J. mar. biol. Ass. India, 1973, **15** (1) : 335 - 344

DISTRIBUTION AND ECOLOGY OF *CERATIUM EGYPTIACUM* HALIM AND ITS VALIDITY AS AN INDICATOR OF THE CURRENT REGIME IN THE SUEZ CANAL*

NAIM M. DOWIDAR

Oceanography Department, Faculty of Science, Alexandria, U.A.R.

ABSTRACT

During a detailed study on the marine plankton of the Egyptian waters, the dinoflagellate species *Ceratium egyptiacum* Halim was recorded from the south-eastern Mediterranean waters at Port Said and the sea area to the East. This species was recorded in the Suez Canal by Ghazzawi (1936) who wrongly identified it as *C. pulchellum* f. *eupulchellu.* Halim (1963) described it from a surface plankton haul sampled in Lake Timsah in June 1957, and identified it as a new species (*C. egyptiacum*). The species was also reported (as *f. suezensis*) from the Suez Bay plankton (Halim, 1965) outside these two localities the species is not reported, as yet, from any other sea area. Its occurrence in the eastern Mediterranean waters is thus a new record to this sea. The pattern of distribution of the species in the Mediterranean waters (both seasonal and spatial) may throw some light on the current regime in the area and on the dynamics of immigration planktonic organisms through the Suez Canal, particularly after the completion of the Aswan High Dam.

The data presented in this paper is based on the examination of more than 320 plankton samples collected on various occasions from the Red Sea, Suez Canal and Mediterranean waters of Egypt. Details of these samples are given in the text.

INTRODUCTION

DURING a detailed study on the marine plankton of the Egyptian waters, the dinoflagellate species *Ceratium egyptiacum* Halim was recorded from the south-eastern Mediterranean waters at Port Said and the sea area to the East. This species was recorded in the Suez Canal by Ghazzawi (1936) who wrongly identified it as *C. pulchellum* f. *eupulchellu.* Halim (1963) described it from a surface plankton haul sampled in Lake Timsah in June 1957, and identified it as a new species (*C. egyptiacum*). The species was also reported (as *f. suezensis*) from the Suez Bay plankton (Halim, 1965) outside these two localities the species is not reported, as yet, from any other sea area. Its occurrence in the eastern Mediterranean waters is thus a new record to this sea. The pattern of distribution of the species in the Mediterranean waters (both seasonal and spatial) may throw some light on the current regime in the area on the dynamics of immigration of planktonic organisms through the Suez Canal, particularly after the completion of the Aswan High Dam.

The data presented in this paper is based on the examination of more than 320 plankton samples collected on various occasions from the Red Sea, Suez Canal

*Presented at the 'Symposium on Indian Ocean and Adjacent Seas — Their Origin, Science and Resources' held by the Marine Biological Association of India at Cochin from January 12 to 18, 1971.

and Mediterranean waters of Egypt. Details of these samples are given in the text and all are deposited in the U.A.R. National Marine Biological Reference Centre.

I wish to express my thanks to my colleagues Dr. Morcos for kindly providing unpublished data concerning the velocity of the currents in the Suez Canal, and for interest in the subject. Thanks are also due to my colleagues in the U.A.R. Nat. Mar. Biol. Ref. Coll. Centre for their help in the collection of the samples during 1969.

DISTRIBUTION AND ECOLOGY OF *C. EGYPTIACUM*

In the Red Sea

The distribution of the species in the Red Sea is traced from its occurrence in the following plankton samples:

- 12 samples collected seasonally during 1962 by the Institute of Oceanography and Fisheries, Red Sea Branch, from various localities in the sea area off Al-Ghardaqa.

21 samples collected by the Russian R/V *Ichthyolog* in the autumn of 1966 from the northern part of the Red Sea and the Gulf of Suez.

- 12 samples collected by the author from the neritic waters between Suez and Al-Ghardaqa in the winter and autumn season of 1969.

These samples covered the area from Lat. 27° N to 30° N. Examination of these samples showed that *C. egyptiacum* is a permanent constituent of the plankton of the northern part of the Red Sea and the Gulf of Suez. It was common in all seasons except the winter where it was less frequent. The species is thus regarded as indigenous and also perennial to this area. The southward extension of the species in the southern part of the Red Sea needs further investigation.

