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New information on the productivity of the deep Eastern Mediterranean and Red Seas

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Introduction and methods: Primary production and plankton biomass were investigated aboard the R.V. Meteor in the winter and summer of 1987. Preliminary results are presented together with much previously unpublished data from earlier cruises into the Red Sea (Table 1).

Chlorophyll a (chl a) in hydrocast samples and primary production by the C 14 method were determined in-situ in the Red Sea but in-situ simulated using Mediterranean water. Zooplankton was collected by stratified sampling using opening-closing nets with mesh sizes of 300 µm (modified Bé net) in the Red Sea and 333 µm (Mocness) in the Mediterranean Sea.

Results. Red Sea: The results, which support earlier findings for November (Khmeleva 1970), show that in February and July, the amount of primary production in the euphotic zone of the southern Red Sea is considerably greater than that in the central part. In March this regional difference is still apparent, but the values for production at all stations were relatively low. The distribution of the phytoplankton biomass, calculated as chl a, generally showed the same pattern. In March, however, there was a greater biomass in the central Red Sea than in the southern part.

A gradual decrease in the average chl a content from 21.8 mg/m^2 in the north to 15.8 mg/m^2 in the south was observed during July in the Sudanese section of the central Red Sea. In contrast, the production values followed the trend for the entire sea and increased to the south from 62 to 83 mgC/m^2.d.

The largest set of data was obtained from the region of the Atlantis II Deep area (A II Deep), which is located in the middle of the open sea section of the Sudan. In March and July, the production remained below 100 mgC/m^2.d, while in June and October, it was obviously greater. The low average for October in Table 1 was computed without including high production figures from two stations, for which there were no data on the Secchi depth. The highest average production, 440.9 mgC/m^2.d, was observed in February 1981, and similarly high values in February 1987 were recorded by Moigis (pers. comm.).

In contrast to the phytoplankton biomass, which showed seasonal variations in the A II Deep area, the biomass of the zooplankton displayed an obvious decrease during the course of the year. Its average value in the upper 1050 m of the water column, in g wet weight per m^2, amounted to 15.6 in February (1981), 10.7 in March, 9.0 in June, about 8 in July, and 5.1 in November (1977). The differences between neighbouring sites were minor. Considering the larger areas of the sea, the zooplankton biomass stocks in the central Red Sea were only half as large as those in the southern Red Sea in March and July.

Eastern Mediterranean Sea: A coursory study of the Levantine basin off the southern coasts of Crete and Cyprus in January 1987 revealed low primary production in the euphotic zone. It ranged between 17.4 and 79.5 mgC/m^2.d. Unlike in the Red Sea, chl a concentrations remained below 0.1 mg/m^3 and were rather uniform throughout the upper 100 m. The zooplankton stock in the upper 1050 m reached about 6 g wet weight per m^2, about 90 % of the stock in the entire 4000 m water column.

Conclusions: The production and biomass data obtained during February and July 1987 fit into the general pattern of biological production in the Red Sea previously proposed by the author (Weikert 1987). Mixing processes promote a high phytoplankton production and support large plankton stocks in the northernmost and southern parts of the sea, at least throughout most of the year. The sharpest gradients of these parameters in the general decrease to the north are apparently located between 17°N and 18°N. Farther to the north, in the central Red Sea, the seasonal destabilization of the water column seems to promote the development of mesotrophic conditions in winter, except perhaps in the Egyptian waters. According to production figures of Khmeleva (1970), these conditions may already develop in November.

Determinations in the Sudanese section of the sea during February 1987 revealed relatively high phytoplankton production and biomass values in the region of the A II Deep (Lenz et al. 1987, Moigis pers. comm). This local increase, which was not observed in July, may have been promoted by a seasonal discontinuity zone in the area.

The annual cycle in the central Red Sea, characterized by production and biomass peaks in winter, resembles that in the Gulf of Aqaba. In contrast, oligotrophic conditions were encountered in the eastern Mediterranean Sea during the winter. However, there are some similarities between these regions, such as the high proportion of picoplankton ($\lessdot$ 2 µm) in the phytoplankton stock. Similarly, more than 85 % of the zooplankton stock was encountered in the upper 1050 m of the water column in both regions. These proportions indicate an effective utilization of energy in the upper water column and only minor losses due to sinking into greater depths.

