ECOLOGY OF SOFT BOTTOM MACROBENTHOS ALONG THE COAST OF SOUTHERN TUSCANY (PARCO NATURALE DELLA MAREMMA)

by

Maria Cristina GAMBI and Eugenio FRESI

Stazione Zoologica di Napoli, Laboratorio di Ecologia del Benthos, ISCHIA PORTO (Napoli).

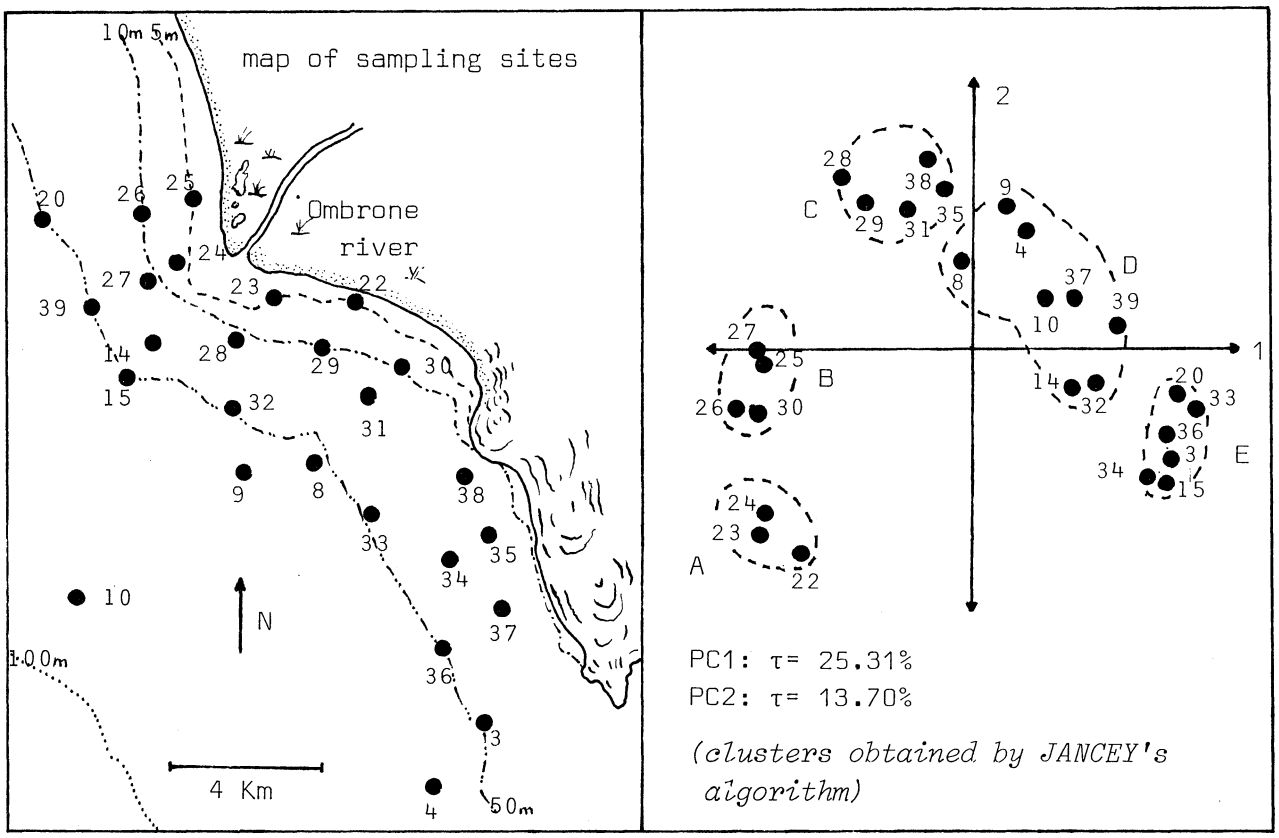
Resumé. *L'analyse du benthos côtier de la Toscane Méridionale (Parc Naturel de la Maremma) montre que la distribution et la structure des biocénoses est corrélée avec les principaux paramètres granulométriques et chimiques du sédiment. Du point de vue biocénotique, seul la Biocénose SFBC se caractérise clairment. Procédant vers le large, on observe un changement continu du peuplement vers la Biocénose VTC qui, d'ailleurs, ne se manifeste de façon distincte.*

