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Spatio-temporal distribution of polychaetes in an Italian coastal lagoon (Lago Fusaro, Naples)

Paolo Sordino(1), Maria Cristina Gambi(2) & Gian Carlo Carrada(3)
(1) Bioservice Soc. Coop., vico S. Domenico Maggiore 9, 80134 Napoli (Italy).
(2) Laboratorio di Ecologia del Benthos (Stazione Zoologica di Napoli), 80077 Ischia Porto (Italy).
(3) Dipartimento di Zoologia dell'Università, via Mezzocannone 8, 80134 Napoli (Italy).

Abstract : The spatio-temporal distribution of Polychaetae populations in an euhaline and polluted lagoon (Lago Fusaro) is discussed.

Samples were taken from June 1985 to May 1986 along an inner-outer transect along the lagoon at four stations : two stations were located on hard-bottoms and two on soft-bottoms. A total of 136 962 individuals of Polychaetes belonging to 35 species were collected. Data were analysed using the Correspondance Analysis (CA). The dominant taxon was *Hydroides elegans*. Other common species were *Nainereis laevigata, Polydora ciliata, Prionospio multibranchiata, Cirriformia tentaculata, Capitella capitata, Ophiodromus pallidus, Podarkeopsis capensis, Syllis gracilis, Neanthes caudata, Schistomeringos rudolphi, Terebella lapidaria* and *Hydroides dianthus*, that can be considered the "core" of the Polychaete community in the Fusaro. All are common taxa in coastal lagoons or other sheltered areas (bays and harbours).

In structural terms, two communities were identified depending on the type of substrate : a soft-bottom community and a hard-substrate one. Both show a variation in species dominances along an inner-outer gradient which, in turn, is modulated by a seasonal trend. In the CA models, in fact, station-points were ordinated according to an inner-outer gradient along the first factor and according to season along the second one. In particular, the Polychaete populations of the inner area were strongly reduced in species number during summer periods, particularly in soft-bottoms. In the outer part of the lagoon, the communities were better structured, due to a more intense water-exchange with the sea.

As a whole, the composition and dynamics of the Polychaete populations in the Fusaro lagoon reflect the environmental characteristics of an euhaline and polluted lagoon and can therefore be considered as good indicators for the interpretation of its ecological conditions.

Résumé : La distribution spatio-temporelle des Polychètes a été analysée dans une lagune côtière italienne (Lago Fusaro). Les échantillons ont été prélevés de juin 1985 à mai 1986 dans deux stations situées sur substrat dur et deux sur fond meuble suivant un transect allant de la partie intérieure vers celle extérieure de la lagune. 136 962 individus de Polychètes ont été récoltés pour un total de 35 espèces. Les données ont été traitées au moyen de l'analyse factorielle des correspondances (AFC). Le taxon dominant est *Hydroides elegans*. Les autres taxa abondants sont *Nainereis laevigata, Polydora ciliata, Prionospio multibranchiata, Cirriformia tentaculata, Capitella capitata, Ophiodromus pallidus, Podarkeopsis capensis, Syllis gracilis, Neanthes caudata, Schistomeringos rudolphi, Terebella lapidaria* et *Hydroides dianthus*. Ce sont des espèces typiques des lagunes côtières ou de milieux confinés (baies abritées ou ports).

En termes structurels on distingue deux communautés corrélées avec le type de substrat : la communauté de substrat dur, et celle de fond meuble. Les deux communautés présentent des variations numériques de leurs espèces dans les deux zones (interne et externe) de la lagune et aussi pendant les saisons. Les résultats de l'AFC montrent que les points-stations sont ordonnés avec le gradient intérieur-extérieur le long du premier facteur et avec la saison le long du deuxième facteur. En particulier, dans la zone interne de la lagune, les peuplements présentent une forte réduction quantitative et qualitative pendant l'été. Les peuplements dans la zone externe sont, au contraire, mieux structurés pendant toutes les saisons en rapport avec un meilleur échange avec la mer. Les Polychètes du Fusaro reflètent bien les caractéristiques mésologiques de cette lagune euhaline et sont pour cela des bons indicateurs pour l'interprétation des conditions écologiques.

INTRODUCTION

The present study is part of a larger project to define the environmental conditions of a coastal lagoon, Lago Fusaro (Southern Italy), as a first step prior to environmental reclamation and resource exploitation. This project includes the analysis of benthic community distribution and dynamics.

In lagoons, the entity of sea-water penetration and exchange, coupled with continental fresh-water inputs, contribute to define a variety of different situations (Barnes, 1980) and more or less pronounced fluctuations of environmental variables that exert a selective pressure on living organisms.

Among brackish-water benthic biota, Polychaetes have long been recognized as an important component in terms of species abundances and biomass (Cognetti *et al.*, 1975 ; 1978 ; Amanieu *et al.*, 1977 ; 1978-79 ; Guelorget & Michel, 1979 a, b ; Guelorget *et al.*, 1982). They also represent, from a functional view-point, nodal points in lagoon food-webs (Cottiglia *et al.*, 1983 a, b). In addition, many Polychaetes in these biotopes show interesting adaptative responses to environmental variability with regard to their reproductive and life history strategies (opportunistic or "r" strategy) (Grassle & Grassle, 1974 ; Cognetti, 1978 ; Manoleli, 1980).

As a consequence of the above and of the significant contribution of coastal lagoons to the physiognomy of the Italian coastline, the bibliography concerning Polychaete distribution and ecology in Italian lagoons is rather rich (Laubier, 1962 ; Bianchi, 1980 ; Bonvicini Pagliai & Cognetti, 1982 ; Bianchi & Morri, 1983-84 ; Gravina & Giangrande, 1983-84 ; Gravina *et al.*, 1983-84 (in press) Bianchi *et al.*, 1984 ; Gravina, 1985).

As regards the Fusaro, previous studies concerning Polychaetes are limited to the faunistic analysis of a few families (Cognetti, 1957, for the Syllidae ; Bianchi, 1983, for the Serpulidae).

The aim of this paper is to identify the spatio-temporal distribution patterns of Polychaetes in the Fusaro lagoon, as a tool for the interpretation of its ecological physiognomy.

STUDY AREA

Lago Fusaro is a coastal lagoon located in the southernmost side of the Gulf of Gaeta, about 15 km from Naples (Fig. 1). The lagoon has been the site of a number of ecological studies (see bibliography) due to its century long importance as a centre of fish and shelfish production.

