THE MACROBENTHIC ANIMAL COMMUNITIES OF THE ISRAELI CONTINENTAL SHELF IN THE MEDITERRANEAN [1]

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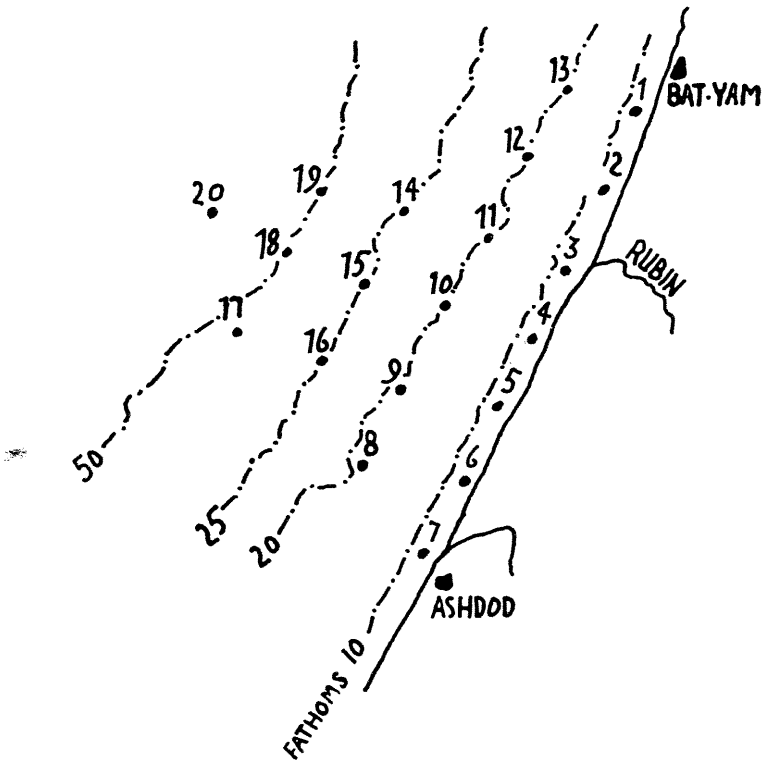
Methods and area of investigation.

The southern section of the Israeli continental shelf was chosen as an object of this investigation because of its importance as a fishing area for demersal species. A grid of stations was planned to cover an area of approximately 50 square miles in a form of triangle placed with its base parallel to the coast line (map showing the stations). The average distance between stations was 2 miles and they were situated along depth lines of 5, 20, 25, 40, 45, 50 and 75 fathoms.



MAP. — *Station grid off Bat-Yam-Ashdod.*

Collection of samples was carried out on board the research vessel "Mevo'ot Yam", by means of a Petersen bottom grab 0,2 square meters (77 samples) ; a triangle dredge (25 samples) and a beam trawl (56 samples). Description of the macrobenthic animal communities is mainly based on beam trawl samples.

(1) This research was sponsored by the Atomic Energy Commission of Israel as a part of a larger programme the purpose of which is to study the uptake of radioactive elements by marine biota.

The sampling was carried out during the period : october 1960-march 1962 and was originally planned at monthly intervals. However, due to technical difficulties sampling cruises were carried out only during the following months : october, december 1960 ; march, april, july, september, october, november 1961 ; january, february, march, april 1962.

Character of substratum.

Quality of substratum in the investigated area varies with depth, being sandy close to the coast and increasing in silt and clay gradually offshore. No rocky areas were encountered. Granulometric analysis of substratum, carried out in the Geological Institute of Jerusalem (report 1 on the Mediterranean, nov. 1961), proved that sand constitutes up to 99 per cent of soil particles at the dephts of 5-10 fathoms and diminishes gradually reaching a minimum of 2 per cent at the depths of 75-100 fathoms.

Percentage of silt increases rapidly from a minimum of 0,5 per cent at the depths of 5-10 fathoms reaching a maximum of 56 per cent at the depth of 40 fathoms ; the clay increases from 0,5 per cent at 5-10 fathoms reaching a maximum of 56 per cent at the depth of 79-100 fathoms.

The method of granulometric analysis for sand, silt and clay and the definition of size limits for each fraction is based on EMERY (1960).

Animal communities of macrobenthos.

Sensitivity of benthic invertebrates to the granulometric composition of the substratum has been stressed by THORSON (1957) who states that the composition of the bottom fauna may be used for the characterization of the substratum even more than its physical and chemical analysis. Correlation between the soil grade and the distribution of marine invertebrates has been proved to exist for polychaetes (SOUTHWARD, 1957) and molluscs (HOLME, 1954) in english waters ; the same relationship was demonstrated for echinoderms in the North Sea (URSIN, 1960) and decapods off North Carolina (WILLIAMS, 1958).

Uniformity of substratum at the same dephts has its influence on formation of benthic communities on the continental shelf of Israel in the Mediterranean. In the southern section (Bat Yam-Ashdod) communities are distributed in longitudinal parallel zones which may be identified by means of isobaths. The sandy bottom community extends along the isobaths of 5-10 fathoms (stations 1-7) and is characterized by the the leading species : *Diogenes pugilator*, *Nassa mutabilis*, *Cardium paucicostatum* and *Echinocardium cordatum*. Polychaetes are not represented in this area by large and frequently occuring species ; however, minute specimens belonging to many species were taken in the Petersen grab. Decapods in the sandy bottom region are represented by the pagurid *Diogenes* the distribution of which is confined to this area only, though semi-pelagic forms are also abundant : *Penaeus kerathurus*, *Metapenaeus monoceros*, *Portunus pelagicus* and *P. hastatus*.

