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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 AMMIRAGLIO 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 MABAHISS (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.

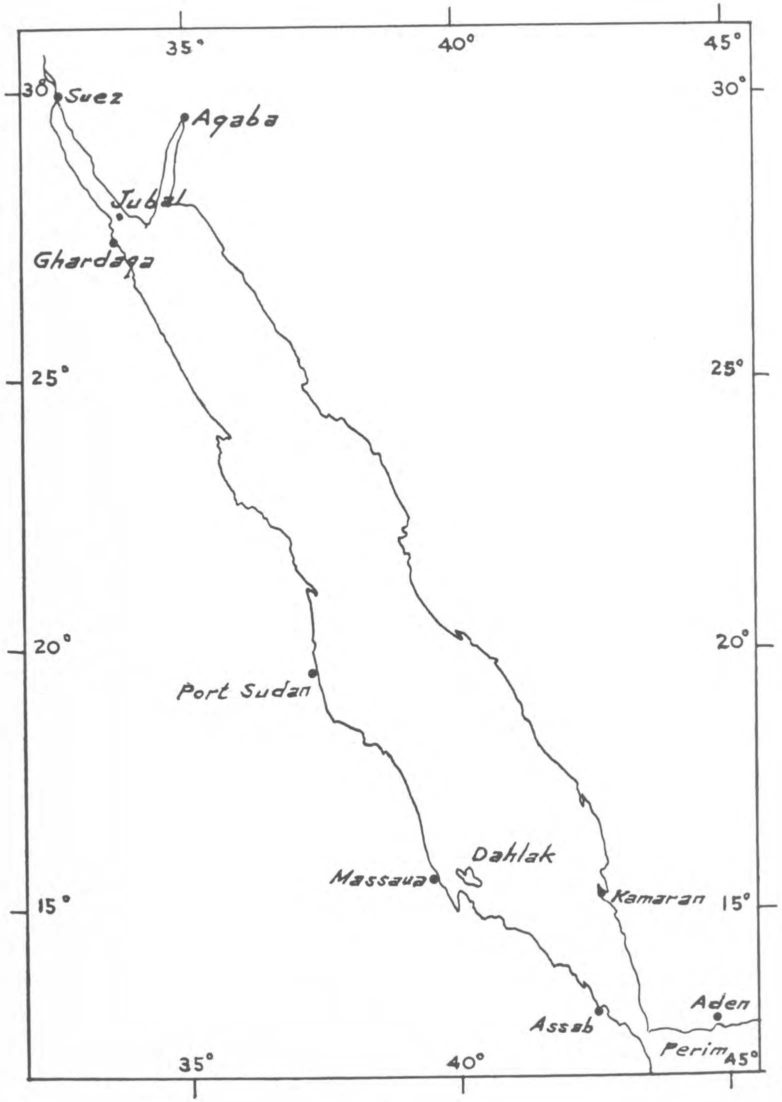


Fig. 1.—The Red Sea.

The average surface temperature fluctuates between 25° C and 32° C in the south, 21·3° C and 27·9° C in the northern Red Sea. The Gulf of Suez shows a slightly greater amplitude, from 17·9° C to 26·5° C (Table I). The lower layers from about 300 m downwards, are almost homothermal, near to 21·7° C, except for an adiabatic increase in the deeper waters, and homohaline around 40·5‰–40·6‰ (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, Tintinnoidea, 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

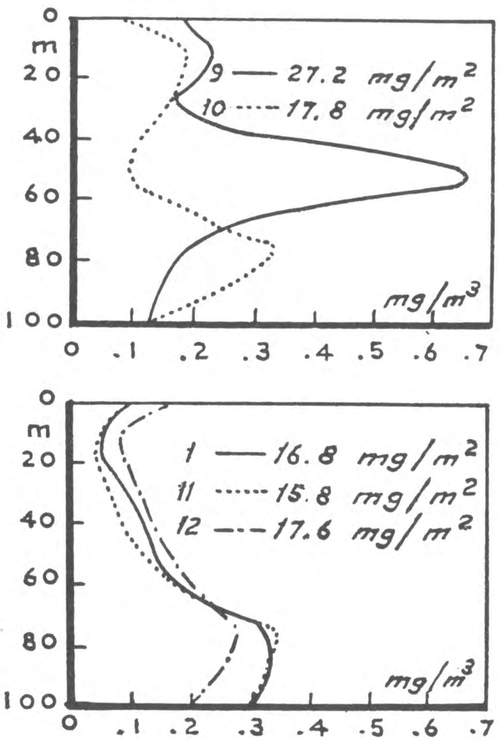
PRODUCTIVITY

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

energy data and an atmospheric transmission coefficient of 0·7. This computation gives values of 500–600 cal. cm^{-2} day^{-1}; Yentsch and Wood (1960) agree that their values for carbon production may be too low for this reason. The chlorophyll profiles of the Red Sea stations of this cruise are given in Figures 2 and 3. They all show a maximum between 50–75 m. Yentsch and Wood (loc. cit.) have interpreted the maximum at this depth as the result of phytoplankton cells sinking from the surface waters. The chlorophyll values are quite low and comparable with other unproductive



Figs 2 (upper) and 3 (lower).—Vertical distribution of chlorophyll in the Red Sea in May–June at Stations 1, 9–12 (Yentsch and Wood, 1960). The figures next to the curves give the concentration of chlorophyll under a square metre of sea surface.

areas of the oceans such as the Sargasso Sea. The Secchi disk disappears at 28–31 m which places the depth of the euphotic zone between 75 and 90 m.

TABLE III

Carbon production in the Red Sea (after Yentsch and Wood, 1960)

Station	Approximate location	Carbon g/m²/day
12	27° 30′ N	0·20
1	25° N	0·16
11	22° N	0·14
10	17° N	0·24
9	15° 30′ N	0·41

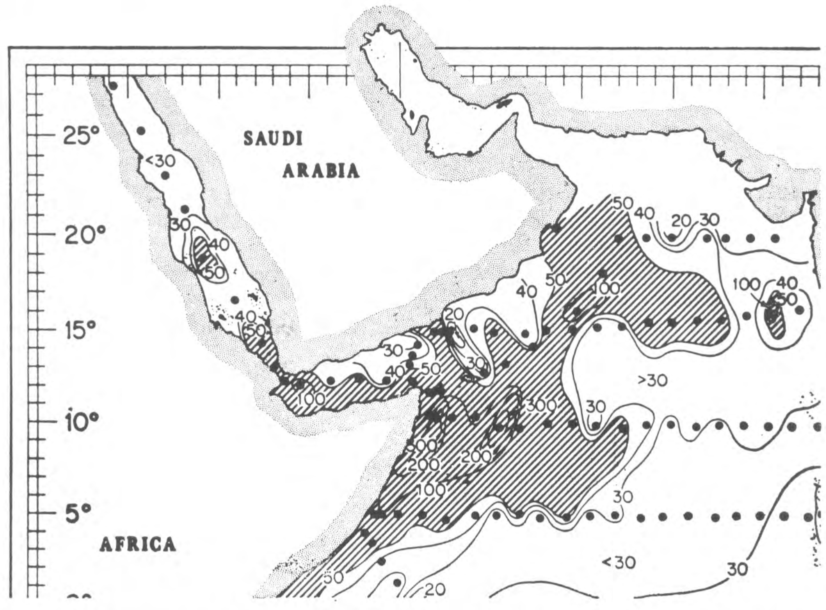


Fig. 4.—Distribution of total pigment concentrations (mg/m²) for 0–200 m during the southwest monsoon period, 1963 (after McGill and Lawson, 1966).

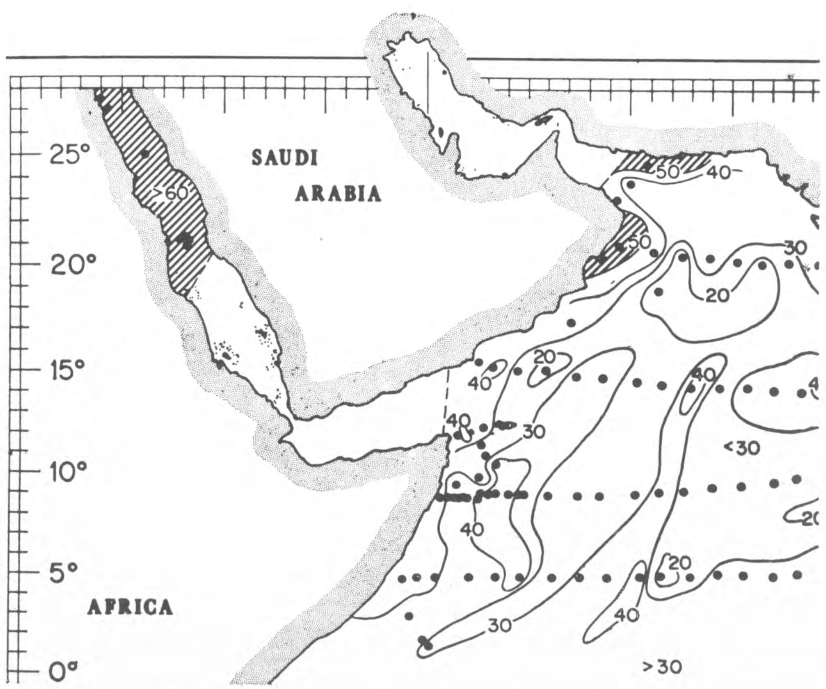


Fig. 5.—Distribution of total pigment concentrations during the northeast monsoon period, 1965 (after McGill and Lawson, 1966).

The integrated total pigment values for 1963 and 1965 are contoured in the distribution pattern shown in Figures 4 and 5. The shaded areas represent values greater than 50 mg/m². The results of the two cruises show a striking seasonal contrast between the two monsoon periods. The 1965 observations, made during the North-east Monsoon, show an increase in the integrated pigment values in the whole area of the Red Sea investigated (north of about 18° N), as opposed to the general decline throughout the North Indian Ocean at the same time. All the Red Sea values ranged between 64·95 and 91·10 mg/m² at 27° 43′ N. (Table IV). During the south-east monsoon period, the situation was reversed. Values higher than 40–50 mg/m² were found only at the southern end of the Red Sea and at one station (18° N), while very high values were observed in the north-western Indian Ocean (Figs 4 and 5). The 1958 values for chlorophyll, made at the end of

Table IV

Phytoplankton pigments at three Red Sea stations (McGill and Lawson, 1966)

Depth	Chlorophyll *a* mg/m³	Phaeophytin mg/m³	Total mg/m³	Pigment mg/m²
	Station 538, Feb. 15th 27° 43′ N, 33° 53′ E			
0	0·55	0·10	0·66	91·10
10	0·80	0·08	0·88	
25	0·14	0·09	0·24	
50	0·27	0·10	0·37	
75	0·29	0·09	0·39	
100	0·38	0·13	0·51	
125	0·34	0·14	0·48	
150	0·30	0·16	0·46	
175	0·32	0·13	0·45	
200	0·38	0·14	0·52	
	Station 539, Feb. 15th 27° 27′ N, 34° 14′ E			
0	0·45	0·10	0·55	70·52
10	0·46	0·10	0·56	
25	0·58	0·13	0·72	
50	0·44	0·11	0·55	
75	0·36	0·09	0·45	
100	0·22	0·07	0·29	
125	0·02	0·20	0·22	
150	0·05	0·14	0·20	
175	0·08	0·02	0·11	
200	0·01	0·06	0·07	
	Station 541, Feb. 17th 21° 17′ N, 38° 00′ E			
0	0·12	0·03	0·15	64·95
10	0·04	0·08	0·12	
25	0·20	0·06	0·26	
50	0·69	0·40	0·09	
75	0·29	0·33	0·62	
100	0·16	0·16	0·32	
125	0·08	0·07	0·15	
150	0·02	0·04	0·06	
175	0·01	0·03	0·04	
200	0·01	0·02	0·03	

the northeast monsoon period (May–June), are low and confirm the conclusions of McGill and Lawson (Table IV), according to whom the high values for 1965 may reflect seasonal blooms. The phytoplankton observations reviewed below show, indeed, a sharp contrast between the two monsoon periods and confirm the pattern obtained from chlorophyll determinations.

PHYTOPLANKTON

Our knowledge of the Red Sea phytoplankton is mainly derived from Cleve (1900, 1903), Ostenfeld and Schmidt (1901), Schröder (1906), Karsten (1907), and Matzenauer (1933) for the main basin (Table V), and Ghazzawi (1936), and Halim and Nassif (in preparation) for Suez waters. Matzenauer

TABLE V

Number of phytoplankton samples taken from the Gulf of Suez, the northern, and southern Red Sea

	Gulf of Suez	Northern Red Sea	Southern Red Sea
January			
Cleve (1903)	2	3	4
Schröder (1906)	0	0	1
February			
Cleve (1900)	0	2	3
March			
Ostenfeld and Schmidt (1901)	0	1	1
April			
Karsten 1907 (3 stations)	0	2	4
May			
Ostenfeld and Schmidt (1901)	0	1	2
August			
Matzenauer (1933)	2	5	6
October			
Cleve (1903)	2	5	6
Schröder (1906)			1
November			
Ostenfeld and Schmidt (1901)	1	2	2

Monthly samples covering one year at Suez: Ghazzawi (1936), Halim and Nassif (in preparation).

(loc. cit.) examined net as well as water samples, but only for dinoflagellates, excluding the genus *Ceratium*. The observations of the earlier authors are based on the examination of a limited number of net samples or net and pump samples (Ostenfeld and Schmidt, 1901). With the exception of Karsten (1907), all were taken from the surface. The Deep-Sea Expedition (Karsten, 1907) made several vertical hauls from 30–15 m to 0 m and from 100 m to the surface: the nomenclature of the species is partly obsolete and has been revised. On the other hand, many species are likely to have been confused since they were only subsequently recognized as separate entities.

Station VI of Ghazzawi (1936) provides a monthly record of the species occurring at Port Tewfik (Suez), with a qualitative estimation of their abundance (July 1934 to July 1935). The quantitative composition of the phytoplankton has been followed at a shallow station (15 m) in the Gulf of Suez from July 1964 to June 1965 (Halim and Nassif, in preparation) *C. egyptiacum* has been described from the Gulf of Suez and the Suez Canal by Halim (1965). It is obvious that present knowledge, particularly with regard to diatoms, is still too scanty to allow for more than tentative conclusions. In addition, it should be borne in mind that most of our information on the Red Sea phytoplankton is of a qualitative nature and concerns the waters of the open deep sea. Conditions in the shallow neritic waters are most probably very different, as suggested by few scattered observations (Santucci, 1937).

Diatoms

The paucity of the diatom population during the warm season is striking (Table VI); 62 species are recorded in November–January–February with a maximum in November, and only 9 in March–May and October (Table X); the records for April are not comparable, since they were taken from vertical hauls. The Gulf of Aden population (Ostenfeld and Schmidt, 1901) was

TABLE VI

Monthly variations in the number of diatoms and dinoflagellate species

	Diatoms	Dinoflagellates		Diatoms	Dinoflagellates
January	32	43	May	1	39
February	31	18	August†	—	62
March	4	22	October	6	40
April*	22	26	November	45	51

* Vertical hauls (Karsten, 1907).
† The genus *Ceratium* is not included (Matzenauer, 1933).

rich in diatoms during March and May, but very poor in October (Cleve, 1903). Although no quantitative observations were made it does not seem that the paucity in species during this period is compensated by any increase in the number of cells. Cleve (1903) remarks on the "almost total absence of diatoms" in October, while dinoflagellates were abundant. Karsten (1907), in his April stations, likewise observed a great paucity in phytoplankton. In January, *Hemidiscus cuneiformis* occurred in massive amounts in the southern Red Sea, imparting a characteristic strong smell to the fresh samples (Cleve, loc. cit). *Striatella delicatula* and *Thalassiosira monile* were abundant in February in the same area. Santucci (1937), in his investigation of the area of Massaua, reports the largest volumes of phytoplankton in January.

In the observations of Ostenfeld and Schmidt (loc. cit.) from the Gulf of Suez as well as from the main Red Sea basin, November appears to be outstandingly rich in diatom species (Talle VI). Ghazzawi (1936) also observed one annual maximum in diatoms at Port Tewfik in November. *Rhizosolenia calcar-avis* occurred in large amounts, followed by *Guinardia flaccida*, *Rhizosolenia shrubsolei* and *R. alata*. Phytoplankton was particularly scanty during March–July. The maximum standing crop of diatoms in Suez Bay was likewise observed in the period from October to January by Halim and Nassif, with values not exceeding 2500–3000 cells/l, and with a minimum from February to May; *Bacillaria paradoxa* and *Thalassionema nitzschioides* were numerically predominant. It appears that, as far as diatoms are concerned, winter is the productive season throughout the Red Sea. This suggests a close dependence on the conditions created by the winter monsoon and conforms to the results of McGill and Lawson (1966) on the relative fertility of the Red Sea in the two monsoon periods (Figures 4 and 5).

