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FIRST OBSERVATIONS AT THE ARTIFICIAL REEF SUBMERGED ON THE SANDBANK OFF SANTA CROCE (TRIESTE, ITALY)

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ABSTRACT

At the artificial reef submerged on the sandbank off S. Croce (45°42'02" N, 13°37'24" E), the following was studied at the site on a monthly basis from March 1999 to October 2000: the chemical-physical parameters of the water column, the ichthyoplanktonic and mesozooplanktonic community, the fish community and the structure of the species population. During the summer, the ichthyoplanktonic community constituted mainly of sparids, serranids and blennies, while in the winter it was made up mainly by Pleuronectiformes. The mesozooplanktonic community was composed principally of copepods - except in the summer, when cladocerans were prevalent. According to the fishing catch data, more species were sampled at the artificial reef than at the control site.

Key words: artificial reef, Gulf of Trieste, chemical-physical data, zooplankton catch data, fishing catch data

PRIME OSSERVAZIONI SULLE STRUTTURE ARTIFICIALI SOMMERSE POSTE IN PROSSIMITÀ DEL DOSSO DI S. CROCE

SINTESI

Sulle strutture artificiali sommerse poste in prossimità del dosso di S. Croce (45°42'02" N, 13°37'24" E), sono stati effettuati campionamenti mensili da marzo 1999 ad ottobre 2000, al fine di rilevare i parametri chimico-fisici della colonna d'acqua, le comunità ittioplanctonica e mesozooplanctonica, nonché la comunità ittica e la struttura della popolazione. Durante il periodo estivo la comunità ittioplanctonica è risultata composta principalmente da Sparidi, Serranidi e Blennidi, mentre durante il periodo invernale hanno prevalso i Pleuronettiformi. La comunità mesozooplanctonica è risultata composta principalmente da copepodi, tranne nei mesi estivi quando hanno prevalso i cladoceri. In base ai dati delle pescate ittiche, è stato rinvenuto un maggior numero di specie in prossimità delle strutture artificiali che non nel sito di controllo.

Parole chiave: strutture artificiali, Golfo di Trieste, dati chimico-fisici, pescate di zooplancton, pescate ittiche

INTRODUCTION

Artificial reefs are bio-ecological mechanisms able to enhance the fishery biomass (Bombace, 1994). Artificial reefs protect eggs and larval/young stages, increase the availability of food, reduce mortality and increase the curves of growth of different species, therefore provide for an increase in total biomass. According to the census (Grove & Sonu, 1991) conducted in 29 countries of the world, the first effect credited to the artificial reefs is a considerable increase in fish production (from 20 to 4000%), the second function is to prevent over-fishing in some areas, and the third is linked to the clear increase of biomass.

As the very same modules placed in environments with different ecological characteristics may lead to a very different evolution of the community (Bombace, 1987), it is necessary to survey regularly the physical and biological characteristics at the reef site in order to obtain a broad set of data suitable for analysis and comparisons in order to obtain the information that could optimise the biotic development in relation to the scopes defined before the artificial structures were submerged.

In order to study the potentialities of an artificial reef submerged in the Gulf of Trieste, the following was studied at the site: the chemical-physical parameters of the water column, the ichthyoplanktonic and mesozooplanktonic community, the fish community and the structure of the species population subject to the fishing in the area attracted by the artificial structures. The artificial reef is located 3.7 miles offshore at the sandbank off S. Croce (45°42'02" N, 13°37'24" E) on a sandy muddy bottom at a depth of approximately 15 metres (Fig. 1). The artificial reef is composed of a series of different structures: of a wreck iron pontoon sunk in April 1995; 30 prefabricated cube-shaped structures submerged in 1999 and positioned so as to form 6 pyramids each made of five cubic blocks of concrete (2 x 2 x 2 m), the aforesaid blocks are hollow with dividing walls in the middle and with holes on external walls; 10 full concrete cubes with anti trawling poles; 50 M.I.M. (microelements integrating the modules) made of a cement base and polyethylene branching in corrugated tubes in vertical position. Some other structures are now being submerged and installed at the reef site. All the above mentioned structures are supposed to perform various functions, mainly to increase the area's ecological diversity and to prevent trawl fishing. The effect should be not only an increase in commercially interesting fish species but also in overall biodiversity of the alieutic species.

