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The Continuous Plankton Recorder Survey: Massachusetts to Cape Sable,  
Nova Scotia, and New York to the Gulf Stream, 1984

by

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In 1972, the U.S. National Marine Fisheries Service (NMFS) began a program of cooperation with the Oceanographic Laboratory, Edinburgh, Scotland (now part of the Institute for Marine Environmental Research (IMER)) for the extension of the long-term Continuous Plankton Recorder (CPR) survey (Glover, 1967) into additional areas of the western North Atlantic. The two monthly sampling routes reported on here are the results of that effort (Figures 1 & 2). The report is meant to present only the major features of the plankton conditions during 1984 and to compare these with average conditions over the span of the survey. Requests for information on the some 170 taxa routinely identified and enumerated from these samples should be made to the Director, National Marine Fisheries Service, Northeast Fisheries Center, Woods Hole Massachusetts, 02543, USA.

Collection and processing methods for CPR samples are available in Colebrook (1960). These methods are those used by NMFS with the following exceptions:

1. Abundance of those phytoplankton taxa which are quantitatively captured are reported as number of cells or chains per cubic meter of water strained.
2. Abundance of zooplankton taxa are reported as number of organisms per 100 cubic meters of water strained.

3. Route polygons have been established on composite plots of all historical sampling locations for a route (see figures 1 and 2). These polygons differ from the IMER's CPR survey standard ecological areas in that these may exhibit considerable environmental variation along their long dimension. Measured features are assumed to show reasonable similarity crosswise at any point along the polygon. Sampling locations are tested against these polygons during data entry excluding any outliers from the route data base.
  
4. Distance to each sample from a route specific reference position is calculated. This same reference distance is calculated for any other biological or environmental measurements made on the cruise. This distance provides spatial comparability to the samples between cruises, facilitates creation of space-time matrices of data for climatological purpose, and permits subsetting of the plankton and the environmental data according to water mass or other concurrently measured features.

Two aspects of plankton variation along these routes are presented. The first is "total phytoplankton" based on relative units of green (Colebrook and Robinson, 1961) and obtained by visual comparison of the green or green-brown color of each sample with a set of color standards. These results, although limited in their applications, are indicative of seasonal and annual variations and timing of phytoplankton abundance. The second aspect is the variation of total copepods.

#### Massachusetts to Cape Sable

Nineteen eighty-four marks the 24th year since sampling began on this route. As with previous reports the Gulf of Maine was treated as one water mass when calculating means. Long term (1961-1984) monthly means of "total Phytoplankton" and total Copepoda are listed in Table 1. Figure 3A shows the mean of "total phytoplankton" from all 1984 samples in each month, and Figure 3B illustrates the anomalies of these values compared to the 1961-1984 means, in standard deviation units (long term

monthly mean minus 1984 monthly mean divided by the standard deviation of the long term monthly mean). Sampling was missed in March and May leaving the description of the spring bloom depending on the April sample which reached slightly over 4 on the relative green scale. Summer values were at or below 1. The next measured increase occurred in October and the fall bloom peaked in November at slightly under 3. Values returned to winter levels in December. The spring and early summer values were slightly above normal. Those in mid-summer and early winter were slightly below normal. The most striking feature was the October anomaly, which exceeded the long term October mean by more than one standard deviation. Figure 4A shows the mean of total copepods from all 1984 samples in each month. The values increase rather steadily from about 1000/100 m<sup>3</sup> in January to over 20,000/100 m<sup>3</sup> in October, only slightly less in November, and a near return to the early year values by December. However, the significant feature of these 1984 data is seen in the anomaly curve (Figure 4B). October is the 22nd straight measured month in the Gulf of Maine with negative anomalies (beginning in October 1982). This period exceeds by 11 measured months the next longest, continuous, below average period (April 1966 to June 1967) since monitoring began in 1961. The November anomaly is only a minor interruption to this condition which resumes in December. As with much of the other 1984 data presented here these anomalies are small, not exceeding 0.5 standard deviations from the long-term monthly means. Nonetheless, their persistence justifies careful future attention.

