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Observations of the Phytoplankton Standing Crop at the Shelf Margin of the Mid Atlantic Bight

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ABSTRACT

A comparison of the total percentage cell abundance and cell biovolume relationships of major phytoplankton categories was made between two station sets across the shelf margin. Diatom values for abundance and biovolume were greater at oceanic stations compared to the outer shelf stations, with dinoflagellates having the reverse pattern. The composite contributions to biovolume and abundance in the standing crop from other phytoplankton categories were greater over the outer shelf than beyond the shelf margin. The major source of biovolume (biomass) from the outer shelf and these oceanic stations came from the diatoms and dinoflagellates, with an average mean of 93% of the total phytoplankton standing crop.

INTRODUCTION

Long term seasonal phytoplankton patterns of the United States northeastern shelf waters have been discussed by Marshall (1978, 1984a, 1984b). These papers characterize the seasonally dominant species of the near surface waters and support the chlorophyll abundance and productivity distribution values for this region as given by O'Reilly and Boush (1984). Cell abundance and productivity decrease from the near coastal waters seaward over the shelf, then increase along the shelf margin (Marshall, 1984a, O'Reilly and Boush, 1984). This region is influenced by current patterns parallel to and over the shelf, with warm core rings also moving southward along this slope. Walsh et al. (1976) noted the total biomass of diatoms increased with depth into oceanic waters while dinoflagellates remained fairly constant, decreasing slightly with depth. Glover et al. (1985) found the ultraplankton accounted for 65 to 97% of the total phytoplankton in this region, with the cyanobacteria most numerous at the surface and the eucaryotes dominant at the lower light levels. Beers et al. (1975) noted phytoplankton concentrations fairly constant to 100 m, then decreasing to 200 m, with biomass maxima in the upper 20 m. In the mid-atlantic bight, Cosper and Stepien (1984) found diatoms and dinoflagellates accounted for the majority of the phytoplankton biomass in waters over the shelf, shelf break and slope. Colton et al. (1985) reported the pico-nanoplankton fraction represented 71% of the total cell counts for all depths, averaging 34.9 x 10^4 cells/l. Diatoms were the next most abundant group, representing 16% (8.0 x 10^4 cells/l) of the total.

The objectives of this paper are to present data on the spatial relationships of phytoplankton at sites across the shelf margin, that will include comments on their abundance and biovolume along a north-south gradient and over a vertical range of depths at these locations.

METHODS

Water samples were taken in April 1984 aboard the R/V CAPE HENLOPEN at stations near the outer northeastern shelf margin of the United States (Figure 1). Stations D-46 and C-47 were oceanic sites beyond the shelf break located approximately 130 km apart, with stations D-35 and C-36 along the inner shelf margin in waters of less than 150 m deep. Phytoplankton from these two oceanic and two shallow shelf stations will be discussed in this report.

At each station a series of water samples were taken with Go- Flo bottles at mean depth values of 1.0, 27.3, 78.1 and 141.6 m. From each depth sampled, three 500 ml water samples were taken and preserved with buffered formalin and returned to the laboratory for analysis. These samples were examined using a modified Utermohl method, where cell counts were made for phytoplankton components to obtain an 85% abundance accuracy estimate (Venrick, 1978; Marshall, 1984a). The autotrophic picoplankton counted were limited to cells of approximately 1.5 to 2.0 microns in size. At each sampling depth, samples were taken in triplicate, with mean concentrations recorded for each taxon. Cell volume data were previously determined by Marshall (1984a).

