

## PLANKTON OF THE RED SEA

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Although two Expeditions have been devoted to the study of the Red Sea, our present knowledge of the plankton is still very unsatisfactory. Much more attention has been given to the hydrography, the benthic fauna, and the fishes, than to the plankton. The Reports of the POLA Expedition to the Red Sea (1895-96; 1897-98) have contributed mainly to our knowledge of the Copepoda, Chaetognatha, Ostracoda and Amphipoda. Detailed accounts of the plankton stations are given by Steuer (1897) and Pesta (1943). The AMNIRAGLIO MAGNAGHI (1923-24) has worked mainly, but not exclusively, in the southern Red Sea (Sanzo, 1930) and the material has been examined for the Euphausiaceae, Mysidacea, Sergestidae, Tomopteridae, Chaetognatha, and planktonic larvae. The VALDIVIA worked several stations in the Red Sea during the German Deep-Sea Expedition to the Indian Ocean (1898-99). Plankton has been collected by the MABAHIS (John Murray Expedition, 1933-34) at only two stations in the central and southern Red Sea. The Reports of the Cambridge Expedition to the Suez Canal include useful observations on the Suez Bay (1924). Much of our knowledge, however, is derived partly or entirely from individual collections made during trips through the Red Sea, in particular for microplankton, medusae and Copepoda. In too many cases the reports present records of the species accompanied only by morphological or systematic observations.

The Red Sea occupies an exceptional position among marine basins. Its peculiar conditions are largely generated by its partial isolation from the open ocean, its geographical position in an arid tropical zone, and the prevailing wind system. This long and narrow basin is connected with the Indian Ocean through the narrow Strait of Bab-el-Mandab at the south. Outside the shallow reef-bound coastal waters, the general depth is about 700 m. but the bottom is irregular and there are depressions whose depths exceed 2000 m. The sill at the southern entrance does not exceed 100 m and consequently the deep water of the Indian Ocean is largely excluded from the Red Sea. Evaporation is active and largely exceeds precipitation so that salinity and temperature are comparatively high. Surface salinity rapidly rises from less than 37‰ at the southern entrance, to 40-41‰ in the northern Red Sea and the Gulf of Aqaba, and to more than 41‰ in the Gulf of Suez.