It is semi-circular in shape, with the main axis oriented in a North-South direction. Maximum and minimum lengths are 1.600 m and 750 m respectively ; the surface area is 97 ha and the maximum depth was, until quite recently, about 5 m. At present, in an area along the southwestern bank, improper dredging activities have dramatically changed the basin profile with the formation of large troughs up to 13 m in depth (Fig. 1). The lake is connected with the sea through three channels : Foce Romana, Foce di Mezza Chiaja and Foce Borbonica, that assure a daily water exchange with the sea of 1/840 (AICP, 1985). In the frame of reclamation works carried out in the thirties, the lagoon basin was provided with cement banks along its entire perimeter. As a consequence, the Fusaro lacks an impor-

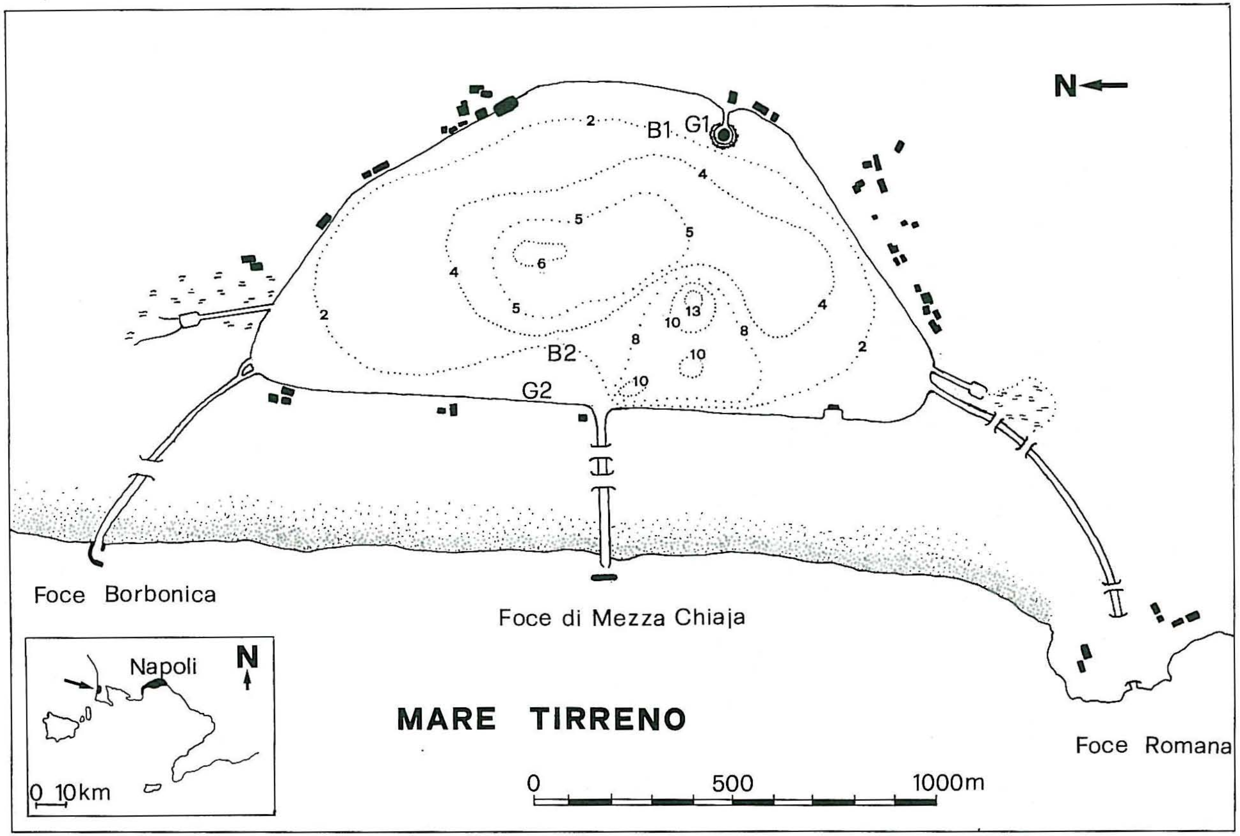


Fig. 1 : Map of the lagoon of Fusaro with the location of the sampling stations on soft - (B1, B2) and hard-bottoms (G1, G2).

tant feature common to most lagoons : the coastal, emerged macrophyte formations which are known to represent a significant material contribution to lagoon food webs. The surface salinity falls within the range of that of the neighbouring coast (37-38 %) ; except for the winter season when values of about 34-35 % are observed. Surface temperatures are characterized by the typical ample seasonal fluctuations of coastal lagoons. More detailed information on spatial and seasonal distribution of physico-chemical factors are given in Carrada *et al.* (1965), Rigillo Troncone (1969 a, b) and Carrada (1973).

Continental natural freshwater inputs are inconspicuous and are almost entirely due to a drainage channel located in the northern side of the lagoon. More importantly, several inflows of untreated urban seawage now drain into the eastern side of the basin.

These increasing anthropogenic inputs have induced substantial changes in the lagoon ecosystem. A first consequence is the increase of nutrient availability which, in turn, has both enhanced the level of primary production as well as its seasonal pattern, with occasional outbreaks of toxic Dinoflagellate blooms (Carrada *et al.*, 1988).

As a result of the above, the distribution of oxygen in the water body has undergone substantial changes with respect to the patterns observed in the past, when anoxic situations were confined to the summer period and to the bottom layers. At present, oxygen undersaturations or anoxic conditions can also be found in other periods of the year, particularly in the dredged area mentioned before. In this area, an insufficient vertical circulation has segregated the bottom layers, thus causing permanent conditions of anoxia starting from a depth of about 4 m (Carrada *et al.*, unpublished data).

MATERIAL AND METHODS

Samples were collected monthly from June 1985 through May 1986 in four stations located along a transect from the western (Casina Vanvitelliana) to the eastern (Foce di Mezza Chiaja) part of the lagoon (Fig. 1), henceforth referred to as "inner" and "outer", respectively. Two stations (G1 and G2) were sampled on the stone and concrete vertical bank at 0.2 m depths, scraping a surface of 400 cm^2 (frame 20 x 20 cm). In both stations the substrate was covered by barnacles and devoided by vegetation. Two stations (B1 and B2) were located on soft-bottoms and were sampled using an Eckman grab (10 replicates of about 1 liter and 400 cm^2 of surface for each station) and the collected material sieved with a 1.5 mm mesh size. Station B1, at a 2.5 m depth, was characterized by fine black mud, rich in hydrogen sulphide and mixed with abundant mollusc shells. The bottom was covered in spring by algal mats of *Gracilaria* sp. Station B2, at a 2.0 m depth, was also characterized by anoxic mud, sometimes covered by algae (*Cladophora* sp., *Radiolingua thysanorhizans*, *Ceramium comptum* and *Ectocarpus* sp.) and tubes of the polychaete *Hydroides elegans*.