#### New York to the Gulf Stream

Shelf water plankton samples were selected from each cruise if their reference distance was less than that of the shelf water front and they were inshore of the shelf break (200m). Long term (1976-1984) monthly shelf water means of the "total phytoplankton" are listed in Table 2. Figure 5A shows the mean of "total phytoplankton" for all 1984 shelf water samples in each month, and Figure 5B shows the anomalies of these values compared to the 1976-1984 means, in standard deviation units as described above. The spring bloom was very slightly above normal as was the beginning of the fall bloom. The most notable feature was the November value which was the largest anomaly of any November and the second largest anomaly for any month since coverage

began in 1976. This peak was dominated by Rhizosolenia alata alata. Unlike the Gulf of Maine data (Figure 3) the fall bloom in the New York Bight exceeded that of the spring bloom. However, an intriguing similarity does exist between the patterns of the anomaly curves of the two routes. Both begin 1984 very slightly below average, both have spring blooms about 0.6 standard deviations above normal, both drop slightly below the long term average in early to mid-summer, both show higher than normal values for the fall bloom with peaks exceeding 1 standard deviation, and finally both end the year with negative anomalies. For the most part these anomalies are small, but their similar seasonal patterns on the two routes suggests a need to examine region-wide, lower food chain relevant environmental variations in 1984 for coincidence with these phytoplankton events. Figure 6 shows the mean of total copepods from all 1984 shelf water samples in each month and these same means for 1976 and 1977, years for which such data are available (Smith & Jossi 1984). Not all of the zooplankton samples for the 1976-1984 series had been examined in time to calculate anomalies for this route. The large annual variability for the three years makes comparisons of doubtful value. From the examination of the completed years of this series it appears that 1984 is not a year of as low a copepod relative abundance as the figure indicates. Rather the 1976 and 1977 years are somewhat above normal.

#### References

- Colebrook, J.M. 1960. Continuous plankton records: Methods of analysis 1950-1959. Bull. Mar. Ecol., 5: 51-64.
- Colebrook, J.M., and G.A. Robinson. 1961. The seasonal cycle of the plankton in the North Sea and the northeastern Atlantic. J. Cons., 26: 156-165.
- Glover, R.S. 1967. The Continuous Plankton Recorder survey of the North Atlantic. Symp. Zool. Soc. Lond., 19: 189-210.
- Smith, D.E., and J.W. Jossi. 1984. Net phytoplankton and zooplankton in the New York Bight, January 1976 to February 1978, with comments on the effects of wind, Gulf Stream eddies, and slope water intrusions. NOAA Tech. Rep. NMFS, 5: 41.

Table 1. Monthly mean conditions of "total phytoplankton" and total Copepoda in all CPR samples taken between the vicinity of Boston Massachusetts and Cape Sable, Nova Scotia, 1961-1984.

"TOTAL PHYTOPLANKTON"												
(relative green)												
	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>
1961-1984 Mean	0.06	0.06	0.89	2.73	1.38	0.58	0.73	0.60	0.38	0.37	2.19	0.34

TOTAL COPEPODA												
(#/100m <sup>3</sup> )												
	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>
1961-1984 Mean	1864	3173	4222	15734	47748	33923	23982	24398	30342	25084	17474	7221

Table 2. Monthly mean conditions of "total phytoplankton" in all shelf water CPR samples taken between New York and Bermuda, 1976-1984.

