Particulate Organic Carbon in the Malaysian Coastal Waters of the South China Sea

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Abstract

Particulate organic carbon (POC) in the Malaysian coastal waters of the South China Sea was measured in samples collected during the three cruises of R. V. Kagoshima-Maru in 1985-1987. The carbon concentration at 43 sampling stations ranged from 18-162 μgC/l. Different types of vertical profiles of POC were observed and the regional variation in carbon concentration was significant in the observed area.

Key words: Oceanography, Particle, Organic carbon, Distribution.

Introduction

Most of the organic matter in sea water originates from photosynthesis in the euphotic layer of the ocean. In the oceanic environment, all organic production takes place in about a 100 meter thick surface layer. In the coastal environment, the photic zone production is greater and the influence of terrigenous organic matter is often increased. Although there have been many studies of the distribution of particulate organic matter in the Pacific Ocean (e. g. HOBSON, 1967; NAKAJIMA, 1973; ICHIKAWA, 1982; ICHIKAWA and NISHIZAWA, 1975), knowledge of the tropical areas is still quite limited. The data on particulate organic carbon (POC) reported here were obtained from the waters off the east coast of Peninsular Malaysia and off West Malaysia (Borneo) during the series of cruises of the Matahari Expedition, a collaboration between the Universiti Pertanian Malaysia and

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Kagoshima University. The object of the expedition was to collect basic data on oceanography and fisheries of the Exclusive Economic Zone (EEZ) of Malaysia in the South China Sea.

Methods

The sea water samples were collected in the coastal waters of the South China Sea during the three cruises of the R. V. Kagoshima-Maru in 1985-1987. Forty-three oceanographic sampling stations were selected for the study of particulate organic carbon (Figs. 1a, 1b, and 1c). The sea water samples for POC analysis were collected at 5 to 6 different depths at each station with a twin 10 liter Van Dorn water sampler. The water samples were drained into 10 liter polyethylene bottles. A six liter subsample was filtered immediately on board through a 47 mm pre-combusted Whatman GF/C glass fiber filter. The filter was then stored in a deep freeze and the analysis was done at the shore laboratory. The particulate organic carbon concentrations were determined by wet oxidation with dichromate and concentrated sulfuric acid following the procedure by PARSONS et al. (1984). The water sampling was carried out by the scientists, technicians, students, and crew on board the R. V. Kagoshima-Maru.

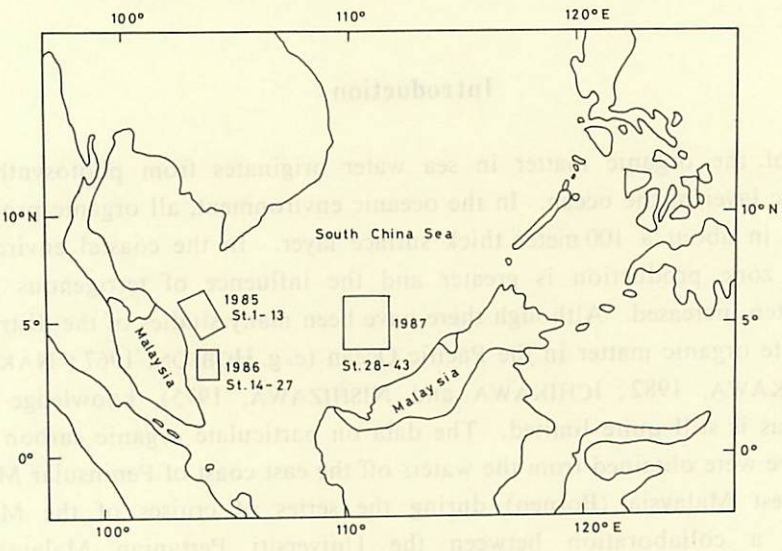

Fig. 1a. Study areas occupied during the three R. V. Kagoshima-Maru cruises in 1985-1987.

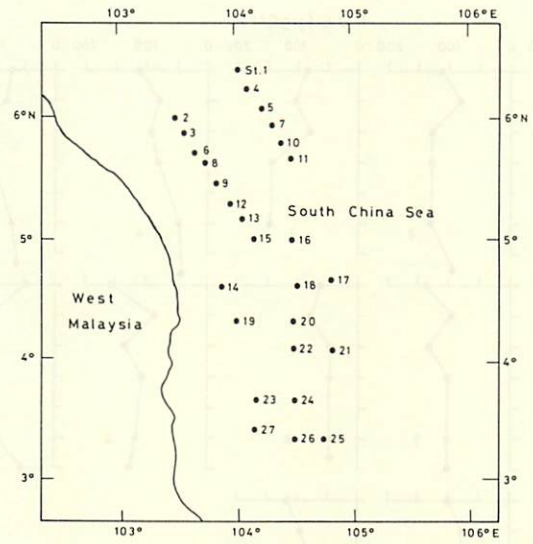

Fig. 1b. Location of sampling stations occupied during the cruise of R. V. Kagoshima-Maru in 1985 and 1986.

