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QUANTITATIVE ANALYSIS OF NORTH AND SOUTH ADRIATIC SHELF ECOSYSTEMS

(Figs. 3, Tabs. 16)

Abstract: The paper presents information on the occurrence of recent benthic organisms of the eastern regions of North and South Adriatic Shelf from the viewpoint of their distribution in individual ecosystems depending on hydrographic and bathymetric conditions as well as on the lithological character of the substrate. The following organisms are dealt with: *Cyanophyta*, *Chlorophyta*, *Phaeophyta*, *Rhodophyta*, *Angiospermae*, *Foraminifera*, *Anthozoa*, *Polychaeta*, *Bryozoa*, *Mollusca*, *Ostracoda* and *Echinodermata*.

Резюме: Статья дает информации о расширении рецентных бентосных организмов восточных регионов Северо- и Югоадриатического шельфа с точки зрения их дистрибуции в отдельных экосистемах, в зависимости от гидрографических и батиметрических условий и литологического характера субстрата. Работа касается следующих организмов: *Cyanophyta*, *Chlorophyta*, *Phaeophyta*, *Rhodophyta*, *Angiospermae*, *Foraminifera*, *Anthozoa*, *Polychaeta*, *Bryozoa*, *Mollusca*, *Ostracoda* and *Echinodermata*.

I have already mentioned the object of our research in an introductory paper on recent ecosystems of the eastern regions of North and South Adriatic Shelf (Seneš, 1988). Our aim was to determine the possibilities of an application of recent ecosystems on fossil, above all Tertiary ones. At the same time I have presented the methods of the research, hydrographic and sedimentation conditions of the studied regions.

This contribution has analytical character. It presents, mostly in tabular form, characteristic species of thanatocenoses of the individual ecosystems (environments, facies), in relation to the lithological character of the sea floor, hydrographic conditions and bathymetry. Such an analysis of the environment of organisms is necessary for the understanding of the descriptions of the studied sea-floor profiles and for the classification of bio- and thanatocenoses determined by these profiles with units defined by their lithological and biological character, hydrographic conditions and bathymetry.

I find it appropriate to repeat the most important characteristics and symbols of the facies, biocenoses or ecosystems.

The symbols S-1 and S-2 denote hard or sandy supralittoral. According to the shore exposition, this zone reaches in the Adriatic up to a height of 0.30 to 2.5 m. It can be characterized above all by sorted or unsorted thanatocenoses. From living organisms, important are the representatives of *Cyanophyta*, *Cirripedia*, and from *Mollusca* the genera *Patella*, *Littorina* and *Truncatella*.

M-1a, M-1b, M-2 and M-3 are the symbols for hard, sandy or gravelled mediolittoral. The shore of the Adriatic Shelf is, due to small height

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difference between high and low tide (max. 0.30—0.40 m), relatively poor in biological data. It is possible to distinguish the supra- and mediolittoral largely only because of frequent strong winds — called in the Adriatic region, according to their direction, Mistral (from N), Bora (from E and NE) and Sirocco (from S) — which, of course, affect by a frequently very intensive surf the occurrence and survival of many organisms in these zones. The mediolittoral can be characterized by several typical species belonging to *Cyanophyta*, *Phaeophyta* and *Rhodophyta*, as well as in large quantities occurring *Cirripedia* and sessile (frequently endolithic) *Mollusca*. A "trottoir" belongs also into this zone, although less classically developed than in the Mediterranean.

By the symbols I-1 to I-7 I denote the extent of infralittoral, divided further according to the lithological character of the substrate (rocky, sandy, organodetrital, muddy-detrital, etc.), as well as according to phytal or aphytal character of the environment. For this reason the infralittoral is divided into units denoted by small letters (e. g. I-5a, I-5b, I-5c), according to the benthic — biological character of the sea floor (e. g. I-4a: *Cardium tuberculatum* — *Pitaria chione* facies, etc. — Sen e š, 1988).

The facies I-1 is representing rocky phytal environment, with ecosystems denoted by the letters "a" to "e", while "a" can be characterized especially by the occurrence of *Acetabularia mediterranea*, the ecosystem "b" by *Padina pavonia*, "c" by a prevailing amount of *Cystoseira*, "d" by prevailing growth of

