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DIATOM POPULATIONS CHANGES IN LAKE GEORGE

PHASE II

FINAL REPORT

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Phase II - Final Report

PROGRAM OBJECTIVE & BACKGROUND

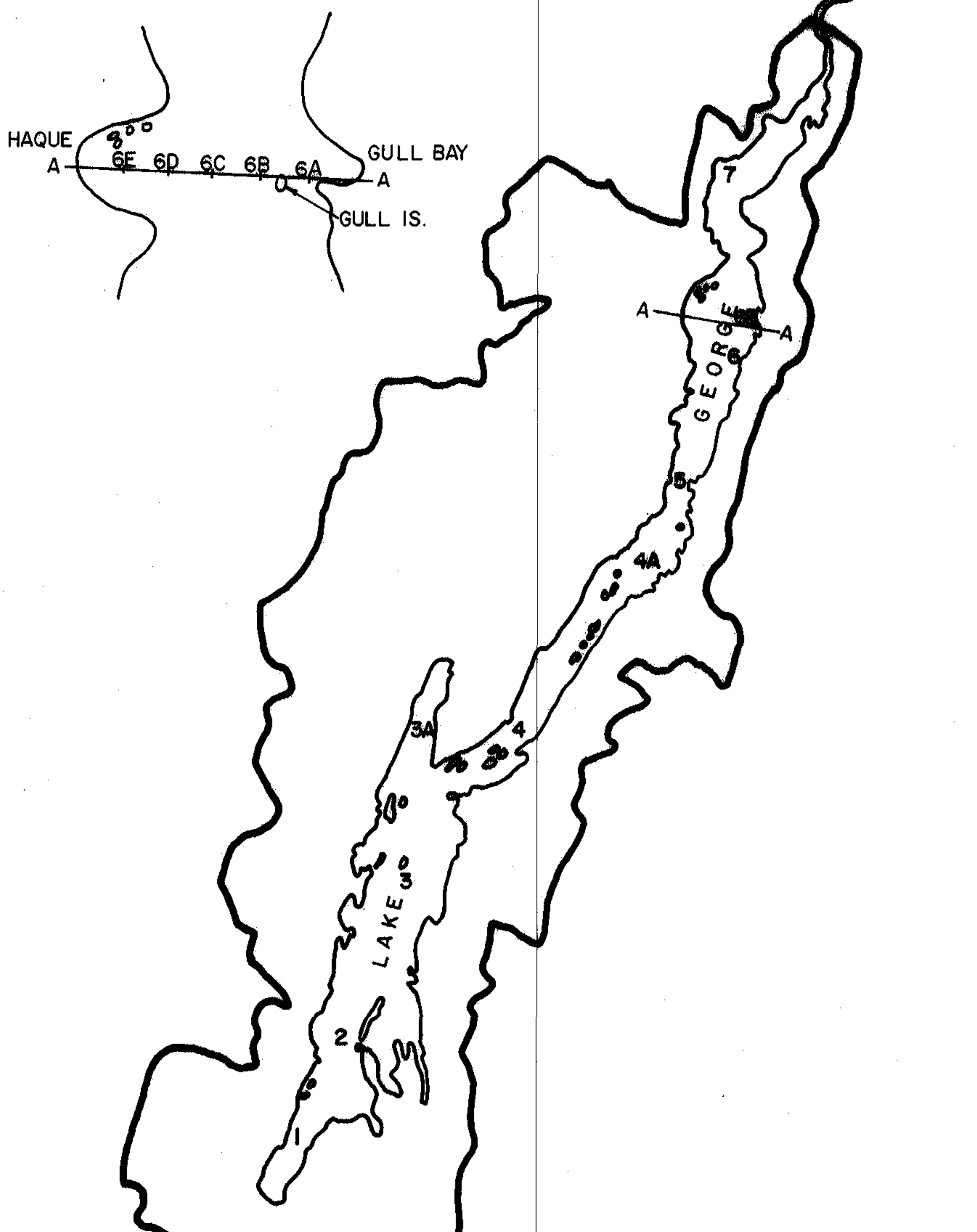
Diatom Populations Changes in Lake George is a three year-three phase program which has the objective of characterizing and measuring the diatom populations in the plankton and periphyton at various depths and locations in Lake George. These biological measurements are being combined with water quality, light intensity, and temperature measurements at the same depths and locations to identify the causative factors for the biological changes taking place and to obtain base line data for the lake to aid in the development of a limnological model of the lake.

During Phase I (the first year of the program) the diatom populations were characterized and enumerated in the plankton and periphyton at seven different lake locations at depths of 3,6,9,12,15 and 21 meters or until bottom was reached. Various water quality measurements were made at these same locations. The results of the Phase I work are summarized in the Phase I final report (1). The work and measurements made during the second year of the program (Phase II) is described and summarized in this report. Since the third year of the program (Phase III) is concerned with the mathematical analysis and the interpretation of the data, only a few general observations are presented in this Phase II report.

DESCRIPTION OF THE PHASE II PROGRAM COMPLETED

During this phase of the program the number of sampling stations on the lake was increased to fourteen in order to get a better measure of the gradients in the plankton and periphyton diatoms and chemical concentration across the northern basin of the lake, in Northwest Bay, and at the northern end of the Narrows region. The fourteen locations are shown in Figure 1.

FIGURE I
PHASE II SAMPLING LOCATIONS



Samples were taken at three depths (3,9 and 15 meters) at these locations for measurement of plankton and periphyton diatom populations and water quality parameters, including the diatom micronutrient elements of cobalt, copper, manganese, silica and zinc. Total non-volatile organic carbon was also measured at most of these depths and locations. To help in interpreting the nature and possibly the rate of the changes taking place with time, the diatom populations occurring in sediment cores taken at seven of the fourteen locations were analyzed. An attempt was also made to measure sedimentation rates at seven locations by placing sediment collectors at the bottom. Due to the loss of the marker buoys at all these locations none of the sediment collectors have yet been found and retrieved although efforts are continuing to recover these collectors. The sampling dates and samples obtained are listed in Figure 2.

