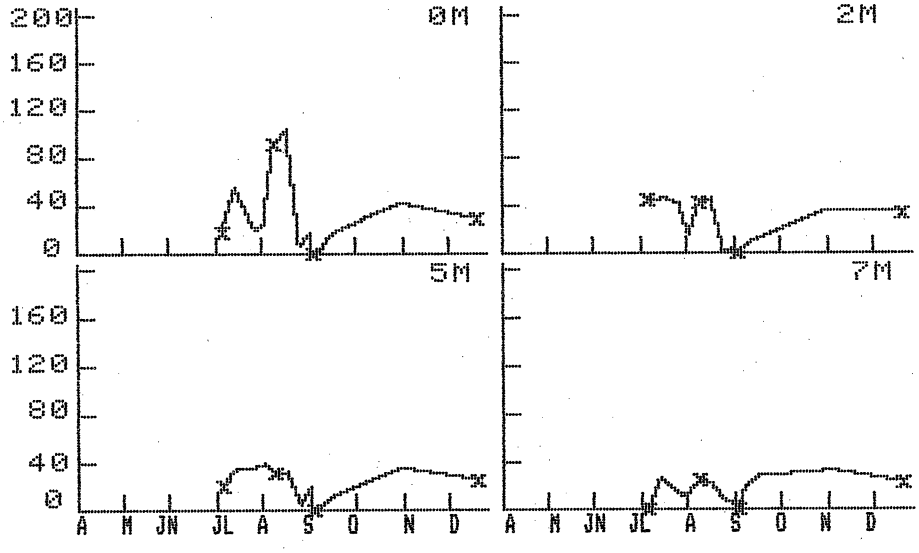
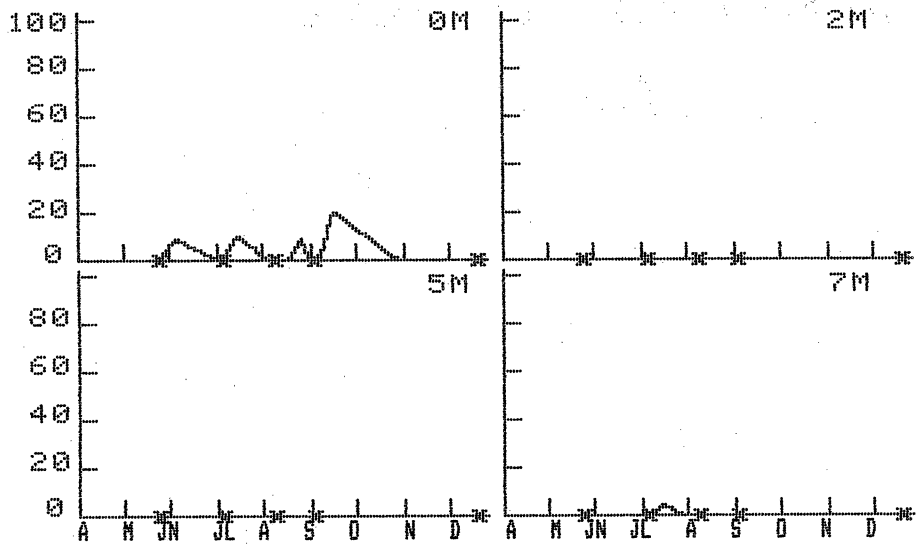


FIGURE 64

MERISMOPEDIA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

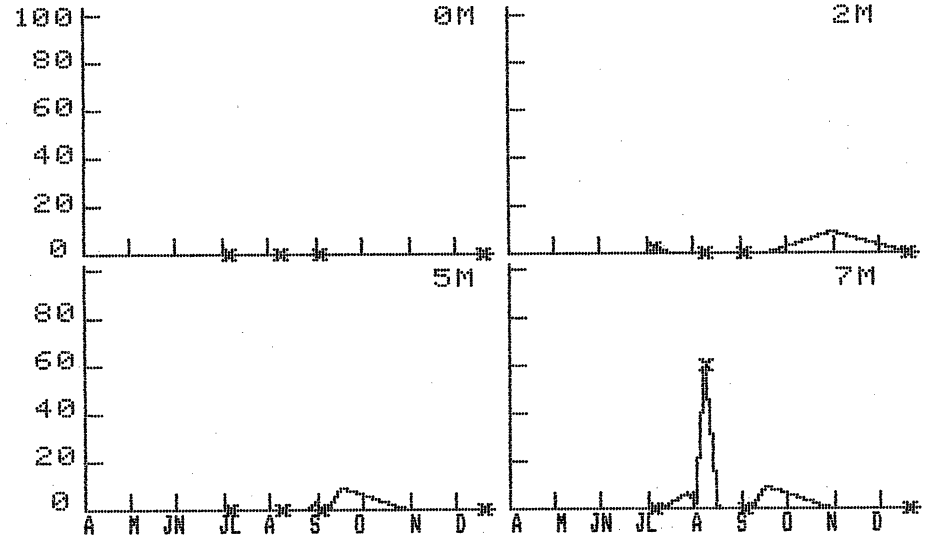
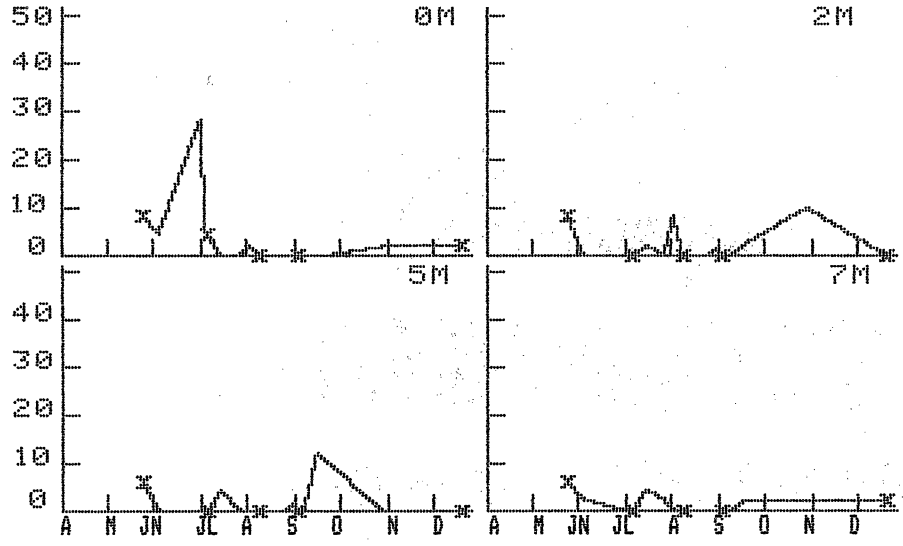


FIGURE 65

MICROCYSTIS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

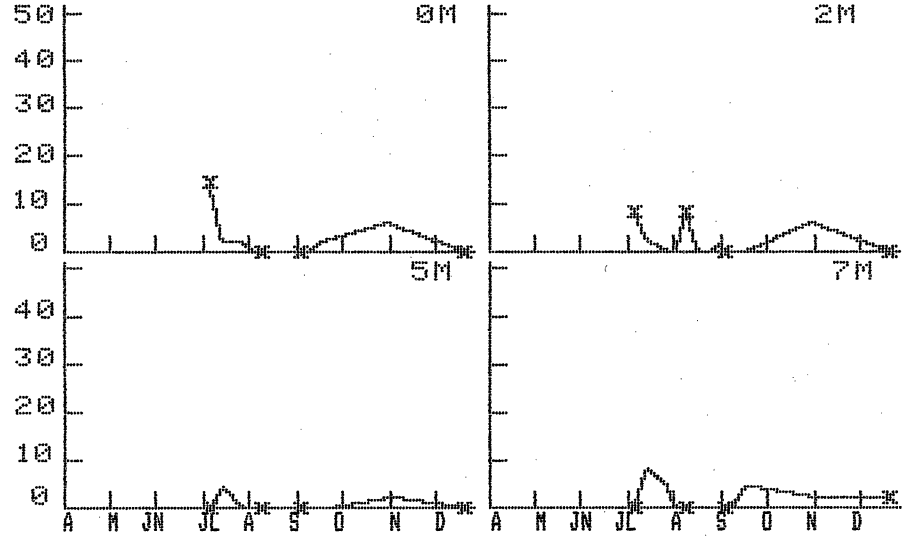
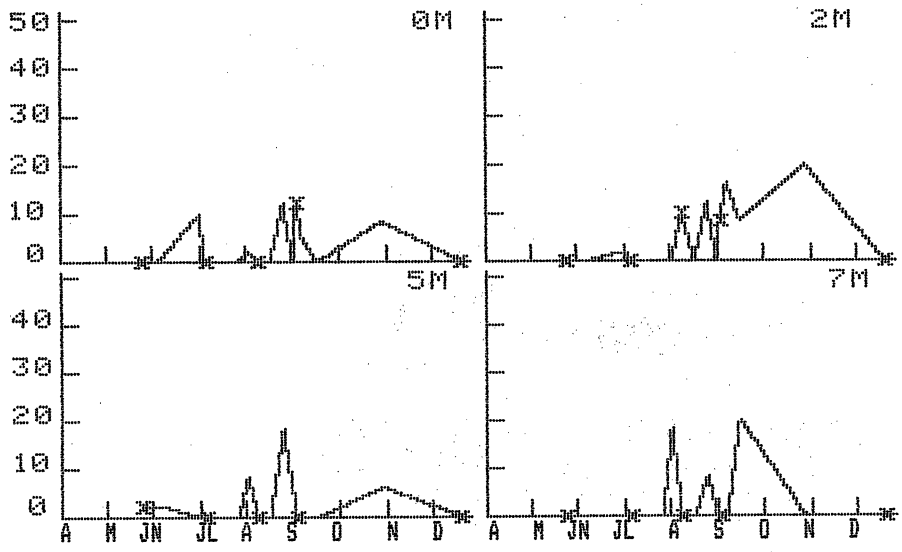