"TOTAL PHYTOPLANKTON"											
(relative green)											
<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>
0.21	0.24	1.50	1.00	0.81	1.49	0.81	1.47	1.13	1.48	0.71	0.38

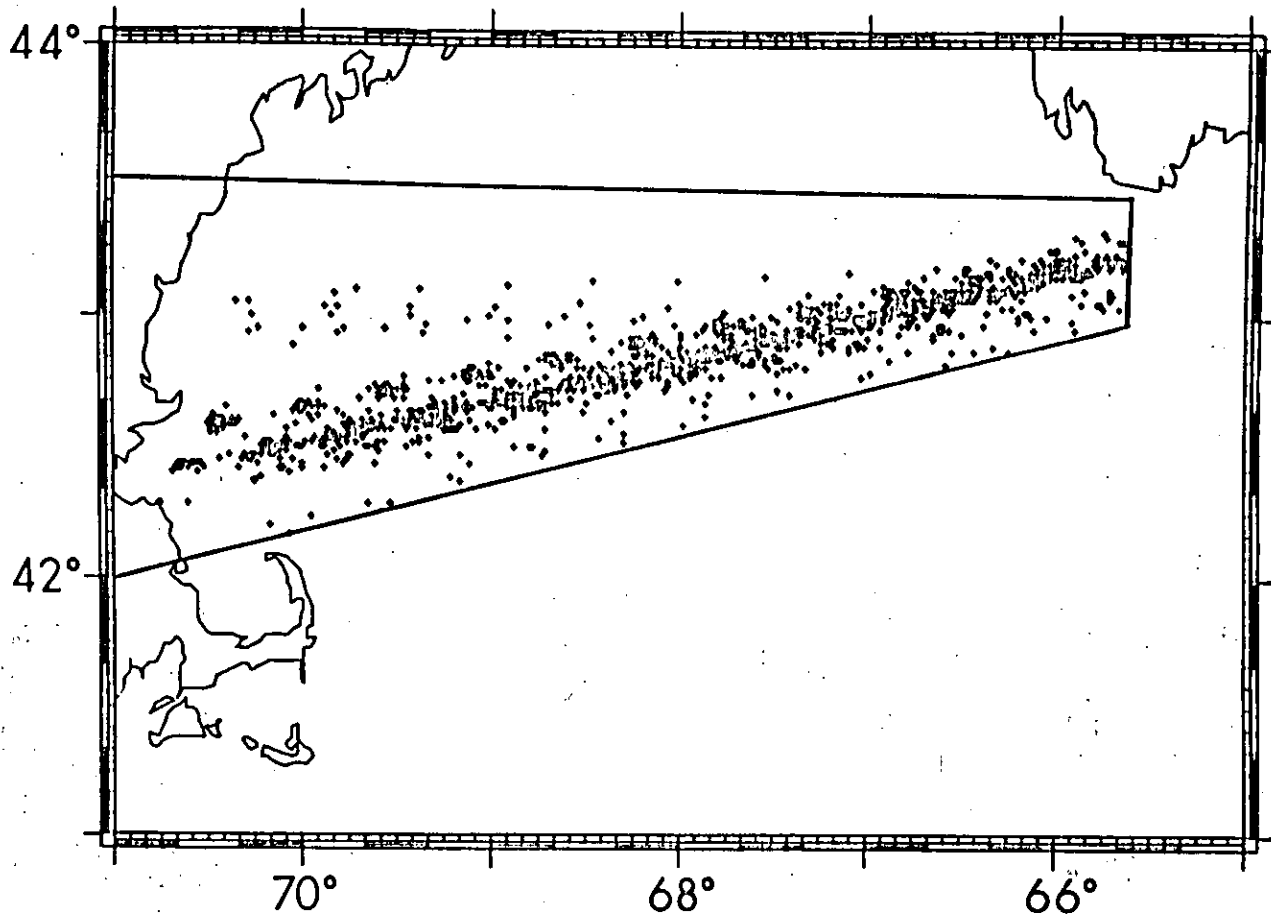


Figure 1. Locations of the 1563 Continuous Plankton Recorder samples collected within the route MC polygon from 1961 through 1984.