The general methods employed in the sampling and analysis are described in the Phase I report. The sampling was expanded during the winter under ice cover during Phase II by the use of a snowmobile and sled. This made it possible to sample locations heretofore inaccessible. However, because of the dangerous ice conditions even for snowmobiles which exists in the Narrows (Stations 4 and 4A) no winter sampling in this region was performed. The core samples were obtained by manually inserting (with SCUBA) 1 3/8" ID, 4 to 6 feet plexiglass tubes into the sediments, inserting an expandable plug into the upper portion of the tube to maintain a vacuum when the tube was withdrawn and then capping the bottom after withdrawal. The cores and tubes were split lengthwise and the point where diatoms first appeared in the sediments determined. The number of diatoms/gram of dried sediment and the diatom population composition were determined at 1 or 5 cm increments from that point to the top of the core. The analysis of the micronutrients was originally planned to be accomplished by atomic absorption spectrometry on samples

FIGURE 2

Phase II Samples

Date	Water Quality and Plankton Stations Sampled	Periphyton Stations Sampled
8/20/69	1,2,3,4,5,6,7	2,6
9/13/69	1,2,3,3A,4,4A,5,6 6A,6B,6C,6D,6E,7	*
10/11/69	1,2,3,3A,4,4A,5,6 6A,6B,6C,6D,6E,7	1,2,3,3A,4,5,6
11/8/69	1,2,3,3A,4,5,6 6A,6B,6C,7	1,3,4,6,7
12/6/69	1,7,	7
2/7/70	1,2,3,3A,5,6 6A,6B,6C,6D,6E,7	*
3/7/70	1,2,5,6,7	1,6
3/27/70	1,6,	
4/28/70	1,2,3,3A,4,4A,5,6 6A,6B,6C,6D,6E,7	*
5/26/70	1,2,3,3A,4,4A,5,6 6A,6B,6C,6D,6E,7	1,2,3A,4A,5,6 6A,6B,6D,6E,7
6/24/70	1,2,3,3A,4,4A,5,6 6A,6B,6C,6D,6E,7	1,2,3A,4,4A,5,6 6A,6B,6C,6D,6E,7
7/22/70	1,2,3,3A,4,4A,5,6 6A,6B,6C,6D,6E,7	3,3A,4,4A,6,6A,6B

* Periphyton samplers installed

concentrated from 10-to 50-fold by evaporation. Initial analysis showed this technique was marginal for some of these elements although with the higher concentration factors (5) some measurements were obtained of all elements. Typical concentrations are listed in Figure 13. The variability near the limit of sensitivity would preclude statistically significant intersample relationships so alternate analytical approaches such as activation analysis and colorimetric analyses are being investigated for some of these elements. Analysis of the samples will be completed during the Phase III work.

PROGRAM RESULTS AND OBSERVATIONS

1. Plankton and Periphyton Diatoms as a Function of Time and Location

Figure 3 shows the trend of the total plankton diatoms at 3,9, and 15 meters as a function of time at Station 1. A sharp recurring spring peak is seen each April in the 3 meter plankton with peaks in the 9 and 15 meter plankton occurring at, or close to, this same month. In April of 1968 and 1970 - Asterionella formosa was the dominant diatom ($>$ 50%) while in April 1969 Synedra tenera dominated the population. This diatom was tentatively identified as Synedra radians in the Phase I annual report (1) but scanning electron microscopy has shown it to be S. tenera. Secondary diatom peaks at 3M appear to occur each August. There is definitely no diatom pulse in the Fall following the October turnover as is generally seen in eutrophic lakes.

The plankton data from the other stations are not as completely analyzed, but show the same general trend. At Station 7 for example, the numbers of diatoms are on the average lower, there is a much wider variation in the 3,9 and 15 meter samples, and the spring peaks are not as great or pronounced as compared to Station 1. The dominant diatom species is usually the same throughout the lake, however, the next most abundant diatom is often different in the north basin than in the south basin. For example in the 3M, May 28, 1970

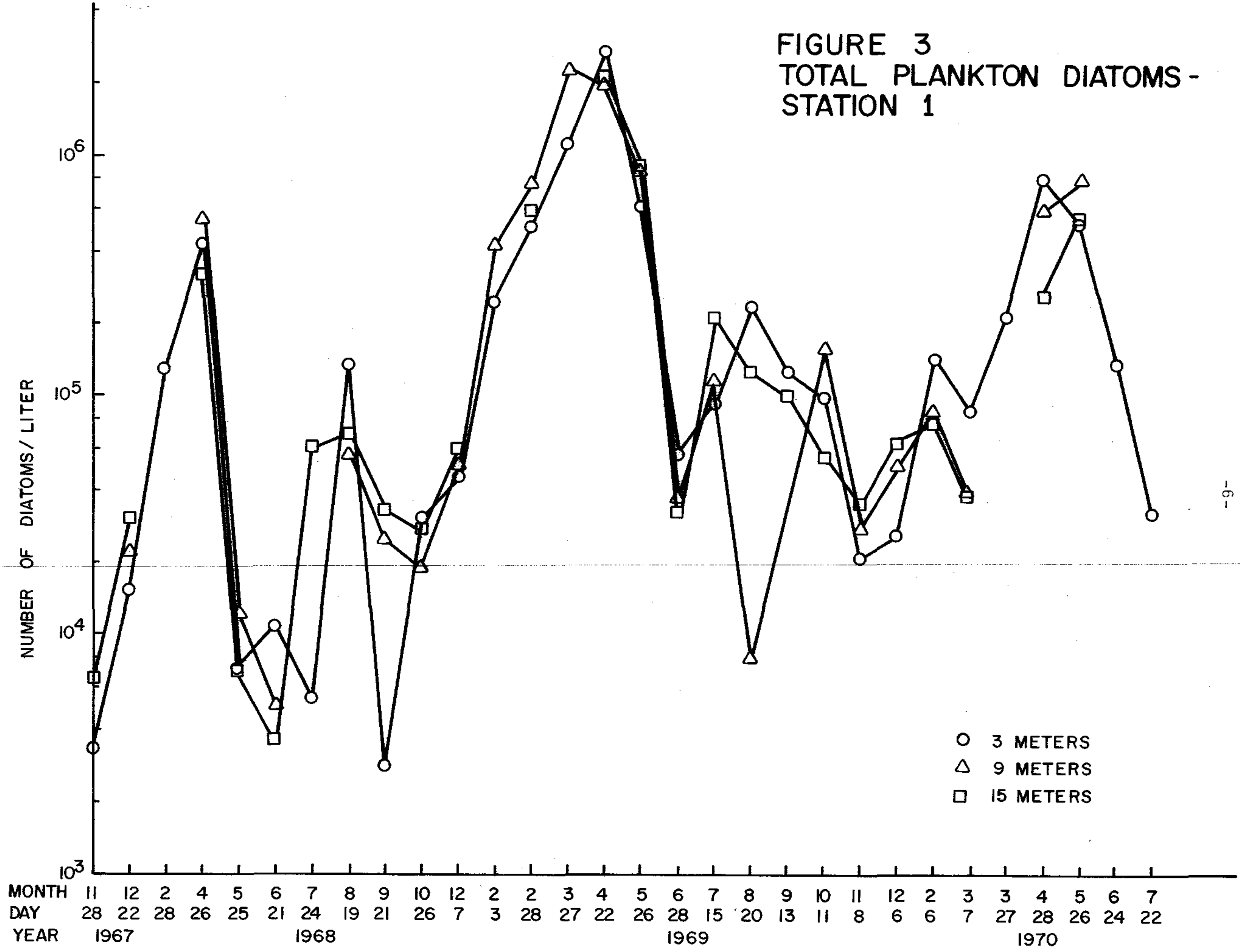


FIGURE 3
TOTAL PLANKTON DIATOMS - STATION 1
NUMBER OF DIATOMS / LITER
10^6
10^5
10^4
10^3
3 METERS
9 METERS
15 METERS
MONTH 11 12 2 4 5 6 7 8 9 10 12 2 2 3 4 5 6 7 8 9 10 11 12 2 3 3 4 5 6 7
DAY 28 22 28 26 25 21 24 19 21 26 7 3 28 27 22 26 28 15 20 13 11 8 6 6 7 27 28 26 24 22
YEAR 1967 1968 1969 1970

samples, Fragilaria crotonensis is the second most abundant diatom after A. formosa at Stations 1,2,3, and 3A, while Tabellaria fenestrata is the second most abundant at Stations 4,5,6,6A,6B,6C,6D,6E and 7.

