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MODIFICATIONS IN BENTHOS UNDER MUSSEL CULTURES IN THE GULF OF TRIESTE (NORTH ADRIATIC SEA)

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ABSTRACT

Mussel farms cover a large coastal area of the Gulf of Trieste (North Adriatic Sea), a shallow bay characterized by a high primary production and a wide variability of temperature, salinity and dissolved oxygen at the bottom. To test the effects of this mariculture on benthos, two stations were located under an old (>10 years) and a new set (2 years) of mussel cultures, while a third was placed in an area free of cultures. In each station, five grab samples were collected. Statistical analyses were performed by non-parametric multivariate methods on both abundance and biomass data. Results show a moderate effect on benthos, mainly in the station located under the oldest farm. The total biomass decreased under the cultures and the lowest value was recorded under the 10-year-old culture.

Key words: benthos, mussel cultures, modificataion, Gulf of Trieste
Ključne besede: bentos, gojišča klapavic, spremembe, Tržaški zaliv

INTRODUCTION

Several authors have dealt in the past with the effects of mussel cultures on the seabed, either with regard to the geochemical characteristics of the sediment (Dahlback & Gunnarsson, 1981; Baudinet *et al.*, 1990) or from the point of view of the benthic communities (Tenore & Gonzales, 1976; Mattsson & Linden, 1983; Kautsky & Evans; 1987). The benthos is reported to decrease its diversity, especially in poor hydrodynamic environments, and to show an increase of opportunistic species under these conditions (Tsuchiya, 1980; Lopez-Jamar, 1982; Mattsson & Linden, 1983).

The Gulf of Trieste (North Adriatic Sea) is a shallow bay with an average depth of 17 m. Mollusc farming is the main mariculture activity and annualy produces 8000-10000 tons of *Mytilus galloprovincialis* in hanging long-lines cultures (Ceschia *et al.*, 1991). In the Italian part of the Gulf, farms are situated along the coast from the promontory of Miramare to Monfalcone and cover an area of approximately 10x0.5 km^2, corresponding to about the 60% of the bathymetric band between 10 and 17m. In this area, bottom currents of 3-5 cm/s were recorded (Mosetti & Purga, 1990); they prevent a massive biodeposition from mussels on the seabed (Larsson, 1985). The Gulf is characterized by a wide variability of environmental parameters such as salinity, temperature and dissolved oxygen at the bottom. In recent years, the occurrence of anoxia, mainly in the deepest part of the Gulf, has lead to a decrease in macrobenthos diversity (Aleffi *et al.*, 1993; Brizzi *et al.*, 1994). Therefore the anoxic episodes, as well as the hydrodynamic features of the Gulf, can hide the effects of cultures on benthic communities (Landri *et al.*, 1993).

The aim of the present paper is to detect whether the mussel-cultivations have caused any modification in the soft-bottom macrobenthos below the farms in the Gulf of Trieste.

MATERIALS AND METHODS

In order to describe the modifications in benthic communities under mussel cultures, three stations were investigated. The studied area was at 10 m depth, about 500 m from the coastal line and characterized by a sandy-pelitic sediment (Brambati *et al.*, 1983). The first station (st.10) was situated under an old (more than 10 years) hanging long-line mussel culture. The second station (st. 2) was located under a new culture (2 years old). The third station, considered as a control (st. C), was placed in a nearby area unaffected by cultures (fig. 1).

On Sept. 16 1993 at each station, five grab samples were collected by 0.1 m^2 van Veen grab and the sediment was sieved through a 1-mm-mesh sieve; the organisms retained were preserved in 4% formalin solution and biomass was measured as wet weight (shells included).

Quantitative data were analysed by different methods, excluding the abundance and biomass of *Mytilus galloprovincialis* which had dropped down from the overlying cultures. The structure of the community was described by the Shannon diversity index (H) on $\log_2$ basis and by the Pielou index (J), both calculated on the species abundances of each grab sample. A one-way ANOVA was performed on the (H) indices to test the existence of significant differences among the three stations. Multivariate methods were also applied on both abundance and biomass data, after transformation by a single square-root and a double square-root, respectively. All similarity computations were based on the Bray-Curtis similarity index because of its independence from "joint-absences" (Clarke & Green, 1988). Non-metric Multi-Dimensional Scaling (MDS) was performed to display the relative position of grab samples. To test the significance of difference among groups of samples, a randomization-permutation test was used (One-Way ANOSIM Test, Clarke & Green, 1988). The consistent species, within those mainly responsible for the grouping of samples (e.g. contributing 70% to the average similarity) suggested by MDS ordinations, were determined by calculating the ratio between their contribution to the average group similarity and the corresponding standard deviation. The good discriminator species for separation of groups (within those accounting for 70% of average dissimilarity) were determined using the ratio between their contribution to the average group dissimilarity and their standard deviation (Clarke, 1993). The statistical analyses were performed using the PRIMER software package developed by Plymouth Marine Laboratory, England.

