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MODIFICATION OF MUDDY BOTTOM MACROFAUNA IN ORBETELLO LAGOON (ITALY) ALONG A GRADIENT OF ORGANIC ENRICHMENT

SUMMARY

The bottom macrofauna of three stations located in the central part of Orbetello lagoon has been studied. The hydrological and sedimentological conditions of the three stations are similar, except for the level of organic enrichment. The mud communities of these stations contain species with high ecological valence and are characterized by a good level of stability throughout an annual cycle. The values of three fundamental parameters: species number, total abundance and biomass show, along a gradient of organic enrichment, a pattern similar to that found in many coastal and estuary environments.

RIASSUNTO

Modificazione della macrofauna di fango nella laguna di Orbetello lungo un gradiente di arricchimento organico.

È stata studiata la macrofauna del fondo fangoso in tre stazioni situate nella zona centrale della laguna di Orbetello, simili per caratteristiche idrologiche e sedimentologiche, ma differenziate da un diverso grado di arricchimento organico. Le comunità in esame sono costituite da specie ad alta valenza ecologica e si presentano notevolmente stabili nel corso del ciclo annuale. Il numero di specie, il numero degli individui e la biomassa presentano, lungo un gradiente di arricchimento organico, un pattern simile a quello riscontrato in molti altri ambienti costieri ed estuariali. Viene suggerito di utilizzare il controllo di questi parametri per una valutazione del massimo carico organico che l'ambiente lagunare può ricevere senza subire un dannoso eccesso di eutrofizzazione.

Key words: lagoons - mud communities - organic enrichment.

Coastal lagoons and estuaries are naturally eutrophic environments and their potential production makes them particularly suitable for aquaculture. Human settlements around these areas usually introduce large amounts of organic material, which further increase the level of eutrophication. This organic enrichment is not always to be considered a negative factor. In fact, if it is maintained within appropriate limits, the total productivity of the system is increased. On the contrary, an excessive enrichment alters the equilibrium of lagoon biocoenoses and reduces the productivity. A fundamental problem in the management of these environments is, therefore, to quantify the amount of organic input which favours productivity and to define the limits above which the excess of eutrophication causes distrophy.

PEARSON & ROSENBERG (1978) examined a large quantity of data concerning the spatial modifications of some fundamental parameters (bio-