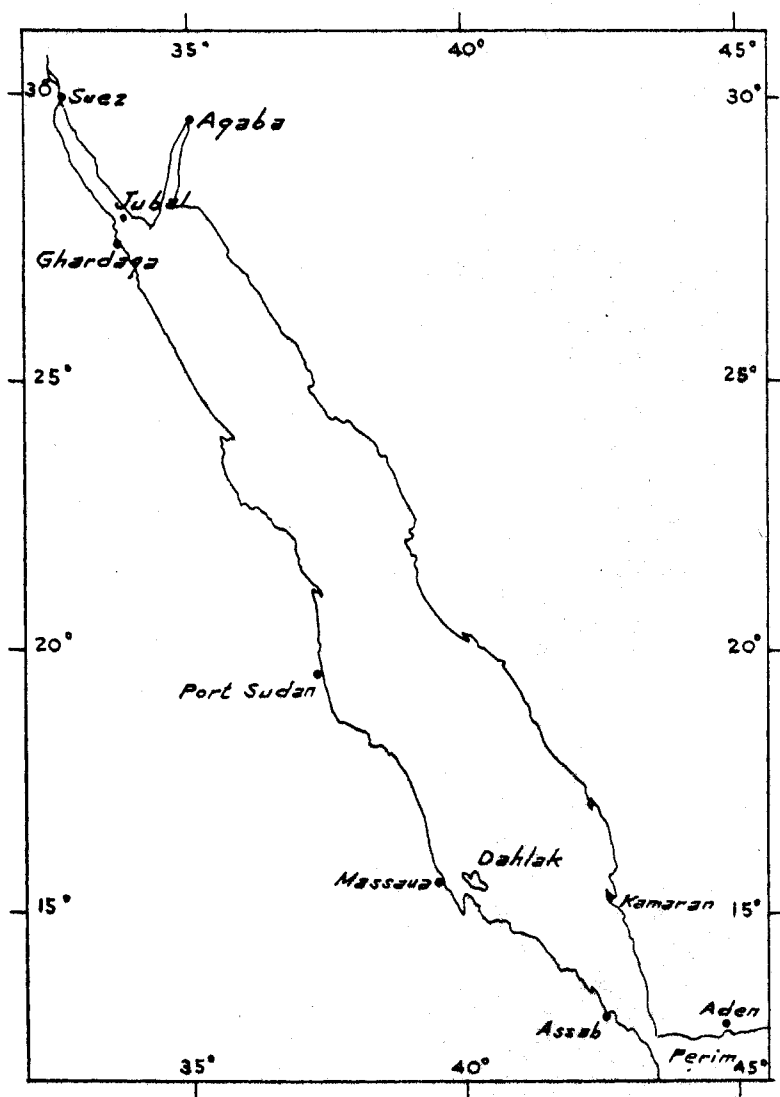


Fig. 1. The Red Sea.

The average surface temperature fluctuates between  $25^{\circ}\text{C}$  and  $32^{\circ}\text{C}$  in the south,  $21.3^{\circ}\text{C}$  and  $27.9^{\circ}\text{C}$  in the northern Red Sea. The Gulf of Suez shows a slightly greater amplitude, from  $17.9^{\circ}\text{C}$  to  $26.5^{\circ}\text{C}$  (Table I). The lower layers from about 300 m downwards, are almost homothermal, near to  $21.7^{\circ}\text{C}$ , except for an adiabatic increase in the deeper waters, and homohaline around  $40.5\text{‰}$ – $40.6\text{‰}$  (Table II). The Red Sea deep waters are warmer than any other marine basin at corresponding levels. A layer of minimum oxygen is present at 300–600 m, with very low values of 0.4–0.6 ml/l at the minimum. The wind system is related to the monsoons of

TABLE I

*Surface temperature of the Red Sea, °C (Morcos, unpublished)*

Lat. N°	28-30	26-28	24-26	22-24	20-22	18-20	16-18	14-16	12-14
Long. E	32-34	33-35	34-36	37-39	38-40	38-40	40-43	42-44	42-44
January	18.4	21.9	22.7	24.8	25.8	26.8	25.7	25.1	24.9
February	17.9	21.3	22.3	24.0	24.9	25.6	25.4	25.1	25.1
August	26.5	27.9	29.1	30.3	30.9	30.7	30.9	31.3	29.2
September	25.7	26.8	28.3	29.8	30.6	30.9	31.7	31.9	30.4

the Indian Ocean. From May to September, the prevailing winds blow consistently from the north-north-west along the entire basin, but during the other half year from October to April, the north-north-west winds reach only as far south as latitude 22° or 21° N.; south of 20° N. south-south-east winds dominate. The surface current flows to the north-north-west into the Red Sea from November to March and to the south-south-east, out of the Red Sea, from June to September. April-May and October seem to be transitional periods. Cross-currents are superimposed on the longitudinal flow (Neumann and McGill, 1962).

The seasonal inflow of the Gulf of Aden surface waters appears to play an important role in the recruitment of pelagic organisms and their diffusion within the Red Sea basin. A considerable proportion, however, of the widespread species in the neighbouring Indian Ocean remains absent from the Red Sea. Many appear only temporarily during the north-west monsoon, or remain restricted to the southern part, the area under direct influence of the Gulf of Aden current. It appears that the peculiar conditions of the Red Sea constitute a barrier to the extension of many species. Stubbings (1939) has correlated the occurrence of large numbers of pteropod shells in the southern part of the Red Sea with the movement of several bodies of water in this area. During the winter season, the inflowing current carries the pteropods into the Red Sea, where they come into contact with warmer and more saline waters which proves fatal to them. Their shells sink down to form the deposit of pteropod ooze which is met with on the north-western side of the sill. The percentage of pteropod shells, at first very small, rises rapidly north of the sill, reaching 8% of the deposit and over 60% of the animal remains. It is likely that the intermixing of the Gulf of Aden with the Red Sea waters is equally fatal to a large number of pelagic organisms. The paucity of the Red Sea plankton compared with that of the Indian Ocean and the gradual decrease in the number of species from the southern Red Sea to the Gulf of Suez are further evidence. It is to be noted, however, that a considerable proportion of the plankton organisms have found a suitable habitat in the Red Sea. The seasonal and geographic distribution of an important part of the Dinoflagellata, Tintinninoidea, Copepoda, and Chaetognatha afford no evidence of a dependence on the southern inflow.