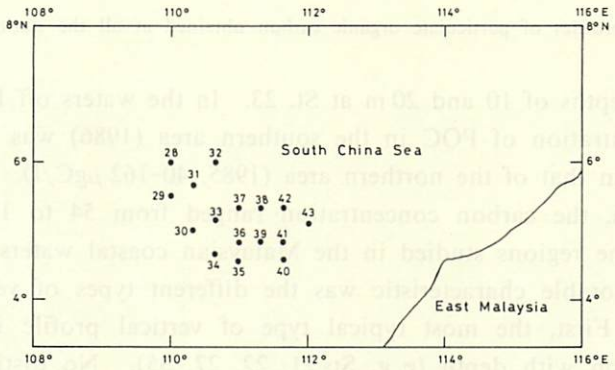

Fig. 1c. Locations of sampling stations occupied during the cruise of R. V. Kagoshima-Maru in 1987.

Results and Discussion

Figs. 2a, 2b, and 2c show the vertical profiles of POC observed at the forty-three stations of the present study. Most of the sampling stations were located on the continental shelf of the South China Sea. The study area in the offshore waters of Borneo also included stations over the continental slope (Sts. 32, 37, 38, 42), the maximum sampling depth was 700 m.

The POC in the three areas varied between 18-162 μgC/l. The highest concentration was found at a depth of 20 m at St. 1 and the lowest concentration

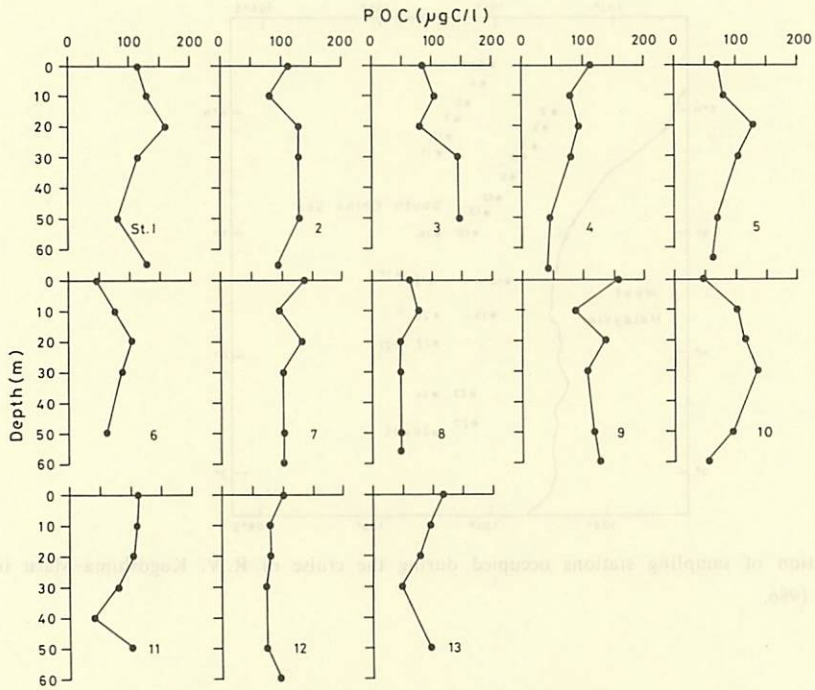

Fig. 2a. Vertical profiles of particulate organic carbon obtained at all the stations in 1985.

was observed at depths of 10 and 20 m at St. 23. In the waters off East Malaysia, the general concentration of POC in the southern area (1986) was slightly lower (18–120 μgC/l) than that of the northern area (1985, 40–162 μgC/l). In the waters off West Malaysia, the carbon concentration ranged from 54 to 142 μgC/l.

