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THE GENUS CERATIUM FROM THE RED SEA

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ABSTRACT

The distribution, and ecology of the genus *Ceratium* in the Red Sea has been studied from plankton samples collected from the central and northern Red Sea between latitudes 17° 40′ and 30° 00′N. A total of 51 *Ceratium* species were identified, of which 23 species are considered as new records, to the Red Sea. Except for *Ceratium egyptiacum* no endemic species were recorded. The seasonal and spatial distribution of the species recorded in the central and northern Red Sea provided no clear evidence of dependence or enrichment through a northward transport from the Indian Ocean via the straits of Bab-el-Mandab. The effect of the special hydrographic conditions of the Red Sea on the ecological affinities of *Ceratium* species and the lability of the *Ceratium* cell were discussed.

INTRODUCTION

Our knowledge of the Red Sea Plankton in general and of the Phytoplankton in particular is still very scanty. Observations made by earlier workers were based on the limited number of samples, almost exclusively from oceanic water. The number of species so far recorded is remarkably small (Halim, 1969), beside, informations on regional and seasonal variations of the species are completely lacking.

The genus *Ceratium* Schrank, is one of the important dinoflagellate genera in tropical waters. It constitutes a permanent and common element of the Phytoplankton of the Red Sea. The present paper deals with the distribution and ecology of 51 *Ceratium* species recorded during this study, 23 of them are new records to the Red Sea. The characteristics of the Red Sea *Ceratium* population and its affinities to the corresponding populations of the Indian Ocean and Mediterranean Sea are also discussed; beside the possible role of *Ceratium* species as biological indicators of currents in the Red Sea is also considered.

MATERIAL AND METHODS

The informations given in this study are based on the examination of specimens of Ceratia represented in more than 80 plankton smaples collected from the following main regions of the Red Sea (Fig. 1):

A. Gulf of Suez and the Northern Red Sea off Al Ghardaqa (from lat. 27° 20′N to 30° 00′N), these comprise:
   1. 24 vertical haul samples collected by a Juday net from 21 stations during the period 2-10 September 1966 by the Russian R/V Ichthyolog. These include vertical hauls from near the bottom to the surface (maximum depth not exceeding 100m), in addition to fractional hauls 200m-100m and 100m-0m in the deeper stations off Al Ghardaqa (Table 1).
   2. 12 surface samples taken by fine-net (No. 25) collected by the author from the inshore waters between Suez and Al Ghardaqa in winter (February) and summer (July) 1969
   3. 12 surface fine-net samples collected seasonally during 1962 by the Institute of Oceanography and Fisheries, Red Sea Branch during 1962 off Al Ghardaqa.

B. The central region of the Red Sea.
   1. 30 fine-net plankton samples collected monthly from the Sea area between Jeddah and obhur (lat. 21° 30′N-21° 40′N) throughout the period November 1975 to February 1977. These samples comprise fractional hauls (maximum depth 100m) as well as horizontal hauls taken from 3 stations covering both neritic and oceanic waters of the region.

TABLE 1

Phytoplankton stations sampled by the R/V Ichthyolog from the Gulf of Suez and the northern Red Sea during September 1966.

(Fractional vertical hauls from 50, 100 & 200m depth were taken at stations 188, 190, 191 & 192).

Station No.	Date	Depth (m)	Coordinates	
			North Lat.	East Lat.
159	2/9/1966	42	29° 35′	32° 37′
162	3/9/1966	40	29° 25′	32° 44′
165	3/9/1966	55	29° 10′	32° 42′
166	3/9/1966	34	28° 59′	32° 39′
167	3/9/1966	65	29° 00′	32° 54′
173	4/9/1966	58	28° 39′	33° 03′
175	5/9/1966	50	28° 31′	33° 07′
176	5/9/1966	38	28° 27′	33° 02′
177	5/9/1966	44	28° 18′	33° 10′
178	5/9/1966	50	28° 18′	33° 16′
179	5/9/1966	60	28° 18′	33° 30′
180	6/9/1966	50	28° 09′	33° 35′
182	6/9/1966	45	28° 00′	33° 25′
184	8/9/1966	50	27° 32′	33° 42′
185	9/9/1966	48	27° 42′	33° 47′
186	9/9/1966	89	27° 44′	33° 49′
187	9/9/1966	34	27° 46′	33° 51′

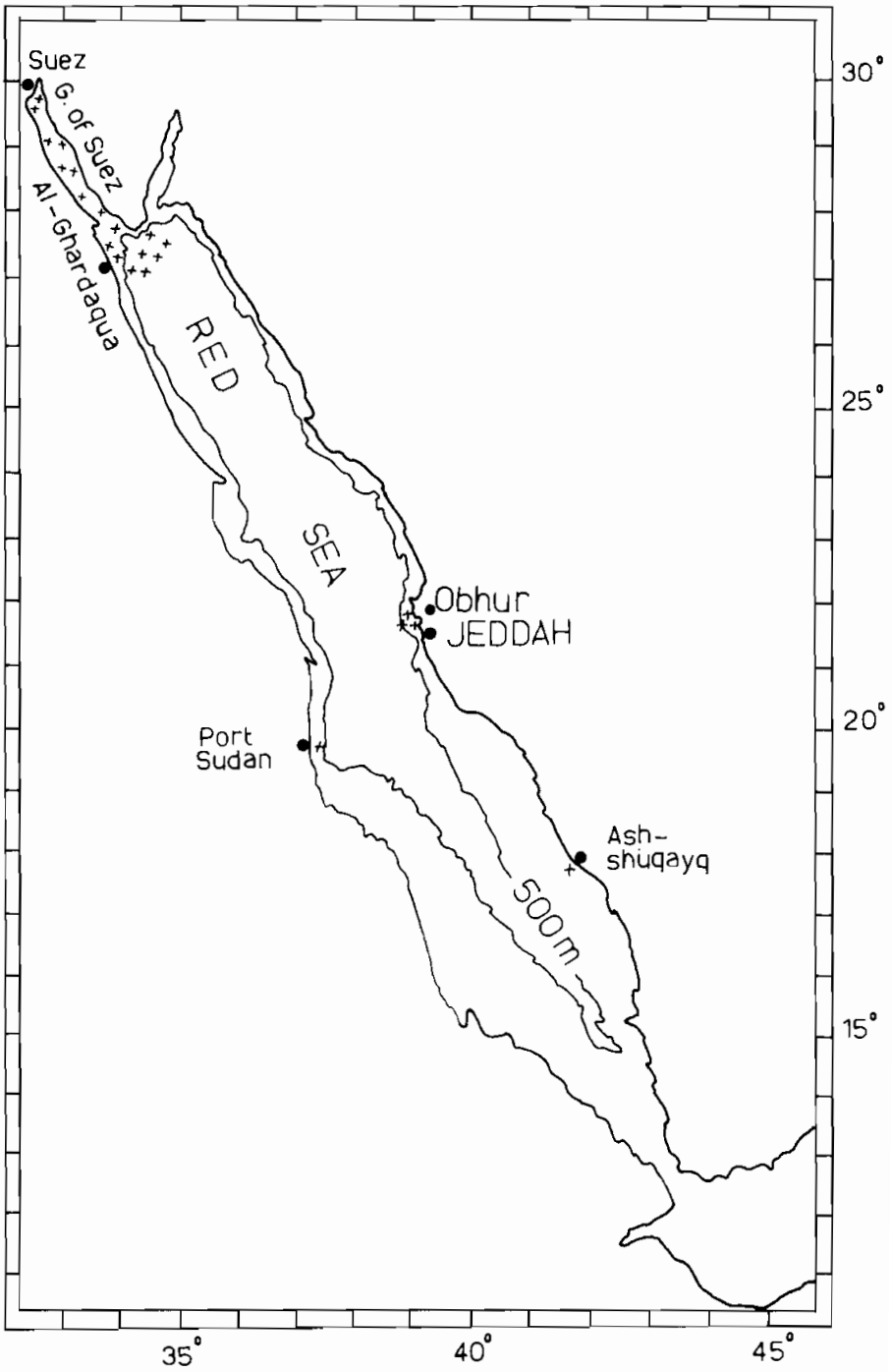

Fig. 1 : Showing the Red Sea and the sites sampled (marked x)

188	9/9/1966	820	27° 42′	34° 14′
190	10/9/1966	1000	27° 34′	34° 08′
191	10/9/1966	230	27° 25′	34° 02′
192	10/9/1966	650	27° 21′	33° 57′

Although the stations were not all sampled regularly, yet, the collection covered the 12 months of the year.

2. Two plankton samples collected from the neritic waters off Port Sudan (lat. 19° 40′N) (1972).
3. Four fine-net plankton samples collected by the author from the inshore waters of Ash-Shuqaya (lat. 17° 40′N) in May 1976.

All samples were preserved in 4% neutralized formaline and adjusted to a volume of 50 or 100 ml. The whole sample was thoroughly examined under a research microscope (at a magnification ×200-×300) and the *Ceratium* species present were identified and listed. The abundance of the species were determined by counting the individuals of each species in 1/10th aliquots of each sample. The relative abundance of species represented in the sample were then arbitrarily considered as abundant, common, frequent or rare according to their frequency of occurrence. Unless otherwise stated, all camera lucida drawings given for the species and varieties were made by the author from the material examined all belong to the Red Sea population. For taxonomic studies the following references were consulted; Jörgensen, 1911; Bohm, 1931; Steemann Nielsen, 1934, 1939; Schiller, 1937; Graham and Bronikowsky, 1944; Dowidar and Aleem, 1963; Sournia, 1966, 1967; Dowidar, 1972.

RESULTS

Ecology and distribution of *Ceratium* species recorded

Subgenus: ARCHAECERATIUM Jörgensen

Section: POROCERATIUM (Vanhöffen) Jörgensen

1 - *Ceratium Praelongum* (Lemm.) Kofoid

Fig. 1, Pl. I

Jörgensen, 1911, Pl. 1, Fig. 9, Graham & Bronikovsky, 1944. P14, Fig. 1.

Strictly tropical spcies of rare and sporadic occurrence in the three oceans as well as in the Mediterranean sea; oceanic, oligophotic.

Not recorded from the Gulf of Suez. Recorded twice in the main basin of the Red Sea, off Jeddah in July and in the northern Red Sea in September, very rare.

2 - *Geratium gravidum* Gourret

Fig. 1, Pl. II

Jörgensen, 1911, Pl. 1, Fig. 8; Graham & Bronikovsky, 1944, P. 15, Fig. 3 & 4.

Oceanic tropical and subtropical species of wide occurrence in warm waters. Usually uncommon, shade species.

Widely distributed in the Red Sea; never common, Occasionally frequent. Recorded in summer in the northern Red Sea off Al Ghardaqa, and in the central region off Jeddah. Also recorded off Port Sudan in winter; rather frequent in vertical hauls from 100-0 m.

Jörgensen (loc. cit.) described several varieties of this species which were more or less accepted by Peters (1934) and Steemann Nielsen (1934). Graham & Bronikovsky (1944) found many intergradations between the wide rotund form *V. latum* (Jörg.) and the narrow form *V. angustum* (Jörg.) and concluded that variability in *C. gravidum* is independent on the geographic locations. This conclusion is probably premature and lacks proper statistical treatment on a large number of specimens. Throughout the present study, *C. gravidum* occurred exclusively in a form almost identical with *V. angustum*.