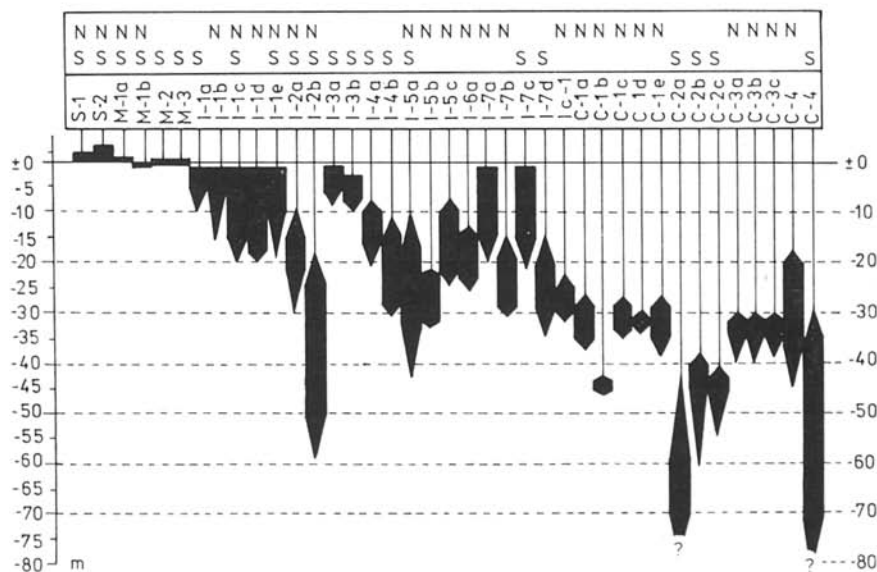


Fig. 1. Graph of bathymetric distribution of ecosystems in eastern regions of North and South Adriatic Shelf.

N — North Adriatic Shelf; S — South Adriatic Shelf; S-1 — C-4 ecosystems (biotops — facies).

Sargassum and "e" by *Lithothamnium lenormandi* — *Halimeda tuna* — *Amphiroa rigida*.

The facies I-2 is representing the so-called Infracoralligene, i.e. incrustations of Rhodophyta on rocky substrate: "a" with a prevalence of *Lithothamnium philippi*, "b" with *Pseudolithophyllum expansum*.

The facies I-3 is representing shallow sandy aphytal infralittoral, in the ecosystem "a" with a prevalence of *Divaricella* and *Loripes*, in the ecosystem "b" with *Dasycladus clavaeformis*.

The facies I-4 is representing sorted sands of aphytal environment, in the ecosystem "a" with a prevalence of *Cardium tuberculatum* and *Pitaria chione*, and in "b" with *Glycymeris glycymeris*.

The facies I-5 can be characterized by fine- to coarse-detrital sands of aphytal environment, with the ecosystems "a" with *Pecten jacobaeus*, "b" with coral bioherms *Cladocora cespitosa* and "c" with *Lithophyllum racemosum*.

The facies I-6 is characterized already by fine-arenaceous to muddy detritus, however, also in aphytal environment. A prevalence of *Pitaria rudis* and *Tellina pulchella* is characteristic for this facies.

The facies I-7 is lithologically similar to the facies I-6, however, it forms phytal environment, with the ecosystems "a", "b" with the sea-grass *Cymodocea nodosa*; "c", "d" with *Posidonia oceanica*. Both species of these angiosperms are markedly separated by the effect of growth thickness and due to the effects of their depth distribution ("a" and "c" are representing a shallower thanatocenose, "b" and "d" a deeper one). Similarly as the ecosystems with *Cystoseira* and *Sargassum* (I-1c, d), they are suitable as an environment especially for fossilizable herbivorous microgastropods.

On North Adriatic Shelf the infralittoral reaches the depth of about 30 m, in some parts of South Adriatic Shelf 40 to over 50 m. (For a survey of infra- as well as circalittoral — see Seneš, 1988 and in this paper the schematic profiles of distribution and mutual relations of the ecosystems, see Figs. 2, 3).

The symbol IC-1 denotes a transitory zone from infra- to circalittoral. However, this zone has been determined only on two profiles on North Adriatic Shelf, in depths of about 30 m. It is represented by muddy aphytal detritus, with the leading species *Apporhais pes-pelecani*.

The symbols C-1 to C-4 denote a marked circalittoral, in the eastern regions of the Adriatic Shelf almost everywhere with already flat sea-floor formed by mud or muddy organogenic detritus, detrital fine sands in an environment almost entirely without macrophytal. It can be characterized as well by *Eucoralligene* (= Coralligene de plateau = sekundäre Hartboden = patch reef).

The facies C-1 is formed by arenaceous to muddy organogenic detritus and it could be divided into clearly defined ecosystems: "a" with a prevalence of *Hippodiplasia foliacea*, "b" with *Scrupocellaria-Porella-Hornera*, "c" with a prevalence of *Arca noae* over *Hippodiplasia*, "d" with mass occurrence of "*Spriographis spallanzanii* — *Sabella pavonina*", "e" with *Chlamys opercularis* — *Ophiotrix quinquemaculata*.

The facies C-2 is represented by organogenic detrital sand, where the ecosystem "a" is characterized by mass occurrence of *Lithothamnium fruticosum* and *Tapes geographicus*, the ecosystem "b" by *Venus casina* —