RESULTS

A total of 168 taxa were identified at these stations and consisted mainly of diatoms (78) and dinoflagellates (52) (Wagoner, 1988). A variety of phytoflagellates and a ubiquitous cyanobacteria component were also present, with several unidentified cells of 1.5 to 10 microns in size placed in several pico-nanoplankton categories. These groups consisted of mainly cyanobacteria cells less than 2 microns in size (picoplankton). Vertical abundance and cell volume (biomass) comparisons of the four stations are given in Figure 2. There is a general pattern of reduced cell concentrations in the upper strata southward, with highest concentrations (16×10^5 cells/l) at the more northern stations both over the shelf and seaward. Abundance levels continued to decrease with depth, with more similar values at each site below 27 m. Each of these stations was characterized by surface populations dominated by phytoflagellates, cyanobacteria, chlorophytes and the pico-nanoplankton categories. The highest concentrations of diatoms, chrysophytes and coccolithophores were above 27 m, before each of these groups decreased in abundance with greater depth. The increased presence of the diatoms at this subsurface depth was responsible for the peak biovolume values noted there at several of the stations (Figure 2). Over the vertical range sampled at both shelf and oceanic stations, the major source of phytoplankton biovolume (biomass) in the standing crop came from the dinoflagellates and diatoms. The percentage attributed to dinoflagellates biovolume was greater over the shelf compared to the diatoms for the upper 78 m, below which the dinoflagellates amounts decreased and the diatoms percentage increased. At the oceanic stations, diatoms were the source of the greatest biovolume. This pattern continued to 140 m at the more northern station (D-46), whereas, the dinoflagellate contribution to the biovolume exceeded the diatoms below 78 m. The percentage abundance for the major components in the standing crop presents the expected dominance of the much smaller picoplankton (Figure 3). These values would also be much greater if the complete range (0.2- 2.0 microns) of the autotrophic picoplankton community had been

