Structural change in a North Adriatic sediment macrofauna

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An increasing input of nutrients into the North Adriatic was noted during the last decades (MARCHETTI *et al.*, 1989). The rise of the primary production evident like phytoplankton blooms in the course of the last 5-6 years made large quantity of organic matter available for the consumers. A certain part of this matter is consumed through bacterial activity requiring considerable amount of oxygen. In conditions of clearly vertical stratification of the sea water column, the concentration of dissolved oxygen is decreasing at the bottom layer. This is one of the factors which lead to hypoxic and anoxic conditions in some parts of the shallow North Adriatic. Such unfavorable conditions for benthic assemblages have already been noted previously, but recently they appear almost as a rule, after the summer period every year.

Macrobenthos was sampled at three offshore stations, in the period 1982-83, November 1990 and October 1991 (Fig. 1). A 0.1 m^2 Van Veen grab and sieve of 2mm mesh were used at all stations surveyed, species diversity recently has noticeable decreased and fell down to the half of the starting value, but the specimen number remained at approximately the same level or increased a bit (Table I).

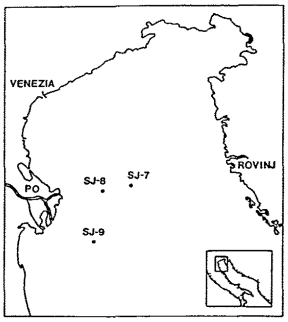

Figure 1. Research stations.

In the community composition indicative changes took place. In the samples from 1982-83, according to abundances, dominated the groups of Polychaeta, Echinodermata and Sipuncula (ZAVODNIK and VIDAKOVIC, 1987). Recent data, however, show an absolute dominance of Mollusca group which account for 80% of all individuals. The share of Polychaeta and Echinodermata remarkably fell down. At the station SJ-7, where echinoderms dominated in the samples from 1982-83, in October 1991 no specimen alive was found. In the contrary, Sipuncula account for 73% of total number of macrofauna collected in the sample (Table II).

All three stations are located in the area of Vatova's zoocoenosis *Turritella* (VATOVA, 1949). The abundance of the screw-shell *Turritella communis*, the preferent species of coastal terrigenous ooze, decreased in regard to the initial situation at the station SJ-7. In the meantime the number of alive individuals have risen at the stations SJ-8 and SJ-9.

Table I. Macrofauna diversity (S) and abundance (N m^{-2}) at station surveyed.

Year		'82	'90	'91
Samples /stat.		30	4	4
7	S	91	41	22
	N	1013	2120	767
8	S	89	30	39
	N	1165	1596	1570
9	S	62	32	32
	N	848	1292	1337

The multiplying share of mollusks in total abundance primarily account for bivalve shell *Corbula gibba* the species of wide ecological distribution which is considered to be an indicator of pollution and/or instability of the community (FAO/UNEP, 1986).

Table II. Relative abundance of different groups.

Station	7			8			9		
Year	82	90	91	82	90	91	82	90	91
MOLLUSCA	15	82	81	10	86	81	6	64	19
SIPUNCULIDA	13	3	1	5	5	4	6	21	73
POLYCHAETA	54	11	14	36	5	8	21	19	6
ECHINODERMATA	16	1	1	48	2	4	66	2	0
VARIA	2	3	3	1	2	3	1	3	2

The species of *Amphiura filiformis*, *A. chiajei* and *Notomastus latericeus*, dominating during the period 1982-83, have almost completely disappeared in samples. At the station SJ-7, the number of sipunculid *Aspidosiphon kovalewskii* has enormously grown up. According to ZAVODNIK and VIDAKOVIC (1987), this growth could be refered to decreasing number of alive individuals of *Turritella communis*.

Table III. Minimum oxygen saturation in the bootom layer.

Year	82-83	91
7	49	17
8	31	10
9	24	29

At stations surveyed, the oxygen saturation data in the bottom layer in 1991 imply the changes in the lowest oxygen values (Table III).

The minimum concentrations in October are three times lower than noted within the period 1982-83 at stations SJ-7 and SJ-8, while its value at the station SJ-9 remained at about the same level. In any case, these values are below the "biological anoxy" limit (STACHOWITSCH, 1991).

We consider the described changes in benthic community structure as a direct consequence of repeated seasonal concentration falls of dissolved oxygen at the bottom layer during the autumn. According to our data the macrofauna at the station SJ-7, which was chosen as a control station during the research in 1982-83, is the most affected. The pronounced domination of *Corbula gibba* and a diminishing species number at the same time, suggest an important change in benthic macrofaunal assemblages. Although in past years no new mass mortality of organisms has been noted, the communities obviously are under constant pressure of limiting environmental factors which do not allow the re-establishment of stable conditions.

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A benthic foraminiferal record documenting the onset of eutrophication in the Northern Adriatic Sea

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The vertical distribution of benthic foraminifera in a core in front of the Po delta (Fig. 1) has been studied in detail. According to our age model, based on ^{210}Pb and ^{137}Cs analyses of a core on the same location, this core documents the last 160 years. The isotope profiles further show that sediment mixing is largely limited to the top cm of the sediment, suggesting that this core should provide an extremely detailed record.

Benthic foraminiferal patterns and grainsize analysis indicate a number of substantial changes in sedimentation rate, food and oxygen availability in the benthic ecosystem. Changes occurring at about 1840 and 1880 can be attributed to man-induced changes in the main outflow canals of the Po river. The first led to an important reduction of the marine vegetation cover which had been present up to that date. The second one resulted in the present-day situation in which the Po outflow is passing the studied core locality closely.

From 1900 onwards, the benthic foraminifera indicate a steadily increasing nutrient load. This trend is interpreted as the effect of the anthropogeneous eutrophication, due to agriculture and waste water disposal. A marked faunal transition around 1930 indicates the intensification of eutrophication.

Around 1960 the first signs of an increasing importance of anoxic events can be recognized in the benthic record. The faunal changes in the last decade, which were described to changes in preservation potential, indicate that more intense or more prolonged anoxia started about 10 years ago, and that the ecological health of the northern Adriatic is still in decline.

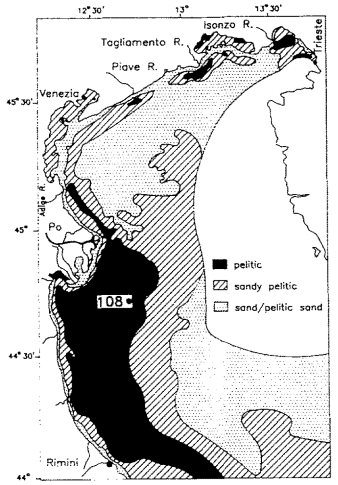

Fig. 1.- Location of core station 108 (water depth 32 m), plotted on a simplified surface sediment map (after BRAMBATI, CIABATTI, FANZUTTI, MARABINI and MAROCCO (1983): A new sedimentological textural map of the northern and central Adriatic Sea. *Boll. Oceanol. Teor. Applic.*, 4, 267-271).