Throughout the regions studied in the Malaysian coastal waters in the South China Sea, one notable characteristic was the different types of vertical profiles of POC found. First, the most typical type of vertical profile is a relatively uniform distribution with depth (e. g. Sts.21, 22, 27, 35). No distinct maximum or minimum layer was found in this type of distribution. Second, a characteristic carbon maximum layer often appeared in the 20–30 m layer (e. g. Sts. 1, 5, 6). This situation was mostly found at stations sampled in 1985. The carbon concentrations in this maximum layer had a range of 104–162 μgC/l, and the peak values exceeded the surface (1 m) values. This carbon maximum layer did not exist at the layer of phytoplankton (RAIHAN and ICHIKAWA, 1986). Below the carbon maximum the concentration tended to decrease with depth down to the 50 m layer just above the sea bottem. Third, a vertical profile that exhibited a decrease in carbon concentrations with increasing depth (e. g. Sts. 4, 32, 33). The amount of this decrease was greater in the shallow water column over the continental shelf (140 μgC/l at St. 30) than over the continental slope (50 μgC/l at St. 32). Finally, a vertical profile that could not be classified into the above

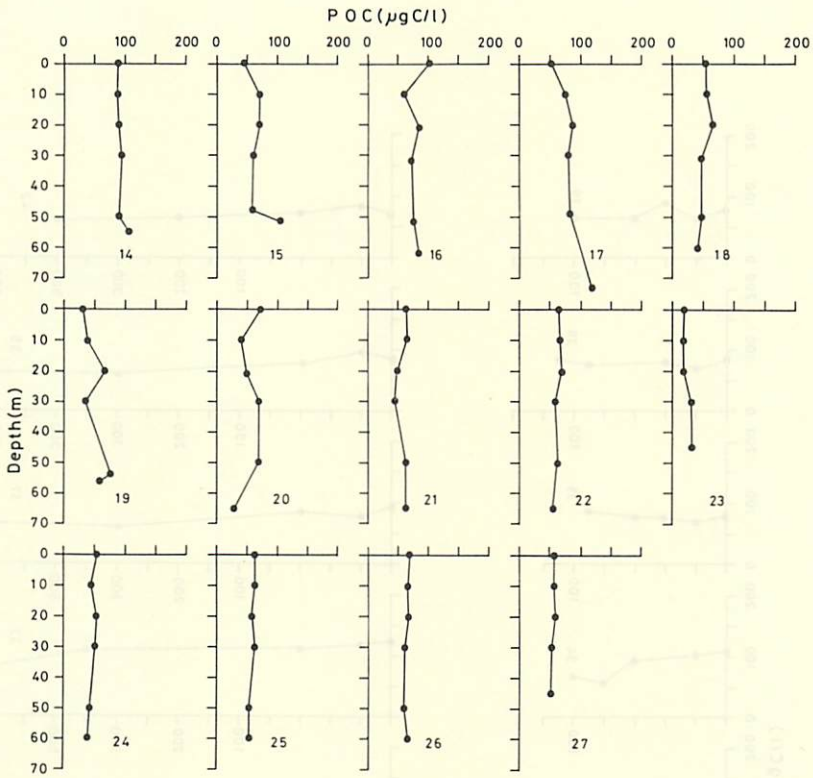

Fig. 2b. Vertical profiles of particulate organic carbon obtained at all the stations in 1986.

three types was observed (e. g. Sts. 3, 11, 15, 17). For example, at St. 17, the carbon concentration systematically increased with depth down to 75 m layer.

The integrated amount of POC under 1 m^2 column of water was calculated for each station for the range of 0 to 50 m. In this depth range, the lowest amount, 1.2 gC/m^2, was obtained at St. 23 and the highest, 6 gC/m^2, at Sts. 1 and 32. This may indicate that the regional variation in carbon concentration is significant in the observed area. The average POC concentration in each water column (0−50 m) ranged from 25 (St. 23) to 120 μgC/l (Sts. 1, 32). The average value at Sts. 1 and 32 is 4.8 times higher than at St. 23. If we neglect the exceptionally low values at St. 23, the average concentration of POC ranged from 50 to 120 μgC/l, and the factor drops to a value of 2. 4. ICHIKAWA (1975) reported on the average concentration of POC in the surface layer (0−50 m) from 21 areas in the Pacific Ocean and adjacent seas including Southeast Asian seas. The results of the present study except for the highest concentrations found at Sts. 1 and 32 are comparable to what ICHIKAWA found in the tropical and subtropical surface layer in the Pacific Ocean and the Southeast Asian seas. The carbon concentration in this particle rich station is comparable to that of the productive north Pacific. In the open tropical waters of the Pacific, the total amount of POC in the 0