Subgenus: BICERATIUM (Vanhöffen) Ostenfeld
Section: CANDELABRA Jörgensen

3 - *Ceratium candelabrum* (Ehrenberg) Stain
Fig. 2, Pl. II

Jörgensen, 1911, Fig. 21; Schiller, 1937. P. 366, Fig. 403.

Interoceanic, euphotic, widely distributed in tropical and temperate waters. Of the many varieties described for this speices, *V. depressum* Jörgensen, *V. curvatulum* Jörgensen, *V. dilatatum* (Gourret) Jörgensen and *V. commune* (Bohm) are probably the most important. Graham & Bronikovsky (1944) agree with Peters (1934) that variations in this species are too continuous for any separation of varieties. Furthermore, the species has been reported to manifest seasonal as well as regional morphological variations (Jörgensen, 1920; Lopez, 1966). Sournia (1967) distinguished two forms with many transitions, *V. candelabrum* (= f. *Commune* Bohm) which is a psychrophile form occurring in winter and *V. depressum* which is a thermophile summer form.

In the Red Sea samples examined, such wide morphological variations were not observed. The species was represented by a constant form greatly resembling f. *commune* Bohm. It was rather frequent in winter in all regions sampled, less frequent. Sometimes rare in summer.

Section: FURCIFORMIA Jörgensen

4 - *Ceratium furca* (Ehrenberg) Clapparédé & Lachmann
Fig. 3, Pl. II

Jörgensen, 1911, Figs. 23-27, 1920; Schiller, 1937, Fig. 404.

This is a highly tolerant cosmopolitan species of common occurrence in all oceans. Although it occurs also in occeanic waters, it is generally classified as a neritic surface form.

C. furca is a highly variable species and is probably composed of many subspecies or races. Jörgensen (1911) designated two subspecies, a northern form, subspecies *berghi* (Lemm.) and a tropical form, subspecies *eugrammum* (Ehrenb.). As suggested by Schiller (1937) *C. hircus* (Schröder) is probably a variety of *C. furca*. In many cases, the three varieties were found to coexist with many integradations (Jörgensen, 1920; Peters, 1934; Steemann Nielsen, 1934; Graham & Bronikovsky, 1944; Sournia, 1966, 1967; Halim, 1967; Subrahmanyan, 1968). However, until the problem of from variability in this species is adequately solved, through proper statistical treatment in its morphological variations, it seems convenient to keep the designations *berghi, eugrammum* and *hircus* as the main varieties of *C. furca*.

In the Red Sea both *V. eugrammum* and *V. hircus* were recorded during this study, the latter occurred almost exclusively in all seasons except in winter, rather common in July-August off Jeddah, less frequent off Al-Ghardaqa and rare in the Gulf of Suez. On the other hand, *V. eugrammum* was rather common in all seasons, sometimes abundant. This variety exhibited interesting seasonal morphological variations. In winter (December-February) it occurred almost exclusively as a short and slender form with length from 110-160 μ while in summer (June-October) the large form (length 160-228 μ) was the dominent type. Bohm (1931) in his material from the west pacific distinguished two form groups of the warm water subspecies *eugrammum* which he considered genotypically distinct, a short form (total length 130-168 μ) and a large form (total length 170-244 μ). the present writer demonstrated wide, morphological variations (seasonal and regional) in *C. egyptiacum* and concluded that the resulting types are mere ecotypes of no immediate systematic consequence (Dowidar, 1972).

5 - *Ceratium belone* Cleve

Fig. 4, Pl. II

Jörgensen, 1911, P. 19, Fig. 28

Rare, intolerant, tropical species of sporadic occurrence in warm water. Rather constant in form, oceanic and euphotic.

Recorded in all the regions sampled from the Red Sea and Gulf of Suez. It occurred in all seasons, rather frequent in summer, particularly in the Gulf of Suez and Bitter Lakes. It appears that its frequency of occurrence increases northwards.

6 - *Ceratium incisum* (Karsten) Jörgensen

Fig. 2, Pl. I

Jörgensen, 1911, P. 19, Fig. 29-30

Oceanic, stenothermal, strictly tropical, rare species, constant in shape and size, oligotrophic. According to Jörgensen (1920) *C. incisum* is a relatively heavy species and does not belong to the proper superficial layers. In the Carnegie collection, it occurred in nearly the same frequency at the surface and 100m depth samples (Graham & Bronikovsky, 1944).

In the Red Sea *C. incisum* occurred in both summer and winter seasons off Jeddah, and in summer (September) in the oceanic samples collected off Al Ghardaqa region. Always rare, not recorded from the Gulf of Suez.

7 - *Ceratium pentagonum* Gourret

Fig. 1, Pl. III

Jörgensen, 1920, P. 26, Fig. 17

Cosmopolitan. Of the different varieties known for this species, only *V. tenerum* Jörgensen was recorded in the Red Sea during this study. the record of *V. robustum* (Cleve) Jörgensen, in the Red Sea claimed by Ostenfeld and Schmidt (1901) is doubtful as this variety is a cold water form and not known with certainty from the Indian ocean (Sournia, 1967). *V. tenerum* is a thermophilic form of common occurrence in tropical waters. It was present in almost all samples collected from the region of Obhur (Jeddah), being rather frequent. In the Gulf of Suez and the northern Red Sea, it was particularly common in autumn.

8 - *Ceratium teres* Kofoid

Fig. 3, Pl. I

Jörgensen, 1911, P. 21, Figs. 34-35 and 1920, 28, Fig. 18

Tropical and subtropical species, widespread in all oceans. Constant in shape, occurs in both oceanic and neritic waters.

Present in the Red Sea in almost all months. Common in winter in the region of Obhur, rare or rather frequent in the Gulf of Suez.

9 - *Ceratium Kofoidi* Jörgensen

Fig. 4, Pl. I

Jörgensen, 1911, Figs. 38-39, 1920, P. 23, Fig. 20

Intertropical, slightly tolerant rare species. Widely distributed in the Red Sea. Recorded from all the regions sampled, present in almost all seasons, rare and usually irregular; rather frequent in warm months.

10 - *Ceratium bohmi* Graham & Bronikovsky

Fig. 5, Pl. I

Graham & Bronikovsky, 1944, P. 22, Fig. 12

This species is closely related to *C. Kofoidi* with which it is easily confused (Bohm, 1931; Sournia, 1967; Subrahmanyan, 1968).

Tropical species known from the Pacific and Indian oceans. Widely distributed in the Red Sea. Recorded from the Gulf of Suez, off Al Ghardaqa, off Jeddah and Ash Shuqaya in almost all seasons, particularly frequent in summer.

11 - *Ceratium lineatum* (Ehrenberg) Cleve

Fig. 6, Pl. I

Jörgensen, 1911, Figs. 36-37

Tolerant species, known from boreal, temperate, as well as tropical waters (Jörgensen, 1911; Cleve, 1900, 1903).

Occasionally recorded from the Gulf of Suez, the northern Red Sea near Shadwan Island and off Jeddah; always rare. Sometimes frequent in summer.

12 - *Ceratium minutum* Jörgensen

Fig. 7, Pl. I

Jörgensen, 1920, P. 34, Figs. 21-23

Rare warm water form, usually confused with *C. Kofoidi* and *C. lineatum*. On account of its small size its geographic distribution is uncertain.

Rare in the Red Sea, recorded only in winter off Jeddah and in the Gulf of Suez.

Subgenus: AMPHICERATIUM (Vanhöffen) Ostenfeld

Section: FUSIFORMIA Jörgensen

13 - *Ceratium fusus* (Ehrenberg) Dujardin

Fig. 8, Pl. I

Jörgensen, 1911, Figs. 52-54, 55.

Cosmopolitan species, widespread in all oceans. Jörgensen (loc. cit.) distinguished a tropical form, *V. seta* from the northern form *V. schutti*. Steemann Nielsen (1934) considered the species to represent a single genotype whose size is modified by ecological conditions. Graham & Bronikovsky (1944) found statistically that the specimens from cold water regions have a distinctly greater diameter than those from the warm water regions, variations in length showed however, a different correlation.

In the Red Sea, *C. fusus* occurred mostly as *V. seta* (Ehrenb.) Jörgensen, in addition to the main form. The species was abundent in winter in both the oceanic and neritic waters of Jeddah, Obhur and Al-Ghardaqa regions and in the Gulf of Suez. In other seasons it was less numerous, sometimes common. It was also common in Suez Bay and the Bitter Lake (Suez Canal) in winter and summer seasons (Dowidar, 1976). In the Gulf of Suez, the species displayed interesting seasonal size variations. The summer population was significantly longer than that of the winter season. A critical statistical study of the morphological variations of such species is needed to throw light on the taxonomic-ecologic problems involved (Graham & Bronikovsky, 1944).

14 - *Ceratium extensum* (Gourret) Cleve

Fig. 5, Pl. II

Jörgensen, 1911, Fig. 50, 1920, Fig. 31.

A tropical-subtropical tolerant surface form. Following Steemann Nielsen (1934) *C. strictum* (Okamura & Nishikawa) is included with this species as a separate form, distinguished by the presence of a well formed right antapical horn.

In the Red Sea, the species showed a clear affinity towards oceanic distribution. It occurred sporadically in autumn, winter and spring seasons in all the regions sampled, never common.

15 - *Ceratium bigelowi* kofoid

Fig. 6, Pl. II

Jörgensen, 1911, Fig. 44; Graham & Bronikovsky, 1944, Fig. 11, I, K-N

Rare tropical species, apparently confined to the Pacific and Indian oceans.

In the Red Sea, it was very rare, recorded only twice in the samples examined; one from a deep station in the northern Red Sea south of Sinai peninsula in September and the other from the oceanic water off Jeddah in August; always in subsurface samples 100-50m. Not recorded from the Gulf of Suez. These findings support the view of steemann Nielsen (1934) that *C. bigelowi* should be a shade species.

16 - *Ceratium inflatum* (Kofoid) Jörgensen

Fig. 7, Pl. II

Jörgensen, 1911, Fig. 45-46, 1920, P. 35, Fig. 25

Strictly warm water species, mostly oceanic apparently oligophotic (Graham & Bronikovsky, 1944; Sournia, 1967).

Rare and of irregular occurrence in the central and northern Red Sea. Frequent in the Suez Canal, particularly common in the Suez Bay in winter. The pattern of distribution of this species in the Red Sea shows clear neritic affinities.

17 - *Ceratium longirostrum* Gourret

Fig. 8, Pl. II

Jörgensen, 1920, P. 37, Figs. 26-27

Tropical-subtropical species. Rare, occurred sporadically off Jeddah in winter; rather frequent in the Suez Gulf and off Al-Ghardaqa, but always irregular.

18 - *Ceratium falcatum* (Kofoid) Jörgensen

Fig. 9, Pl. I

Jörgensen, 1920, P. 39, Fig. 28

Rare warm water species classified by Steemann Nielsen (1934) and Graham & Bronikovsky (1944) as intolerant tropical surface form.

Rare in the Red Sea. Recorded occassionally off Jeddah in winter and summer, also recorded in summer from the Gulf of Suez and Suez Bay, always in very small numbers.

