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Project »Biodiversity Preservation in the Adriatic Sea« – Specially protected area »Palagruža«

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Abstract

The project »Biodiversity Preservation in the Adriatic Sea« is created to promote special protection of selected areas. The network of specially protected areas (marine parks, fish reserves, special reserves etc.) in the Croatian part of the Adriatic Sea with strictly defined management regulation has an aim to preserve and to protect the biodiversity and to allow the natural renewal of bioresources, especially of economically important species.

In present preliminary research, the following main characteristics of the marine area of the island of Palagruža have been determined: dimension and bathymetry; physical parameters: temperature, salinity, density, transparency and colour; chemical parameters: concentration of nutrients, pH and oxygen concentration; benthic bionomy: distribution and composition of benthic communities, and composition of coastal populations of fish, cephalopods and crustaceans. The proper protocol for systematic protection includes a thorough inventory of species, conditions and environmental impacts, the collection of monitoring data to track change and ongoing research into the dynamics of underwater communities.

Priority concerning, research and inclusion into specially protected areas should be extended to the open sea islands. The elaboration and implementation concepts of projects are thus highly compatible with the development – policy guidelines of national scientific-research programme and National Island Development Strategy.

KEY WORDS: Adriatic Sea, Palagruža, Specially protected area.

Introduction

The Adriatic ecosystem and its biodiversity are endangered in two basic ways: directly, through excessive picking of edible shellfish, crabs and cephalopods, and overfishing; and indirectly, through destruction of important habitats. Habitat endangering includes various forms of pollution and contamination (wastewater, river flowing, oil and gas wells, maritime traffic, and even mariculture), constructin in coastal areas, inappropriate developments that could cause major landslides and excessive erosion, or disposal of large volumes of soil and other waste material into the sea.

It is essential to increase the number of protected areas in the Adriatic and to extend studying them by drawing up development and management plans for such areas, giving them suitable funding to enable promulgation of those plans, taking into account the rights of the local communities likely to be affected.

The project »Biodiversity Preservation in the Adriatic Sea« is created to promote a special protection of selected areas – marine parks – along the Croatian coast of the Adriatic Sea, primarily with an aim to preserve and protect the biodiversity and enable undisturbed natural reproduction of the economically important marine species. In implementing sound management strategies for biodiversity protection special attention should be paid to the habitat of the depleted, threat-

ened, rare or endangered species and to the insular environments [1–3].

The methods and inventories developed in the European Union and in other international organizations adapted to Croatian and local conditions could serve as basis in this respect. The protected areas could play an important role in the development of economically depressed areas of Croatian islands, through the promotion of environment-friendly tourism and therefore hold a great potential for both ecology and economy [4].

The project is in compliance with National Programme for Development of Islands, national priorities of scientific research activities in the Republic of Croatia and with signed international conventions on the protection of the sea and biodiversity.

Description of Sites Studied

The oceanographic, biological and marine research of the Palagruža archipelago waters done so far, though rare, point to their extraordinary ecological and economic significance [5–16].

In recent years, however, negative influence of man on pelagic populations of small blue fish has been noted as well as drastic impoverishment of bottom fish, cephalopods and edible species of crustacean settlements due to over-fishing. Significant qualitative and quantitative changes have been noted. Average catch per trammel net decreased to as much as 69,4% in the last thirty years [14, 15].

Geographically the Palagruža archipelago belongs to the Adriatic open sea area. It is situated on the border between the central and the south Adriatic and is the furthermost group of any Adriatic islands. Because of Palagruža the outer line of the Croatian territorial waters reaches very far out and coincides with the separation line of epicontinental belt of the Republic of Croatia and the Republic of Italy [17].

The archipelago is a microgeomorphological regional unity and consists of two islands Velika Palagruža (91 m high) and Mala Palagruža (41 m high), three islets (Kamik od tramuntane, Kamik od oštra, Galijula) and about fifteen smaller rocks (Pupak, Volići, Gaće, Baba, Cufi et al.) (Fig. 1). The total area of the islands is 0,40 km^2. The biggest is Velika Palagruža with 0,29 km^2, situated along a line WNW-ESE, 1400 m long and with maximum width of 310 m [18].

Southern coastlines of the island of Palagruža and of adjacent islets descend into the sea at a lesser declivity angle (20–45°) than the northern ones (up to 90°). Furthermore, rocky bottom in the southern part of this marine area gradually turns into sandy or detritic bottoms at depths smaller (cca 20 m) than in the case of the northern part.