FIGURE 64

OSCILLATORIA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

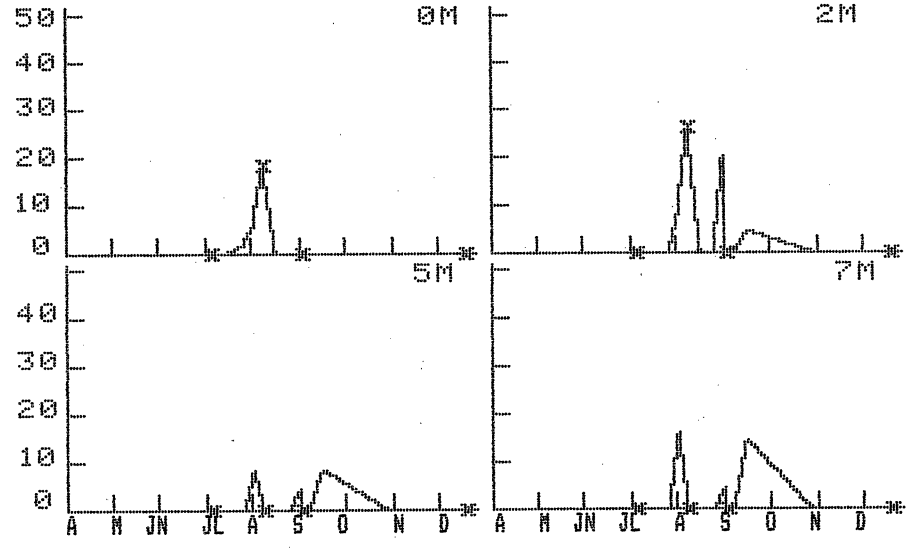
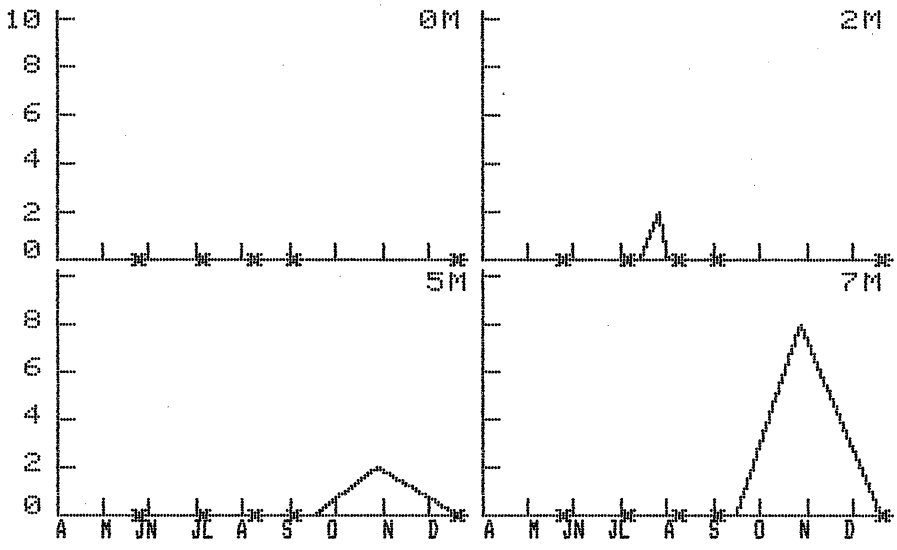


FIGURE 67

BIDDULPHIA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

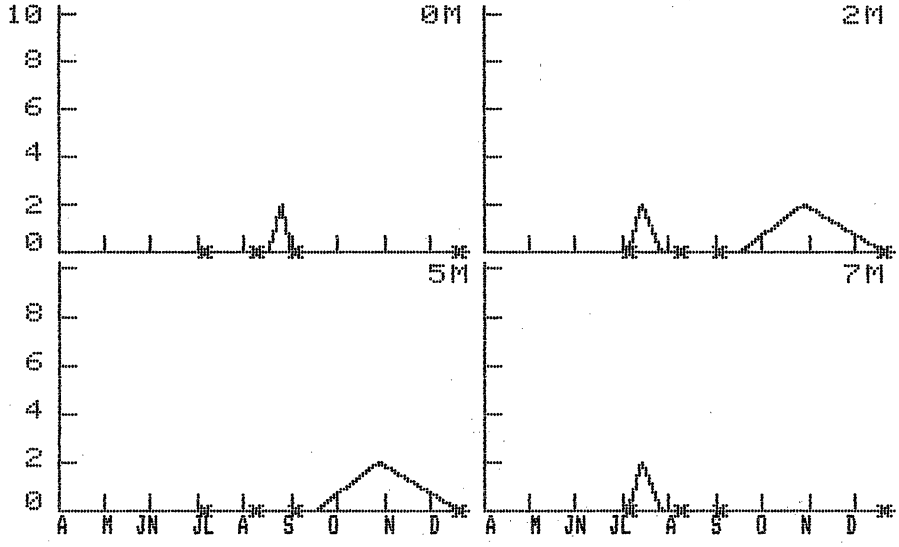
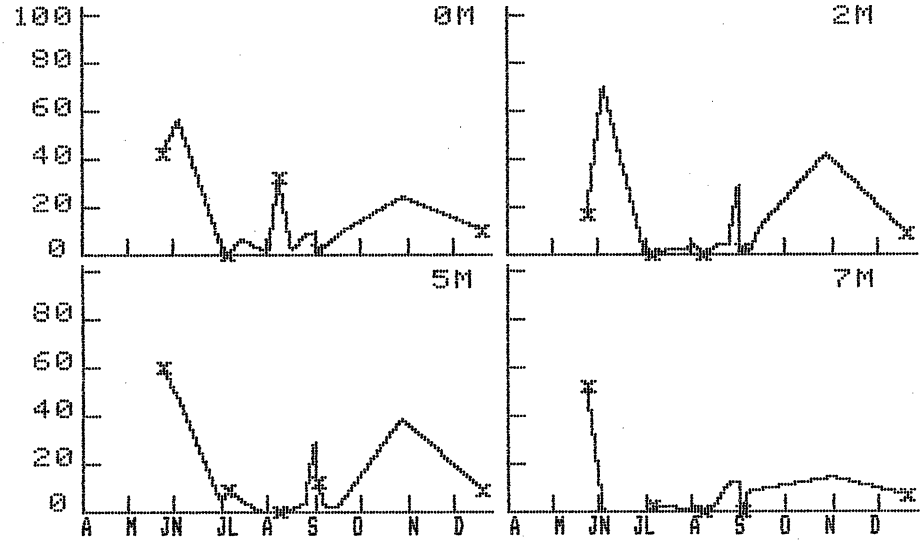