Subgenus: EUCERATIUM (Vanhöffen) Ostenfeld
Section: TRIPOS Ostenfeld

19 - *Ceratium tripos* (Müller) Nitzsch
Fig. 9, Pl. II

Jörgensen, 1920, Figs. 33-34 peters, 1934, Fig. 50. Steemann Nielsen, 1934; Schiller, 1937, Figs. 321-322

This cosmopolitan species is probably the most complex and highly variable of the genus. Its high lability in response to the variable environmental conditions has led to the description of numerous infraspecific structure. The taxonomic history of the species has undergne several trials of combinations and separations by several authors (cf. Jörgensen, 1920; Pavillard, 1931; Peters, 1934; Steemann Nielsen, 1934; Schillar, 1937; Graham & Bronikovsky, 1944; Sournia, 1967).

In the Red Sea, variations in *C. tripos* were remarkably limited. In the samples examined, the species was represented by two main forms *V. atlanticum* (Ostenfeld) Paulsen and *V. semipulchellum* (Jörgensen). According to Graham & Bronikovsky (loc. cit.) *V. atlanticum* is more characteristic of temperate and cold waters although not absent from tropical waters; *V. semipulchellum* is, on the other hand, a slightly tolerant tropical and warm water form. The species was frequent in almost all months and was present in about 68% of the samples examined. *V. semipulchellum* dominated in summer in the central and northern Red Sea, while *V. atlanticum* was more frequent in the Gulf of Suez.

20 - *Ceratium Pulchellum* Schröder
(= *C. Pulchellum* f. *eupulchellum* Jörgensen)
Fig. 10, Pl. I

Jörgensen, 1911, Fig. 62

Slightly tolerant, warm water, surface form.

This species was not recorded from the central Red Sea. It was rather frequent in the Suez Bay in almost all seasons. Also recorded from the Gulf of Suez and the neritic waters off Al-Ghardaqa, but always rare and irregular. It was also frequent in the Suez Canal (Ghazzawi, 1939; Dowidar, 1976). A southward emmigration via the Suez Canal is suggested.

21 - *Ceratium breve* (Ostenfeld & Schmidt) Schröder
Fig. 10, Pl. II & Fig. 12, Pl. III

Jörgensen, 1911, Figs. 84-86

Variable species, strictly tropical, indifferently occurring in oceanic as well as neritic waters although more frequent in neritic waters.

Ceratium breve is widely distributed throughout the Red Sea and the Gulf of Suez. It occurred in 70% of the samples examined from the various localities, being present in all seasons. It was particularly common in winter in the neritic waters off Port Sudan, Jeddah, Al-Ghardaqa and in the Gulf of Suez. Also recorded from the Bitter Lakes (Dowidar, 1976). The main form as well as *V. curvulum* Jörgensen and *V.*

parallelum (Schmidt) Jörgensen were recorded. The three forms together with few intergradations were particularly common in the Gulf of Suez and Suez Bay.

22 - *Ceratium schmidti* Jörgensen
Fig. 3, Pl. III

Jörgensen, 1911, Fig. 110

Tropical surface species with clear neritic affinities.

Less numerous than *C. breve*. Rather frequent in the Gulf of Suez, Suez Bay and Bitter Lakes, in all seasons. Also recorded in small numbers off Al-Ghardaqa, Jeddah, Port Sudan and Ash-Shuqayq, particularly in winter.

23 - *Ceratium arietinum* Cleve
Fig. 10, Pl. III

Jörgensen, 1911, Fig. 102-103, 1920; Fig. 62

Interoceanic tropical species, represented in the Red Sea by two forms; *f. detortum* (Stuwe) Jörgensen and f. *gracilentum* Jörgensen.

f. *gracilentum* is strictly tropical and common in the Bitter Lakes (Suez Canal) Suez Bay, Gulf of Suez and off Al-Ghardaqa particularly in summer, less frequent off Jeddah. f. *detortum*, on the other hand, is probably cosmopolitan (Sournia, 1967); it was rare in the Red Sea plankton, recorded only off Jeddah in winter.

24 - *Ceratium humile* Jörgensen
Fig. 4, Pl. VII

Jörgensen, 1911; Graham & Bronikovsky, 1944, P. 27, Fig. 14A

Rare, tropical species, with clear neritic affinities. In the Red Sea, the species was recorded from the neritic plankton of Jeddah in December and August; also recorded off Al-Ghardaqa in September, always rare and sporadic.

25 - *Ceratium symmetricum* pavillard
Fig. 1, Pl. VI & Fig. 5, Pl. IV

Jörgensen, 1920, Fig. 94; Schiller, 1937, Fig. 44 ld. Graham & Bronikovsky, 1944, P. 29, Fig. 15H-L

Following the opinion of several authors (Steemann Nielsen, 1934; Schiller, 1937; Graham & Bronikovsky, 1944; Sournia, 1967) the name *C. gracile* (Gourret) should be dropped and replaced by *C. symmetricum* because of the confusion it made through misuse by different authors. *C. symmetricum* is classified as a tropical shade species. It includes three well defined varieties: *V. symmetricum* Pavillard, *V. coarctatum* Pavillard and *V. orthoceros* Jörgensen; all of them were recorded in the Red Sea during this investigation; off Jeddah in December and August, off Al-Ghardaqa in August and September as well as from the Gulf of Suez, always rare and sporadic.

26 - *Ceratium azoricum* Cleve
Fig. 7, Pl. IV

Jörgensen, 1911, Figs. 97-98

Highly tolerant interoceanic, tropical species with sporadic occurrence in tropical and temperate waters.

Very rare and irregular in the Red Sea. Single specimens were recorded from the Gulf of Suez in February, off Al-Ghardaqa in September and off Jeddah in December.

27 - *Ceratium euarcuatum* Jörgensen
Fig. 12, Pl. II

Jörgensen, 1920, Fig. 54

Rather constant and well defined tropical shade species. It is principally oceanic and oligotrophic but does not avoid neritic or eutrophic waters (Graham & Bronikovsky, 1944; Sournia, 1967).

Very rare in the Red Sea, the only records were from Jeddah and Al-Ghardaqa regions in December and September respectively.

28 - *Ceratium declinatum* (Karsten) Jörgensen
Fig. 1, Pl. VII

Jörgensen, 1920; P. 66, Fig. 63-65. Schiller, 1937. Fig. 445

Tolerant and variable species. Indiscriminately oceanic and neritic, widespread in the three oceans and in the Mediterranean Sea.

Of the many varieties and forms described of this species (Jörgensen, 1920; Peters, 1934; Steemann Nielsen, 1934; Graham & Bronikovsky, 1944) *V. normale* Jörgensen was the predominant and probably the only form occurring in the Red Sea. In the Mozambique channel (Sournia, 1967) the species was also represented by this form.

C. declinatum is widely distributed throughout the Red Sea. It occurred in nearly all the stations sampled from Suez to Ash-Shuqayq. It was particularly common in the neritic plankton of Al-Ghardaqa, Jeddah and Port Sudan in May, September and December respectively.

29 - *Ceratium egyptiacum* Halim
Fig. 4, Pl. III

Halim, 1963, 1965; Dowidar, 1972

This is so far, the only *Ceratium* species endemic to the Red Sea. It was first described from the Bitter Lake and Suez Bay (Halim, loc. cit.). Later, it was found in the Gulf of Suez and the northern Red Sea off Al-Ghardaqa (Dowidar, 1971). The seasonal and regional morphological variations of this species in Suez Bay, Bitter Lake and Port Said has been studied by Dowidar (1972).

The present study has shown that *C. egyptiacum* is one of the commonest species in the Red Sea. Its range of distribution has been extended throughout the main basin as far south as Ash-Shuqayq. It is mostly neritic, common in summer and sutumn, rather frequent, sometimes rare in winter.

30 - *Ceratium contortum* (Gourret) Cleve
Fig. 2, Pl. V; Fig. 2, Pl. VI & Fig. 3 Pl. VIII

Jörgensen, 1911, Figs. 120-121, 1920; Steemann Nielsen, 1934; Graham & Bronikovsky, 1944, Fig. 18

Common, slightly tolerant tropical species.

The taxonomy of this species and *C. karsteni* Pavillard (= *C. arcuatum* Cleve), has been much confused. As suggested by Sournia (1967), the name *arcuatum* should be dropped because it has been misused by earlier authors. Jörgensen (1911) treated *C. karsteni, C. longinum* and *C. contortum* as separate species. He also distinguished a robust form *V. robustum* of *C. karsteni* and considered *C. saltans* Schröder as a variety of *C. contortum*. Peters (1934) considered *C. longinum* a variety of *C. karsteni*. Graham & Bronikovsky (1944) found all possible intergrades between *C. karsteni, C. longinum, C. contortum* and the varieties *robustum* and *saltans;* they

united all three species under *C. contortum*. Sournia (loc. cit.) made the same combination and distinguished four varieties among *C. contortum* viz.: *V. robustum*, *V. karsteni*, *V. longinum* and *V. contortum*.

The author is inclined to separate the regular form *C. karsteni* with long and subparallel antapical horns from *C. contortum* characterized by its distorted body and clearly inward bent right antapical horn. Following Peters (1934) *C. longinum* should be treated as a variety of *C. karsteni*. Inspite of the intergradations reported, *V. robustum* should be treated as a variety of *C. karsteni* while *V. saltans* is treated as a variety of *C. contortum* as originally suggested by Jörgensen (1911).

Ceratium contortum is one of the commonest species of the genus in the Red Sea. The species was common in the Suez Bay, Gulf of Suez and off Al-Ghardaqa in almost all seasons with *V. saltans* the predominant form. It also occurred in the plankton samples collected from Ash-Shuqayq (in spring), Port Sudan and Jeddah in all seasons, but usually in small numbers, rather frequent in October. The species was also reported from the Suez Canal and Port Said (Dowidar, 1976).

31 - *Ceratium karsteni* Pavillard

Fig. 6, Pl. IV

Jörgensen, 1911, Fig. 116

Highly tolerant, tropical-subtropical species.

In the Red Sea both the main form and *V. robustum* (Karsten) Jörgensen were recorded. The species occurred in all seasons in 25% of the samples examined. Throughout, it was less common than *C. contortum*, rather frequent off Jeddah, more frequent in the Gulf of Suez and off Al-Ghardaqa.

32 - *Ceratium gibberum* Gourret

Fig. 5, Pl. II

Jörgensen, 1911, Fig. 108. 1920, P. 69, Fig. 68.

Slightly tolerant tropical and temperate species.

Rare in the Red Sea; recorded only twice off Al-Ghardaqa in September and off Obhur in winter throughout as *f. dispar* (Pouchet) Jörgensen.

33 - *Ceratium concilians* Jörgensen

Fig. 6, Pl. III

Jörgensen, 1920, P. 72, Fig. 69

Jörgensen (loc. cit.) separated this species from *C. gibberum* with which it is similar; this separation was accepted by subsequent authors (Peters, 1934; Steemann Nielsen, 1934; Graham & Bronikovsky, 1944).

In the Red Sea *C. concilians* was extremely rare, recorded only twice as single specimen; in the Gulf of Suez in September and off Jeddah in December.

34 - *Ceratium lunula* (Schimper) Jörgensen

Fig. 4, Pl. VI

Jörgensen, 1911, Figs. 112-115

Strictly tropical species.