Approx. Lat.	Northernmost 27°N		Central 25°N		21°N		Southern 15°N-17°N		Depth
	PP	Chl a	PP	Chl a	PP	Chl a	PP	Chl a	(m)
Feb. 1981	-	-	-	-	440.9	23.2	-	-	140
Feb. 1984***	621.3*	73.3*	77.3*	24.3*	132.3*	38.3*	750.9	59.2	160
Mar. 1979	-	-	-	-	47.0	22.4	90.0*	16.8*	150
Jun. 1979	-	-	77.0	27.2	134.0	35.0	-	-	150
Jul. 1987	-	-	-	-	80	17.0	330	21.9	140
Oct. 1980	-	-	85.6	9.4	108.0 195.0**	16.0	-	-	140

Table 1: Regional and seasonal changes in phytoplankton production (PP, mgC/m^2.d) in the euphotic zone and chlorophyll a (Chl a, mg/m^2) at given depths along the central trough of the Red Sea. * Single sample, ** Calculation for the upper 140 m including high production values from two stations. *** From Petzold (1986)

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Microplankton of the Red Sea, the Suez Canal and the Levantine Basin. Some characteristic features and aspects of distribution

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The taxonomic categories considered in this contribution include the whole spectrum of phytoplankton size groups and the major groups of planktonic protozoa as they have been studied over the years in the three environments.

The data analysed are based on the results of past and recent investigations carried out within the framework of national and internationally sponsored research programs. Notably among the latter are the migration of biota through the Suez Canal and the impact of the Aswan High Dam on the Levant Basin of the Mediterranean.

A common feature of the microplankton in the three environments is the presence of a large number of species, particularly among the diatoms and dinoflagellates of the larger phytoplankton, and among the tintinnids of the ciliate protozoans. This seems to fit a basic characteristic of oligotrophic seas, particularly in regard to the areas of the open ocean in the tropics which show a relatively low productivity (Russell-Hunter 1970). In fact, low levels, particularly phosphates and nitrates, chlorophyll a and productivity values as recorded in recent years in the Gulf of Aqaba and in both the inshore and the offshore waters of the Levantine Basin, point to these areas as among the least productive in the world (Levanon-Spanier et al. 1979; Berman et al. 1984; Azov 1986).

The microflora and microfauna of the Suez Canal consists, as expected, of numerous species common both to the Red Sea and the Mediterranean which are able to subsist in a shallow and hyperhaline environments. Our knowledge of the Suez Canal microbiota is limited to diatoms, dinoflagellates and tintinnids.

A number of autochtonous species in the plankton of the Red Sea are not found, so far, in the Levantine Basin, particularly among the dinoflagellates, and phaeodarian radiolarians (Halim 1969). At the same time a number of species of indopacific origin such as the well known commensalic association of Chaetoceros coarctatus with Vorticella microstoma and Ceratium egyptiacum, among others, have made their appearance in the plankton of the Levantine Basin during the past few decades and established stable populations.

Symbiotic and commensalic associations involving diatoms with cyanobacteria, diatoms with ciliates, foraminiferids, radiolarians and acantharians with algal symbionts are a common occurrence in the plankton of both seas. In some cases they may constitute important contributors to the primary productivity of these areas as was the case with Sphaerozoum punctatum which dominated the surface plankton of the Levantine Basin in April 1981. The presence of one or more deep chlorophyll layers has been recorded both in the Red Sea and in the Levantine Basin. These layers are characterised by a high phytoplankton standing crop associated largely with pico and nanoplankton organisms which together constitute over 90% of the total phytoplankton (Kimor et al. 1987).

The shade flare consisting of oligophotic organisms at the base of the photic zone is well represented in the microplankton of both environments but it is not to be confused with the phenomenon of summer submergence of winter epipelagic species which is common to several groups of the marine microbiota, particularly dinoflagellates and tintinnids.

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