MATERIALS AND METHODS

Planktonic samplings were carried out from 9 March 1999 to 18 October 2000 every two weeks at the fixed station (S. Croce sandbank) in the Gulf of Trieste. The main chemical-physical parameters of the water (temperature, salinity, oxygen content) were measured with the Multiprobe sounder, as well as the transparency by the use of the Secchi disc. Plankton samplings were carried out with a Bongo 20 type net (236 µm and 335 µm mesh), FAO (236 µm mesh) and WP2 (500 µm mesh) equipped with a flow-meter and double oblique catches from the bottom to the surface. Each sample was fixed in 4% formalin. From the entire sample, the ichthyoplanktonic fraction (teleosts eggs and larvae) was separated by the use of binocular microscope from the mesozooplanktonic for the qualitative-quantitative determination. Thus the total number of eggs and larvae per cubic meter was determined.

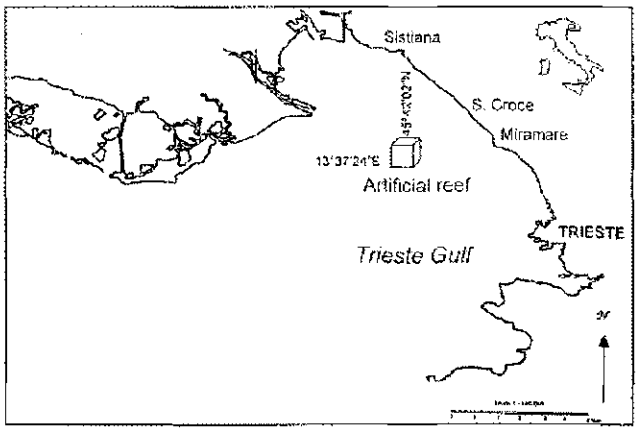

Fig. 1: Position of the artificial reef in the Gulf of Trieste.
Sl. 1: Lega umetnega podvodnega grebena v Tržaškem zalivu.

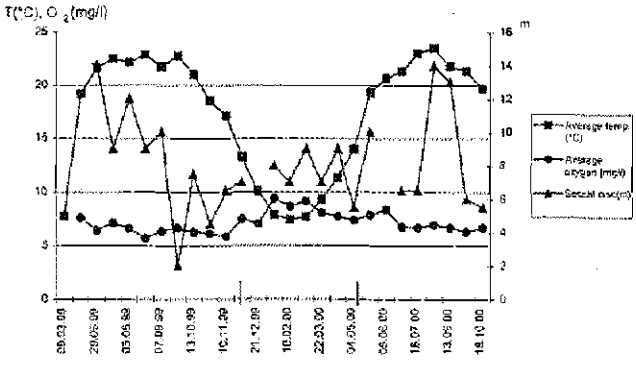

Fig. 2: Average temperature (°C), transparency (m) and oxygen content (mg/l) along the water column during the studied period.
Sl. 2: Povprečna temperatura (°C) morske vode, prozornost (m) in vsebnost kisika (mg/l) v vodnem stolpcu v vzorčevalnem obdobju.

The fishing survey was carried inside the area delimited with submerged artificial structures and at the control site placed one nautical mile away in north-western direction on the same bathymetric and the same type of sea bottom. Catch samplings were conducted with the use of a bottom trammel net measuring 260 m in length, 2 m in height, with 70 mm inner mesh size and 350 mm outer mesh size. The nets were placed in the sea before the sunset and extracted on the following morning with the permanence of approximately 12 hours. Samplings were conducted at both sites at the same time. From December 1999 to November 2000, eleven monthly samplings were carried out. The samples were transported to the laboratory for some successive analyses. The samples were measured (total length in mm) and weighed (in g).

RESULTS

Chemical - physical parameters

The averages of temperature (°C), salinity (PSU) and oxygen content (mg/l) along the water column were calculated. The lowest average temperature during the sampling period was in February 2000 (7.45°C) and the highest in August 2000 (23.50°C) (Fig. 2). Homothermia was noted along the water column during the autumn; temperature values falling in winter (inverse thermal stratification) with a minimum in February. In spring, after a short period of isothermy, thermocline was clearly formed that lasted during the summer. The oxygen content during the period of sampling showed a minimum of 5.68 mg/l in August 1999 and a maximum of 9.42 mg/l in January 2000 (Fig. 2). During the survey period, the highest transparency was observed in the summer 1999 (Fig. 2). In the summer of 2000, low values of transparency for the months of June and July were recorded, probably due to the presence of the floating mucilage in the Gulf of Trieste. The highest values were recorded in August. The lowest transparency values were established during the autumnal-winter period with an absolute minimum (2 m) at the end of September 1999. This is probably related to the contribution of the sediments from the Isonzo and Timavo rivers flowing into the Gulf.