Widespread in the Red Sea particularly in the northern part and in the Gulf of Suez where it was rather frequent, sometimes common particularly in September and December. Also recorded off Port Sudan and Jeddah in winter and summer but always less frequent. Jörgensen (loc. cit.) distinguished two forms: f. *brachyceros* with short apical and comparatively long antapical horns, and f. *megaceros* with

relatively shorter antapical and long apical horns. This distinction is unjustified as these forms probably represent two elements of a chain; both forms were, however, recorded in the Red Sea during this investigation.

35 - *Ceratium platycorne* Daday
Fig. 6, Pl. VII

Jörgensen, 1911, Figs. 127-128. 1920, P. 79 & 81

A distinctly shade species with wide occurrence in the tropical-subtropical waters of all oceans.

Rare in the Red Sea, recorded only on three occassions, in September off Al-Ghardaqa and in July & December off Jeddah, all from oceanic waters.

Section: DENSA Jörgensen

36 - *Ceratium dens* Ostenfeld & Schmidt
Fig. 3, Pl. VI

Jörgensen, 1911, fig. 56

Tropical species, provisionally restricted to the Indopacific region (Sournia, 1970). Classified by Steemann Nielsen (1934) as typically tropical and neritic. This species was occassionally common in the central Red Sea off Jeddah during warmer months, rare in winter. It was recorded once from the northern Red Sea, absent from the Gulf of Suez. The distribution of this species showed inverse relation to that of *C. egyptiacum* which was remarkably common in the Gulf of Suez and northern Red Sea, less frequent in the central and southern regions.

Section: LIMULUS Jörgensen

37 - *Ceratium limulus* Gourret
Fig. 8, Pl. IV

Jörgensen, 1911, Fig. 122. 1920, Fig. 72

Rare warm water species.

Recorded from the central region off Jeddah in winter always rare and sporadic, not recorded in other regions.

Section: PAIMATA (Pavillard) Jörgensen

38 - *Ceratium ranipes* Cleve
Fig. 5, Pl. V

Jörgensen, 1920, P. 82, Fig. 76. Bohm, 1931, P. 31, Figs. 28-31.

Tropical and subtropical shade species.

Occurred on the Red Sea in about 30% of all samples; always in very small numbers, sporadic, never common. All records were from offshore waters, off Jeddah and Al-Ghardaqa regions. Not recorded from the Gulf of Suez.

Section: MACROCEROS Ostenfeld

39 - *Ceratium macroceros* (Ehrenberg) Vanhöffen
Fig. 5, Pl. VII

Jörgensen, 1911, Figs. 134-135

Ceratium macroceros was represented in the Red Sea by the subspecies *gallicum* (Kofoid) Jörgensen. This is a tropical and subtropical form, of common occurrence in the three oceans as well as in the Mediterranean Sea. Mostly oceanic but does not avoid neritic waters. According to Graham & Bronikovsky (1944), *C. macroceros* possibly avoids waters with high concentration of nutrient salts.

In the Red Sea this species was widely distributed in almost all the stations sampled from Ash-Shuqayq in the south to Suez Bay in the north. It was rather common in May, August and September. Particularly in the Gulf of Suez where it was abundent in several stations.

40 - *Ceratium deflexum* (Kofoid) Jörgensen

Fig. 1, Pl. IV

Jörgensen, 1911, Fig. 138

Tropical species probably restricted to the indopacific region. According to Graham & Bronikovsky (1944), it is mostly a surface form and probably prefers eutrophic waters.

In the Red Sea the species occurred in two samples taken from the oceanic waters in the northern Red Sea south of Sinai Peninsula in September, also recorded off Jeddah in December and July, always very rare.

41 - *Ceratium massiliense* (Gourret) Jörgensen

Fig. 11, Pl. II & Fig. 1, Pl. VIII

Jörgensen, 1911, Pl. 7, Figs. 140-143 & Pl. 8, Figs. 144-146. Graham & Bronikovsky, 1944, Fig. 22 F-L

Variable species, common in tropical and temperate seas.

In the Red Sea, *V. macroceroides* (Karsten) Jörgensen was the commonest form of the species. It occurred in more than 80% of all samples; common sometimes abundant in the Gulf of Suez, frequent in the plankton of the Arabian coast from Ash-Shuqayq to the northern part of the Red Sea, also in Port Sudan. Specimens simulating *V. protuberans* (Karsten) Jörgensen and *V. armatum* (Karsten) Jörgensen occurred sporadically in all samples. Graham & Bronikovsky (1944) found all forms with many intergradations and stated that the varieties of this species showed no correlation with geographical positions or hydrographic conditions.

42 - *Ceratium carriense* Gourret

Fig. 8, Pl. III & Fig. 3, Pl. V

Jörgensen, 1911, Figs. 147-148

Interoceanic, tropical and warm water species.

Both the main form and the well defined and constant variety *V. volans* (Cleve) Jörgensen were recorded. The species was rather frequent in the Gulf of Suez particularly in winter. Also recorded in the northern Red Sea samples and off Jeddah but always rare and sporadic.

43 - *Ceratium trichoceros* (Ehrenberg) Kofoid

Fig. 2, Pl. IV

Jörgensen, 1911, Fig. 159; 1920, Fig. 85

Intertropical, stenothermic, indifferently oceanic and neritic, mostly a surfaced form.

One of the commonest species in the Red Sea. Common in the Suez Bay, Gulf of Suez in all seasons, also common in the Suez Canal in summer. Frequent to common in Jeddah and Al-Ghardaqa regions from May to October, less frequent in other months.

44 - *Ceratium contrarium* (Gourret) Pavillard

Fig. 1, Pl. V & Fig. 7, Pl. III

Jörgensen, 1920, P. 93, Fig. 84

Warm water species, widely distributed in tropical and temperate waters.

One of the most common *Ceratium* species in the Red Sea. It occurred in nearly all samples. f. *claviceps* (Schröder) Jörgensen, with thickened clavate ends of antapical horns, was occassionally recorded from the Suez Bay and Gulf of Suez. The distribution of the species in the Red Sea showed no preference toward any particular season. Graham & Bronikovsky (1944) found that it showed no regard for the nutrient content of the water, being found as much in oligotrophic as eutrophic waters.

45 - *Ceratium horridum* Gran

Fig. 6, Pl. VI & Fig. 2, Pl. VII

Jörgensen, 1920, Figs. 86-92. Schiller, 1937; Graham & Bronikovsky, 1944, Fig. 23 I-L, 24 C-I, 25 AG

The taxonomic position of the different forms and varieties assigned to this species remain complex and uncertain. Jörgensen (1920) united *C. intermedium, C. tenue* and *C. molle* in *C. horridum,* and distinguished two subspecies within *C. horridum* viz. Subspecies *horridum* comprising the northern cold water forms and subspecies *buceros* which includes various tropical thin horned forms. Paulsen (1930) and Steemann Nielsen (1934) separated *C. horridum* from *C. tenue.* The latter author also considered *C. claviger* Kofoid a separate species although it is only distinguished from *C. molle* by the clavate ends of the antapical horns. Shciller (1937) raised the two subspecies of *C. horridum* to the rank of species: *C. horridum* including the thick horned forms occurring in cold and temperate waters and *C. buceros* Zacharias comprising the same delicate forms. f. *tenue* (Ost. & Schm.), f. *inclinatum* (Kof.), f. *claviger* (Kof.), f. *molle* (Kof.), f. *tenue* and f. *denticulatum* (Jörg.). Graham & Bronikovsky (1944) separated *C. horridum* and *C. tenue,* the former comprises three varieties, a more or less cosmopolitan form *(V. horridum)* and two tropical forms, *V. molle* and *V. claviger. C. tenue* contain two tropical forms *V. inclinatum* and *V. tenuissimum.* Sournia (1967) grouped all this complex under *C. horridum* which he proposed to comprise *V. horridum, V. buceros,* with many transitions and f. *claviger.* The present writer finds it more suitable and also justified to separate the delicate long horned forms of strictly tropical affinities under the species name *C. buceros* from the more robust cosmopolitan *C. horridum* which comprises also *V. molle.* As suggested by Halim (1967) *C. claviger* should be treated as a varient form of *V. molle.*

In the present collection of the Red Sea, *C. horridum* occurred in 18% of all samples. Few intergrades were found with *V. molle* (Kofoid) the most predominant form. The species was rather frequent in the Gulf of Suez in winter, less frequent in summer; also found off Al-Ghardaqa, Jeddah and Port Sudan in winter but in small numbers.

46 - *Ceratium buceros* Zacharias

(= *C. tenue* Ostenfeld & Schmidt)

Figs. 3 & 4, Pl. IV

Jörgensen, 1911, Figs. 1620, 166; Schiller, 1937

In the Red Sea, this species was represented by two well defined and easily recognised varieties: *V. inclinatum* (Kof.) with the antapical horns directed more or less apically and *V. tenuissium* (Kof.) in which the antapical horns are directed laterally. *V. inclinatum* was by far more common than *V. tenuissimum* being present in 60% of all samples; more numerous in the Gulf of Suez and Suez Bay particularly in autumn and winter. In the other regions it was less numerous. Contrary to the

findings of Steemann Nielsen (1934) and Graham & Bronikovsky (1944) this variety is mostly a surface form. *V. tenuissimum*, on the other hand, is probably a shade form. It occurred in oceanic samples off Jeddah almost exclussively in winter, always rare and sporadic.

47 - *Ceratium longissimum* Kofoid

Fig. 3, Pl. VII

Jörgensen, 1911, Fig. 173

Rare, tropical and shade species.

Very rare in the Red Sea, recorded only from a deep station in the northern Red Sea from a vertical haul (200-100m) in September.

48 - *Ceratium vultur* Cleve

Fig. 5, Pl. VI

Jörgensen, 1911, Figs. 151-152; Schiller, 1937

Tropical, oligophotic, confined to regions of warm water in the three oceans.

Widely distributed in the Red Sea. Present in all seasons in about 40% of all samples. Both *V. vulture* (Cleve) and *V. japonicum* (Schröder) were recorded, the latter variety was by far more frequent.

49 - *Ceratium pavillardi* Jörgensen

Fig. 4, Pl. V

Jörgensen, 1911, Figs. 157-158

Rare warm water form, probably oligophotic.

In the Red Sea it was recorded from the Gulf of Suez and off Al-Ghardaqa in September, always rare, rather frequent in subsurface samples (100-50m) in the northern Red Sea.

50 - *Ceratium hexacanthum* Gourret

Fig. 6, Pl. V

Jörgensen, 1920, P. 101, Fig. 94, Schiller, 1937, P. 421, Fig. 462

Highly tolerant tropical species of common occurrence in warm waters; neritic and oceanic, mostly a surface form.

Recorded in 10% of the samples examined. Rather frequent in the Gulf of Suez in September, rare and sporadic in other regions.

Section: REFLEXA Jörgensen

51 - *Ceratium reflexum* Cleve

Fig. 6, Pl. III

Jörgensen, 1911, Pl. 10, Fig. 184

Intolerant, tropical shade species, rare in the Atlantic and Indopacific regions.

Rare in the Red Sea, sporadic, occurred in 10% of all samples. Probably oceanic, shade species, occurred in oceanic samples off Jeddah and Al-Ghardaqa, absent from the neritic plankton of the Gulf of Suez.