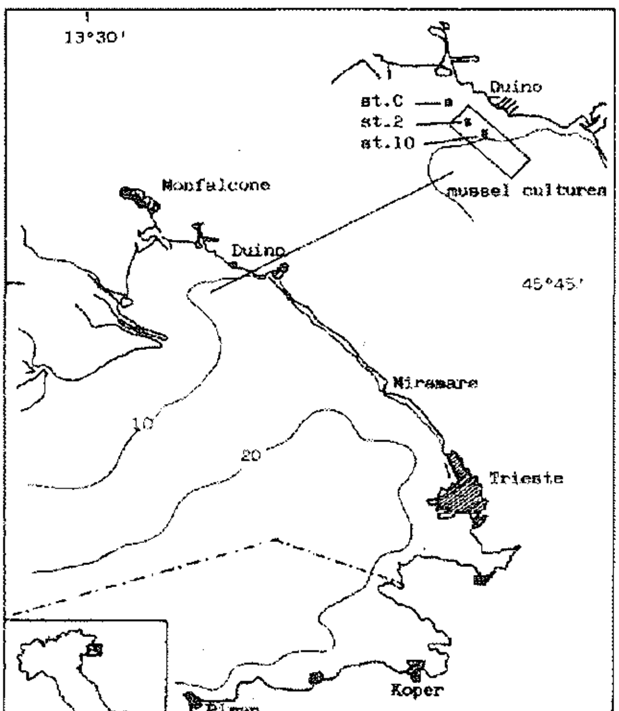

Fig. 1: The Gulf of Trieste and position of the stations.
Slika 1: Tržaški zaliv in položaj posameznih postaj.

RESULTS

Abundance data

The average Shannon and Pielou indices, calculated for each station, were very close and indicate communities partially dominated by few species. The ANOVA did not show any significant differences between the Shannon indices of the five grab samples of each station (tab. 1).

	st. 10		st. 2		st.C		One-Way Anova		
	H	J	H	J	H	J		F	p
sample									
1	2.49	0.86	3.02	0.90	2.58	0.84	st. 10 vs st.2	0.34	0.57
2	2.79	0.87	2.60	0.82	2.73	0.82	st. 10 vs st.C	0.05	0.83
3	2.22	0.89	2.59	0.90	2.02	0.76	st. 2 vs st.C	1.66	0.23
4	2.36	0.83	2.40	0.89	2.49	0.83			
5	2.70	0.79	2.40	0.77	2.54	0.82			
average	2.51	0.85	2.60	0.86	2.47	0.81			
S.D.	0.21	0.03	0.23	0.05	0.24	0.03			

Tab. 1: Shannon (H) and Pielou (J) indices for each sample and analysis of variance on H between stations.three stations.
Tabela 1: Shannonov (H) in Pieloujev (J) indeks za vsak posamezni vzorec in analiza variance na H med postajami.

