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**MARINE BIOLOGICAL STUDIES IN EGYPTIAN MEDITERRANEAN WATERS:  
A REVIEW**

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VODAMA EGIPTA**

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## INTRODUCTION

The earliest information on the plankton and the bottom fauna of the Southeast Levant basin can be found in the reports of the POLA Expedition (1890—94) to the East Mediterranean. From 1936 onwards, the »Notes and Memoires« of the Institute of Hydrobiology in Alexandria published a number of contributions by different specialists on the fauna collected by Steuer (1935) from the fishery grounds near Alexandria, and later, on various problems pertaining to the fishery biology of the area. Since the Department of Oceanography of the University of Alexandria was created 25 years ago, investigations of the marine environment off the Egyptian Mediterranean coast has been reactivated and achieved some progress in the last 18 years. Work has proceeded along different lines. Faunistic and ecological studies have provided information on the standing crop of both phyto- and zooplankton, their seasonal quantitative variations and their systematic composition. Groups such as diatoms, dinoflagellates, copepods, chaetognaths and appendicularians are, now, better known from this area (*vide infra*). Work on the micro- and macrofauna associated with fouling growth (Megually, 1971), especially amphipods and isopods (El-Nasry, 1973), on decapod crustaceans, especially shrimps (Dowidar and Ramadan, 1972; Abdel-Razek, 1974), and on gastropod and lamellibranchs (Dowidar and Hassan, 1972; Hassan, 1974) is also proceeding.

In the following, the plankton studies and the environmental changes observed since the emplacement of the new Aswan Dam are briefly reviewed.

## PHYTOPLANKTON

The phytoplankton of the Egyptian Mediterranean waters has been investigated since 1956. The standing stock and the systematic composition of diatoms and dinoflagellates have been studied by various authors at different localities, but more regular observations are available from around Alexandria. To date, however, nothing is known of the nannoplanktonic forms, such as Coccolithophorids. Productivity measurements by the  $C^{14}$  technique are proceeding.

**Diatoms.** — Check-lists of plankton diatoms have been compiled (Salah, 1971; Dowidar, 1974a) and some new species described (Salah, 1967, 1968, 1974). Monthly observations on the standing stock of which more than 95 percent are diatoms, are available from Alexandria waters for 1957 (El-Maghraby and Halim, 1965), 1961—62 (Dowidar and Aleem, 1967), 1965 (Guerguess, 1970) and 1969—70 (unpublished). Observations on the Nile bloom were carried out in 1956, 1957 and 1959 around the Damietta outlet (Halim, 1960a). The cruise of the *ICHTHYOLOG* in October 1964 surveyed the hydrographic conditions, the phyto- and zooplankton over the continental shelf, between 29°E and 33°E, during the last normal flood season (Halim, Guerguess and Salah, 1967). All observations since 1965 (Table 1) show a drop in the magnitude of the diatom blooms, reflecting the drastic reduction in the Nile outflow.

**Dinoflagellates.** — Dinoflagellates have been investigated in the waters off Alexandria, Damietta and Port-Said and yielded a rich variety of forms (Dowidar, 1971, 1972, 1974b; Halim, 1960a, b, 1963, 1965, 1970; Hassan, 1972). The populations appear to be comparable in diversity to those in other Mediterranean localities, including those which have been more intensively investigated. A total of 190 species have been recorded, of which six are new. In Villefranche and San-Remo, in the north of the western basin, 200 and 250 species are known to occur respectively. The seasonal periodicity is analogous with its two annual peaks, but start respectively earlier and later off Alexandria, and the composition is somewhat different. The great majority of the species, as elsewhere in the Mediterranean, are either inter-oceanic subtropical, such as *Ceratium massiliense* or the truly cosmopolitan *Peridinium trochoideum* (Hassan, 1972). A small number of species, however, some of which become highly abundant at times, present a peculiar biogeographic affinity. They are the Indo-Pacific and the autochthonous forms, all of them known only from this part of the Mediterranean. Halim (1970) has recorded some of the Indo-Pacific forms from Port-Said such as *Pyrodinium schilleri*; others including *Peridinium nipponicum* are also found off Alexandria. *Ceratium egyptiacum* is remarkably well defined in its distribution. This indigenous species in the Suez Gulf and Suez Canal (Halim, 1963, 1965) is now spreading to the Mediterranean (Dowidar, 1971). Two of the autochthonous species are worth mentioning here, the minute *Exuviaella cordata* and *Alexandrium minutum*. The former appears to be a relict species of the »Caspian« flora, widespread in the Aral, the Caspian and Black Seas, as well as in the neritic Mediterranean waters (Halim, 1960a; Hassan, 1972). *Alexandrium minutum* is the responsible organism for the recurrent outbreak of a harmless red-tide in the Eastern Harbor of Alexan-