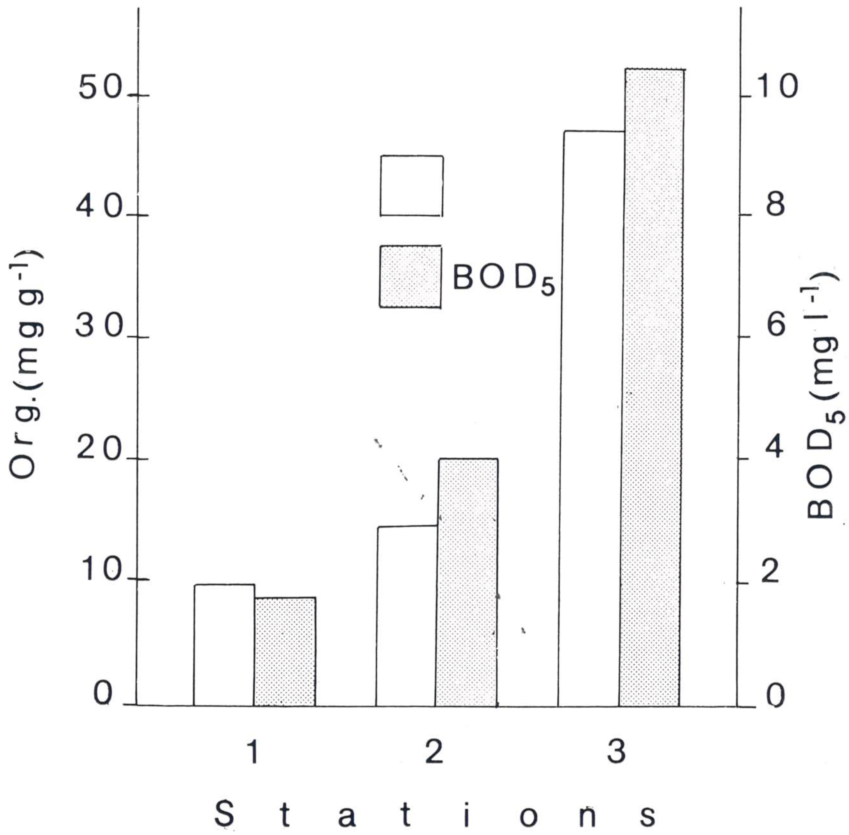

Fig. 1. — BOD and organic matter (Org.) in the sediment of each sampling station.

mass, abundance, species numbers) in coastal areas and estuaries with respect to organic enrichment (Bellan & Bellan Santini, 1972; Anger, 1975; Leppakoski, 1975; Pearson & Rosenberg, 1976; Rosenberg, 1976). These data, although from a variety of environments, show a general pattern, which can be taken as a general model of the progressive modifications of the benthic macrofauna in response to increasing levels of organic pollution (fig. 1).

The Orbetello lagoon presents a series of environmental conditions which vary spatially (Cognetti et al., 1978). Along the coast of both basins the soft bottom populations are principally influenced by water exchange from both the sea and fresh waters. The central areas of the lagoon are not affected by the sea exchanges and are subject to a heavy organic pollution from urban discharges.

In this paper the macrobenthic communities of some stations located in the central part of the lagoon and differing for the level of organic enrichment are examined.

Methods

Three collection stations were fixed in the central part of the lagoon. The first station is located in the center of the western lagoon and supports a low level of organic enrichment. The second station is located in the center of eastern lagoon; this basin support, for a large extent, high quantities of organic materials. The third station, finally, is located in the area facing the town of Orbetello in the western lagoon. This area support a very high level of organic enrichment, being directly influenced by urban outflows and liquid wastes from a slaughterhouse.

The samples were collected using a Eckman-Birge dredge with manual closure, having a sampling surface of 0.225 m^{-2}. Three replicates per station were taken during 12 monthly sampling occasions during 1976-77. The samples were sieved through a 0.5 mm mesh screen and the portion retained fixed in 4% neutral formalin. Animals were removed under a stereomicroscope and identified to species. The biomass was determined as wet weight after elimination of the non-living parts. The BOD_5 was determined on water samples collected near the bottom at each sampling occasion. The quantity of organic matter in the sediment was determined on a portion of the dredged material using chromic oxidation method of Walkey & Black (1934).

Results of chemical analyses are represented in fig. 1.

RESULTS AND DISCUSSION

The species number, total abundance (ind. m^{-2}) and biomass (g m^{-2}) are reported in Table 1, and shown graphically in fig. 2.

Station 1 has the lowest level of organic enrichment. In this station 13 habitual species are found; among these *Armandia cirrosa* and *Aricia foetida* are the predominant Polychaetes and *Abra ovata* is the predominant Mollusk. The annual biomass is moderate for a lagoon environment, amounting to 37.75 g m^{-2}; the abundance is 900 ind m^{-2}.

Station 2 has a higher level of organic enrichment. A marked increase in the biomass and total abundance is detected; the biomass is more than double that of station 1, while the abundance is actually 7 times greater. The gap between the increase of biomass and the increase of abundance is due to the dominance, in this station, of the Polychaete *Armandia cirrosa* and the Oligochaete *Peloscoles* sp., which, because of their small size, have a little influence on total biomass. The moderate increase of the