Figures 4,5,6, and 7 show the geographical trend of the total 3 meter plankton and periphyton diatoms in the Fall, Winter and Spring (1969-70). When these data are compared with the Phase I data (1) it is observed that the diatom populations (May 1969 vs May 1970; Feb. 1969 vs Feb. 1970; Sept. 1968 vs Sept. 1969) are about the same in the lake as a whole, although the standing crop of both the plankton and periphyton diatoms appear to be increasing more in the northern basin locations particularly at Station 7, thereby appearing to diminish the differences between the two basins (north and south) noted in the past. The distribution of the total standing crop of plankton diatoms found in the Winter (Feb. 1970) under the ice was similar to the spatial distribution seen at the end of May. In the southern basin (Stations 1,2,3, and 3A) the numbers of diatoms at the four locations were almost identical with those observed in September of 1969. The standing crop of plankton diatoms (Fig. 5) across the northern basin (Stations 6A,6B, 6C,6D, and 6E) was generally similar at all locations in February and May of 1970 but showed a much greater variation in September of 1969. Less periphyton data were obtained across the lake but from these data (Fig. 7) it appears there is a much greater transverse variation (across the lake) in the periphyton diatoms than in the plankton diatoms.

2. Diatoms in the Lake Sediments

The diatoms in the sediments underlying seven of the sampling locations are shown in Figure 8. It is observed from this figure that the accumulation of diatoms has apparently been much higher in the southern part of the lake than in the northern, indicating greater productivity and standing crops in the past. In all of the main lake locations (Station 3A excepted) the numbers of diatoms per gram of sediment increase as the top of the core is approached