The main shipping route in the Adriatic passes along the Palagruža islands. Being an area of heavy traffic it is exposed to pollution and permanent disturbance of normal ecosystem conditions [19]. For the above mentioned reasons as well as for the extraordinary attractive marine environment it was already in 1995 suggested that Palagruža and the surrounding sea should be declared a specially protected area [1].

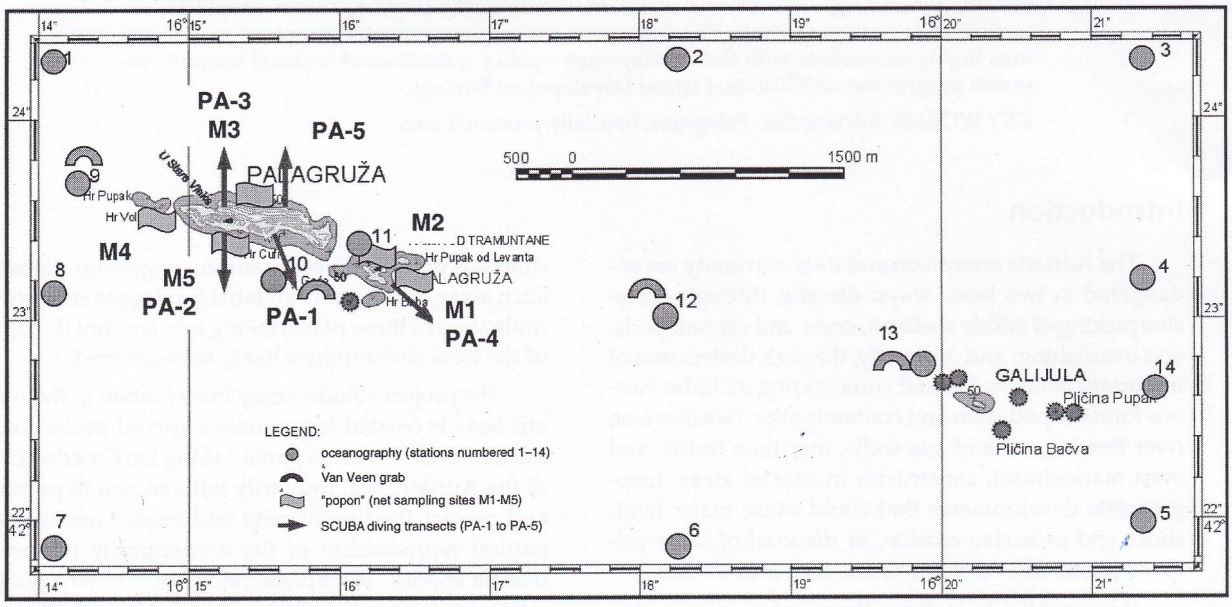

Figure 1 – Research area with sampling sites.

Materials and Methods

Preliminary research of physical, chemical, geological and biological characteristics was undertaken in May 1998 at 23 stations (Fig. 1, Tab. 1).

Table 1 – Geographic coordinates of the oceanographic stations in the research area

STATION	LATITUDE	LONGITUDE	DEPTH (m)
1	42°24'18"N	16°14'05"E	118
2	42°24'18"N	16°18'12"E	162
3	42°24'18"N	16°21'40"E	161
4	42°23'15"N	16°21'40"E	161
5	42°22'00"N	16°21'40"E	85
6	42°22'00"N	16°18'06"E	113
7	42°22'00"N	16°14'05"E	90
8	42°23'15"N	16°14'05"E	74
9	42°23'40"N	16°14'36"E	74
10	42°23'18"N	16°16'00"E	10
11	42°23'14"N	16°16'26"E	44
12	42°22'55"N	16°18'10"E	60
13	42°22'35"N	16°19'50"E	46
14	42°22'30"N	16°21'05"E	65

Temperature and conductivity were measured in May 1998 at stations 1 to 14 using SEABIRD multiprobe. Salinity and density were calculated from the temperature, conductivity and depth data. Density of the seawater is presented as sigma-t value. Sigma-t is calculated by subtracting 1000 kg/m^3 from density.

Analytical methods for determining the concentration of nutrient salts were based on the reaction in wich coloured compounds were formed. Intensity of their colour measured by spectrophotometer as extinction is in direct proportion with the concentration of nutrient salts in a wide area of concentrations. Oxygen concentration was determined according to Winkler.

Sediment samples for granulometric (wet seiving and Sedigraph 5000) and carbonate share determinations were collected at four stations (1, 9, 12, 13).