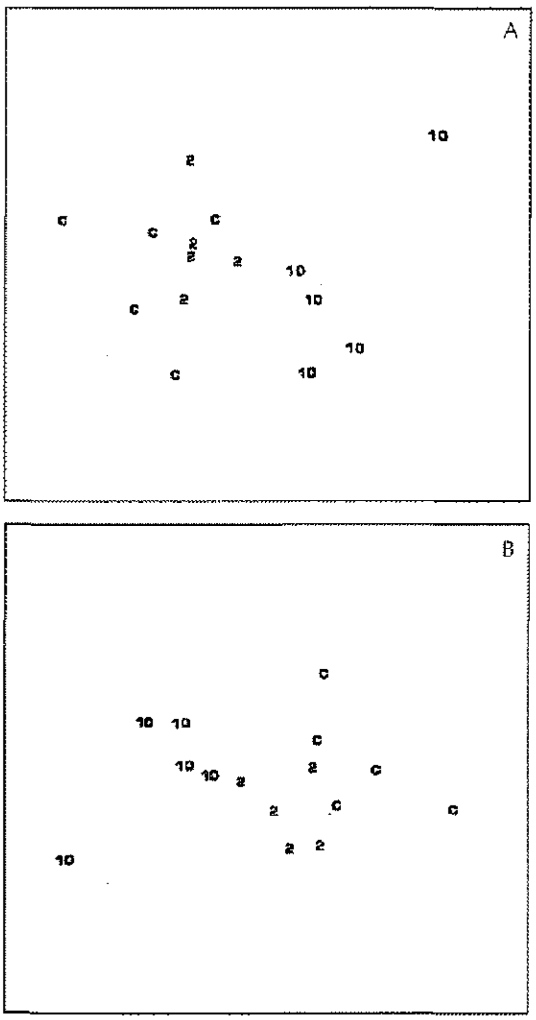

Fig. 2: Multi Dimensional Scaling (MDS) on grab samples - A: abundance data (stress=0.12). - B: biomass data (stress=0.10).
Slika 2: MDS poskusnih vzorcev - A: podatki o številčnosti vrst (Poudarek = 0.12), B: MDS poskusnih vzorcev - podatki o biomasi (poudarek = 0.10).

The multi-dimensional scaling applied to the abundance data of grab samples showed two separate groups (fig. 2), the first corresponding to samples of st. C and st. 2, the second of st. 10. In this latter group, one grab sample is separated from the others because of its scarcity of organisms (tab. 2).

The ANOSIM global test gave an R=0.447 at p=0.001, indicating a significant non-randomness of the grab samples' distribution. The pairwise test between the three stations' groups of samples clearly separated st. 10 from the others (tab. 3), but failed to distinguish between st. C and 2.

The first group displayed by ordination (st. 2+C) is chararcterized by the consistent abundance of *Nucula nucleus, Telepsavus costarum, Maldane glebifex, Melinna palmata, Eunice vittata* and *Phylo foetida*, while in the group of samples corresponding to st. 10, the only important species are *Lumbrineris latreilli, Telepsavus costarum* and *Nassarius reticulatus* (tab. 4). All these species are commonly found on muddy bottoms of the Gulf of Trieste (Vatova, 1949; Orel & Mennea, 1969; Aleffi *et al.*, 1993; Brizzi *et al.*, 1994) and some are reported as opportunistic species (Pearson & Rosenberg, 1978).

The dissimilarity between the two groups is mainly due to *Maldane glebifex*, which is only present in group st. 2+C, and *Scolopols armiger, Lumbrineris gracilis, Nassarius reticulatus* and *Erichthonius brasiliensis*, present in the st. 10 (tab. 5).

Biomass data

The MDS plotted on the basis of the biomass data (fig. 2) showed three groups of grab samples related to three stations with significant differences between them (tab. 6). St. C is characterized by a consistent biomass of *Nucula nucleus, Maldane glebifex, Telepsavus costarum, Amphiura chiajei, Melinna palmata, Eunice vittata* and *Phylo foetida;* st. 2 by *Nucula nucleus,*

date: 16. 10. 1993															
Station	St.10					St.2					St.C				
Grab	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Sargatia elegants												2			
Calliactis parasitica										1				2	
Edwarsia claparedii								2						2	
Calyptraea chinensis		1													
Hexaplex trunculus									1						
Nassarius reticulatus	2	1	1	1	1		1		1						
Philine aperta															1
Euspira guillemini						2				2					
Nucula nucleus	4	5		6	2	14	18	2	10	29	13	19	3	21	4
Nuculana pella													1		
Chlamys varia					1										
Chlamys glabra											1				
Chlamys flexuosa					2										
Limea loscombi					1										
Andontia fragilis						1	1	3		1					
Thyasira flexuosa												1			
Diplodonta rotundata					1								1		
Tellimya ferruginosa						3									
Acanthocardia paucicostata											1				
Tellina distorta						2	2	1				1			1
Gastrana fragilis			1							1					
Abra alba	1				1	1	2		1	2	3				
Abra prismatica						5									3
Azorinus chamasolen											1	1			
Gouldia minima											1				
Paphia aurea	2	2		1	2	5	1		2	1	7	5		5	
Corbula gibba	4					4	1	3			2				4
Dentalium inaequicostatum							2				2		4		
Harmothoe sp.		1										1			
Anaitides lineata														1	
Syllis sp.													2	1	
Ceratonereis costae					1								6		
Nereis lamellosa		1				1				2					
Perinereis sp.															1
Glycera rouxii						1								1	
Glycera unicornius										1	1				1
Eunice vittata	1	2	1		5	7	2	1	5	1	3	4	3	2	6
Marphysa sanguniea	2		2	1	3	2	1	2	1		2	2		1	
Hyalinoecia bilineata							1								
Lumbrinereis gracilis		1	1	1	1	5									
Lumbrinereis latreilli	3	2	6	4	10	3	2	1	4	4	6	11		5	2
Drilonereis filum												1			
Phylo foedita		2	1		5	3	3	2	2	6	1	1	2	1	2
Scoloplos armiger		1	1	1	2										
Laonice cirrata			1												
Spiophanes kroyeri		1													
Pseudopolydora atennata					1										
Polydora ciliata												1			
Polydora flava					2										