FIGURE 68

MELOSIRA VARIANS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

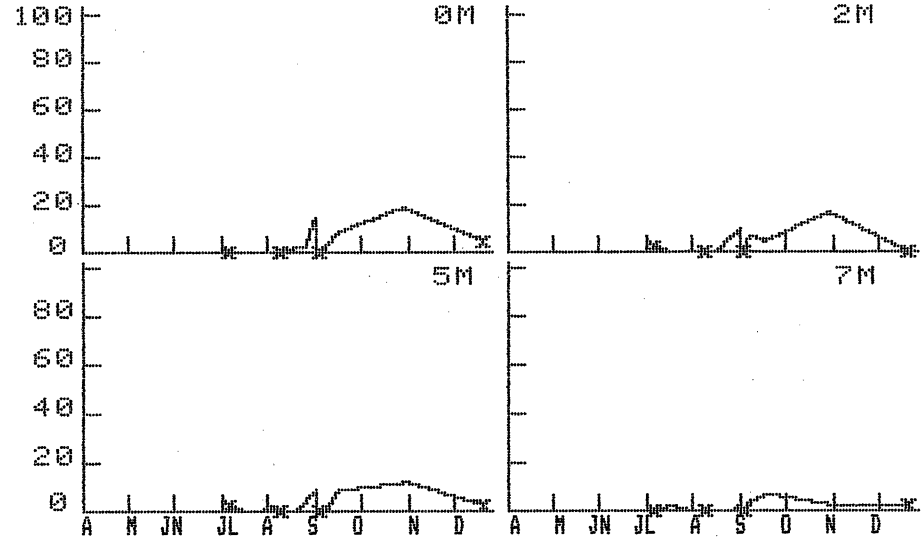
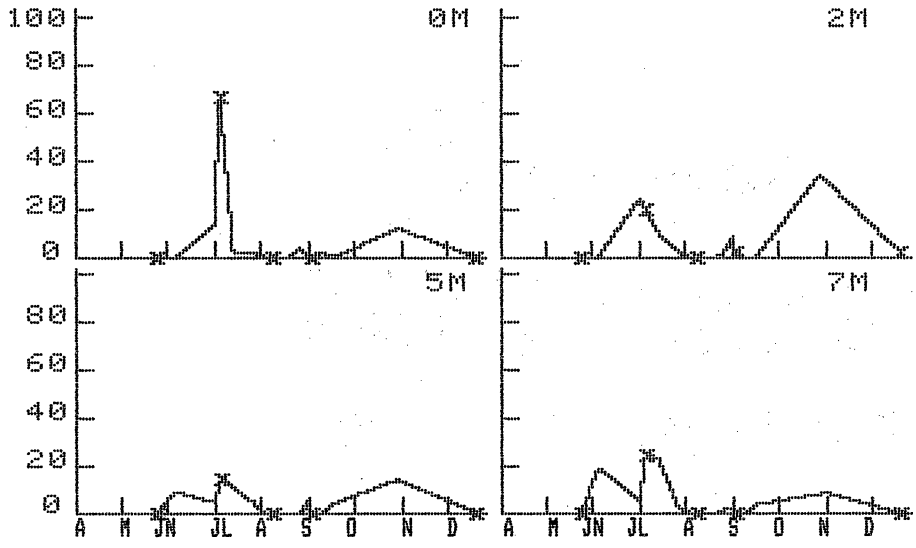


FIGURE 69

STEPHANODISCUS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

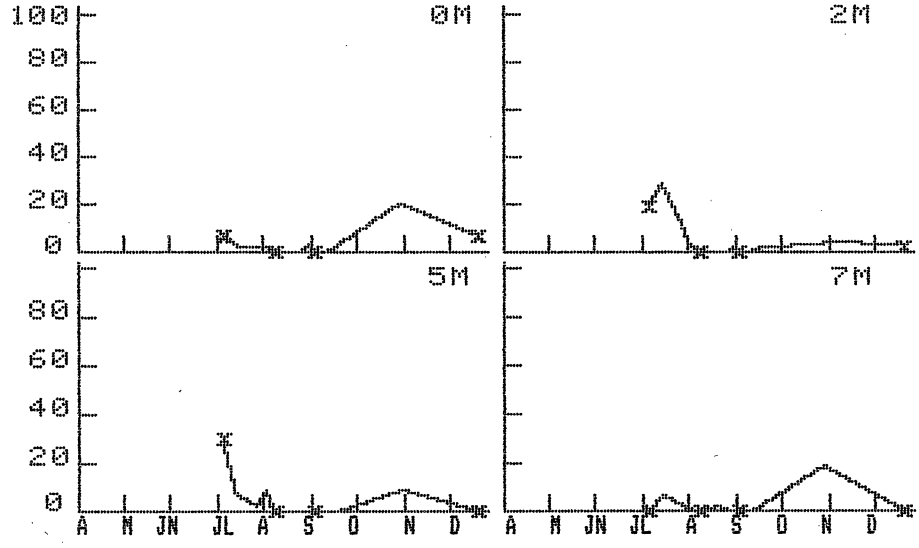
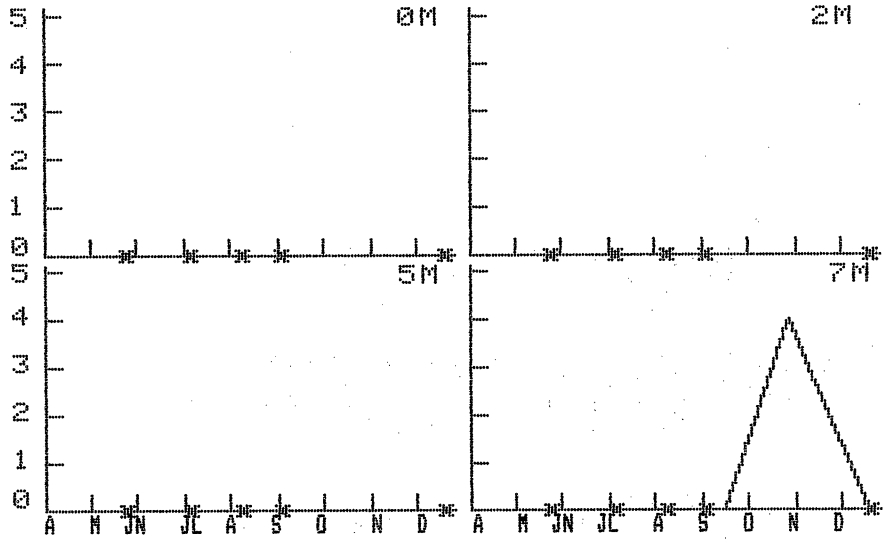


FIGURE 70

TABELLARIA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

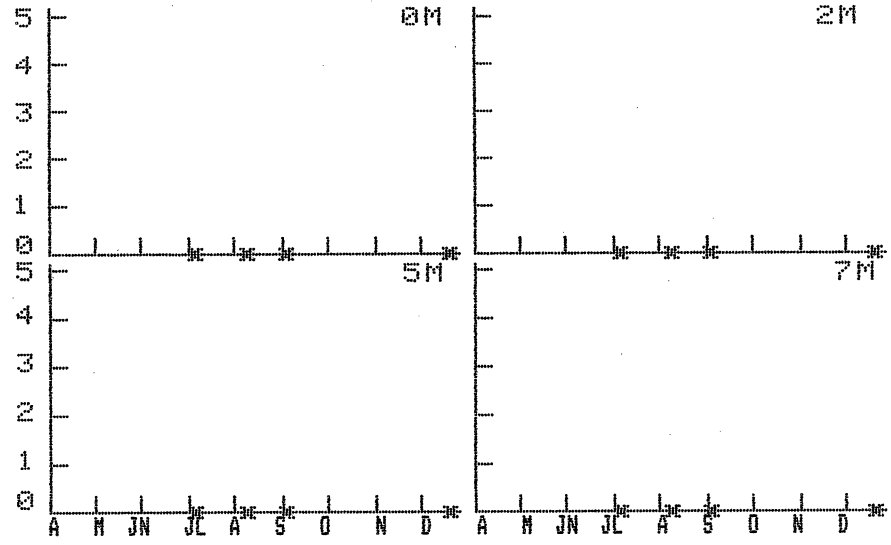
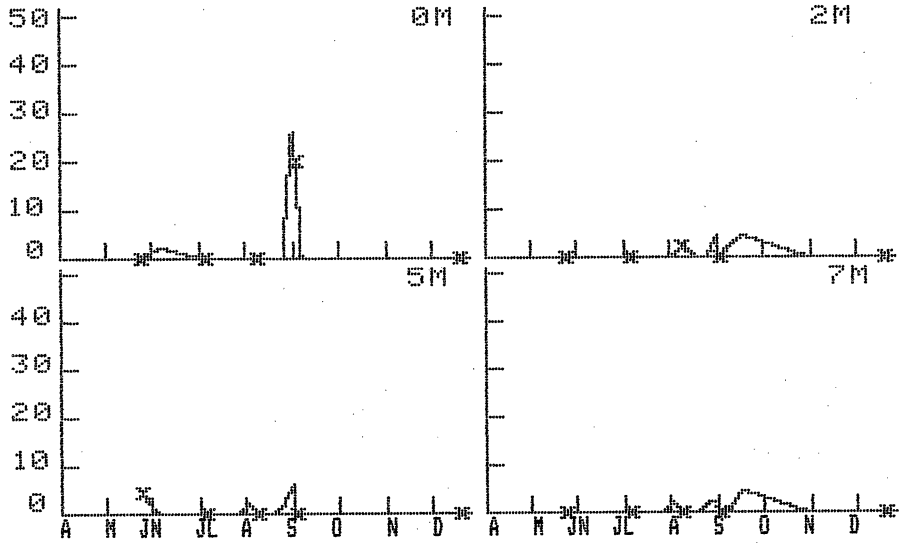