Regarding the ecological affinities of the species in the Red Sea, as deduced from its occurrence in the samples examined, the species is a strictly neritic surface form, avoiding oceanic and deep waters. It was almost completely absent in samples taken at depths below 25 m and in surface samples taken over depths more than 50 m. The salinity and temperature ranges for the species in this area are respectively 40‰- 43‰ and 15.8°C to 29.1°C.

In the Suez Canal

Examination of 7 plankton samples collected from the Great Bitter Lake (50–60 kms North of Suez) during the warm seasons (June to November in different years 1957–1969) showed that the species was a common constituent of the surface plankton of the Bitter lakes throughout this period. It was also common in the surface waters of Lake Timsah (85 kms North of Suez; Halim, 1963). Unfortunately no plankton samples were collected from the Suez Canal in winter; however, the occurrence of the species in the Canal in this season, at least as far as Bitter Lakes, is confirmed by the fact that it is rather frequent in the Suez Bay in winter.

Judging from its occurrence in Lake Timsah and Bitter Lakes, the salinity and temperature ranges of the species in this area are respectively 33.5‰ - 47.0‰ and 14.2°C - 33.0°C.

Occurrence in the Mediterranean

The occurrence of the species in the eastern Mediterranean in the last 10 years was traced from the following plankton samples collected from the south eastern Mediterranean waters along the Egyptian coast:

a. 16 samples collected in March 1959 by the Japanese Oceanographic Boat *Shoyo-Maru*, between longitudes 25°E to 32°E.

b. 50 samples collected by the Russian R/V *Ichthyolog* in October 1964. Those samples covered both the oceanic and the neritic regions between long. 29°00′E to 33° 30′E, and comprise fractional vertical hauls at 25 m intervals from the surface up to a maximum of 100 m depth.

c. 146 samples collected by the Russian R/V *Ichthyolog* in 1966. These samples comprise vertical hauls operated seasonally (Jan. – Feb. – Ap. Aug.– Oct. and Nov.) in both the neritic and oceanic zones between long. 29°00′E to 33°40′E.

d. 60 samples collected by the U.A.R. National Marine Biological Reference Collection Centre from several stations covering the northern entrance of the Suez Canal at Port Said and the sea area around it, these comprise surface as well as vertical hauls collected at monthly intervals from April 1969 to March 1970.

A detailed account on the distribution of the species in the Mediterranean is needed because it is the best way to test the immigration of erythraean species. Moreover, it furnishes good bases to trace month by month the magnitude and extent of migration and its relation to the water circulation and environmental conditions in the area involved.

The following are the results of examination of the above mentioned samples:

a. *Ceratium egyptiacum* was totally absent in the samples of March 1959, as well as in the surface and subsurface samples of October 1964. This may suggest that upto this date, the species was not established in the Mediterranean Sea and any immigration to that sea was not yet successful.

b. The species was recorded for the first time in the Mediterranean Sea in the samples of 1966. In these samples it exhibited an interesting distribution pattern (both in space and time). It was completely confined to the area east of Port Said *viz.*, Tina Bay and EL Arish regions. In this area it appeared as single specimens in the samples collected from the neritic waters of Tina Bay in August.

In October it extended its area of distribution and was numerically rather frequent in both Tina and El Arish regions. The species reached its maximum abundance in the Mediterranean in November when it became common in the entire neritic area east of Port Said forming a maximum of 24% of the total *Ceratia* in Tina Bay (Table I).

As evident from this table, the species was almost confined to the neritic stations of depths less than 50 m ; the maximum was found at stations with depths

not more than 25 m. These data confirm the neritic and surface affinities exhibited by the species in the Red Sea.

In January, February and April the species was not recorded in any of the samples taken in the neritic or oceanic zones.

c. In the area of Port Said Harbour, the species was recorded during most of the year but with varying frequency. It was absent in winter and frequent to common in other seasons (Table 2).

TABLE 1. *Numerical occurrence and percentage frequency of C.* egyptiacum *in Tina Bay and El-Arish regions in November, 1966. The temperature and salinity data given are the average for the whole water column sampled.*

	Tina Bay					El-Arish			
Station No.	377	378	379	380	381	362	363	364	365
Depth m.	9	15	24	50	–	13	25	70	450
N°/m²	460	860	1362	8	–	460	520	12	–
% to the total *Ceratium*	24.0	11.5	15.4	0.4	–	11.8	18.8	1.4	–
Temperature (°C)	23.0	23.9	24.3	24	21.3	23.9	24.2	24.2	23.0
Salinity (‰)	39.0	39.3	39.4	39.2	38.9	39.7	39.6	39.5	39.2

