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The tidal lagoon environment as an expression of confinement ?

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The aim of this work is to analyse the macrobenthic assemblage of an intertidal environment on loose sediment, in the light of the confinement theory proposed by Guelorget and Perthuisot (1983). The intertidal lagoon environment pertaining to loose sediment has been studied very little in the Mediterranean, given the relative unimportance of tidal excursion in this basin; nevertheless in the North Adriatic spring-tide excursions of about 1 m are recorded. In the environment we studied - the Canarin lagoon, a brackish lagoon in the Po river delta - there are certain areas where the banks are formed of loose sediment and inclination is very slight, in these areas low spring-tides uncover tidal flat having a width of approximately 100 m.

The Canarin lagoon has a surface of 7 km ^{2} and an average depth of 1 m, salinity varies considerably (8-35 %) depending on the tide and the contribution from the Po River; the lagoon communicates well - by means of a mouth - with the sea in front of it, which slopes very gradually away from the shore. In the period of July 14-17, 1987, samplings were made with a Van Veen grab in 9 stations in the area of the sea facing the lagoon, to a depth of 8 m, in 6 sandy-silt subtidal stations in the lagoon and in 4 stations on an intertidal silty-sand flat in the lagoon (for each station three samplings were made). Of the 9 stations located in the lagoon, 3 were chosen at increasing distance from the mouth, 2 in fringe areas less affected by hydric changes caused by the tide and one in an even more marginal area which, unlike the other stations, has a depth of 3.5 m; in the intertidal area the stations were situated at MLWS, MLWN, MTL and MHWS. A previous publication (Parisi et al., 1985) indicated that in the lagoon, the distance from the mouth opening on the sea had a positive correlation with a decreasing hydrodynamic gradient.

The macrobenthic communities in the marine area before the lagoon can be classified as biocoenosis of fine sands in very shallow water (SFHN) at 2.5 m depth and biocoenosis of fine well-sorted sand at 5 and 8 m; in the lagoon the macrobenthic assemblage of the subtidal stations is quantitatively dominated by the polychaetes Neanthes succinea , Nephthys hombergii, Streblospio shrubsolii e Polydora ciliata, by the gastropod Hydrobia ventrosa, by the bivalve Cerastoderma glaucum an by the crustaceans Corophium orientale and C. insidiosum. Thus the lagoon presents an original macrobenthic assemblage, having no elements in common with the sea in front of it except for two species: N. hombergii and P. ciliata.

The hypothesis to be tested is the following: should the intertidal lagoon macrobenthos be considered as an expression of further confinement with respect to that of the subtidal lagoon population, as suggested by Guelorget and Perthuisot? This is the same as replying to the following questions:

1) with respect to the macrobenthic assemblage of the submerged area, does the intertidal population present special bionomics characteristics?
2) does it have increased density?
3) is there a decrease in number of species?
4) does it show structural simplification?

Because of a lack of data, we cannot yet discuss production. Bionomics examination of the macrobenthic assemblage was carried out by Correspondence Analysis; other structural parameters used were: density, number of species, diversity (Shannon's diversity index) and evenness (H/log2).

Regarding the results, we must first say that the most confined station, at 3.5 m depth, presented an almost complete lack of fauna. In our opinion, this situation is due to the thermic and haline stratification which results in a low oxygen concentration (1.34 ml/l O_2), and for this reason this station was not utilized in the bionomic and structural analysis of the macrobenthos. We feel that it is important to point out that in lagoon environments affected by contributions of fresh water, depth probabily acts as a confinement factor. On the axes determinad by the Correspondence Analysis, the first axis arranges the subtidal stations in relation to their distance from the mouth opening on the sea and the intertidal stations are placed together with the more confined stations. The intertidal macrobenthic assemblage is therefore similar to that found in the stations that are less affected by hydrodynamism and does not show original characteristics with respect to the subtidal one; beginning with the species present in the area closest to the mouth, one simply notes a gradual impoverishment passing from the more confined to the intertidal stations. There is a reduction in number of species passing from the subtidal stations closest to the mouth (34 species) to the intertidal stations (20 species); the two most confined subtidal stations show an even greater decrease (12 species). In the intertidal stations, density (25,000 ind./m^2) has values five times greater than those of the subtidal stations. Regarding diversity, the subtidal stations have values of Shannon's index between 2.01 and 2.89; intertidal values are between 0.70 and 1.10 while the most confined subtidal stations have intermediate values. Evenness follows a course similar to that of diversity, with values that diminish as distance from the sea mouth increases. Increased confinement therefore determines a reduction in the number of species, simplification of macrobenthos structure, an increase in the relative dominance of a very few species and increased density. Both the order resulting from the Correspondence Analysis and the trend of the structural parameters indicate a resemblance from the bionomics and structural points of view between the two stations less affected by hydrodynamism and the intertidal stations. At this point there are two possible answer: (1) either the same group of environmental factors (confinement) cause the same type of response in the two different areas as suggested by Guelorget and Perthuisot, or (2) the limiting environmental factors are differentiated in the two areas - on one hand, a decrease in the beneficial influence of the tide and on the other, more or less prolonged periods of exposition to the air. At the end, however, both groups of environmental factors result in the same macrobenthic structure. In our opinion, it appears that the more plausible reply is the second, and that in both areas, although the environmental limiting factors are different, the same group of species manages to survive, this for in the lagoon, subject to noticeable fluctuation of environmental parameters, the species have already been chosen for their high ecological adaptability.