DISCUSSION

The general paucity in species of the Red Sea Phytoplankton was referred to by many authors (cf. Halim, 1969). Considering the genus *Ceratium*, Halim (loc. cit.) has collected references of only 28 species as occurring in the Red Sea. However, the

present study has greatly increased our knowledge of the species composition of the genus *Ceratium* in the Red Sea. The number of new records is strikingly high. Of the species recorded during this study, at least 23 species are new to the Red Sea. The absence of these species from previous records may be due to the fact that most of them are either shade and/or rare tropical forms. With these new records, the present list of Red Sea *Ceratium* population (Table 2) comprises 51 species. These findings show clearly that the Red Sea *Ceratium* population is fairly well diversified. and is quite comparable to the corresponding *Ceratium* populations in adjacent seas. The number of species recorded in the Mediterranean Sea is about 50 species. (Jörgensen, 1920); in the Mozambique channel, 53 species (Sournia, 1970); in the Indian Ocean about 60 species (Wood, 1954, 1963; Subrahmanyan, 1968); in the Atlantic and North Pacific Oceans, 58 species (Graham & Bronikovsky, 1944). The idea of the general paucity of Phytoplankton species in the Red Sea is thus, not far from criticism. The claim that the special hydrographical and geographical conditions in the Red Sea are responsible for the low species diversity reported in some groups, particularly the microplankton, is probably premature. This is better attributed to lack of adequate investigations. More intensive and thorough study would, undoubtedly, increase the number of Phytoplankton species inhabiting the Red Sea.

The *Ceratium* flora of the Red Sea are composed of cosmopolitan, warm water, tropical and subtropical elements (Table 2). Few are, so far, restricted to the Indopacific region e.g. *C. bigelowi, C. deflexum* and *C. dens.* All of the species recorded (except *C. egyptiacum*) are known from the Indian and Pacific Oceans (Jörgensen, 1911; Bohm, 1931; Sttemann Nielsen, 1939; Graham & Bronikovsky, 1944; Sournia, 1967, 1970; Subrahmanyan, 1968). The Red Sea population was dominated by the following perennial species:

C. furca
C. fusus
C. pentagonum
C. teres
C. breve
C. tripos
C. arietinum
C. karsteni
C. contortum
C. egyptiacum
C. declinatum
C. massiliense
C. macroceros
C. trichoceros
C. contrarium
C. lunula

TABLE 2

Check-list of *Ceratium* species recorded in the Red Sea and their biogeographic affinities to the Mediterranean Sea and Indian Ocean populations

Species	Red Sea			Mediterranean		Indian Ocean	Remarks
	Gulf of Suez	North R.S.	Central R.S.	West	East		
Ceratium							
arietinum	+	+	+	+	+	+	tt
azoricum	+	+	+	+	–	+	tt
belone	+	+	+	+	–	+	t
bigelowi	–	+	+	–	–	+	ip,N
bohmi	+	+	+	–	–	+	t, N
breve	+	+	+	–	–	+	t
buceros	+	+	+	+	+	+	t
candelabrum	+	+	+	+	+	+	tt
carriense	+	+	+	+	+	+	tt
concilians	+	–	+	+	+	+	tt,N
contortum	+	+	+	–	–	+	t
contrarium	+	+	+	+	+	+	tt
declinatum	+	+	+	+	+	+	tt,N
deflexum	–	+	+	–	–	+	ip,N
dens	–	+	+	–	–	+	ip
egyptiacum	+	+	+	–	+	–	t, E
euarcuatum	–	+	+	+	+	+	t, N
extensum	+	+	+	+	+	+	tt
falcatum	+	–	+	+	+	+	t, N
furca	+	+	+	+	+	+	C
gibberum	–	+	+	+	+	+	tt,N
gravidum	–	+	+	+	+	+	tt
hexzcanthum	+	+	+	+	+	+	tt
horridum	+	+	+	+	+	+	C
humile	–	+	+	–	–	+	t, N
incisum	–	+	+	+	+	+	t
inflatum	+	+	+	+	+	+	t, N
karsteni	+	+	+	+	+	+	tt
kofoidi	+	+	+	+	+	+	t, N

. . . . . continue to next page

Table 2 continued

Species	Red Sea			Mediterranean		Indian Ocean	Remarks
	Gulf of Suez	North R.S.	Central R.S.	West	East		
limulus	–	–	+	+	+	+	t
lineatum	+	+	+	+	–	+	tt
longirostrum	+	+	+	+	+	+	t,N
longissimum	–	+	–	+	+	+	t,N
lunula	+	+	+	+	+	+	t,N
macroceros	+	+	+	+	+	+	tt
massiliense	+	+	+	+	+	+	tt,N
minutum	+	–	+	+	+	+	tt,N
pavillardi	+	+	–	+	+	+	tt,N
pentagonum	+	+	+	+	+	+	C
platycorne	–	+	+	+	–	+	C,N
praelongum	–	+	+	+	–	+	t,N
pulchellum	+	+	–	+	+	+	tt,N
ranipes	–	+	+	+	+	+	tt,N
reflexum	–	+	+	–	–	+	t
schmidti	+	+	+	–	–	+	ip
symmetricum	+	+	+	+	+	+	tt,N
teres	+	+	+	+	+	+	tt,N
trichoceros	+	+	+	+	+	+	t
tripos	+	+	+	+	+	+	C
vultur	+	+	+	–	–	+	t
Total	**37**	**47**	**48**	**40**	**36**	**50**	

C : Cosmopolitan.
E : Endemic to the Red Sea.
ip : Mostly restricted to Indopacific or Indian Ocean.
N : New records.
t : Tropical seas.
tt : Tropical and temperate seas.
– : Not recorded.

The following species were more or less frequent: *C. candelabrum, C. carriense, C. vultur, C. belone, C.dens, C. horridum,* and *C. bohmi.* The remaining species i.e. 50% of the species recorded, were usually rare.

The present study has shown that the high salinity of the Red Sea (Ca 41-42‰) is well tolerated by all the species recorded. In other words, such a high salinity does

not represent a barrier to the dispersal of these forms, even when coupled by the high summer temperature. In fact, differences in the species composition of the summer and winter populations were not significant.

Of the species recorded in the Red Sea, 40 are known from the Mediterranean Sea (Jörgensen, 1920; Dowidar & Aleem, 1963; Halim, 1963; Dowidar, 1974). Migration of *Ceratium* species from the Mediterranean to the Red Sea via the Suez Canal was not detected, (except for a probable migration of *C. pulchellum*).

Unlike the sessile fauna, the percentage of Red Sea endemic species among phytoplankton elements seem to be insignificant. This is most probably attributed to the free transport and continuous mixing with the adjoining rich flora of the Indian Ocean. Except for *C. egyptiacum* no endemic species were recorded. This species is, as yet, not known outside the Red Sea. It was formerly recorded from the Bitter Lakes and Gulf of Suez (Halim, 1963; Dowidar, 1971). In the present study it proved to be widely distributed in the whole Red Sea, being recorded further south to lat. 17° 40'N. Its numerical density decreased gradually by going southwards. During the present study, it was observed that the distribution of this species showed almost an opposite pattern to that of *C. dens*. The frequency of occurrence of the latter species decreased going northward and it was absent from the northern Red Sea and the Gulf of Suez where *C. egyptiacum* was common. Both species are almost identical in shape and dimensions of the cell as well as of the right antapical horn. The main difference is that, in *C. dens* the left antapical horn is short and atrophied while in *C. egyptiacum*, it is more or less longer but highly variable and directed apically (Dowidar, 1972). It is probable that *C. egyptiacum* might have originated from *C. dens* in the course of its evolution in the Red Sea. The high lability of the *Ceratium* cell in response to the variable environmental conditions has been referred to by many authors (cf. Jörgensen, 1920; Lopez, 1966).

One of the important characteristics of the Red Sea *Ceratia* revealed from this study is the marked constancy, in shape and size, of many Red Sea species. In all oceans (also in the Mediterranean) several infraspecific structure and many intergradations has been described for quite a large number of species (Bohm, 1931; Steemann Nielsen, 1934; Peters, 1934; Graham & Bronikovsky, 1944; Lopez, 1966; Sournia, 1967). A general character of the Red Sea *Ceratia* is the presence among many species of a limited number of infraspecific distinctions. In most cases the species is represented by only one constant form. Further, morphological seasonal variations among many species were, on the whole, less pronounced. This is, most probably, correlated with the relative constancy of environmental conditions in the main basin of the Red Sea. Within, the area sampled in the main basin seasonal and regional variations of the important environmental parameters i.e. temperature and salinity are not pronounced. The salinity varies between 39‰41‰ and the surface temperature varies between 25 and 31°C in the south and 21 and 28°C in the north (Morcos, 1970). These conditions seem to check the lability of the *Ceratium* cell and do not favour the formation of infraspecific structures. When fluctuations of environmental condition are pronounced, wide morphological variations of the *Ceratium* cell are liable to occur. Such variations have been demonstrated by the author in *C. egyptiacum* from the Gulf of Suez (salinity 41-42% and temperature 16-

28.5°C) and from the Bitter Lakes (salinity 44-47% and temperature 15-30°C) (Dowidar, 1971).

Concerning the regional distribution of species, 37 were recorded from the Gulf of Suez, 47 from the northern part and 48 from the central part (Table 2). The comparatively small number of species recorded from the Gulf of Suez may be accounted for by the fact that the Gulf represents a shallow shelf (depth 55-73m) filled with the surface water of the Red Sea (Morcos, 1970). Accordingly many of the shade forms are excluded from the Gulf, such species are: *C. bigelowi, C. euarcuatum, C. gravidum, C. incisum, C. limulus, C. longissimum, C. platycorne, C. praelongum, C. ranipes* and *C. reflexum*. In addition, the following rare tropical species were absent from the Gulf: *C. dens, C. deflexum* and *C. humile*.

The Ceratia of the Red Sea seem to constitute an indigenous population to that basin. Most of them are perennial occurring in both winter and summer seasons. Their seasonal distribution in the central and northern Red Sea affords no evidence of dependence or enrichment through a northward transport from the Indian Ocean through the straits of Bab-el-Mandab.

As revealed from this study, the occurrence and distribution of oligophotic or shade species in the Red Sea presents an interesting phenomenon, being correlated with seasons and regions of upwelling. As reviewed by Morcos (1970) the main circulation in the Red Sea is set up in a manner that, in summer, piling up of surface water takes place on the African coast and an upwelling of deeper water occurs on the eastern coast. In summer too, another circulation nearly parallel to the longitudinal axis occurs, resulting in sinking of water in the south, north of the sill, with a corresponding upward movement of deep water in the northern part of the Red Sea. In winter nearly the opposite condition takes place. The occurrence of the forementioned shade species provides a biological support for this circulation. Nearly all of them occurred in summer in the surface plankton off Jeddah and in the northern Red Sea.

SUMMARY

The occurrence and distribution of *Ceratia* has been studied in more than 80 plankton samples collected from various regions in the Red Sea between latitudes 17° 40′N and 30° 00′N. The population is highly diversified and comparable to those found in other oceans. A total of 51 species were recorded of which 23 species are considered as new records to the Red Sea. The idea of the general paucity of phytoplankton species in the Red Sea has been criticized. An intensive and thorough study is needed to evaluate the effect of the special hydrographic conditions of the Red Sea on the primary productivity and species composition of the phytoplankton community.