The benthos primarily was surveyed by SCUBA divers along transects from the sea surface to a maximum of 60 m depth. Visual observations and hand collection were supplemented by underwater photography and video records. At three stations the sediment was sampled by a Van Veen 0.1 m^2 grab and processed through a 1 mm mesh sieve.

Whenever possible, biological material was identified in field. Specimens were also preserved in 4% buffered formol solution, or in 60% ethanol, and processed in laboratory. Voucher specimens are kept in the Biological Department of Faculty of Science, University of Zagreb, in the Centre for Marine Research, »Ruđer Bošković« Institute, Rovinj, and the Institute of Oceanography and Fisheries in Split.

The quantitative and qualitative composition of fish, cephalopods and edible crustacean communities were investigated in the coastal area of the Palagruža island (5 stations) in May 1998 by experimental trammel bottomset catches. Construction characteristics of used trammel bottom nets were: length 32 m, height 1.8 m, external netting layer (»popon«) with 114 mm and internal netting layer (»maha«) with 28, 30, 32, 35 and 40 mm mesh size. Experimental coastal fishing were carried out with 6–12 nets connected together in rows. Nets were set at the bottom usually between 3 and 40 m depth, rarely at greater depths, but in the most cases down to 20 m. Fishings were performed on the different bottom types. Nets were set down at the sea bottom in the evening and hauled up next day in the morning.

Results and Discussion

Temperature, salinity and density

The sea temperature and salinity are essential parameters when characterizing physical conditions of the seawater. Observations of these parameters enable investigation of seasonal and local variations in density, seawater mixing, dynamic structure (currents), upwelling and downwelling phenomena, as well as explanation of many biological and chemical processes.

Changes in thermohaline parameters in the Palagruža Sill area are under the strong influence of seasonal physical processes (absorption, precipitation etc). There are some processes with temporal scale lower than seasonal: wind, inflow of fresh (salty) water, etc. Furthermore, in order to explain thermohaline properties of the Palagruža Sill, it must be pointed out that it is the site of exchange of the northern and southern Adriatic waters (mostly in the deeper layers) and waters from Croatian and Italian coastal area (mostly in the surface layer) [20, 21].

Figures 2 to 4 show vertical profiles of temperature (°C), salinity (ppt) and sigma-t at stations 2, 4, 6, 8, 10 and 11, characteristic for some parts of the Palagruža Sill area. Stations 4 and 8 are representative for E – W differences (gradients) of thermohaline parameters, while stations 2 and 6 for N – S gradients. Stations 10 and 11 are representative for gradients in shallow part in the narrow passage between Palagruža and Mala Palagruža Islands.

The thermohaline structure observed in May 1998 was typical for the spring season [22, 23]. Temperature ranged from 12.7 °C in the bottom layer of station 4 to 17.8 °C in the surface layer of station 10. Salinity range was small, between 38.24 ppt and 38.48 ppt. Sigma-t values were found to be between 27.92 (surface layer of station 10) and 29.06 (bottom layer of station 4). Ther-

mohaline gradients were strong in N – S as well as E – W direction, indicating intensive gradient currents.

Vertical stratification was observed from surface to the depth of 35 m in deep waters (Fig. 2, 3), mainly caused by heating of the surface layer by the sun. Therefore a moderate termocline and pycnocline were formed in the surface layer. Intensity of termocline and pycnocline was determined according to LEDER and VUKOJEVIĆ [24]. From the depth of 35 m to the bottom, vertical structure of water masses was pretty homogeneous. Variation of salinity from the surface to the bottom was small, but »salinity spikes« in surface layer indicated existence of upwelling (downwelling) processes or turbulent mixing generated by internal waves. Wind generated mixing was excluded because of calm weather conditions. According to ZORE-ARMANDA [23] upwelling processes were frequently observed in the area of Palagruža Sill in the spring season. Stratification of the water masses was not so strong in shallow water near Palagruža Island, but strong gradient of thermohaline properties between two sides of the Island was observed.

Concentration of dissolved oxygen measured in May 1998ranged between 5.19 ml/l and 6.12 ml/l. The highest concentration of oxygen was found in the surface layer (station 4). The lowest concentration was detected at a depth of 160 m (station 4). The highest values of oxygen saturation were recorded in the surface layer at a depth of 30 m. At the same time higher concentrations of nutrient salts were identified on the bottom while lower concentrations were identified on the surface. Concentration of phosphates was below the detection limit.