Mean salinity values were the lowest (35.15 PSU) in July 2000 and the highest (38.02 PSU) in February 2000 (Fig. 3). These values reflect the characteristics of the Gulf of Trieste, in which the freshwater inflows are quite remarkable. In substance the salinity of the Gulf of Trieste is pretty low and the haline stratification rather anomalous (Specchi & Famiani, 1976; Mosetti, 1988; Stravisi, 1988; Vinzi & Bussani, 2000).

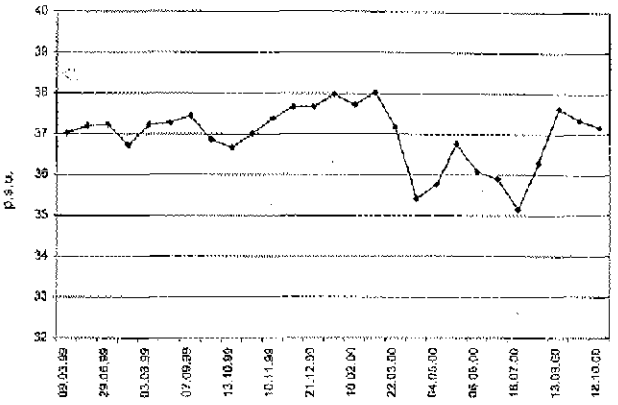

Fig. 3: Average salinity (PSU) along the water column during the studied period.
Sl. 3: Povprečna slanost (PSU) morske vode v vodnem stolpcu v vzorčevalnem obdobju.

Ichthyoplanktonic and mesozooplanktonic survey

According to Specchi & Furlan (1974), *Sardina pilchardus* (Walb.) eggs and larvae were more abundant during spring and autumn, while *Engraulis encrasicolus* (L.) eggs and larvae were more abundant at the end of spring and in summer. During the summer, ichthyoplankton community of the artificial reef constituted of other groups, mainly sparids, serranids and blennies, and in the winter of pleuronectiformes (Tabs. 1 and 2).

The different mesozooplanktonic taxa, which are presented in figure 4, were collected in 4 categories: copepods, cladocerans, eggs and larvae (larval stages of holoplanktonic and meroplanktonic organism, such as molluscs, annelids, echinoderms and teleosts) and others (ctenophores, chaetognaths and urochords). The mesozooplanktonic community constituted principally of copepods during the spring and from the end of the autumn to the end of the winter. During the summer, although copepods were abundant, cladocerans were found in greater numbers due to the presence of *Penilia avirostris*.

Fishing catch data

Fishes, cephalopods and crustaceans caught at the artificial reef (Tab. 3) showed the presence of 25 species (21 fishes, 3 cephalopods and 1 crustacean), while at the control site 19 species were caught (16 fishes, 2 cephalopods and 1 crustacean) (Tab. 4). In total, 31 species were sampled. The distribution of the species and the corresponding number of individuals in the various seasons indicated a greater number of individuals caught in the summer at both sites and a lesser number in the winter (Fig. 5). The highest number of individuals at the artificial reef was caught in July, and at the control site in August.

Tab.1: Abundance of teleost eggs (ind/m³) sampled at the artificial reef during 1999-2000.
Tab. 1: Število jajc morskih kostnic (ind/m³) na območju umetnega podvodnega grebena v obdobju 1999-2000.

Legend/Legenda:

S.p.: Sardina pilchardus **(Walb.)**
S.s.: Sprattus sprattus **(L.)**
E.e.: Engraulis encrasicolus **(L.)**
A.l.: Arnoglossus laterna **(Walb.)**
A.t.: Arnoglossus thori **Kyle**
B.p.: Bothus podas **(Del.)**
P.m.: Psetta maxima **(L.)**
S.r.: Scophthalmus rhombus **(L.)**
P.f.i.: Platichthys flesus italicus **(L.)**
S.l.: Solea lutea **(Risso)**
S.i.: Solea impar **Benn.**
S.v.: Solea vulgaris **Quens.**
D.a.: Diplodus annularis **(L.)**
D.v.: Diplodus vulgaris **(Geoffr.)**
O.m.: Oblada melanura **(L.)**
C.r.: Ctenolabrus rupestris **(L.)**
C.f.: Callionymus festivus **Pallas**
C.b.: Callionymus belenus **Les.**
S.sc.: Serranus scriba **(L.)**
T.t.: Trachurus trachurus **(L.)**
T.m: Trachurus mediterraneus **(Stdr.)**
L.s.: Liza saliens **(Risso)**
M.b.: Mullus barbatus **L.**
G.m.: Gaidropsarus mediterraneus **(L.)**
M.m.: Merlangus merlangus **Geoffr.**

