Note on Particulate Organic Carbon in Bermuda Waters

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Particulate organic matter in the ocean comprises various components of living (plankton, bacteria, etc.) and non-living (organic aggregates) materials. The major fraction of particulate organic matter in sea water is non-living material (Parsons, 1963). Nearly all of the particulate organic matter in the entire ocean has, directly or indirectly, its origin in the photosynthetic assimilation performed by phytoplankton inhabiting the shallow surface layer of the ocean, at most one hundred meters in depth. Studies on particulate organic matter in the ocean have been reviewed by Nishizawa (1966, 1969), Riley (1970) and by Menzel (1974). Gordon (1970 b, 1977) investigated in detail the distribution of particulate organic carbon in the North Atlantic Ocean. In Bermuda waters, Gordon (1964, 1970 a) studied organic aggregates using microscopic observation. The data on particulate organic carbon reported here were obtained from the Atlantic Ocean in Bermuda inshore (St. Georges Harbour) and offshore (Station "S") waters in 1981.

Water samples were collected with Niskin bottles from October 6 to 12, 1981, at three stations. The station locations are shown in Fig. 1. The sampling cruises were made on the boats, Panulirus II and Velella, which belong to the Bermuda Biological Station for Research. The water samples were emptied into plastic bottles and immediately filtered through 47 mm Whatman GF/C glass fiber filters at the shore laboratory. All filters were combusted in advance at 450 C for two hours. For samples taken at Station "S", 9 to 10 liters of water were filtered for each layer. For samples taken at St. Georges Harbour, 2.5 liters of each sample were filtered. After filtration, the filter samples were frozen until later analysis. No acid treatment was made to remove carbonate carbon from the filters prior to analysis. Particulate organic carbon was analyzed by wet oxidation with dichromate (Strickland and Parsons, 1972). Menzel (1966) suggested that dissolved organic carbon in sea water was adsorbed onto the filters during the filtering process. The author used the value of 16 μgC per sheet (Ichikawa, 1975) for adsorption correction for the present study. The carbon concentrations were determined as the amount of organic carbon on the filter minus adsorption effect of 16 μgC, and these corrected values were divided by the water volume filtered.

Fig. 2 shows the vertical profile of particulate organic carbon at Station "S" in the Atlantic Ocean off Bermuda. The carbon values in the water column down to 1,400 m depth were in the range of 16 to 66 μgC/l. The highest carbon concentration was observed at 10 m depth and the lowest value appeared at 30 m depth. The general range of carbon concentrations in the present data is comparable to those

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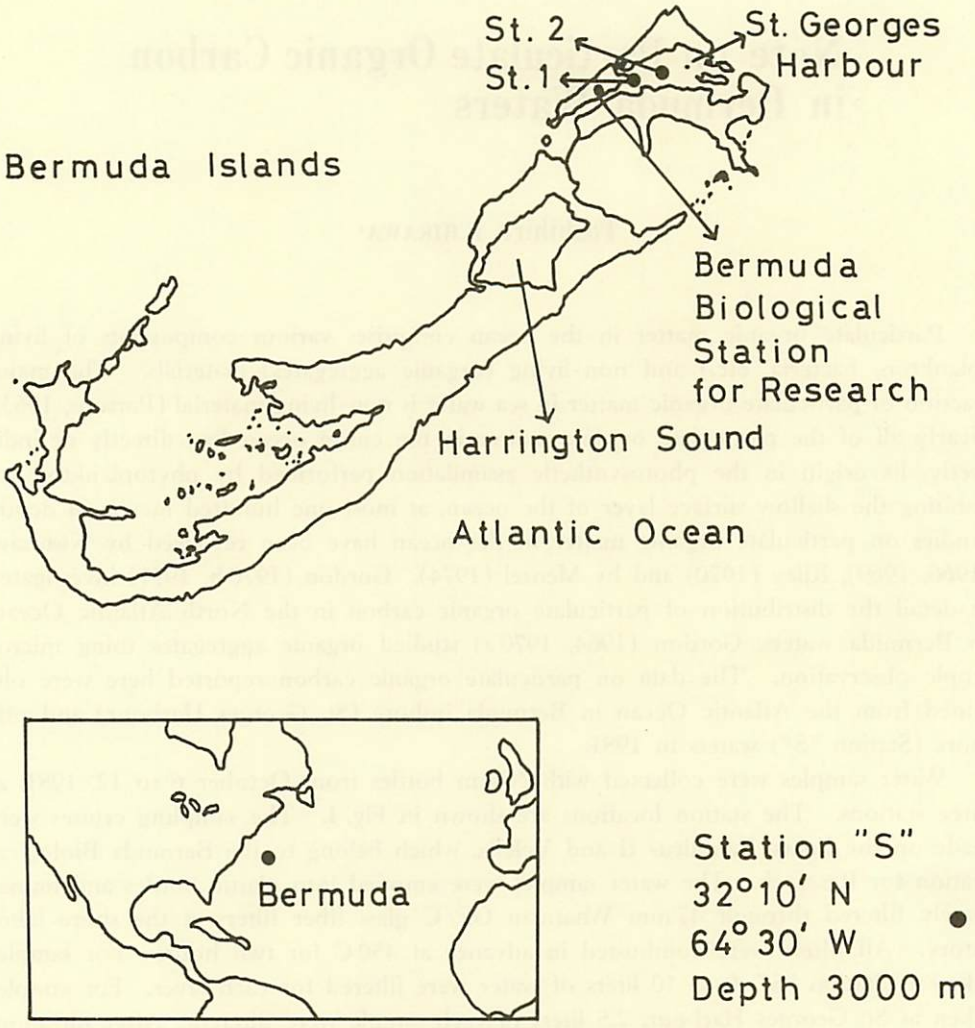