Several species described from the Red Sea are so far unknown from elsewhere, but their number is very small in comparison with the endemic

TABLE II

*Vertical distribution of temperature and salinity in June and November, (Neumann and Densmore, 1959; Dietrich et al., 1966)*

Red Sea						Indian Ocean	
ATLANTIS St. 5640 24 June 1958 22° 37' N. 37° 40' E.			METEOR St. 26 21 Nov. 1964 22° 08' N. 37° 57' E.			METEOR St. 94 17 Dec. 1964 12° 06' N. 48° 43' E.	
Depth (m)	T (°C)	S‰	Depth (m)	T (°C)	S‰	T (°C)	S‰
1	29.40	39.35	0	27.23	39.33	24.66	36.15
30	28.23	39.48	30	27.46	39.43	22.89	35.98
50	—	39.93	50	27.16	39.57	18.24	35.53
75	24.00	40.21	75	25.63	39.84	17.67	35.62
100	23.21	40.39	100	24.35	40.07	15.88	35.51
199	22.09	40.50	200	22.13	40.48	14.09	35.49
398	21.67	40.59	400	21.73	40.58	12.78	35.63
995	21.72	40.62	1000	21.77	40.60	10.84	35.89
1190	21.79	40.65	1200	21.81	40.61	8.42	35.49
1488	21.85	40.62	1300	21.84	40.62	7.42	35.34
1662	21.86	40.65	1392	21.86	40.62	6.52	35.22
1736	21.85	40.59					

forms reported from the benthos, namely, 70% of the crinoids and more than 30% of the decapod crustaceans (Ekman, 1953) but in view of our still imperfect knowledge of the populations of the Arabian Sea and Indian Ocean, it would be too hazardous to admit them as endemic.

## PRODUCTIVITY AND PHYTOPLANKTON

### PRODUCTIVITY

#### *Seasonal variation in the relative fertility*

Very little is known about the productivity of the Red Sea water. The ATLANTIS Cruise 242 made five productivity stations in the Red Sea and several others in the Gulf of Aden and the Indian Ocean in the period from May 16th to June 28th, 1958 (Yentsch and Wood, 1960). Observations on phytoplankton pigments in the western Indian Ocean and the Red Sea were made during ATLANTIS Cruise 8, from July to November 1963, and ATLANTIS Cruise 15, from February to July 1965 (Yentsch, 1965; McGill and Lawson, 1966). The value of these observations is enhanced by the fact that they were taken in the two opposite periods of the year and give the first approximation of the relative fertility of the area.

Total carbon production (Table III) was calculated by Yentsch and Wood (1960) from chlorophyll and light intensity. As Kimble's tables do not extend to this area, the radiation values were computed using total light

## TINTINNOIDEA

Tintinnid species have been recorded from the Red Sea by Cleve (1900) in February, Ostenfeld and Schmidt (1901) in March, May and November, Cleve (1903) in January and October, Jörgensen (1924) from near Djeddah in October, Santucci (1937) from near Massaua in January–May, Komarowsky (1959) from Aqaba in different months, and Komarowsky (1962) from Massaua and the Straits of Tiran. Most of the species mentioned by both Cleve and Ostenfeld and Schmidt are given under obsolete names.

The Red Sea appears to be inhabited by a comparatively large variety of tintinnid species. A list of some 108 species has been established from the above records (Table XIII), while the Mediterranean species recorded by Jörgensen (1924) amount to 90, and the South Pacific species listed by Balech (1962) to 104.

About 31 species are, so far, only known from south of 18° N from the records of Ostenfeld and Schmidt (1901), Cleve (1903), Jörgensen (1924), Santucci (1937) and Komarowsky (1962). Three species are only recorded in winter, namely, *Epiplocylis reticulata* in November and January to May, *Cyttarocylis cassis* only in January, and *Dictyocysta templum* only in February. 39 species seem to be widespread and common since they have been recorded from different localities in the main basin and most of them also extend to the Gulf of Aqaba, the Gulf of Suez or both (Table XIII A).

At least 62% of the Red Sea species are known from the Gulf of Aqaba. Although as many as 34 have not, as yet, been reported from the main basin, all are circumtropical and 42 occur in the Mediterranean.

## SIPHONOPHORA

Practically nothing was known about the siphonophores of the Red Sea prior to the report of Totton (1954) and his records remain the only source on this order. Two dozen species were identified in material collected by the WESTON (1935–36), DISCOVERY (1951), and MANIHINE (1948–49 and 1950–51), from different parts of the Red Sea and the Gulf of Aqaba. All the collections were made in winter (Table XIV).