	S.p.	S.s.	E.e.	A.l.	A.t.	B.p.	P.m.	S.r.	P.f.i.	S.l.	S.i.	S.v.	D.a.	D.v.	O.m.	C.r.	C.f.	C.b.	G.m.	M.m.	S.sc.	T.t.	T.m.	L.s.	M.b.
09.03.99									0,41																
23.03.99	0.44								0.15																
07.04.99	0.25								0.37									0.50							0.12
26.04.99	39.90		0.48	0.60			0.12			1.20					0.12	1.44	0.60	3.13							
10.05.99	2.39			0.13												0.13	0.27	0.13							
25.05.99	6.41		0.43														0.21				1.28				
15.06.99			0.66	4.91						2.79						0.53									
29.06.99			0.12	9.80						1.49							0.25							0.50	0.25
15.07.99			2.21		3.73					2.80												11.19		3.73	
03.08.99			0.80			11.86											0.16								
24.08.99																									
07.09.99	0.21				2.11											0.11									
22.09.99	8.32			0.54		1.30											0.11			0.22			0.22		
13.10.99	63.96			0.12																					
28.10.99	17.52			2.10																					
10.11.99	81.09			0.55			0.18																		
25.11.99	0.20																								
21.12.99		1.30							0.19			0.09													
13.01.00		3.41																							
10.02.00		0.64		0.05					0.27			0.21													
24.02.00		0.04		0.04			0.15					0.04													
22.03.00	1.14	0.19		0.19						0.10															
10.04.00	15.92			0.57						1.63	0.24					0.08		2.94							
04.05.00	2.31		1.08	0.12						0.38			0.04					2.92							
24.05.00	6.13		0.19	2.13						0.25			1.31				0.13								
06.06.00			0.54	1.69						0.20			4.81												
27.06.00			0.67	3.67													0.13								
18.07.00				10.14																		2.98			
02.08.00			0.04	2.49												0.08						1.10		0.20	0.24
13.09.00																									
27.09.00	16.95		0.03	3.80												0.10			1.42						
18.10.00	65.74																								

Tab. 2: Abundance of teleost larvae (ind/m³) sampled at the artificial reef during 1999-2000.
Tab. 2: Število ličink morskih kostnic (ind/m³) na območju umetnega podvodnega grebena v obdobju 1999-2000.

Legend/Legenda:

S.p.: Sardina pilchardus **(Walb.)**
E.e.: Engraulis encrasicolus **(L.)**
A.l.: Arnoglossus laterna **(Walb.)**
P.f.i.: Platichthys flesus italicus **(L.)**
D.a.: Diplodus annularis **(L.)**
L.r.: Lithognathus mormyrus **(L.)**
C.: Crenilabrus sp. **(Cuv.)**
C.f.: Callionymus festivus **Pallas**
G.: Gobius spp. **L.**
G.m.: Gaidropsarus mediterraneus **(L.)**
M.m.: Merlangus merlangus **Geoffr.**
S.sc.: Serranus scriba **(L.)**
D.l.: Dicentrarchus labrax **(L.)**
B.p.: Blennius pavo **Risso**
C.n.: Corvina nigra **Cuv.**
T.d.: Trachinus draco **L.**
S.a.: Syngnathus abaster **Risso**