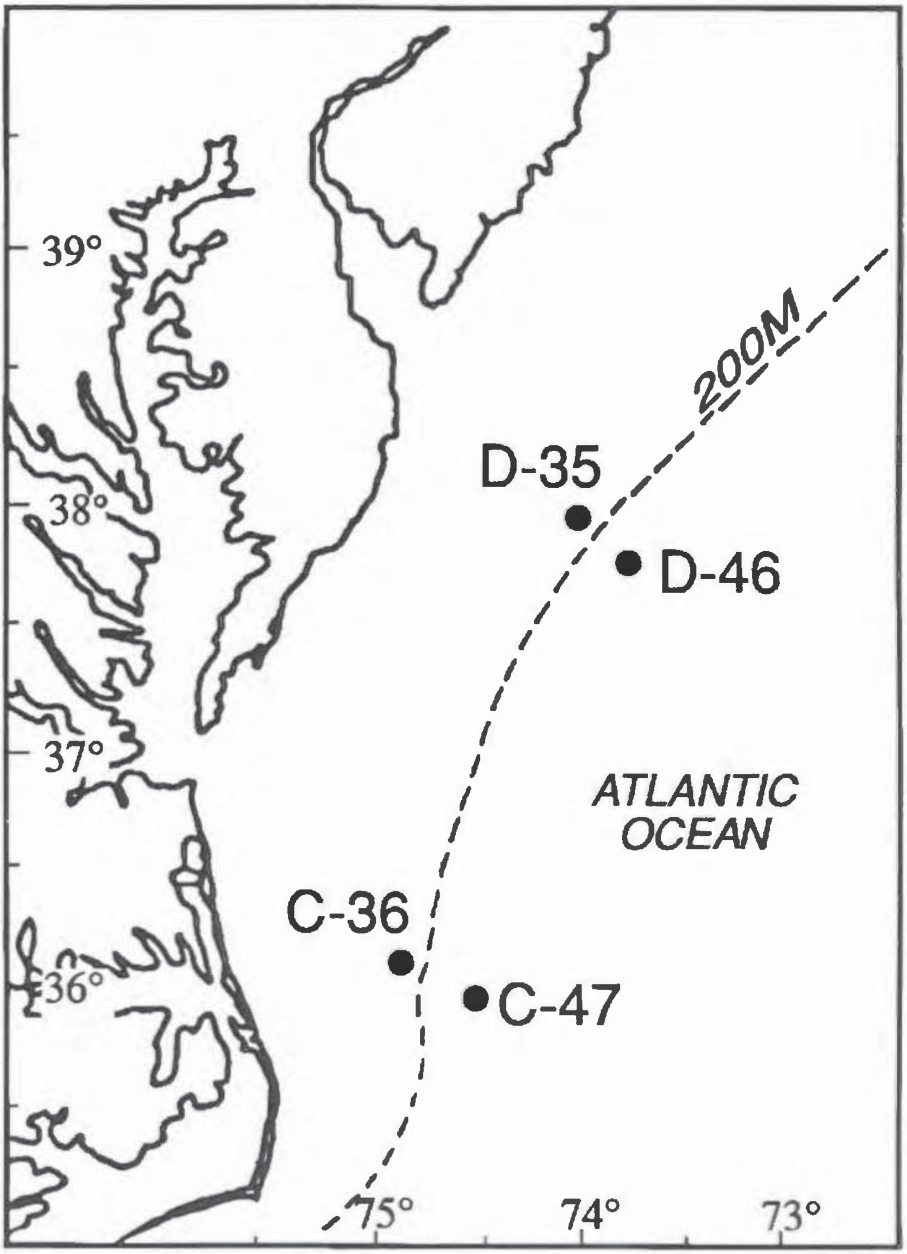

FIGURE 1. Station locations along the 200 meter depth contour of the continental shelf margin.

included and analysis not limited to light microscopy. The autotrophic picoplankters have been reported as ubiquitous in world oceans with concentrations in the North Atlantic at 10^6-10^7 cells/l (Murphy and Haugen, 1985). However, due to their small size their contribution to the volume of the standing crop is not great.

In general, the diatoms had their highest percentage contribution in the northern oceanic region compared to the other sites. There was also a greater contribution of a more diverse floral base over the shelf in comparison to the oceanic sites. The major contributors to the cell biovolume (biomass) of the standing crop of phytoplankton at these outer shelf and oceanic stations were diatoms and dinoflagellates (Figure 4). The dinoflagellate biovolume values decreased seaward, but increased southward, with the diatom proportion greater at the