dria, where counts of  $20 \times 10^6$  cells/L in summer are not uncommon. Both species, at present only known from the Eastern Basin, are examples of autochthonous forms to the inner Mediterranean.

## ZOOPLANKTON

**Copepoda.** — Since 1961, several contributions to the study of the Copepoda of the southeast Levant Sea have been published by El-Maghraby and Dowidar, either separately or in collaboration. El-Maghraby (1965a) reported on a small collection made by the Japanese vessel *SHOYO-MARU* in March 1959, between Salloum and Port-Said. The four seasonal cruises of the *ICHTHYOLOG* in 1966 yielded 120 plankton samples from both inshore and offshore waters (Dowidar and El-Maghraby, 1973). The area of Alexandria and the neighboring Abu Kir Bay, however, have been more regularly investigated over several years, thus providing some ecological observations, in addition to biogeographic and faunistic studies.

The developmental stages of *Euterpina acutifrons* (El-Maghraby, 1964), the seasonal variations in length of neritic copepods (El-Maghraby, 1965b), their occurrence and their temperature and salinity requirements (Dowidar and El-Maghraby, 1971a, b; El-Maghraby and Dowidar, 1970a, in press) have been investigated. Species such as *Paracalanus parvus*, *Oithona nana* and *Euterpina acutifrons* appear to have a wide salinity tolerance. They thrive in the saline waters of the Bitter Lakes as well as in the diluted waters in the vicinity of the Nile mouth. *Clausocalanus arcuicornis*, *Temora stylifera* and *Acartia negligens* on the other hand, are stenohaline. The latter three species also belong to the perennial Red Sea population, from which this stenohaline Eastern Mediterranean stock might be derived (Halim, 1969).

The copepod population as a whole is well diversified, comprising 132 species, a number fairly comparable to the records from the Gulf of Naples (157 species) but lower than in the Adriatic (200 species). All the species are Mediterranean-Atlantic, but three more strictly North-Atlantic and bathypelagic appear to be new Mediterranean records including *Megacalanus longicornis*, *Gaidius tenuispinus* and *Euchirella maxima*. Some ten smaller species are dominant the year round, such as *Paracalanus parvus*, *Oithona nana*, *Calocalanus pavo*. On the other hand, some are given as possible immigrants from the Red Sea (*Paracalanus aculeatus* and *pavo*) and others as indicators of the Atlantic North-African current (*Calanus tenuicornis*, *Isias clavipes*, *Centropages violaceus*, *Pontellina plumata*, *Acartia danae*), but such conclusions are only tentative.

**Chaetognatha.** — About 8000 specimens belonging to 7 species of *Sagitta* were collected from Egyptian Mediterranean waters from October 1964 to April 1966. The morphometric characters of all specimens were recorded and the biology of the different species investigated (Guergues, 1970; Guergues and Halim, 1973; Halim and Guergues, 1973). *Sagitta friderici*, a species earlier considered to be allochthonous to the Mediterranean and an indicator of the Atlantic current, proved to be a dominant and permanent component of the southern Levant plankton, making up to 77

percent of all the species of *Sagitta* recorded. It also proved to be a euryhaline species, and the only *Sagitta* sp. associated with the Nile Stream in 1964 where both adults and juveniles were abundant (Halim, Guergues and Saleh, 1967). Analysis of its population showed continuous breeding the year round, except in mid-summer, but breeding was more active whenever the zooplankton crop increased. Some light could be thrown on the morphometric characters of the larval *S. friderici* and its development, hitherto only little known.