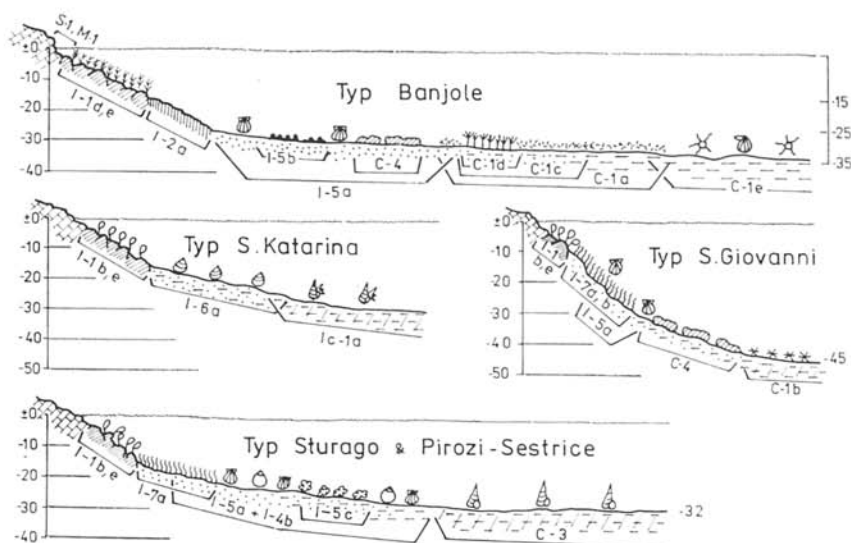


Fig. 2. Scheme of the space distribution and mutual relations of ecosystems in the Rovinj region of North Adriatic Shelf.

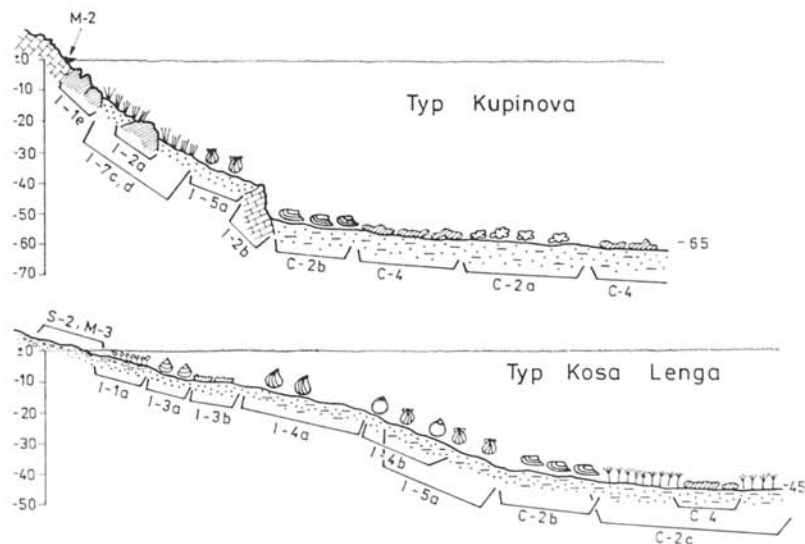


Fig. 3. Scheme of the space distribution and mutual relations of ecosystems in the Pelješac region of South Adriatic Shelf.

Tapes geographicus and "c" by extensive areas with "*Sabella pavonina*", with the presence of *Venus casina*.

Muddy detritus forms the facies C-3, in the ecosystem "a" with *Turritella communis*, as well as with mass occurrence of *Aloidis gibba*, in the ecosystem "b" *Myrtea spinifera* prevails, along with *Turritella*, and the prevailing species in the ecosystem "c" are *Leda fragilis* and *Tellina* div.sp.. The limits of the individual ecosystems of C-3 are difficult to determine, the ecosystems change gradually one into another.

There are certain differences in the development of the facies C—4 on North and on South Adriatic Shelf. The region of South Adriatic Shelf is much richer in eucoralligene, thus, some of the biocomponents are to a certain extent different. However, they are everywhere of irregularly round or loaf-like form and in both cases they are continually affected by biological erosion. In the region of Istria they occur sporadically in depths between 20 and 40 m, in the region of Pelješac mostly between 30 and 80 m, or even deeper.

The biologically eroded eucoralligene, if it is not dispersed by currents, forms organodetrital- sandy enclaves (C-4s) in the surrounding sediments. Their thanatocenoses are various and strongly affected by organisms from the surrounding ecosystems. They often form a substrate for the formation of new eucoralligene bioherms. Fossile so-called "lithothamnium sands" are definitely analogues of a degraded eucoralligene.

Deeper regions of the shelf (under 70 m) have been studied by us on the South Adriatic Shelf only with the help of cores. I denote their biotope by C-5 (Facies of "large"). We did not obtain sufficient quantity of biological material from these muddy-detrital and detrital-sandy sediments to make their more detailed classification possible.

The depth of circalittoral on the Adriatic Shelf does not exceed (with the exception of North Adriatic Basin) the depth of 80—150 m. On North Adriatic Shelf it varies between 30—50 m, on South Adriatic Shelf (on our sections) mostly between 40 and 90 m (Fig. 1).