IMPORTANCE OF THE SPECIES AS AN INDICATOR OF THE CURRENT REGIME IN THE SUEZ CANAL

The importance of the Suez Canal as a passageway between the faunal realms of the Indian and of the Atlantic Ocean has recently gained a world wide interest. Although published lists including organisms of Indo-Pacific or of Red Sea origin, which have immigrated to the Mediterranean, comprise more than 100 names (Steinitz, 1968), yet there is ample evidence that, such lists do not include all immigrated organisms. This may be attributed to absence of records or unavailability of reference of some species; besides those species which have immigrated without being noticed in the new area since they are masked by the presence of individuals of the same kind already existing in the Mediterranean (Red Sea - Mediterranean & Atlanto-Indopacific species). As far as plantonic forms are concerned, records of erythraean immigrants in the Mediterranean are very scanty since; most of the interest was given to the migration of macrofauna. The immigration of macrofauna including planktonic forms has, so far, received very little attention.

The migration and transport of planktonic organisms (temporary or holoplanktonic) depend on the currents, consequently many of them are used to characterise different water masses. Of these, members of the genus *Ceratium* has long been used as current indicators (Jorgensen, 1924 ; Peters, 1934 ; Nielsen, 1934; Graham and Bronikovsky, 1944; Wood, 1958; and others).

Previous studies on the current regime in the Suez Canal Fox, (*e.g.*, 1926; Wimpenny, 1930; Faouzi, 1936; Morcos, 1960.....) showed that, during most of the year, the mean sea level is higher at Suez than at Port Said and a northward current is set in the canal, while from July to October the mean sea level at Port

Said is higher than at Suez and thus the current is reversed, *i.e.*, it becomes southward. This pattern of seasonal variations is more or less a constant phenomenon which repeats itself every year. In 1966, and by the completion of the first stage of the Aswan High Dam and complete storage of the Nile flood water in front of it, Morcos (1967) studied the distribution of salinity in the canal and showed that in September the direction of the current in the canal was unusually northward. As an explanation, Morcos (1967) stated that the Nile flood water discharged into the Mediterranean through Damietta branch aided by the northern wind, normally piles up in front of Port Said, and thus causing the southward diluted water current usually experienced in the canal at that time of the year. After the complete storage of Nile flood water in front of the High Dam, the condition is entirely altered and instead a weak northward current was established in the canal in September 1966; El-Sabh (1968) disagreed with these results and claimed that, according to his own salinity data taken also in September 1966, the current in the canal is not reversed.

As previously shown (*vide supra*) *Ceratium egyptiacum* is a Red Sea species. Its presence in the Mediterranean is, as yet, dependent on the population of the Red Sea and Bitter Lakes transported to it by the northerly current. The monthly fluctuations in the numerical abundance of the species at Port Said in 1969-70 and the adjacent Mediterranean waters in 1966 (Table 1 and 2) may thus reflect the fluctuations in the current regime in the Suez Canal and throws some light on the problem of immigration of plankton organisms via this important pathway.

As evident from Table 2 the occurrence of *C. egyptiacum* at Port Said during the period April-July is in good agreement with the gradually decreasing velocity of the northward current in the Suez Canal. The relatively strong current of April-May is undoubtedly responsible for the numerous population recorded at Port Said where the environmental conditions are favourable for the species (salinity 38.8 - 38.6‰; temperature 19.8 - 28.5°C). It is worth mentioning that during this period the species, though numerous, was almost confined to the area of Port Said. It was not recorded in Tina Bay and El-Arish regions in April 1966; moreover it was totally absent from samples taken 15 kms off Port Said during this seasons This may be attributed to the local water circulation in the area which led to either a condition of "stagnation" of the harbour water or else the sinking down of the more saline canal water below the Mediterranean water; in the latter case the species may be carried down to unfavourable depths where it eventually perish. The satisfactory explanation to this condition however, needs further study. The low population of the species at Port Said during June, July, August and September is mostly due to the decrease in the rate of restocking due to the sluggish northward current. Furthermore, contrary to the condition in the previous two months, the species became dispersed in the Mediterranean waters east of Port Said, as demonstrated by its presence, though in small numbers; in Tina Bay in early August 1966. It seems that from July onwards the species was involved in the water circulation of the south-eastern Mediterranean and is thus carried easterly by the general eastward current flowing along the North African coast. The growing population of the species in Tina Bay recorded in October 1966 and its spreading to El-Arish region indicates, besides its successful propagation in the Mediterranean waters, an allochtonous enrichment through a continuous supply from the original stock of the Bitter Lakes and the Red Sea by the northward current from August to October. Had the current been reversed in August and September 1966 the species would have been absent from Port Said and would have also disappeared or at least decreased in numbers in Tina Bay in these months. The contiuous supply of the species by the continuous unreversed northward current of the Canal culminated