The ecological and biogeographical affinities of Red Sea Ceratia were discussed; it was found that all the species recorded belong primarily to the Indopacific population. Except for *C. egyptiacum*, no endemic species were recorded. The Red Sea Ceratia seem to constitute an indigenous, self maintained population. Most of them are perennial; however about 50% of the species recorded were numerically

important, the remaining were usually rare. The seasonal distribution of the species recorded in the central and northern Red Sea affords no evidence of dependence or enrichment through a northward transport from the Indian Ocean through the straits of Bab-el-Mandab. Most of the shade species recorded are usually excluded from the shallow Gulf of Suez from which only 37 species were recorded.

The high lability of the *Ceratium* cell was also discussed. It was found that the diversity in form and dimensions reported for many species in all oeceans is much less pronounced in the Red Sea. It is concluded that the special hydrographic conditions of the Red Sea seem to check the lability of the *Ceratium* cell.

The occurrence and distribution of shade species in the Red Sea was mostly correlated with seasons and regions of upwelling. Most of these species occurred in summer in the surface plankton off Jeddah and in the northern Red Sea, thus providing a biological evidence of upwelling of deeper water in these regions.

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Explanation of Plates :
(t = transdiameter across the girdle; l = length of the cell body;
A = length of apical horn)

Fig. 1 – *Ceratium praelongum* (t = 64 μ)
2 – *C. incisum* (t = 37μ)
3 – *C. teres* (t = 40μ)
4 – *C. kofoidii* (t = 37μ)
5a,b – *C. bohmi* (t = 28μ, l: 40μ)
6 – *C. lineatum* (t = 36μ)
7 – *C. minutum* (t = 28μ)
8 – *C. fusus var-seta* (t = 22μ; total length 308 μ)
9 – *C. falcatum* (t = 28μ)
10 – *C. pulchellum f. eupulchellum* (t = 39μ)

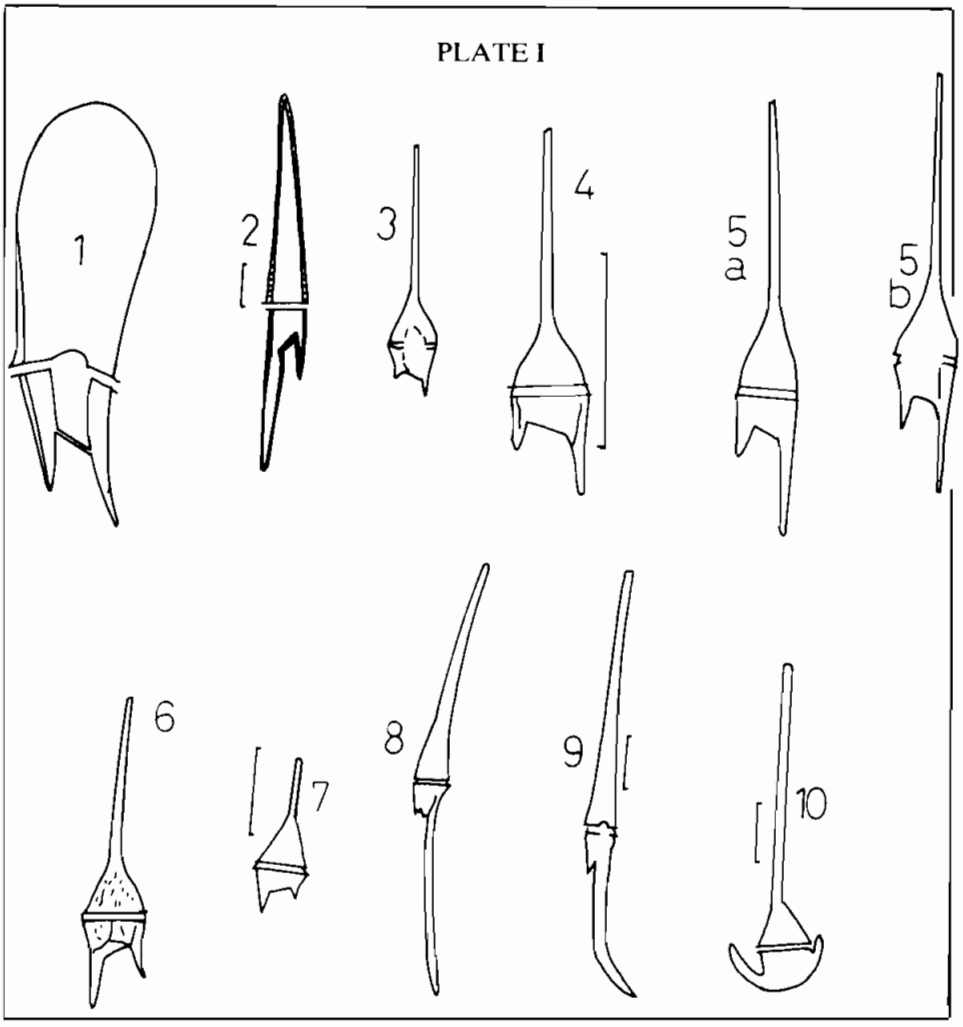


Fig. 1 – *Ceratium gravidum* (t = 65μ; length of epitheca 351μ)
2 – *C. candelabrum* (t = 74μ; l: 57μ; A: 157μ)
3 – *C. furca* (t = 48μ; total length 266μ)
4 – *C. belone* (total length 62μ)
5a – *C. extensum* (total length 1218μ)
5b – *C. estensum f. strictum* (total length 1155μ)
6 – *C. bigelowii* (total length 924μ)
7 – *C. inflatum* (t = 39μ; total length 819μ)
8 – *C. longivostrum* (t = 18μ; total length 638μ)
9 – *C. tripos* (t = 64μ; l: 74μ)
10 – *C. breve* (t = 82μ; l: 88μ)
11 – *C. massiliense* (t = 75μ; l: 91μ)
12 – *C. euarcuatum* (t = 38μ)

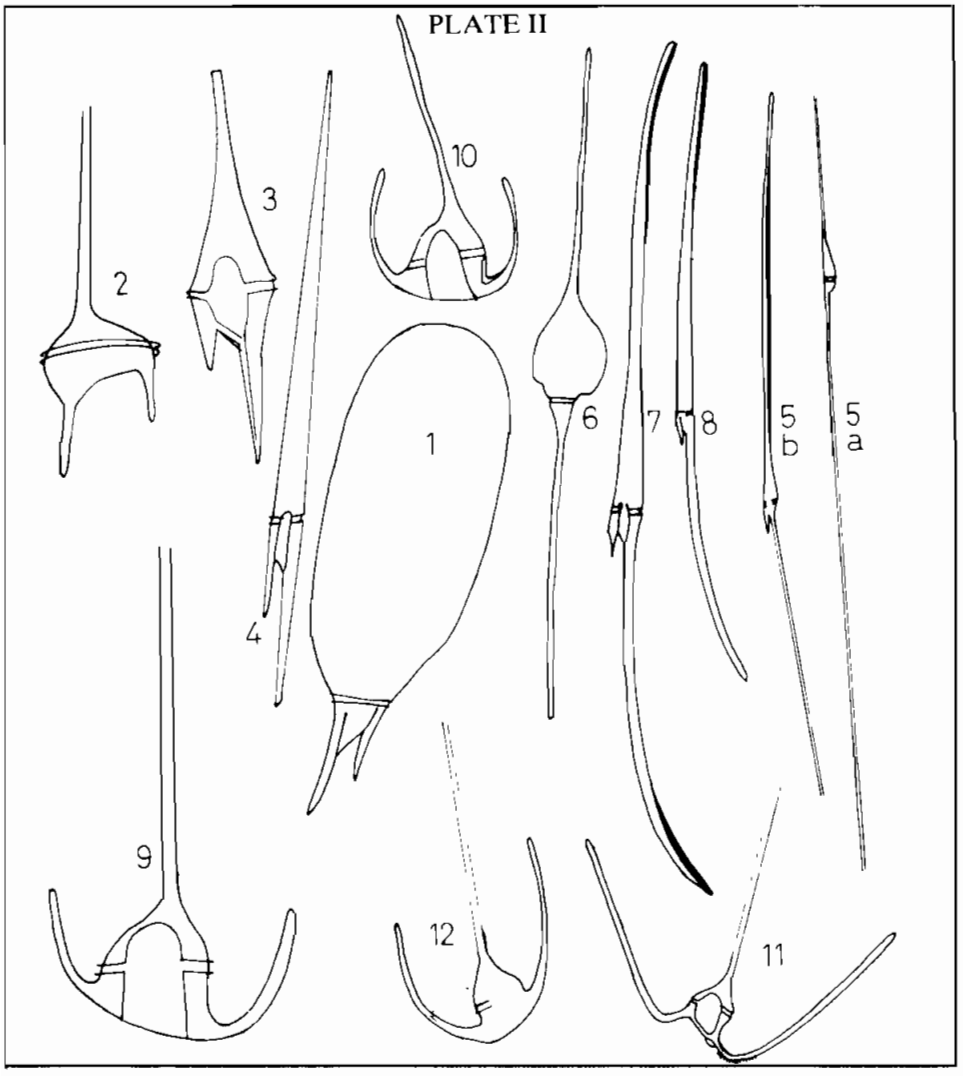


Fig. 1 – *Ceratium pentagonum* (t = 82μ; l: 86μ; A: 372μ)
2a – *C. breve var. parallelum* (t = 73μ; l: 86.5μ; A: 186μ)
2b – *C. breve* from the Bitterlake (Suez Canal) (t = 69μ; l: 86μ; A: 200μ)
3a – *C. schmidtii* (t = 70μ; l: 85μ; A: 174μ)
3b – *C. schmidtii* (t = 77μ; l: 86μ; A: 160μ)
4a – *C. egyptiacum* (t = 82μ; l: 80μ)
4b – *C. egyptiacum* (t = 78μ; l: 73μ)
5 – *C. gibberum* (t = 92μ; l: 94μ)
6 – *C. concilians* (t = 75μ; l: 88μ)
7 – *C. contrarium f. claviceps* (t = 38μ; l: 42μ; A: 435μ)
8 – *C. carriense* (t = 38μ; l: 42μ)
9 – *C. reflexum* (t = 60μ; l: 68μ)
10 – *C. arietinum* (t = 42μ; l: 46μ)