The Red Sea is considerably poorer in siphonophores than the Indian Ocean: 27 species recorded from the latter basin are absent from the Red Sea. There are probably two reasons for this paucity of the Erythrean fauna, namely: (a) the excluding action of the deep outflow over the sill at the southern entrance of the Red Sea on the deep water species; and (b) the effect of the high (21.5–22°C) minimum temperature of the Red Sea deep water in inhibiting many species (Totton, loc. cit.). Bigelow and Sears (in Totton, loc. cit.) gave an equivalent interpretation for the paucity of the Mediterranean in siphonophores, as compared with the Atlantic. *Halistemma rubrum* in the Mediterranean is known to leave the surface when temperature rises above 21°C and appears, therefore, to live in the Red Sea at its upper limit of temperature tolerance. Such is also the case with *Diphyes dispar*, *D. chamissonis*, *Lensia subtiloides*, *L. subtilis*, *Abylopsis tetragona*, *A. escholtzii*, and *Bassia hassensis*. Additional excluding factors are also the high salinity (40.5–41.0‰) and the very low oxygen content (below 1 ml/l in summer, about 2 ml/l at the end of winter) below sill depth.

TABLE XIV  
Chondrophores and siphonophores taken in the Red Sea  
(after Totton, 1954)

Area of Red Sea	Southern			Central				Northern					
<i>Verella velella</i>	—	—	—	+	—	—	—	—	—	—	—	—	—
<i>Forskalia</i> spp.	+	+	—	+	—	+	+	—	—	—	+	—	—
<i>Nanomia bijuga</i>	+	+	+	+c	—	—	—	—	—	—	—	—	—
<i>Halistemma rubrum</i>	—	—	—	+	—	+	+	—	—	+	+	—	—
<i>Agalma elegans</i>	—	—	—	+	—	—	—	—	—	+	—	—	—
<i>A. okeni</i>	+	+	—	+	—	+	—	—	+	—	L	—	L
<i>Athorybia rosacea</i>	—	—	—	+	—	+	—	—	—	—	+	—	—
<i>Amphicaryon</i> sp.	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Cordagalma cordiformis</i>	—	—	—	—	—	—	—	—	—	—	+c	—	—
<i>Sulculeolaria chuni</i>	+	+	—	+	+	+	+	—	—	—	—	—	—
<i>S. quadrivalvis</i>	+	+c	—	+	—	+	+	—	—	—	—	—	—
<i>Diphyes dispar</i>	—	+	—	2c	—	—	—	—	—	—	—	—	—
<i>D. chamissonis</i>	2	2	2c	2c	2	—	—	—	—	—	—	—	—
<i>Ahylopsis escholtzii</i>	—	—	2	—	—	—	—	—	—	—	—	—	—
<i>A. tetragona</i>	—	—	—	2c	E	2	2	2	2	—	2	—	—
<i>Bassia bassensis</i>	—	—	2	2c	—	E	—	—	—	—	—	—	—
<i>Enneagonum hyalinum</i>	2	2c	—	2c	P	—	—	—	—	—	—	—	—
<i>Lensia campanella</i>	—	—	—	P	—	—	—	—	—	—	—	—	—
<i>L. fowleri</i>	—	—	—	P	—	—	—	—	—	—	—	—	—
<i>L. hotspur</i>	—	—	—	+	—	+	—	2	2	+	2	—	—
<i>L. meteori</i>	—	—	—	P	—	—	—	—	—	—	P	—	—
<i>L. subtilis</i>	—	—	—	P	—	—	—	—	—	—	2c	—	P
<i>L. subtiloides</i>	+	—	2c	+c	—	—	P	—	P	—	—	—	—
<i>Chelophyes contorta</i>	+	—	—	2	P	2	2	2	—	—	2	—	—
<i>Muggiaca atlantica</i>	—	—	—	—	—	—	—	—	—	—	—	—	—
<i>Sphaeronectes</i> sp.	—	—	—	—	—	—	—	—	—	—	—	—	—

present; — = absent; P = polygastric stage; E = eudoxid stage; 2 = both stages; L = larval stage; c = common.  
\* *Stephanomia rubra* in Totton, 1954, p. 12. should be changed into *Halistemma rubrum* (Totton, pers. comm.).