Transition from sandy to muddy substratum starts between the dephts of 10 and 20 fathoms isobaths (stations 8-13). The community of sand-muddy bottom is composed of the following leading species : *Maldane glebifex*, *Charybdis longicollis*, *Aporrhais pespelecani* and *Schizaster canaliferus*. The shrimp *Parapenaeus longirostris* is also abundant though it prefers muddy bottom. The lamellibranch *Cardium paucicostatum* forms a patch (stations 11 and 12) but its distribution is not uniform at the other stations of the 20 fathoms isobath.

Penetration of species, dominant in the adjacent communities of shallower and deeper waters, into the community of sand-muddy substratum, proves that no exact limit can be determined for the distribution of benthic invertebrates on level bottom substrata. Several species are common inhabitants along the isobaths of 20 and 25 fathoms ; however, a lower percentage of sand in deeper waters is the main factor responsible for changes in the community

composition. The dominant species of the 25 fathoms isobath community are : *Sabella pavonina*, *Maldane glebifex*, *Charybdis longicollis* and *Antedon mediterranea*. The accompanying species characteristic for this subcommunity (the communities on the 20 and 25 fathoms isobaths may be regarded as one community *Maldane-Charybdis*) are the following : *Parapenaeus longirostris*, *Myra fugax*, *Doripe lanata*, *Cardium paucicostatum* and *Schizaster canaliferus*.

Increase of clay and silt in the substratum is characteristic for the area comprising the 40 and 50 fathoms isobaths, which are close to each other being placed near the continental slope. The community in this zone (stations 17-19) is typical for muddy bottom and is dominated by *Sabella pavonina* and *Brissopsis lyrifera*. These two representatives of the community penetrated into shallower waters and were found on the sand-muddy substratum. *Parapenaeus longirostris* and *Antedon mediterranea* which are very abundant on muddy substratum, have a broader distribution and may be regarded as components of other communities as well.

At the edge of the continental shelf (75-100 fathoms ; station 20) few samples were taken so as to enable an evaluation of the community composition, but the dominance of *Brissopsis lyrifera* in this area is definite. The presence of *Sternaspis scutata* in the muddy bottom community of deeper waters should be also stressed.

None of the above described communities is distinctly separated from the adjacent community in deeper or shallower waters. Transition from one into the other is gradual to the extent to wich the composition of the substratum changes. Arrangement of the communities is zonal but in areas in which the substratum composition diverges from uniformity, the character of macrobenthic communities is influenced. Such conditions happen to exist in areas close to riverlet outlets, where the clay-silt percentage is higher. In these areas, the muddy bottom community penetrates into sandy bottom and is disclosed in shallow waters.

Discussion.

This study confirms the validity of the ecological concept of animal bottom communities. The correlation between the distribution of invertebrates and edaphic characteristics of the area studied is evident, though it is impossible to prove the existence of mutual relations among the community members. A small increase in sand relative to clay and silt, leads to a preponderance of *Echinocardium* while increase in clay favours the dominance of *Brissopsis* and *Maldane* (THORSON, 1957). The same situation prevails in the investigated area on the Israeli continental shelf, where the polychaete *Maldane glebifex* is often accompanied by another species *Sabella pavonina*. Both species are abundant in the bottom community of the 25 fathoms isobath, but with the advance into deeper waters in wich the percentage of clay is higher, *Sabella* becomes dominant.

Many of the benthic invertebrates are suspension or deposit feeders and their larvae are attracted by a favourite substratum, rich in certain species of microorganisms as proved for *Ophelia bicornis* (WILSON, 1955). Attraction of larvae to a substratum is the main factor regulating the distribution of adult populations. WILSON (1956) claims that the larvea, being at settlement time sensitive to the quantity and quality of microorganisms in the substratum, are choosing their food which they obtain at the adult stage by swallowing sand or mud.

The most abundant molluscs in level bottom communities of the Israeli continental shelf are *Aporrhais pespelecani* and *Cardium paucicostatum*. The first species is a deposit feeder, its distribution being controlled by edaphic factors. The lamellibranch is a suspension feeder, taking in a continuous current of sea water and filters out of it the microscopic plankton organisms suspended close to the sea bed (YONGE, 1961).

Echinoderms are well represented in the investigated area by irregular echinoids. In the sand-mud bottom communities the dominant species is *Schizaster canaliferus* while in muddy bottom communities *Brissopsis lyrifera* is the leading species. Distribution of the latter in the North Sea is a function of its food, which is composed of minute benthic and planktonic organisms deposited in the substratum.

The community, in which *Charybdis longicollis*, a crab of Indo-Pacific origin, is one of the dominating species, may be compared with the community of *Pinnixa rathbuni* on sandy substratum, in japanese waters. It is claimed by the descriptor of this community that large numbers of crabs cannot occupy the bottom for a long period. THORSON (1957) denies this and states that such communities do exist permanently in the Persian Gulf. The presence of such a community, by no means a seasonal one, in the eastern mediterranean, proves that *Charybdis* can exist in larger concentrations forming a thriving population wich presumably competes with the endemic species of crabs on the availability of food. The dominance of Indo-Pacific species over endemic mediterranean species of benthic invertebrates is worth mentioning. Explanation of this fact can be sought in studies on the ecological adaptation of species which migrate from Red Sea through the Suez Canal into eastern mediterranean.

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