In the framework of an investigation on the macrobenthos along the coast of Southern Tuscany, from the mouth of the river Ombrone to the promontory of Talamone, a number of stations have been sampled both for biological and sedimentological studies. CASTAGNOLO et al. (1978) reported on the distribution of macrobenthos over an area in front of the mouth of the Ombrone and came to the conclusion that two main associations can be detected which are referrable to the "Biocénose de Sable Fin Bien Calibré" (SFBC) and to the "Biocénose de la Vase Terrigène Côtière" (VTC) described by PICARD (1965). BALDI & BARGAGLI (1978), in turn, reported on the distribution of sedimentological characteristics over the entire area with emphasis on the heavy metals concentration.It was therefore interesting not only to complete the study by analyzing the benthos in the remaining stations, but also to correlate the community structure with the most relevant physico-chemical characteristics of the sediments.
We have used two different techniques of multivariate analysis: 1) Principal Component Analysis (PCA) for the ordination of the stations; 2) RQ-Factor Analaysis (RQA) (HATHEWAY, 1971) for the simultaneous ordination of observations and variables. The latter technique was used in particular to obtain the biocoenotical characterization of different stations as it produces diagrams where the proximities between station- and species-points reflect mutual relationships. In both cases, the significance of the extracted factors was tested by the method proposed by FRONTIER (1974).

26 samples were studied covering an area of 200 Km^2 and distributed between the 5 m and 100 m isobaths. 195 species have been recorded (72 Molluscs, 50 Polychaetes, 57 Crustaceans, 11 Echinoderms, 4 Fishes and 1 En-

teropneust). This list has been reduced (to diminish "noise" and to save in computer memory space) to 116 species (40 Molluscs, 31 Polychaetes, 38 Crustaceans, 6 Echinoderms and 1 Fish) using the method proposed by CARRADA et al. (in press). For the RQA only 77 species were considered (29 Molluscs, 19 Polychaetes, 23 Crustaceans and 6 Echinoderms). The diagram shows the ordination model of PCA in the plane of the first two factors. By using JANCEY's (1974) clustering algorithm, 5 groups of station-points can be identified. The first component clearly orders the stations according to their distance from the coast, as clusters A and B consist of inshore stations, and clusters D and E consist of offshore stations. The cluster C contains intermediate stations. Thus this component reflects a coenocline that develops itself along a complex gradient directed from the coast to the open sea. Covariance analysis reveals that this axis is significantly correlated to the relevant sedimentological parameters: %sand (r=-0.85); %silt (r= 0.80); %clay (r= 0.68); %C (r= 0.71); %N (r= 0.65). This seems to allow the interpretation of the ecocline responsible for the distribution of benthic communities in terms of *sedimentary balance* (input-distribution-deposition) which, of course, reflects a *water movement gradient*.
The second component shows only an "intensity effect" as it opposes mean- and low-density stations (e.g. clusters A and E) to high-density ones (cluster C). It is interesting to note that the most dense and diverse stations (namely those belonging to cluster C) are situated in the zone where the river plume affects the benthic environment at least in terms of sedimentation. These stations show a hig C/N ratio which, according to POCKLINGTON & LEONARD (1979), is characteristic of land-derived organic matter. The resulting larger availability of food can explain the higher richness of benthos observed in these stations .

The RQA produces an ordination of the station-points, in the plane of the first two factors, which is very similar to that obtained through PCA. The arrangement of species-points exhibits the same trend as that of the station-points though with a remarkable continuity. In the space of the first factor, however, two "poles" can be distinguished. The first one contains species such as *Bela nebula, Owenia fusiformis, Echinocardium cordatum, Neverita josephina, Chamelea gallina, Sphaeronassa mutabilis, Urothoe pulchella*, etc., that are typical representatives of the SFBC-community. The second "pole" consists of elements such as *Glycera rouxi, Sternaspis scutata, Labidoplax digitata, Alpheus glaber, Corophium rotundirostre, Harpinia della-vallei*, etc., that favour muddy sediments. Some of them are considered typical for the VTC-community, although they are not sufficient to clearly identify this community. The intermediate zone has characters of ecotone as it results on one hand, from elements belonging both to SFBC and to VTC, and, on the other hand, from a remarkable number of widely distributed species.



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