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The effects of the sludge dumping and disposal on the benthic fauna in Izmir Bay

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Izmir Bay is an area which has been subject to efforts to deepen the harbour since 1930. This bay is divided into an inner bay, a middle bay and an outer bay, from the standpoint of topographical and hydrographical characteristics (Fig. 1). The polluted inner bay, where the Izmir harbour is located and where mud-dredging efforts have been carried out, is narrow (57 km2) and shallow (maximum depth 21 m); the unpolluted outer bay, where the mud has been dumped, is much wider (539 km^2 and deeper (45-70 m).

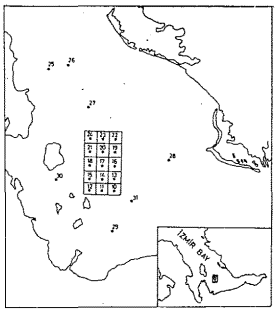

Figure 1. Sampling stations.

Dredging efforts were carried out in the harbour in two periods : 1930-1976 and 1976-1988. In the first period 2.8 million m^3 of mud was dumped back into the inner bay; in the second period 9 million m^3 of mud dredged out was dumped in the outer bay near Hekim Island. In order to determine the effect of the mud dumped in the outer bay upon benthic communities, samples were taken by grab (10 dm^3) from 22 stations which had been decided on in the area in question during June 1990. The results of these samples showed 98 species belonging to 8 groups. Speaking qualitatively, Polychaeta were first with 41 species, followed by Crustacea, with 25 species (Fig. 2).

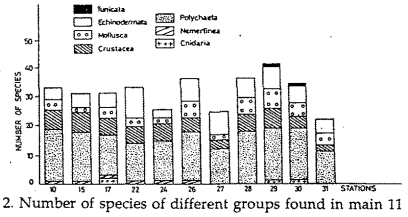

Figure 2. Number of species of different groups found in main 11 stations.

In order to determine the degree of similarity among the 22 stations, when the dendogram made using the BRAY-CURTIS similarity coefficient is examined, the maximal similarity is seen to be 67% (Fig. 3). Of these, the first group, with a similarity of about 56%, was at stations 28 and 29, the second was at station 31, the third group at stations 25 and 26, the fourth group at station 30, and the fifth group, with similarity changed from 45 to 67%, was at the other stations (Fig.4).

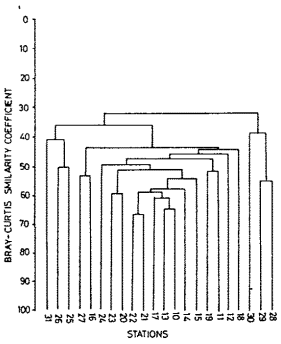

Figure 3. Bray-Curtis similarity dendogram among stations.

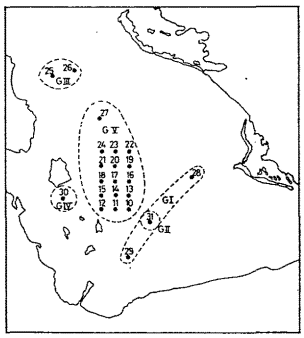

Figure 4. The result of MDS analyses.

In the studies carried out in the dumping area, only *Audouinia tentaculata* of the species characteristic of polluted zones was observed, and a few examples of *Corbula gibba*, characteristic of semi-polluted zones, were observed. In addition, examples of such species as *Brissopsis lyrifera, Labidoplax digitata, Sternaspis scutata* and *Turritella communis* which are characteristic of clean zones, were encountered at all stations. In conclusion, when studies done earlier (GOKCEN and CIRIK, 1988; KOCATAS *et al.*, 1988) are compared with those carried out at stations outside the dumping area, it may be seen that benthic species in this area have not been much affected.

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Seasonal structure and ecological status of Varna Bay (Black Sea) sandy and muddy macrozoobenthic coenoses

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Recently Varna Bay has been considered as an ecologically threatened area mainly due to Varna lake high eutrophic water discharge. According to investigations carried out in 1981 (the season is not mentioned) 5 zoocoenoses are differentiated and 2 new Mollusca species are established (*Mya arenaria* and *Anadara* sp.)(MARINOV *et al.*, 1983). The periodical summer postblooming mass mortality since 1986 has indicated a critical status of macrozoobenthic communities (KONSOULOVA *et al.*,1991). In the present investigations carried out in 1990-1991 period 22 benthic samples have been taken seasonaly from 11 sampling stations (two samples from each station) by a Van Veen grab covering 0.1m2 (Fig.1). The mean data are used for calculating Sorensen's coefficient of similarity, Shannon-Weaver's information index (H) and kombined K-dominance curves for species abundance/biomass comparison detecting the pollution effect on marine macrozoobenthic communities (ABC method)(WARWICK *et al.*,1937).