Wind generated surface waves

The elements of the wind generated surface waves were measured at wavered station Palagruža (about 3.5 M south-westward from the lighthouse Palagruža) in the period from 1978 through 1989. From the existing data two situations with Sirocco (SE) and Bora (NE) winds were selected, with maximum recorded wave heights [25], and statistical parameters of the developed sea states were analysed (Tab. 2).

Maximum wave height of 8.40 m was measured on 22 December 1979 at 10 am during a Sirocco gale. Significant wave height ($H_{1/3}$) was 5.04 m and $H_{1/10}$ was 6.21 m. Significant wave period was 7.5 seconds and mean wave length 90 m. The highest wave height (6.20 m) during Bora wind was recorded on 1 January 1980 at 10 am At that time $H1_{/3}$ and $H_{1/10}$ were 3.89 m and 4.78 m, respectively. Significant wave period was 6.9 seconds and wave height 75 m. Therefore, it can be concluded wind generated surface waves play an important role in the life of animals and plants in the broad littoral zone of the Palagruža Island.

Palagruža sediments

Granulometric parameters of investigated sediment samples differred significantly among stations (Tab. 3). Sample at station 1 was a sandy gravel collected by SCUBA diving at the depth of 10 m. It consisted of partially rounded and rounded granules and pebbles deriving from coastal erosion of Palagruža Island rocks. However, particles were mainly carbonatic

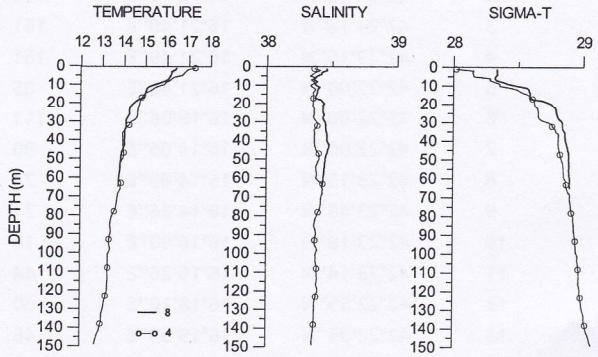

Figure 2 – Vertical profiles of temperature, salinity and sigma-t at stations 2 and 6 (May 1998).

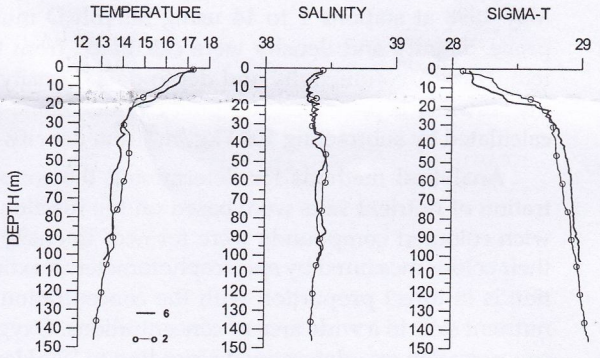

Figure 3 – Vertical profiles of temperature, salinity and sigma-t at stations 4 and 8 (May 1998).

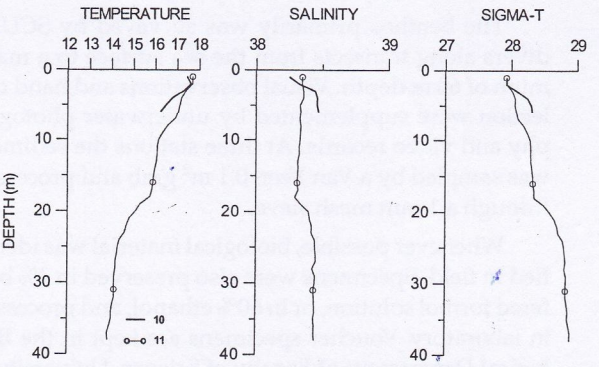

Figure 4 – Vertical profiles of temperature, salinity and sigma-t at stations 10 and 11 (May 1998).