Table VII

Diatom species only recorded south of 20° N

Actinoptichus undulatus	*Rhizosolenia setigera*
Biddulphia sinensis	*Stephanopyxis turris*
Chaetoceros neapolitanum	*Streptotheca thamesis*
C. robustum	*Striatella delicatula*
C. schmidti	*Thalassiosira monile*
C. tetrastichon	*Thalassiothrix longissima*
Lauderia annulata	

Three species occurred only in the vertical hauls examined by Karsten, namely, *Coscinosira oestrupii*, *Synedra crystallina*, and the dinoflagellate *Ornithocercus splendidus*. About twelve other species are recorded only from the southern Red Sea, south of 20° N (Table VII).

Dinoflagellates

The Red Sea dinoflagellate populations differ from those of the diatoms in several respects. They are at all times—except in February—more abundant than diatoms (Tables VI and XI) and the total number of species recorded is distinctly greater. On the other hand, the dinoflagellates seem to thrive at the high temperature of the Red Sea summer (29–32° C in the south), while diatoms are almost completely absent. It appears that the Red Sea dinoflagellates constitute an indigenous population which does not depend on the winter monsoon nor on the inflow from the Gulf of Aden, either for recruitment or for nutrient renewal.

The population is entirely tropical but about 20 species are more strictly so and do not occur in the Mediterranean. Several are restricted to the Indo-Pacific tropico-equatorial belt (Table VIII). Matzenauer (1933) gave a list of ten Red Sea species which were completely absent from his Indian Ocean collection. Of these species, only the f. *maris rubri* of *Dinophysis caudata*, the two forms *maris rubri* and *triposoides* of *D. miles*, and possibly *Gymnodinium galeaeformis* are not known as yet from outside the Red Sea; *Pyrodinium schilleri*, a typical tropico-neritic species, is diffused throughout the Red Sea and extends north to Port Said through the Suez Canal (Halim, 1968), but it also occurs in the Persian Gulf (Böhm, 1931, *P. bahamense* f. *compressa*). The other species are more or less widespread and by no means characteristic of the Red Sea. *Ceratium egyptiacum* is to be added to the

Table VIII

Strictly tropical dinoflagellates absent from the Mediterranean

A—Circumtropical species	B—Restricted to the Indo-Pacific Region:
Ceratium breve	*Ceratium dens*
C. deflexum	*C. schmidti?*
C. reflexum	*Ceratocorys bipes*
C. vultur	*Dinophysis miles*
Peridinium africanoides	*Ornithocercus orbiculatus*
P. elegans	*Parahistioneis crateriformis*
P. matzenaueri (= *P. subinerme asymmetricum*)	*Peridinium nipponicum*
	P. orientale
	Pyrodinium schilleri

C—Red Sea only

Ceratium egyptiacum
Dinophysis caudata f. *maris rubri*
D. miles f. *maris rubri*
D. miles f. *triposoides*
Gymnodinium galeaeformis?

preceding endemic forms. It is only known from the Gulf of Suez and the Suez Canal where it is common at all times and seems to be on its way to extend to the neighbouring Mediterranean waters (Halim, 1968).

Thick blooms of the dinoflagellate *Noctiluca miliaris* often occur in the Red Sea, particularly in the warm season (Kullenberg, in Möbius, 1888; Karsten, 1907; Santucci, 1937).

Matzenauer (1933) noticed the gradual disappearance in August of several dinoflagellate species from the area between 25°–20° N. and their reappearance beyond it; these were *Amphisolenia bidentata*, *Exuviella oblonga*, *Gonyaulax turbynei*, *G. minima*, *Peridinium divergens*, *P. inflatum*, *Peridinopsis asymmetrica*, *Pyrocystis pseudonoctiluca*, *Pyrodinium schilleri*. A similar discontinuity in the north–south distribution of planktonic species also appears on examination of the list given by Ostenfeldt and Schmidt (1901) for November (Table IX). A considerable proportion of the diatoms

Table IX*

Number of dinoflagellate, diatom and tintinnid species in the Red Sea in November (from Ostenfeldt and Schmidt, 1901)

Position	*Dinoflagellates*	*Diatoms*	*Tintinnids*
27° 42′ N	31	28	11
25° N	8	0	1
20° N	36	4	8
17° 42′ N	20	6	5
14° N	40	37	11
Gulf of Aden			
12° 20′ N	42	11	12
12° 17′ N	47	19	15

and dinoflagellates found at the entrance of the Gulf of Suez disappear from the northern Red Sea, gradually reappearing south of 20° N. Some examples are: *Bacteriastrum varians*, *Cerataulina compacta*, *Chaetoceros decipiens*, *C. denticulatum*, *C. lorenzianum*, *Climacodium frauenfeldianum*,

* Note: Tables X and XI follow Table XII.

Guinardia flaccida, *Eucampia cornuta*, *E. hemiauloides*, and several others. Among the dinoflagellates may be mentioned: *Dinophysis sphaerica*, *Parahistioneis crateriformis*, *Peridinium divergens*, *P. conicum*. The minimum number of diatoms, tintinnid and dinoflagellate species is invariably located around 25° N.

It is unfortunate that the data given by other authors do not allow one to ascertain whether this discontinuity also occurs at other times of the year and whether it applies to some or to all of the plankton. Matzenauer (1933) attempted to interpret the existence of this plankton-poor area as a result of the pattern of circulation in summer and pointed out that the Gulf of Suez and the southern Red Sea populations are connected by the southward current running along the African coast in summer. This unusual distribution however, still lacks a satisfactory explanation.

Cyanophyceae and others

Discoloration of the Red Sea waters by *Trichodesmium erythraeum* has been reported over a long period (Möbius, 1888). Dense blooms of this characteristic Red Sea alga have been observed by Karsten (1907), Santucci (1937), and several others; Santucci noticed an excluding effect on zooplankton of the blooms of *Trichodesmium*. Other planktonic Cyanophyceae reported are *T. thiebaulti*, *Pelagothrix clevei*, *Oscillatoria* sp., and *Richelia intracellularis*. The heterocont *Halosphaera viridis* is widespread and perennial. *Rhabdosphaera claviger* (Coccolithophoridae) is recorded from the centre (Ostenfeld and Schmidt 1901).

The relative importance of diatoms, Cyanophyceae, dinoflagellates, and other planktonic phytoflagellates, in the productivity of the Red Sea remains to be ascertained.

ZOOPLANKTON

RADIOLARIA

The Radiolaria recorded by Cleve (1900, 1903) are given in Table XII.

TABLE XII

Occurrence of radiolarians

Gulf of Suez:
- *Amphilonche elongata*, October
- *Medusetta inflata*, January

Northern Red Sea:
- *Lithoptera mülleri*, October
- *Triastrum aurivilli*, January

Southern Red Sea:
- *Acanthochiasma krohnii*, October
- *Acanthometron siculum*, October
- *A. quadrifolium*, February
- *Amphilonche elongata*, January
- *A. tetraptera*, October
- *Triastrum aurivillii*, January
- *Diploconus fasces*, February

TABLE X

Diatoms of the Red Sea; monthly variations in composition (for references, see Table V)

	Jan.	Feb.	Mar.	Apr.	May	Aug.	Oct.	Nov.
Actinoptichus								
undulatus								+
Asterolampra								
marylandica		+						
Asteromphalus								
flabellatus	+							
reticulatus	+	+						
Bacteriastrum								
delicatulum		+						+
varians								+
Biddulphia								
sinensis	+						+	+
Cerataulina								
bergoni	+	+						
compacta								+
Chaetoceros								
anastomosans								+
coarctatum	+		+	+			+	+
compacta								
compressum								+
contortus		+						
decipiens								+
denticulatum								+
distans								+
diversus		+						+
exiguus		+						
frauenfeldi		+						
longicruris		+						
lorenzianum	+	+		+				+
messanense	+	+						
neapolitanum	+			+				
peruvianum	+	+		+				
robustum								+
rostratum								+
schmidti								+
schütti		+						+
seychellarum?				+				
sumatranum?				+				
tetrastichon								+
Climacodium								
biconcavum		+						
frauenfeldianum	+	+		+			+	+
Corethron								
cryophilum								+
Coscinodiscus								
anguste-linearis		+						
excentricus				+	+			+
gigas	+						+	+
lineatus				+				
radiatus							+	+
Coscinosira								
oestrupii				+				
Dactyliosolen								
antarcticus								+
hyalinus		+						+
mediterraneus		+						
Eucampia								
cornuta		+						+
hemiauloides								+
Guinardia								
flaccida	+			+				+

TABLE X—*continued*

	Jan.	Feb.	Mar.	Apr.	May	Aug.	Oct.	Nov.
Hemiaulus								
heibergi		+						
Hemidiscus								
cuneiformis	+		+					+
Lauderia								
annulata								+
Leptocylindricus								
danicus		+						
Navicula								
membranacea	+	+						
Nitzschia								
atlantica		+						
longissima	+							
seriata	+							
Planktoniella								
sol	+	+		+				
Rhizosolenia								
alata	+	+		+				+
alata gracillima	+							
alata indica	+						+	+
amputata?	+							
calcar-avis	+							
fragillima?	+			+				
hyalina				+				
imbricata				+				+
quadrijuncta				+				
robusta	+	+						+
schrubsolei	+	+	+					+
semispina			+					
setigera	+			+				+
stolterfothi	+			+				+
styliformis	+	+						+
truncata	+							
Schroderella								
delicatula	+							+
Stephanopyxis								
turris	+							+
Streptotheca								
indica				+				
thamesis	+							+
Striatella								
delicatula		+						+
Synedra								
crystallina				+				
Thalassiosira								
acuta?				+				
monile		+						+
Thalassiothrix								
frauenfeldi								+
longissima		+						+

Recorded in the Gulf of Suez: *Bacillaria paradoxa* and *Thalassionema nitzschioides* (Halim and Nassif).

TABLE XI

Dinoflagellates of the Red Sea; monthly variations in composition (for references, see Table V)

	Jan.	Feb.	Mar.	Apr.	May	Aug.	Oct.	Nov.
Amphidinium								
turbo						+		
Amphisolenia								
bidentata				+	+	+		+
globifera	+						+	
palmata		+						
Blepharocysta								
splendor-maris	+	+	+		+			+
Ceratium								
arietinum				+	+			+
azoricum	+							
belone	+							
breve	+				+			+
candelabrum	+				+		+	
carriense			+		+			+
carriense volans	+	+		+	+		+	+
contortum	+	+			+	+	+	+
contrarium				+				
dens	+				+		+	+
extensum	+		+			+		
furca	+	+	+	+	+		+	+
fusus	+	+	+	+				+
gravidum	+						+	
hexacanthum				+			+	+
incisum				+				
karsteni	+		+	+	+			
limulus					+		+	
lineatum		+			+		+	+
macroceros	+				+		+	+
pentagonum	+							
reflexum					+		+	
schmidti	+						+	
tenue			+					+
trichoceros	+			+	+		+	+
tripos	+	+	+				+	+
vultur	+	+	+	+	+		+	+
Ceratocorys								
bipes	+							
horrida	+			+	+	+	+	+
jourdani					+	+	+	
Cladopyxis								
brachiolata					+			
Dinophysis								
caudata				+		+	+	+
hastata						+	+	
michaelis?			+		+			+
miles	+	+			+	+	+	+
punctata						+		
similis						+		
sphaerica			+	+			+	+
tripos			+					
uracantha						+		
Diplopsalis								
lenticula	+		+		+	+	+	+
saecularis	+				+			+
Exuviella								
compressa	+	+	+		+	+	+	+
oblonga						+		
Goniodoma								
polyedricum	+	+	+	+	+	+	+	+
sphaericum						+		
Gonyaulax								
hyalina						+		
minima						+		
orientalis						+		
ovata						+		
polygramma	+		+		+	+	+	+
spinifera						+		
turbynei						+		
Gymnodinium								
galeaeformis						+		
Noctiluca								
miliaris		+	+					

TABLE XI—*continued*

	Jan.	Feb.	Mar.	Apr.	May	Aug.	Oct.	Nov.
Ornithocercus								
magnificus	+	+	+		+	+		+
orbiculatus						+		
quadratus					+		+	+
splendidus				+				
Oxytoxum								
constrictum								+
gladiolus								+
milneri								+
scolopax								+
sphaericum								+
tesselatum							+	+
Parahistioneis								
crateriformis								+
Peridinium								
abei						+		
africanoides						+		
crassipes						+		
crassipes asymmetricum						+		
conicum						+		
depressum						+		
diabolus							+	
divergens	+		+		+	+	+	+
elegans	+					+	+	+
ellipticum?				+				
inflatum						+		
globulus	+	+		+	+	+	+	+
gracile?				+				
grande				+	+			
leonis						+		
matzenaueri						+		
(= *subinerme asymmetricum*)								
nipponicum						+		
obtusum						+		
oceanicum (+ *obliquum*)	+	+			+	+	+	+
orientale						+		
ovatum						+		
penduncalatum	+		+	+				+
pustulatum?				+				
schutti?				+				
sinaicum						+		
solidicorn						+		
sphaericum						+		
spheroides						+		
steini						+		
subpyriform						+		
tristylum				+	+			+
venustum						+		
Peridiniopsis								
asymmetrica						+		
Phalacroma								
argus	+					+		
cuneus						+		
doryphorum		+	+		+	+	+	+
operculatum				+			+	
porodictyum					+			+
rapa						+		
Podolampas								
bipes	+				+		+	+
palimpes	+				+	+	+	+
Prorocentrum								
gibbosum						+		
gracile								+
micans	+							+
Protoceratium								
reticulatum						+		
Pyrodinium								
schilleri						+		
Pyrophacus								
horologicum	+						+	
Pyrocystis								
ellipsoides						+		
fusiformis			+	+	+			+
hamulus	+							
lunula	+				+			+
pseudonoctiluca	+.	+		+		+	+	+
Spiraulax								
jollifei	+						+	

TABLE XIII

Tintinnids of the Red Sea

References and abbreviations:

C.1: Cleve, 1900.	K.1: Komarowsky, 1958.
C.2: Cleve, 1903.	K.2: Komarowsky, 1962.
O.Sch.: Ostenfeld and Schmidt, 1901.	G.Aq.: Gulf of Aqaba.
Jörg.: Jörgensen, 1924.	G.Sz.: Gulf of Suez.
Sant.: Santucci, 1937.	R.S.: Red Sea.

A. Widespread tintinnid species in the Red Sea.

Species	Localities in the Red Sea.
Amphorella quadrilineata	Common G.Aq.(K.1); 20° N, January (K.2); All R.S., March and November (O.Sch.)
Codonella galea	G.Aq.(K.1); Tiran (K.2); South R.S., May (O.Sch.)
C. olla v. *minor*	G.Aq. (K.1); Tiran (K.2)
Codonellopsis	
eylathensis	G.Aq. (K.1); 23° N (K.2)
C. laciniosa	G.Aq. (K.1); 23° N (K.2)
C. longa	G.Aq. (K.1); 23° N (K.2)
C. morchella	G.Aq. (K.1); G.Sz. and all R.S. in all seasons (C.1, C.2, O.Sch.); Massaua (K. 2) Common
C. orthoceras	Common G.Aq. (K.1); north R.S. and G.Sz. in January (C.2); 23° N, Jan. (K.2)
C. ostenfeldi	G.Sz. in Oct. (C.2); Massaua, Jan–May (Sant.)
Craterella obscura	G.Aq. (K.1); Massaua, Jan.–May (Sant.)
C. urceolata	G.Aq. (K.1); south R.S. in Nov. (O. Sch.)
Coxliella annulata	North R. S., Mar. and May, central R.S. in Nov. (O.Sch.)
Cyttarocylis eucecryphalus	G.Aq. (K.1); Djeddah, 18° N, in Oct. (Jörg.); 23° N in Jan. (K. 2)
C. striata	Throughout main basin in Mar., May and Nov. (O.Sch.)
Dictyocysta pacifica	G.Aq. (K.1); 20° N (K.2), Jan.
Epicancella nervosa	G.Aq. (K.1); Massaua, Jan. (K.2)
Epiorella curta	G.Aq. (K.1); Massaua, Jan. (K.2)
Epiplocylis acuminata	Central R.S. in Jan.–Feb. (C.1, C.2); central and northern R.S. in Oct. (C.2)
E. undella	G.Aq. (K.1); 23° N (K.2)
Eutintinnus fraknoi	Common G.Aq. (K.1); central and south R.S. in Feb. and May (C.1, O.Sch.); 23° N. in Jan. (K.2); G.Sz. and all R.S. in Oct.–Nov. (C.2, O. Sch.); Massaua in Jan.–May (Sant.)
E. lusus-undae	G.Aq. (K.1); G.Sz. in Nov. (O.Sch.); Massaua in Jan.–May (Sant., K.2). Common
E. macilentus	G.Aq. (K.1); Massaua in Jan. (K.2)
Favella azorica	G.Aq. (K.1); Massaua in Jan.–May (Sant., K.2)
Petalotricha ampulla	Common G.Aq. (K.1); G.Sz. in Oct.–Nov. (C.2, O.Sch.); Tiran (K.2); Djeddah in Oct. (Jörg.)
P. major	G.Aq. (K.1); 23° N (K.2)
Protorhabdonella simplex	G.Aq. (K.1); Massaua in Jan. (K.2); all R.S. in Nov. (O.Sch.)
Rhabdonella amor	Common G.Sz. and all R.S. in Oct.–Nov. (C.2, O. Sch.); Massaua and south R.S. in Jan.–May (O.Sch., Sant.)
R. brandti	G.Aq. (K.1); Tiran (K.2)
R. poculum	G. Aq. (K.1); central R.S. in Nov. (O.Sch.); Massaua in Feb. (K.2)

TABLE XIII—*continued*

R. spiralis	Central R.S. in Feb. (C.1); G.Sz. and all R.S. in Nov. O.Sch.); throughout main basin in May (O.Sch.)
R. valdestriata	G.Aq. (K.1); Tiran (K.2)
Salpingella acuminata	G.Aq. (K.1); Tiran (K.2) in Feb.; north R.S. in May, south R.S. in Nov. (O.Sch.)
Steenstrupiella steenstrupii	G.Aq. (K.1); north R.S. in May, G.Sz. Nov. (O. Sch. i.)
Tintinnopsis beroidea	G.Aq. (K.1); Massaua (K.2)
T. beroidea v. *rotundata*	G.Aq. (K.1); Massaua (Sant.)
Undella claparedei	Common G.Sz. and all R.S. in Oct.–Nov., all main basin in Jan.–Feb., Mar. and May (C.1, C.2, O.Sch.); G.Aq. (K.1)
Xistonella treforti	Common G.Aq. (K.1); north R.S. in Mar.; G.Sz. and all R.S. in Nov. (O.Sch.); 23° N in Jan. (K.2); Djeddah in Oct. (Jörg.)