[6]

TABLE 2. *Monthly fluctuations of* C. egyptiacum *at Port Said from April 1969 to March 1970 together with the relevant temperature and salinity data* [*Data on current velocity (cm/sec) in the northern and central canal in 1948–1949 are also given for comparison (Suez Canal authority)*]

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Current (cm/sec.) Northern part.	20.5	11.0	11.3	6.4	- 2.4	- 4.0	10.1	25.9	25.8	44.0	34.6	27.4
Current (cm/sec.) Central part.	8.6	9.6	0.0	-1.7	- 2.9	- 6.7	1.3	8.7	7.0	13.0	10.8	11.4
Abundance of species	+++	++	+	+	+	+	++	—	++	O	O	O
Salinity (‰)	36.8	37.9	38.6	38.0	37.4	37.8	38.2	—	38.3	37.4	38.3	37.1
Temperature (°C)	19.8	23.0	28.0	28.5	29.5	29.0	25.1	—	17.0	16.5	14.9	16.8

— = not sampled; O = not recorded; S = one single specimen; + = rare to less frequent; ++ = frequent; +++ = common.
—ve sign of current velocity indicates southward current.

in November to an abundance of the species in the neritic waters of the south eastern Mediterranean east of Port Said (Table 1). The absence of the species from the samples taken in October 1964 in front of Port Said and in Tina Bay is a further evidence that the condition since 1966 has been different from previous years, that the current is northward during this period is confirmed by the salinity distribution in the canal. The salinity of the northern half of the Great Bitter Lake (Km 115) recorded in July 1969 *viz.*, 43.35‰ demonstrate the condition of a northward current (contrary to the usual condition during this period; Morcos, 1960). The water of the Suez Bay, salinity 42.97‰, envaded the southern part of the canal, thus recalling the conditions usually prevailed in April. Morcos (1967) recorded a salinity of 43.95‰ and 43.93‰ at 103 Km in April 1954 and 1964 respectively.

According to the data presented above it is thus most probable that since 1966, the northward current in the canal is not reversed during the period July-October. These results however, need further confirmation by continuous sampling of several stations along the canal and in the eastern Mediterranean waters throughout several years.

The condition in winter is more peculiar, for, although the northward current of the canal is at its maximum velocity, the species was neither recorded at Port Said nor in the adjacent Mediterranean waters. This indicates that, in this season, enrichment of the species by the northward current is not successful; moreover the large stock of the previous season has completely disappeared. The disappearance of the species from the eastern Mediterranean waters during this season is not easy to explain because our knowledge of the physiological property of the species is still incomplete. In view of the available data the following suggestions may serve as probable explanations for the absence of the species from the Mediterranean waters in winter:

1. The low winter temperature (14-17°C) and the salinity of the water at Port Said (37-38‰) are within the range tolerated by the species; thus both are eleminated as factors limiting the distribution of the species in this season. Could the low winter population of the species in the Gulf of Suez be the cause of its disappearance in the Mediterranean? In all probabilities this may only cause a decrease in the numbers of the species at Port Said, however the high velocity of the northward current is able to compensate for this decreases.

2. Judging from the high velocity of the northward winter current (Table 2) (max. 44 cm/sec.) a plankton organism at the northern end of the Bitter lake takes less than 3 days to reach Port Said (about 100 kms apart) (a distance usually traversed by the current in more than 40 days in summer). Throughout this distance the salinity and temperature of the canal water is not appreciably altered. In February the salinity of the water column at 5 Km south of Port Said ranges from 42.25‰ to 42.34‰, that of Bitter Lakes is 44.87‰- 44.49‰ (Morcos, 1960) while at Port Said the salinity drops to 37.0-38.0‰. The temperature in the whole traverse is around its minimum, 14 - 17°C. Could this abrupt drop of salinity be deleterious to the species especially at this low temperature? If this is so for the individuals transported in winter, what had happened to the population which was already existing and flourishing in the Mediterranean in November?