Table 2 – Statistical parameters of the sea state: situation with Scirocco from 21 to 23 December 1979 and situation with Bora from 31 December 1979 to 1 Januar 1980

	$H_{1/3}$ (m)	$H_{1/10}$ (m)	H_{max} (m)	H_{mean} (m)	T_{mean} (sec)	L_{mean} (m)
Scirocco	3.58	4.74	8.40	2.12	6.92	74.86
Bora	3.06	3.96	6.20	1.83	6.21	60.26

Table 3 – Granulometric analysis of sediment samples

	Station			
	PA 1	PAOC 9	PAOC 12	PAOC 15
Mz / μm	% fraction			
>2000	87.06	6.52	22.04	0.0
1000–2000	10.17	15.87	24.50	0.53
500–1000	2.25	27.59	24.81	1.18
250–500	0.36	24.47	19.67	9.13
125–250	0.12	18.88	7.62	33.15
63–125	0.03	4.55	0.71	40.94
<63	0.01	2.12	0.65	15.07

due to the fact that Palagruža Islands consist of Middle Jurrasic (Doger, J_2) limestones. In the sediment a small fraction of biogenous carbonate fragments also occurred. The sediment was actively reworked and fragmentation of biogenous particles and rounding of all particles occurred due to the wave action, indicating high energy environment above the wave base.

Sample at station 9 collected with grab at the 105 m depth was medium to coarse sand. It had 93% of carbonates and was mainly of biogenous origin. Sample at station 12, collected at 65 m depth, was coarser than sample of station 9, and belonged to the gravel sand. It was almost entirely carbonatic (97%) and of biogenous origin. The grab sample collected at 150 m depth, station 15, belongs to the muddy sand, and was much finer than the previous ones. The sand fraction was very fine to fine sand. Percent of carbonates was significantly lower (67%), indicating alumosilicate, terrigenous origin of part of the sediment grains. However, a large part of the sediment was of biogenous origin.

The benthic communities

The Palagruža Island benthos has never been subject of extensive research. It seems that only ADENSAMER [5] and BABIĆ, RÖSSLER [7] noted occasionally some invertebrates from the area. Contrary to this, commercially important ichthyofauna, cephalopods and crustaceans were extensively studied by JARDAS et al. [14]. Also well known is the marine flora of Palagruža and the nearby islets studied by CAMMERLOHER [6], SCHILLER [8], ERCEGOVIĆ [10] and ŠPAN et al. [16].

Littoral biota was examined only at the Palagruža Island. At sites exposed to wave action, on a steep rocky substrate the suprallitoral community reached more than two metres above the mean sea level. It was characterised by the periwinkle *Littorina neritoides* and the barnacle *Euraphia depressa* which, however, at some sites were absent. In comparison to most other Adriatic Sea areas, populations of both species were rather scarce at Palagruža. It was also the same case with the isopod crustacean *Ligia italica*. A special note derived the occurrence of *Patella rustica* individuals 70 centimetres above the sea level, at the transect PA-5. Rock cavities niches harboured cushions of the red alga *Catenella repens*.

The upper belt of the midlittoral zone was distinguished by dense *Chthamalus stellatus* and *Chthamalus montagui* populations associated by numerous *Patella rustica* and, occasionally, *Littorina neritoides*. The biocoenosis of the lower midlittoral rock was much more diverse. Algal assemblages were represented by *Rivularia mesenterica, Rivularia atra, Gastroclonium clavatum, Nemalion helminthoides, Laurencia paniculata, Polysiphonia sertularioides, Cystoseira compressa, Ralfsia verrucosa* and coralline algae – *Phymatolithon lenormandii, Lithophyllum incrustans* and *Lithophyllum lichenoides*, characteristic for forming structures called »pavement«. This last noted species occurred in the cushion-like thalli, or somewhere created a peculiar belt extending some metres in length. A yellow strip of the green alga *Entocladia endolithica* was somewhere present. Large *Patella caerulea, Monodonta turbinata* and many beadlet anemones Actinia equina distinguished the macrofauna. A maximum density of anemones was 18 young specimens per 100 cm^2. In a sheltered *Stara Vlaka* cove neighbouring the transect PA-3, very large *Actinia equina* whose basal parts were 8 cm in diameter were collected.

At Palaguža Island midlittoral rock pools were rather scarce. *Lithothamnion lenormandii, Cladophora* sp.,

Laurencia paniculata, Lepidochitona corrugata occupied them and also *Mytilaster* sp., associated somewhere with *Actinia, Monodonta, Gastrochaena dubia* etc. In the area, only occasionally brachyuran decapods *Eriphia verucosa* and *Pachygrapsus marmoratus* were noted.