	S.p.	E.e.	A.l.	P.f.i.	D.a.	L.m.	C.	C.f.	G.	G.m.	M.m.	S.sc.	D.l.	B.p.	C.n.	T.d.	S.a.
09.03.99			0.27														
23.03.99	0.44															0.15	
07.04.99		0.12															
26.04.99		0.12															
10.05.99		0.27															
25.05.99																	
15.06.99		0.13			0.53			0.13									
29.06.99		0.25			0.62	0.12											
15.07.99		4.08			1.28			0.12			0.12	0.23					0.12
03.08.99		1.28															
24.08.99																	
07.09.99	1.16																
22.09.99	4.65							0.11									
13.10.99	0.16																
28.10.99	3.33																
10.11.99																	
25.11.99	0.20																
21.12.99														0.09			
13.01.00	0.97		0.11												0.05		
10.02.00			0.11	0.05						0.05							
24.02.00	0.11			0.40						0.04			0.07				
22.03.00				0.10							0.10						
10.04.00																	
04.05.00		0.38												0.04			
24.05.00		0.88						0.44	0.19					0.13			
06.06.00								0.07	0.07								
27.06.00																	
18.07.00		4.47						0.37	1.49					0.09			
02.08.00		0.78	0.04				0.04	0.12	0.08								
13.09.00																	
27.09.00	0.51																
18.10.00	0.87																

Tab. 3: Artificial reef catch data composition.
Tab. 3: Ulov rib, rakov in mehkužcev na območju umetnega podvodnega grebena.

NAME	DEC'99	JAN'00	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL	% of ind.
Dicentrarchus labrax	5											2	7	4.6%
Engraulis encrasicolus								2					2	1.3%
Gobius sp.		1											1	0.7%
Hippocampus hippocampus			1										1	0.7%
Labrus merula							1						1	0.7%
Loligo vulgaris												1	1	0.7%
Merlangus merlangus	1											15	16	10.6%
Mullus surmuletus											1		1	0.7%
Mustelus vulgaris												1	1	0.7%
Octopus vulgaris	3												3	2.0%
Pagellus erythrinus								4		2			6	4.0%
Pagrus pagrus												1	1	0.7%
Platichthys f. italicus		3	1										4	2.6%
Raja stellata												2	2	1.3%
Sardina pilchardus	2									1	3	6	12	7.9%
Scorpaena porcus											2		2	1.3%
Sepia officinalis				1	3	1		9				2	16	10.6%
Serranellus hepatus										1			1	0.7%
Solea hispida								2					2	1.3%
Solea vulgaris						1							1	0.7%
Sparus aurata			1										1	0.7%
Squilla mantis	9					8	4	9	18		4	10	62	41.1%
Trachurus trachurus		1	1										2	1.3%
Trisopterus m. capelanus		4											4	2.6%
Umbrina cirrosa	1												1	0.7%
No. of individuals	21	9	4	1	3	10	5	26	18	4	10	40	151	100.0%
No. of species	6	4	4	1	1	3	2	5	1	3	4	9	25	
% of ind.	13.9%	6.0%	2.6%	0.7%	2.0%	6.6%	3.3%	17.2%	11.9%	2.6%	6.6%	26.5%	100.0%	
Biomass (kg)	4.999	1.22	0.59	0.17	0.56	0.79	0.46	2.586	0.874	0.13	0.65	6.196	19.221	

Tab. 4: Control site catch data composition.
Tab. 4: Ulov rib, rakov in mehkužcev na referenčni postaji.

NAME	DEC'99	JAN'00	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	TOTAL	% of ind.
Alosa fallax					4								4	1.1%
Engraulis encrasicolus							1	1	44	1	2	2	51	14.4%
Merlangus merlangus	6										1	18	25	7.0%
Mustelus vulgaris							3	2	9	4	17		35	9.9%
Ozaena moschata										1			1	0.3%
Pagellus erythrinus									1	2			3	0.8%
Platichthys f. italicus	11	3											14	3.9%
Raja clavata					2								2	0.6%
Raja stellata							1				2	1	4	1.1%
Sardina pilchardus	9				1			3				3	16	4.5%
Scomber scomber											1		1	0.3%
Sepia officinalis				1	2	4		9		6		1	23	6.5%
Solea vulgaris	1				1								2	0.6%
Sparus aurata							1						1	0.3%
Squilla mantis	7				15	22	9	27		7	27	53	167	47.0%
Trachurus trachurus			1										1	0.3%
Trigla hirundo											2	1	3	0.8%
Trisopterus m. capelanus									1				1	0.3%
Trygon pastinaca										1			1	0.3%
No. of individuals	34	3	1	1	25	26	15	42	55	22	52	79	355	100%
No. of species	5	1	1	1	6	2	5	5	4	7	7	7	19	
% of ind.	9.6%	0.8%	0.3%	0.3%	7.0%	7.3%	4.2%	11.8%	15.5%	6.2%	14.6%	22.3%	100%	
Biomass (kg)	2.38	0.17	0.18	0.14	3.14	1.83	1.33	3.75	5.04	5.2	15.12	6.12	44.38	