FIGURE 71

PENATE DIATOM (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

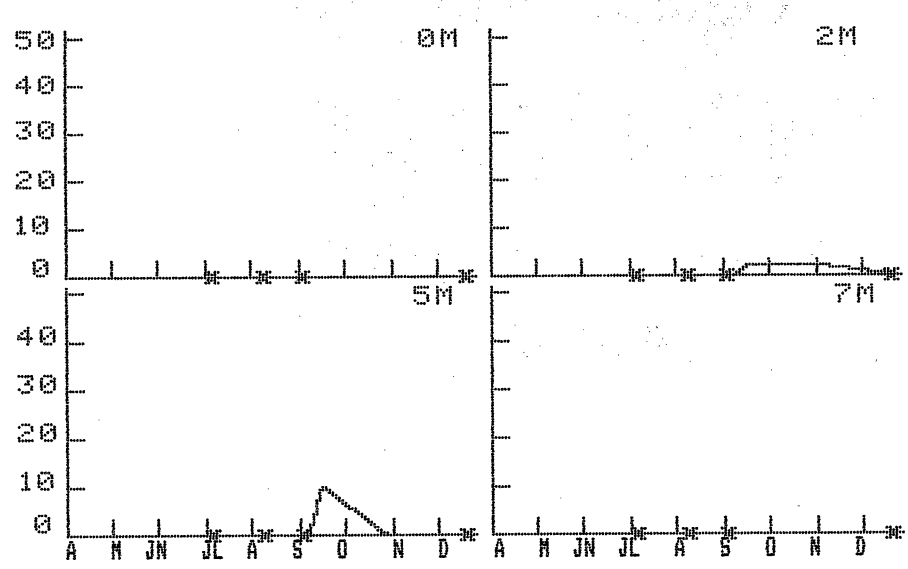
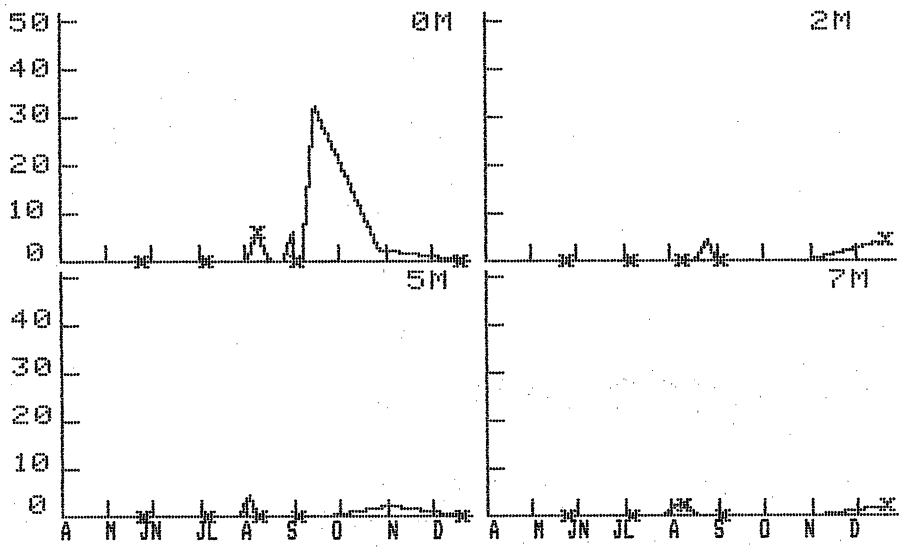


FIGURE 72

EUGLENA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

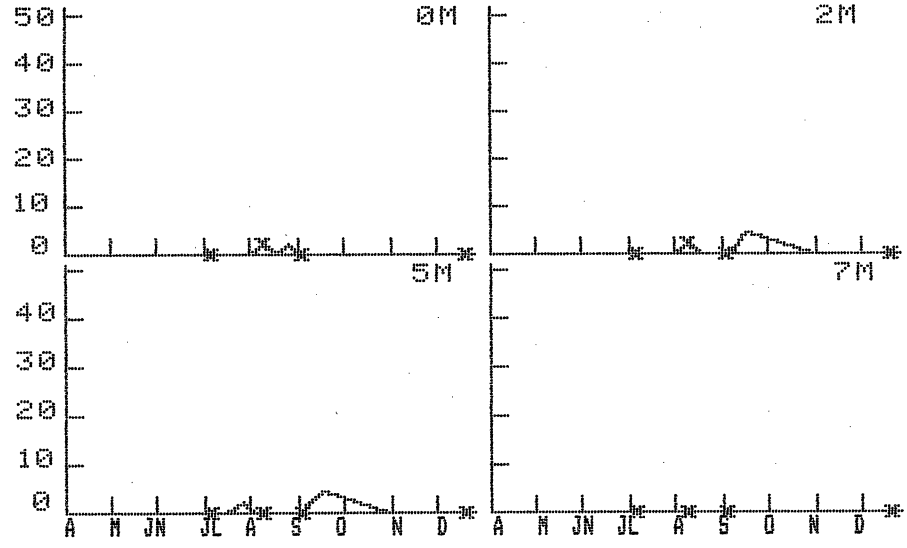
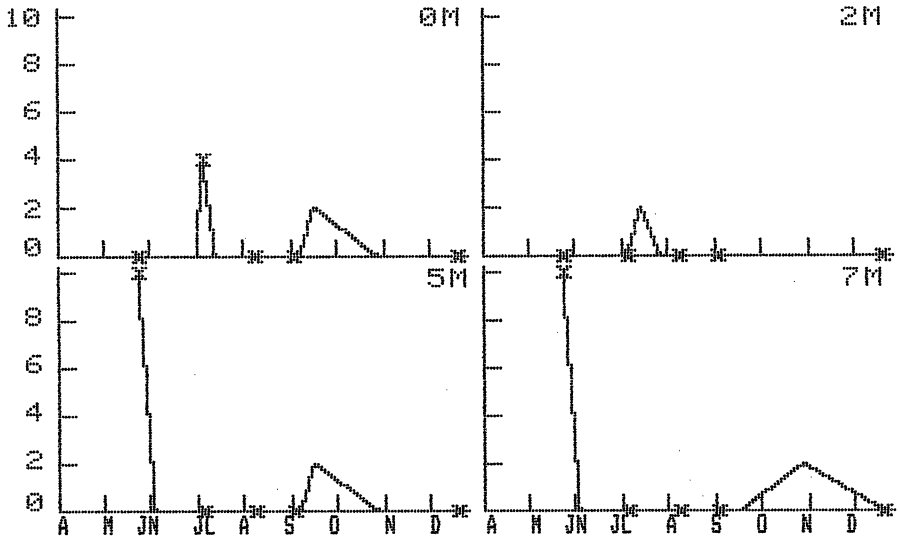