Data relative to the months June, July and November 1985 and January and March 1986 are discussed. Such months were chosen in from previous knowledge of the lagoonal metabolism in order to have a good picture of the year evolution of the Polychaete populations.

Polychaetes have been identified to the species level and counted. For each taxon, quantitative dominance (DQ) was calculated in each month. For each station and in each month, species richness, total abundance, diversity (H', according to Shannon & Weaver, 1949) and evenness (J, according to Hurlbert, 1971) were calculated. A corrrespondance Analysis (CA) (Benzecri, 1973) has been performed on a reduced set of species, after elimination of those present only in one sample with few individuals. The abundance of selected species was transformed in a semi-quantitative code (0 = absence ; 1 = from 1 to 10 individuals, 2 = from 10 to 100 ; 3 = from 100 to 500 ; 4 = from 500 to 1 000, 5 = from 1 000). Significance of factorial axes has been tested according to Frontier (1974).

RESULTS

FAUNISTICAL AND ECOLOGICAL ANALYSIS

Preliminary information on the faunistic features of the Polychaetes in the Fusaro has already been published (Sordino & Gambi, in press). The present paper deals with a total of 136 962 individuals of Polychaetes, belonging to 35 taxa, 32 genera and 16 families (Table I). Among them, 5 species were present only once with few individuals. The dominant taxon was *H. elegans*, (DQ > 70 in all samples), which is one of the most frequent species in brackish-waters, uniformely distributed in the Fusaro along the transect considered, in both types of substrates and in all months. Other common species (DQ > 1), almost always present, were : *Nainereis laevigata, Polydora ciliate, Prionospio multibranchiata, Cirriformia tentaculata, Capitella capitata, Ophiodromus pallidus, Podarkeopsis capensis, Syllis gracilis, Neanthes caudata, Schistomeringos rudolphi, Terebella lapidaria* and *Hydroides dianthus*. These taxa, which can be considered the "core" of the Polychaete community of the Fusaro, are common to all coastal lagoons or other sheltered environments such as coves and harbours (Gravina *et al.*, 1983-84).

Some of the remaining taxa, such as *Ctenodrilus serratus, Caulleriella alata, Dodecaceria concharum, Eulalia rubiginosa, Leocrates chinensis, Syllidia armata, Sabellaria spinulosa, Branchiomma lucullana* and *Laonome salmacidis* are species which have never or very rarely been found in brackish-water habitats, although in the Fusaro their occurrence was limited to the outer stations where hydrografic exchanges with the sea are stronger (Table I).

In respect to more turbulent environments, in lagoons, the polarization between hard and soft substrates is smoothened by the strong processes of sedimentation which leads to the presence of "patches" of soft sediments within hard substrates. On the other hand, the presence of macrophytes and organogenous detritus (such as dead shells and polychaete tubes) within soft bottoms allows for the settlement of species typical of hard substrates. However, the preference for substrate type remains clear for some species (*Genetyllis rubiginosa* collected only in B1 and B2 Fig. 2 a ; *Perinereis cultrifera* collected only in G1 and G2 Fig.

TABLE I : Species abundances and frequencies. Diversity (H') and evenness (J) are also shown for each sample. The species marked with asterisk have not been considered in the Correspondence Analysis.

	JUNE 1985				JULY			
	G1	B1	B2	G2	G1	B1	B2	G2
Nainereis laevigata (Grube)	0	0	307	1	0	28	105	0
* *Paradoneis lyra* (Southern)	0	0	1	0	0	0	0	0
* *Ctenodrilus serratus* (O. Schmidt)	0	0	0	0	0	0	0	0
Polydora ciliata (Johnston)	31	0	1 260	164	0	76	393	93
Prionospio multibranchiata Berkeley	0	0	1 396	9	0	32	297	2
Pseudopolydora antennata (Claparede)	0	1	6	0	0	0	0	0
* *Caulleriella alata* (Southern)	0	0	1	0	0	0	0	0
Cirriformia tentaculata (Montagu)	4	0	479	130	22	72	345	97
Dodecaceria concharum Oersted	47	0	0	0	0	0	9	0
* *Capitella capitata* (Fabricius)	0	3	0	0	0	0	0	0
Capitomastus minimus (Langerhans)	0	0	6	0	0	0	0	0
* *Anaitides cf mucosa* (Oersted)	0	0	0	0	0	0	0	0
Eulalia rubiginosa Saint Joseph	0	0	0	2	0	0	0	5
Genetyllis rubiginosa (Saint Joseph)	0	0	4	0	0	0	0	0
* *Pholoe cf synophthalmica* Claparede	0	0	0	1	0	0	0	0
Leocrates chinensis Kinberg	0	0	1	0	0	0	0	0
Ophiodromus pallidus (Claparede)	7	1	102	209	0	16	112	43
Podarkeopsis capensis Day	0	0	228	55	0	108	472	53
Syllidia armata Quatrefages	0	0	8	0	0	0	0	0
Syllis gracilis Grube	49	0	103	75	19	0	5	134
* *Pionosyllis* sp.	0	0	0	1	0	0	0	0
* *Pseudobranchia clavata* (Claparede)	0	0	0	0	0	0	0	0
Neanthes caudata (Delle Chiaje)	185	4	756	148	0	960	1 867	11
Nereis falsa Quatrefages	0	0	0	0	0	0	0	0
Perinereis cultrifera (Grube)	0	0	0	0	63	0	0	69
Platynereis dumerili (Aud. & M. Edwards)	0	0	4	0	0	0	4	0
Schistomeringos rudolphi (Delle Chiaje)	0	0	43	27	1	8	8	194
* *Sabellaria spinulosa* Leuckart	0	0	0	0	0	0	4	0
Terebella lapidaria (Kahler)	5	0	10	25	0	0	9	70
Branchiomma lucullana (Delle Chiaje)	0	0	0	0	0	0	0	0
* *Laonome salmacidis* Claparede	0	0	1	0	0	0	0	0
Hydroides dianthus (Verrill)	20	0	30	1	0	48	235	16
Hydroides elegans (Haswell)	287	4 625	9 102	4 638	0	10 520	15 820	489
Pomatoceros lamarcki (Quatrefages)	4	0	0	0	0	0	0	2
Vermiliopsis striaticeps (Grube)	0	0	0	0	0	1	0	0
number of individuals	639	4 634	13 848	5 486	105	11 869	19 685	1 278
number of species	10	5	21	15	4	11	15	14
Diversity (H')	2.18	0.024	1.84	1.05	1.42	0.69	1.19	2.85
evenness (J)	0.36	0.99	0.58	0.73	0.32	0.79	0.69	0.27