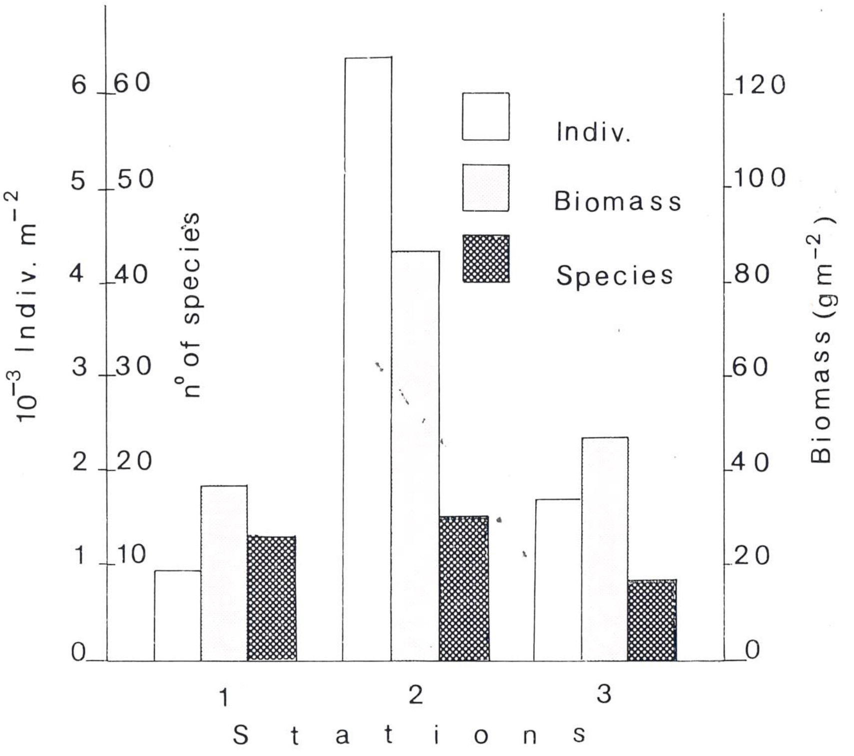

Fig. 2. — Diagram of species numbers, abundance and biomass in the stations under study.

species number can be attributed to the presence of a Phyllodocidae species in the mud community. Usually Phyllodocidae do not belong to the mud community, but, as observed in station 1, to the algae community. On the contrary, in the lagoon area including station 2, where underwater vegetation is almost completely absent, Phyllodocidae have become part of the mud community. This is a typical case of an adaptive strategy adopted by species with high ecological valence (Cognetti, 1978a; 1978b).

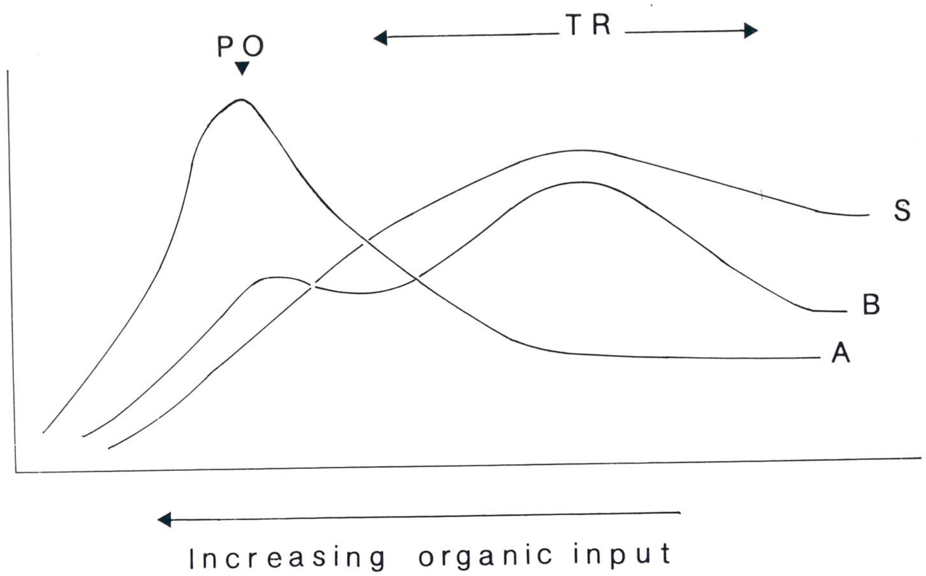

Fig. 3. — Diagram from Pearson & Rosenberg: S, species numbers; A, total abundance; B, total biomass; PO, peak of opportunists; TR, transition zone.