In the distinguishing of the individual ecosystems of infralittoral I use the terms "phytal" and "aphytal". Since the term "phytal" is in scientific literature used frequently for the whole depth and space extent of infralittoral (i.e. also for biotopes with sciaphillic algae and rock-forming rhodophytes occurring often up to the edge of bathyal), I would like to remark that I use the term phytal in my contributions especially for those ecosystems in which there is a predominance of the from the viewpoint of geological interpretation exceptionally important macrophytal as the bearer of fossilizable, rhodophytes, foraminifers, perifers, polychaets, microgastropods and bryozoans. Above all there are angiosperms, from them especially extensive fields of *Posidonia oceanica*, *Cymodocea nodosa* and infrequent occurrences of *Zostera* (I-7a-d). For the same reason I denote as „phytal" also dense growths of large phaeophytes on the submarine slopes of infralittoral, especially from the genera *Sargassum* and *Cystoseira* (I-1c, d). To a certain extent fossilizable are the extensive growths of the algae *Padina pavonia*, *Acetabularia mediterranea* and *Halimeda tuna*, which form the most conspicuous component of individual biocenoses. Thus I consider their occurrence to be also a phytal environment (I-1a, b).

Table 1—16

Quantitative analysis of the Northern- and Southern Adriatic shelves ecosystems

Flora & Fauna	N S	N S	N S	N S	S	S	S	N	N S	N	N S	N S	N S	N S	S	S
	S ₁	S ₂	M 1a	M 1b	M ₂	M ₃	I 1a	I 1b	I 1c	I 1d	I 1e	I 2a	I 2b	I 3a	I 3b	
	Supra litto ral		Medio littoral				Infralittoral									
<i>Cyanophyta</i>	⊙		⊙		⊙											
<i>Rivularia atra</i> ROTH	✱		×		×		+	+								
<i>Entophysalia granulosa</i> KÜTZ.	+															
<i>Colothrix scopulorum</i> AG.	+															
<i>Chlorophyta</i>			⊙	⊙			⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
<i>Cladophora pellucida</i> KÜTZ.			+				+									+
<i>Cladophora dalmatica</i> ROTH			+													
<i>Enteromorpha intestinalis</i> LINK.			+													
<i>Enteromorpha compressa</i> L.			+	+												
<i>Halimeda tuna</i> LAM.							+	+	+	+	✱	×	+			
<i>Udotea petiolata</i> BÖRGES							+		+	+	+	+	+			
<i>Acetabularia mediterranea</i> LAMOUR							✱	+	+	+	+					+
<i>Valonia utriculus</i> ROTH							+		+	+		+	+			
<i>Dasycladus clavaeformis</i> ROTH							+							+	✱	
<i>Codium bursa</i> L.									+	+						
<i>Codium dichotomum</i> HUDS.										+						
<i>Palmophyllum crassum</i> RABEN														×		
<i>Phaeophyta</i>			⊙	⊙			⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
<i>Fucus virsoides</i> AG.			+													
<i>Padina pavonia</i> L.				✱			×		+	+	+					
<i>Cystoseira barbata</i> AG.							+	+	✱	×		+		+	+	
<i>Cystoseira spicata</i> ERCEG.								+	+	+		+				
<i>Cystoseira discors</i> AG.										+		+	+			
<i>Cystoseira abrotanifolia</i> AG.							+	+	×	×		+			+	
<i>Cystoseira adriatica</i> SAUVAG.							+	+	×	+		+	+	+		
<i>Sargassum hornschiui</i> AG.												+	+			

N = North-Adriatic Shelf (Rovinj)

S = South-Adriatic Shelf (Pelješac — Mljet)

Table 2

Flora & Fauna	N S	N S	N S	N S	S	S	S	N	N S	N	N S	N S	N S	N S	S	S
	S ₁	S ₂	M 1a	M 1b	M ₂	M ₃	I 1a	I 1b	I 1c	I 1d	I 1e	I 2a	I 2b	I 3a	I 3b	
	Supra littoral		Medio littoral				Infralittoral									
<i>Sargassum linifolium</i> AG.									*	×		+				
<i>Halopteris scoparia</i> L.				+			+	+	+			+		+	+	
<i>Halopteris filicina</i> KÜTZ.														+		
<i>Zanardinia collaris</i> AG.										+	+	+				
<i>R h o d o p h y t a</i>			⊙	⊙	⊙		⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	
<i>Lithothamnium lenormandi</i> FOSLIE	+		+	+	+		×	+	+	×	*	×			+	
<i>Lithothamnium philippi</i> LEM.									×	+	+	*	+			
<i>Lithothamnium fruticosum</i> KÜTZ.																
<i>Lithothamnium calcareum</i> FOSLIE																
<i>Lithothamnium solutum</i> LAM.																
<i>Lithophyllum incrustans</i> PHIL.			+	×	×						+	+				
<i>Lithophyllum tortuosum</i> MENEHGH.				+	*											
<i>Lithophyllum papillosum</i> HOWE			+	+	+											
<i>Lithophyllum racemus</i> LAM.																
<i>Pseudolithophyllum expansum</i> PHIL.												+	*			
<i>Neogoniolithon notarisii</i> FOSLIE				+	×											
<i>Neogoniolithon mamillosum</i> FOSLIE													×			
<i>Mesophyllum lichenoides</i> FOSLIE												?	×			
<i>Peyssonnelia polymorpha</i> DEC.										+		+	×			
<i>Peyssonnelia squamaria</i> GMEL.												+	×			
<i>Peyssonnelia rubra</i> FOSLIE														+		
<i>Gelidium crinale</i> LAMOUR.			+													
<i>Phyllophora nervosa</i> GREV.										+		+	+			
<i>Halymenia dichotoma</i> PHIL.										+		+	+			
<i>Cryptonemia lomotion</i> AG.							+	+		+			+			