NOVEMBER				JANUARY 1986				MARCH				
G1	B1	B2	G2	G1	B1	B2	G2	G1	B1	B2	G2	Frequency
0	4	7	0	0	0	18	1	3	11	25	0	11
0	0	0	5	0	0	0	0	0	0	0	0	2
0	0	0	0	0	0	0	4	0	0	0	0	1
15	8	0	22	8	84	12	49	14	126	0	60	16
0	10	0	2	0	18	12	2	1	108	18	4	14
0	20	15	0	0	0	0	0	0	26	0	5	6
0	0	0	0	0	0	0	0	0	0	0	0	1
14	2	81	28	19	12	54	6	3	0	32	4	18
0	0	0	0	0	0	0	0	5	0	0	0	3
0	1	0	0	0	0	354	0	0	0	0	0	3
0	0	8	0	0	0	0	0	0	0	7	0	3
0	0	4	0	0	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	1	0	0	0	2	5
0	0	16	0	0	0	12	0	0	0	3	0	4
0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	4	0	0	0	0	0	0	0	10	0	3
122	33	4	327	130	210	6	204	345	548	5	27	19
73	199	140	418	40	822	120	55	4	612	81	120	17
0	0	0	1	0	4	0	0	0	0	0	0	3
106	2	5	666	192	12	0	377	95	0	12	1 031	16
0	0	0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	1	0	0	0	0	0	0	0	1
87	1 614	614	10	12	1 404	1 002	0	5	312	392	1	18
0	0	0	0	0	0	0	13	21	0	0	24	3
6	0	0	76	28	0	0	12	5	0	0	4	8
0	0	4	0	0	24	6	0	6	10	9	0	8
131	1	46	260	161	30	96	164	122	8	186	219	18
0	0	0	0	0	0	0	0	0	0	0	0	1
23	0	0	207	29	6	0	66	104	0	0	125	12
0	0	3	0	0	0	24	0	0	0	0	0	2
0	0	0	0	0	0	0	0	0	0	0	0	1
522	0	10	203	72	0	0	283	115	0	9	247	14
4 038	5 568	1 480	16 203	2 525	14 040	126	5 972	2 412	6 235	220	2 826	19
0	0	0	0	1	0	0	0	2	0	2	8	6
0	0	0	0	17	0	0	0	21	0	0	0	3
5 137	7 462	2 441	18 429	3 235	16 666	1 842	7 209	3 283	7 996	1 011	4 707	
11	12	16	15	14	12	13	15	18	10	15	16	
1.26	1.03	1.71	0.86	1.38	0.9	2.17	1.11	1.54	1.25	2.53	1.84	
0.63	0.71	0.58	0.78	0.64	0.75	0.42	0.71	0.64	0.62	0.36	0.54	