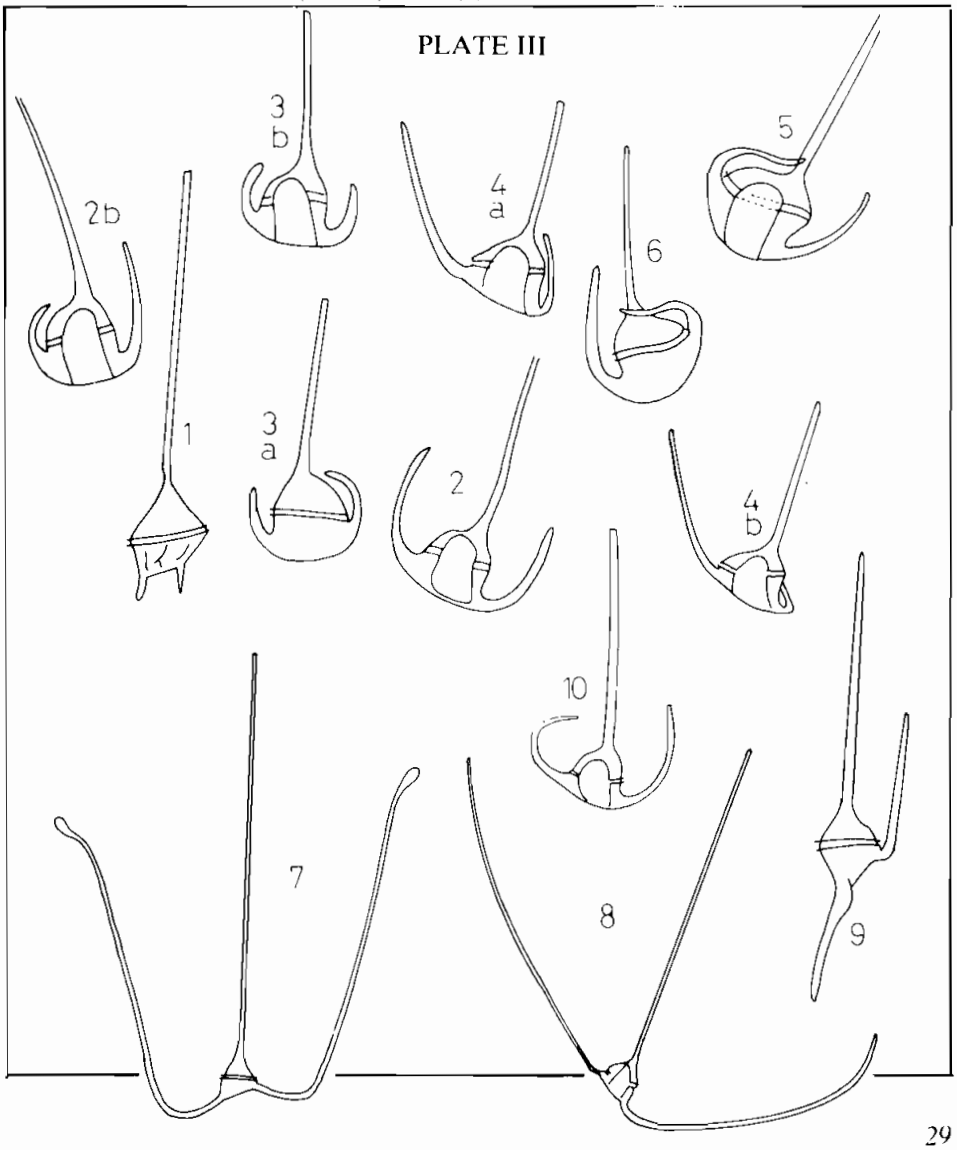


Fig. 1 – *C. deflexum* (t = 53μ; l: 73μ)
2a – *C. trichoceros* (t = 45μ; l: 47μ)
2b – *C. trichoceros* (t = 48μ)
3 – *C. buceros var. inclinatum* (t = 40μ)
4 – *C. buceros var. tenlssimum* (t = 39μ; l: 42μ; A: 306=)
5 – *C. symmetricum var. orthoceros* (a long horned form) (t = 56μ; l: 65μ)
6 – *C. karstenii* (t = 95μ; l: 96μ)
7 – *C. azoricum* (t = 46μ)
8 – *C. limulus* (t = 72μ)

PLATE IV

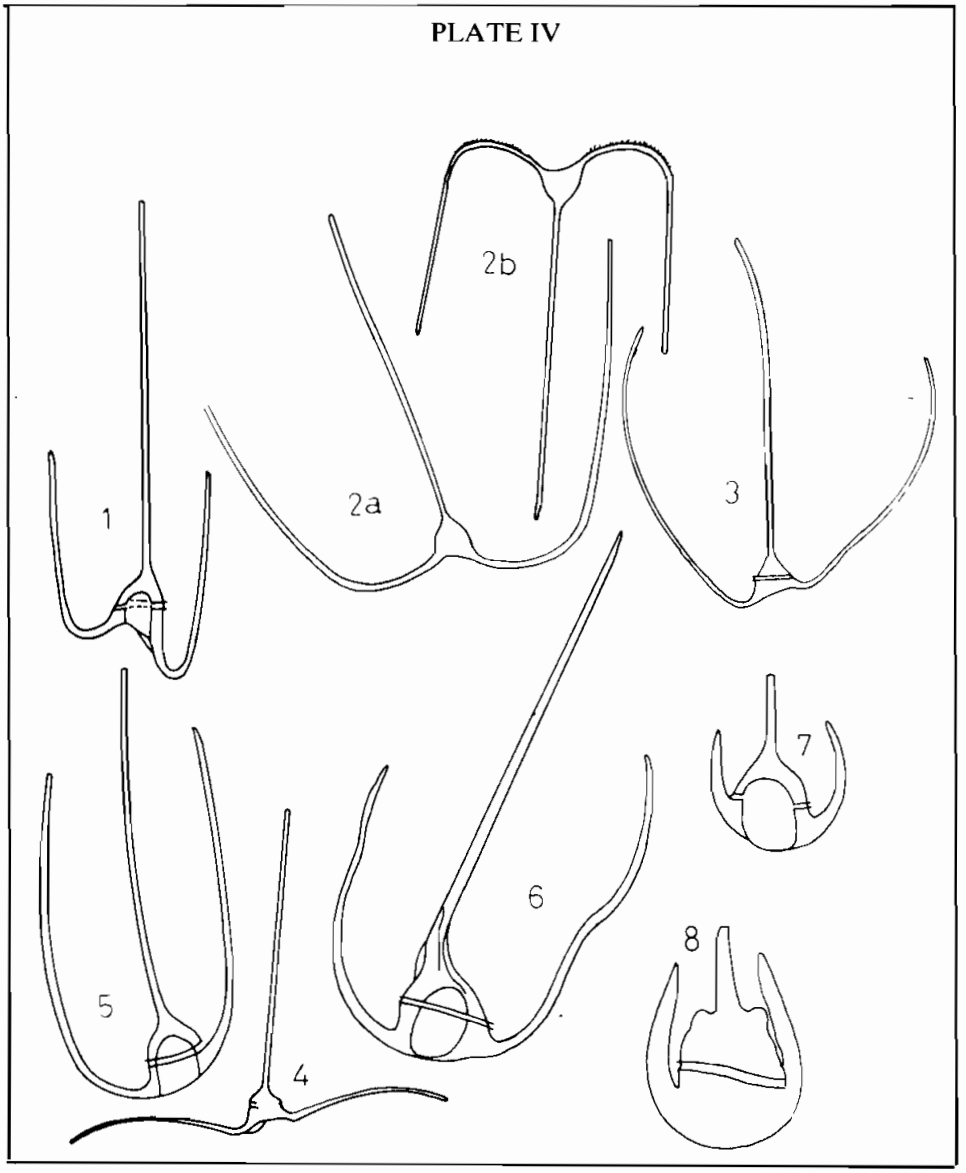


Fig. 1 – *Ceratium contrarium* (t = 51μ) l: 58μ; A: 445μ)
2 – *C. contortum* (t = 66μ; l: 68μ)
3 – *C. carriense* (t = 40μ)
4 – *C. pavillardi* (t = 84μ; l: 89μ)
5 – *C. renipes* (t = 62μ; l: 72μ)
6 – *C. hexacanthum* (t = 82μ)

PLATE V

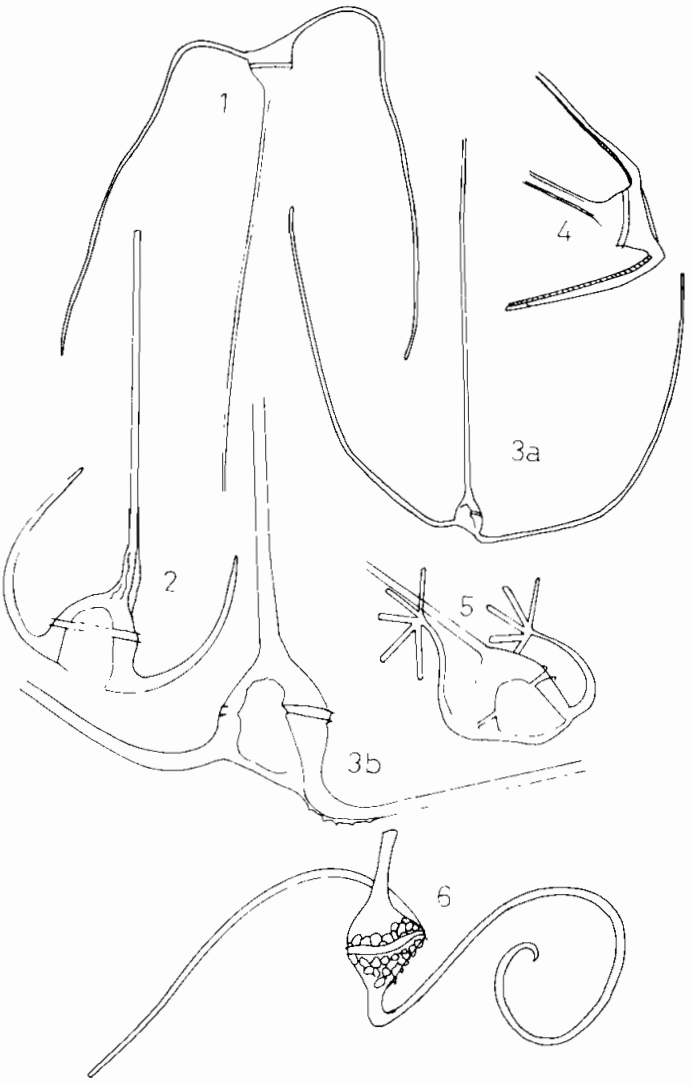


Fig. 1 – *C. symmetricum* (t = 93μ)
2 – *C. contortum* (t = 88μ)
3 – *C. dens* (t = 76μ)
4 – *C. lunula var. brachyceros* (t = 89μ)
5 – *C. vultur var. japonicum* (t = 62μ)
6 – *C. horridum* (t = 38μ; l: 40μ)