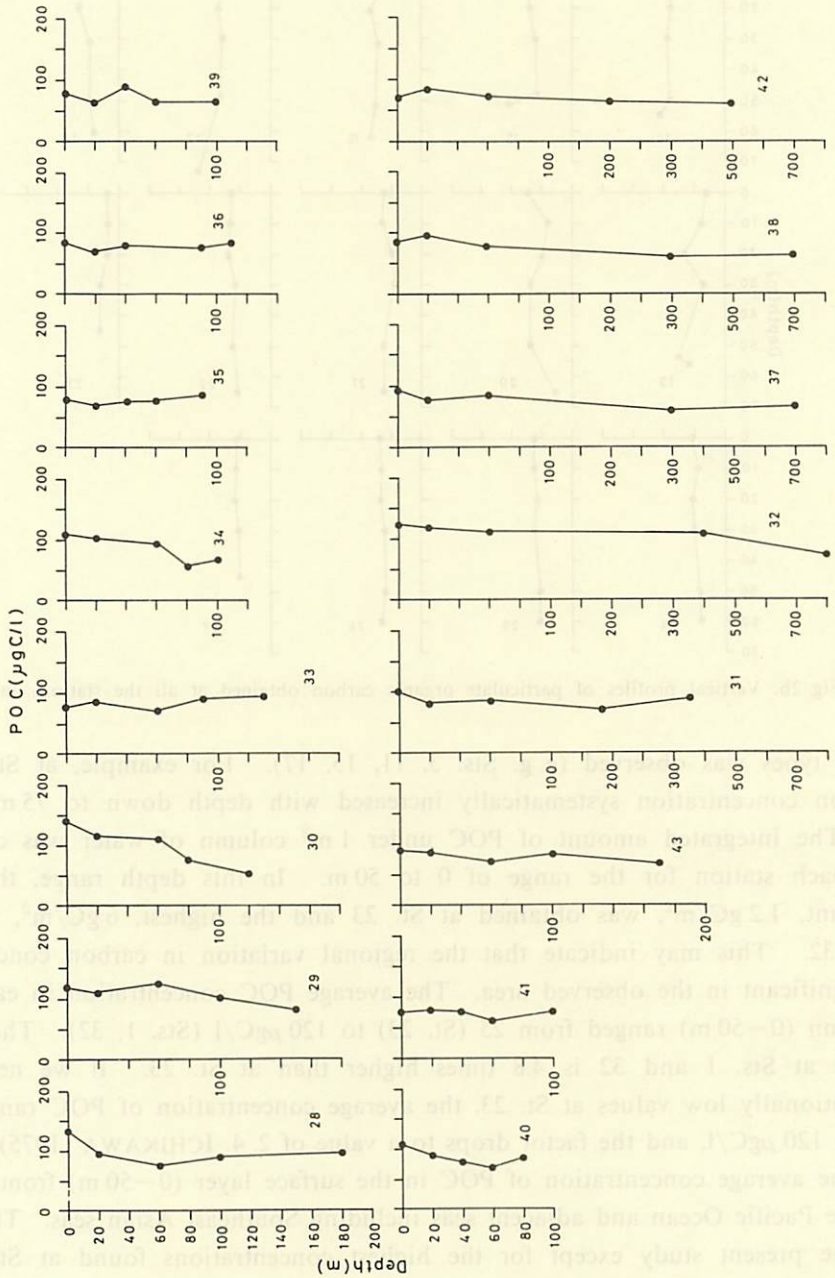

Fig. 2c. Vertical profiles of particulate organic carbon obtained at all the stations in 1987.

to 50 m depth was in the range of 0.9 to 1.4 gC/m^2 (ICHIKAWA and NISHIZAWA, 1975). This indicates that the waters off the Malaysian coast are particle rich compared with open waters in the tropical Pacific. This regional variation appears to be related to primary productivity in the euphotic layer.

It is probable that the pattern of vertical profiles recorded in the present study is not stable, and the POC distribution may be strongly affected by the local hydrographic conditions and biological activities. The organic matter of terrestrial origin would also be an important source of POC in coastal waters. The biological activities would include primary productivity of phytoplankton and grazing activity of zooplankton. In the temperate coastal water, NAKAJIMA and NISHIZAWA (1968) observed seasonal cycles of phytoplankton and POC in the Tsugaru Strait between Hokkaido and Honshu in Japan. Weekly observations during the two year study showed that the seasonal variation of POC was closely related to phytoplankton variation. In tropical areas it might be assumed that there are only small changes in phytoplankton production throughout the year. The relative importance of these various factors can not be stated at present. Since our data is still fragmental, further work is needed to describe POC distribution in the entire Malaysian coastal waters. The following topics may be suggested for the next step: (a) more detailed regional and vertical observation, (b) long term seasonal observation of POC (weekly, monthly) at selected fixed oceanographic stations including some biological (phytoplankton and zooplankton), chemical (nutrients, ATP etc.), and physical (water movement, light etc.) characteristics, and (c) estimation of POC movement and transportation.

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