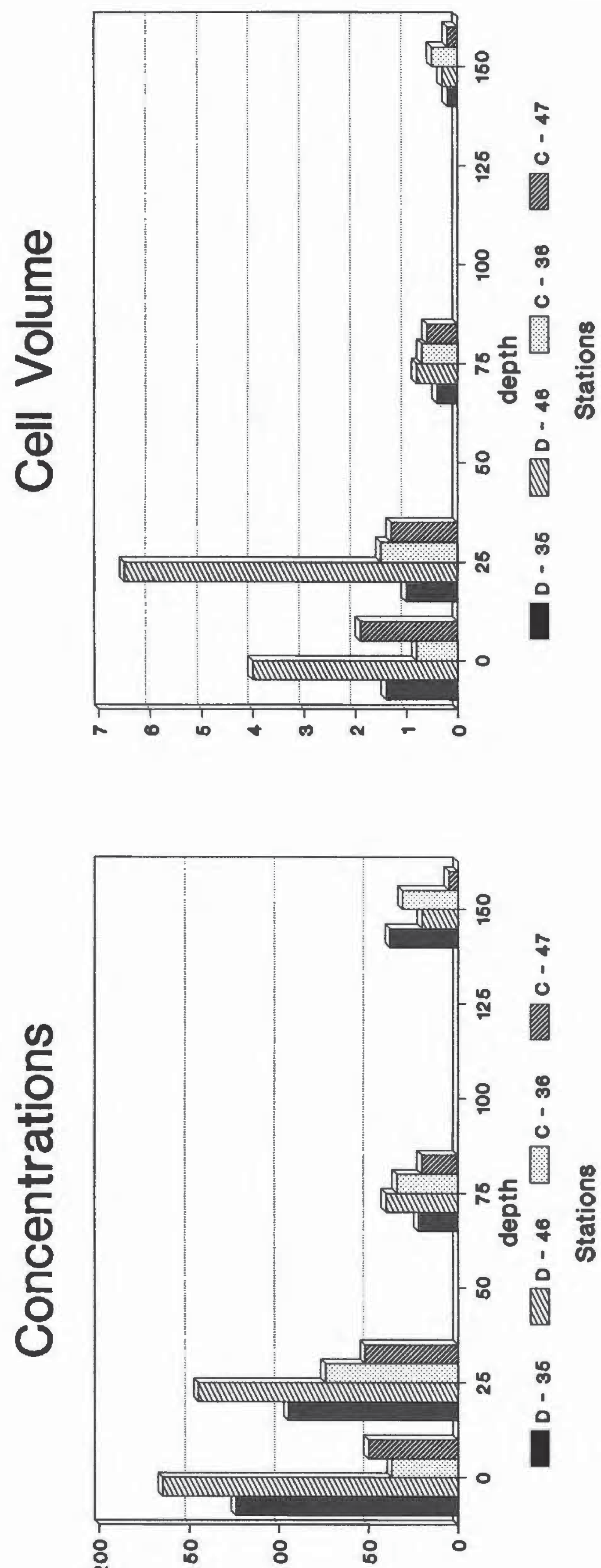

FIGURE 2. Vertical phytoplankton cell concentrations and cell volumes for stations along the continental shelf margin.