S	S	N S	N	N	N	N	N	S	S	N	N	N	N	N	N	S	S	S	N	N	N	N	S
I 4a	I 4b	I 5a	I 5b	I 5c	I 6a	I 7a	I 7b	I 7c	I 7d	IC 1	C 1a	C 1b	C 1c	C 1d	C 1e	C 2a	C 2b	C 2c	C 3a	C 3b	C 3c	C 4	C 4
Infralittoral										Circalittoral													
							+		+														—
		+							+													+	—
		+								+							+	+				+	—
⊙	⊙	⊙	⊙	⊙	⊙			⊙	⊙	⊙	⊙	⊙		⊙	⊙	⊙	⊙	⊙				⊙	⊙
									+														+
		+	+	+				+	+														+
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		+	+						+			+		+	+		×	+		+	×	×	—
																							—
		+	+	+	+		+			+							+				+	+	—
+		+	+														+	+			+	+	—

Table 3

Flora & Fauna	N S	N S	N S	N S	S	S	S	N	N S	N	N S	N S	N S	N S	S	S
	S ₁	S ₂	M 1a	M 1b	M ₂	M ₃	I 1a	I 1b	I 1c	I 1d	I 1e	I 2a	I 2b	I 3a	I 3b	
	Supra littoral		Medio littoral				Infra littoral									
<i>Sphaerococcus coronopifolius</i> AG.													+			
<i>Rhodymenia corallicola</i> ARDISS.													+	+		
<i>Wrangelia penicillata</i> AG.										+			+	+		
<i>Batryocladia batryioides</i> FELDM.													+	+		
<i>Lomentaria linearis</i> ZANARD.														+		
<i>Faucheia repans</i> MONT							+							+		
<i>Corallina mediterranea</i> ARESCH.				+			+	+					+			
<i>Nemalion helminthoides</i> BATTERS			+	+												
<i>Ceramium rubrum</i> AG.				+			+	+	+					+	+	
<i>Laurencia papillosa</i> LAM.				+				+						+		
<i>Laurencia obtusa</i> HUDS.				+			+	+	+							
<i>Jania rubens</i> LAMOUR							+	+	+	+					+	
<i>Hypnea musciformis</i> LAM.				+			+	+								
<i>Amphiroa rigida</i> LAMOUR							×	×	+	+	*	+				
<i>Melobesia farinosa</i> HOWE										+	+				+	
<i>Melobesia lejolisi</i> HOWE													+			
<i>Vidalia volubilis</i> AG.														+		
<i>Angiospermae</i>							⊙	⊙	⊙	⊙				⊙	⊙	
<i>Posidonia oceanica</i> L.							+								+	
<i>Cymodocea nodosa</i> ASCH.							+	+	+	+						
<i>Zostera marina</i> L.							+	+						+	+	
<i>Zostera nana</i> ROTH.							+	+						+	+	
<i>Foraminifera</i>									⊙	⊙				⊙	⊙	
<i>Ammonia beccari</i> (L.)									+	+				×	+	

[illegible]

Table 4

Flora & Fauna	N S	N S	N S	N S	S	S	S	N	N S	N	N S	N S	N S	N S	S	S
	S ₁	S ₂	M 1a	M 1b	M ₂	M ₃	I 1a	I 1b	I 1c	I 1d	I 1e	I 2a	I 2b	I 3a	I 3b	
	Supra litto ral		Medio littoral				Infralittoral									
<i>Rotalia</i> cf. <i>granulata</i> (DI NAPOLI)									+	+				+	+	
<i>Cassidulina subglobosa</i> BRADY														+		
<i>Cibicides lobatulus</i> (WAL.—JAC.)															+	
<i>Cibicides</i> cf. <i>boueanus</i> (ORB.)									+	+				+	+	
<i>Elphidium advenum</i> CUSH.														+		
<i>Elphidium crispum</i> (L.)									+	+				+		
<i>Gyroidina soldanii</i> <i>altiformis</i> R.—S.										+					+	
<i>Bulimina</i> div. sp.									+	+				+	+	
<i>Nonion boueanum</i> (ORB.)									+	+				+		
<i>Planornbulina</i> <i>mediterraneensis</i> (ORB.)																
<i>Cibicides boueanus</i> (ORB.)									+	+				+	+	
<i>Textularia calva</i> LALICH.															+	
<i>Reussella spinulosa</i> RSS.																
<i>Rosalina obtusa</i> ORB.																
<i>Textularia conica</i> ORB.																
<i>Globigerinoides</i> sp.																
<i>Miliolidae</i> div. sp.																
<i>Calcispongiae</i>								+	+	+	+	+	+	+		
<i>Desmospongiae</i>								+	+	+	+	+	+	+		
<i>Anthozoa</i>								⊙		⊙	⊙		⊙	⊙		
<i>Cerianthus membranaceus</i> SPALL.																
<i>Epizoanthus arenaceus</i> CHIAJE																
<i>Parazoanthus axinellae</i> SCHM.													+	×		
<i>Cladocora cespitosa</i> L.									+				+			
<i>Balanophyllia italica</i> MICH.										+			+	+		