FIGURE 4
3 METER PLANKTON DIATOMS

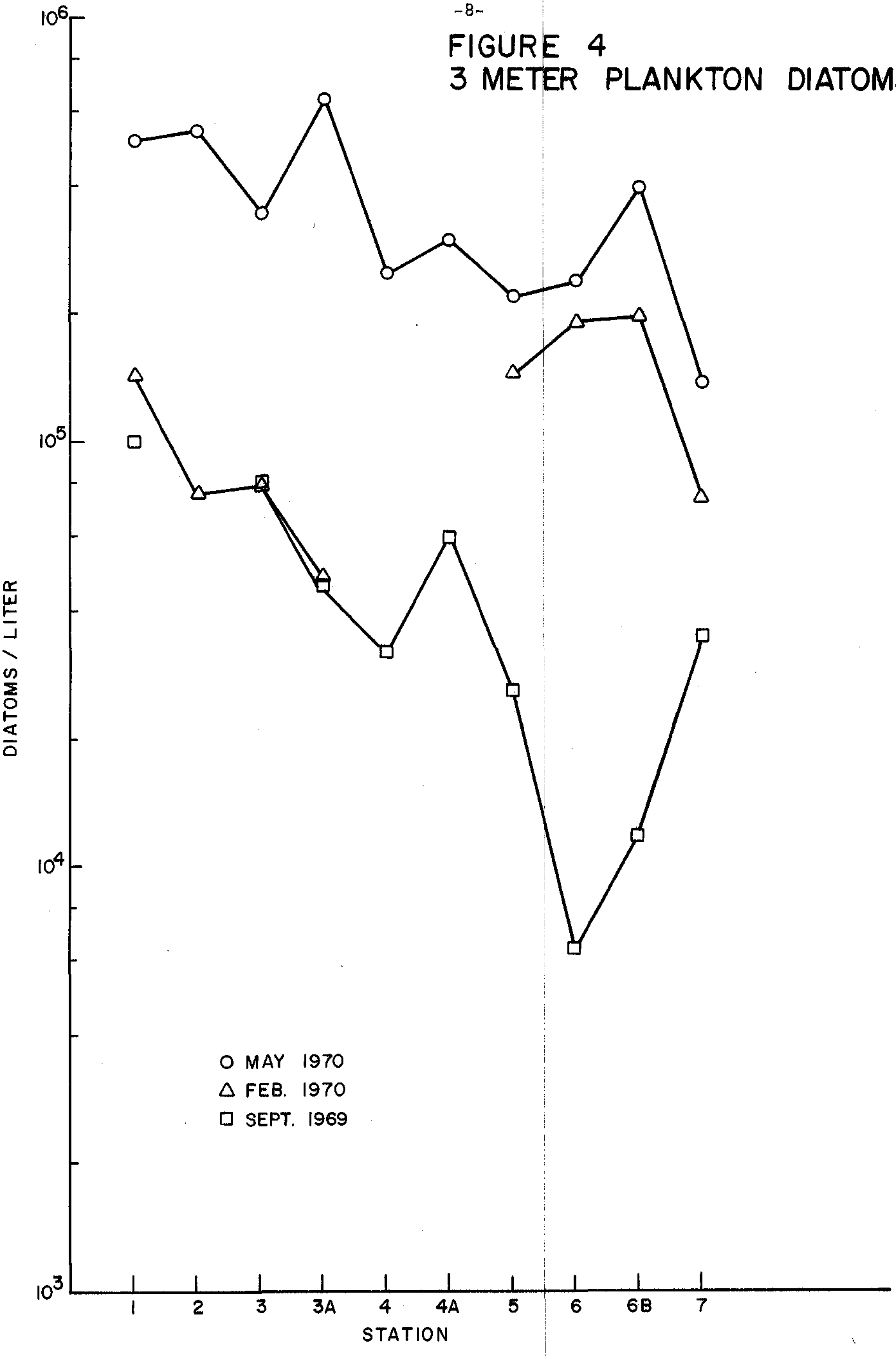


FIGURE 5
3 METER TRANSVERSE PLANKTON
DIATOMS

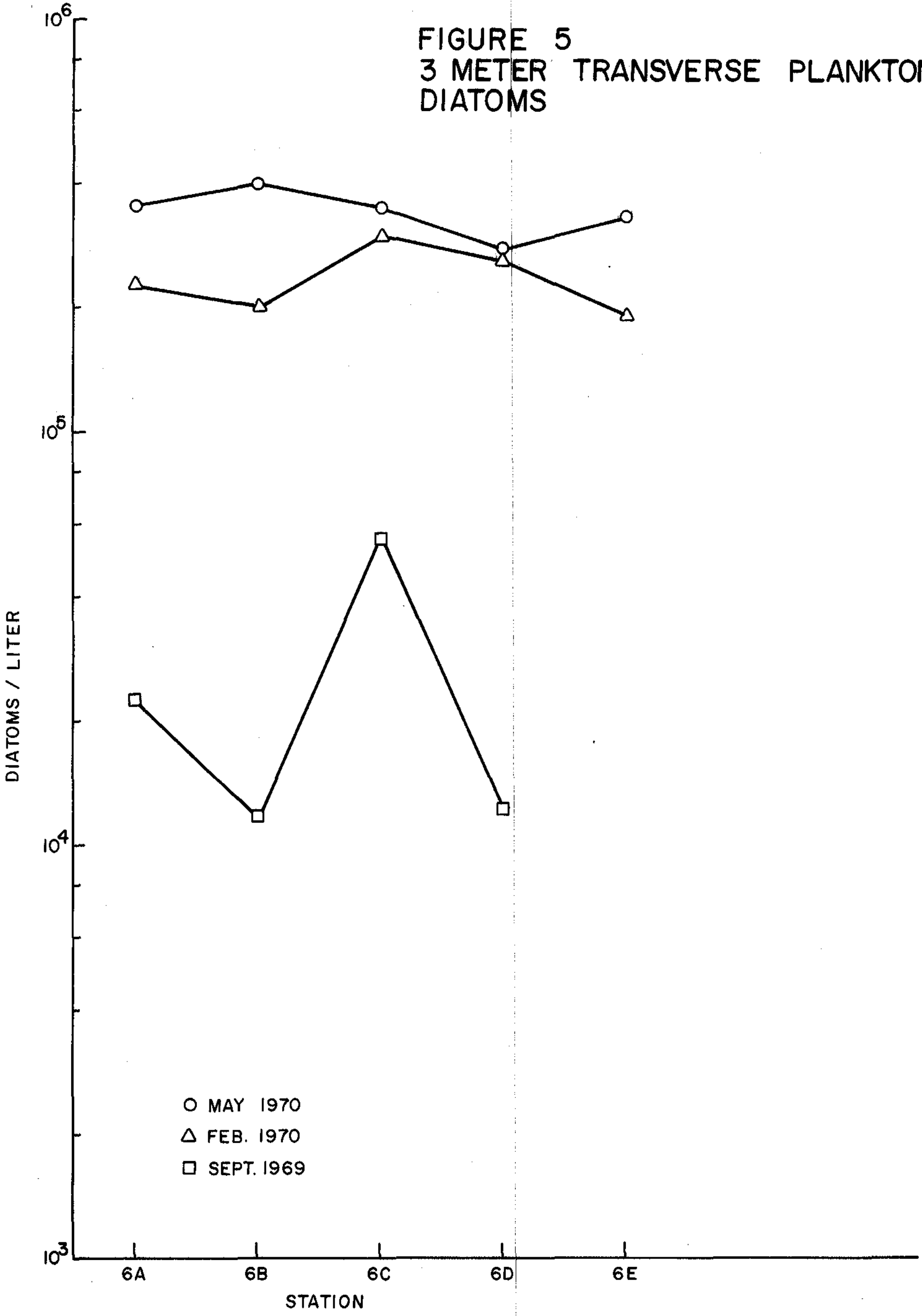


FIGURE 6