*Sagitta serratodentata*, the next in importance (21 percent) is not as salinity and temperature tolerant as *S. friderici*. It was widespread in the deeper layers below the Nile Stream in 1964, only rising to the surface beyond the stream boundary. From the remaining species, *S. neglecta* is worth mentioning. This is a new Indo-Pacific form in the Mediterranean, but only one mature specimen was collected (Guergues and Halim, 1973).

Appendicularia. — The species composition and seasonal variation in numerical abundance of the Appendicularia have been followed during two year-cycles, in 1965–66 and in 1969–70 (Halim, Aboul-Ezz and Guergues, 1974). The data obtained do not point to any correlation with temperature, as far as the population as a whole is considered, but winter species, such as *Fritillaria borealis*, and summer species, such as *Appendicularia sicula* do occur. Peaks of highest population abundance occurred in winter and in autumn following, in both cases, an increase in the phytoplankton production and after a delay of one month. The highest peak observed followed the Nile bloom of September 1965, but in the second year-cycle, no such peak was observed, as the flow of Nile water into the Eastern Mediterranean ceased. Since the new Aswan Dam became functional, the density and periodicity of secondary producers in this area are governed by intrinsically marine environmental factors.

Approximately two thirds of the Mediterranean Appendicularia occur in this area, but the percentage composition differs slightly from that of the Western basin (Fenaux, 1963). *Appendicularia sicula*, a rare species in the Western basin, is largely dominant (49 percent), especially from May to September (more than 80 percent). It is followed by *Oikopleura dioica*, *O. longicauda*, *O. parva* and *Fritillaria borealis*. *Appendicularia sicula* appears to be one of the characteristic zooplankters of the southeast Levant, together with *Sagitta friderici*.

#### THE POST-HIGH DAM ENVIRONMENTAL CHANGES

Since 1965, the periodic rise and fall of the Nile River, which has been going on for so many centuries, and only partially regulated, has been fully controlled. Drastic and complex changes in the conditions of the innermost region of the Levant have resulted from the complete retention of the excess flood water. Changes in the hydrographic conditions, the biological economy, and the composition of the fauna and flora are progressively coming to light. For an understanding of the processes now going on, a comparison with the pre-Aswan High Dam conditions is necessary. The reader is referred to Halim (1960b), Halim, Guergues, and Saleh (1967) and Dowidar and Aleem (1967) for an investigation of the direct effects of the

flood outflow and for further references. Data on the pre-High Dam hydrographic conditions have been collected around Alexandria by Dowidar (1965), El-Kirsh (1966) and Hassan (1972). The offshore conditions have been investigated from the *SHOYO-MARU* by Gorgy, and Shaheen (1964) and the *ICHTHYOLOG* by Halim, Guergues and Saleh (1967). Subsequent surveys made in 1966 (Morcos and Moustafa Hassan, 1973; Emara, Halim and Morcos, 1973) and 1970—71 (Morcos and El-Rayiss, 1973) show that the stratification of the water masses on the continental shelf follows the general pattern of the Levant. From August to November, formerly the season of the flood outflow, the Nile Stream is now replaced by a layer of high salinity (39.0 to 39.4‰). Contrasting with the high supersaturation in oxygen resulting from increased productivity in the past (120 to 130 percent), the surface oxygen tension during this season is now the annual minimum (90 to 105 percent). The surface layer is followed by a layer of reduced salinity (38.0 to 38.70‰) and high oxygen content, presumably an extension of the North-African current of Atlantic origin (Emara, Halim and Morcos, 1973). Away from terrestrial drainage, the phosphate content falls within the low Eastern Mediterranean range (0.04 to 0.10  $\mu\text{g}$  at/L), and consequently, the whole food chain is affected. As early as 1965, the September phytoplankton bloom dropped to about 10 percent of its 1964 value (Table I). The total catch for all

Table 1. *Datom* blooms (cell/L) in nearshore waters off Alexandria.