Fig. 1. Locations of sampling stations.

reported by Gordon (1970 b) in the Sargasso Sea off Bermuda. Higher concentrations were found in surface waters than in layers below (Fig. 2). However, characteristic carbon minimum layers appeared at 30 and 200 m depth. These carbon minimum layers were reported by Newell and Kerr (1968) in the Indian Ocean and by Nakajima (1969) in the Bering Sea, and further by Ichikawa (1975) in the Pacific Ocean. The existence of particle minimum layers seems to be universal phenomenon.

The range of particulate organic carbon below the 200 m layer was 24-48 μgC/l. The highest value was found at 600 m depth and the lowest value appeared at 1,000 m depth. Particulate carbon below the euphotic layer showed a significantly irregular variation with depth. Two carbon maxima were found in the water column between 200 m and 1,400 m depth. Significant irregularities in the vertical variation of the carbon concentration of deep water have been reported by many workers (Dal Pont and Newell, 1963 ; Gordon, 1970 b ; Nakajima, 1969 ; Ichikawa and Nishizawa, 1975).

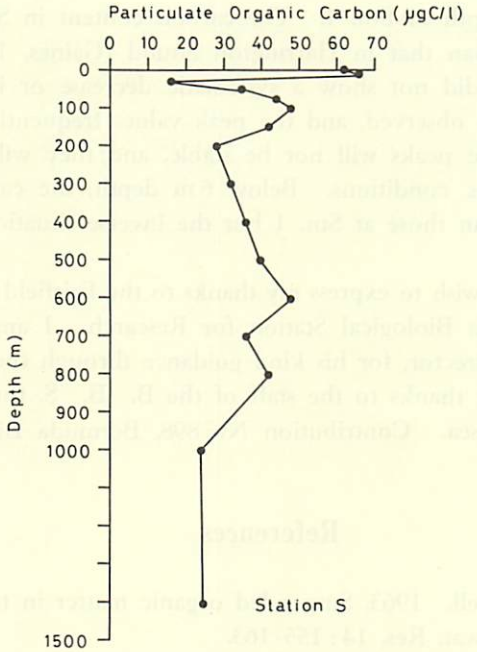

Fig. 2. Vertical profile of particulate organic carbon at Station "S" off Bermuda, October 6, 1981.

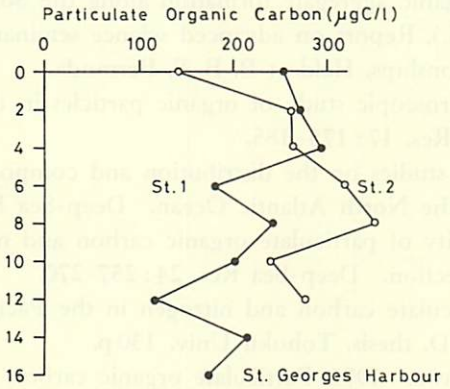

Fig. 3. Vertical profiles of particulate organic carbon at two stations in St. Georges Harbour, Bermuda, October 12, 1981.

Below 1,000 m depth, particulate carbon concentration showed a uniform value of 24 μgC/l down to 1,400 m depth. This uniform value was considered to be the background concentration at Station "S". The amount of carbon decrease was 24 μgC/l within the water column from 600 to 1,400 m depth. This means that particulate organic matter is gradually being utilized by the organisms living in the deep water.

Fig. 3 shows the vertical profiles of particulate organic carbon in St. Georges Harbour. Particulate organic carbon in this area varied between 118-349 μgC/l. The highest concentration was found at 8 m depth of Stn. 2 and the lowest concentration

was observed at 12 m depth of Stn. 1. The carbon content in St. Georges Harbour was significantly lower than that in Harrington Sound (Gaines, 1965). The particle distribution in this area did not show a systematic decrease or increase with depth. Marked peaks were often observed, and the peak values frequently exceeded the surface values (Fig. 3). The peaks will not be stable, and they will soon be dispersed by the local hydrographic conditions. Below 6 m depth, the carbon concentrations at Stn. 2 were higher than those at Stn. 1 but the inverse situation was found above 4 m depth.

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