The infralittoral fringe somewhere was distinguished by *Cystoseira amentacea* var. *spicata* and *Mytilus galloprovincialis* settlements, and by *Corallina officinalis* belt at other sites. Occasionally *Cystoseira compressa* and *Cystoseira crinita* were noted. Shaded gaps under eroded vertical cliffs were rich in various *Peyssonnelia* and *Gelidium* species, and *Schottera nicaeensis*. In few steep sites, on well illuminated bedrock bottom the canopy of photophilic algae such as *Dictyota dichotoma, Dilophus fasciola, Padina pavonica,* and *Halopteris scoparia* occurred to about two metres depths. Here the landscape was changed to a barren rock settled only by small patches of clionids, *Crambe crambe* and *Reptadeonella violacea*. Isolated individuals of *Balanophyllia europaea* and endolithic bivalves *Lithophaga lithophaga* and *Gastrochaena dubia* also were noted. The mobile fauna was represented by a black sea urchin *Arbacia lixula*, needle shell *Bittium reticulatum* and many benthic fish such as *Thalassoma pavo, Parablennius rouxi, Tripterygion delaisi* and, occasionally, *Scorpaena porcus* and *Coris julis*. At 5–6 m depth, the echiurid worm *Bonellia viridis* occurred.

The precoralligenous facies of the coralligenous biocoenosis appeared at 10 meters of depth. It was characterised by sciaphilic *Flabelia petiolata, Halimeda tuna* and *Peyssonnelia polymorpha*, coralline algae *Lithophyllum racemus, Phymatolithon calcareum, Spongites fruticulosum.* associated with *Petrosia ficiformis, Axinella damicornis, Parazoanthus axinellae, Cladocora caespitosa,* tubiform Polychaetes, *Myriozoum truncatum, Porella cervicornis*, and others. Photophilic algae such as *Padina pavonica* and *Acetabularia acetabulum* were only occasionally collected in this community. At southern transects PA-1 and PA-2 large *Codium bursa* were extremely abundant at 25–30 m depth. On rocky bottoms the main components were *Cystoseira adriatica, C. corniculata* ssp. *laxior, C. schiffneri* f. *latiramosa, Sargassum vulgare*. At northerly sites *Flabelia petiolata, Halimeda tuna* and three *Codium* species (*C. adherens, C. bursa, C. tomentosum*) appeared abundant at the 42–45 m depth.

The typical coralligenous community was characterised by encrusting *Lithophyllum grandiusculum, Peyssonnelia polymorpha* and *Peyssonnelia rubra,* Madreporaria *Leptopsammia pruvoti* and the erect bryozoan *Myriozoum truncatum*. It was poor in *Axinella* and *Eunicella* species and, contrary to our expectations, *Corallium rubrum* and *Paramuricea clavata* were not found. No submarine caves were found at sites studied.

During the present survey, no special attention was paid to the sedimentary bottom communities. The rocky substrate altered into rough sand mixed with organogenic debris between 26 m (transect PA-1) and 45 m depth (transect PA-5). Somewhere clumps of the lithothamnian *Lithophyllum racemus* were abundant. Isolated boulders and outcrops, and large dead shells that occasionally appeared in this zone were mostly inhabited by species characteristic as coralligenous biota such as *Leptopsammia, Eunicella, Myriozoum, Porella,* and others. Marine algae at a depths exceeding 100 m, however, were known from previous research [16].

On the southern coast, near the transect PA-1, a pebble shore named Žalo in a shallow water is replaced by gravel and rough sandy sediment. At this location, at the depth of 10 m, the biocoenosis characterised by *Branchiostoma lanceolatum* (»*Amphioxus*« sand) was found.

During field surveys some facts were noted which deserve special attention. For example, at the transect PA-1, at the depth of 26 m two large agglomerations of sea urchin *Sphaerechinus granularis* were found, each containing more than 200 individuals concentrated on only 2–3 m^2. On sublittoral rocks the *Holothuria sanctori, Hacelia attenuata, Ophidiaster ophidianus* and *Peltaster placenta* were not rare. Many times the polychaetes *Eunice torquata, Hermodice carunculata, Serpula vermicularis* and *Sabella pavonina,* lobsters (*Homarus gammarus*) and crawfish (*Palinurus elephas*) were noted by divers. Endolithic sponges of the family Clionidae (especially *Clione celata*), the echiurid worm *Bonellia viridis* and sessile foraminiferan *Miniacina miniacea* at some sites occurred throughout the transect line.

In previous algal research [16] the total of 321 taxa of benthic algae were determined (Rhodophyta 213 taxa or 66.4%, Phaeophyta 72 taxa of 22%, Chlorophyta 36 taxa or 11.2%). Only seagrass *Posidonia oceanica* was noted. This considerably prolific floristic composition influences the structure of significant benthic vegetation, characterised by broad depth distribution and rich biodiversity.