Figure 6 shows the yields with 100 m long nets both at the artificial reef and at the control site. The yield at the artificial reef varied between 2.38 kg in November 2000 to 0.05 kg in September 2000. The average data for the 11 months samplings gave a mean fishing yield of 0.61 kg for the 100 m long net. Higher values were recorded at the control site, the mean value reaching 1.41 kg, with a maximum of 5.81 kg in October and a minimum of 0.05 kg in March. According to the Shannon-Weaver index (Tab. 5), the lowest diversity values (H' = 0) were recorded in the reef area during the months of March, April and August. The same situation (H' = 0) occurred at the control site in the months of January, February and March. The highest diversity value in the reef area was recorded in November 2000 (H'=1.72), whereas at the control site it was registered in September 2000 (H'=1.67).

As a whole, the total diversity highlights a slightly higher value in the reef area (H'=0.90) compared to the control site against (H'=0.81), although these differences are not statistically significant as resulted from the ANOVA analysis (P>0.05).

DISCUSSION

The main chemical-physical parameters recorded at the S. Croce sandbank from March 1999 to October 2000 reflect typical situation in the Gulf of Trieste, in accordance with the data collected by Specchi & Famiani (1976), Mosetti (1988), Aleffi *et al.* (1992). In the period from December 1999 to the end of March 2000, a high value of oxygen content was observed (in compliance with the falling temperatures) as well as a rather increased salinity, which is typical of the winter months in the Gulf of Trieste. The high transparency of the water column during the winter months is due to the small contribution of sediment from the rivers Isonzo and Timavo (with the smallest capacities in this particular period) and to the reduced presence of plankton in the colder months.

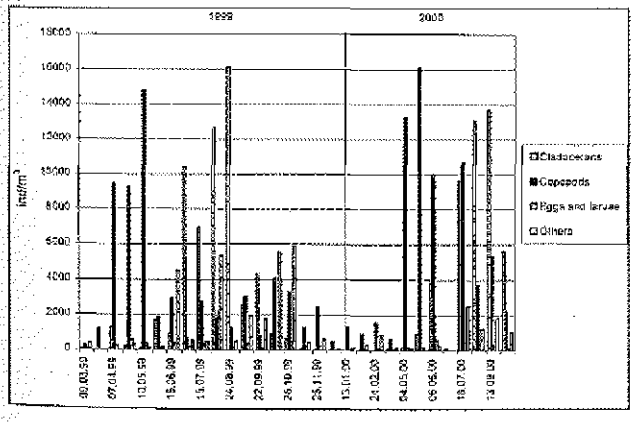

Fig. 4: Mesozooplankton (ind/m³) sampled at the artificial reef during 1999-2000.
Sl. 4: Gostota mezozooplanktona (ind/m³) na območju umetnega podvodnega grebena v obdobju 1999-2000.

The structure of the mesozooplanktonic community confirms the description presented by several authors (Specchi *et al.*, 1979; Fonda Umani *et al.*, 1983-84) both from qualitative and quantitative points of view.

Sampled ichthyoplanktonic fraction constituted of eggs belonging to 24 species, mainly represented by the eggs of two pelagic species, *Sardina pilchardus* and *Engraulis encrasicolus*, which are, however of less interest as far as colonizing of the artificial reef is concerned. Eggs belonging to *Diplodus annularis, D. vulgaris, Oblada melanura, Ctenolabrus rupestris, Serranus scriba, Blennius pavo* are more important for the potential colonization of the site. The same can be said of the larval stages. The study of the ichthyoplankton can give a useful indication on the efficiency of the reef area as a "nursery" site. It is important to notice the abundant presence of larval stages of natural rock reef species such as *Diplodus annularis, Serranus* scriba *etc.* that are going to colonize the artificial reef site giving rise to a new fish community.

According to the fishing catch data, more species were sampled at the artificial reef than at the control site. At both stations, the most abundant species was *Squilla mantis*. At the reef, an exclusive presence of some economically important species was noted, such as *Scorpaena porcus, Dicentrarchus labrax* and *Umbrina cirrosa*. The above data is confirmed by the Shannon-Weaver index that evidences a greater overall value for the artificial reef site (H'=0.90) in comparison with the control site (H'=0.81). In this respect, the results obtained during these first study stages seem to be encouraging, bearing in mind that the pyramidal structures was submerged in 1999.

