

SURVEY OF BENTHIC COMMUNITIES IN THE AREA OF OSOR (NORTH ADRIATIC SEA)

ISTRAŽIVANJE BENTONSKIH ZAJEDNICA NA PODRUČJU OSORA

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Benthic communities in the surroundings of Osor, a small tourist resort in the north Adriatic Sea, were surveyed. Local distribution patterns and the composition of communities are discussed. It was established that the area is not yet influenced by pollution.

INTRODUCTION

The townlet Osor is located on the strait between Cres and Lošinj, two large islands in the Kvarner region of the Adriatic Sea. The strait was reconstructed into a channel, which joins two fairly different aquatoria: the shallow and sheltered part named Osor Port (Osorska Luka) in the south, and the deep and exposed Osor Bay (Osorski Zaljev) in the north.

In the entire area, the coast line is limestone rock and cliffs which are very intersected and rich in cracks, recesses, and small hollows at many sites. Depending on slope, and exposure to waves, at some places the rocky bottom at a depth of only 1—2 meters passes to a sedimentary bottom of five gravels and coarse sands, which are locally enriched with pebbles. In Osor Bay, sandy slopes are often interrupted by rocky steps and walls, or genuine ruderal habitats consisting mainly of large loose stones. At still larger depths, silty fractions stepwise dominate, and the sediments finally turn to sandy and clayey silts.

Wave action is an important ecological factor only in Osor Bay which is exposed to the Kvarner Gulf. On the contrary, southern Osor Port is sheltered to any influences from the open sea and thus waves caused by winds (bora and jugo) do not have a destructive force. With regard to sea currents, the area is characterised by alternate tidal currents. The sea water is good aerated and the salinity varies in normal ranges for this part of the Adriatic Sea.

Until recently, the area of Osor was seldom subject to biological investigations. Some general remarks on Osor and its surroundings were noted already by Fortis (1771), but Grube (1864) was the first who thoroughly

studied the benthic fauna in this area. Later authors have mostly repeated the results of Grube but only little additional information on the marine fauna of Osor was provided (Stossich 1880—1883, Ludwig 1879, Pesta 1918, Kolosváry 1940, Karaman 1971). Regrettably, the marine flora and benthic communities in this area have never been subjects of special research.

Recently several actions were initiated to develop the tourist attraction of Osor and its surroundings. Therefore, in coordination with other undertaken actions, the benthos in this area was also surveyed.

METHODS

The present research was initiated as a routine survey. The coastal communities were analysed visually at many sites (Figure 1). At greater depths, the collections and in situ observations were made by SCUBA divers. In Osor Bay, several samplings were made by the Van Veen 0.1 m² type grab.

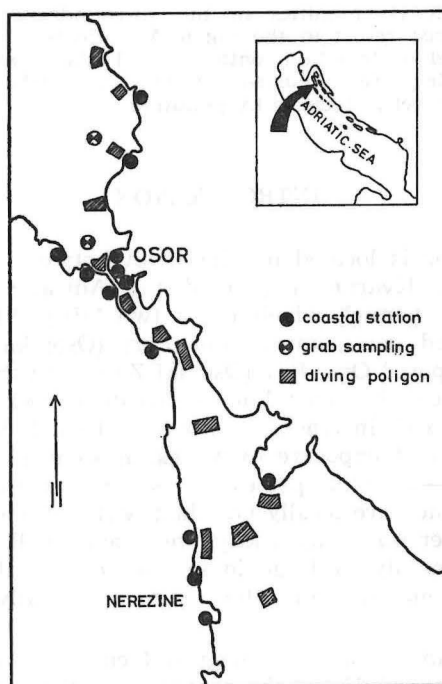


Figure 1. Investigated area

The material was processed through 1 mm mesh sieve; subsequent treatment was done according to standard methods. The biocoenological analyses were based on the modified phyto-sociological method, and communities were identified according to Pérès and Picard (1964). For biogeographical purposes, the list of species collected at present research is annexed.

RESULTS AND DISCUSSION

At all studied localities the distributional patterns of benthic communities are very similar. In the supralittoral zone, limestone rocks are occupied everywhere by a biocoenosis of supralittoral rocks which is typical for the Adriatic Sea. Species most characteristic and distributed are *Chthamalus depressus*, *Littorina neritoides*, and *Ligia italica*. The lichen *Verrucaria adriatica* was found only occasionally. At localities exposed to the strong north-eastern wind, bora, the brown coloured belt of epilithic Cyanophyta can attain a height of several meters. In the lower belt of this zone, *Patella rustica* and *Chthamalus stellatus* are distributed elsewhere. In cracks not exposed to direct sun light in which moisture is retained for long periods, carpets of tiny red alga *Catenella caespitosa* are locally well developed. These settlements are rich in small molluscs, arthropods and worms, as it was established also at some other regions in the Adriatic Sea (Zavodnik, 1967).