Prionospio cirrifera			1	1			1								
Poecilochetus serpens			1			4		1						1	1
Aricidea sp.							1								
Chaetopterus variopedatus												1	1		
Telepsavus costarum	2	3	1	4	1	8	12	9	8	18	7	4	8	4	7
Pherusa plumosa											1				
Notomastus latericeus											1	1			
Capitellidae indet.								1							
Maldane glebifex						10	13	2	4	5	13	14	24	5	10
Lagis koreni	1					2	1			1			1		3
Amphictene auricoma													1		
Ampharete acutifrons						1									
Melinna palmata	3	2		3	3	11	8	7	3	14	16	4	3	3	1
Amphitrite affinis															1
Terbellides stroemi				1	1	2	1	3	1	2	2	5	2		3
Serpula concharum					1										
Serpula vermicularis		2		1	1	1						6			
Hydroides elegans	2														
Hydroides pseud. pseud.														1	
Pomatoceros triqueter	15	2		10	35	16	10		9	5		16		4	26
Protula sp.	1				1					1					1
Pandalina brevirostris												2			
Processa edulis														1	
Processa sp.		2			4										
Clinbanarius erythoropus		6			4										
Brachynotus sexdentatus	9	10		2	5			1	2	1					
Pisidia longicornis	3	15		13	26	9	4	1		2	1	40		2	3
Pisidia sp.		2			8										
Galathea intermedia							1								
Dynamene bidentata		1													
Ericthonius brasiliensis	1	1		1	2										
Elasmopus rapax						1									
Caprillidae indet.	1														
Ophiothrix quinquemaculata					4	4						18			5
Ophiothrix sp.		2													
Amphiura chiajei						2					1	6	2	2	1
Psammechinus microtuberculatus							1	1		3					
Phallusia mammilata		1													
Microcosmus sulcatus												4			
Ascidiacea indent.				1											

Tab. 2: Abundance of species in the grab samples of the three stations.
Tabela 2: Številčnost vrst v poskusnih vzorcih, zbranih na treh postajah.

Global Test			**Pairwise Test**		
Sample used	Statistical value (R)	Prob.	Groups compared	Statistical value (R)	Prob.
15	0.447	0.001	st. 10-2	0.548	>0.01
			st.-10-C	0.648	>0.01
			st. 2-C	0.108	19.0

Tab. 3: One-Way ANOISM global and pairwise test on abundance data.
Tabela 3: Enostranska analiza po metodi ANOSIM Global and Pairwise za podatke o številčnosti.

Groups	2+ C		10	
	Avg. Si	S.D.	Avg. Si.	S.D.
Nucula nucleus	*6.9	2.4	3.0	3.0
Telepsavus costarum	*6.9	2.0	*3.8	1.2
Maldane glebifex	*6.4	1.9		
Melinna palmata	*5.1	1.8	2.6	2.4
Eunice vittata	*3.8	1.2		
Phylo foetida	*3.3	1.0		
Lumberineris latreilli	*3.2	1.9	*5.8	2.1
Pisidia longicornis			4.4	4.3
Pomatoceros triqueter			4.0	4.2
Nassarius reticulatus			*3.3	1.0
Brachynotus sexdentatus			3.2	3.1
Average similarity within groups of stations	52.4		46.3	

Tab 4: Contribution of each species to the average Bray-Curtis V¯ transformed similarity Si (abundance data) within groups of stations. Important species (with high ratio Avg./S.D.) are higlihted (*). Cutoff 70% of total similarity.
Tabela 4: Prispevek posameznih vrst k povprečni Bray-Curtisovi trasformirani podobnosti Si (podatki o številčnosti) v skupinah postaj. Poudarjene (*) so pomembne vrste (z visokim razmerjem Avg/S.D.). Presek podobnosti je 70%.