FIGURE 73

TRACHELOMONAS (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

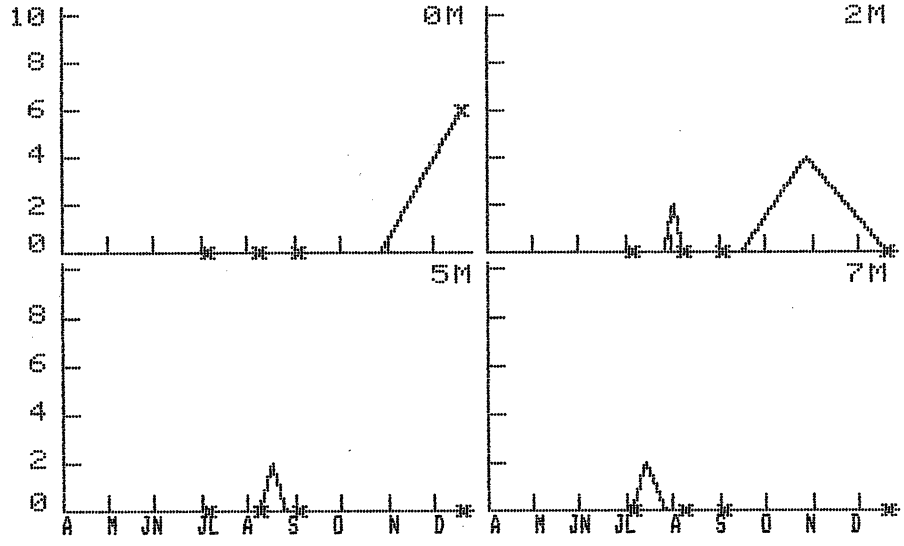
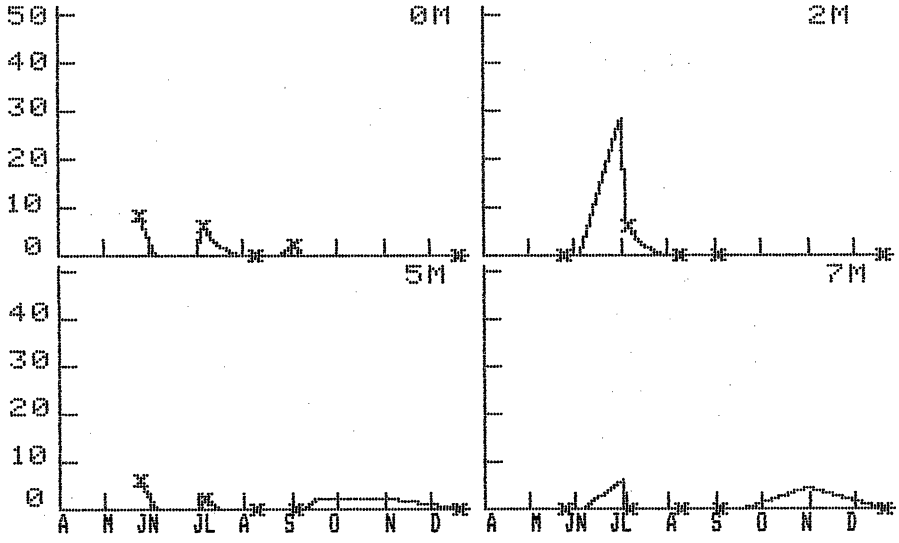


FIGURE 74

CHRYSOCHROMULINA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

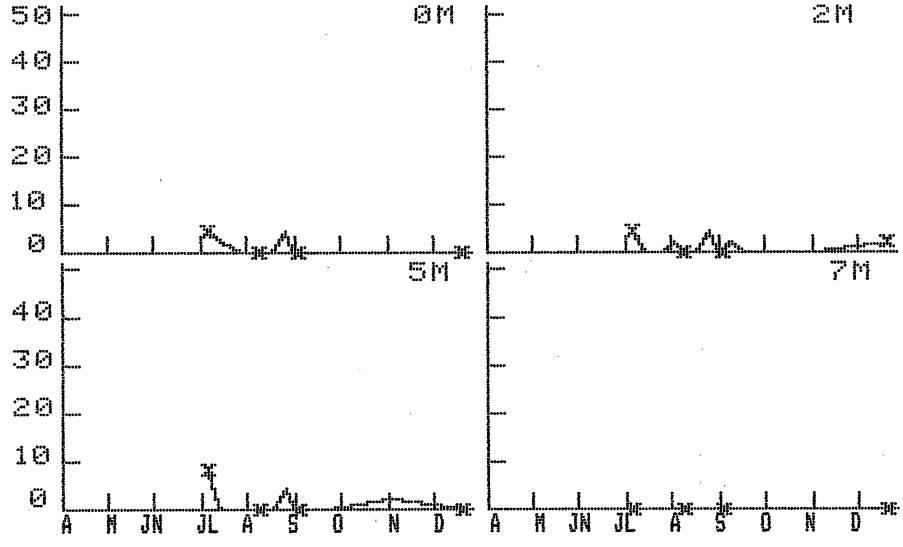
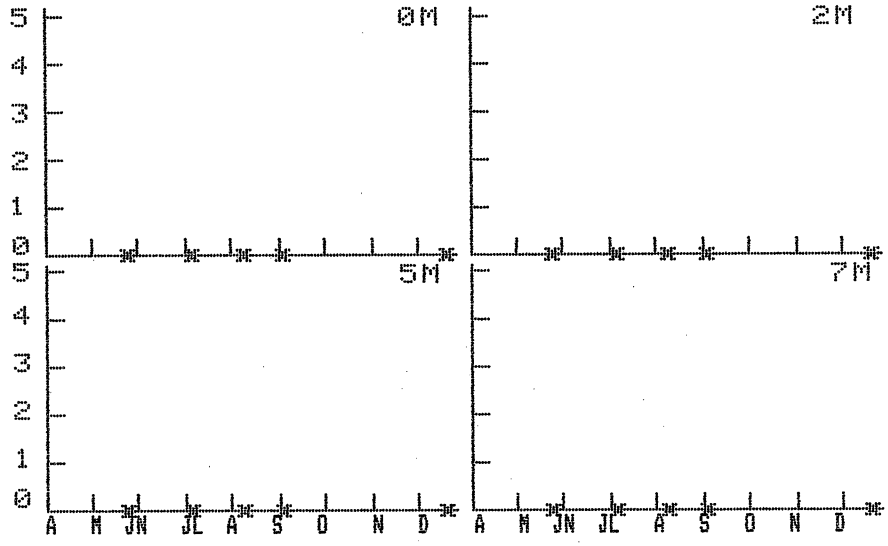


FIGURE 75

EXUVIELLA (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

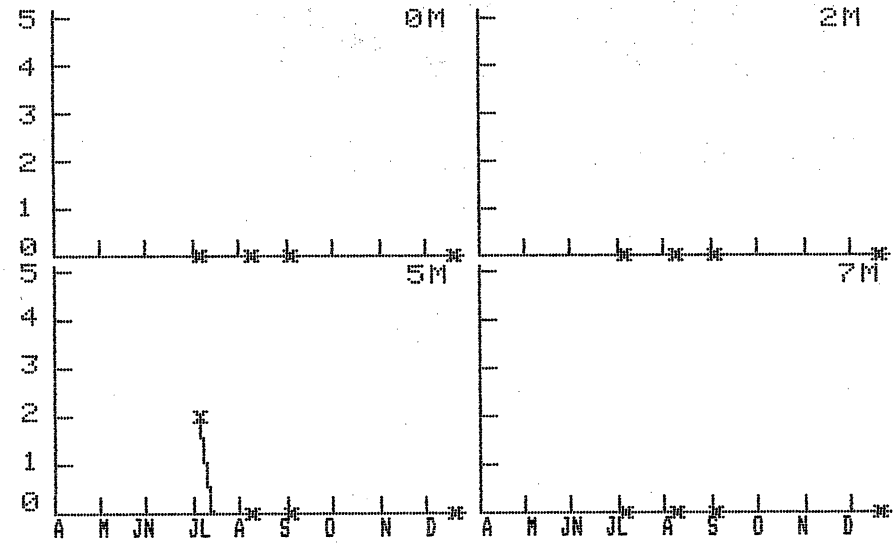
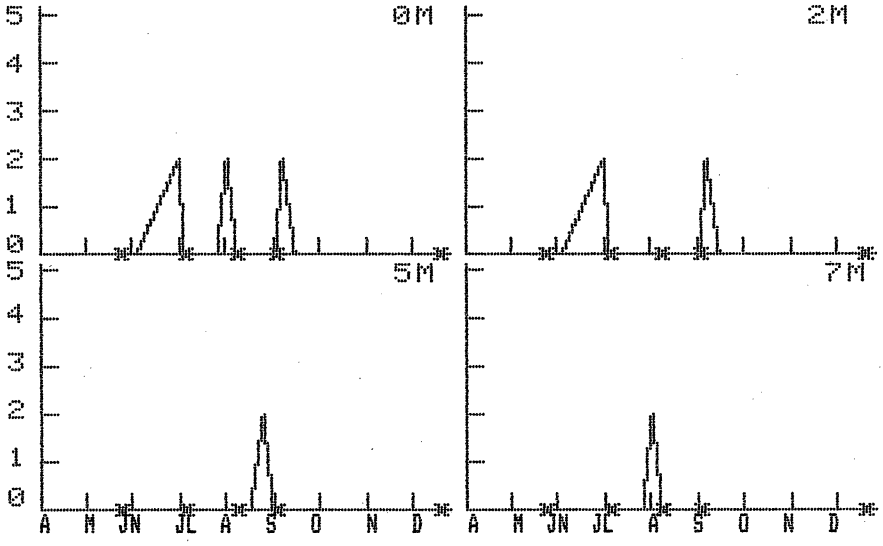