The fished biomass is in compliance with the expectations of a maximum in the summer and a minimum in the winter. In fact it is known that the nearshore fish communities of the northern Adriatic are characterized by seasonal variations, as most of the fish species move offshore to deep waters in the winter months to avoid the low coastal water temperatures. The amount of fished biomass with 100 m long trammel net was clearly smaller at the artificial reef than that obtained at the control site. These data are in contrast to those obtained by several authors (Bohnsack & Sutherland, 1985; Arculeo *et al.*, 1990; Fabi & Fiorentini, 1994) who reported higher catch rates at the artificial reef than at the control site. The reason for small catch rates at the artificial reef could be, in the present study, the short time passed from the reef deployment and the lack of the visual census data. Different authors (Harmelin-Vivien & Francour, 1992; Relini *et al.*, 1995; Francour, 1999) reported that trammel net fishing and visual census present the same fish community differently. The trammel

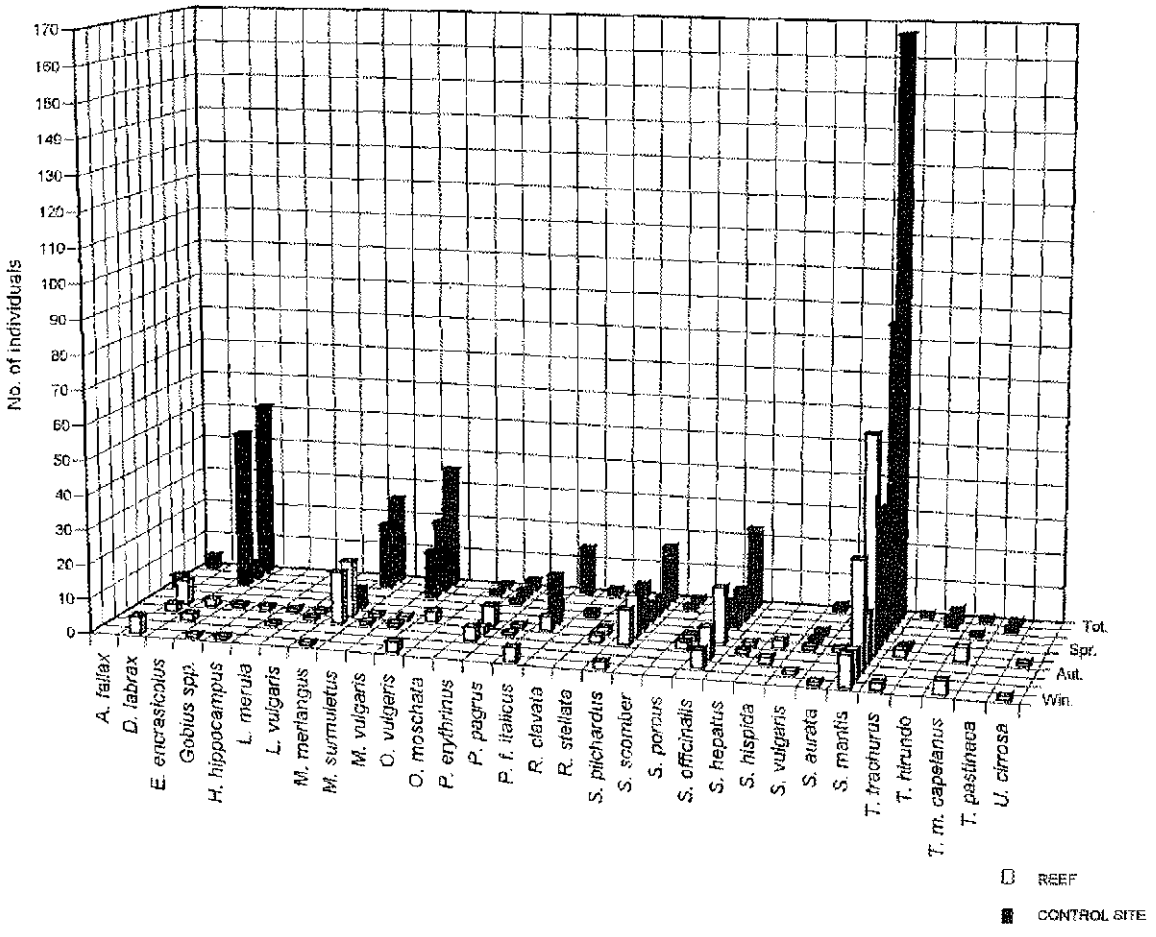

Fig. 5: Seasonal composition of fishing catch data at the artificial reef and at the control site.
Sl. 5: Podatki o sezonski strukturi ulova rib, rakov in mehkužcev na območju umetnega podvodnega grebena in na referenčni postaji.