B. Tintinnids recorded only in the Gulf of Aqaba (Komarowsky, 1958)

Amphorella minor	*E. brandti*
Codonella acerca	*E. elegans*
C. perforata	*E. latus*
Coxliella decipiens	*E. medius*
C. fasciata	*Parundella aculeata*
C. meunieri v. *minor*	*P. inflata*
Dadayella bulbosa	*Petalotricha pacifica*
D. ganymedes	*Poroecus curtus*
Epiplocylis atlantica	*Proplectella angustior*
E. blanda	*P. fastigata*
E. exquisita	*P. ostenfeldi*
Eutintinnus apertus	*P. perpusilla*
E. apertus v. *curta*	*P. praelonga*
	P. subangulata
	P. tenuis
	Rhabdonella indica
	Salpingella attenuata
	S. decurtata
	Steenstrupiella gracilis
	S. intumescens
	Xystonella clavata

C. Tintinnids recorded in the south Red Sea near Massaua (Santucci, 1937; Komarowsky, 1962), Djeddah (Jörgensen, 1924), and south of 18° N (Ostenfeld and Schmidt, 1901; Cleve, 1903); (see also section A, this table)

Amphorella amphora	*Rhabdonella elegans*
Codonellopsis erythraensis	*Rhabdonellopsis tritoni* (20° N.)
C. indica	*Tintinnopsis angulata*
C. ostenfeldi	*T. annulata*
C. schabi	*T. bütschli* v. *mortenseni*
Cyttarocylis annulifera	*T. campanula*
Dictyocysta duplex	*T. compressa*
D. reticulata	*T. cyathus*
Epiplocylis brandti	*T. lobiancoi*
E. reticulata	*T. platensis*
Eutintinnus erythraensis	*T. radix*
Favella campanula	*T. tocantinensis*
F. panamensis	*T. tubulosa*
Helicostomella subulata	*Xistonella longicauda*
Metacylis jörgenseni	*X. scandens*
Protorhabdonella curta	

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 XIIIA).

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 bassensis*. 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					
Velella velella	—	—	—	+	—	—	—	—	—	—	—	—	—
Forskalia spp.	+	+	—	+	—	+	+	—	—	—	+	—	—
Nanomia bijuga	+	+	+	+c	—	—	—	—	—	—	—	—	—
Halistemma rubrum	—	—	—	+	—	+	+	+	—	+	+	—	—
Agalma elegans	—	—	—	+	—	—	—	—	—	+	+	—	—
A. okeni	+	+	—	+	—	+	+	+	+	—	L	—	L
Athorybia rosacea	—	—	—	+	—	+	+	—	—	—	+	—	—
Amphicaryon sp.	—	—	—	—	—	—	—	—	—	—	+	—	—
Cordagalma cordiformis	—	—	—	—	—	—	—	—	—	—	+c	—	—
Sulculeolaria chuni	+	+	—	+	+	+	+	+	—	+	+	—	—
S. quadrivalvis	+	+c	—	+	—	+	+	+	—	+	+	—	—
Diphyes dispar	—	+	—	2c	—	—	—	—	—	—	—	—	—
D. chamissonis	2	2	2c	2c	2	—	—	—	—	—	—	—	—
Abylopsis eschscholtzii	—	—	2	—	—	—	—	—	—	—	—	—	—
A. tetragona	—	+	—	2c	E	2	2	2	2	+	2	—	—
Bassia bassensis	—	—	2	2c	—	E	—	—	—	—	—	—	—
Enneagonum hyalinum	2	2c	—	2c	P	—	—	—	—	—	—	—	—
Lensia campanella	—	—	—	P	—	—	—	—	—	—	—	—	—
L. fowleri	—	—	—	P	—	—	—	—	—	—	—	—	—
L. hotspur	—	—	—	+	—	+	+	2	2	+	2	—	—
L. meteori	—	—	—	P	—	—	—	—	—	—	P	—	—
L. subtilis	—	—	—	P	—	—	—	—	—	—	2c	—	P
L. subtiloides	+	+	2c	+c	+	—	P	—	P	—	—	+	—
Chelophyes contorta	+	+	—	2	P	2	2	2	—	+	2	—	—
Muggiaea atlantica	—	—	—	+	—	—	—	—	—	—	—	—	—
Sphaeronectes 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.).

MEDUSAE: SCYPHOMEDUSAE

Since Forskal (1775, in Mayer, 1910), several collections of Scyphomedusae have been made from various localities in the Red Sea: Suez Bay and the Suez Canal (Brown, 1926), El-Tor in the Gulf of Suez (Haeckel, 1879, in Mayer, 1910), Ghardaqa (Crossland, in Stiasny, 1938; Gohar and Eisawy, 1960a, b), the Gulf of Aqaba (Maaden, 1958), Kamaran (Stiasny, 1938, 1939), Suakin (Keller, 1883), Assab (Vanhöffen, 1888, in Stiasny, 1938). Mayer (1910) has reviewed the synonymy of the earlier records. Stiasny

TABLE XV

Scyphomedusans of the Red Sea (Mayer, 1910; Stiasny, 1938, 1939)

Species	Locality	Geographical distribution
Cubomedusae		
Charybdea alata	Kamaran	Not known from Arabian Sea
Rhizostomae		
Cephea cephea	Kamaran, Port Sudan	Widespread Indo-Pacific
Cephea octostyla	East coast of Red Sea	Tropical Pacific
Cotylorhiza erythrea	Assab	
Mastigias gracile	Assab	Red Sea
Cassiopea andromeda	Widespread in Red Sea, Gulf of Aqaba, Gulf of Suez, Bitter Lakes and Lake Timsah	Indo-Pacific
Nitrostoma caerulescens	Gulf of Suez	Arabian Sea, Malay and Philippines
Lorifera lorifera	El-Tor, Ghardaqa Kamaran	Malay Archipelago
Crambionella orsini	Southern Red Sea and Ghardaqa	Arabian Sea but not Gulf of Aden
Rhopilema hispidum	Kamaran, Gulf of Suez	Indo-Pacific but not Arabian Sea
Semaeostomae		
Pelagia noctiluca	Gulf of Suez	Mediterranean, tropical Indian and Atlantic Oceans
Sanderia malayensis	Bay of Suez	Indo-Pacific widespread
Cyanea sp.	Kamaran	Not in Arabian Sea
Aurelia aurita	Diffused in Red Sea, Gulfs of Aqaba and Suez	Cosmopolitan
Coronatae		
Palephrya antiqua	Gulf of Suez	Red Sea
Stauromedusae	none	

(1938) has had access to some of the specimens collected by the earlier authors; from a critical examination of all the previous records and from his own observations, he gives a list of 14 Red Sea Scyphomedusae. Later he (Stiasny, 1939), added the cubomedusan *Charybdea alata* from Kamaran (Table XV).

The scyphomedusan fauna of the Red Sea can by no means be considered to have been the object of a systematic investigation. The appearance of *Cyanea* sp. or *Rhopilema hispidum*, hitherto unknown from the Arabian Sea, together with the absence of common species in the latter area, strongly suggests that any such investigation is likely to give many surprises. The paucity of the Erythrean fauna with regard to the Indian Ocean, will presumably still remain, since no deep-sea Medusae can be expected to penetrate over the shallow sill at Bab-el-Mandab or, if they succeeded in doing so, they can hardly survive the relatively high temperature of the deep Red Sea waters. Such is probably the case with *Periphylla hyacinthina*, recorded in considerable numbers from various localities in the Gulf of Aden, and *Atolla wyvillei* (Stiasny, 1937), but not with the cosmopolitan surface species *Nausithoë punctata*, records of which are to be expected from the Red Sea in the future (Stiasny, 1938). On the other hand, there is no evidence of any immigration through the Suez Canal, as was claimed by Keller (1888). Only two species are common to the Mediterranean, namely, *Pelagia noctiluca* and *Aurelia aurita*. The former is also common in the tropical Atlantic and Indian Oceans, while the latter is almost cosmopolitan. The genus *Cotylhoriza* has very different representatives in both Seas. The species designated by Keller (1888) after Ehrenberg (1837, in Stiasny, 1938) as "*Rhizostoma cuvieri*", has been identified by Stiasny (1938) as *Rhopilema hispidum* and hence gives no grounds for Keller's assertion. The Red Sea scyphomedusan fauna is purely Indo-Pacific in its affinities.

Several species seem to be well established and widespread in the Red Sea. *Cassiopea andromeda* is the most common, being present throughout the main basin and within the southern half of the Suez Canal up to Lake Timsah. Massive occurrences of this medusa are reported from Kamaran, north of Hodeida (Stiasny, 1938), from Suakin and other localities in the southern Red Sea (Keller, 1883), from Massaua (Vanhöffen, 1888, in Stiasny, 1938), from Aqaba (see, Maaden, 1958), Ghardaqa (Stiasny, 1938; Gohar and Eisawy, 1960a,b), from the Bitter Lakes and Lake Timsah in the Suez Canal (Keller, 1883; Brown, 1926; Stiasny, 1938, and several other authors). Its biology and development have been studied at Ghardaqa by Gohar and Eisawy (1960a,b). The two other *Cassiopea* sp. reported from the Red Sea, *C. polypoides* Keller (1883) and *C. picta* Vanhöffen (1888, in Stiasny, 1938), are but synonyms of *C. andromeda* (Stiasny, 1938; Gohar and Eisawy, 1960a).

Both *Aurelia aurita* and *A. maldivensis* are reported from the Red Sea. *A. aurita* is known from Aqaba (Maaden, 1958) and near Djeddah (Ehrenberg, in Stiasny, 1938), and *A. maldivensis* from Perim (Stiasny, 1919), from the southern tip of the Sinai Peninsula in vast shoals (Stiasny, 1935) and in the collection of R.Ph. Dollfuss from the Gulf of Suez (Stiasny, 1938). Undetermined *Aurelia* sp. were particularly abundant near Ghardaqa in June 1964 (personal observation). Examining a number of *Aurelia* sp. from Kamaran, Stiasny (loc. cit.) found characters suggesting *A. aurita*, *A. maldivensis*, *A. colpota*, *A. solida*, and *A. flavidula*, but owing to the bad condition of the material, he recorded them simply as *Aurelia* sp. The systematics of the genus are still not quite clear, but there is strong evidence that the *Aurelia* sp. of the literature are but local varieties of the variable and cosmopolitan *A. aurita* (Stiasny, 1935, 1940; Maaden, 1958). On this basis, *A. aurita* would be the only representative of the genus in the Red Sea.

Crambionella orsini occurs in large numbers round the Island of Kamaran and is also known from Assab and Ghardaqa (Stiasny, 1938, 1939). It is

also recorded in the Gulf of Oman and the Arabian Sea. *Rhopilema hispidum*, reported from Kamaran where at times it is abundant, and from the Gulf of Suez (Stiasny, 1938), was earlier known from the Red Sea under *Rhizostoma corona* and *R. cuvieri* (Forskal, Ehrenberg, Haeckel, in Mayer, 1910). It is widespread in the Indian Ocean. The massive occurrence of both *Crambionella orsini* and *Rhopilema hispidum* round Kamaran coincides every year with the strong southerly winds blowing from October to March (Ziesel, in Stiasny, 1938). Most of the recorded Scyphomedusae of the Red Sea are presumably also driven in by the winter current. Several are reported as single specimens and mostly from the south: *Cephea cephea*, at Kamaran and Port Sudan (Stiasny, 1938), *Charybdea alata* at Kamaran (Stiasny, 1939), *Cotylorhiza erythrea* at Assab (Vanhöffen in Mayer, 1910; Stiasny, 1938), *Cyanea* sp. at Kamaran (Stiasny, 1938) *Lorifera lorifera* at Kamaran, El-Tor and Ghardaqa (Mayer, 1910; Stiasny, 1938). Others, such as *Pelagia notciluca*, *Sanderia malayensis* (Brown, 1926), *Netrostoma coerulescens* (Stiasny, 1938) have reached the Gulf of Suez, although they have, until now, escaped observation in the main basin. The *N. coerulescens* collected by Haeckel from El-Tor and Suez and reported under *Polyrhiza vesiculosa* were later re-examined by Stiasny and ascribed to *Netrostoma coerulescens*. *Palephrya antiqua* Haeckel and *Mastigias gracile* Vanhöffen (in Mayer 1910, for both) are not known outside the Red Sea.

MEDUSAE: HYDROMEDUSAE

Very little is known about the Hydromedusae of the Red Sea. The following list (Table XVI) includes the species recorded by Haeckel, Vanhöffen, Maas (in Mayer, 1910), Keller (1883), and Furnestin (1958). Eight other Hydromedusae have been recorded from neritic waters by Mergner (Mergner,

TABLE XVI

Hydromedusans of the Red Sea

Leptomedusae	
Aequorea pensilis	Widley distributed in the Red Sea and tropical Indo-Pacific. Absent from the Mediterreanean
Gastroblasta timida	Suakin; Red Sea only
Trachymedusae	
Aglaura hemistoma	Red Sea and Gulf of Aqaba Inter-oceanic, Mediterranean
Narcomedusae	
Solmaris forskali	Inter-oceanic
Pegantha aureola	Red Sea, coast of Arabia
Anthomedusae	
Dicodonium cornutum	El-Tor, Gulf of Suez
Phialidium sp.	Gulf of Aqaba

pers. comm.). They are the following: *Bythotiara murrayi*(?), *Obelia* sp., *Aequorea forskalea*, *Geryonia proboscidalis*, *Liriope tetraphylla*, *Rhopalonema velatum*, *R. funerarium*, *Solmaris leucostyla*. Ten neritic species are mentioned by Kramp (1968) from his "Red Sea sub-region" of the Indian Ocean, in which the Gulf of Aden is included. Only two species, *Dicodonium cornutum* and *Aequorea pensilis* are recorded from the Red Sea proper; the remaining eight species are not known from north of Bab-el-Mandab.