Telepsavus costarum, Maldane glebifex, Phylo foetida, Melinna palmata and *Lumbrineres latreilli*; station 10 by *Nassarius reticulatus, Lumbrineres latreilli* and *Telepsavus costarum* (tab. 7). The dissimilarities among the three stations are due to about one-third of the total number of species, while only some of them are good discriminators: *Amphiura chiajei* and *Phylo foetida* between st. C and st. 2; *Maldane glebifex, Chaetopterus variopedatus, Brachynotus sexdentatus* and *Lumbrineris latreilli* between st. 10 and st. 2; *Maldane glebifex, Nassarius reticulatus* and *Amphiura chiajei* between st. 10 and st. C (tab. 8).

	Avg. Di	S.D.
Maldane glebifex	*4.5	2.1
Pomatoceros triquter	3.3	2.5
Pisidia longicornis	3.3	2.0
Nucula nucleus	3.4	3.0
Brachynotus sexdentatus	2.5	1.5
Telepsavus costarum	2.2	1.3
Melinna palmata	2.0	1.9
Terebellides stroemi	1.6	1.1
Paphia aurea	1.5	1.2
Phylo foetida	1.3	1.0
Eunice vittata	1.3	1.1
Corbula gibba	1.3	1.4
Nassarius reticulatus	1.3	0.8
Scoloplos armiger	*1.3	0.7
Lumbrineres latreilli	1.3	1.2
Lumbrineres gracilis	*1.3	0.7
Ophiothrix quniquemaculata	1.2	1.7
Amphiura chiajei	1.2	1.1
Erichtonius brasiliensis	*1.2	0.7
Clinbanarius erythropus	1.1	1.4
Serpula vermicularis	1.0	0.9
Pisidia sp.	1.0	1.3
Marphysa sanguinea	1.0	0.9
Arba alba	1.0	1.0
Lagis koreni	0.9	0.9
Processa sp.	0.8	1.0
Average dissimilarity betwen groups of stations	46.3	

Tab. 5: Contribution of each species to the average Bray-Curtis V¯ transformed dissimilarity Di between groups of stations (2+C) and 10 (abundance data). Important species (with high ratio Avg./S.D.) are higlihted (*). Cutoff 70% of total disimilarity.
Tabela 5: Prispevek posameznih vrst k povprečni Bray-Curtisovi trasformirani različnosti Di med skupinami postaj (2+C) in 10 (podatki o številčnosti). Poudarjene (*) so pomembne vrste (z visokim razmerjem Avg/S.D.). Presek različnosti je 70%.

Global Test			Pairwise Test		
Sample used	Statistical value (R)	Prob.	Groups compared	Statistical value (R)	Prob.
15	0.535	0	st. 10-2	0.600	>0.01
			st.-10-C	0.748	>0.01
			st. 2-C	0.280	>0.02

Tab. 6: One-Way ANOSIM global and pairwise test on biomass data.
Tabela 6: Enostranska analiza po metodi ANOSIM Global and Pairwise za podatke o biomasi.

Stations	10		2		C	
	Avg. Si	S.D.	Avg. Si.	S.D.	Avg. Si	S.D.
Nassarius reticulatus	*9.6	1.7				
Lumbrineres latreilli	*6.5	1.3	*3.2	0.5		
Marphysa sanguinea	5.9	5.6	3.8	3.3		
Nucula nucleus	4.6	4.1	*7.6	1.3	*6.8	1.3
Telepsavus costrarum	*3.2	0.8	*5.7	0.7	*5.1	1.7
Brachynotus sexdentatus	3.1	2.7				
Paphia aurea	2.6	2.5				
Maldane glebifex			*4.8	0.4	*5.9	1.1
Phylo foetida			*4.6	0.7	*2.8	1.2
Melinna palmata			*3.9	0.5	*3.3	0.8
Psammechinus microtuberculatus			3.0	4.8		
Amphiura chiajei					*4.7	0.9
Eunice vittata					*2.9	0.4
Avarage similarity within stations	50.7		56.4		45.2	

Tab 7: Contribution of each species to the average Bray-Curtis VV˙ transformed similarity Si within stations (biomass data). Important species (with high ratio Avg./S.D.) are higlihted (*). Cutoff 70% of total disimilarity.
Tabela 7: Prispevek posameznih vrst k povprečni Bray-Curtisovi trasformirani podobnosti Si (podatki o biomasi) znotraj postaj. Poudarjene (*) so pomembne vrste (z visokim razmerjem Avg/S.D.). Presek podobnosti je 70%.