FIGURE 76

GYMNODINIUM (X)
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

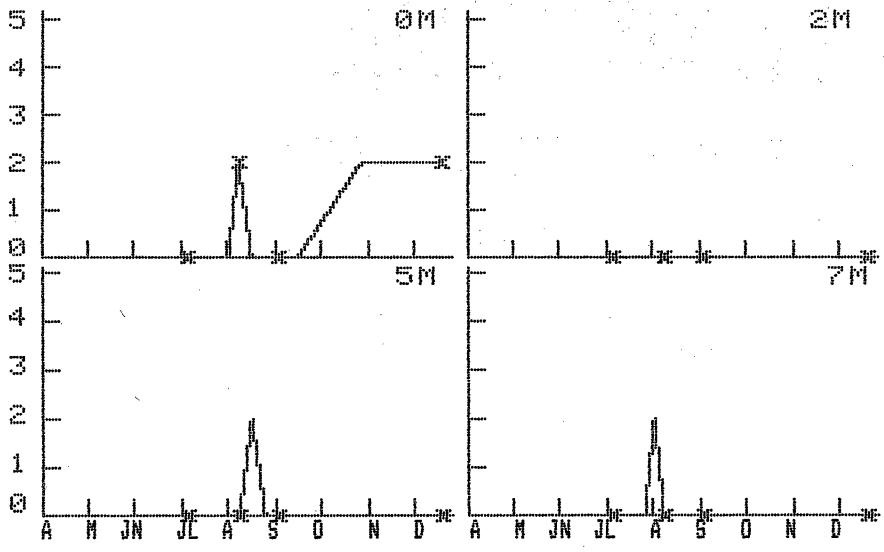
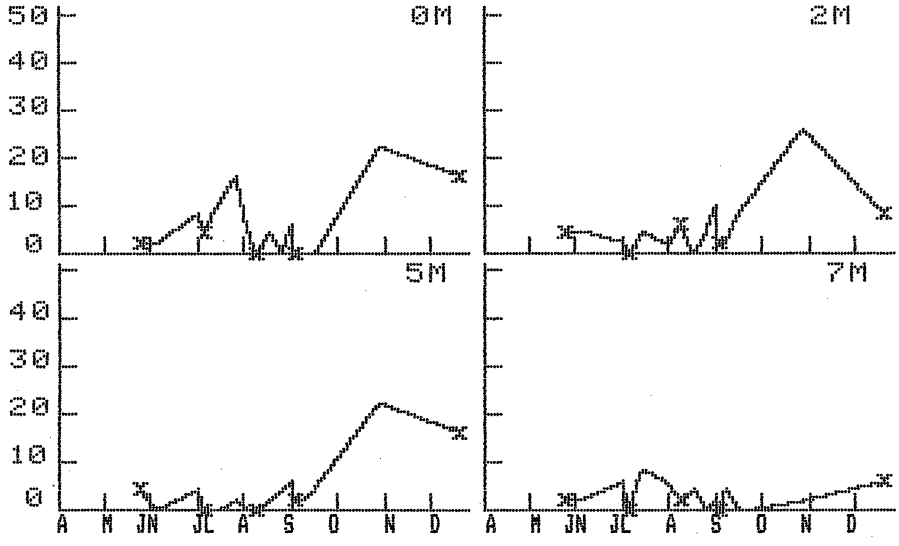


FIGURE 77

TOTAL *SCENEDESMUS*
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

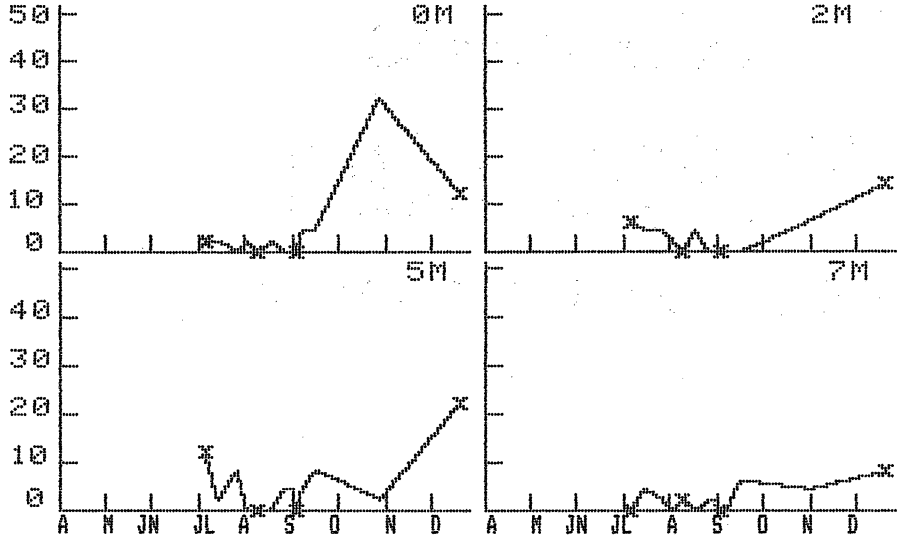
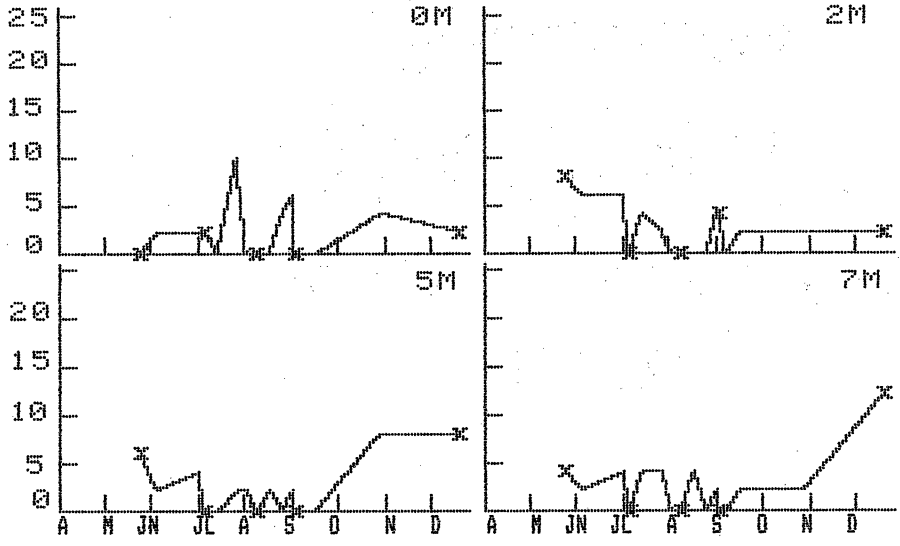