OSTRACODA AND CLADOCERA

Graf (1931) reported on the Cypridinidae collected by the POLA Expedition. Ten species are recorded of which four were new. Two ostracod species are mentioned by Scott (1902) and two others by Cleve (1903). The latter author also recorded *Evadne tergestina* from the southern Red Sea, and several

TABLE XVII

Ostracods and cladocerans of the Red Sea
(*Scott, 1902; Cleve, 1903; Gurney, 1927a; Graf, 1931, Santucci, 1937; Komarowsky, 1958*)

Species	Locality and reference	Geographical distribution
Cypridina dorsocurvata	Suez Gulf (Graf)	Red Sea
Halocypris atlantica	Central Red Sea (Scott)	Intertropical
Pyrocypris amphiacantha	Throughout Red Sea, regular 1200–0 m (Graf)	Malay Archipelago
P. chierchiae	16°–24° N (Graf) Gulf of Suez to 22° N (Cleve)	Atlantic and Indian Oceans
P. rivilli	16°–18° N., surface (Graf)	Arabian Sea
P. sinuosa	Perennial, common north of 20° N and in Gulf of Suez (Graf)	Indian Ocean
Philomedes gibbosa	Southern Red Sea (Scott)	Indian Ocean
P. polae	One male specimen, Suez (Graf)	Red Sea
Philomedes sp. (1) and (2)	Gulf of Suez (Graf)	
Asterope arabica	Gulf of Suez (Graf)	Red Sea
A. mariae	Gulf of Suez (Graf)	Red Sea
Euconchoecia chierchiae	October, 15° N, January 16° N. (Cleve)	Gulf of Aden, Arabian Sea
Evadne tergestina	16° N (Cleve); Gulf of Suez and Bitter Lakes (Gurney); Gulf of Aqaba (Komarowsky)	Widespread
Penilia avirostris	Abundant in Gulf of Suez (Gurney); Massaua (Santucci)	Widespread
Podon schmackeri	One specimen, Port Tewfik (Gurney)	Hong Kong

cladocerans from the Gulf of Aden and the Arabian Sea. Three cladocerans are recorded from the Gulf of Suez by Gurney (1926) and one from the Gulf of Aqaba by Komarowsky (1958). 13 Ostracoda in all are so far known from the Red Sea and only three Cladocera (Table XVII).

The ostracod population is pronouncedly Indo-Pacific. *Pyrocypris amphiancantha*, *P. rivilli*, *P. sinuosa*, *Philomedes gibbosa*, and *Euchonchoecia chierchiae* are not known beyond the Indo-Pacific region while *Cypridina dorsocurvata*, *Philomedes polae*, *Asterope arabica*, and *A. mariae* seem to be restricted to the Red Sea from which they have been described by Graf (1931). *Halocypris atlantica* and *Pyrocypris chierchiae* are tropical inter-oceanic.

The Gulf of Suez appears to be inhabited by more ostracod species than the main Red Sea basin, with *Cypridina dorsocurvata*, *Asterope arabica*, *A. mariae*, *Philomedes polae*, and 2 undetermined *Philomedes* sp. (Graf 1931) only known from this Gulf. *Pyrocypris chierchiae* and *P. sinuosa*, occurring in the main basin, also extend to the Gulf of Suez. *Euconchoecia chierchiae* is a perennial species restricted to the southern Red Sea. It has been recorded both in October and January at an average salinity of 37·01‰, but never beyond 15°–16° N. (Cleve, 1903). *Philomedes gibbosa*, *Pyrocypris amphiacantha*, *P. chierchiae* and *P. sinuosa* are widespread in the Red Sea.

The cladoceran *Evadne tergestina* is recorded from the main basin of the Red Sea at 16° N by Cleve (1903), and occurs abundantly in the summer plankton of the Gulf of Aqaba (Komarowsky, 1958). In spite of their high salinity, it is also very abundant in the Bitter Lakes of the Suez Canal, but less so in the Gulf of Suez (Gurney, 1926). *Penilia avirostris* is reported as common in the Gulf of Suez (Gurney loc. cit.) and near Massaua (Santucci, 1937). Both species are inter-oceanic and widespread. Gurney observed also one specimen of *Podon schmackeri* in Port Tewfik (Suez Bay). The species is otherwise only known from Hong Kong.

Several cladocerans occurring in the Gulf of Aden, *Conchoecia magna Microconchoecia clausii*, and *Paraconchoecia oblonga*, are not at present known from the Red Sea.

AMPHIPODA

The report of Spandl (1924), on the results of the POLA Expedition, constitutes the main contribution to knowledge of the pelagic amphipoda of the Red Sea. Cecchini (1930) recorded three species in the collection of the A. MAGNAGHI, namely, *Rhabdosoma whitei*, *Oxycephalus clausi*, and *O. erythraeus*. The first two species are diffused throughout the Red Sea basin, *O. clausi* occurring down to 800–900 m. Barnard (1937) reported *Phronima sedentaria*, *P. atlantica* var. *solitaria*, *Platyscelus inermis*, and *Rhabdosoma whitei* from the southern half of the Red Sea. Spandl (loc. cit.) reports that all the species have been collected from pelagic regions of the Red Sea, while dredging at different depths did not yield a single species.

COPEPODA

More attention has been given to the Copepoda than to any other component of the Red Sea plankton. Cleve (1900, 1903), Giesbrecht (1897), Thompson (1900), Scott (1902), and Thompson and Scott (1903) have examined collections covering the whole basin. Giesbrecht (1891) has given a list of Copepoda collected from Assab and Sciacchitano (1930) one from two stations in the southern Red Sea. Some species are reported by Santucci (1937) from near Massaua. Gurney (1967a) reported on the Copepoda of the Suez Canal and the Bay of Suez, while Steuer (1898) has dealt with the *Sapphirina* collected by the first POLA Expedition to the northern half of the Red Sea (1895–1896) and Pesta (1941, 1943) with the genera *Candacia*, *Calanopia*, *Rhincalanus*, *Euchaeta*, *Centropages*, *Temora*, and *Tortanus* of both POLA Expeditions (1895–96 and 1896–97). The John Murray Expedition did not add to our knowledge of the Red Sea Copepoda but Sewell (1948) has reviewed the copepod population of this basin. Some of his conclusions however, require qualification. With the exception of Pesta (loc. cit.) and Sciacchitano (loc. cit.) all the collections were made from surface waters. Littoral Copepoda in the Gulf of Suez and the Suez Canal have been dealt with by Gurney (1927c) and in Ghardaqa by Nicholls (1944). Except for the planktonic species these results are not included in this review.

A fair picture of the geographical distribution and the seasonal composition may be obtained by comparing the different records, since they were made in different months, thus; January (Cleve, 1903; Thompson and Scott, 1903), February (Cleve, 1900), March (Scott, 1902), April (Thompson and Scott, loc. cit.), May–June (Thompson, 1900), June (Assab only, Giesbrecht, 1891), July–August (Giesbrecht, 1896), October (Gurney, 1927a), January to May (Santucci, 1937). The POLA collections were made through winter and summer.

The Red Sea population is considerably poorer than that of the Indian Ocean. The list in Table XXIV, compiled from the above authors, comprises 158 species. Sewell (1948) admitted only 111*. The peculiar conditions of

TABLE XVIII

Copepods of the Red Sea (after Sewell, 1948)

Region	Total number of indigenous species	Number taken in Red Sea	Percentage
East Pacific	179	78	44%
West Pacific	109	23	21%
Indian Ocean	72	6	8%

temperature and salinity of this Sea constitute a barrier to the extension of at least 112 Indian Ocean species, since this latter basin is known to be inhabited by about 270 species (Sewell, 1948).

A few species seem to have had their origin in the Red Sea and are at present only known from this region: these are, *Acartia fossae* Gurney, *Calanopia media* Gurney, *Candacia samassae* Pesta, *Scolecithrix chelipes* Giesbr., and *Tortanus recticauda* A. Scott. Sewell (loc. cit.) mentioned only *Tortanus recticauda* and *Labidocera orsini* as endemic, but the latter species is also known from the Malay Archipelago (Cleve, 1900).

Table XXIV gives seven Mediterranean species which are still not known from the Indian Ocean. *Eucalanus attenuatus* is recorded from the central and southern, and *Scolecithrix auropecten*, from the southern Red Sea. The presence of the remaining five species, *Acartia dubia*, *A. longiremis*, *Canuella perplexa*, *Metridia lucens*, and *Pseudocalanus elongatus* in the Red Sea is open to doubt since they were collected by indirect pumping while the ship was

* Sewell, apparently, had no knowledge of Cleve's (1900) work and that of Pesta (1941, 1943), since they were not mentioned in his list of references.

passing through the Suez Canal and Gulf (Thompson and Scott, 1903). Besides these and the five endemic forms mentioned above, all Red Sea Copepoda are known to be inhabitants of the Indo-Pacific region but up to 33% are not known from the Mediterranean. According to Sewell (1948), 78 species are common in the East Pacific area, 23 in the west but not the east Pacific and six have not been recorded from east of the Indian Ocean (Table XVIII). The Red Sea appears as an impoverished extension of the Indo-Pacific region. Sewell (loc. cit.) emphasized its dependence on the periodical influx through the southern Straits.

Regional and Seasonal Variations

Distinct variations in the number of species and the composition are observable, both geographically along the north-south axis, and seasonally. The majority of the species, 69%, are recorded from the deeper part of the Red Sea. The southern zone (south of 18° N) is somewhat poorer with 63, while the Gulf of Suez is distinctly so with only about 50% of all Red Sea species. Although the horizontal distribution is not homogenous, an important proportion of the population shows neither regional nor seasonal variation. It constitutes a stock of permanent-indigenous species well adapted to the conditions of the Red Sea (Table XIX). About 50% of the species recorded from the main basin are permanent and diffused throughout. In the Gulf of Suez, the proportion is somewhat reduced (31%).

TABLE XIX

Copepods distributed throughout the main Red Sea basin in all seasons (perennial-indigenous); species marked (*) are also perennial in the Gulf of Suez

*Acartia centrura**	*Euchaeta concinna*
A. erythrea	*E. marina*
A. negligens	*Euterpina acutifrons**
*Acrocalanus gibber**	*Labidocera acuta**
A. gracilis	*L. minuta*
Calanopia elliptica	*Microsetella atlantica**
C. minor	*M. rosea*
Calocalanus pavo	*Oithona plumifera**
Candacia bispinosa	*O. similis**
C. bradyi	*Oncea conifera*
C. catula	*O. media**
C. curta	*O. mediterranea*
Canthocalanus pauper	*O. venusta**
Centropages elongatus	*Paracalanus aculeatus*
C. furcatus	*P. parvus**
C. gracilis	*Pleuromamma abdominalis*
C. orsini	*P. robustus*
C. violaceus	*Pontellopsis krameri*
*Clausocalanus arcuicornis**	*Rhincalanus nasutus*
*C. furcatus**	*Sapphirina nigromaculata*
Clytemnestra scutellata	*S. ovatolanceolata*
Copilia mirabilis	*Setella gracilis**
Corycaeus danae	*Scolecithrix chelipes*
C. gibbulus	*Temora stylifera**
*C. venustus**	*T. discaudata **
Eucalanus subcrassus	*Undinula vulgaris*

Regional and seasonal differences are more apparent in winter. The population reaches its maximum diversity during this season, which is that of the north-east monsoon period and decreases considerably afterwards. This periodical trend is consistent in the three zones. Of all the species recorded from the Suez Gulf, the central-northern Red Sea and the southern Red Sea (south of 18° N), 79%, 93%, and 92% respectively were taken in winter. The summer–autumn population falls to 52% in the Gulf and 62% in the rest of the Red Sea (Table XXB). The monthly records show everywhere a maximum in the number of species in January (Table XXA).

Table XX

Monthly and seasonal variations in the number of copepod species in the Red Sea

A—Monthly

Month	Gulf of Suez	Central and Northern part (north of 18° N)	Southern part (south of 18° N)
January	39	65	66
February-March	33	52	62
April	18	33	26
May–June	19	23	39
August	8	28	—
October	24	33	37

B—Seasonal

Gulf of Suez	Number of species	% of Gulf population
Exclusively winter	37	48·0
Exclusively summer	16	21·5
Perennial	25	31·0
Total	78	100·0
Central and northern Red Sea		% of central and northern population
Exclusively winter	41	38·0
Exclusively summer	6	5·5
Perennial	60	55·0
Total	107	100·0
Southern Red Sea		% of Southern Red Sea population
Exclusively winter	36	36·0
Exclusively summer	7	7·0
Perennial	57	57·0
Total	100	100·0

At least two processes can be responsible for the periodical winter increase in the number of species in all parts of the Red Sea, namely, upward vertical migration and/or, the influx through the Strait of Bab-el-Mandab. The available information on the occurrence of Copepoda in the deeper layers is restricted to a limited number of species (Sciacchitano, 1930; Pesta, 1941, 1943). The importance of seasonal or diurnal vertical movements still remains a matter of conjecture, but it cannot, as was done by Sewell (1948), be totally disregarded. Some at least of the species disappearing from the surface in summer are likely to be found in the cooler deeper layers. *Euchaeta marina*, common in surface waters in winter (Scott, 1902; Cleve, 1903; Thompson and Scott, 1903), was only found at depths of 381–1000 m in October–November (Pesta, 1943). *Candacia bradyi*, a winter surface species, was taken in October only in plankton collected in the early morning or at sunset (Pesta, 1941). The same applies to *Centropages gracilis* and *Rhincalanus nasutus*. It seems certain, however, that the seasonal difference in the number of species is mainly correlated with the current system in the Red Sea basin, and more particularly with the winter inflow through the Strait of Bab-El-Mandab, as already shown by Sewell (1948). A close inspection of the composition in the three zones reveals a well characterized seasonal gradation which is in agreement with the expected distribution.

36 species appear in the southern Red Sea only in the period from January to April–May (Table XXI), of which 16 are restricted to this zone (Table XXIA), while 18 of the remaining species will be carried further north by the northward winter current (Table XXIB), and five of them succeed in penetrating into the Suez Gulf (Table XXIC). Besides the 16 winter species, two Indo-Pacific species seem to be unable to extend beyond this zone, namely, *Labidocera orsini* and *Temora turbinata*, which are recorded only from Assab in June (Giesbrecht, 1891). The coastal pelagic *Oithona nana* is a brackish water species, perennial and particularly abundant in

Table XXI

Winter species, presumably introduced by the surface inflow through the Strait of Bab-el-Mandab

A. Species restricted to the southern Red Sea

Candacia aethiopica	*Rhincalanus cornutus*
C. bispinosa	*Sapphirina gastrica*
C. longimana	*S. maculosa*
C. simplex	*S. scarlata*
Eucalanus crassus	*S. vorax*
E. subtenuis	*Scolecithrix auropecten*
Phaenna spinifera	*S. tenuipes*
Pontella fera	*Xanthocalanus gigas*

B. Species diffused throughout the main Red Sea basin

Acrocalanus longicornis	*Lucicutia flavicornis*
A. monachus	*Mecynocera clausi*
Calocalanus plumulosus	*Oithona minuta*
Clytemnestra rostrata	*O. spinifrons*
Corycaeus gracilicaudatus	*Oncaea notopus*
Eucalanus attenuatus	*Undinula darwini*
E. pileatus	

C. Species extending to the Gulf of Suez

Ectinosoma atlanticum	*Lubbockia squillimana*
E. roseum	*Oncea minuta*
Laophonte inornata?	

the Bitter Lakes and the Gulf of Suez. Records of it from the northern and southern Red Sea are restricted to the summer (Giesbrecht, 1897; Cleve, 1903), possibly as a result of the southward transport prevailing at this season. *Calanopia media* (Massaua, winter; Pesta, 1941) *Labidocera pavo* (Assab; Giesbrecht, 1891), *Schmackeria salina* (Assab; Giesbrecht, loc. cit.) and *Corycaeus robustus* (13° N, 43° E, winter; Cleve, 1900) are recorded in the neritic waters of the southern Red Sea and the Gulf of Suez, but not inbetween.

The majority (65%) of the winter population of the central and northern Red Sea (north of 18° N) is of southern origin. Half the species (Table XXIB,C) are presumably introduced by the inflowing Gulf of Aden winter current, and become distributed throughout the main basin. Six perennial forms in the southern zone also contribute to the winter population of the northern Red Sea, and three of them reach the Gulf of Suez (Table XXIIA).

TABLE XXII

Perennial species progressing northward in winter

A. Perennial in the southern zone, recorded in the northern zone only in winter; (* Gulf of Suez also in winter)	B. Perennial in the main basin, recorded in the Gulf of Suez only in winter.
*Corycaeus catus**	*Acartia erythraeus*
C. lubbocki	*A. negligens*
*C. ovalis**	*Calocalanus pavo*
*C. specious**	*Corycaeus gibbulus*
Nannocalanus minor	*Centropages gracilis*
Pontellina plumata	*Calanopia minor*
	Oithona similis
	Pleuromamma abdominalis

Several other winter species, *Sapphirina metallina*, *S. stellata*, *Candacia samassae*, *Centropages kroyeri*, *Corycaeus carinatus*, *Stenhelia irrasa* and *S. erythrea* have not been recorded elsewhere. With the exception of *Sapphirina metallina*, all are rare or very rare and have only been reported once. Other species restricted to the northern Red Sea are of perennial occurrence, namely, *Corycaeus elongatus*, *C. longistylis*, *Sapphirina auronitens*, *S. bicuspidata*, and *S. lactens*. There is also a single record of *Lubbockia aculeata* in summer. *Acartia clausi*, frequent in the Gulf of Suez and the Suez Canal, extends to the northern and central Red Sea in summer, but does not reach as far south as *Oithona nana*. Although both species are known from the Indian Ocean, their seasonal distribution in the Red Sea suggests a possible Mediterranean origin in this basin.