3 METER PERIPHYTON DIATOMS

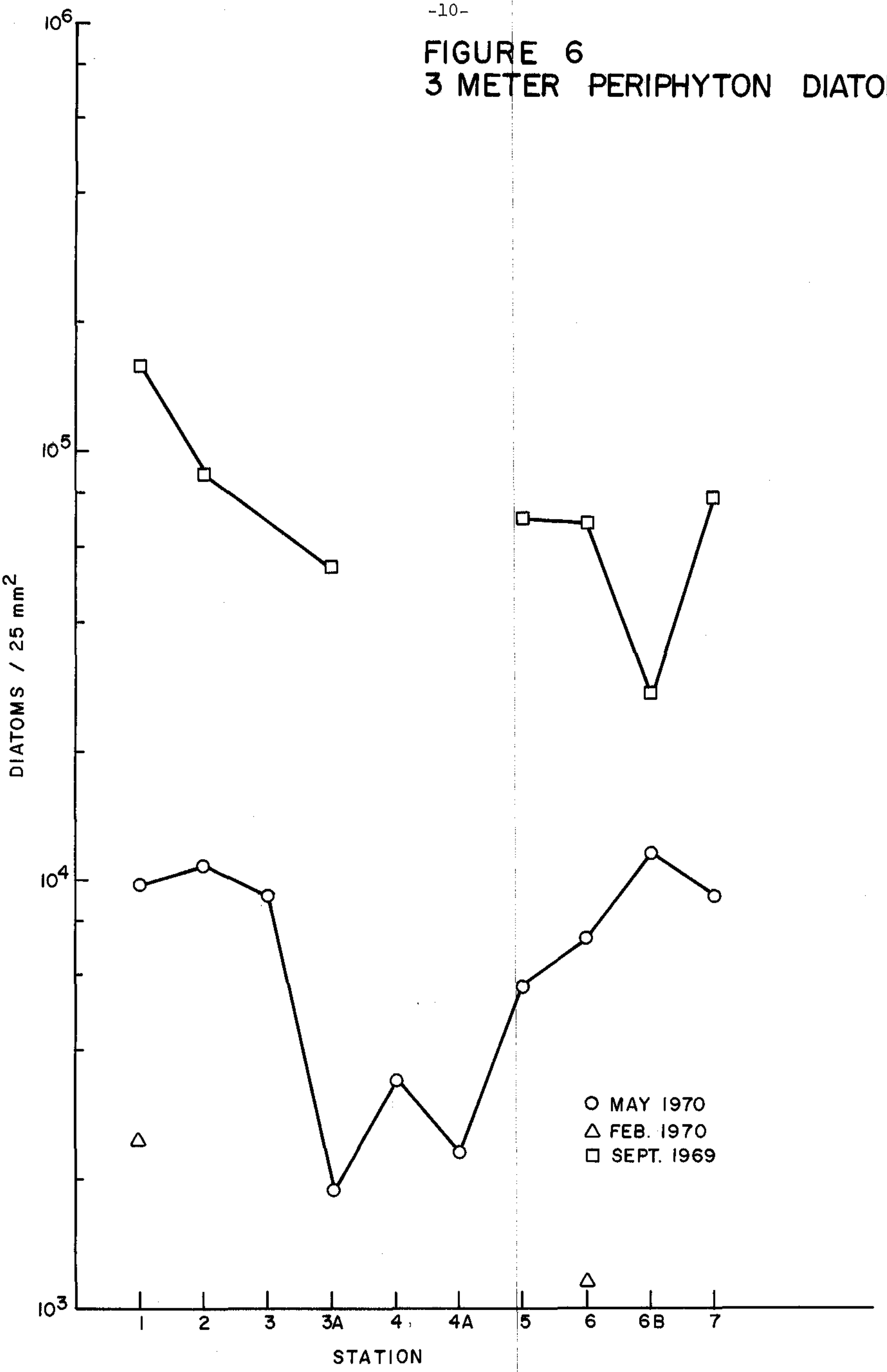


FIGURE 7
3 METER TRANSVERSE
PERIPHYTON DIATOMS

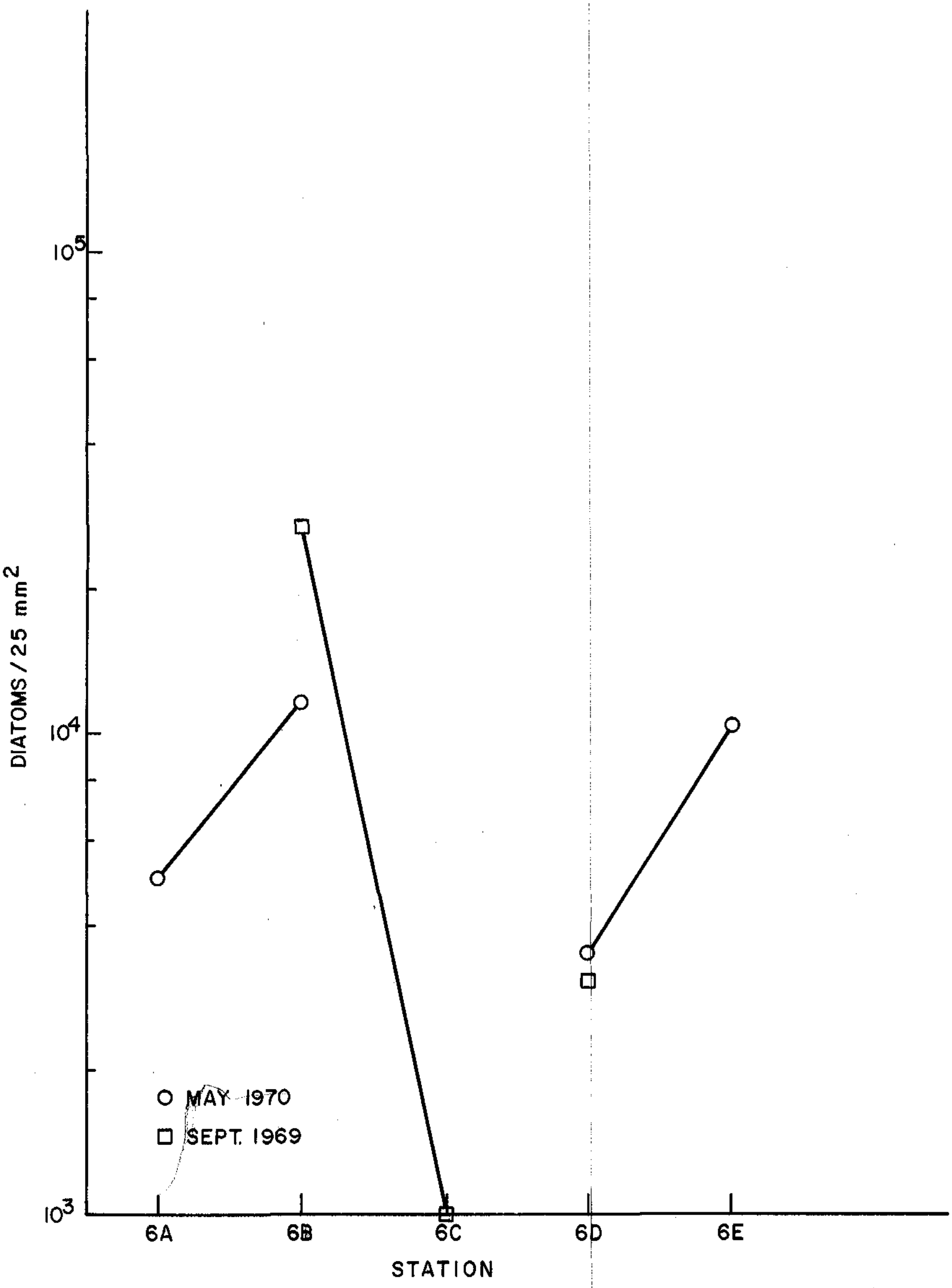
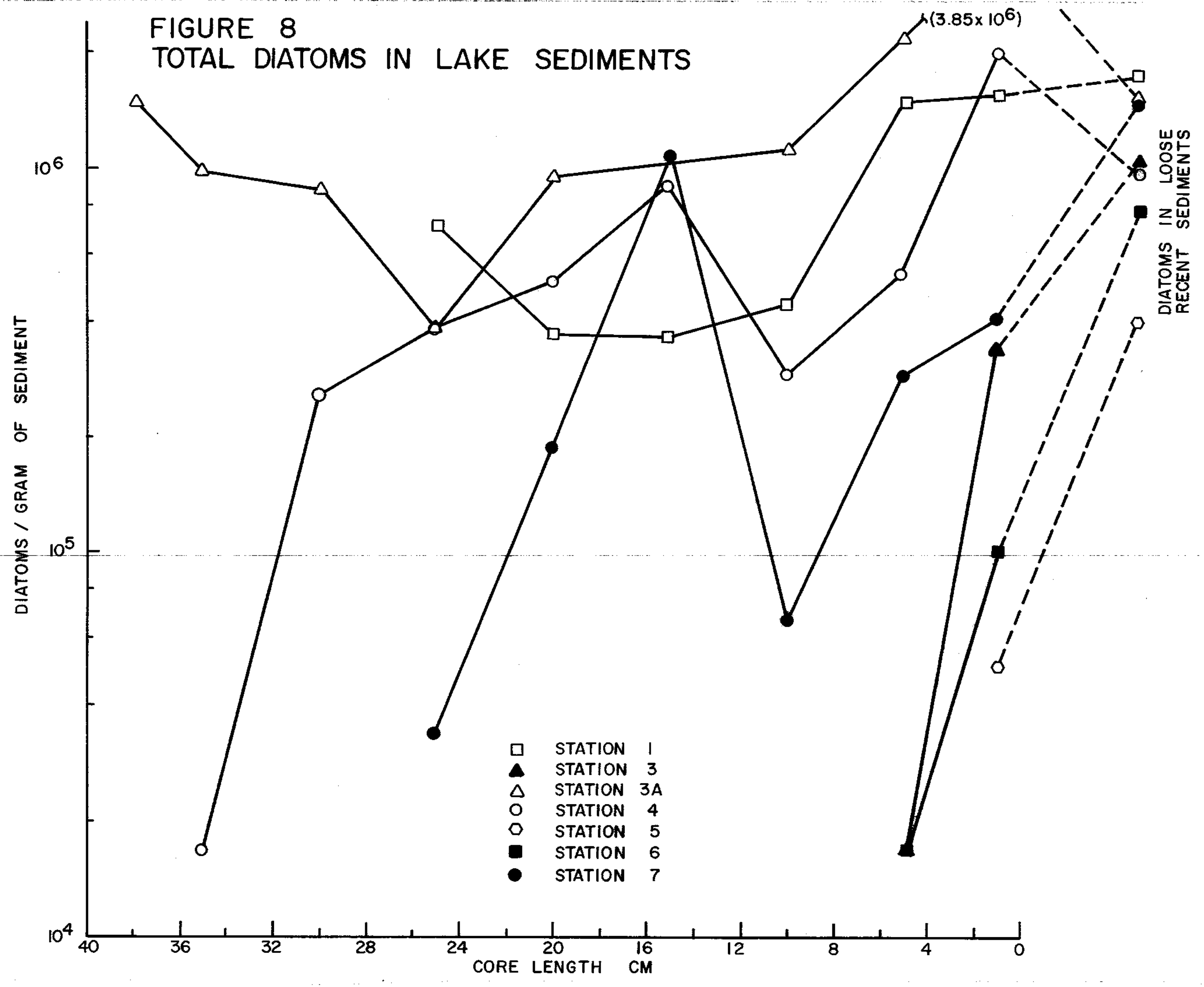


