THE INFLUENCE OF THE NILE FLOOD ON THE SHORE WATERS OF ISRAEL

by O.H. Oren and B. Komarovsky

The arrival of the Nile Flood off the coast of Israel, mostly during the month of September, is a periodic phenomenon caused by the opening of the dams in the Rosetta and Damietta arms of the Nile delta sometimes during the end of July or the beginning of August.

According to Liebman's data (1935), it takes the flood, advancing with the counter clockwise current of the Mediterranean, at a speed of 10 km per 24 hour period, about 6 weeks to reach the central part of the coast of Israel. From data available to us, the velocity of the current determined at a point off Ashdod with the Neyrpic current-meter, fluctuted between 0,00 — 0,21 m/s, at a depth of 7 m/with most frequent velocities of 0,1 m/s, corresponding to a velocity of 8,6 km per 24 hours. The direction of the measured current was between 0 — 5°N and in extreme cases between 0 — 30°N.

One arm of the current also enters the Suez Canal, causing far-reaching changes in the hydrographical conditions and in the natural plankton cycles common to any natural marine environment. These changes in the Suez Canal are limited to its northern part only, gradually fading away towards the south (Ghazzawi, 1939).

The nature of these changes brouhgt about by the outflow of very considerable quantities of fresh water from the Nile into the sea, has been considered by a number of authors. Among the first, Steuer (1935) spoke of the outburst of planktonic algae, mainly diatoms, taking place in the contact zone of the fresh water with sea water of normal salinity. Along the then Palestine coast, Liebman (1935) observed the same phenomenon at a point near the Mount Carmel Promontory at the southern end of Haifa Bay in September, 1930. The drop in salinity noted by that author was from what was considered by him as the normal salinity of the water, 38.11 ‰ in August, to 34.02 ‰ towards the end of September.

More recent information about the mean monthly salinities and temperatures along the coast of Israel in comparison with other areas in the western Mediterranean was provided by data collected and processed by Oren (1952, 1957). Some of the plankton characteristics of the same coast, such as the mass development of diatom blooms in late spring and fall as well as the occurence of the cladoceran *Podon polyphemoides* in swarming condition in neritic waters of lower salinities as a result of the Nile Flood, have been considered by Komarovsky (1953, 1956). The most recent contribution to date on this problem is a report by Halim (1960) on observations on the Nile bloom of phytoplankton in the Mediterranean. The tremendous increase in the number of cells per litre of sea water is responsible, according to the latter author, for a very considerable increase in the biological stock and consequently in the productivity of the eastern Mediterranean at that particular time of the year.

During 1959 and 1960 a special survey was carried out of the hydrographical conditions and plankton characteristics of the coastal waters of Israel during the Nile Flood. While during the month of September, 1959, important data were collected on the horizontal distribution of the current both inshore and offshore, the data collected during the same month in 1960 brought further light on the bathymetric distribution of salinities and temperatures of the sea water along the whole length of the coast (fig. 1). At the same time the composition of the plank-