The distinctive feature of the Gulf of Suez is its paucity and its dependence on the main basin. Only 50% of the perennial-indigenous species of the main basin (Table XX) have been able to establish themselves as such in the Gulf. Eight of the others seem only to be able to extend to the Gulf of Suez in winter (Table XXIIB), while the remaining species have not been recorded there at all. 65% of the winter population (24 species) are derived from the main basin and consist of about equal amounts of perennial and winter forms in the latter, but only five species can be traced back to the southern end. A number of species are, however, only known in the Red Sea from this shallow Gulf. It is not surprising that they should be mostly

cht, 1897
, 1927a.
941.

cies	Locality of record in Red Sea	Reference	Geographical distribution
strömii	Gulf of S.	S.(3)	N. Atlantic
ia tisboid	Central R.S.	S.(3)	Tropical Indo-Pacific
	Gulf of Aqaba	Furnestin (1958)	Mediterranean, cosmopolitan
ninuta	Southern R.S.	S.(2), S.(3)	
atlantica	All main basin	P.(2)	
ps	Central and northern R.S.	S.(4)	Mediterranean, Indian Ocean
	Southern R.S., rare	T.(2)	Indian Ocean
	Rare, central R.S.	S.(4)	Mediterranean, inter-oceanic
ttenuatu	Central and northern R.S.	S.(4)	Indo-Pacific, Mediterranean
	Southern R.S.	S.(3)	Mediterranean, Indian and Atlantic Oceans
	Northern R.S.	S.(4)	Mediterranean, inter-oceanic
us			
	Assab	G.(1)	Mediterranean, Indo-Pacific
	Southern R.S.		
	Central and southern R.S.	S.(3)	
	Central and northern R.S.	S.(4)	
oncinna	Northern and central R.S.	S.(4)	Mediterranean, Indian Ocean
	Central and southern R.S.	T.(2)	Mediterranean, Indian Ocean
	Central R.S.	C.(2)	
	Northern and central R.S.	S.(4)	
	Southern R.S.	C.(2)	Indo-Pacific Atlantic
cutifrons			
	Central and northern R.S.	S.(4)	Mediterranean, Indian Ocean
	Northern R.S.	C.(2)	Indian Ocean
	Southern R.S.	S.(2), S.(3)	Mediterranean, Indian Ocean
a	Assab	G.(1)	Red Sea
	Gulf of S.	G.(2)	
acuta	Southern R.S., rare	T.(2)	Mediterranean, Atlantic Ocean
	Assab	G.(1)	Red Sea
	Northern R.S.	T.(2)	
	Throughout main basin	G.(2)	
	Southern R.S., rare	T.(2)	Gulf of Guinea
	Assab	G.(1)	Mediterranean, inter-oceanic
	Bitter Lakes, Gulf of S. and main Basin	G.(2)	
	Gulf of S. and all R.S.	C.(2), S.(3), T.(2)	
	Central R.S.	S.(3)	
	Central R.S.	S.(3)	
	Gulf of S.	S.(3)	Atlantic, Indian Ocean
	S. Bay	G.(3)	
	Assab	G.(1)	Indo-Pacific
ris	Massaua	S.(1)	
i	Southern R.S.	C.(1), C.(2)	
	Gulf of S. and all R.S.	P.(2), S.(3), T.(2)	
	Bitter Lakes Gulf of S., main basin	G.(2)	
s minor	Southern R.S.	S.(3)	Mediterranean, Ocean
	Gulf of S., central and northern R.S.	T.(1)	
	Gulf of S., all R.S.	C.(2)	
coronata	Assab	G.(1)	Indian Ocean, not in Medit.
	Gulf of S. and northern R.S.	T.(2)	Atlantic, Indo-Pacific, not in Mediterranean
aculeata			
na			
	Assab	G.(1)	Indian Ocean
avicornis	Southern R.S.	P.(2)	
	Gulf of S. and all R.S.	C.(2), P.(2)	Indo-Pacific
	Gulf of S.	G.(3), T.(2)	
la gracil	Assab	G.(1)	Red Sea
	Gulf of S.	T.(1)	Inter-oceanic, not in Mediterranean
a clausi	Southern R.S.	C.(1)	Circumtropical, not in Mediterranean
aumi	S. Canal, southern R.S.	T.(2)	
	Assab	G.(1)	Circumtropical, not in Mediterranean
	Massaua	S.(4)	
cens	Throughout main basin	C.(2), G.(2), S.(3)	
	Gulf of S. and all R.S.	T.(1), T.(2)	
	Southern R.S.	S.(2)	Indian Ocean

References and abbreviations: Cl.(1): Cleve, 1900. Cl.(2): Cleve, 1903. G.(1): Giesbrecht, 1891. G.(2): Giesbrecht G.(3): Gurney, 1 P. (1): Pesta, 194

Species	Locality of record in Red Sea	Reference	Geographical distribution
Acartia centrura	Bitter Lakes and Gulf of S. Gulf of S., common, all S. Canal but not Port Said Northern and central R.S.	G.(2) G.(3) T(2)	Indian and Atlantic Oceans
A. clausi	S. Canal and Port Said Gulf of S., northern and central R.S.	G.(3) T.(1)	Mediterranean and Indian Ocean
A. dubia	S. Canal and northern R.S.	T.(1)	Mediterranean
A. erythrea	Gulf of S. to south R.S. Central and southern R.S. Assab Massaua Throughout main basin	S.(3), T.(2) C.(2) G.(1) S.(1) G.(2)	Indian Ocean
A. fossae	Southern part of S. Canal and S. Bay	G.(3)	Red Sea
A. longiremis	S. Canal and Gulf of S.	T.(2)	Mediterranean
A. negligens	Assab Central R.S. Gulf of S., central and northern R.S. Throughout main basin Gulf of S. to south R.S.	G.(1) C.(2), C.(1) C.(2) G.(2) T.(2), S.(3)	Mediterranean and inter-oceanic
Acrocalanus gibber	Assab Central and southern R.S. Throughout main basin of R.S. Gulf of S. to southern R.S. Gulf of S. and S. Canal	G.(1) C.(2) S.(3) T.(1), T.(2) G.(3)	Circumtropical, not in Mediterranean
A. gracilis	Assab Southern R.S. Central and southern R.S. Throughout main basin Gulf of S., central and northern R.S.	G.(1) C.(1) C.(2) G.(2) T.(2)	Indian Ocean
A. longicornis	Southern R.S. All R.S. and Gulf of S.	C.(1) T.(2)	Indian Ocean
A. monachus	Central R.S. Central and southern R.S.	C.(1) C.(2)	Indian Ocean
A. pedigeri	Central R.S.	C.(2)	Indian Ocean
Aetideus armatus	Gulf of S., rare	T.(2)	Mediterranean, inter-oceanic
Altevtha bopyroides	Northern R.S.	S.(3)	
Calanopia elliptica	Assab S. Canal and Gulf Main basin Gulf of S., central and northern R.S. Gulf of S., all R.S.	G.(1) G.(3) G.(2) T.(1) C.(2), P.(1), S.(3), T.(2)	Indian Ocean
C. media	Gulf of S., southern part of S. Canal Massaua	G.(3) P.(1)	Red Sea
C. minor	Central part Common in main basin Gulf of S. and all R.S.	C.(1) P.(1), S.(3) T.(2)	Indian Ocean
Calocalanus pavo	Assab Central R.S. Gulf of S., central and northern R.S. Gulf of S. and all R.S.	G.(1) C.(1), T.(1) S.(3), T.(2)	Mediterranean, circumtropical
C. plumulosus	All R.S. main basin Gulf of S. and all R.S.	S.(3) T.(2)	Mediterranean, Indian Ocean
Candacia aethiopica	Southern R.S., common	T.(2)	Mediterranean, Indian Ocean
C. bispinosa	Southern R.S. Central R.S.	T.(2) C.(2)	Mediterranean, Indo-Pacific
C. bradyi	Southern R.S. Main basin Gulf of S. and all R.S.	S.(3) T.(2) P.(1)	Indo-Pacific
C. catula	Assab Central part of R.S. Throughout main basin Gulf of S. and all R.S.	C.(1) P.(1), S.(3) G.(2), T.(2) C.(2)	Indo-Pacific
C. curta	Assab Southern R.S. Central and southern part Northern and central parts Throughout main basin	G.(1) T.(2) C.(2) P.(1) G.(2)	Indo-Pacific, South Atlantic
C. longimana	Southern R.S.	T.(2)	Mediterranean and Indian Ocean
C. samassae	Northern R.S., rare	P.(1)	Red Sea
C. simplex	Southern R.S.	T.(2)	Mediterranean and Indian Ocean
C. truncata	Central R.S. Central and southern R.S., Gulf of S. Gulf of S. and all R.S., common	C.(2), S.(3), T.(1) T.(2) P.(1)	Indo-Pacific
Canthocalanus pauper	Gulf of S. Gulf of S. to central R.S. Gulf of S. and all R.S.	C.(2), G.(3) T.(1) S.(3), T.(2)	Mediterranean, Indo-Pacific

Species	Locality of record in Red Sea	Reference	Geographical distribution
Canuella perplexa	S. Canal Port Said, Lake Menzalah, fresh water lagoons	T.(2) G.(3)	Mediterranean, widespread but not in Indian Ocean
Centropages calaninus	Northern R.S. Northern R.S. and Gulf of S.	C.(1), C.(2) S.(3)	Indo-Pacific
C. elongatus	Assab Central part Northern R.S. Throughout main basin	G.(1) S.(3) C.(2), P.(2), T.(2) G.2)	Indian Ocean
C. furcatus	Assab Main basin South and centre Gulf of S. and whole R.S. Gulf of S. and all S. Canal	G.(1) G.(2) T.(2) C.(2), P.(2), S.(3), T.(1) G.(3)	Mediterranean, circumtropical
C. gracilis	Gulf of S. and all R.S. Throughout main basin, surface and deep layers	T.(2) P.(2)	Indian Ocean
C. kroyeri	Northern R.S., rare	P.(2)	Indian Ocean and Mediterranean
C. orsini	Assab Massaua Central part Throughout main basin	G.(1) S.(1) C.(2) G.(2), P.(2), S.(3)	Indian Ocean
C. violaceus	Northern R.S. Gulf of S. and all R.S.	T.(2) T.(1)	Mediterranean and Indian Ocean
Clausocalanus arcuicornis	Southern R.S. Gulf of S. Gulf of S. and all R.S.	C.(1) G.(3) C.(2), T.(2)	Mediterranean, inter-oceanic
C. furcatus	Assab Main basin Centre Gulf of S. and all R.S.	G.(1) G.(2) C.(1) C.(2), T.(2), S.(3)	Mediterranean, circumtropical
Cletodes limicola	Gulf of S.	S.(3)	North Atlantic, Indian Ocean
Clytemnestra rostrata	Central and southern R.S.	T.(2)	Mediterranean, circumtropical
C. scutellata	Assab Main basin G. of Suez, not in S. Canal	G.(1) G.(2), S.(3) G.(3)	Mediterranean, Indo-Pacific
Copilia mirabilis	Assab Southern R.S. Northern R.S. Central R.S. Throughout main basin	G.(1) S.(3) T.(1) C.(1), C.(2) G.(2), T.(2)	Mediterranean, circumtropical
Corycaeus agilis	Throughout main basin	T.(2)	Indian Ocean
C. asiaticus	S. Bay to km 152 in S. Canal	G.(3)	Indo-Pacific
C. carinatus	Northern R.S., rare	T.(2)	Mediterranean and Indian Ocean
C. catus	Southern R.S. Central and southern R.S. Gulf of S. and all R.S.	C.(1) C.(2) T.(2), S.(3)	Mediterranean and Indian Ocean
C. crassiusculus	Southern R.S. Central and southern R.S. Gulf of S. and all R.S.	C.(1) C.(2), T.(2) S.(3)	Mediterranean and Indo-Pacific
C. elongatus	Northern R.S. Northern and central R.S.	C.(2) T.(2)	Mediterranean and Indian Ocean
C. erythraeus	Gulf of S. Bay of S., rarer in S. Canal	C.(2) G.(3)	Indian Ocean
C. gibbulus	Southern R.S. All main basin Gulf of S. and all R.S.	C.(1), T.(1) S.(3) T.(2)	Indo-Pacific
C. longistylis	Central R.S. Central and northern R.S.	T.(1) T.(2)	Indo-Pacific
C. lubbocki	Central and southern R.S. Throughout main basin	C.(2) S.(3)	Indian Ocean
C. medius	Gulf of S. and Canal	C.(3)	Indo-Pacific
C. ovalis	Southern R.S. Central and southern R.S. Southern R.S. and Gulf of S.	T.(2) C.(2) S.(3)	Mediterranean and Indian Ocean
C. robustus	Southern R.S. Gulf of S.	C.(1) 2.(2)	Tropical Indo-Pacific, South Atlantic
C. rostratus	Gulf of S. Gulf of S. and all R.S.	C.(2) T.(1)	Mediterranean, inter-oceanic
C. speciosus	Central R.S. Throughout main basin Gulf of S. and all R.S.	C.(2) T.(2) S.(3)	Mediterranean and Indian Ocean
C. venustus	S. Canal Gulf of S. and all R.S.	T.(2) S.(3), T.(1)	Mediterranean and Indian Ocean

TABLE XXIV

Copepods of the Red Sea

G.(2): Giesbrecht, 1897.
G.(3): Gurney, 1927a.
P. (1): Pesta, 1941.

P. (2): Pesta, 1943.
S.(1): Santucci, 1937.
S.(2): Sciacchitano, 1930.

S.(3) Scott, 1902.
S.(4) Steuer, 1898.
T.(1): Thompson, 1900.

T.(2): Thompson and Scott, 1903.

S.: Suez
R.S.: Red Sea
Southern R.S.: South of 18° N

Species	Locality of record in Red Sea	Reference	Geographical distribution
Dactylopus strömii	South of S.	S.(3)	
Dactylopusia tisboides	S. Canal Gulf of S. Ghardaqa	T.(1), G.(3) S.(3) Nicholls (1944)	Mediterranean, inter-oceanic
Delavalia minuta	Gulf of S. and all R.S.	S.(3)	Indian Ocean
Ectinosoma atlanticum	Gulf of S. and all R.S.	S.(3), T.(2)	Cosmopolitan
E. melaniceps	S. Bay, Lake Menzalah	G.(3)	Mediterranean, Atlantic, Pacific Oceans
E. roseum	Gulf of S. and all R.S.	T.(2)	Mediterranean, Indian Ocean
Eucalanus attenuatus	Southern R.S. Central and southern R.S.	C.(1) T.(2)	Mediterranean, inter-tropical but not in Indian Ocean
E. crassus	Southern R.S.	C.(2), S.(3), T.(2)	Mediterranean, inter-oceanic
E. pileatus	Southern R.S.	T.(2)	Indo-Pacific, Atlantic
E. subcrassus	Assab Massaua Southern R.S. Central and southern R.S. Throughout main basin	G.(1) S.(1) C.(1), T.(2) C.(2) G.(2)	Indian Ocean
Euchaeta concinna	Southern R.S. Central R.S. Throughout main basin	T.(2) C.(2) P.(2)	Indian Ocean
E. marina	Southern R.S. Central and southern R.S. Main basin in deep layers	S.(3), S.(2) C.(2) P.(2)	Mediterranean, Indo-Pacific
Euterpina acutifrons	Northern and central R.S. Assab Gulf of S. and all R.S. Gulf of S. and northern R.S. Main basin, Gulf of S. to Bitter lakes S. Gulf of Canal	C.(2) G.(1) S.(3), T.(2) T.(1) G.(2) G.(3)	Mediterranean, inter-oceanic
Idya furcata	Gulf of S.	S.(3), T.(2)	Mediterranean and Indian Ocean
Labidocera acuta	Assab Massaua Southern R.S. Gulf of S. S. Canal and southern R.S. Throughout main basin	G.(1) S.(1) C.(1), S.(3) C.(2) T.(2) G.(2)	Mediterranean and Indian Ocean
L. minuta	Assab Southern R.S. Gulf of S. and northern and central R.S. S. Bay, S. Canal to Kabrit	G.(1) C.(1), S.(3), T.(2) C.(2) G.(3)	Indo-Pacific
L. orsini	Assab	G.(1)	Indian Ocean
L. pavo	Assab	G.(1)	Indian Ocean
Laophonte brevirostris	Gulf of S. Gulf of S. (one specimen)	C.(2), G.(3) T.(2)	Mediterranean, inter-oceanic
L. herdmani	S. to central R.S.	S.(3)	
L. inornata	S. to central R.S.	S.(3)	Indian Ocean
L. pygmea	Ghardaqa Gulf of S.	Nicholls (1944) S.(3)	Gulf of Guinea.
Lichomolgus minor	Gulf of S. S. Canal S. Bay and S. Canal	S.(3) T.(3) G.(3)	Indian Ocean
Longipedia coronata	Gulf of S. S. Canal S. Bay and S. Canal	S.(3) T.(2) G.(3)	Mediterranean, inter-oceanic
Lubbockia aculeata	Central R.S.	C.(2)	Indo-Pacific
L. squillimana	Gulf of S. and all R.S. Main basin	T.(2) S.(3)	Mediterranean and Indian Ocean
Lucicutia flavicornis	Central R.S. Central and southern R.S. S. Canal to southern R.S.	C.(2) S.(3) T.(3)	Mediterranean, Indian Ocean
Macrosetella gracilis	Massaua	S.(1)	Mediterranean and cosmopolitan
Mecynocera clausi	Throughout main basin	T.(2)	Indo-Pacific
Metis jousseaumi	Gulf of S. S. Canal	S.(3) T.(2)	Atlantic, Indian Oceans
Metridia lucens	Ghardaqa S. Canal	Nicholls (1944) T.(2)	Mediterranean, inter-oceanic