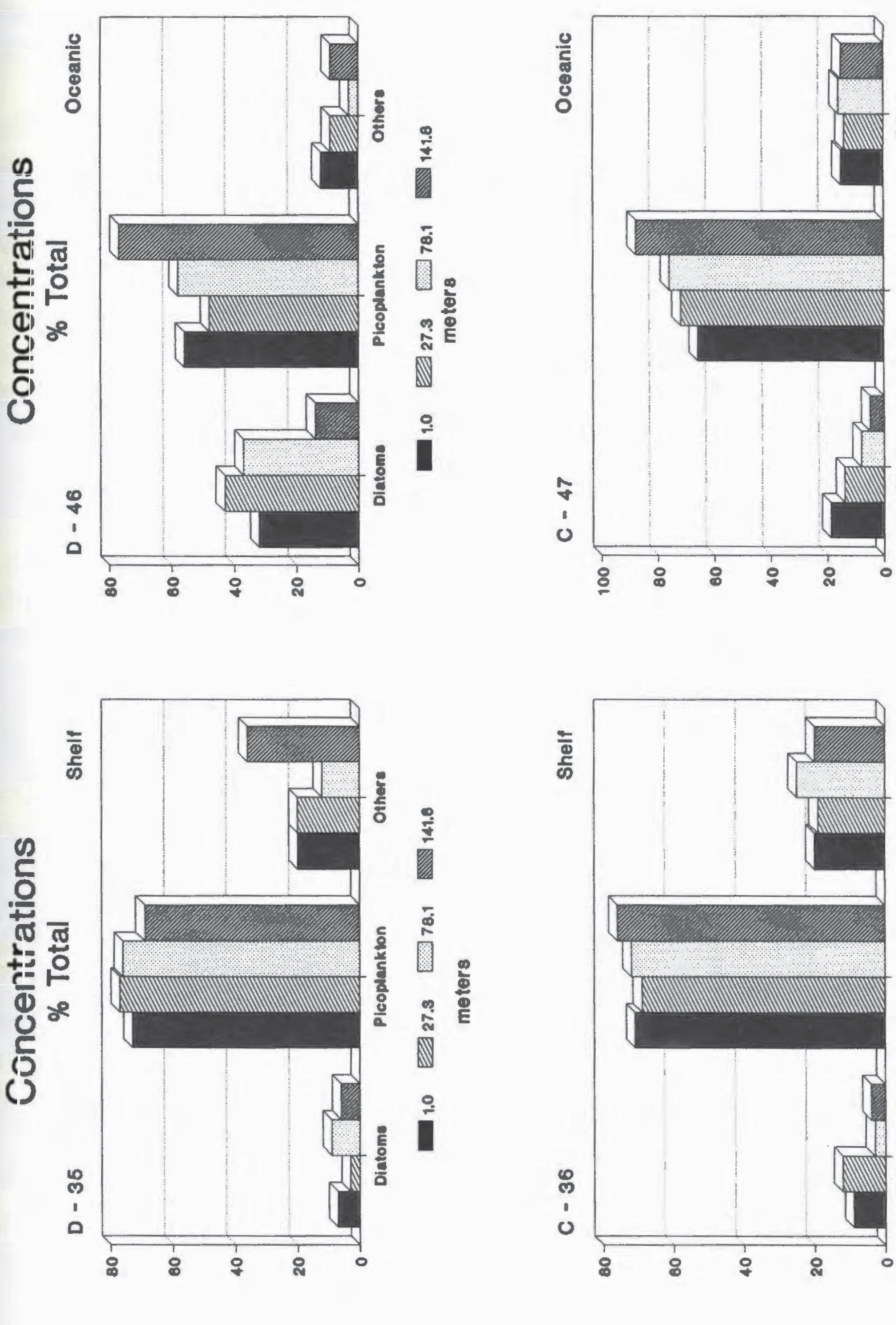

FIGURE 3. Phytoplankton concentrations, in percentage of the total abundance, attributed to diatoms, picoplankters and other categories for stations at mean depths sampled along the continental shelf margin.