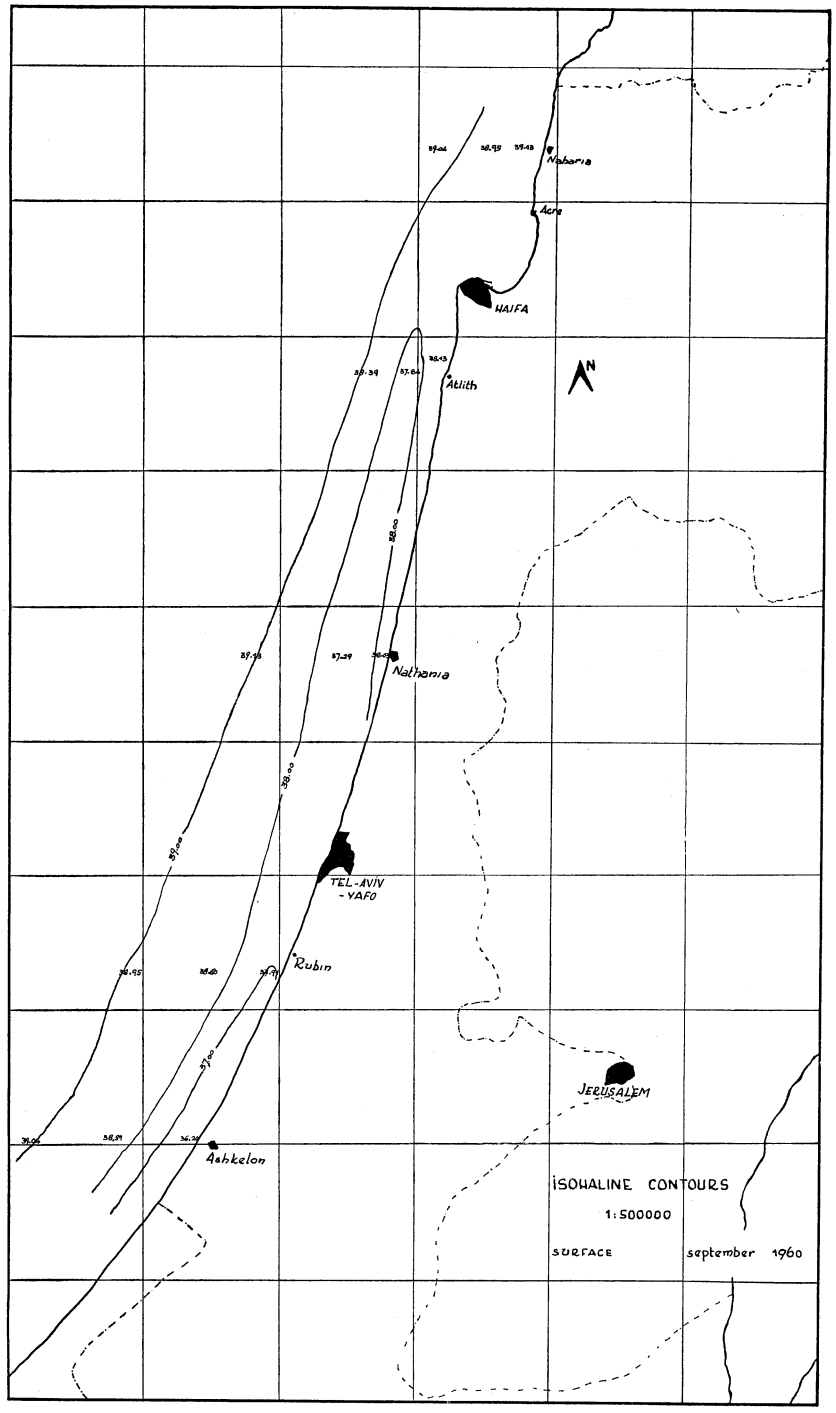
Nahariya
Acre
HAIFA
Afilith
N
Nathania
TEL-AVIV
-YAFO
Rubin
JERUSALEM
Ashkelon
ISOHALINE CONTOURS
1:500000
SURFACE
september 1960

FIGURE 1.

ton in shore waters affected by the Flood in comparison to adjacent areas, beyond its reach, was examined with a view to checking and confirming earlier results in this respect.

During the survey trip carried out in September, 1960, water samples were collected at intervals of 5 metres, vertically, from three depth lines of 10, 25 and 75 fathoms respectively, along 6 more or less equidistant profiles at right angles to the coast from Naharia in the north to Ashkelon in the south. At the same stations and profiles vertical and horizontal plankton samples were collected for subsequent analyses in the laboratory.

Results.

The lowest salinity of 36.24 ‰ was observed at 10 fathoms Ashkelon, the southernmost profile of the survey trip. The 37 ‰ isohaline extended to waters flowing very close to the shore and up to a distance of 4,5 km offshore. The vertical influence of the fresher water of this magnitude reached in the southern part of the coast to a depth of 20-25 m.

The 38 ‰ isohaline spread to a distance of 10 km offshore and to a maximum depth of 40 m.

The region of lowest salinity during that season, e.g. water masses delimited by the 37 ‰ isohaline, narrowed abruptly off Rubin to not more than about 1 km in width and 10 m in depth, while the 38 ‰ isohaline extended to some 5 km offshore in the same region.

The surface temperature prevailing at the time at the region of lowest salinity of 10 fathoms off Ashkelon was 28°C and the same isotherm for surface waters extended to some 20 km offshore.

There was a definite zoning along the coast defining the penetration of fresher water from the south northwards. Water masses with a salinity under 37 ‰ reached Rubin, those of a salinity of 38 ‰ reached up to Nathania, while the head of the current marking the transition zone to waters of normal salinities for the eastern Mediterranean of over 39 ‰ was found to be somewhere between Nathania and Atlith close to the 25 fathoms contour line. The Naharia profile, the most northerly one examined by the authors, was found to be unaffected by the current at that particular time of the year (10th of September).

The composition of the plankton samples collected during the same survey trip was found to be different from that of previous years, especially in so far as the phytoplankton is concerned. The diatom species which proved to be the most abundant off Nathania and Atlith was *Ditylum intricatum* of the Centricae, mainly at the 10 fathom contour line, in concentrations decreasing gradually further offshore. No explanation could be offered why this species proved more numerous in the samples in areas where the surface salinity of the sea water varied between 37.24-38.84 ‰ while occuring in much lower numbers in the southern part of the coast, especially off Ashkelon, where the salinity was lowest at the time (36.24 ‰). On the other hand, several species of diatoms like *Chaetoceros affinis*, *C. decipiens*, *Thalassiothrix frauenfeldii* and *T. nitzschioides* did not produce the characteristic water-blooms present in the samples of the previous years; these species, if present at all in the samples, occured only in very limited numbers.

The dinoflagellates were represented by some 30 species of which 14 belong to the genus *Ceratium*. Of the latter, a number of species were evenly distributed in low numbers along the coast, like *Ceratium candelabrum*, *C. macroceros* subsp. *gallicum* and *C. karstenii*.