[illegible]

Table 5

Flora & Fauna	N S	N S	N S	N S	S	S	S	N	N S	N	N S	N S	N S	N S	S	S
	S ₁	S ₂	M 1a	M 1b	M ₂	M ₃	I 1a	I 1b	I 1c	I 1d	I 1e	I 2a	I 2b	I 3a	I 3b	
	Supra litto ral		Medio littoral				Infralittoral									
<i>Cariophyllia clavus</i> SACCHI							+			+		+	+			
<i>Alcyonum palmatum</i> PALL.													+			
<i>Eunicella cavolinii</i> KOCH													+			
<i>Eunicella stricta</i> BERTOL.												+	+			
<i>Polychaeta</i>							⊙	⊙	⊙	⊙		⊙	⊙			
<i>Serpula vermicularis</i> L.							+	+	+	×		×	+			
<i>Pomatoceros triqueter</i> L.								+		+		+	+			
<i>Spirorbis pagenstecheri</i> QUATREF.							+	+	+	+		×				
<i>Protula tubularia</i> MONT.								+		+		+				
<i>Sabella pavonina</i> SAV.																
<i>Spirographis spallanzanii</i> VIVIANI										+						
<i>Bryozoa</i>							⊙	⊙	⊙	⊙	⊙	⊙	⊙			
<i>Aetea truncata</i> (LANDSBOR.)								+	+	+						
<i>Aetea recta</i> (L.)									+							
<i>Scrupocellaria reptans</i> L.								+		+		+	+			
<i>Electra pilosa</i> (L.)																
<i>Electra posidoniae</i> (L.)																
<i>Membranipora membranacea</i> (L.)							+	+	+	+						
<i>Cellaria fistulosa</i> L.												+	+			
<i>Retepora beaniana</i> KING.									+	+	+	×	+			
<i>Myrionozoum truncatum</i> (PALLAS)									+	+	+	×	+			
<i>Tubocellaria opuntiioides</i> (PALLAS)																
<i>Crisia eburnea</i> (L.)																
<i>Schizoporella sanguinea</i> NORMAN									×	+						

[illegible]

Flora & Fauna	N S	N S	N S	N S	S	S	S	N	N S	N	N S	N S	N S	N S	S	S
	S ₁	S ₂	M 1a	M 1b	M ₂	M ₃	I 1a	I 1b	I 1c	I 1d	I 1e	I 2a	I 2b	I 3a	I 3b	
	Supra littoral		Medio littoral				Infralittoral									
<i>Microporella malusi</i> (AUD.)								+								
<i>Microporella johannae</i> (L.)																
<i>Porella cervicornis</i> PALLAS														+		
<i>Hippodiplosia foliacea</i> ELLIS—SOL.																
<i>Cellopora pumicosa</i> HINCKS								+	+		×					
<i>Hornera frondiculata</i> LAMOUR																
<i>Lichenopora radiata</i> AUD.										+	+	+	+			
<i>Mollusca</i>	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
<i>Acanthochiton communis</i> (RISSO)								+		+		+				
<i>Acanthochiton fascicularis</i> (L.)				+					+							
<i>Isrochiton rissoi</i> (PAYR.)				+												
<i>Callochiton laevis</i> (MONT.)																
<i>Middendorfia caprearum</i> (SCACCHI)				+			+	+				+				
<i>Chiton olivaceus</i> SPENG.			+	+	+											
<i>Chiton corallinus</i> RISSO												+	+			
<i>Haliotis lamellosa</i> LAM.							+	+		+						
<i>Emarginula elongata</i> COSTA										+						
<i>Emarginula cancellata</i> PHIL.										+						
<i>Diodora gibberula</i> (LAM.)				+								+				
<i>Diodora graeca</i> (L.)							+	+	+	+			+			
<i>Diodora italica</i> (DEFR.)										+						
<i>Patella coerulea</i> L.	+	+	+	+				+								
<i>Patella lusitanica</i> GMEL.	+	+	+	+												
<i>Acmaea virginea</i> (MÜLLER)										+		+	+			
<i>Calliostoma conulus</i> (L.)													+			

S	S	N	N	N	N	N	S	S	N	N	N	N	N	N	S	S	S	N	N	N	N	S
I	I	I	I	I	I	I	I	I	IC	C	C	C	C	C	C	C	C	C	C	C	C	C
4a	4b	5a	5b	5c	6a	7a	7b	7c	7d	1	1a	1b	1c	1d	1e	2a	2b	2c	3a	3b	3c	4
Infralittoral										Circalittoral												
						+	+	+														
								+	+													
			+						+		+	*	+	+	+	+	+	+			+	+
		+	+								*	+	+	+		+					+	+
						+	+	+	+		+	+										
											+	*	+									+
					+				×	+	+	+			+						+	
⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙	⊙
					+			+							+							+
		+																				
					+										×		+					+
					+						+		+									+
		+			+	+	+			+	+				+						+	+
										+					+	+			?		+	+
						+	+	+							+							
									+	+					+							
																					+	
									+		×								+			+