The total biomass decreased from st. C to st. 2 and reached the lowest value at st. 10 (fig. 3).

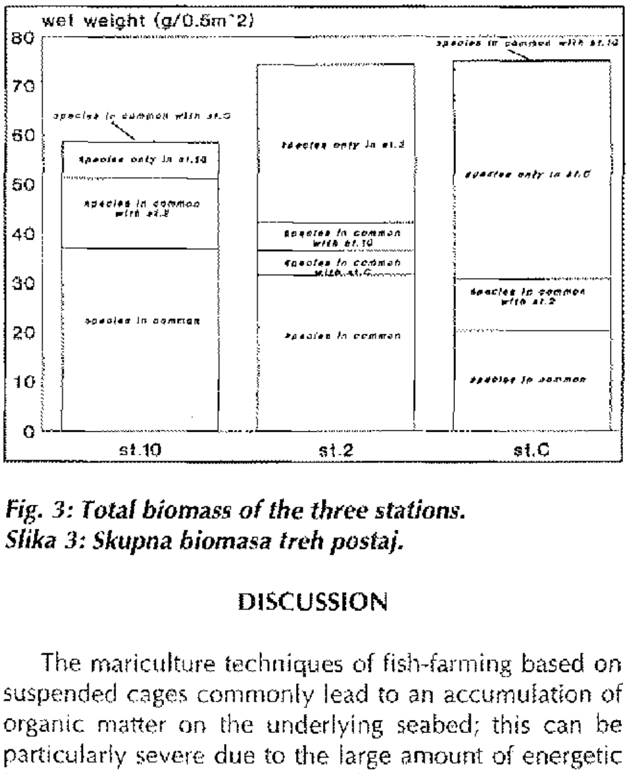

Fig. 3: Total biomass of the three stations.
Slika 3: Skupna biomasa treh postaj.

DISCUSSION

The mariculture techniques of fish-farming based on suspended cages commonly lead to an accumulation of organic matter on the underlying seabed; this can be particularly severe due to the large amount of energetic input (e.g. food pellets) required to fishes grow to commercial size. Not-ingested food pellets and faeces accumulate under the cages, which may result in a decline of benthos (Ritz *et al.*, 1989; Weston, 1990).

Mussels actively filter phytoplankton and convert it to biomass, thus allow extracting a considerable amount of organic matter from the pelagic system (Officer *et al.*, 1982; Loo & Rosenberg, 1989). A secondary part of this matter is transferred to the bottom over a limited area, while the main one is exported from the system when the mussels are harvested.

A larger number of *Mytilus galloprovincialis* was observed in the samples of st. 10 than in those of st. 2. They fall down from the overlying ropes, particularly in the first stages of growing or in summer, before their collection, when the adult byssus threads break. The mussels commonly survive on the seabed for several months, although three-year-old specimens have occasionally been collected. In this way the mussel cultures result in a transfer to the benthic system of a large amount of organic matter available for predators and scavengers, as well as in a settlement of faeces and pseudofaeces utilizable by detritus feeders (Frankenberg & Smith, 1967; Tenore *et al.*, 1973; Stuart *et al.*, 1982; Rosenberg & Loo, 1983). The decay of such matter can also lead to local hypoxic or anoxic conditions, especially in summer (Dahlback & Gunnarsson, 1981; Kaspar *et al.*, 1985).

The substitution or the variation in biomass or abundance of some species cannot be directly related to the lack of oxygen at the bottom caused by decaying organic matter; in fact, certain species generally unaffected by anoxia, such as *Maldane glebifex* (Aleffi *et al.*, 1993; Brizzi *et al.*, 1994), are absent in st. 10. This is probably due to the mussel biodeposition, which alters the compactness of the sediment, disturbing the building of its tube (Glemarec *et al.*, 1986).

Using univariate methods the community structure seems to be unaffected by mussel cultures; in fact, the mean values of the Shannon index under the cultures are similar to st. C, which represents the undisturbed area.