3. In winter as a result of the cooling of the surface layers, the water column is highly unstable and vertical mixing is more effective. The individuals of *C. egyptiacum* (both previously existing or newly introduced by the currents in winter)

will be involved in the vertical circulation of the water column; consequently they are carried downwards to unfavourable depths at which they eventually disappear. This seems to occur at shallow depths probably not more than 20 m or even less, for as judged from its ecological affinity in the Red Sea the light requirements of the species seem to be very high; moreover, winter is the cloudy and rainy season in the area.

The last mentioned assumption seems to be the most reasonable for explaining the peculiar winter distribution of the species in the Mediterranean Sea.

POSSIBLE BIOLOGICAL IMPORTANCE OF THE NEW CONDITIONS IN THE CANAL

The Suez Canal is a very shallow, 14–15 m deep and narrow, (average 130 m wide) pathway extending 162.5 kms; as such it does not permit the exchange of large quantities of water. The net volume of water transported annually to the Mediterranean via the canal is about 4000×10^6 m^3, with an average of 127 m^3/sec. This volume is exceedingly negligible when compared with, for *e.g.*, the volume of Atlantic water transported annually to the Mediterranean through the straits of Gibraltar, *viz.*, 552×10^{11} m^3 , with an average of 1.75×16^3m^3/sec. (Sverdrup *et al.*, 1942). With this large amount of water the Atlantic Current penetrates into the Mediterranean water for long distances retaining, to a great extent, its chemical and biological characteristics Through this current a considerable number of Atlantic plankton organisms were able to migrate to the Mediterranean (particularly in the Eastern Basin), some of them are already established in the new environment while others are still dependent on their enrichment by the inflowing Atlantic current.

The role of currents in the dispersal of plankton organisms is very much appreciated. However, it must be emphasized that the successful transport of several plankton organisms by currents is due to the fact that these currents displaces, in the mean time, the environmental conditions; when mixing is great; the displaced water looses its identity and the resulting new environment may no longer be suitable for the organisms transported and they eventually disappear. Cosmopolitan and highly tolerable organisms are exceptions. The water of the Canal and Gulf of Suez transported by the northward Canal current, with its low magnitude and velocity, is almost completely mixed with the dilute Harbour water at Port Said. The salinity of the surface water of the Harbour varies between 36.0‰ and 38.6‰ while that of the subsurface layers at 6 and 12 m depth mostly lies between 38.4‰ and 39.2‰ (Morcos, 1960). The identity of this current is totally lost, 5–10 kms off Port Said Harbour. Consequently the capacity of this current to transport Red Sea plankton to the Mediterranean is very much reduced.

As a shallow and long inter-oceanic connection, the Suez Canal does not allow except for the migration of neritic and littoral plankton forms. Oceanic deep water or shade species are not liable to be involved in such migration. Moreover, in discussing the northward migration of planktonic organisms through the Suez Canal, the high salinity barrier of the Great Bitter Lake stands as one of the most decisive factors controlling this process. Fortunately and by virtue of the continuous dissoluation of the salt-bed in the past 100 years, the salinity of the Great Bitter Lake has been gradually decreasing (Table 3) and is now in the range tolerated by a large number of Red Sea plankters.

TABLE 3. *Salinity values of the water in contact with the salt bed near the bottom of the Great Bitter Lake from 1872 to 1966 (Data compiled from various authors).*

Year	1872	1886	1895	1924	1933	1954	1966
Salinity (‰)	68.9	61.8	59.2	53.5	48.8	47.9	46.9

From the foregoing it could be concluded that, as regards the northward migraton of plankton organisms prior to 1966, the prevailing conditions did not permit a significant rate. The plankton populations of Red Sea immigrants in the Mediterranean were, in most cases, too low to compensate for their natural mortality and their consumption by filter feeding animals. This is because (besides the fore mentioned conditions) during the periods of maximum transport by the strong winter current, the conditions in the Mediterranean are not suitable for the successful propagation of most of the phytoplankton organisms. When the latter conditions were suitable, the north ward current of the canal was either weak or completely reversed (as demonstrated by the period June to October).

After the erection of the Aswan High Dam and from 1966 onwards, it seems that a new era in the history of the canal as a link between two distinct faunal realms is beginning. The current in the canal is always northward throughout the whole year. Southward migration of planktonic organisms from the Mediterranean will be hardly possible. The Red Sea plankton, on the other hand, will have better chance to invade the eastern Mediterranean and to build up a flourishing population (particularly in summer and autumn). Also larval stages of littoral Red Sea animals and of the southern canal, breeding in summer and autumn will be able, for the first time since the opening of the canal, to penetrate further northward before they settle. The northward migration will be facilitated further by the progressive decrease of the salinity of the waters of the Bitter Lakes.

