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Characteristics of Neritic Waters along the West Coast of India with Respect to Upwelling, Dissolved Oxygen & Zooplankton Biomass

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Assuming temperature of the water layer at 50 m depth along the shore as an inverse index of upwelling, zooplankton biomass of the pelagic waters off the west coast of India in relation to upwelling intensity is studied. Productive value of upwelling, is reflected in the abundance of biomass of the total zooplankton. At much higher intensity of upwelling, the waters are very much depleted with respect to dissolved oxygen. Temporal and spatial lag of occurrence of zooplankton with upwelling is noticed in the analysis. Upwelling and plankton production take place earlier in the southern part of the coastline than in the northern.

Under the UNDP/FAO Project on pelagic fisheries off the west coast of India regular survey was carried by the Project. In the present study, a few aspects of the waters within the shelf of the west coast with regard to zooplankton biomass, dissolved oxygen concentration and intensity of upwelling were considered. The study was aimed at observing the response of secondary production (zooplankton) to the environmental changes caused by variations of upwelling intensity resulting in changed conditions of dissolved oxygen of the euphotic zone.

Hydrographic conditions[1] from June 1971 to Jan. 1973 pertaining to 4 sections off the coast namely Karwar (14°55'N, 73°10'E-74°05'E), Kasargod (12°30'N, 73°51'E-74°48'E), Cochin (10°N, 75°13'E-76°08'E) and Quilon (8°52'N, 75°30'E-76°25'E) and the average zooplankton biomass distribution[2] over different months from Sept. 1971 to Aug. 1973 for these 4 areas reported earlier, formed the data source for the present analysis.

From the reported[1] vertical sections of dissolved oxygen in different cruises in the study areas, values of dissolved oxygen (DO) of the near shore pelagic waters not exceeding 50 m depth from the surface were chosen and drawn in graphical form to get a smooth annual curve. The values of DO obtained from smoothened out curve for different months of the year were used for analysis.

Upwelling which generally starts from a depth of about 500 m terminates near the surface. The water layer at 50 m depth is assumed to be situated well within the upwelling column. As upwelling intensifies, the temperatures at 50 m depth gets reduced depending on the coolness of the waters below and also on the rate of upward flow. Therefore, the average temperature at 50 m depth at the near shore station about 50 km from shore is considered here as an inverse index of upwelling.

As a result of upwelling, nutrient enrichment of the waters of the euphotic zone takes place thereby enriching the waters with phytoplankton production followed by zooplankton as a chain reaction. Variations of zooplankton with progress of upwelling is presented in Fig.1. There is no ap-

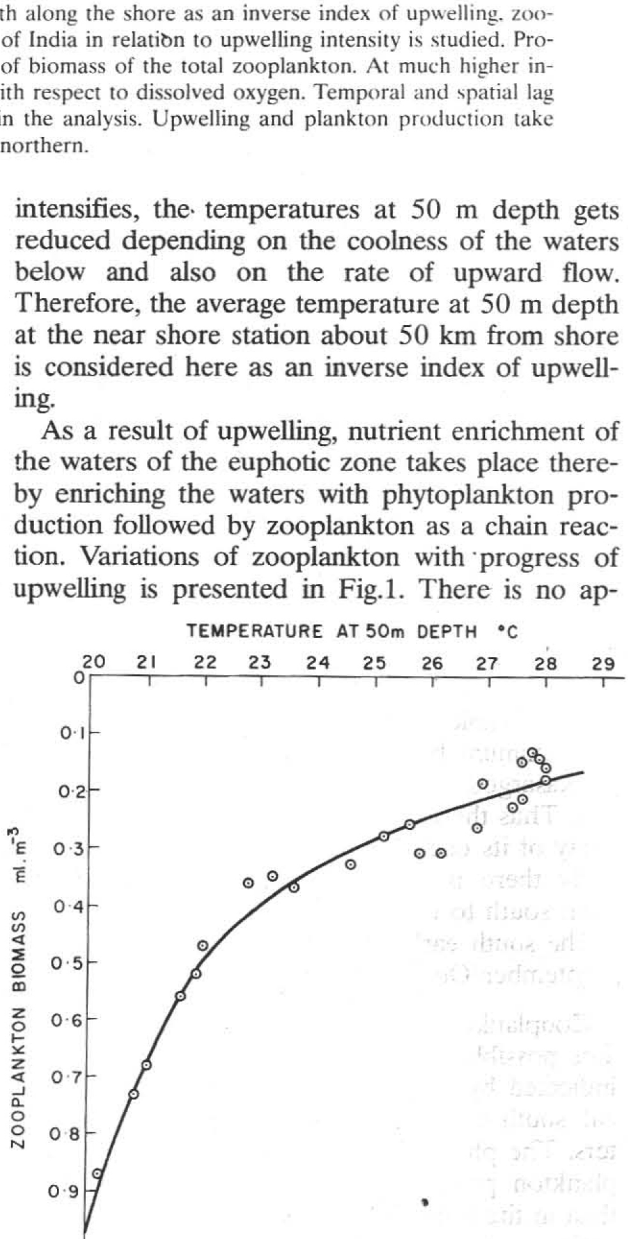

Fig. 1— Relation of zooplankton to temperature at 50 m depth as inverse index of upwelling

preciable change in the zooplankton biomass when the temperature changes are on the higher range beyond 23°C. It is probable that upwelling is effectively initiated in the waters when the 50 m depth layer attains this critical value of temperature. At the peak of upwelling the waters are rich with zooplaknton (1 $ml.m^{-3}$ neritic water).