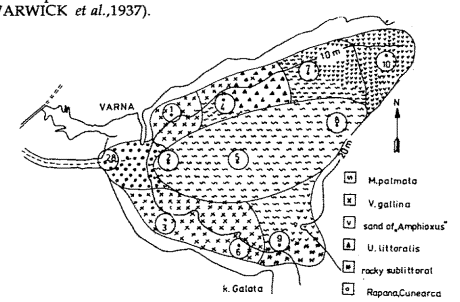

Fig. 1. Sampling stations and zoocoenoses location in Varna Bay

Results

Zoocoenosis Venus gallina (*Chamelea gallina*)(st. 1, 3, 6). From the total of 41 species and groups 20 are Annelida, 12 - Mollusca and 8 - Crustacea. The mean density varies greatly seasonally, the minimum being in spring (596 ind.m^{-2}) and the maximum - in summer (11529). In the structure prevail Annelida-69.6% (*Capitomastus minimus, Polydora ciliata*) followed by Mollusca - 22.1% (*Ch. gallina*), while Crustacea are the least numerous - minimal in summer (3.7%-Balanus improvisus) and greater in autumn (14.15% - *Diogenes pugilator, Ampelisca diadema*). The biomass is almost entirely composed of Mollusca (96.3%) including the new immigrants *Rapana thomasiana* and *Cunearca cornea*. The information index H is the lowest in summer (1.7) and according to ABC graphplots configuration the communities in the sotlthern part of the bay (st.3,6) are "moderately polluted"in this season.

Zoocoenosis Melinna palmata (st.2,5,8). It cover the bottom in the central part of the bay. The total of 44 species are established out of which 15 Annelida, 13 Crustacea and 13 Mollusca. Both the density and structure do not vary greatly seasonally: Annelida are the dominant group (*M. palmata*, Oligochaeta) - average 88.8%, followed by Mollusca *Ch. gallina, Spisula subtruncata*) - 7.0% and Crustacea - 2.6%. The biomass is composed prevailingly of Mollusca dominant species C. *cornea*) - 92.0% It is lowest in autumn (499.6 g.m^{-2}) and highest in spring (1267). The information index H is reduced in summer to minimum 1.8 and in autumn it is increased to maximum 2.2. The manifest dominance of *M. palmata* in summer and the reduction of a number of species in winter determines this zoobenthic community as "moderately polluted" in summer and "grossly polluted" in winter according to the ABC graph-plots configuration.

Zoocoenosis of "Sand of *Amphioxus*" (st. 10). From the total of 61 species 28 are Annelida, 15 - Mollusca and 15 - Crustacea. The mean density varies in a wide range: the minimum is in winter (2390 ind. m^{-2}) and the maximum - in summer (13372). Although Annelida are again the dominant group (*Staurocephalus kefersteinii*) - average 73.0%, in spring and summer they are followed by Mollusca (*Calyptrea chinensis, Mya arenaria*) - 19.5% while in winter and especially in autumn they are followed by Crustacea - 25.2% (*Corophium bonelli, Ampelisca diadema*). The biomass is composed mainly of Mollusca and varies seasonally between minimum 59.0 g.m-Z in autumn and 2364 in spring (*Ch. gallina*). The information index H varies between 2.5 in summer and 3.0 in autumn. According to the kombined K-dominance curves this zoocoenosis is "moderately polluted" in winter. In the rest of the stations macrozoobenthic communities are composed of typical for the neighbouring zoocoenoses species. Dead Crustacea (*U. littoralis, Calianassa pestai* and *Macropipus holsatus*) were registered in the summer postblooming period in 1991 in this area.

The results of comparatively studied two types of zoocoenoses in summer 1990 (in normal disolved oxygen content in the near bottom layers) and 1991 (in the postblooming hypoxia) reveal different responses of the zoobenthic communities. In the *Melinna* zoocoenosis (distingushed by the lowest annual H index - 2.0) information index H goes down from 2.7 in 1990 to 1.9 in 1991, together with a decrease in the total abundance and biomass - 1.4 and 4 times respectively, which determines a trend to a further total reduction of species and specimens. In the zoocoenosis of "Sand of *Amphioxus*" (characterized by the highest H - index) a reaction typical for an earlier stage of pollution is to be observed: the abundance and biomass increase threefold and fourfold respectively in 1991 accompanied by an abrupt drop in the H - index - from 4.1 to 2.15.

Conclusions

1/Summer is the most critical season for the macrozoobenthic communities in Varna bay.

2/The zoocoenoses in the northern part of the bay are in a better ecological status compared to those in the southern part, which in summer are "moderately polluted".

3/In the most unfavourable position is the community in the central part of the bay (muddy bottom) which is "moderately polluted" in summer and "grossly polluted" in winter.

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