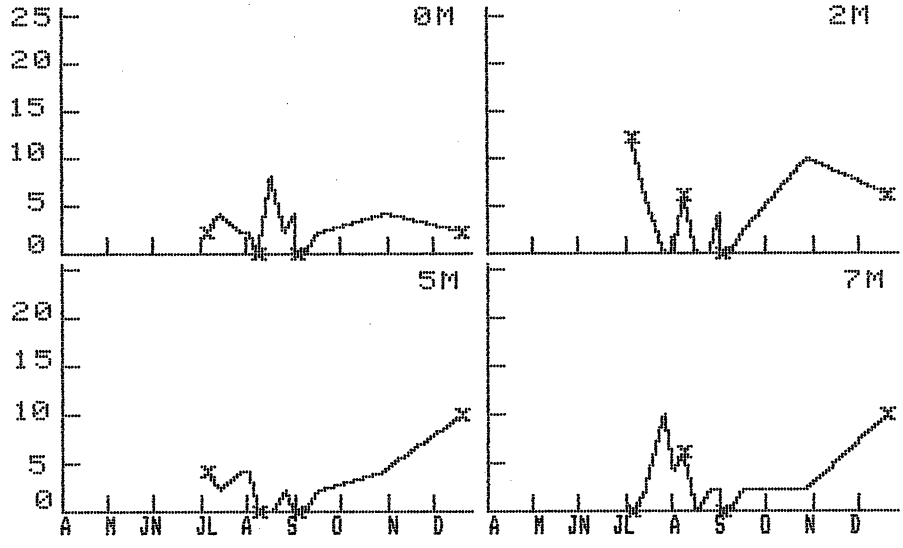
FIGURE 78

TOTAL *TETRAEDRON*
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2



APPENDIX E

FIGURES 79 THROUGH 83

ALGAL COUNTS

BY PHYLA, TOTAL MOTILE ALGAE

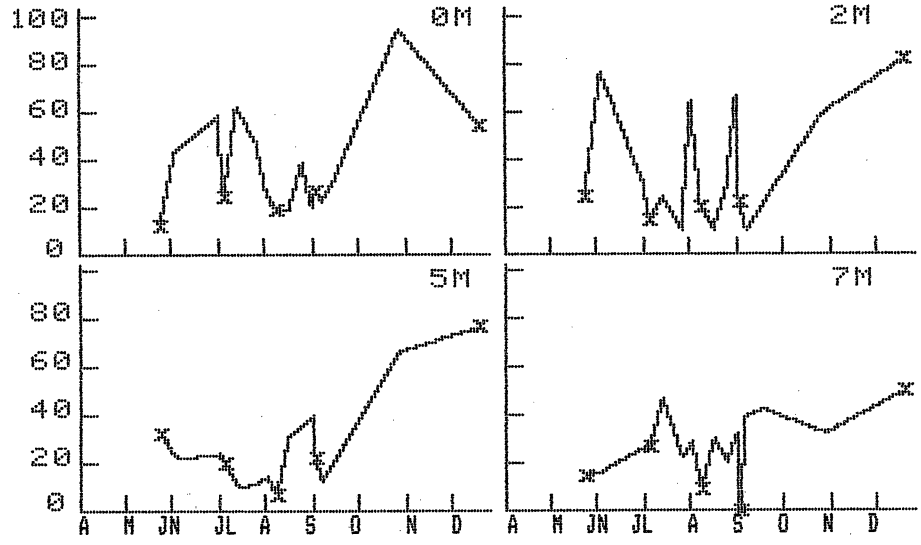
AND TOTAL ALGAL POPULATION

VS. TIME

FIGURE 79

TOTAL CHLOROPHYTA
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

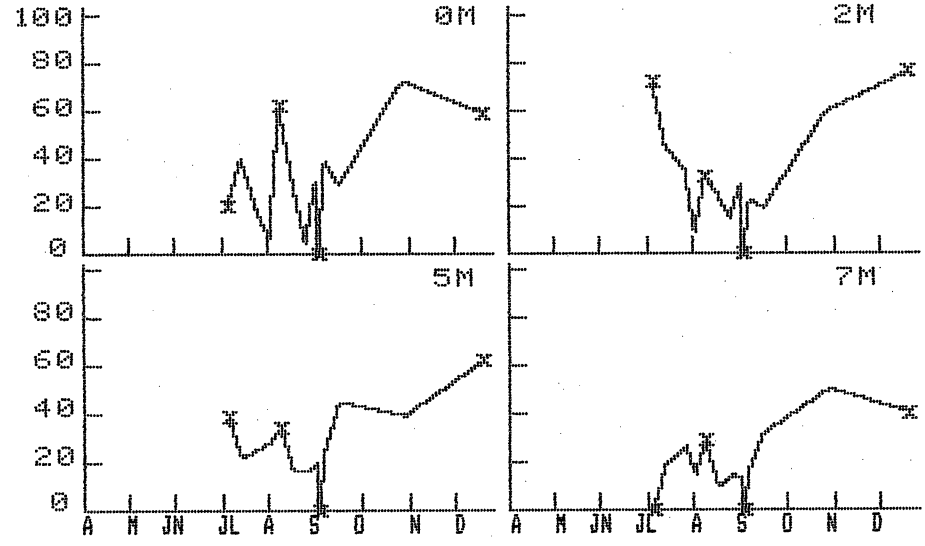
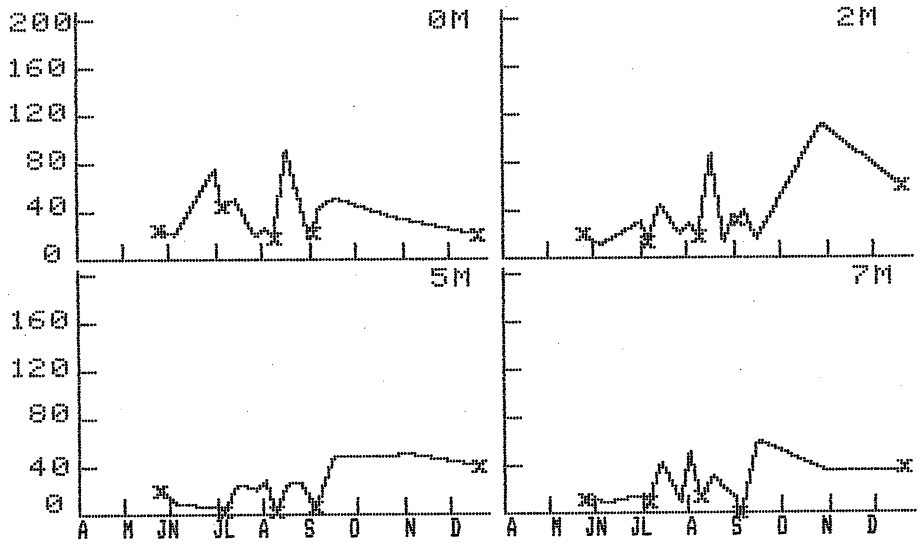


FIGURE 80

TOTAL CYANOPHYTA
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

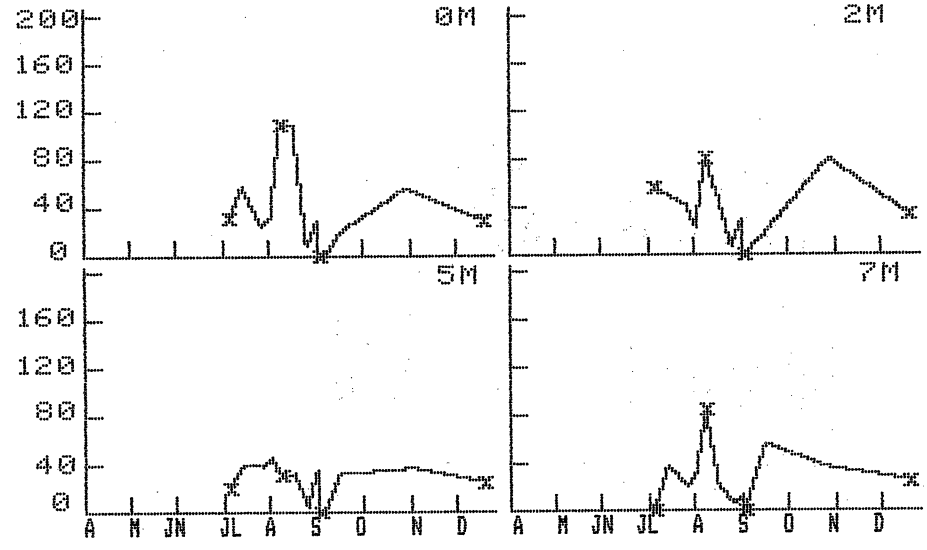
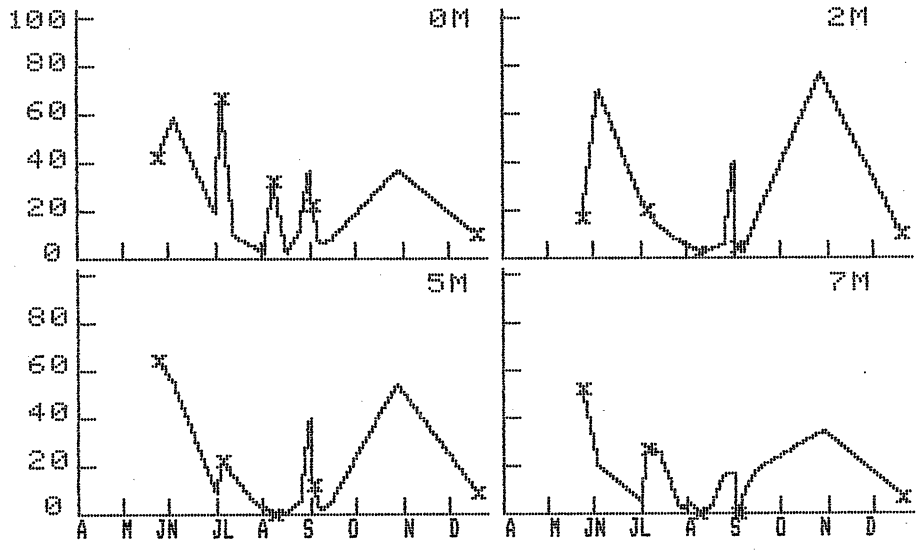