Species	Locality of record in Red Sea	Reference	Geographical distribution
Microsetella atlantica	Assab Central R.S. Gulf of S., northern and central R.S. Gulf of S. and all R.S. Gulf of S., Bitter Lakes and all R.S.	G.(1) C.(1) C.(2) T.(1) G.(2)	Mediterranean, Indo-Pacific
M. norvegica	S. Bay, rare	G.(3)	Cosmopolitan
M. rosea	Central and southern R.S. Gulf of Suez, central and southern R.S.	T.(1) C.(2)	Mediterranean, inter-oceanic
Nannocalanus minor	Central R.S. Gulf of S. and all R.S.	C.(1) T.(2)	Mediterranean, intertropical
Oithona minuta	Main basin	S.(3)	Atlantic, Pacific Oceans
O. nana	Southern R.S. Assab Central and southern R.S. Gulf of S., Bitter Lakes	C.(1) G.(1) C.(2), G.(2) G.(3)	Mediterranean, inter-oceanic
O. plumifera	Assab Massaua Southern R.S. S. Bay, not in Canal Gulf of S. and all R.S.	G.(1) S.(1) C.(1) G.(3) G.(2), S.(3), T.(2)	Mediterranean, inter-oceanic
O. rigida	Assab Throughout main basin	G.(1) G.(2)	Indian Ocean
O. setigera	S. Canal Gulf of S.	T.(2) C.(2)	Mediterranean, Indo-Pacific
O. similis	Central and southern R.S. Gulf of S. Gulf of S. and all R.S.	C.(2) T.(1) S.(3), T.(2)	Mediterranean and Indian Ocean
O. simplex	S. Bay, not in Canal	G.(3)	Indian Ocean
O. spinifrons	Throughout main basin	T.(2)	Mediterranean, Indian Ocean
Oncea conifera	Southern R.S. Central and southern R.S. Gulf of S. and northern R.S.	C.(1), S.(3) C.(2) T.(1)	Mediterranean and Indo-Pacific
O. media	Southern R.S. Northern and central R.S. Gulf of S. and northern R.S. Gulf of S. and all R.S. S. Bay	C.(1) S.(3) T.(2) C.(2) G.(3)	Mediterranean and Indian Ocean
O. mediterranea	Southern R.S. Throughout main basin	C.(1) C.(2), T.(2)	Mediterranean, inter-oceanic
O. minuta	Gulf of S. and all R.S.	T.(2)	Mediterranean and Indian Ocean
O. notopus	S. Canal Main basin	T.(2) S.(3)	Indo-Pacific
O. venusta	Southern R.S. Central and southern R.S. Gulf of S., central and northern R.S. Gulf of S. and all R.S.	C.(1) C.(2) T.(1) S.(3), T.(2)	Mediterranean, inter-oceanic
Paracalanus aculeatus	Assab Southern R.S. Throughout main basin Gulf of S. to central R.S.	G.(1) C.(1), C.(2) G.(2) S.(3)	Mediterranean, inter-tropical
P. crassirostris	S. Bay; all S. Canal	G.(3)	Mediterranean, Southern Atlantic
P. parvus	Northern R.S. Gulf of S. and all R.S. Gulf of S. and all S. Canal	 C.(2), S.(3), T.(2) G.(3)	World wide
Phaenna spinifera	Southern R.S., rare	T.(2)	Mediterranean, Indian Ocean
Pleuromamma abdominalis	Assab Main basin Gulf of S. and all R.S.	G.(1) G.(2) S.(3), T.(1), T.(2)	Mediterranean, inter-oceanic
P. gracilis	Gulf of S. and all R.S.	T.(2)	Mediterranean and Indian Ocean
P. robustus	Central and southern R.S.	C.(2)	Cosmopolitan
Pontella fera	Southern end of R.S.	S.(3)	Indo-Pacific and South Atlantic
Pontellina plumata	Central R.S. All main basin Gulf of S. and all R.S.	C.(1), C.(2) T.(2) S.(3)	Mediterranean, inter-oceanic
Pontellopsis krameri	Assab All main basin	G.(1) G.(2), T.(2)	Indo-Pacific
Pseudocalanus elongatus	Gulf of S. and Canai	T.(2)	Mediterranean, not in Indian Ocean
Pseudodiaptomus salinus	S. Gulf and all S. Canal S. Gulf, S. Canal and northern R.S.	G.(3) T.(2)	Mediterranean, Indian Ocean

Species	Locality of record in Red Sea
Pseudothalestris major	Gulf of S.
Rhincalanus cornutus	Central R.S.
R. nasutus	Gulf of Aqaba Southern R.S. All main basin
Sapphirina bicuspidata	Central and northern R.S.
S. gastrica	Southern R.S., rare
S. iris	Rare, central R.S.
S. lactens	Central and northern R.S.
S. maculosa	Southern R.S.
S. metallina	Northern R.S.
S. nigromaculata	Assab Southern R.S. Central and southern R.S. Central and northern R.S.
S. opalina	Northern and central R.S.
S. ovatolanceolata	Central and southern R.S. Central R.S. Northern and central R.S.
S. scarlata	Southern R.S.
S. sinuicauda	Central and northern R.S.
S. stellata	Northern R.S.
S. vorax	Southern R.S.
Schmackeria salina	Assab Gulf of S.
Scolecithrix auropecten	Southern R.S., rare
S. chelipes	Assab Northern R.S. Throughout main basin
S. tenuipes	Southern R.S., rare
Setella gracilis	Assab Bitter Lakes, Gulf of S. and main Basin Gulf of S. and all R.S.
Stenhelia erythrea	Central R.S.
S. irrasa	Central R.S.
S. normani	Gulf of S. S. Bay
Temora discaudata	Assab Massaua Southern R.S. Gulf of S. and all R.S. Bitter Lakes Gulf of S., main basin
T. stylifera	Southern R.S. Gulf of S., central and northern R.S. Gulf of S., all R.S.
T. turbinata	Assab
Temoropia mayumbaensis	Gulf of S. and northern R.S.
Tortanus barbatus	Assab Southern R.S.
T. gracilis	Gulf of S. and all R.S. Gulf of S.
T. recticauda	Assab
Undeuchaeta major	Gulf of S.
Undinula darwini	Southern R.S. S. Canal, southern R.S.
U. vulgaris	Assab Massaua Throughout main basin Gulf of S. and all R.S.
Xanthocalanus gigas	Southern R.S.

TABLE XXIV
Copepods of the Red Sea

S.(3) Scott, 1902.
S.(4) Steuer, 1898.
T.(1): Thompson, 1900.
T.(2): Thompson and Scott, 1903.

S.: Suez
R.S.: Red Sea
Southern R.S.: South of 18° N

Reference	Geographical distribution
S.(3) T.(1), G.(3)	Mediterranean, inter-oceanic
S.(3) Nicholls (1944)	Indian Ocean
S.(3)	Cosmopolitan
S.(3), T.(2) G.(3)	Mediterranean, Atlantic, Pacific Oceans
T.(2)	Mediterranean, Indian Ocean
C.(1) T.(2)	Mediterranean, inter- tropical but not in Indian Ocean
C.(2), S.(3), T.(2)	Mediterranean, inter-oceanic
T.(2)	Indo-Pacific, Atlantic
G.(1)	Indian Ocean
S.(1) C.(1), T.(2) C.(2) G.(2)	
T.(2)	Indian Ocean
C.(2) P.(2)	
S.(3), S.(2) C.(2)	Mediterranean, Indo-Pacific
P.(2) C.(2) G.(1)	Mediterranean, inter-oceanic
S.(3), T.(2) T.(1) G.(2) G.(3)	
S.(3), T.(2)	Mediterranean and Indian Ocean
G.(1) S.(1)	Mediterranean and Indian Ocean
C.(1), S.(3) C.(2) T.(2) G.(2)	
G.(1)	Indo-Pacific
C.(1), S.(3), T.(2) C.(2)	
G.(3)	
G.(1)	Indian Ocean
G.(1)	Indian Ocean
C.(2), G.(3)	
T.(2)	Mediterranean, inter-oceanic
S.(3)	
S.(3)	Indian Ocean
Nicholls (1944)	
S.(3)	Gulf of Guinea.
S.(3)	Indian Ocean
T.(3) G.(3)	
S.(3) T.(2)	Mediterranean, inter-oceanic
G.(3)	
C.(2)	Indo-Pacific
T.(2) S.(3)	Mediterranean and Indian Ocean
C.(2) S.(3)	Mediterranean, Indian Ocean
T.(3)	
S.(1)	Mediterranean and cosmopolitan
T.(2)	Indo-Pacific
S.(3) T.(2)	Atlantic, Indian Oceans
Nicholls (1944)	
T.(2)	Mediterranean, inter-oceanic

Species	Locality of record in Red Sea	Reference	Geographical distribution
Microsetella atlantica	Assab Central R.S. Gulf of S., northern and central R.S. Gulf of S. and all R.S. Gulf of S., Bitter Lakes and all R.S.	G.(1) C.(1) C.(2) T.(1) G.(2)	Mediterranean, Indo-Pacific
M. norvegica	S. Bay, rare	G.(3)	Cosmopolitan
M. rosea	Central and southern R.S. Gulf of Suez, central and southern R.S.	T.(1) C.(2)	Mediterranean, inter-oceanic
Nannocalanus minor	Central R.S. Gulf of S. and all R.S.	C.(1) T.(2)	Mediterranean, intertropical
Oithona minuta	Main basin	S.(3)	Atlantic, Pacific Oceans
O. nana	Southern R.S. Assab Central and southern R.S. Gulf of S., Bitter Lakes	C.(1) G.(1) C.(2), G.(2) G.(3)	Mediterranean, inter-oceanic
O. plumifera	Assab Massaua Southern R.S. S. Bay, not in Canal Gulf of S. and all R.S.	G.(1) S.(1) C.(1) G.(3) G.(2), S.(3), T.(2)	Mediterranean, inter-oceanic
O. rigida	Assab Throughout main basin	G.(1) G.(2)	Indian Ocean
O. setigera	S. Canal Gulf of S.	T.(2) C.(2)	Mediterranean, Indo-Pacific
O. similis	Central and southern R.S. Gulf of S. Gulf of S. and all R.S.	C.(2) T.(1) S.(3), T.(2)	Mediterranean and Indian Ocean
O. simplex	S. Bay, not in Canal	G.(3)	Indian Ocean
O. spinifrons	Throughout main basin	T.(2)	Mediterranean, Indian Ocean
Oncea conifera	Southern R.S. Central and southern R.S. Gulf of S. and northern R.S.	C.(1), S.(3) C.(2) T.(1)	Mediterranean and Indo-Pacific
O. media	Southern R.S. Northern and central R.S. Gulf of S. and northern R.S. Gulf of S. and all R.S. S. Bay	C.(1) S.(3) T.(2) C.(2) G.(3)	Mediterranean and Indian Ocean
O. mediterranea	Southern R.S. Throughout main basin	C.(1) C.(2), T.(2)	Mediterranean, inter-oceanic
O. minuta	Gulf of S. and all R.S.	T.(2)	Mediterranean and Indian Ocean
O. notopus	S. Canal Main basin	T.(2) S.(3)	Indo-Pacific
O. venusta	Southern R.S. Central and southern R.S. Gulf of S., central and northern R.S. Gulf of S. and all R.S.	C.(1) C.(2) T.(1) S.(3), T.(2)	Mediterranean, inter-oceanic
Paracalanus aculeatus	Assab Southern R.S. Throughout main basin Gulf of S. to central R.S.	G.(1) C.(1), C.(2) G.(2) S.(3)	Mediterranean, inter-tropical
P. crassirostris	S. Bay; all S. Canal	G.(3)	Mediterranean, Southern Atlantic
P. parvus	Northern R.S. Gulf of S. and all R.S.	C.(2), S.(3), T.(2)	World wide
Phaenna spinifera	Gulf of S. and all S. Canal Southern R.S., rare	G.(3) T.(2)	Mediterranean, Indian Ocean
Pleuromamma abdominalis	Assab Main basin Gulf of S. and all R.S.	G.(1) G.(2) S.(3), T.(1), T.(2)	Mediterranean, inter-oceanic
P. gracilis	Gulf of S. and all R.S.	T.(2)	Mediterranean and Indian Ocean
P. robustus	Central and southern R.S.	C.(2)	Cosmopolitan
Pontella fera	Southern end of R.S.	S.(3)	Indo-Pacific and South Atlantic
Pontellina plumata	Central R.S. All main basin Gulf of S. and all R.S.	C.(1), C.(2) T.(2) S.(3)	Mediterranean, inter-oceanic
Pontellopsis krameri	Assab All main basin Gulf of S. and Canai	G.(1) G.(2), T.(2) T.(2)	Indo-Pacific
Pseudocalanus elongatus	S. Gulf and all S. Canal	G.(3)	Mediterranean, not in Indian Ocean
Pseudodiaptomus salinus	S. Gulf, S. Canal and northern R.S.	T.(2)	Mediterranean, Indian Ocean

Species	Locality of record in Red Sea	Reference	Geographical distribution
Pseudothalestris major	Gulf of S.	S.(3)	N. Atlantic
Rhincalanus cornutus	Central R.S.	S.(3)	Tropical Indo-Pacific
R. nasutus	Gulf of Aqaba Southern R.S. All main basin	Furnestin (1958) S.(2), S.(3) P.(2)	Mediterranean, cosmopolitan
Sapphirina bicuspidata	Central and northern R.S.	S.(4)	Mediterranean, Indian Ocean
S. gastrica	Southern R.S., rare	T.(2)	Indian Ocean
S. iris	Rare, central R.S.	S.(4)	Mediterranean, inter-oceanic
S. lactens	Central and northern R.S.	S.(4)	Indo-Pacific, Mediterranean
S. maculosa	Southern R.S.	S.(3)	Mediterranean, Indian and Atlantic Oceans
S. metallina	Northern R.S.	S.(4)	Mediterranean, inter-oceanic
S. nigromaculata	Assab Southern R.S. Central and southern R.S. Central and northern R.S.	G.(1) S.(3) S.(4)	Mediterranean, Indo-Pacific
S. opalina	Northern and central R.S.	S.(4)	Mediterranean, Indian Ocean
S. ovatolanceolata	Central and southern R.S. Central R.S. Northern and central R.S.	T.(2) C.(2) S.(4)	Mediterranean, Indian Ocean
S. scarlata	Southern R.S.	C.(2)	Indo-Pacific Atlantic
S. sinuicauda	Central and northern R.S.	S.(4)	Mediterranean, Indian Ocean
S. stellata	Northern R.S.	C.(2)	Indian Ocean
S. vorax	Southern R.S.	S.(2), S.(3)	Mediterranean, Indian Ocean
Schmackeria salina	Assab Gulf of S.	G.(1) G.(2)	Red Sea
Scolecithrix auropecten	Southern R.S., rare	T.(2)	Mediterranean, Atlantic Ocean
S. chelipes	Assab Northern R.S. Throughout main basin	G.(1) T.(2) G.(2)	Red Sea
S. tenuipes	Southern R.S., rare	T.(2)	Gulf of Guinea
Setella gracilis	Assab Bitter Lakes, Gulf of S. and main Basin Gulf of S. and all R.S.	G.(1) G.(2) C.(2), S.(3), T.(2)	Mediterranean, inter-oceanic
Stenhelia erythrea	Central R.S.	S.(3)	
S. irrasa	Central R.S.	S.(3)	
S. normani	Gulf of S. S. Bay	S.(3) G.(3)	Atlantic, Indian Ocean
Temora discaudata	Assab Massaua Southern R.S. Gulf of S. and all R.S. Bitter Lakes Gulf of S., main basin	G.(1) S.(1) C.(1), C.(2) P.(2), S.(3), T.(2) G.(2)	Indo-Pacific
T. stylifera	Southern R.S. Gulf of S., central and northern R.S. Gulf of S., all R.S.	S.(3) T.(1) C.(2)	Mediterranean, Ocean
T. turbinata	Assab	G.(1)	Indian Ocean, not in Medit.
Temoropia mayumbaensis	Gulf of S. and northern R.S.	T.(2)	Atlantic, Indo-Pacific, not in Mediter- ranean
Tortanus barbatus	Assab Southern R.S.	G.(1) P.(2)	Indian Ocean
T. gracilis	Gulf of S. and all R.S. Gulf of S.	C.(2), P.(2) G.(3), T.(2)	Indo-Pacific
T. recticauda	Assab	G.(1)	Red Sea
Undeuchaeta major	Gulf of S.	T.(1)	Inter-oceanic, not in Mediterranean
Undinula darwini	Southern R.S. S. Canal, southern R.S.	C.(1) T.(2)	Circumtropical, not in Mediterranean
U. vulgaris	Assab Massaua Throughout main basin Gulf of S. and all R.S.	G.(1) S.(4) C.(2), G.(2), S.(3) T.(1), T.(2)	Circumtropical, not in Mediterranean
Xanthocalanus gigas	Southern R.S.	S.(2)	Indian Ocean

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littoral forms, obtained by continuous filtration of pumped water, while the ship is passing through the Suez Canal and the Suez Gulf (Thompson and Scott, 1903) or by sampling nearshore plankton (Gurney, 1927a) (Table XXIII). They are, in fact, more characteristic of the inshore waters of the Bay of Suez and the Suez Canal, than of the Gulf waters.