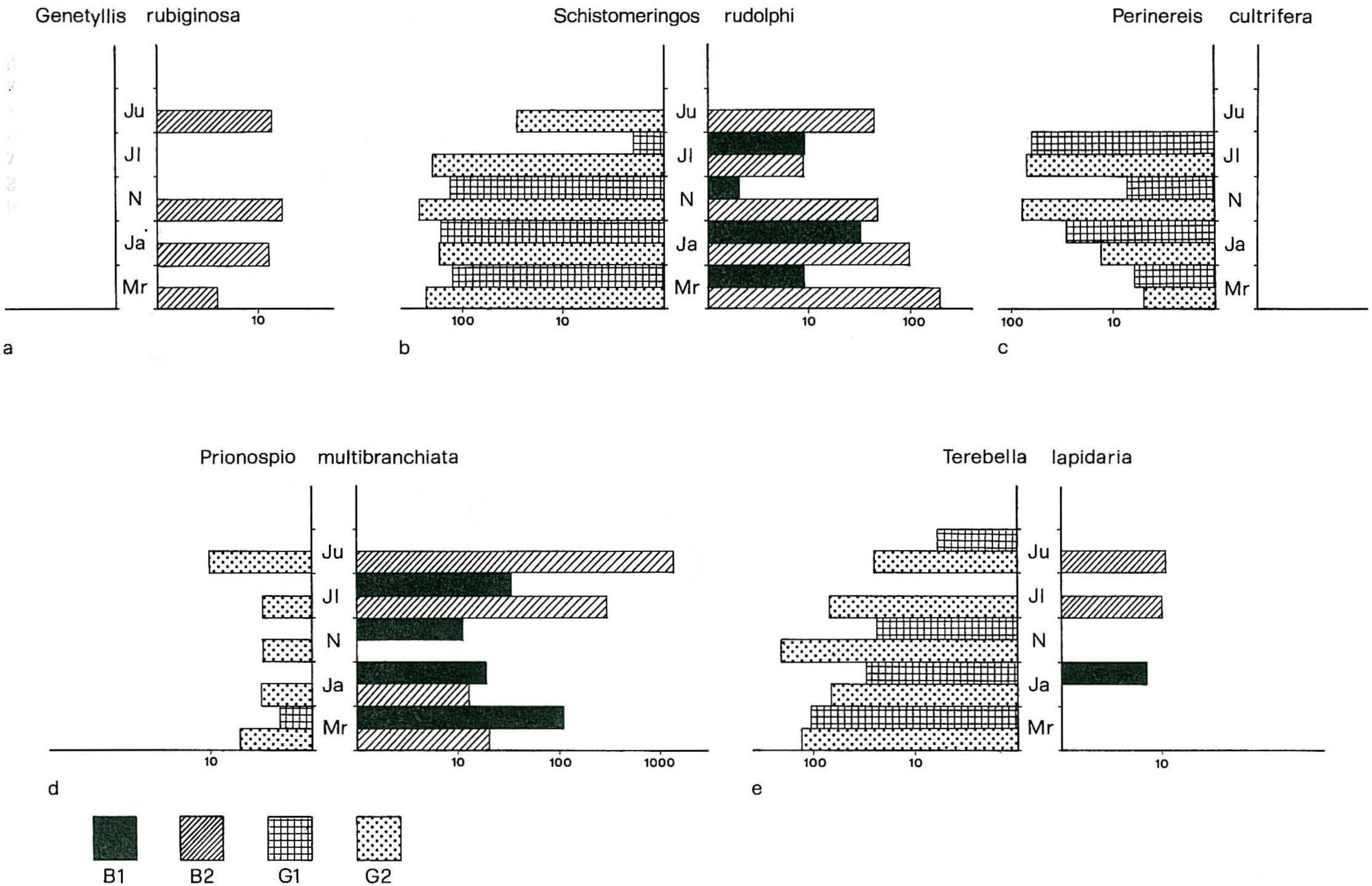


Fig. 2 : Examples of the abundances of some species according to substrate type and seasonal cycle. a : *Genetyllis rubiginosa* ; b : *Schistomeringos rudolphi* ; c : *Perinereis cultrifera* ; d : *Prionospio multibranchiata* ; e : *Terebella lapidaria*.

2 c) or, generally, when relative abundances are considered (*S. rudolphi, P. multibranchiata* and *T. lapidaria*, Fig. 2 b, d, e).

An analysis of spatial distribution showed that 22 taxa were present in both areas (inner and outer), 13 were exclusive of the outer zone while none was exclusive of the inner one.

Station B1 : The Polychaete community of this station was characterized exclusively by species typical of lagoons or other sheltered environments and was dominated by *H. elegans*. Species richness (Fig. 3) showed a minimum in summer and an increase in the following months. Abundances were uniformely high due to the constant dominance of *H. elegans* and *N. caudata* (Fig. 3). The low number of taxa coupled with the redundancy of some of them were responsible for the low values of Diversity (H') observed during all months. Evenness (J) had a trend specular to H' (Table I).

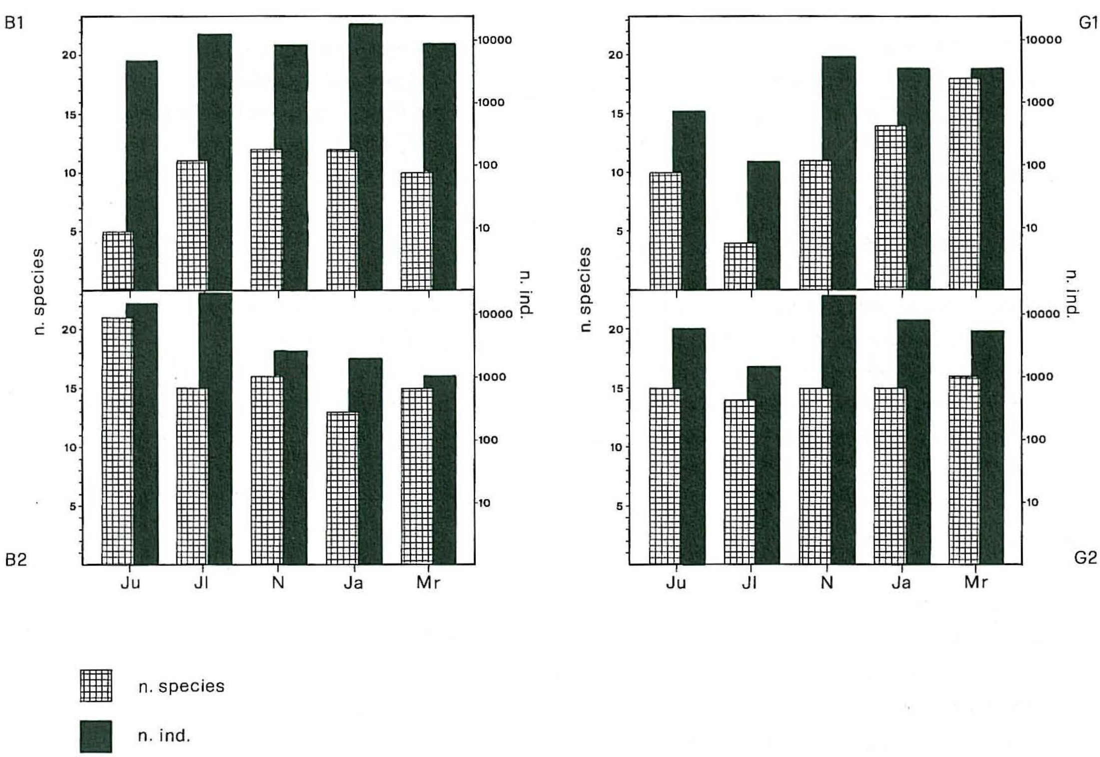


Fig. 3 : Variation of species richness and total abundances according to station and month.

Station B2 : The Polychaete community of this station was characterized by species characteristics of brackish-water, as well as by marine taxa and by the presence of 9 species exclusive for this station. Of these, *Capitomastus minimus, G. rubiginosa* and *L. chinensis* were the most abundant. Species richness was quite constant over time, except in June when a maximum was observed (Fig. 3). Total abundance showed a summer maximum, due to the dominance of *H. elegans, P. ciliata* and *P. multibranchiata*, and a decrease in the fall-winter months (Fig. 3). Diversity was at a minimum in July but a marked increase occurred in the following months. Evenness, once again, showed a trend specular to H' (Table I).