Stations	10:2		10:C		2:C	
	Avg. Si	S.D.	Avg. Si.	S.D.	Avg. Si	S.D.
Psammechinus microtuberculatos	3.7	3.2			3.6	3.1
Maldane glebifex	*3.0	0.5	*3.3	1.0		
Nassarius reticulatus	2.9	2.2	*5.0	1.0	2.0	2.5
Maraphysa sanguinea	2.8	2.0	3.7	3.2	2.1	1.8
Nucula nucleus	2.1	2.0	1.8	1.9	1.4	1.1
Corbula gibba	1.7	1.5	1.3	1.5	1.7	1.4
Chaetopterus variopedatus	*1.7	0.7	1.4	2.1	1.3	1.8
Paphia aurea	1.7	1.4	2.0	1.6	1.7	1.5
Tellina distorta	1.7	1.5			1.6	1.2
Brachynotus sexdentatus	*1.6	0.8	2.3	1.3	1.0	0.9
Clinbanarius erythoropus	1.6	2.0	1.7	2.2		
Abra alba	1.6	1.2	1.0	1.1	1.7	1.2
Hexaplex trunculus	1.6	3.2			1.5	3.1
Phylo foetida	1.5	1.3	1.2	0.7	*1.2	0.4
Gastrana fragilis	1.5	2.3	1.3	2.8		
Euspira guillemini	1.3	1.7			1.3	1.7
Pisidia longicornis	1.3	0.9	1.5	1.0	1.0	0.7
Lumbrineres latreilli	*1.2	0.5	1.8	1.5		
Anodontia fragilis	1.2	0.9			1.2	0.8
Pomatoceros triqueter	1.2	1.1	1.6	1.3	1.4	1.1
Terebellides stroemi	1.2	0.9	1.3	1.1		
Melinna palmata	1.2	1.0				
Serpula vermicularis	1.0	0.9	1.2	1.0		
Amphiura chiajei			*2.8	0.6	*2.1	1.0
Ophiothrix quinquemaculata			1.7	1.9	1.6	1.8
Microcosmus sulcatus			1.6	3.3	1.5	3.0
Caliactis parasitica			1.3	2.7	1.5	2.3
Scoloplos armiger			1.1	0.7		
Dentalium inaequicostatum			1.1	1.4	1.1	1.2
Telepsavos costarum			1.0	0.7		
Glycera unicornis			1.0	1.3	1.0	1.1
Sagartia elegans			0.9	1.9	0.8	1.7
Edwardsia claparedii					1.0	1.4
Lumbrineres gracilis			1.0	0.6	0.8	0.8
Avarage similarity within stations	58.4		67.8		53.6	

Tab 8: Contribution of each species to the average Bray-Curtis VV̄ transformed disimilarity Si within stations (biomass data). Important species (with high ratio Avg./S.D.) are higlihted (*). Cutoff 70% of total disimilarity.
Tabela 8: Prispevek posameznih vrst k povprečni Bray-Curtisovi trasformirani različnosti Di med skupinami postaj (2+C) in 10 (podatki o biomasi). Poudarjene (*) so pomembne vrste (z visokim razmerjem Avg/S.D.). Presek različnosti je 70%.

The number of taxa is also very close in the three stations (47/0.5 m^2 in st. 10, 44/0.5 m^2 in st. 2 and 52/0.5 m^2 in st. C). In contrast, the total biomass is similar in st. 2 and C (74 and 75 g/0.5 m^2 respectively), but in st. 10 decreases down to 58 g/0.5 m^2 in accordance with the contribution of the typical species (e.g. those not in common) of each station (fig. 3).

In the two stations under mussel cultures, biomass due to the common tolerant or opportunistic species increases. Here, an increased organic input presumably increases food quantity and quality for those species that are able to exploit enriched areas based on their physiological, behavioral and life history adaptations (Weston, 1990). One species that confirms this condition is the polychaete *Marphysa sanguinea:* its mean biomass in st. 10 is more than three times the values of the other two stations. Moreover, this species represents about 40% of the total biomass at st.10.

CONCLUSION

The benthos in the three stations shows certain differences. These differences are most evident in st. 10, under the oldest culture. Mussel farms modify the seabed by the accumulation of shells and organic matter on the sediment under the cultures: the effect of this disturbance on the benthos is the decrease of some infaunal species and a variation of the total biomass. However, the low dissimilarity between stations indicates that the majority of the species are not involved in such changes and thus that the mussels do not lead to a severe impact in the investigated area. This is due, above all, to the large number of tolerant or opportunistic species in the community of muddy bottoms of the Gulf of Trieste. They can survive large variations of ecological factors and in some cases increase their biomass due to the reduction of competitors.