[illegible]

[illegible]

[illegible]

S	S	N	N	N	N	N	N	S	S	N	N	N	N	N	N	S	S	S	N	N	N	N	S
I	I	I	I	I	I	I	I	I	I	IC	C	C	C	C	C	C	C	C	C	C	C	C	C
4a	4b	5a	5b	5c	6a	7a	7b	7c	7d	1	1a	1b	1c	1d	1e	2a	2b	2c	3a	3b	3c	4	4
Infralittoral										Circalittoral													
								+															
							+					+					+		*	*	×		
		+		+								+											
			+									+										×	×
+	+																						
						*	+	*	+	+												?	
+		+		+	×	×	+	+	+	+	+	+		+	+		+	+			+	×	×
						+		+			×	+											
					+	+		+											+				
										+	+	+			+	+				+			
					×	+	+	+	*	×	+												+
		+								+												+	+
+		+														+	+						+
+		+				+	+	+		+	×			×									
+	+	+		+		+		+															
+					+					+	+				+	+			+	+	+		+
						+					+	+			+								
+	+			+	+	+				+													+

[illegible]

S	S	N S	N	N	N	N	N	S	S	N	N	N	N	N	N	S	S	S	N	N	N	N	S
I 4a	I 4b	I 5a	I 5b	I 5c	I 6a	I 7a	I 7b	I 7c	I 7d	IC 1	C 1a	C 1b	C 1c	C 1d	C 1e	C 2a	C 2b	C 2c	C 3a	C 3b	C 3c	C 4	C 4
Infralittoral										Circalittoral													
									+							×	×	+					×
											+						+	+					+
												+					+	×	+				+
	+	+		+	+	+	+			×	+			+	+		+					+	+
	+	+		×		+	+			+	+										+	+	+
					+	+	+			*	+		+		+		+		+	×	+		
		+		+		+		+														+	
							+	+	×														
								+	+	+	+												
	+						+	+	+	+	+		+										+

S	S	N	N	N	N	N	N	S	S	N	N	N	N	N	N	S	S	S	N	N	N	N	S
I	I	I	I	I	I	I	I	I	I	IC	C	C	C	C	C	C	C	C	C	C	C	C	C
4a	4b	5a	5b	5c	6a	7a	7b	7c	7d	1	1a	1b	1c	1d	1e	2a	2b	2c	3a	3b	3c	4	4
Infralittoral										Circalittoral													
×	×	×	×	×		+	+	+	+	+	×	+	*		×							×	×
+	+	+		+		+	+						+		+							+	+
	+	+		×			+		+		+		+		+		+					+	+
+	+					+	+	+	*	+				+	×								+
	*	*		+		+	×		+		+				+								
	×	+																					
+								+															
		+		+		+	+	×	+		×				×							+	+
		+							*	+												+	+
								+															
+	+	+																					
		+				×	+	+	+		+												
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																							+
		+		+							+		+		*		+			+			
	+	+				+	+	+	+	+	×			+	+				×	×	+	+	
+	+					+	+	+	+						+						+	+	+
+	+					+	+	+	+		+						+				+	+	
+	×	*		×		×					+												
			+					+			+	+	+	+	×	×						+	+
								×			+	+	+	+	+							+	+
											×				×	×	×	×				+	+

[illegible]

Table 13

Flora & Fauna	N	N	N	N	S	S	S	N	N	N	N	N	N	N	S	S
	S ₁	S ₂	M _{1a}	M _{1b}	M ₂	M ₃	I _{1a}	I _{1b}	I _{1c}	I _{1d}	I _{1e}	I _{2a}	I _{2b}	I _{3a}	I _{3b}	
	Supra litto ral		Medio littoral				Infralittoral									
<i>Cardium echinatum</i> L.																+
<i>Cardium paucicostatum</i> SOW.																+
<i>Cardium papillosum</i> POLI																
<i>Cardium deshayesi</i> PAYR.																
<i>Venus verrucosa</i> L.								+	×	+						+
<i>Venus gallina</i> L.									+					+		+
<i>Venus fasciata</i> COSTA									×							
<i>Venus ovata</i> PENN.																
<i>Venus casina</i> (GMEL.)																
<i>Pitaria rudis</i> (POLI)									+							
<i>Pitaria chione</i> (L.)																
<i>Dosinia exoleta</i> L.									+					+		+
<i>Dosinia lupinus</i> L.														+		+
<i>Gouldia minima</i> (MONT.)																
<i>Tapes rhomboideus</i> (PENN.)																
<i>Tapes aureus</i> (GMEL.)																
<i>Tapes pullaster</i> (MONT.)																
<i>Tapes geographicus</i> (GMEL.)																
<i>Tapes decussatus</i> (L.)									+							
<i>Irus irus</i> (L.)				+				+		+						
<i>Petricola lithophaga</i> RETZ.								+				+				
<i>Spisula subtruncata</i> (L.)																
<i>Mactra stultorum</i> (L.)																
<i>Mactra corallina</i> L.																
<i>Donax variegatus</i> L.																
<i>Donax trunculus</i> L.									+					+		+