FIGURE 8
TOTAL DIATOMS IN LAKE SEDIMENTS



indicating that the growth has been increasing with time. By comparing the number of diatoms/gram sediment in the recent flocculent layer to the consolidated sediments in the cores, it is seen that there has been a relatively recent increase in the diatom growth at Station 3 and the northern basin stations since the numbers are much greater in the recent loose sediments than in the cores for these stations while the opposite is true for the other south basin stations. No Asterionella formosa was seen in the consolidated core samples although this diatom specie was present in the more recent loose sediments, again suggesting that the present oligotrophic-mesotrophic diatom populations are of relatively recent origin in this lake. These changes evidently occurred first in the south basin since many of the current plankton diatom species have been found in the upper 5 cm of the south basin cores but not in the north basin cores.

3. Nitrogen and Phosphorus as a Function of location and Time

The concentrations of the two principal nutrients N and P do not show any obvious locational trends nor any obvious relationship to the diatom crop. The total P (dissolved and particulate) shows peaks at Station 3A and 6B in May 1970 which correspond to similar peaks in the plankton diatom standing crop in May 1970. The total P, however, in the south basin (Stations 1,2,3, and 3A) in September 1969 appears to be lower than that found in February 1970 (although the spatial distribution curves are quite similar) while as previously mentioned the plankton diatom crop is almost identical in the two periods. In the transverse samples (Fig. 10) the total P appears to be higher at the more westward stations but this does not appear to influence the diatom populations. In most cases the total soluble phosphorus and the orthophosphate are below the limit of sensitivity of the method ($\leq$ 4 μg/L).

The inorganic nitrogen found in the lake is mainly in form of ammonia - nitrogen. This is believed due to the high level of ammonia in the rain and