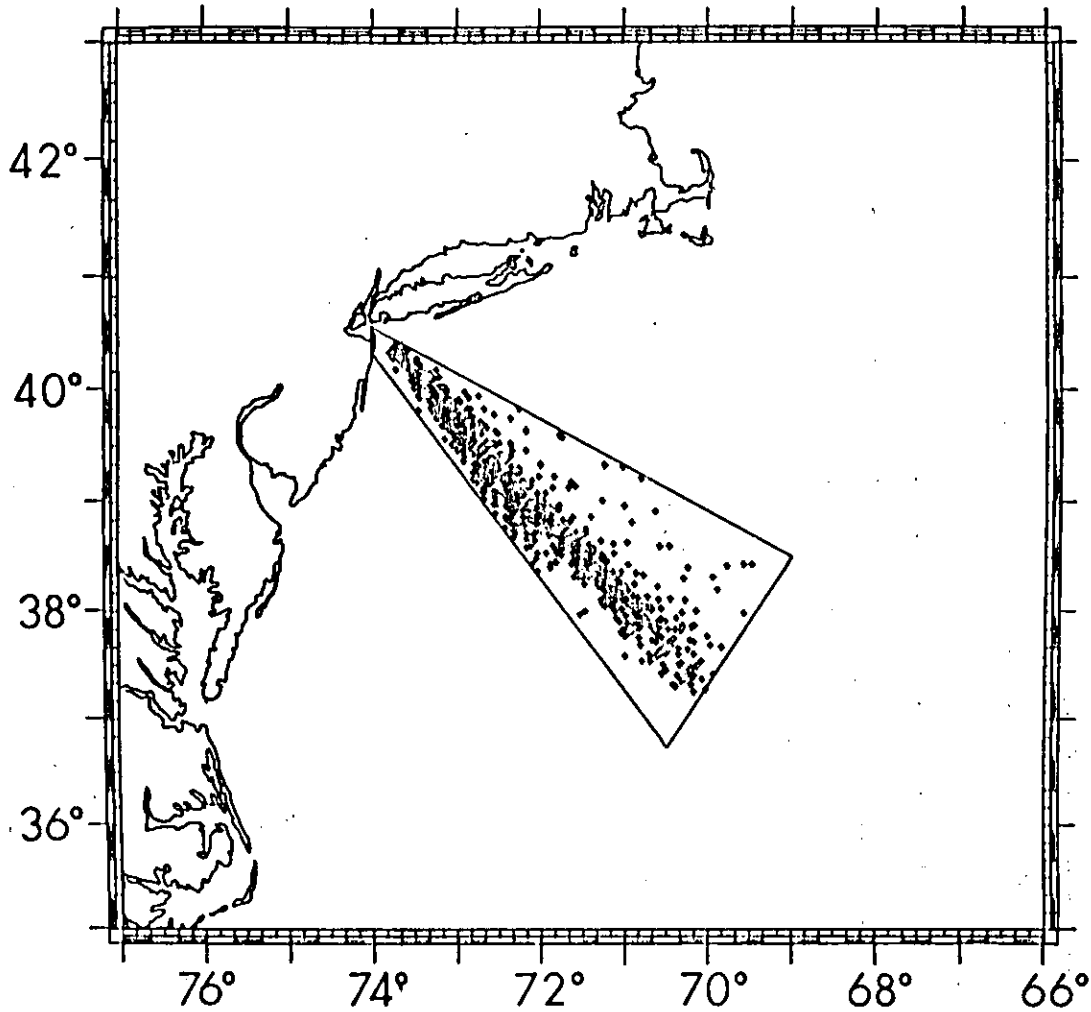


Figure 2. Locations of the 980 Continuous Plankton Recorder samples collected within the route MB polygon from 1976 through 1984.