Station 3, with the highest level of organic enrichment, presents a drastic reduction in species number, total abundance and biomass. The last is of the order of that found in station 1, which has the lowest level or organic enrichment.

The data on the settlements in the three stations under study fit the general pattern of the « transition zone » found in coastal areas and estuaries subject to organic enrichment (fig. 3). The peak of opportunist is not present in this environment; these communities, in fact, possess a high degree of tolerance, even to high levels of organic enrichment. The increase of total abundance and biomass in response to moderate organic input and

Table 1 — Species, abundance and biomass in the three stations under study

Species	Stations 1		2		3	
	ind m^{-2}	g m^{-2}	ind m^{-2}	g m^{-2}	ind m^{-2}	g m^{-2}
Aricia foetida	192	6.52	696	23.66	755	25.60
Armandia cirorsa	222	0.07	2779	0.85	—	—
Capitella capitata	14	0.22	—	—	—	—
Eulalia punctifera	—	—	14	0.07	—	—
Eulalia viridis	—	—	32	0.14	—	—
Nereis caudata	—	—	—	—	15	0.53
Perinereis cultrifera	14	0.20	—	—	—	—
Phyllodoce pusilla	—	—	44	0.19	—	—
Phylllodoce rubiginosa	—	—	31	0.13	30	0.12
Platynereis dumerilii	—	—	14	0.21	—	—
Polydora antennata	—	—	33	0.33	—	—
Scololepis fuliginosa	15	0.37	46	1.15	—	—
Staurocephalus kefersteini	—	—	—	—	118	4.13
Peloscolex sp.	—	—	1644	8.22	563	2.82
Lineus nigricans	30	0.60	—	—	31	0.50
Abra ovata	192	7.32	758	28.80	148	5.63
Cerastoderma glaucum	30	16.01	29	15.47	14	7.42
Amiclyna corniculum	44	3.11	—	—	—	—
Cyclope neritea	29	2.36	76	6.08	—	—
Hydrobia ventrosa	74	0.37	152	0.80	—	—
Chironomus salinarius	30	0.60	—	—	—	—
Cumacea sp. indet.	14	—	133	0.15	—	—
Total	900	37.75	6481	86.25	1674	46.75

their fall in response to heavy enrichment may supply an objective indication to quantify the limit at which organic input must be managed to permit lagoon fertilization while preventing distrophy.

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REFERENCES

ANGER K., 1975 — On the influence of sewage pollution on inshore benthic communities in the South of Kiel Bay: 2 Quantitative studies on community structure. — *Helgol. Wiss. Meeresunters.*, 27: 408-438.

BELLAN G., BELLAN SANTINI D., 1972 — Marine pollution and Sea life. M. Ruivo Ed. — *F.A.O., Fishing News*, Ltd. London, 624 pp.

COGNETTI G., 1978a — On some aspects of the ecology of the benthic littoral Polychaetes. — *Boll. Zool.*, 45: 145-154.

GOGNETTI G., 1978b — Influence of substratum on predominantly physically controlled communities. — *Rapp. Comm. int. Mer Médit.*, 25/26: 181-182.

COGNETTI G. et al., 1978 — Risanamento e protezione dell'ambiente idrobiologico delle lagune di Orbetello. — *Ingegneria Ambientale*, 7 (4): 316-406.

LEPPAKOSKI E., 1975 — Assessment of degree of pollution on the basis of macrozoobenthos in marine and brackish-water environments. — *Acta Acad. Aboensis, Ser. B Math. e Phys.*, 35: 1-90.

PEARSON T. H., ROSENBERG R., 1976 — A comparative study of the effects on the marine environment of wastes from cellulose industries in Scotland and Sweden. — *Ambio*, 5 (2): 77-79.

PEARSON T. H., ROSENBERG R., 1978 — Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. — *Oceanogr. Mar. Biol. Ann. Rev.*, 16: 229-311.

ROSENBERG R., 1976 — Benthic fauna dinamics during succesion following pollution abatement in a Swedish estuary. — *Oikos*, 23 (3): 414-427.

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