TABLE XXIII

Species recorded only from the Gulf of Suez (Suez Bay)

A. Recorded in winter	B. Recorded in summer
Aetideus armatus	*Corycaeus asiaticus*
Oithona setigera	*C. erythraeus*
Laophonte brevirostris	*Microsetella norvegica*
L. pygmea	*Paracalanus crassirostris*
Longipedia coronata	*Undeuchaeta maior*
Cletodes limicola	
Dactylopusia tisboides	
Dactylopus stromii	
Pseudothalestris major	
Lichomolgus minor	
Idya furcata	
Metis jusseaumi	

EUPHAUSIACEAE AND MYSIDACEAE

The euphausiid population of the Red Sea represents only about 31% of the species known from the Indo-Pacific region. Torelli (1934), Tattersall (1938) and Ponomareva (1968) have recorded 14 species in all from the main basin, but no euphausiids are known from either the Gulf of Suez or the Suez Canal (Table XXV).

Four species, *Euphausia diomediae*, *E. distinguenda*, *Stylocheiron affine*, and *S. armatum* are predominant but several others are widely distributed from the Strait of Bab-el-Mandab to the Strait of Jubal namely *Euphausia diomediae*, *E. messanensis*, *E. sanzoi*, *Stylocheiron armatum*, and *S. abbreviatum*. *Stylocheiron affine* and *Euphausia distinguenda* only extend to the middle of the Red Sea while *Pseudeuphausia latifrons* appears to be restricted to the southern end. *P. colosii* and *Euphausia gibboides* are less common.

With the exception of *Euphausia messanensis*, the population of the Red Sea is entirely derived from the Indian Ocean. The two endemic species, *E. sanzoi* and *Pseudeuphausia colosii* are very similar to *Euphausia gibboides* and *Pseudeuphausia latifrons*, from which they might have evolved as a result of isolation (Ponomareva, 1968). *E. messanensis*, other than in the Red Sea, is only known from the Strait of Messina. There is no evidence, however, of its passage—nor indeed of any other euphausiid—through the Suez Canal. According to Ponomareva, the species does not occur in the Red Sea, and its mention by Torelli (1934) results from a confusion with *E. gibboides*.

Six species occurring in the Gulf of Aden (Torelli, 1934), seem to have been unable to penetrate into the Red Sea: *Thysanopoda orientalis*, *T. monacantha*, *T. acutifrons*, *Nematoscelis gracilis*, *Stylocheiron suhmii*, and *S. longicorne*. All of them being bathypelagic, it is likely that they have been prevented by the shallow sill at the Strait of Bab-el-Mandab from penetrating into the Red Sea.

TABLE XXV

Euphausiaceae of the Red Sea (Torelli, 1934; Tattersall, 1938; Ponomareva, 1968)

Species	Abundance and references	Occurrence in Red Sea	Geographic distribution
Euphausia diomediae	Numerous specimens (Torelli; Tattersall; Ponomareva)	Diffused throughout, mainly bathypelagic (1000–0 m)	Widespread tropical Indo-Pacific
E. distinguenda	Numerous specimens (Torelli; Ponomareva)	Southern half (one specimen from Strait of Jubal); 1000–400 m (Torelli)	Widespread tropical Indo-Pacific
E. gibboides	(Tattersall)	500–0 m, 18° N	Indian Ocean
E. messanensis	24 specimens (Torelli)	Diffused, bathypelagic (1000–400 m)	Strait of Messina (Mediterranean) only
E. sanzoi	(Ponomareva; Torelli: 39 specimens)	Diffused, bathypelagic (1200–200 m)	Red Sea only
Pseudeuphausia latifrons	36 specimens (Torelli)	Records restricted to area south of 14° N (582–0 m)	Indian Ocean
P. colosii	Rare (Torelli; Ponomareva)	Middle part (150–0 m)	Red Sea only
Stylocheiron armatum	97 specimens (Torelli)	Diffused (800–0 m)	Tropical Atlantic (Caribbean Sea) and Indian Oceans
S. abbreviatum	(Torelli: 74 specimens; Tattersall; Ponomareva)	Diffused (1000–0 m)	Mediterranean; inter-oceanic
S. affine	(Torelli: 100 specimens; Ponomareva)	Not recorded north of 23° N; 1000–50 m. (Torelli)	Inter-oceanic

Recorded by Ponomareva without indication of location: *Euphausia brevis*, *E. mutica*, *Stylocheiron carinatum* (relatively abundant), *S. elongatum*.

The Mysidaceae collected by the A. MAGNAGHI have been examined by Colosi (1924, 1930, 1934, all in Santucci, 1937) and Coifman (1937).

SERGESTIDAE

Cecchini (1933) found seven sergestid species in the material collected by the A. MAGNAGHI at 16 stations extending from Bab-el-Mandab to the entrance of the Gulf of Suez (October 1923 to May 1924). Three types of *Mastigopus* were also found and described. *Sergestes orientalis* is distributed throughout the Red Sea, from the surface to a depth of 1200 m, but it is less abundant than in the Gulf of Aden; 23 specimens in all were collected. *Leucifer hanseni* only occurred at three southern stations but it was particularly abundant at 15° N (Umm-es-Shahrig). Five *L. faxoni* were taken in surface hauls at the southern end of the Red Sea (14° 47′ N) and in the Strait of Bab-el-Mandab, while in the Gulf of Aden it was only found in

vertical hauls. One *Sicyonella maldivensis* was collected at 15° 13′ N and two *Sergestes colosii* at 20° 47′ N. *Leucifer orientalis* and *L. typus* are present in the Gulf of Aden and within the Strait of Bab-el-Mandab, but both are absent from the Red Sea proper. From the number of individuals caught, *L. hanseni* appears to be the most abundant sergestid in the Red Sea, followed by *L. orientalis* and *Sergestes orientalis*. The other species are represented by only few individuals in the catches.

TABLE XXVI

Sergestids of the Red Sea (Cecchini, 1933)

Species and locality	Remarks	Species and locality	Remarks
Sergestes orientalis		*Leucifer hanseni*	
12° 36′ N		15° 6′	
Off Ras Dumeira		NE of Umm-es-Shahrig	surface
18° 27′ N		18° 27′ N	400 m
North of Dahalak		NE of Dahalak Island	
19° 37′ N	surface, 600 m, 1200 m		
Off Port Sudan			
20° 24′ N	440 m, 600 m	Dahalak Kebir	surface
20° 47′ N	1200 m	*Leucifer faxoni*	
NE. of Port Sudan		12° 42′ N	surface
23° 32′ N	800 m	Strait of Bab-el-Mandab	
SE. of John Island			
25° 9′ N	1000 m	14° 47′ N	surface
NE. of Daedalus Archipelago		*Leucifer typus*	
		12° 42′ N	surface
26° 38′ N	800 m	Strait of Bab-el-Mandab	
N of the Brothers Island		*Leucifer orientalis*	
27° 33′ N	900 m	12° 42′ N	surface, 50 m
Strait of Jubal		Strait of Bab-el-Mandab	
Sergestes colosii		*Sicyonella maldivensis*	
20° 47′ N	1200 m	15° 13′ N	surface
NE of Port Sudan		Anchorage West of Adjuz Island	

It is obvious from the records of Cecchini (1933) (Table XXVI) that with the exception of *Sergestes orientalis* and possibly *Leucifer hanseni*, the Red Sea sergestids are not indigenous in this sea. Their scarcity and their preference for the surface layer of the southern Red Sea show a close dependence on the inflow from the Gulf of Aden.

TOMOPTERIDAE

The only record of Tomopteridae from the Red Sea is that of Caroli (1930) from the material gathered by the A. MAGNAGHI. The collection was made at three southern stations in December, March and May and at a central station in May. The latter yielded only one individual (Table XXVII).

The catch examined by Caroli comprised 74 worms which were obtained mostly in December. In March and May, only six and seven worms, respectively, were taken. Ten species were represented in the catch, showing a

TABLE XXVII

Tomopteridae of the Red Sea (data from Caroli, 1930)

Position	Date	Depth of haul (m)	Specimens	Geographic distribution
1 *Tomopteris dunckeri*:				
Zebayir Island	23rd Dec.	0	20	Ceylon and N. Guinea
		95	2	
		190	5	
		380	1	
		522	2	
		713	4	
	27th Dec.	450	2	
		630	1	
2 *T. aloysii-sabaudiae*:				
Zebayir Island	23rd Dec.	0	10	East Pacific
		95	3	
		190	3	
		522	2	
		713	2	
	27th Dec.	90	1	
Shab-Shaks	25th Mar.	0	2	
3 *T. membranaceae*:				
Gebel Teir Island	27th Dec.	450	1	Red Sea
Shab-Shaks	22nd Mar.	0	3	
4 *T. planktonis*				
Zebayir Island	7th May	200	4	Atlantic, Mediterranean
5 *T. elegans*				
Zebayir Island	7th May	200	1	Mediterranean, Inter-oceanic
6 *T. erythrea*				
Gebel Teir Island	27th Dec.	630	1	Red Sea
7 *T. ehlersi*				
Gebel Teir Island	27th Dec.	630	1	Red Sea
8 *T. sanzoi*				
Zebayir Island	7th May	400	1	Red Sea
9 *T. mariana*				
John Island	21st May	400	1	Tropical Atlantic
10 *T. novaroi*				
Shab-Shaks	17th Mar.	0	1	Red Sea

Locations; Zebayir Island, 14° 50′ N; John Island, 23° 24′ N; Gebel Teir Island, 15° 56′ N; Shab Shakhs, about 15° N.

remarkably rich variety with respect to the population of the world oceans—about 27 species in all (Caroli, loc. cit.). *Tomopteris dunckeri* and *T. aloysii-sabaudiae* constitute 50% and 31% respectively of the catch. Both species are known from the Indo-Pacific region. In the Red Sea, they appear as winter forms with a distinctly higher frequency at the surface, although also occurring down to depths of about 700 m. *T. planktonis* and *T. mariana* are known from the Atlantic but not the Indian Ocean. The occurrence of a single specimen of *T. elegans* in the southern Red Sea 'creates' a biogeographic problem, since the species is only known from the Mediterranean.

It must be left to future investigations to clarify its origin and distribution in the Red Sea. The remaining five species were newly described by Caroli from the Red Sea.

CHAETOGNATHA

Ritter-Zahony (1909) examined 101 samples collected by the POLA Expedition from the whole Red Sea and the Gulf of Suez but not the Gulf of Aqaba. They include only four deep vertical hauls from the northern, central, and southern parts. The collection covers the two main seasons of the year, from September to March. Ghirardelli (1947) reported on material collected by the CHERSO at a number of coastal stations in the southern Red Sea, from February to May 1938. The Chaetognatha of the Suez Bay are included in the Report of Burfield (1926). Furnestin (1958) examined twelve samples taken in different seasons from the northern and southern parts of the Gulf of Aqaba. Two species are mentioned by Fowler (1906) and three by Schilp (1941) from the central Red Sea.

The chaetognath population of the Red Sea (Table XXVIII) is decidedly tropical Indo-Pacific in its affinity. Nearly half the species are not known beyond the tropico-equatorial belt of the Indo-Pacific region, in particular, *Sagitta ferox*, *S. neglecta*, *S. pacifica*, *S. regularis*, *S. robusta*, and *S. sibogae*. The three dominant species, however, *S. inflata*, *S. hexaptera*, and *S. serratodentata* are widespread warm-temperate species, also abundantly represented in the Indian Ocean. The occurrence of *S. bipunctata* in the Red Sea is doubtful (Ritter-Zahony, 1909; Ghirardelli, 1947).

The majority of the Red Sea chaetognaths appear to be well established in this sea. *S. hexaptera*, *S. inflata*, *S. pacifica*, *S. robusta*, *S. serratodentata*, and *S. sibogae* are permanent inhabitants of the Red Sea and show no seasonal or geographical variation in relation to the inflowing Gulf of Aden current. *S. neglecta*, *S. regularis*, and *Krohnitta pacifica* are the only species providing some evidence of a winter recruitment through the Strait of Bab-el-Mandab. 61% of the records of Ritter-Zahony (1909) for *Sagitta neglecta* fall in the period from December to March, and 61% are from south of 22° N. For *S. regularis*, 72% of the records fall in the winter season but only 20% are from the southern half of the Red Sea. Neither of the two species, however, is completely restricted to the winter season, nor to the vicinity of the Strait. Both extend to the Gulf of Suez and *S. regularis* is also known from the Gulf of Aqaba. *Krohnitta pacifica* is recorded at seven winter stations (Ritter-Zahony, 1909) and at only one in October, but the records are equally scattered throughout the Red Sea. It remains for future investigations to determine whether *Sagitta ferox* and *Pterosagitta draco*, only recorded in the southern Red Sea, are actually unable to penetrate any further. The question also arises why *Sagitta bedoti* and *S. pulchra* which are not uncommon in the Gulf of Aden and along Somaliland (Ghirardelli, 1947) remain unknown from the Red Sea. All the species, except *S. sibogae*, are epiplanktonic. *S. sibogae* occurred only in the four vertical hauls of the POLA Expedition in which *S. hexaptera* was also present.

Both the Gulfs of Suez and Aqaba are poorer in species than the main basin and the latter Gulf is poorer than the former. Their populations are, however, less well known. The following seven species are recorded from the

TABLE XXVIII
Chaetognatha of the Red Sea

Species	Occurrence in the Red Sea	Reference	Geographic distribution
Sagitta ferox	Southern	Ghirardelli, 1947 (*S. hispida*)	Indo-Pacific, tropico-equatorial
S. bipunctata	(?) Southern, surface Feb.–May	Ghirardelli, 1947	Indian Ocean and Mediterranean. Inter-oceanic, temperate warm (Alvariño, 1965)
S. hexaptera	Southern, surface Feb.–May	Ghirardelli, 1947	Inter-oceanic, temperate warm, epiplanktonic (Alvariño, 1965)
	Central R.S.	Schilp, 1941	
	Common and fairly regular throughout; all seasons; epi- and meso-planktonic	Ritter-Zahony, 1909	
	Gulf of Aqaba, all seasons, mesoplanktonic. Less common	Furnestin, 1958	
S. inflata	Central	Fowler, 1906 Schilp, 1941	Inter-oceanic warm temperate, epiplanktonic (Alvariño, 1965)
	Southern, common, Feb.–May	Ghirardelli, 1947	The commonest surface species in both Indian Ocean and Red Sea; (Fowler, 1906; Ritter-Zahony, 1909)
	Abundant and regular throughout; all seasons epiplanktonic	Ritter-Zahony, 1909	
	Gulf of Suez, all seasons	Ritter-Zahony, 1909 Burfield, 1927	
	Gulf of Aqaba, all seasons, epiplanktonic	Furnestin, 1958	
S. neglecta	Irregular scattered throughout in all seasons, but main occurrence south of 17° S, mid-winter	Ritter-Zahony, 1909	Indo-Pacific, tropical equatorial, neritic (Alvariño, 1965)
	Gulf of Suez	Ritter-Zahony, 1909; Burfield 1927	
S. pacifica	Gulf of Aqaba, surface and subsurface, all seasons	Furnestin, 1958	Indo-Pacific, epiplanktonic (Alvariño, 1965)
S. regularis	Uniform occurrence throughout, but never abundant; all seasons, but more regular in winter—Rare in Gulf of Suez (March)	Ritter-Zahony, 1909	Indo-Pacific tropico-equatorial oceanic (Alvariño, 1965)
	Aqaba, winter–spring	Furnestin, 1958	
S. robusta	Frequent throughout Red Sea and in Gulf of Suez; all seasons	Ritter-Zahony, 1909	Indo-Pacific tropico-equatorial oceanic epiplanktonic (Alvariño, 1965)

TABLE XXVIII—*continued*

Species	Occurrence in the Red Sea	Reference	Geographic distribution
S. serratodentata	Central	Fowler, 1906 Schilp, 1941	Inter-oceanic, warm–temperate (Fowler, 1906; Schilp, 1941; Alvariño, 1965)
	Abundant and regular throughout and in Gulf of Suez; all seasons; next in importance to *S. inflata*	Ritter-Zahony, 1909	
S. sibogae	Widespread but exclusively in deep water, occurs in all vertical hauls but totally absent from horizontal hauls	Ritter-Zahony, 1909	Indian Ocean (Fowler, 1906)
Krohnitta pacifica	Rare specimens scattered throughout, mostly in winter; epiplanktonic; Gulf of Suez in winter	Ritter-Zahony, 1909	Inter-oceanic, tropico-equatorial, epipl., oceanic (Alvariño, 1965)
K. subtilis	Single specimens near Suez	Burfield, 1927	Inter-oceanic temperate, mesoplanktonic (Alvariño, 1965) Furnestin, 1958)
	Gulf of Aqaba, two specimens in April	Furnestin, 1958	
Pterosagitta draco	One specimen, southern, Feb.–May	Ghirardelli, 1947	Inter-oceanic temperate; epiplanktonic, oceanic (Alvariño, 1965)

Gulf of Suez, *S. inflata*, *S. neglecta*, *S. regularis*, *S. robusta*, *S. serratodentata*, *Krohnitta pacifica*, *K. subtilis*, and five from the Gulf of Aqaba, namely, *Sagitta inflata*, *S. hexaptera*, *S. regularis*, *S. pacifica* and *Krohnitta subtilis*. *Sagitta bipunctata*, abundant at Port Said, was totally absent from the Suez Canal. *S. neglecta*, present throughout the Canal, is not known from the Mediterranean (Burfield, 1937).