Tab. 5: Shannon-Weaver index of diversity at the artificial reef and at the control site
Tab. 5: Shannon-Weaverjev diverzitetni indeks na območju umetnega podvodnega grebena in na referenčni postaji.

MONTH	CONTROL SITE	REEF
DEC'99	1.30	1.59
JAN'00	0.00	1.21
FEB'00	0.00	1.39
MAR'00	0.00	0.00
APR'00	1.26	0.00
MAY'00	0.43	0.64
JUN'00	1.17	0.50
JUL'00	1.04	1.42
AUG'00	0.62	0.00
SEP'00	1.67	1.04
OCT'00	1.23	1.28
NOV'00	0.99	1.72
MEAN	0.81	0.90

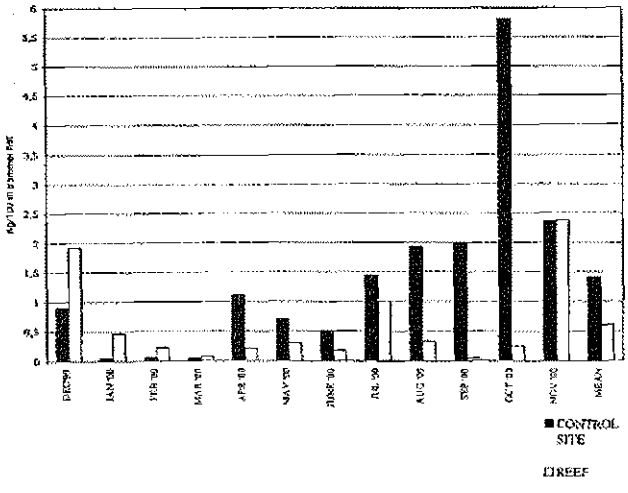

Fig. 6: Monthly fishing yield by 100 m trammel net at the artificial reef and at the control site.
Sl. 6: Mesečni ribolovni izkoristek po vleku s 100 m povlečno mrežo na območju umetnega podvodnega grebena in na referenčni postaji.

net fishing collects more species of the sandy-muddy habitat, while visual census better estimates fast swimming species and some cryptic fish species, such as *Conger conger* or *Scorpaena scrofa*.

In conclusion, bearing in mind that the artificial reef structures were installed in April 1999, the results seem to be encouraging. An increase in biodiversity was indeed noted in the reef area which, together with a reasonably expected increase in biomass, may in time bring positive consequences in the entire ecosystem of the Gulf of Trieste.

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PRVE UGOTOVITVE, OPAŽENE OB UMETNEM PODVODNEM GREBENU NA PEŠČENI PLITVINI V BLIŽINI KRIŽA (TRST, ITALIJA)

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POVZETEK

Na lokaciji umetnega podvodnega grebena, potopljenega na peščeno plitvino v bližini Križa (45° 42' 02" N - 13° 37' 24" E), so avtorji pričujočega članka med marcem 1999 in oktobrom 2000 mesečno opravljali raziskave o kemijsko-fizikalnih parametrih vodnega stolpca, ihtioplanktonskih in mezozooplanktonskih skupnostih, ribjih skupnosti in strukturi populacij različnih vrst. Poleti so ribjo planktonsko skupnost sestavljale predvsem ličinke šparov, zobčastih ostrižev in babic, pozimi pa ličinke bokoplut. Mezozooplanktonsko skupnost so sestavljali v glavnem ceponožci, razen poleti, ko so prevladovale morske bolhe. Glede na podatke o ribjem ulovu je bilo več vrst vzorčenih na umetnem morskem grebenu kot na kontrolni lokaciji.

Ključne besede: umetni podvodni greben, Tržaški zaliv, kemijsko-fizikalni parametri, podatki o ujetem zooplanktonu

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