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E-I2

Inventory of the Amphipod Crustaceans of the Italian Peninsula Coastal Lagoons

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RESUME - INVENTAIRE DES CRUSTACES AMPHIPODES DES LAGUNES COTIERES DE LA PENINSULE ITALIENNE. Plus de 40 espèces ont été récoltées dans 17 lagunes côtières italiennes de la Mer Tyrrhénienne et de la Mer Adriatique. Les lagunes de la Mer Tyrrhénienne sont caractérisées par une diversification plus marquée, et par la dominance des espèces à large répartition, accompagnée par la pauvreté d'éléments endémiques, contrairement à celles de la Mer Adriatique.

The Amphipod Crustaceans of the Italian peninsula coastal lagoons have been studied in various works (for the bibliography, see in DIVIACCO, 1981; 1982; 1983, DIVIACCO & PINKSTER, 1982; RELINI et al., 1985; TARAMELLI & PEZZALI, 1986) and, although detailed information on ecology and their distribution in some zones are still lacking, it is possible to make up a preliminar inventory (TAB. I).

TABLE I

	North ← Tyrrhenian Sea											South ↔ Adriatic				North Sea
	O	B	F	M	C	S	F	L	P	F	M	L	A	V	L	S	C.
	R	U	O	O	A	A	O	U	A	U	I	U	L	A	E	C	A
	B	R	G	N	P	B	N	N	T	S	S	C	I	R	S	A	N
	E	A	L	A	R	A	D	G	R	A	E	R	M	A	I	R	A
	T	N	I	C	O	U	I	O	I	R	N	I	I	N	N	D	R
	E	O	A	I	L	D		A	O	O	N	N	O	A	O	I	
	L		N		A	I					O	I			V	N	
	L		O		C	A									A		
	O				E										R		
															I		
Amphithoe ramondi	o				o												
Lembos sp.					o												
Leptocheirus pilosus		o	o			o	o									o	o
Microdeutopus gryllotalpa	o		o	o	o	o				o		o	o	o	o		
Colomastix pusilla	o																
Corophium acherusicum	o		o			o						o			o	o	o
Corophium acutum	o																
Corophium insidiosum	o	o	o	o	o	o	o	o	o	o	o	o	o		o	o	o
Corophium orientale		o				o	o	o	o							o	o
Erichthonius brasiliensis	o				o					o		o					
Erichthonius punctatus	o				o							o					
Dexamine spinosa	o			o	o												
Echinogammarus olivii																	o
Echinogammarus pungens														o			o
Echinogammarus pungentoides																	o
Echinogammarus sp.						o											
Elasmopus affinis										o							
Elasmopus pocillimanus					o												
Elasmopus rapax			o														
Gammarella fucicola					o												
Gammarus aequicauda	o	o	o	o	o	o	o	o	o	o				o	o		o
Gammarus crinicornis																o	o
Gammarus insensibilis	o		o	o	o	o	o	o		o							
Melita hergensis					o		o										
Melita palmata	o	o		o		o	o	o	o			o		o		o	o
Microprotopus maculatus			o														
Ischyrocerus inexpectatus	o																
Jassa marmorata	o																
Jassa sp.																	o
Leucothoe incisa					o												
Leucothoe spinicarpa					o												
Perioculodes aequimanus	o																
Perioculodes longimanus					o												
Perelonotus testudo	o																
Hyale crassipes	o									o							
Orchestia gammarellus														o			
Orchestia mediterranea	o			o		o				o				o			
Orchestia platensis									o					o			
Caprella acanthifera	o																
Caprella dilatata				o													
Caprella equilibra	o		o		o												
Caprella sp.					o						o						
Phtisica marina					o												
Pseudoprotella phasma	o											o					

Seventeen lagoonal environments have been considered, distributed along the Tyrrhenian sea and Adriatic sea, northwards up to the Po river delta. The Venice lagoon, constituted by a whole of environments, from marine, to harbour, and proper brackish waters, is not considered here.

The Amphipod list, obtained from the literature (see bibliography) and from personal observations, includes over 40 species. Thirty-nine species, 29 of which exclusive, are present in the Tyrrhenian lagoons, while 15 species, 6 of which exclusive, are present in the Adriatic ones. Nine species are present in both zones.

The greater variety of the Tyrrhenian lagoons certainly contributes to their species richness, in opposition to the poverty in Adriatic sea, even if this fact may be partially due to the greater number of studies in the lagoons of the former sea.

Orbetello and Caprolace are the most diversified environments, with a greater number of species, some of which even marine, particularly in the areas near the sea. Typically lagoonal species are less than half of the total number, and only 2 (*Corophium insidiosum* and *Gammarus aequicauda*) are distributed almost everywhere, tolerating extreme ecological conditions.

Widely distributed species (cosmopolite and circumtropical) and eastern and northern Atlantic species dominate in Tyrrhenian basins, while amphiatlantic and Mediterranean endemic elements are scarce. Widely distributed species are also scarce in south Adriatic basins and their number still decreases northwards, in favour of Mediterranean endemic elements.

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