FIGURE 81

TOTAL BACILLARIOPHYCEAE
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

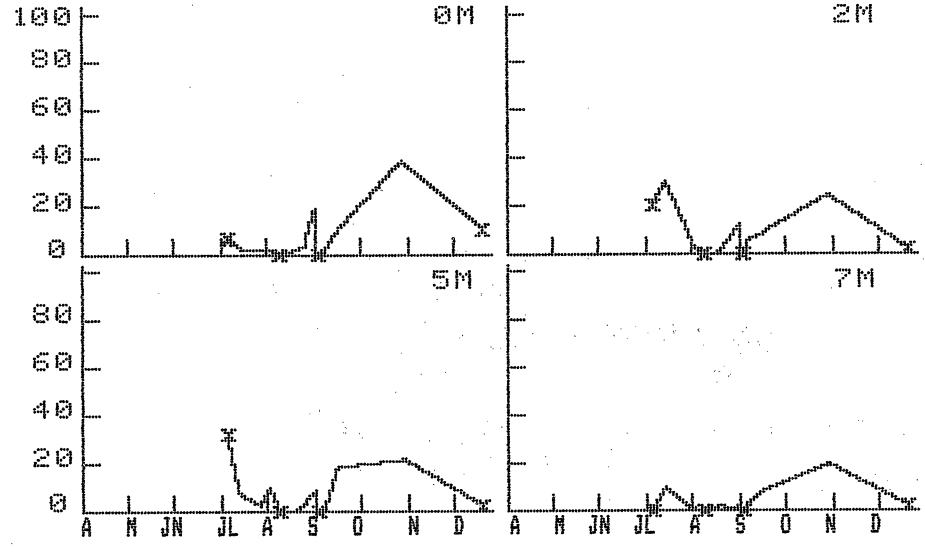
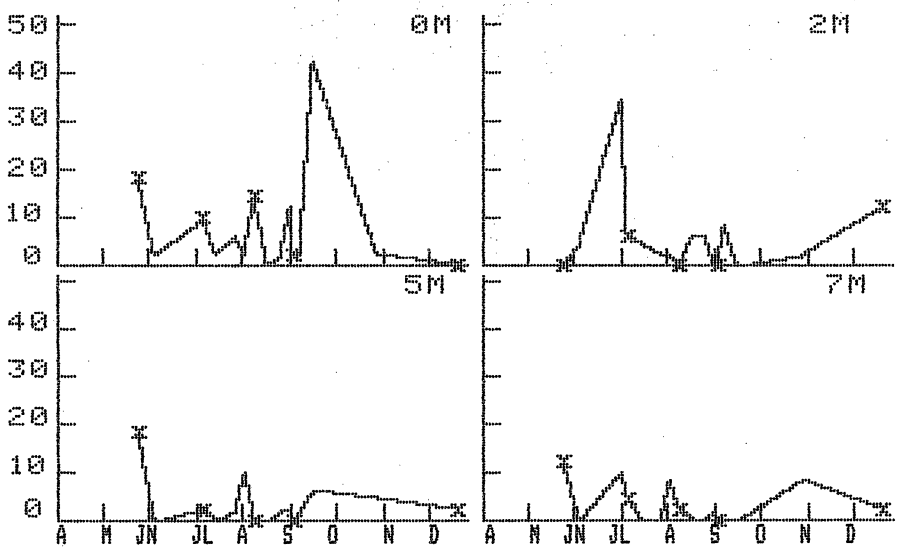


FIGURE 82

TOTAL MOTILE ALGAE
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2

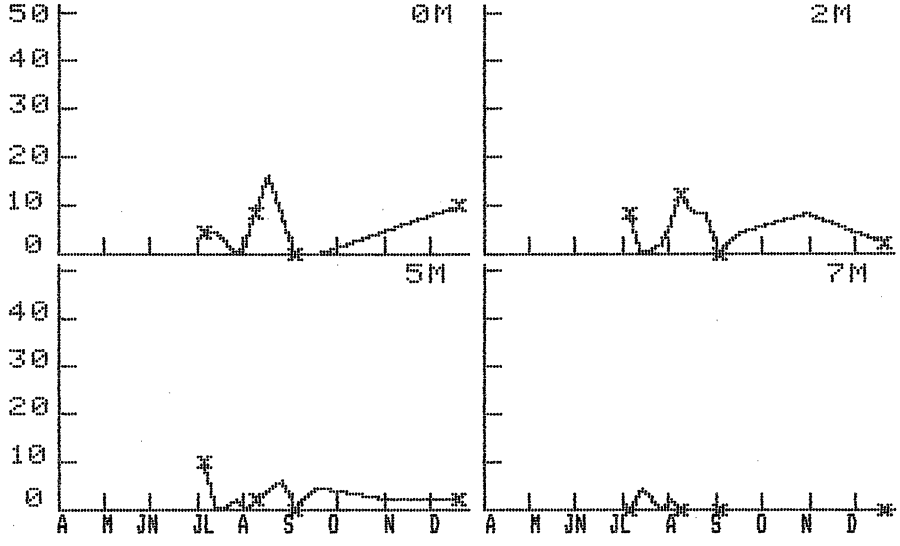
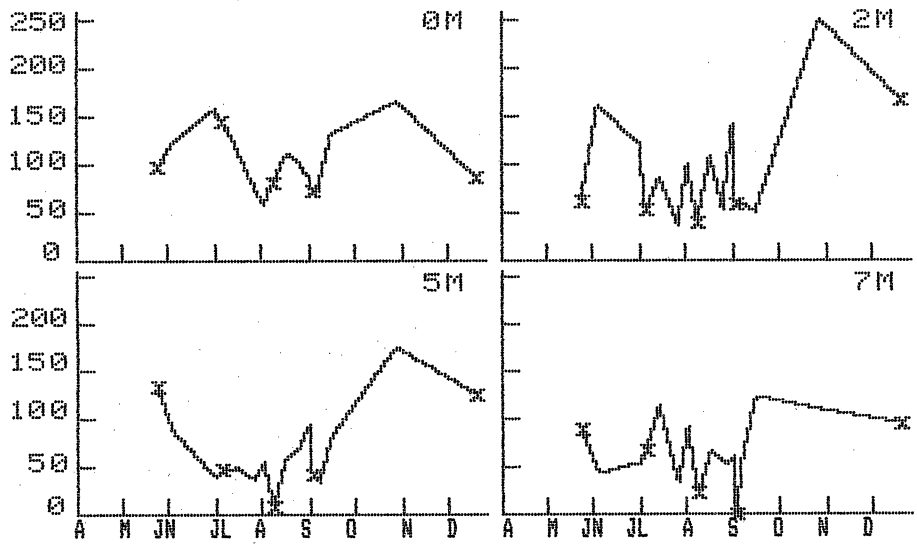


FIGURE 83

TOTAL ALGAL POPULATION
AT VARIOUS DEPTHS THROUGHOUT THE STUDY
CELLS PER CUBIC CENTIMETER TIMES 1000 VS. TIME

STATION 1



STATION 2