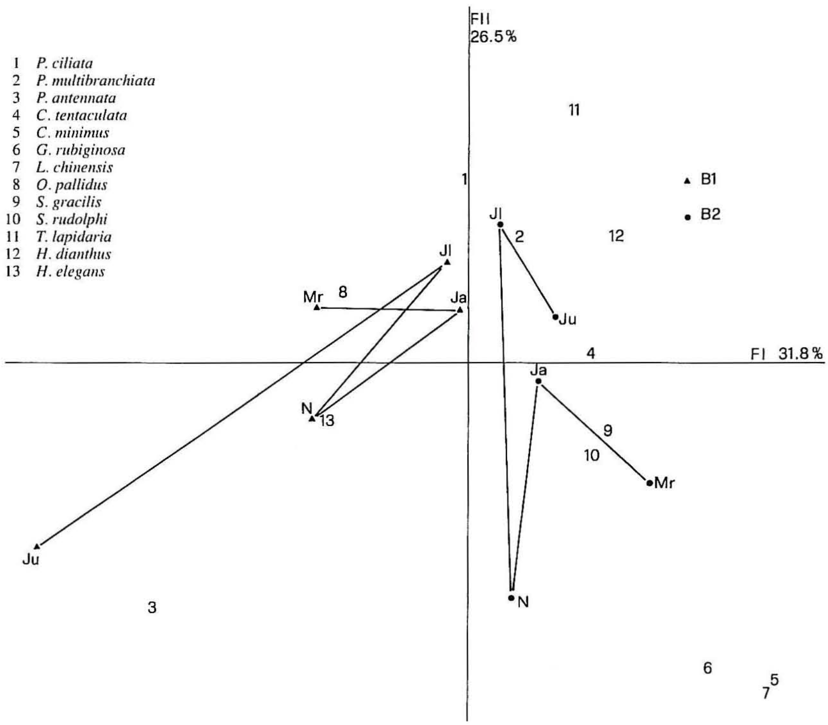
Station G1 : The Polychaete community in this station was composed mostly by brackish-water species dominated by *H. elegans, O. pallidus* and *S. rudolphi*. Both species richness and total abundances showed a minimum in summer and a marked increase in fall and winter (Fig. 3). Diversity values were quite low due to the redundancy of *H. elegans*, except in June, as confirmed also by the values for evenness (Table I).

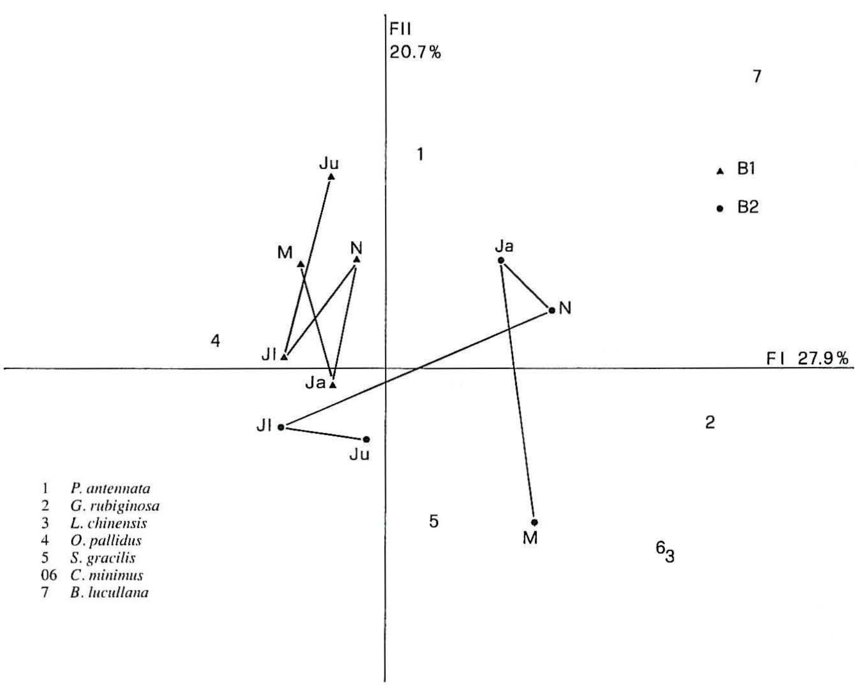
Station G2 : Both brackish-water and marine species were present in this station ; of the latter group, *S. gracilis* and *T. lapidaria* were particularly abundant. In addition, this station included four exclusive taxa. Only one of these taxa, *E. rubiginosa*, occurred in all months. Species richness was constant over time (Fig. 3). The trend of total abundances was similar to St. G1, with a summer minimum and an increase in the following months mainly due to *H. elegans* and *S. gracilis* (Fig. 3). Diversity showed wide fluctuations with lower values in June, November and January, due to the dominance of *H. elegans*. This was also confirmed by the values for evenness (Table I).

As regards the temporal distribution of species, only 14 were present during the months considered. In general, four main trends were identified (see Table 1) : a) species occurring only, or more abundantly in fall and winter (*G. rubiginosa, O. pallidus, S. gracilis, P. cultrifera*) ; b) species more abundant in summer, although limited to the outer area (B2 an G2) (*N. laevigata, P. multibranchiata, C. tentaculata*) ; c) species characterized by strong fluctuations in abundances (*P. ciliata, Pseudopolydora antennata, C. capitata)* ; d) species having uniform abundances (*N. caudata, H. dianthus, H. elegans*).

STRUCTURAL ANALYSIS

Ordination models of the Correspondence Analysis relative to stations B1, B2 and G1, G2 in the plane defined by the first two axes (F I and F II) are shown in Fig. 4 a, b. In the model considering stations B1 and B2, the variance explained by F I and F II, in both cases significant, was 31.8 % and 26.5 %, respectively. Along F I, a separation between all B1 samples (in the negative side) and the B2 samples (in the positive side) was observed (Fig. 4 a). Along F II, stations were ordinated according to the sampling period : samples from B1 were arranged in an irregular way, while samples from B2 had summer samples in the positive side and fall and winter ones in the negative side. Species having the highest abso-


FII
26.5%
1 P. ciliata
2 P. multibranchiata
3 P. antennata
4 C. tentaculata
5 C. minimus
6 G. rubiginosa
7 L. chinensis
8 O. pallidus
9 S. gracilis
10 S. rudolphi
11 T. lapidaria
12 H. dianthus
13 H. elegans
B1
B2
FI 31.8%
Jl
Ja
Ju
N
Mr


FII
20.7%
B1
B2
FI 27.9%
1 P. antennata
2 G. rubiginosa
3 L. chinensis
4 O. pallidus
5 S. gracilis
06 C. minimus
7 B. lucullana
Ju
M
N
Ja
Jl