Year	Winter Bloom	September Bloom
1957, 1961, 1962	$0.250 \times 10^6$	$9 \text{ to } 10 \times 10^6$
1965	$0.002 \times 10^6$	$0.090 \times 10^6$
1969—1970	$0.011 \times 10^6$	$0.002 \times 10^6$

fish species has dropped to about 30 percent of the 1962 value, but it is the *Sardinella* fisheries which has been more dramatically effected by the disappearance of the Nile bloom (Table 2). The future developments of the new environmental conditions, however, are still unpredictable. It is likely that the new situation will favor the less euryhaline forms and immigration of Erythrean species is expected to become more active and more successful. On the other hand, a partial recovery in the biological productivity is not

Table 2. Mediterranean fisheries of Egypt. Total catch for all species, for *Sardinella* spp., and for *Penaeidae* from 1962 to 1969, in metric tons. (From Annual Statistical Reports, Institute of Oceanography and Fisheries, Alexandria).

Year	All species (metric tons)	<i>Sardinella</i> spp. (metric tons)	<i>Penaeidae</i> (metric tons)
1962	37,832	18,166	7237
1963	33,000	13,000	8300
1964	26,000	7372	7110
1965	24,700	7635	5000
1966	15,045	1233	3733
1967	12,213	812	3082
1968	13,586	463	3135
1969	8521	600	1128

to be excluded. The observations of Morcos and El-Rayiss (1973) show a positive vertical gradient in nutrient concentration in winter and a general increase during this season. With the observed rise in surface salinity and surface density, it is not unlikely that winter convection from the deeper layers will gradually become more effective.

## SUMMARY

Studies on the phytoplankton and zooplankton communities conducted prior to and after damming of the Nile River are reviewed. Changes in components of the communities as well as changes in certain physical, and chemical parameters are noted.

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## PRIKAZ BIOLOŠKIH STUDIJA MORA U MEDITERANSKIM VODAMA EGIPTA

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### KRATAK SADRŽAJ

U radu se daje historijski prikaz istraživanja fito- i zooplanktona u egipatskim mediteranskim vodama.

Istraživanja fitoplanktona odnose se na gustoću fitoplanktona te na sastav dijatomeja i dinoflagelata, dok podataka za nanoplanktonske oblike do danas nema. Mjerenja produktiviteta su u toku.

Ukazuje se na znatno smanjenje fitoplanktonskih cvatnji od 1965. dalje, kao posljedice smanjenog dotoka voda Nila nakon izgradnje asuanske brane. Istraživanja dinoflagelata dala su inventar od 190 vrsta.

Zooplanktonska istraživanja usredotočena su prvenstveno na kopepode i sistematski su provođena kroz više godina. Odnose se na ekološka, biogeografska i faunistička zapažanja. Poznate su 132 vrste kopepoda.

Iz materijala, također sakupljanog kroz duži period u egipatskim vodama, identificirano je 7 vrsta roda *Sagitta*. Osim biologije studirane su i morfometrijske karakteristike.

Istraživani su također sastav i sezonske varijacije numeričke abundancije apendikularija. Prije izgradnje asuanske brane, glavni maksimum apendikularija u septembru bio je usko povezan s nilskom cvatnjom fitoplanktona, što nije više slučaj nakon tog zahvata.

Ukazuje se i na druge promjene sredine poslije izgradnje brane na Nilu 1965. godine. Te promjene se odnose na hidrografske uslove, resurse mora i sastav faune i flore. Izgleda, međutim, da će novo nastalo stanje favorizirati vrste organizama koje nisu izrazito eurihaline i utjecati na imigraciju eritrejskih vrsta. S druge strane se ne isključuje mogućnost djelomičnog povećanja biološke proizvodnje jer se, na temelju rezultata novijih hidrografskih istraživanja, pretpostavlja da će zimska konvekcijska strujanja postepeno postati djelotvornija u tom dijelu Mediterana.