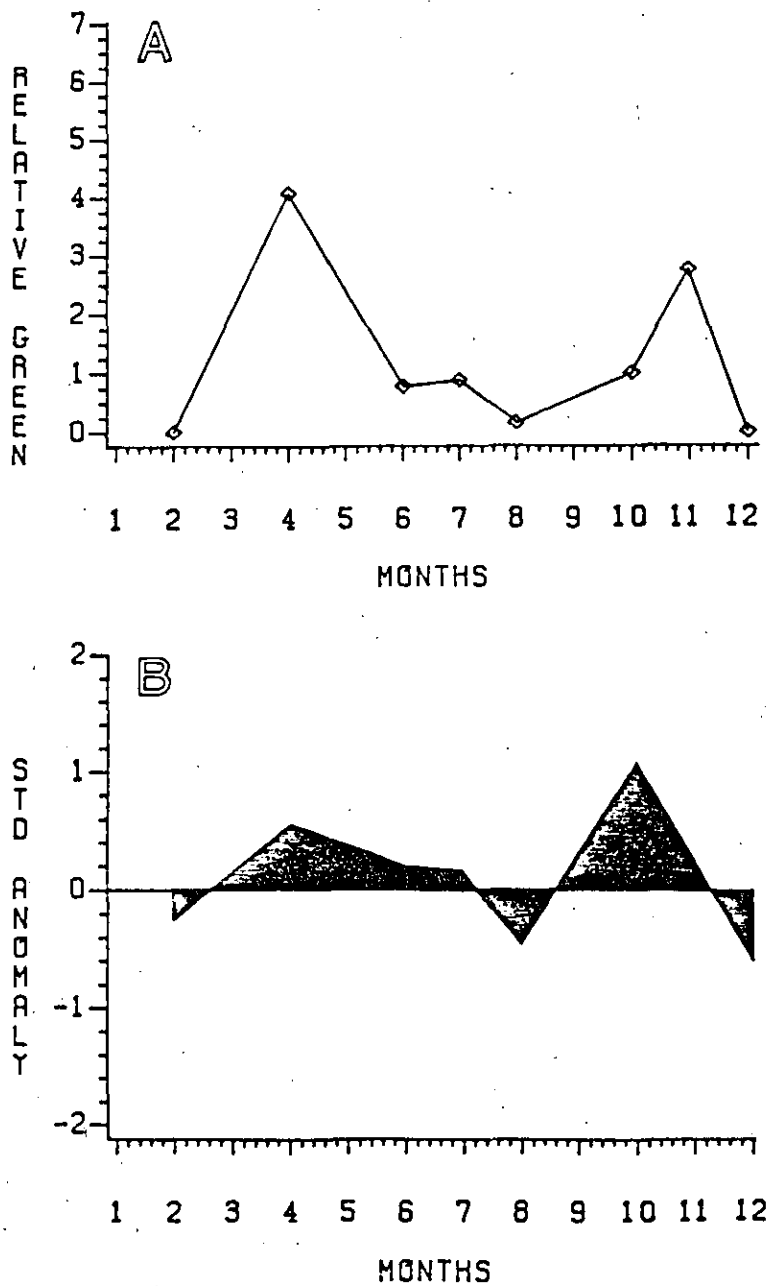


Figure 3. (A) Monthly means of "total phytoplankton" from Continuous Plankton Recorder samples taken between Massachusetts and Cape Sable, N.S., during 1984.

(B) Deviations of the 1984 means from the 1961-1984 long term means in standard deviation units (see text for explanation).