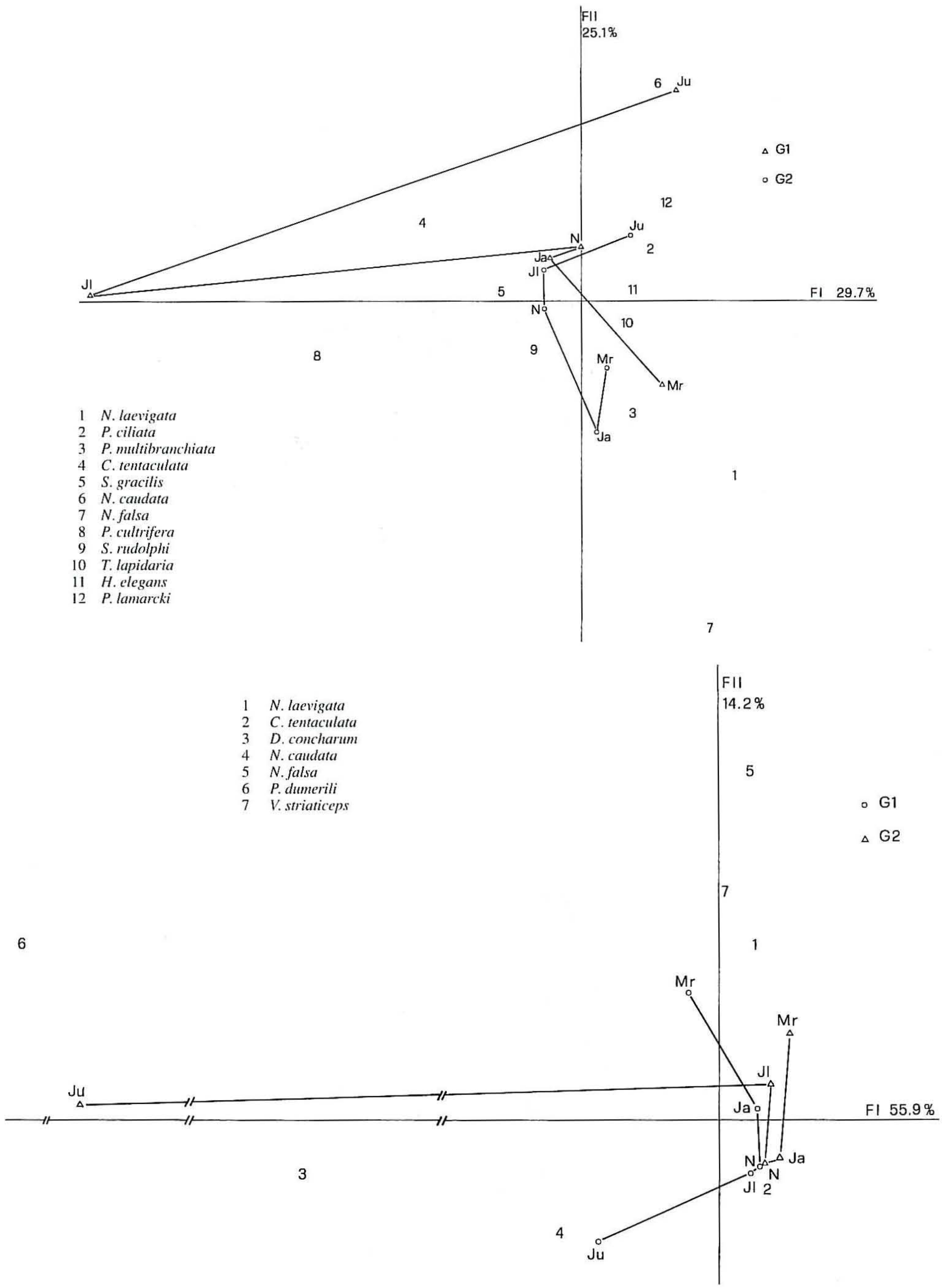


Fig. 4 : Ordination models of the Correspondence Analysis (CA) in the plane defined by the first two factors (F I, F II) ; the species with highest absolute contributions to F I and F II are also reported ; a : soft-bottom stations (B1, B2) ; b : hard-bottom stations (G1, G2).

lute contribution on F I were *P. antennata, C. tentaculata, C. minimus, G. rubiginosa, L. chinensis, O. pallidus* and *H. elegans,* while on F II are *P. ciliata, P. multibranchiata, P. antennata, C. minimus, G. rubiginosa, L. chinensis* and *T. lapidaria* (Table II a).

In the model considering stations G1 and G2, the variance explained by F I and F II, in both cases significant, was 29.7 % abd 25.1 %, respectively. Along F I, a distinct separation between inner and outer stations was not observed, except for station G1 in July, which was strongly polarized on the negative side, probably due to the presence of only four species (Fig. 4 b). Along F II, both stations (G1, G2) were ordinated according to the sampling period, with summer samples in the positive, upper side of F II and the following ones ordinated progressively towards the negative side. On the whole, except for the summer samples, stations G1 and G2 showed a very similar trend. The species with the highest absolute contribution on F II were *C. tentaculata, S. gracilis, N. falsa, P. cultrifera* and *H. elegans,* and on F. II were *N. laevigata, P. multibranchiata, C. tentaculata, N. caudata* and *N. falsa* (Table II b).

TABLE II : Highest absolute contributions of the species and of the stations to F I and F II in the Correspondence Analysis ; a : soft-bottom stations (B1, B2) ; b : hard-bottom stations (G1, G2).

TABLE II a

SPECIES	FI	FII
Polydora ciliata	<0.1	17.8
Prionospio multibranchiata	1.3	9.4
Pseudopolydora antennata	19.9	13.7
Genetyllis rubiginosa	8.4	16.6
Leocrates chinensis	6.7	9.4
Ophiodromus pallidus	7.7	2.8
Cirriformia tentaculata	6.4	0.1
Capitomastus minimus	6.7	9.4
Terebella lapidaria	0.8	5.6
Hydroides dianthus	4.6	4.2
Hydroides elegans	24.0	42.0
STATIONS		
B1 JUNE	36.6	7.9
B1 JULY	0.3	7.5
B1 NOVEMBER	13.9	2.1
B1 MARCH	16.1	2.6
B2 JUNE	7.8	2.7
B2 JULY	0.9	20.1
B2 NOVEMBER	1.2	43.9
B2 MARCH	20.1	10.6

TABLE II b

SPECIES	FI	FII
Nainereis laevigata	3.1	4.8
Polydora ciliata	3.9	2.6
Prionospio multibranchia	0.7	4.0
Cirriformia tentaculata	19.0	5.7
Syllis gracilis	8.6	<0.1
Neanthes caudata	3.9	37.7
Nereis falsa	4.3	34.0
Perinereis cultrifera	41.0	2.1
Hydroides elegans	4.9	0.3
STATIONS		
G1 JUNE	6.4	37.5
G1 JULY	75.7	< 0.1
G1 MARCH	8.3	11.6
G2 JUNE	3.1	6.6
G2 JANUARY	0.3	27.4
G2 MARCH	1.0	7.8