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POVZETEK

Gojišča užitnih klapavic zavzemajo precejšen obrežni del Tržaškega zaliva, katerega značilnosti so visoka primarna produkcija in velika nihanja v temperaturi, slanosti in raztopljenemu kisiku na dnu. Z namenom, da bi ugotovili, kako gojenje klapavic vpliva na tamkajšnji bentos, so bile v njem nameščene tri postaje: ena pod starim (desetletnim) gojiščem, druga pod novejšim (dveletnim) gojiščem, tretja pa v območju, kjer gojišč ni. Na vsaki postaji je bilo zbranih po pet poskusnih vzorcev. Statistične analize tako glede številčnosti kot biomase so bile opravljene z neparametričnimi multivariatnimi metodami. Rezultati so pokazali zmeren vpliv gojenja školjk na tamkajšnji bentos, predvsem pod najstarejšim gojiščem. Skupna biomasa se manjša pod temi kulturami in najnižja vrednost je bila ugotovljena pod desetletnim gojiščem.

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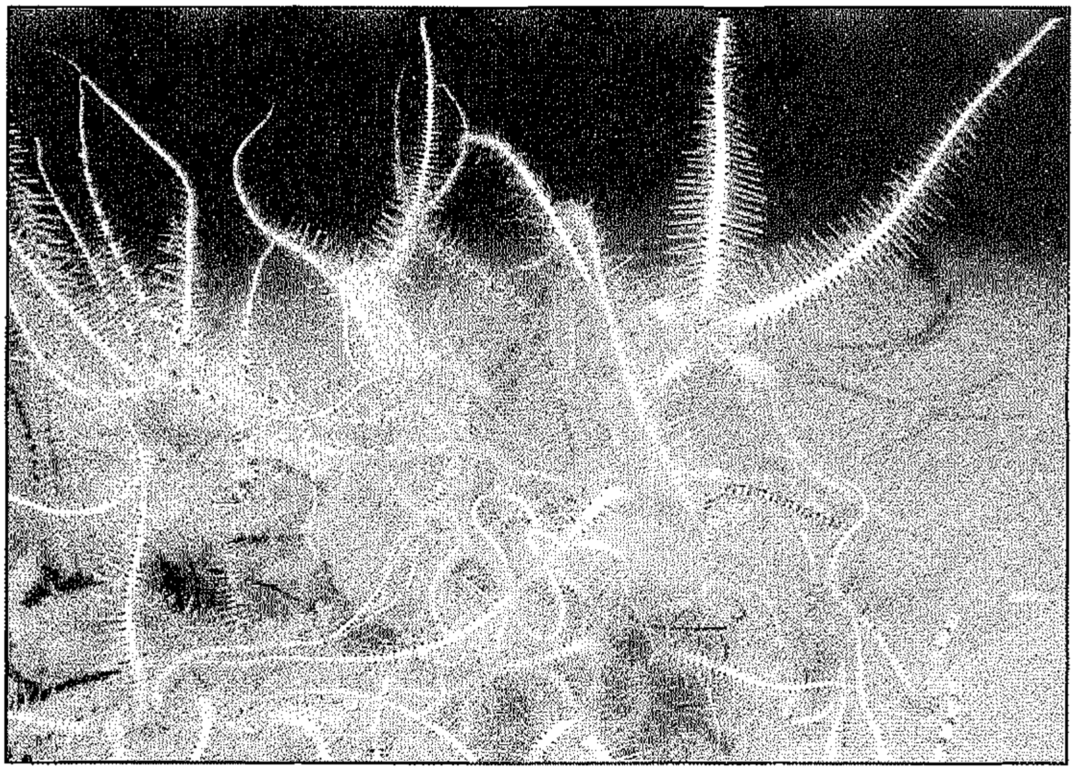

The brittle star* Ophiotrix quinquemaculata *and the sponge* Reniera *in the Gulf of Trieste (Photo: M. Stachowitsch). See article Stachowitsch & Fuchs.
Kačjerep* Ophiotrix quinquemaculata *in spužva iz rodu* Reniera *v Tržaškem zalivu. (Foto: M. Stachowitsch). Gl. članek Stachowitsch & Fuchs.