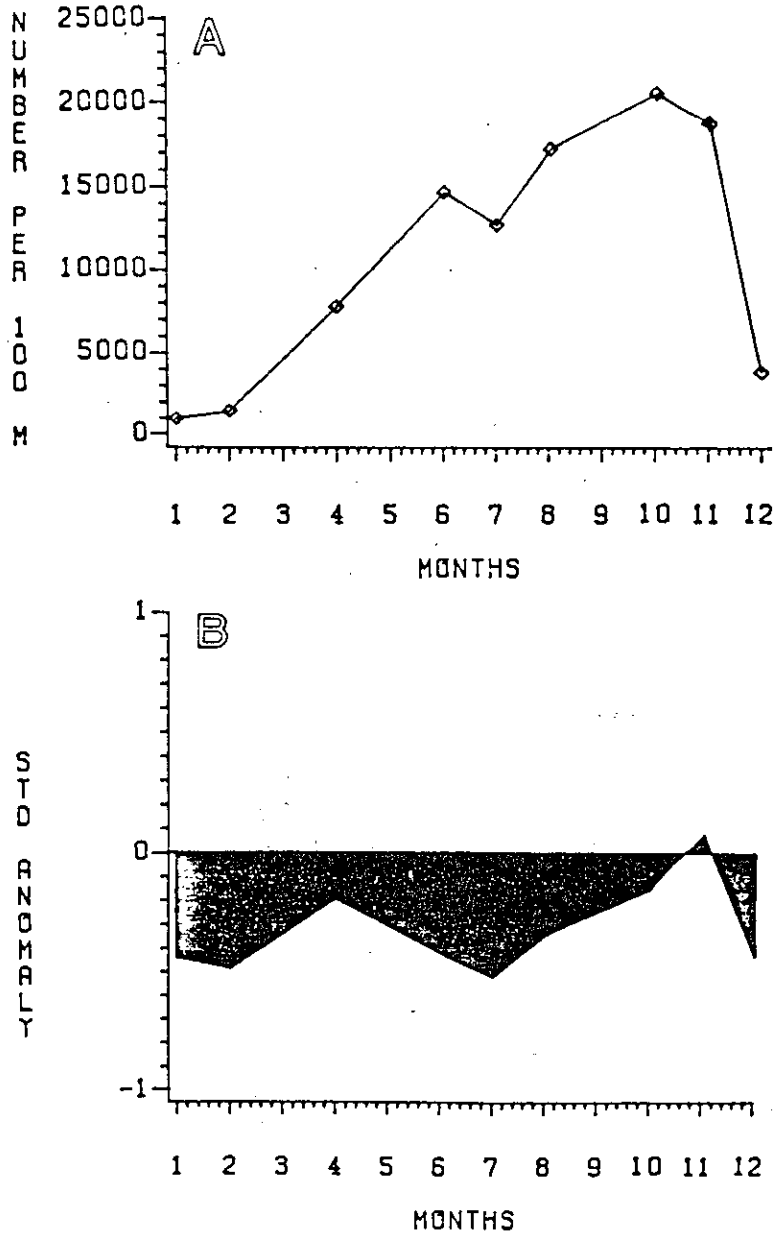


Figure 4 (A) Monthly means of total copepoda from Continuous Plankton Recorder samples taken between Massachusetts and Cape Sable, N.S., during 1984.

(B) Deviations of the 1984 means from the 1961-1984 long term means in standard deviation units (see text for explanation).