FIGURE 9
TOTAL PHOSPHORUS

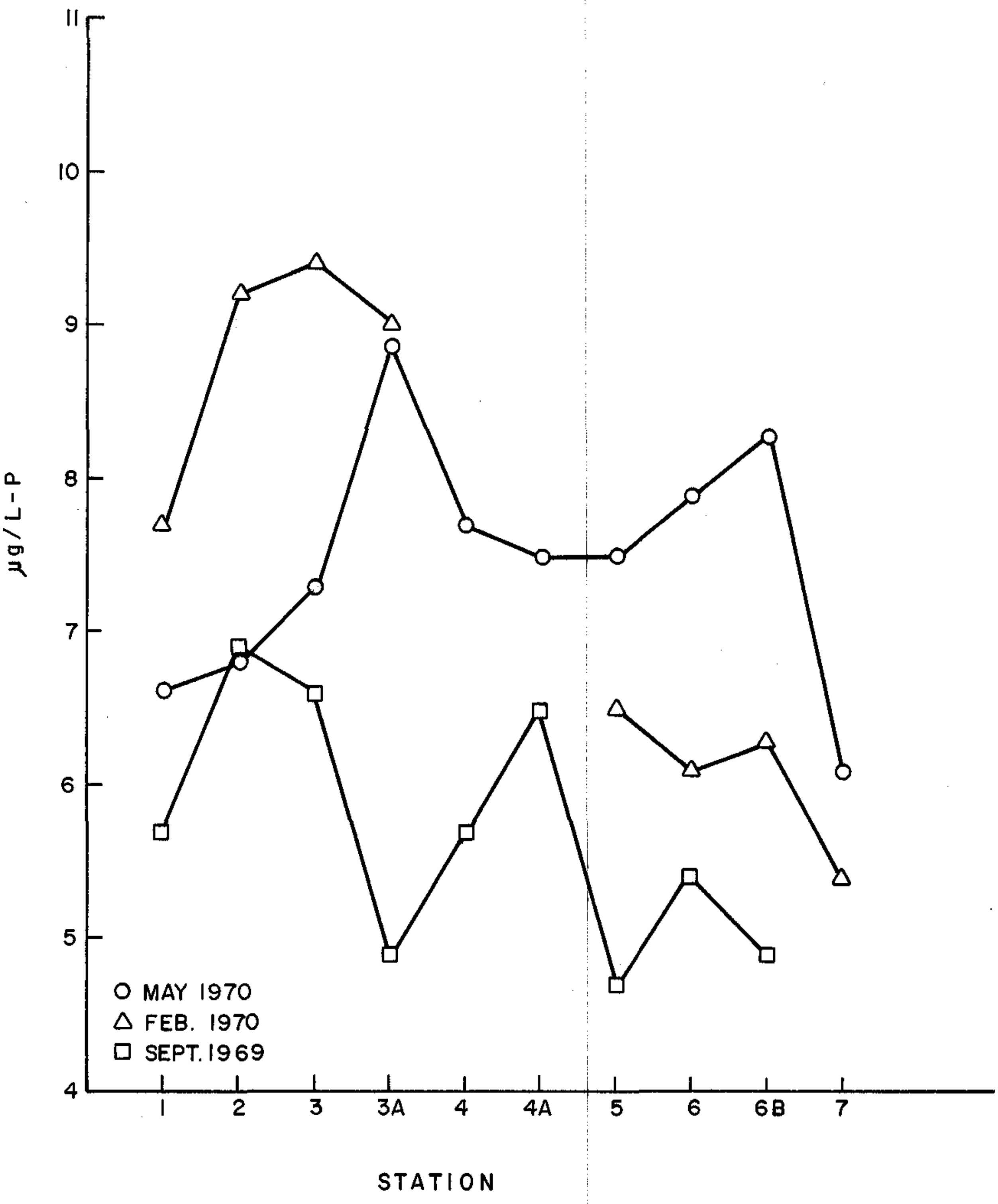


FIGURE 10
TOTAL PHOSPHORUS - TRANSVERSE

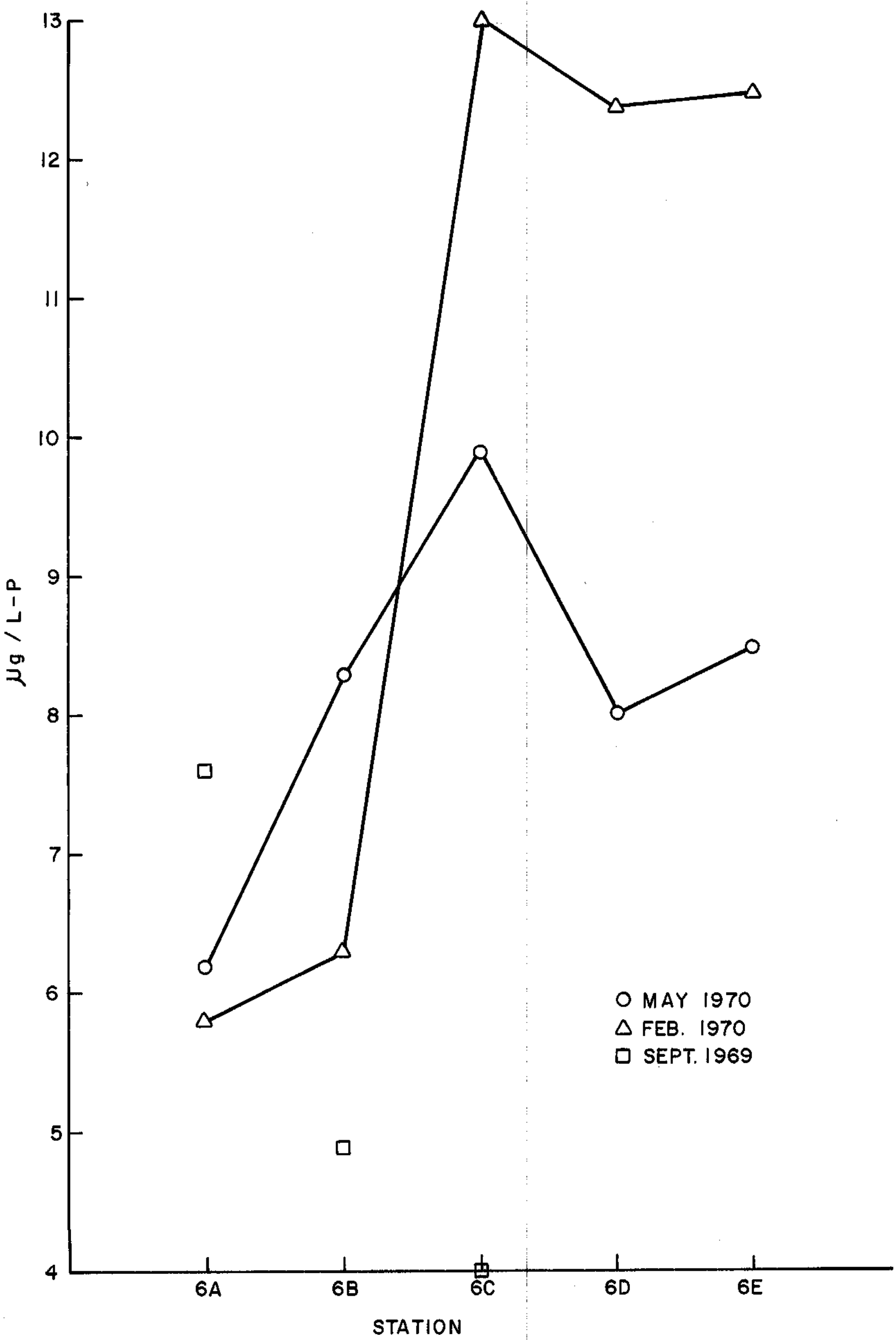


FIGURE 11
AMMONIA - NITROGEN

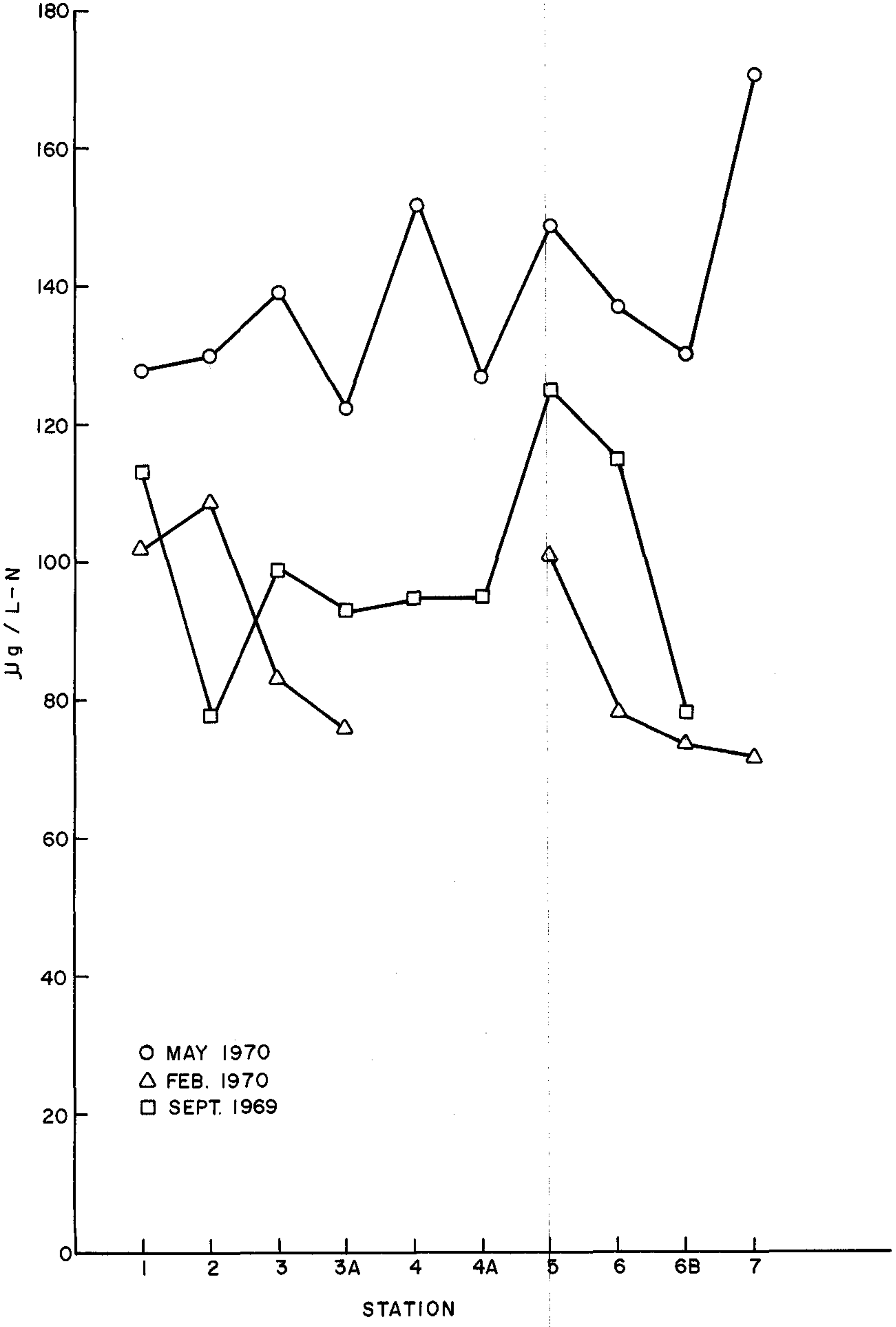
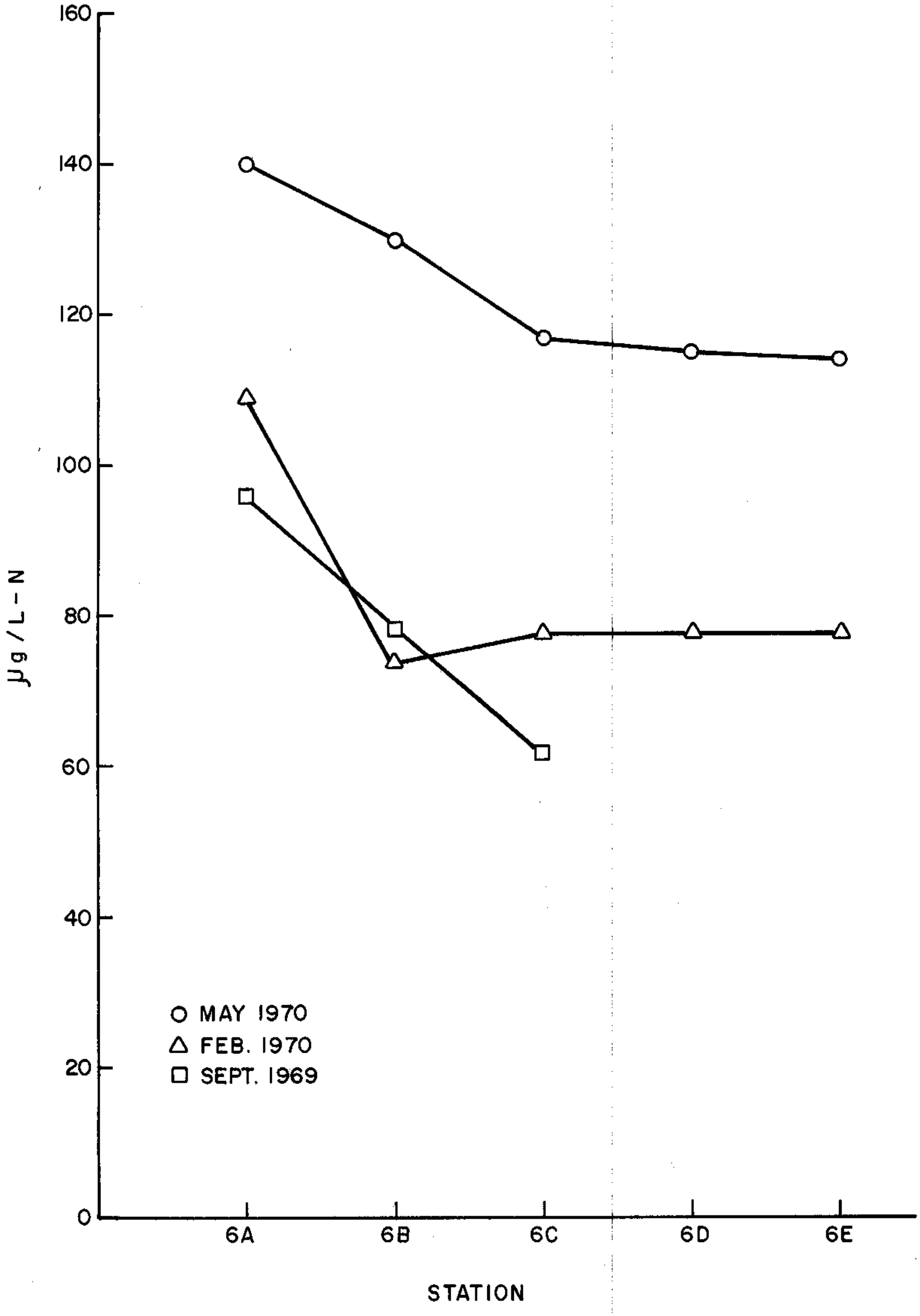


FIGURE 12
AMMONIA-NITROGEN TRANSVERSE



snow falling on the lake and its basin (490 μg/L-N average) and to a low level of ammonia utilization. A drop off in ammonia is seen in the winter under ice cover and the highest levels of NH_3 are seen in the spring after the ice cover melts releasing the nutrients accumulated in the overlying snow. No definite longitudinal or transverse trend is seen in the ammonia concentrations at the various lake locations. The relatively uniform transverse distribution is consistent with the plankton diatom standing crop pattern seen across the lake.

4. Other Nutrients

Most of the various nutrients utilized directly or indirectly by the algae in the lake and their approximate seasonal depth average concentrations are listed in Figure 13. Except for the ammonia, the levels are about those expected in an oligotrophic glaciated lake in a precambrian region. The silicon appears to be somewhat lower than expected possibly due to the increased growth of diatoms in this lake.

FUTURE WORK

The third and final phase of the program which started August 1, involves a more detailed examination of typical regions where nutrients are believed to be entering the lake, a greater sampling of the lake sediments, measurements of diatom doubling rates in the plankton and periphyton of Stations 1 and 6, and most importantly the mathematical analysis of the experimental data obtained in all three program phases and the formulation of a lake - lake basin ecosystem model relating diatom growth and standing crop to the various environmental factors operating within the basin. This last phase is scheduled to be completed by July 30, 1971.

REFERENCES

1. Williams, S.L. and Clesceri, N.L., "Diatom Populations Changes in Lake George Phase I - Final Report", Lake George Water Research Center, Rensselaer Polytechnic Institute, Troy, N.Y. Report No. 1 (1969).