PELAGIC TUNICATES: THALIACEAE

Thalia democratica appears to be the commonest of the Red Sea Desmomyaria. Several blastozooids and oozoids were collected from the main basin by the German Deep-Sea Expedition (Apstein, 1906) and from the Gulf of Aqaba (as var. *orientalis*) by Godeaux (1960). A thick sound-scattering layer constituted by chains of *T. democratica* has been observed at a depth of 400 m at a position just south of the Gulf of Suez (personal unpublished observation). *Salpa cylindrica* is mentioned from the southern Red Sea by Sewell (1953) and from the inner part of the Gulf of Aqaba by Godeaux (loc. cit.). *S. maxima* is recorded from the Gulf of Aqaba by Van Name (1952), Furnestin (1958), and Godeaux (loc. cit.). It is not yet known from the main basin. Two other Desmomyaria were also recorded and redescribed by Godeaux (loc. cit.) from the Gulf of Aqaba, namely, *Brooksia rostrata* and *Ritteriella amboinensis*. *Salpa cylindrica*, *Brooksia rostrata*, and *Ritteriella amboinensis* are absent from the Mediterranean and the latter two species are not known beyond the tropico-equatorial belt of the Indo-Pacific Region. The occurrence of much *Doliolum* sp. in the southern Red Sea is mentioned by Cleve (1903) and Santucci (1937) and single blastozooids of *D. denticulatum*, *D. nationalis*, and *D. intermedium* were collected from the main basin by the German Deep-Sea Expedition (Neumann, 1906). Advanced nurses of *D. mulleri*, advanced nurses, phorozooids and gonozooids of *D. denticulatum*, and nurses, phorozooids carrying advanced buds and gonozooids of *D. gegenbauri* var. *tritonis* are reported by Godeaux (1960) from the Gulf of Aqaba. Gigantic colonies of *Pyrosoma indicum* (*P. spinosum* Farran) have been reported by Bonnier and Perez (1902) from the main basin.

PELAGIC TUNICATES: APPENDICULARIANS

Only little is known about the appendicularians of the Red Sea, present knowledge being restricted to the records of Lohmann (1931), Fenaux (1966a) from the main basin, and Fenaux (1960) from the Gulf of Aqaba.

TABLE XXIX

Distribution of the appendicularians (partly after Fenaux, 1966b)

Region	Recorded appendicularian species
Red Sea	14
Mediterranean	36
Indian Ocean	35
Pacific Ocean	44

Other than a mention of *Oikopleura longicauda* by Hervé-Harant (1927), nothing is known of this group in the Gulf of Suez. The Red Sea fauna appears, therefore, to be strikingly poorer than either the Mediterranean or the Indo-Pacific region. (Tables XXIX and XXX).

As far as our present knowledge goes, the peculiar conditions of the Red Sea are unfavourable to the establishment of 60% of the Indo-Pacific Appendicularia. Of the fourteen Red Sea species, only six are known from 15° 43′ N (Fenaux 1966a), namely, *Fritillaria tenella*, *F. formica*, *F. digitata*, *F. borealis*, *F. sargassi*, *Oikopleura albicans*, *O. parva*, and *Stegosoma magnum*. Of the remaining eight species, not more than three, *Oikopleura rufescens*, *Megalocercus abyssorum* and *M. huxleyi* (Fenaux, 1960), seem to have been able to penetrate into the Gulf of Aqaba. It must be left to future investigations to ascertain whether this distribution reflects other than our lack of information.

All recorded appendicularians are inter-oceanic and with the exception of *M. huxleyi* which has not hitherto been recorded beyond the Indo-Pacific region they also occur in the Mediterranean. In the Red Sea, it extends from the southern part to the Gulf of Aqaba where it was observed in winter by Fenaux (1960). *Oikopleura rufescens* common in the Gulf of Aqaba is particularly rare in the Mediterranean (Fenaux, 1966b).

TABLE XXX

Appendicularians of the Red Sea

Species	Locality	Reference
Fritillaria borealis f. sargassi	15° 43′ N	Fenaux, 1966a
F. formica f. digitata	15° 43′ N	Fenaux, 1966a
F. tenella	15° 43′ N	Fenaux, 1966a
Megalocercus abyssorum	Aqaba	Fenaux, 1960
M. huxleyi	Aqaba, main basin	Fenaux, 1960; Lohmann, 1931
Oikopleura albicans	15° 43′ N	Fenaux, 1966a
O. cophocerca	Main basin	Lohmann, 1931
O. dioica	Main basin	Lohmann, 1931
O. fusiformis	Diffused in main basin	Lohmann, 1931
O. intermedia	Main basin	Lohmann, 1931
O. longicauda	Diffused; Gulf of Suez	Lohmann, 1931; Hervé-Harant, 1927
O. parva	15° 43′ N	Fenaux, 1966a
O. rufescens	Aqaba and 15° 43′ N	Fenaux, 1960, 1966a
Stegosoma magnum	15° 43′ N	Fenaux, 1966a

PLANKTONIC LARVAE

New larvae of Ceriantharia have been described by Calabresi (1928) from the material of the A. MAGNAGHI. Gohar and Eisawy (1960b) have described the developmental stages of *Cassipea andromeda*.

The free-swimming veliger larvae of various opisthobranch and prosobranch gastropods have been described from Ghardaqa: these include *Berthellina atrina* (Gohar and Abul-Ela, 1957a), *Chromodoris pulchella*, *C. annulata* and *C. ghardaqana* (Gohar and Abul-Ela, 1957b), *Phyllodesmium xeniae* (Gohar and Abul-Ela, 1957c), *Chromodoris quadricolor*, *Casella atromarginata* and *Discodoris erythraensis* (Gohar and Abul-Ela, 1959), *Hexabranchus sanguinolentus* (Gohar and Soliman, 1963b), *Trochus erythraeus* Gohar and Eisawy, 1963). Gohar and Soliman (1963a) have also described the veliger larvae of three Coralliophillidae, namely, *Leptoconchus cumingii*, *L. globosus* and *Magilopsis lamarcki*.

Gurney (1927b) has described a number of larval stages belonging to sixteen species of Penaeidae, Caridae, Anomura and Brachyura collected by the Cambridge Expedition to the Suez Canal. *Phyllosoa* larvae of Scyllaridae and Palinuridae collected by the A. MAGNAGHI were described by Santucci (1930a,b). Stomatopod larvae, presumably *Alima* sp. and *Pseuderichtyus communis*, were recorded by Foxon (1939). The complete series of the larval stages of *Squilla massavensis*, *Squilla* sp. and *Gonodactylus glaborus* are described by Gohar and Al-Kholy (1957a), and a complete series of larval stages were also obtained in culture for the following Crustacea: *Chlorodiella magia*, *Ostracotheres tridacnae*, *Dotilla sulcata*, *Grapsus strigosus* (Gohar and Al-Kholy, 1957b), *Alpheus pacificus*, *Petrolisthes rufescens*, *Camposcia retusa* and *Menaethius monoceros* (Gohar and Al-Kholy, 1957c). Zoea and megalopa stages of the following Decapoda have been described from Ghardaqa by Al-Kholy; *Galatheae* sp., *Hippa* *adactyla* and *Dromia* sp. (Al-Kholy, 1959a), *Stilbognathus erythraeus*, *Elamens mathaei*, *Ocypode aegyptiaca* and *Macrophthalmus* sp. (Al-Kholy, 1959b), *Alpheus ventrosus*, *Arapax* sp., *Saron marmoratus*, *Hippolyte* sp. (Al-Kholy, 1961), *Tetralia globirrema* (Al-Kholy, 1963a), *Alpheus microstylus*, *Periclimenes* sp., *Leucosia signata*, *Hapalocarcinus marsupialis*, *Thalamita poissonii* and *Trapezia maculata* (Al-Kholy, 1963b). The eggs and a number of leptocephalus larvae of Red Sea murenoids are described by D'Ancona (1930) from the material of the A. MAGNAGHI. All this work is, however, of a purely morphological character and provides no information on the seasonal occurrence or ecology of planktonic larvae.

Santucci (1937), in his five-month investigation of the plankton of the coral reefs near Massaua, noticed a surprising abundance at times of planktonic larvae of various benthic and pelagic invertebrates. Zoea, metazoea and megalopa larvae of Decapoda constitute an important fraction of the plankton from the end of February through April. Different echinoderm larvae, *Erichtus* larvae of Stomatopoda and *Mastigopus* of *Leucifer* were also observed in variable amounts in some samples. Successive peaks of abundance for copepod nauplii were observed at short intervals, indicating several broods during this period.

PLANKTON OF THE CORAL REEFS

A semi-quantitative investigation of the plankton in the area near Massaua and the Dahlak Islands has been made by Santucci (1937). Horizontal hauls were made for 10 min with a phytoplankton net (No. 25), a zooplankton net (No. 3) and a stramin net for macroplankton, at 1–2 m over the bottom. Some 50 samples were taken in this way from shallow waters overlying coral reefs in the period from January to May 1933. A few vertical hauls were also made. A brief inventory of the dominant forms and the volume of each sample are given together with salinity, temperature, and other observations. The copepoda and tintinnids were examined in more detail (Santucci, loc. cit.). Although the sampling was made at different localities and the method is only roughly comparative this investigation is—so far—the only one which provides an approximation of the standing crop and its fluctuations at any locality in the Red Sea. The results obtained from the horizontal hauls are summarized in Table XXXI below. The copepod and tintinnid species are given elsewhere.

In comparison with the Mediterranean (Ligurian Sea), the plankton of the area investigated is decidedly more abundant and varied. Abundance and diversity increased with the progress of the season. The volumes obtained fluctuated between 3–75 ml, but more than half the samples exceeded 10 ml. According to Santucci such fluctuations result mainly from the different local conditions of the stations investigated and particularly the absolute depth. Three peaks were observed, 47·5 ml in February at the minimum temperature of 26·4°, 63 ml in April at 30·2° C and 75 ml in May at 30·5° C. The first peak is due to a thick bloom of *Noctiluca miliaris*, while the latter two are almost exclusively of *Chaetoceros* sp. and *Trichodesmium* sp., respectively. The plankton community was characterized by the great proportion of the larval forms of benthic invertebrates, the larvae of higher crustacea (together with copepods) constituting the major part of the crop.

Associated with these are polychaete larvae, the veliger larvae of molluscs, and fish eggs. Larvae of pelagic organisms, larvae of echinoderms, hydromedusans, and tintinnids also constitute an important but variable proportion of the plankton. Most of the samples were rich in copepod nauplii and metanauplii. The catches of March and the beginning of April were generally rich in both eggs and larvae. In May, a decrease in the quantity of zooplankton was observed in proportion with the increase in Cyanophyceae. The composition of both phyto- and zooplankton is typically neritic.

TABLE XXXI

Relative volume of plankton near Massaua from January to May 1933 (from Santucci, 1937)

Date	Volume (ml)	Dominant forms
A. Phytoplankton net No. 25, 10 min horizontal haul (diameter of net opening, 40 cm).		
10th Jan.	20·5	Phytoplankton, diatoms and dinoflagellates; some copepods, chaetognaths, *Doliolum* and appendicularians
11th Feb.	47·5	*Noctiluca*, foraminiferans, hydromedusans, chaetognaths, copepods, polychaetes and decapods, appendicularians abundant
11th Feb.	12·5	Zooplankton, tintinnids, copepods and copepod nauplii
16th Feb.	20·0	Copepods, also *Noctiluca*, hydromedusans, chaetognaths, polychaete larvae, diatoms abundant
18th Feb.	12·5	Mainly *Noctiluca*, also copepods and tintinnids, some *Erichtus* and *Ophiopluteus* larvae
13th Mar.	5·0	Zooplankton, scarce, copepods; few *Dyphies* sp.
15th Mar.	6·0	Zooplankton, littoral copepods, few larvae of crustaceans and gastropods
17th Mar.	14·0	Diatoms and dinoflagellates, copepod nauplii and copepodids, pteropods
19th Mar.	6·0	Zooplankton, larvae of polychaetes and gastropods, dinoflagellates numerous, *Trichodesmium*
31st Mar.	8·5	Zooplankton, tintinnids, hydromedusans, copepods and nauplii, dinoflagellates more numerous than diatoms.
10th Apr.	8·5	Zooplankton, same composition, numerous diatoms and dinoflagellates
20th Apr.	17·0	Phytoplankton, Cyanophyceae, diatoms and dinoflagellates, also tintinnids, polychaete and gastropod larvae, some *Penilia avirostris*
22rd Apr.	8·0	Zooplankton, tintinnids, many larvae of polychaetes, gastropods and lamellibranchs, copepods
22nd Apr.	4·5	Zooplankton, tintinnids, nauplii of copepods, *Ophiopluteus*, cirripede larvae, gastropod and lamellibranch larvae
23rd Apr.	3·0	Phytoplankton, zooplankton scarce, larvae
25th Apr.	4·5	Phytoplankton, diatoms and dinoflagellates, few tintinnids, siphonophores, hydromedusans, larvae, copepods scarce
28th Apr.	63·0	Diatoms abundant, zooplankton scarce
9th May	75·0	Phytoplankton, Cyanophyceae, zooplankton scarce
10th May	28·0	Phytoplankton, diatoms, Cyanophyceae and dinoflagellates, some tintinnids and copepod nauplii.
11th May	15·0	Phytoplankton, diatoms, Cyanophyceae and dinoflagellates, some tintinnids

TABLE XXXI—*continued*

B. Zooplankton net No. 3, 10 min horizontal haul (diameter of net opening 40 cm).		
21st Jan.	4·5	Phytoplankton, some hydromedusans, few copepods, larvae decapod crustaeceans
3rd Mar.	4·5	Zooplankton, foraminiferans, hydromedusans, ostracods, copepoda very scarce
18th Mar.	28·0	Zooplankton, tintinnids, hydromedusans, chaetognaths, numerous copepods, *Zoea* larvae, pelagic amphipods, veliger larvae, Appendicularia, *Doliolum* sp.
29th Mar.	21·0	Zooplankton, hydromedusans, *Dyphies* sp., *Sagitta* sp, numerous copepods, larvae of *Squilla* sp. and decapods, fish eggs
31st Mar.	36·0	Zooplankton, *Sagitta* sp., copepods, polychaete larvae, some larvae of *Leucifer* and of *Paguridae*
19th Apr.	4·5	Zooplankton, scarce
20th Apr.	6·0	Fish eggs, Cyanophyceae, numerous nauplii, few copepods, some veliger larvae, Appendicularia
22nd Apr.	47·0	*Noctiluca*, *Sagitta* sp., numerous copepods, some decapod larvae, fish eggs and Appendicularia, *Trichodesmium*
11th May	28·0	Phytoplankton, Cyanophyceae, diatoms and dinoflagellates, zooplankton, siphonophores, hydromedusans, *Sagitta* sp., copepod nauplii, cirripede nauplii, zoea, metazoea of decapoda, *Auricularia*, *Spatangopluteus*, *Echinopluteus*, some fish eggs

The variety and abundance of the standing crop in such shallow parts of the Red Sea contradict the general impression of paucity which results from the study of the open deep sea.

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