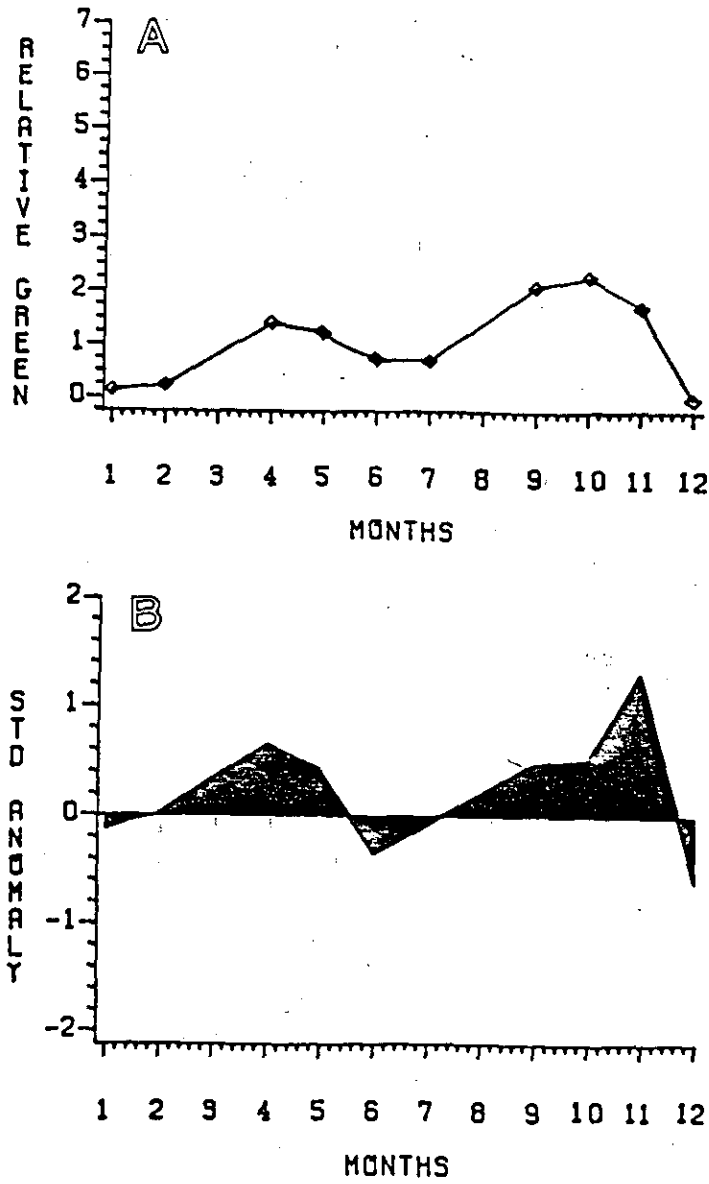


Figure 5. (A) Monthly means of "total phytoplankton" from Continuous Plankton Recorder samples taken between New York and the Gulf Stream during 1984.

(B) Deviations of the 1984 means from the 1976-1984 long term means in standard deviation units (see text for explanation).

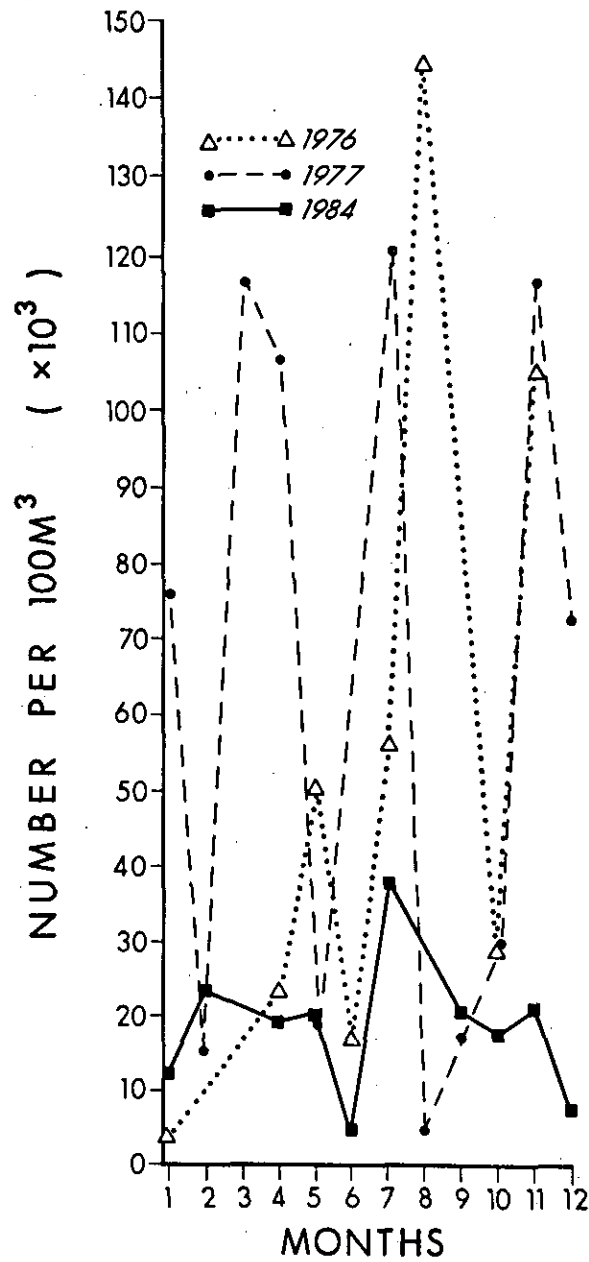


Fig. 6. Monthly means of total Copepoda from Continuous Plankton Recorder shelf water samples taken southeast from New York during 1976, 1977, and 1984.