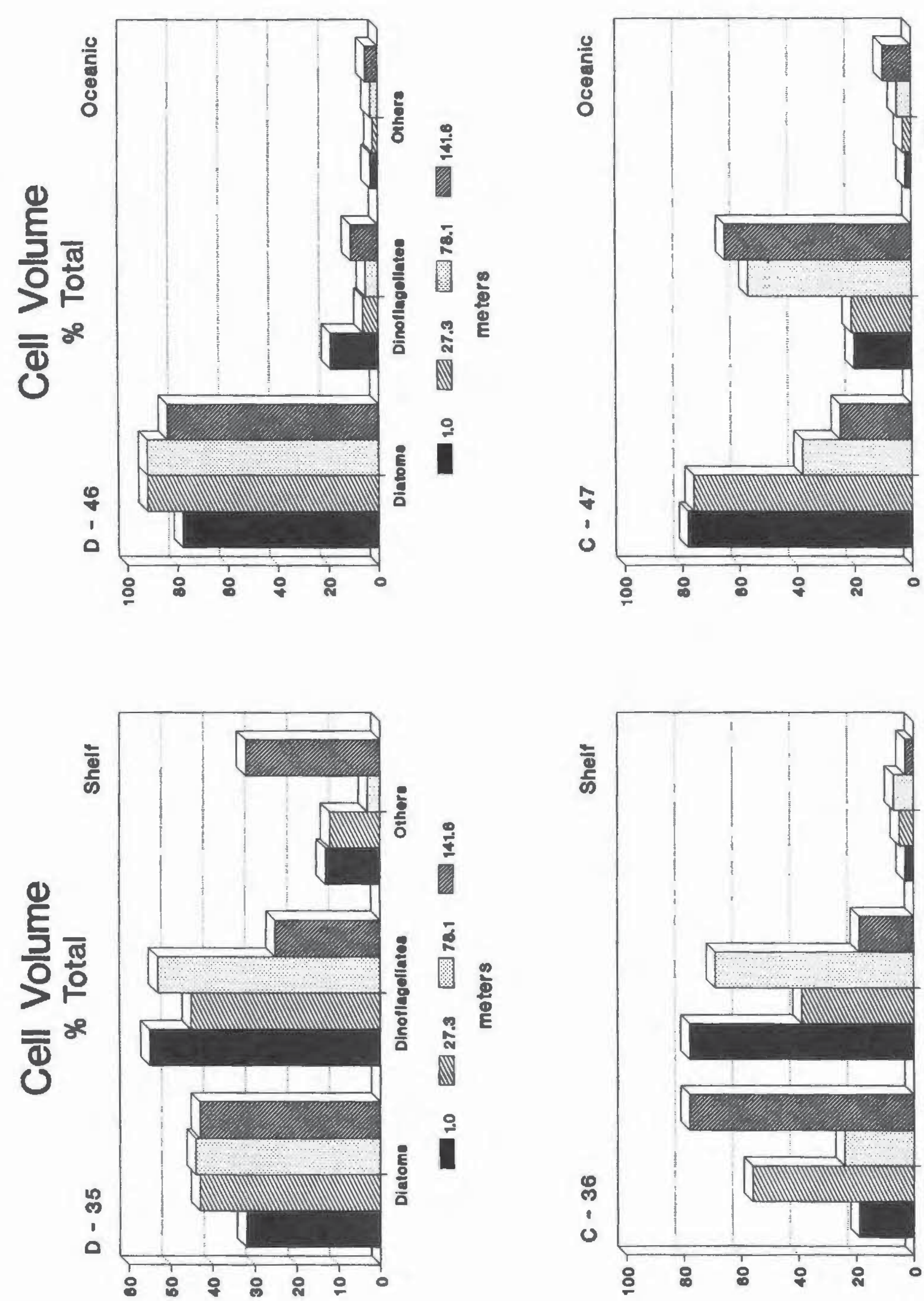

FIGURE 4. Phytoplankton cell volumes, in percentage of the total composition, for diatoms, dinoflagellates and other categories at mean depths sampled along the continental shelf margin.

northern stations over the different depths sampled. The other components were slightly more represented at the outer shelf stations, but decreased southward over the shelf and seaward. The cryptomonads and euglenoids had sporadic appearances where their concentrations were high and the contributions to the total biovolume increased. The combined mean contribution, over the vertical series, for the diatoms and dinoflagellates to the phytoplankton biovolume for these stations were: Shelf stations D-35 (85%), C-36 (95%); Oceanic stations D-46 (97%), C-47 (95%), with an overall mean of 93%.

Wagoner (1988) has also reported in further analysis of this data set, that the following patterns were found: 1. the dinoflagellates, cryptophyceans, and prasinophyceans decreased in abundance with depth; 2. the coccolithophores, diatoms and chrysophytes concentrations generally increased to 30 m, then decreased with depth over the next 150 m, 3. the chlorophytes and silicoflagellates had a mixed pattern above 30 m at all sites, but decreased in numbers below this depth, 4. the euglenoids were most abundant above 30 m over the shelf, and 5. the pico and nanoplankton abundance varied, but was most abundant at the surface, then decreased in numbers to 80 m where there was a similar continuation of reduced cell abundance.

CONCLUSIONS

The standing crop relationships for the major phytoplankton categories indicated several differences between stations over the outer shelf and seaward. Abundance and biovolume values were greater in the upper water strata, having greater abundance and biovolume associated with waters at the more northern stations, yet, being more comparable to each other at the lower depths. The proportional contribution of diatom numbers to the total increased seaward, as the other components generally decreased, with this pattern more developed at the northern stations. However, the biovolume from the diatoms and dinoflagellates was greater than all other constituents over the outer shelf and at the more seaward stations, with the dinoflagellates dominating the surface waters over the shelf. Diatoms and dinoflagellates together averaged 93% of the total phytoplankton biovolume (biomass) at these stations. The contributions from the mixed category of other phytoplankters was greatest over the northern shelf station (D-35), but decreased seaward and to the south. In contrast, the major contributor to the standing crop biovolume beyond the shelf were the diatoms, with the dinoflagellates the next most abundant source.

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