DISCUSSION AND CONCLUSIONS

With the exception of a few exclusively marine species (*A. cf mucosa, G. rubiginosa, Pholoe cf synophthalmica* and *L. chinensis*), it is worth noting that brackish-water species such as *Nereis diversicolor* and *Ficopomatus enigmaticus*, typical representatives of reduced and variable salinity environments (Gravina *et al.*, 1983-1984), are absent. This is not surprising since the lagoon is characterized by a rather uniform salinity distribution and values very similar to those at sea. Accordingly, the Polychaete species are not selected against a salinity gradient but it is likely that other environmental factors are responsible for the structure of its communities. In fact, the core of the Polychaete community is mainly represented by species typical of environments submitted to a certain degree of organic enrichment such as *N. laevigata, P. ciliata, P. antennata, C. capitata, S. rudolphi, H. elegans*, or characterized by a low level of hydrodynamics (*C. tentaculata, C. minimus, S. gracilis*) (Cognetti & Taliercio, 1970 ; Cognetti, 1972, 1975 ; Gravina *et al.*, 1983-84). In fact, the main environmental feature of the Fusaro is the high level of anthropogenic eutrophication distributed according to an inner-outer gradient. In faunistic and ecological terms, a comparison of our data with those of other authors further support our interpretation that a close similarity exists between the Fusaro and several Pontine lagoons (central Tyrrhenian coast), namely Caprolace and Sabaudia. In particular, the outer Fusaro area is similar to the Caprolace lagoon where a good exchange with the sea, as confirmed by the high values for species richness and diversity, gives rise mainly to the presence of marine taxa.

The inner Fusaro area and Polychaete population "core" is very similar to that of the Sabaudia lagoon, where there is a strong organic enrichment that gives rise to the presence of species typical of biotopes such as harbours (Gravina & Giangrande, 1983-1984 ; Gravina *et al.*, in press).

Finally, it is interesting a comparison with the previous data of Cognetti (1957) and Bianchi (1983). The former author recorded in the lagoon 14 species of Syllidae that are absent in our samples except *S. gracilis* ; this can be explained by the different sampling methods but also by the worse actual ecological conditions of the lagoon. Bianchi (1983), in 1979, observed in the lagoon the dominance of *H. dianthus* that is still present in the Fusaro but quantitatively has been replaced by the ecologically equivalent *H. elegans*.

In structural terms, two communities can be identified according to the type of substrate : a community inhabiting soft-bottoms and characterized mostly by *N. laevigata, P. ciliata, P. multibranchiata, P. antennata, C. tentaculata, P. capensis, N. caudata* and *P. dumerili*, and a community of hard substrates with a dominance of *S. gracilis, P. cultrifera, S. rudolphi, T. lapidaria, H. dianthus* and *H. elegans*. Both community of hard substrates with a dominance of *S. gracilis, P. cultrifera, S. rudolphi, T. lapidaria, H. dianthus* and *H. elegans*. Both communities show a variation in the dominance of some of its components along the inner-outer gradient which, in turn, is modulated by a seasonal succession. In particular, the Polychaete populations of the inner area are strongly reduced in species number during the summer period. In both the CA ordination models, the first axis can be interpreted as the effect of a confinement gradient that appears more evident for the soft-bottom community. The second axis can be interpreted as the effect of seasonality. This latter axis shows a cyclic trend in the two outer stations (B2 and G2), while in the inner ones the trend is characterized by a wider drift in the distances between stations, probably linked to the effect of stochastic, unpredictable events which are typical of Mediterranean lagoons, particularly in summer. In turn, this is probably coupled to heavy anthropogenic disturbance. These seasonal trends are similar to those ones observed for the Polychaete populations of the Ischia harbour where Fresi *et al.* (1983) have shown that the communities in inner stations had higher seasonal fluctuations. By contrast, in the stations external to the harbour, a cyclic seasonal trend was observed. These results suggest that factors regulating community selection and structure are probably the same for lagoons and semi-enclosed biotopes and are mostly related to a regime of reduced water exchange. In the case of Fusaro, the latter further enhances the effects of pollution, particularly in the inner area immediatly adjacent to sewage outfalls.

Riassunto : Viene discussa la distribuzione spazio-temporale del popolamento a Policheti di una laguna costiera italiana (Lago Fusaro). I prelievi sono stati effettuati mensilmente da Giugno 1985 a Maggio 1986 in quattro stazioni poste in due aree della laguna lungo un transetto interno-esterno. Due stazioni sono su fondo duro e due su fondo mobile. I dati sono stati elaborati mediante l'Analisi Fattoriale delle Corrispondenze (AFC).

Sono stati rinvenuti complessivamente 136 962 individui appartenenti a 35 specie. Il taxon dominante è *Hydroides elegans*. Altre specie abbondanti sono *Nainereis laevigata, Polydora ciliata, Prionospio multibranchiata, Cirriformia tentaculata, Capitella capitata, Ophiodromus pallidus, Podarkeopsis capensis, Syllis gracilis, Neanthes caudata, Schistomeringos rudolphi, Terebella lapidaria* and *Hydroides dianthus*. Queste specie possono considerarsi come il "nucleo" del popolamento a Policheti del Fusaro e sono tutti taxa tipici di lagune costiere o altri ambienti confinati (baie riparate o porti). In termini strutturali si possono identificare due comunità correlate con il tipo di substrato : la comunità di fondo duro e quella di fondo mobile. Entrambi questi popolamenti presentano variazioni nella dominanza dei loro componenti lungo il gradiente interno-esterno e che sono anche modulate dalla stagionalità. Nei modelli relativi alla AFC, infatti, i punti-stazione si ordinano secondo l'area interna o esterna lungo il primo fattore e secondo la stagione di prelievo lungo il secondo fattore. In particolare, le comunità della parte più interna della laguna presentano un notevole impoverimento quali-quantitativo spemente durante il priodo estivo, e che è inoltre più accentuato a livello del fondo. Nella zona più esterna, invece i popolamenti si presentano generalmente meglio strutturati in conseguenza del maggior scambio idrico con il mare aperto che si verifica in quest'area.

Nel complesso, i Policheti del lago Fusaro riflettono piuttosto bene le caratteristiche mesologiche di questa laguna eualina e costituiscono quindi degli utili indicatori per l'interpretazione delle sue condizioni ecologiche generali.

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