Of the Dinophysiaceae, the species belonging to the genera *Ornithocercus* and *Dinophysis* were recorded in the plankton in low concentrations and irregularly distributed along the coast.

The zooplankton recorded during the September trip was found to be very rich and varied in composition. It included representatives of almost all the phyla of invertebrates occuring in the plankton in addition to numerous eggs and fish larvae.

The protozoa were chiefly represented by the Tintinnina. Some 6 species were recorded in the plankton, mostly from Ashkelon and Rubin. All but one, *Metacylis mediterranea*, are warm-water species recorded also from the Red Sea and Indian Ocean.

By far most conspicuous phylum of invertebrates characterizing the zooplankton of the Nile Flood was the Crustacea. Of these the Cladocera were represented by 3 species: *Podon polyphemoides*, *Evadne tergestina*, *E. spinifera*.

Podon polyphemoides, already reported as a neritic, euryhaline species (KOMAROVSKY, 1953), thriving particularly well in lower salinities, was recorded all along the coast more or less following the isohalines of 36-38 ‰ in its greatest incidence. This can be seen from the following table which confirms earlier results.

The occurrence of *Evadne spiniferam*, although heavy at times, proved less regular and apparently unrelated to the varying degree of salinity prevailing at the time.

The Copepoda were most numerous in the plankton, the dominant species being *Temora stylifera*, a warm-water species also known from the Indian Ocean and the Red Sea.

Temora stylifera occured all along the coast in varying densities with distinct peaks at Atlith 75 fathoms and Nathania 25 fathoms.

Depth in fathoms	Naharia	Acre	Atlith	Nathania	Rubin	Ashkelon
10	x / 30.94	x	x / 38.13	xxx / 38.03	/ 39.31	xxx / 38.24
25	x / 38.95	xxx / 38.42	xxx / 37.84	xxx / 37.29	xxx / 38.60	xxx / 38.51
75	x / 39.13		x / 38.39	/ 39.13	/ 38.95	xxx / 36.24

Distribution of the cladocearan Podon polyphemoides *in relation to salinities along the coast of Israel (september* 1960*)*, x = rare xx = common xxx = abundant.

Copepod nauplii also proved most abundant off Naharia at 10 and 25 fathoms while zoea of the Decapoda Macrura, otherwise evenly distributed along the coast, reached a peak in abundance off Naharia at 10 fathom. In the same region considerable concentrations of *Sagitta friderici*, the main chaetognath species occurring in our costal waters, were also recorded.

Special mention is to be made of the large scale occurrence of sand grains appearing in a considerable number of samples. These grains, mostly of irregular shape and microscopic size, are largely responsible for the turbidity of the coastal waters affected by the Nile Flood. Their occurrence in the plankton samples was quite heavy off Ashkelon, Rubin, Nathania, then gradually subsiding off Atlith, Haifa Bay and Naharia, suggesting that the head of the current was probably in that region at that time of the year.

General considerations.

When the composition of the plankton collected during the Nile Flood off the coast of Israel is considered as a whole, certain considerations may be deemed appropriate.

Most of the forms recorded in the systematic list are neritic. This seems to suggest that the paucity of « open sea » forms like large Siphonophora, Salpae or thecate Pteropoda present, as a rule, in the plankton of the summer months, is indicative of the fact that the water of the open sea has been « pushed away » by the fresher water coming from the Nile. This is exactly the term used also by the late Prof. STEUER who observed the same trend in the composition of the plankton in his studies of the Fishing Grounds off Alexandria in 1935.

This view is substantiated by the presence in swarming condition of certain organisms like *Podon polyphemoides* wich reach mass development in the coastal waters with lower salinities.

At the same time, the composition of the plankton during the Nile Flood in 1960 is somewhat different from that of previous years. The absence of characteristic water-blooms produced by a number of centric and pennate diatoms like *Chaetoceros affinis*, *C. decipiens* and *Thalassiothrix frauenfeldii* and *T. nitzschioides* has already been pointed out. This may be caused by the fact that the influence of the Nile Flood was somewhat weaker in 1960 than in previous years as is shown by the salinity values which did not drop below 36.24 ‰ at their lowest off Ashkelon 10 fathoms.

To obtain additional data which could throw further light on the horizontal and vertical distribution of planktonic organisms during the Flood, closing nets and plankton samples taken by the sedimentation method from various depths, would have to be used during the 1961 Flood season. This should enable us to determine the bathymetric distribution of characteristic plankton organisms in relation to the data on temperatures and salinities at the various depths. At the same time, an attempt should be made to compute numerical data based on actual counts per unit volume of sea water of those organisms whose presence in the plankton at this time of the year may be significant.

Acknowledgments. The authors wish to express their thanks to Mr. D. Divon, Head, Coast Study Division, Ministry of Transport, for data on shore currents, to Mr. U. SALVADOR for the help at sea and the technical drawings, and to Mrs. H. Hornung for the many chemical analyses.

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