How and to what extent will this new condition affect the already existing Mediterranean population; the productivity, food chain and fisheries of the eastern Mediterranean in particular, must await several years of continuous investigations.

REFERENCES

DOWIDAR, N.M. 1965. Distribution and ecology of marine plankton in the region of Alexandria, Egypt. (U.A.R.). Ph.D. Thesis.

————AND A.M. EL-MAGHRABY 1970. Notes on the occurrence and distribution of some zooplankton species in the Mediterranean Waters of U.A.R., *Comm. int. Exp. Medit., Rapp. et P.-V.*, 22. (under publication).

EKMAN, S. 1953. *Zoogeography of the Sea* - London, Sidgwick & Jackson, Ltd., pp.417.

EL-SABH, H.I. 1968. Effect of the Aswan High Dam on the distribution of salinity in the Suez Canal. *Nature*, **218** (5143) : 758-760

FAOUZI, H. 1936. Regime des Courants dans le Canal de Suez. *Fish. Res. Directo., Egypt*, Notes and Memoires No. 23.

FOX, M.H. 1926 Zoological Results of the Cambridge expedition to the Suez Canal, 1924. *Trans. Zool. Soc.*, **22** (1), No.1.

FURNESTIN, M.L. 1966. Le plankton indicateur Hydrologique. *Rev. Trav. Inst. Pêches marit.*, **30** (2): 119-142.

GAUDY, R. 1963. Sur la presence a Marseille d'espèces planktoniques indicatrices d'eaux d'origine Atlantique. *Comm. Int. Explor. Sci. Medit., Rapp. et P-V.*, **17** (2) : 539-543.

GHAZZAWI, F.M. 1936. A study of the Suez Canal Plankton. A. The Phytoplankton. *Fish. Res. Directo. Egypt*, Notes and Memoires 24.

GRAHAM, H. W. AND N. BRONIKOWSKY 1944. The genus *Ceratium* in the Pacific and North Atlantic Oceans. *Carnegie Inst. Wash., Publ.*, **565**.

HALIM, Y. 1963. Microplankton des eaux Egyptiennes. Le genre *ceratium* Schrank (Dinoflagellés). *Rapp. Comm. int. Mer. Medit.*, **17** (2): 495-502.

————, 1965. Microplankton des eaux Egyptiennes. II-Chrysomonadines Ebriediens et Dinoflagellés nouveaux ou d'interet biogeographique. *Ibid.*, **18** (2) : 373-379.

HASSAN, H.M. 1969. The hydrography of the Mediterranean waters along the Egyptian Coast Thesis; Faculty of Science, Alexandria University, U.A.R.

JORGENSEN, E. 1920. Mediterranean *Ceratia. Rep. Dan. Oceanogr. Exp., 1908-1910, Biology*, **2**: 1-110.

MORCOS, S.A. 1960. Die verteilung der Salzgehalte im Suez-Kanal. *Kieler Meeresforschungen*, **16** (2) : 133—154.

————, 1967. Effect of the Aswan High Dam on the current regime in the Suez Canal. *Nature*, **214** (5991) : 901-902.

NIELSEN, J.N. 1912. Hydrography of the Mediterranean and Adjacent Waters. *Danish Oceanogr. Exped., 1908-10*, I : 77-191.

NIELSEN, E.S. 1934. Untersuchungen über die Verbreitung, Biologie und variation der Ceratien im Sudlichen Stillen Ozean. *Dana Report* No.4 : 1-67.

PETERS, N. 1934. Die Benolkerung des Sudatlantischen Ozeans mit Ceratien. *Wissensch. Ergebn. Deut. Atlantische Exped. Meteor, 1925-1927*, II : 1-69.

STEINITZ, H. 1968. Remarks on the Suez Canal as pathway and as habitat. *Rapp. Comm. int. Mer Medit.*, **19** (2) : 139-141.

SVERDRUP, H.U., M.W. JOHNSON AND R.H. FLEMING 1942. *The Oceans*. Prentice-Hall., Inc. New York.

WIMPENNY, R.S. 1930. Some hydrographic data from the Suez Canal., 1928-1929. *Fish. Res. Direct., Egypt*. Notes and Memoires No.1.

WOOD, E.J.F. 1954. Dinoflagellates in the Australian Region. *Australian J. Mar. Freshw Res.*, **5** (2).