[illegible]

[illegible]

S	S	N	N	N	N	N	S	S	N	N	N	N	N	N	S	S	S	N	N	N	N	S
I	I	I	I	I	I	I	I	I	IC	C	C	C	C	C	C	C	C	C	C	C	C	C
4a	4b	5a	5b	5c	6a	7a	7b	7c	7d	1	1a	1b	1c	1d	1e	2a	2b	2c	3a	3b	3c	4
Infralittoral										Circalittoral												
+								+														
+			*		+																	
			+						+		+					×	×					
×															+							
				+				+		+							+		+	+	+	+
				+			+		+	×			+						*	*	×	
								+						+					+	+		
									+										+	+	+	
×	+								+		+								+	+	+	
		+								+												
×	+	+		+	+				+		+					×	+	+				
				*	×	+				+	+			+	+				+	+	+	
+		+	+																×	×	*	
+								+							+	+					+	
×	+					+	+				+		+		+	+	+	+				
+				+				+		+					+	+	+	+				
									+													
															+		+					
+																						
×																						
+	+									+					+							
+						+																
						+																
						+																
		+		+	+	+			×	+			+	+					*	*	×	
	+			+														+				

Table 15

Flora & Fauna	N	N	N	N	S	S	S	N	N	N	N	N	N	N	N	S	S
	S ₁	S ₂	M _{1a}	M _{1b}	M ₂	M ₃	I _{1a}	I _{1b}	I _{1c}	I _{1d}	I _{1e}	I _{2a}	I _{2b}	I _{3a}	I _{3b}		
	Supra littoral		Medio littoral				Infralittoral										
<i>Gastrochaena dubia</i> (PENN.)							+		+	+							
<i>Pholas dactylus</i> L.				+													
<i>Pandora inaequalis</i> (TURT.)																	
<i>Thracia papyracea</i> (POLI)																	
<i>Thracia distorta</i> (MONT.)																	
<i>Thracia pubescens</i> (PULTN.)																	
<i>Cuspidaria cuspidata</i> (OLIVI)																	
* <i>Alvania cimex</i> (L.)									×	×							
<i>Ostracoda</i>				○	○	○	○		○	○	○	○	○	○	○	○	○
<i>Cypridina mediterranea</i> COSTA									+	+				+	+		
<i>Conchoecia spinirostris</i> CLAUS																	
<i>Sclerochylus contortus</i> (NORM.)									+	+							
<i>Cythereis antiquata</i> BAIRD																	
<i>Cythereis jonesi</i> BAIRD																	
<i>Falunia turbida</i> MÜLLER				+	+	+	+				+						
<i>Krythe similis</i> MÜLLER									+	+				+	+		
<i>Callistocythere adriatica</i> MASOLI							+				+						
<i>Loxoconcha decipiens</i> MÜLLER									+								
<i>Echinodermata</i>				○			○	○	○	○	○	○	○	○	○	○	○
<i>Antedon mediterranea</i> (LAM.)												+	+				
<i>Astropecten bispinosus</i> OTTO									+	+							
<i>Astropecten platyacanthus</i> PHIL.																	
<i>Astropecten aurantiacus</i> (L.)									+					+			
<i>Astropecten spinulosus</i> (PHIL.)														+	+		

* appendix

[illegible]

[illegible]

In contrast to this, I denote infralittoral biotopes with other algae not forming dense growths as aphytal ecosystems. From the viewpoint of their application in geology I do not consider it useful to denote e.g. trottoir as a phytal unit, even though it contains the algae *Lithophyllum cristatum* (syn. *L. tortuosum*) and *Lithophyllum incrustans*, as well as facies in shallower environment of sandy sea-floor with *Lithophyllum racemus* (I-5c) or in deeper environment with *Lithophyllum fruticulosum* (C-2a). Similarly I do not denote as phytal ecosystem the extensive and also as fossiles well known lithothamnium incrustations on hard infralittoral slopes and walls. With the exception of trottoir I denote these incrustations as infracoralligene (I-2a, b), in contrast to the real eucoralligene occurring mostly already in greater depths and always on mobile sandy or clayi, muddy or organodetrital sea-floor.

From the viewpoint of correct reapplication in geology I thus use the terms "phytal" or "aphytal", "infracoralligene" or "eucoralligene" in the abovementioned sense.

In further contributions I intend to analyse, from the region of North Adriatic Shelf, above all profiles traced in all directions from the island Banjole, the more important profiles between the islands of the region Róvinj; on South Adriatic Shelf the profiles studied on the SW shore of the peninsula Pelješac and between Pelješac and the island Mljet.

Translated by K. Janáková

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See references in the paper:

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