So far 217 animal species have been identified and it is not yet time to produce a comprehensive list of taxa. It is worth to note that very rare cnidarian for the Adriatic, *Coenocyathus anophyllites,* has been noted. One species of Cnidaria, *Halcampoides purpurea,* and two species of Bryozoa (*Escharoides megarostris* and *Palmicellaria skenei*) were not noted previously in the Adriatic Sea [26][27].

Though our survey was designed as a preliminary one (as many as 217 animal species have been identified so far), it is not yet time to produce a comprehensive list of taxa. It is worth to note that very rare species for the Adriatic have been noted (such as Cnidaria *Coenocyanthus anophyllites* and a few species of Bryozoa), as well as one species of Cnidaria (Halcampoides purpurea) and two species of Bryozoa (*Escharoides megarostris, and Palmicellaria skenei*) were not noted previously in the Adriatic Sea [26, 27]. It is inter-

esting that no one of opisthobranch gastropods identified (*Aplysia* cf. *parvula, Bosellia mimetica, Chromodora krohni, Coryphella pedata, Crimora papillata, Elysia timida, Homoiodoris sticta, Hypselodoris elegans, Hypselodoris tricolor, Platydoris argo* and *Thuridilla hopei*) has ever been noted at the offshore Adriatic Sea islands.

Fish, cephalopod and edible crustacean coastal settlements

Along the coastal zone of Velika Palagruža (3 stations: M3, M4, M5) and Mala Palagruža (2 stations: M1, M2) research areas, by analyzing the trammel bottom set catches, 25 species of fishes, 1 cephalopod and 7 edible crustacean species were detected (Tab. 4). The most abundant species in total obtained catches were – numerically: *Mullus surmuletus* (Mullidae) – (25.2%), *Palinurus elephas* (Palinuridae) – (13.7%), *Serranus cabrilla* (Serranidae) – (10.3%), Scyllarus *arctus* (Scyllaridae) – (9.7%) and *Scorpaena porcus* (Scorpaenidae) – (8.5%) and weightily: *Lophius piscatorius* (Lophiidae) – (33.2%), *Palinurus elephas* (15.1%), *Mullus surmuletus* (14.2%), *Scomber japonicus* (Scombridae) – (6.7%) and *Phycis phycis* (Gadidae) – (4.8%). The most abundant families, regarding the biomass, were Lophiidae, Palinuridae, Mullidae, Scombridae and Scorpaenidae. Such catch

Table 4 – Qualitative and quantitative composition of trammel bottom set catches in the Palagruža area during the spring (May) 1997.

SPECIES	N	W (g)	Mean Lt (cm) ± SD	Mean W (g) ± SD
PISCES				
Scyliorhinus canicula (Linnaeus, 1758)	1	342	48.5 ± 0	342.0 ± 0
Raja (Raja) asterias Delaroche, 1809	2	2138	55.5 ± 3.7477	1069.0 ± 360.6245
Muraena helena Linnaeus, 1758	1	2580	113.1 ± 0	2580.0 ± 0
Phycis phycis (Linnaeus, 1766)	22	5825	28.7 ± 4.4686	266.1 ± 151.5316
Scorpaena notata Rafinesque, 1810	25	1290	14.2 ± 1.2731	51.6 ± 13.2665
Scorpaena porcus Linnaeus, 1758	38	4211	18.00 ± 2.7455	110.8 ± 61.5432
Scorpaena scrofa Linnaeus, 1758	4	1194	25.8 ± 2.9045	298.5 ± 124.1249
Trigloporus lastoviza (Brunnich, 1768)	1	185	26.2 ± 0	185.0 ± 0
Anthias anthias (Linnaeus, 1758)	1	75	20.2 ± 0	75.0 ± 0
Serranus cabrilla (Linnaeus, 1758)	46	4643	21.3 ± 1.4382	100.9 ± 22.2365
Serranus scriba (Linnaeus, 1758)	1	163	23.1 ± 0	163.0 ± 0
Diplodus vulgaris (E.G.-Saint-Hilaire,1817)	2	665	27.6 ± 1.1314	332.5 ± 53.0330
Oblada melanura (Linnaeus. 1758)	12	2019	24.1 ± 2.0961	168.3 ± 34.6308
Pagellus acarne (Risso, 1826)	8	911	20.4 ± 2.3694	113.9 ± 20.6497
Pagrus pagrus (Linnaeus, 1758)	2	379	22.9 ± 1.6263	189.5 ± 31.8198
Spondyliosoma cantharus (Linnaeus, 1758)	5	375	17.2 ± 1.1068	75.0 ± 14.4568
Spicara maena (Linnaeus, 1758)	5	1137	23.8 ± 1.9228	227.4 ± 72.5614
Mullus surmuletus Linnaeus, 1758	112	17096	23.6 ± 2.5796	152,7 ± 62.0722
Chromis chromis (Linnaeus, 1758)	8	503	15.0 ± 0.5099	62.9 ± 4.4219
Scomber japonicus Houttuyn, 1782	11	8034	42.3 ± 2.4877	730.4 ± 115.3701
Acantholabrus palloni Valenciennes, 1839	1	171	21.9 ± 0	171.0 ± 0
Labrus bimaculatus Linnaeus, 1758	7	1567	26.9 ± 2.4425	223.9 ± 64.3621
Symphodus (Crenilabrus) tinca (Linnaeus, 1758)	3	488	22.6 ± 1.9698	162.7 ± 47.0567
Uranoscopus scaber Linnaeus, 1758	2	588	24.9 ± 6.8589	294.0 ± 268.7006
Lophius piscatorius Linnaeus, 1758	3	39950	105.2 ± 26.0064	13316.7 ± 7076.4280
Subtotal	**323**	**96529**	–	–
CEPHALOPODA				
Octopus vulgaris Cuvier, 1797	4	2030	–	507.5 ± 85.6680
CRUSTACEA DECAPODA				
Palinurus elephas (Fabricius, 1787)	61	18103	21.3 ± 6.0136	296.8 ± 257,7689
Scyllarus arctus (Linnaeus, 1758)	43	1249	10.8 ± 1.4548	31.1 ± 12.7349
Homarus gammarus (Linnaeus, 1758)	3	1832	28.6 ± 7.7655	610.7 ± 503.9745
Galathea strigosa (Linnaeus, 1761)	5	142	–	–
Munida intermedia A.M.Edvards & Bouvier,1899	4	72	–	–
Dromia personata (Linnaeus, 1758)	1	269	8.3 ± 0	269.0 ± 0
Maja crispata Risso, 1827	1	10	–	10.0 ± 0
Subtotal	**118**	**21677**		
TOTAL	**445**	**120236**	–	–