PLATE VI

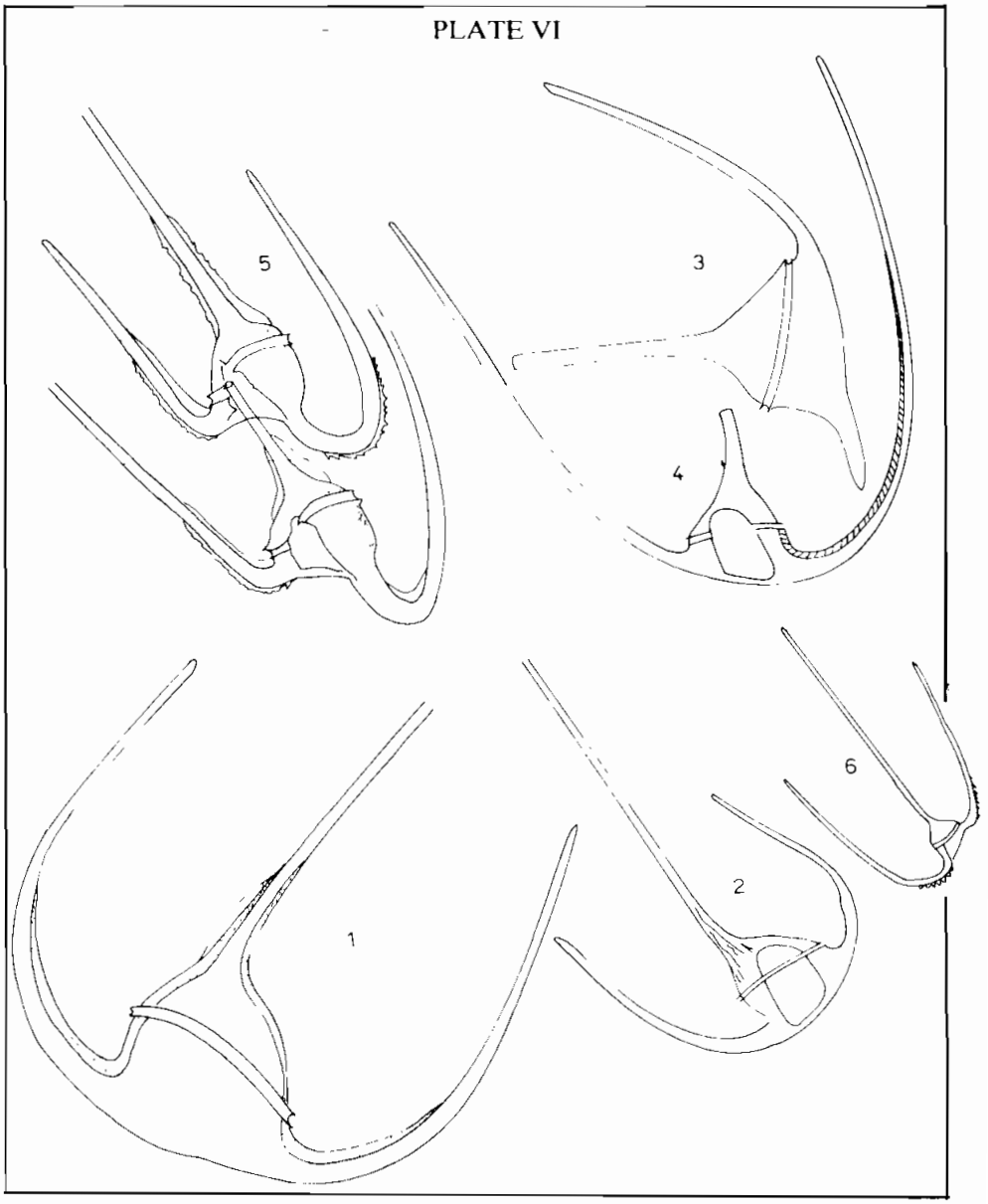


Fig. 1 – *Ceratium declinatum* (t = 37μ; l: 52μ)
2 – *C. horridum var. molle* (t = 39μ; l: 49μ)
3 – *C. longissium* (t = 48μ)
4 – *C. humile* (t = 65μ) [after Graham & Bronikovsky]
5 – *C. macroceros var. gallicum* (t = 42μ; l: 52μ)
6 – *C. platycorne* (t = 63μ)

PLATE VII

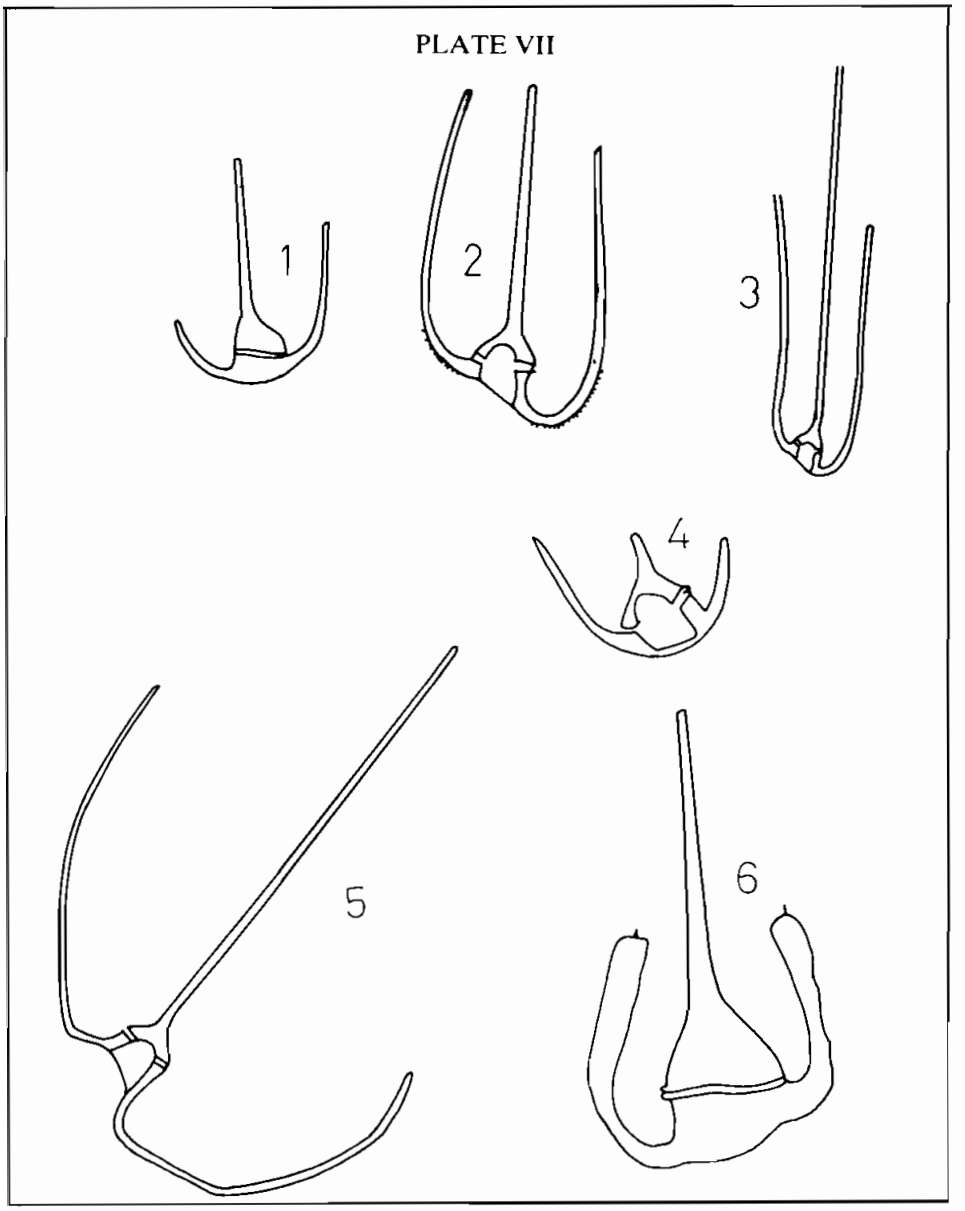
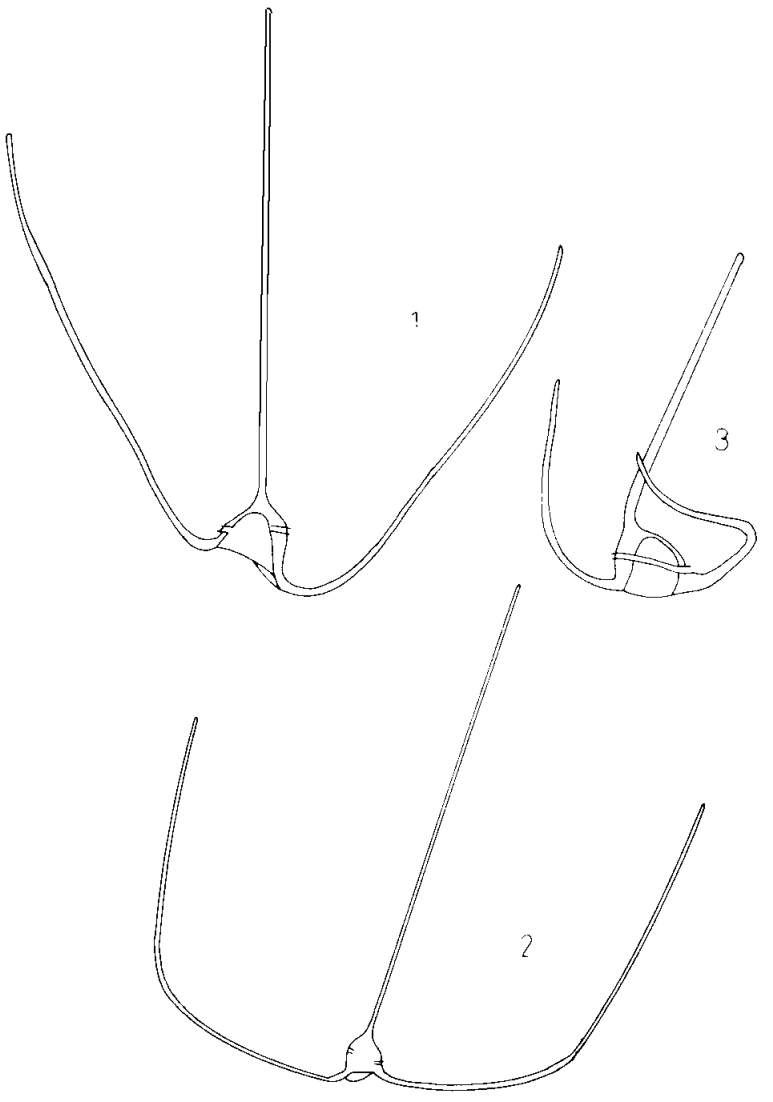


Fig. 1 – *Ceratium massiliense* (t = 72μ; l: 81μ)
2 – *C. carriense var. volans* (t = 47μ; l: 66μ)
3 – *C. contortum* (t = 69μ; l: 75μ)

PLATE VIII



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دراسة بيئية لجنس السيراشيم في البحر الأحمر

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في هذا البحث أجريت دراسة توزيع جنس السيراشيم في البحر الأحمر عن طريق جمع أكثر من ٨٠ عينة من الهائمات البحرية من أماكن مختلفة بين خطى عرض ٣٠ ٧م . ٣٠ شمالا . وتم التعرف على ٥١ نوع من السيراشيم منها ٢٣ نوع اكتشف وجوده لأول مرة بالبحر الأحمر .

وباستثناء سيراشيم جنيـ ـ لم يسجل أي نوع آخر من السيراشيم متوطن بمنطقة البحث .

كما تبين أن الازدهار الفصلى للأنواع المختلفة في وسط وشمال البحر الأحمر لايعتمد على حركة المياه المتجهة من المحيط الهندي خلال باب المندب والمتجهة الى الشمال ، بل أنها تعتمد أساسا على حركة التقليب الرأسي كما أن معظم الأنواع التى تم دراستها تتواجد في فصل الصيف ضمن المياه السطحية بجدة ، وكذلك في شمال البحرِ الأحمرِ .

وقد تم مناقشة خواص السيراشيم بالبحر الأحمر وتشابهه للأنواع المقابلة في المحيط الهندي بالاضافة الى الدور المحتمل لنوع السيراشيم كدليل بيولوجي للتيارات البحرية في البحر الأحمر .