Fig.2 presents DO content of neritic waters at different densities of zooplankton biomass. From a maximum level of about 5 $ml.l^{-1}$, DO gets depleted to <1.5 $ml.l^{-1}$ as the upwelling advances to its maximum as indicated by the abundant amount of zooplankton. Although the mid-depth waters are enriched with respect to nutrients, as a result of upwelling effect, the depleted condition of waters with respect to DO is likely to affect the composition of zooplankton, which includes fish eggs and larvae found abundant during the upwelling season[3].

The inverse relation between the temperature of the layer at 50 m depth and the zooplankton biomass of the pelagic waters is clearly indicated in the annual variations (Fig.3). It is therefore of interest to study further the impact of upwelling on the plankton biomass of the waters.

The difference between an arbitrarily chosen temperature, 30°C, and the temperature T°C at 50 m depth is treated as a positive index of upwelling for the sake of convenience of expression. The values of the upwelling parameter (30-T)° with the corresponding values of plankton biomass from July to November at the 4 different regions are presented in Table 1 in order to identify the time and place of occurrence of maximum of these parameters in the waters.

From Table 1 it is clear that upwelling attains its maximum by August/September from Quilon to Kasargod and by September/October at Karwar. Thus there is a tendency of about one month delay of its occurrence from south to north. Similarly there is a lag of zooplankton occurrence from south to north, maximum production occurs in the south earlier (August/September) and later (September/October) in the north.

Zooplankton production lags behind upwelling. The possible lead of upwelling by a few weeks is indicated by the tendency of temporal and spatical (south to north) variations of both the parameters. The phase difference between upwelling and plankton production may be more in the north than in the south. However, on an average for the entire west coast (last column, Table 1) both upwelling and zooplankton production attain their maximum values in September.

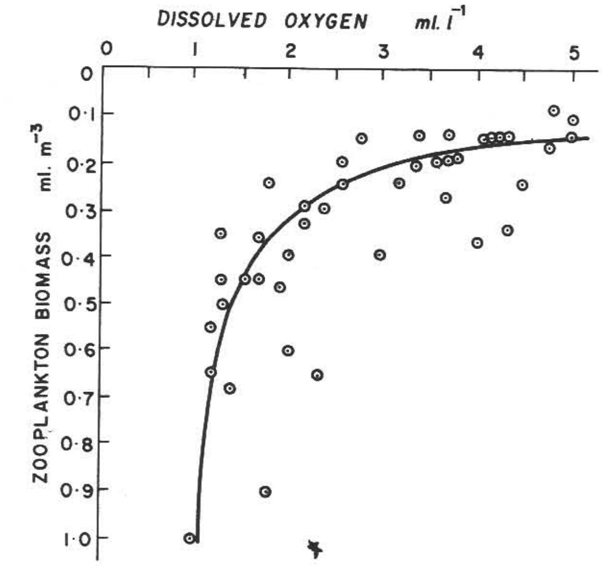

Fig. 2— Relation of zooplankton to dissolved oxygen content

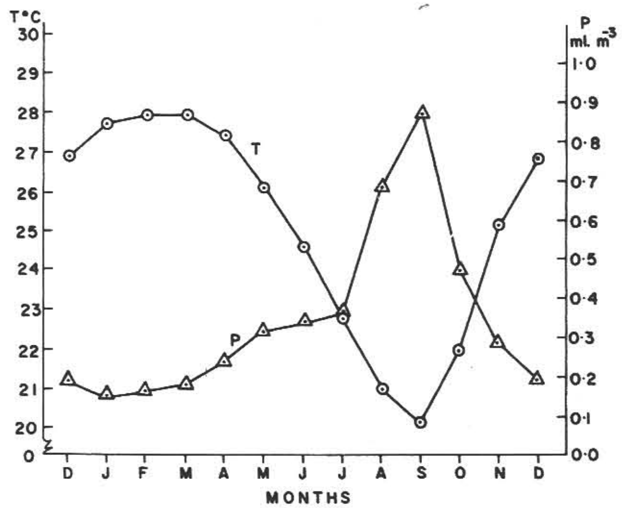

Fig. 3— Annual variations of zooplankton biomass and the upwelling index [Δ zooplankton biomass (P); ⊙, Temperature (T) at 50 m depth, an inverse index of upwelling]

Table 1 — Detection of Maximum Occurrence, in Time and Space, of Upwelling and Zooplankton Production

[Maximum occurrences are marked by vertical lines]

Month	Quion	Cochin	Kasargod	Karwar	Mean
		Upwelling parameter (30-T)°			
July	8.0	7.8	7.0	5.8	7.2
Aug.	9.0	10.0	9.0	8.0	9.0
Sept.	9.0	10.2	10.0	10.0	9.8
Oct.	7.0	7.2	8.5	9.3	8.0
Nov.	3.2	4.2	5.2	5.8	4.8
		Plankton biomass ($P=ml.l^{-3}$)			
July	0.45	0.45	0.30	0.25	0.36
Aug.	0.90	1.00	0.45	0.35	0.68
Sept.	1.22	1.40	0.65	0.55	0.96
Oct.	0.85	0.30	0.50	0.60	0.56
Nov.	0.35	0.20	0.21	0.37	0.28

It is atleast qualitatively proved from observations in the past that the upwelling and the upwelling-induced plankton production influence rigorously the results of bottom trawling[4] and the pelagic fisheries of oil sardine and mackerel[5,6].

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