composition is considerably different from other, primarly, continental research areas along the eastern Adriatic coast [28, 29, 30] and it is specific for less overfished, remote island fishing areas.

According to the estimating scale [12] of catch per unit effort values – CPU (catch per one net) 60% obtained catches belonged to »excellent class« (> 2 kg), while 20% catches belonged to »very good class« (1.5–2 kg) and »good class« (0.8–1.5 kg). These values are much higher than the same values obtained in the other research areas, which confirm the statement about rather preserved and rich coastal benthic communities of the Palagruža region.

Qualitative and quantitative analysis of the coastal settlements of fishes, cephalopods and crustaceans in the area around Palagruža and their changes have been researched, at longer or shorter intervals, from 1961 until now [31, 12, 32, 33, 14,]. Although this region is richer than other continental and island areas in the eastern Adriatic today, these surveys showed great changes in benthic community structure during last forty years, expressed by decline of CPU, decrease of numerical and weightily representation of many important and valuable fish and crustacean species in the catches and decrease of their mean body length and weight.

Conclusion

Palagruža Island is apparently very rich in the sea bottom biota. In spite of the fact that our survey was designed as a preliminary one, as many as the total of 321 taxa of benthic algae, one sea grass (*Posidonia oceanica*) was noted, and 217 animal species have been identified so far.

Considerably prolific floristic composition influences the structure of significant benthic vegetation, characterised by broad depth distribution and rich biodiversity.

There is not yet time to produce a comprehensive list of taxa but it is worthwhile noting that a very rare species for the Adriatic has been observed, some species have been observed for the first time in the off shore islands region, and ten species have been observed for the first time in the Adriatic.

The sea around Palagruža has always been known as a rich fishing area. In research of qualitative contents of catches from »popona« nets done in the Palagruza area so far 25 species of fish have been recorded as well as 7 edible species of crustaceans and 1 species of cephalopods. Catches of fish and crustaceans have constantly been decreasing in the last forty years with regard to the biomass and number of specimens per one net.

Taking into account all this we are suggesting that a sea belt of 5NM width around Palagruža and Galijula should be declared »special habitat – marine park« according to the Law on the Marine Fisheries of the Republic of Croatia (NN 46/97). In that way one of the richest Croatian fishing areas also known as a spawning area of economically most significant pelagic fish could be protected. By well-organized and responsible management of regenerative bioresources we will also be able to influence the Adriatic and the Mediterranean Sea biodiversity preservation.

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