The midlittoral zone is characterised by a biocoenosis of midlittoral rocks typical for the North Adriatic. In the upper level, the rocks are elsewhere inhabited by *Chthamalus stellatus* whose populations are extremely abundant at localities exposed to waves, especially on very intersected rocks in the Osor Bay. Quite common in the area are also *Littorina neritoides*, *Patella aspera*, *Monodonta turbinata*, *Gibbula adriatica*, and *Mytilaster minimus*. Unexpectedly, dense populations of the common mussel *Mutilus galloprovincialis* were not noted near the sea level, though this shellfish is common and distributed in the midlittoral zone in the entire Kvarner area (Zavodnik and Zavodnik, 1979). In sheltered habitats, in the lower level of the midlittoral zone, *Anemonia sulcata* and some species of the genus *Gibbula* were also observed. In the harbour, the nitrophilic algae *Ulva*, *Cladophora* and *Halopteris* were noted on the infralittoral fringe.

The upper infralittoral zone, in the investigated area, is characterised by vertical or subvertical rocky walls, 1—3 meters high, which at depth continue in compact rocky terraces, or in fields and slopes of loose stones. As of rule, these surfaces are deprived of macroalgal vegetation, except of the crustaceous stone alga *Lithophyllum incrustans*. Here mass populations of black sea urchins *Arbacia lixula* (4—5 spm. m⁻²) are distributed, but rarely also isolated specimens of the sponge *Verongia aerophoba* and some polyzoan colonies (probably *Schizoporella*) can be found. In the Osor Bay, subvertical infralittoral walls, recesses and niches, are populated by large colonies of *Parazoanthus axinellae*, variously coloured sponges, the algae *Halimeda tuna*, *Peyssonnelia squamaria*, *Wrangelia penicillata*, and many other organisms.

The carpet of photophilic algae is distributed usually below the 1—3 meters depth. The seaweeds highly characteristic for this biocoenosis in the northern Adriatic are distributed elsewhere: *Laurencia obtusa*, *Padina pavonia*, *Dictyota dichotoma*, *Dictyota linearis*, *Wrangelia penicillata*, *Acetabularia acetabulum*, *Codium bursa*, and others. Most important, however are species of the genus *Cystoseira*, especially *Cystoseira corniculata* ssp. *laxior*. Of all algae noted, this species is by far most abundant and at some places its settlements cover the rocky bottom almost completely (covering rate = 80% — 100%), until the depths of about 20 meters. In average, the standing crop of this alga surpasses 6 kilograms w.wt. per square meter.

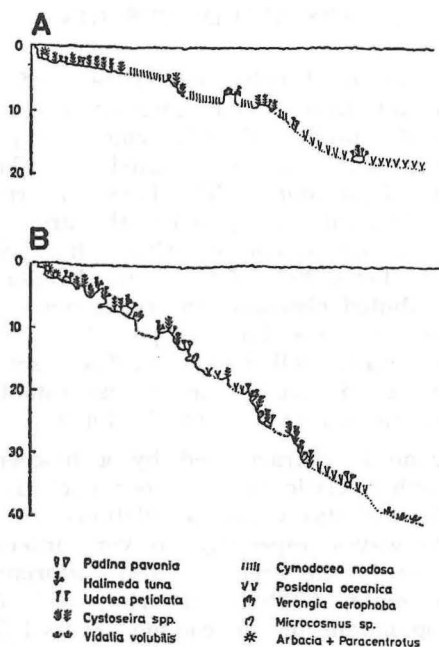


Figure 2. Distribution of characteristic organisms in Osor Port (A) and Osor Bay (B)

The biocoenosis of high photophilic algae is also very rich in sedentary and vagile animals. Thus, very common are endolithic sponges Clionidae (mostly *Clione viridis* and *C. celata*) which, at some sites, at the depths between 10—15 meters, burrow in all rocky surfaces available, in all large and smaller loose stones and boulders, and even in the majority of large gastropod and bivalvian shells. In this biocoenosis, also some other sponges such as *Chondrilla nucula*, *Petrosia ficiformis*, and *Ircinia* sp., corallians *Balanophyllia europaea* and *Cladocora caespitosa*, tube building polychaete worms *Pomatoceros triqueter*, *Protula tubularia* and various spirorbids, many gastropods and shellfishes (for example, *Spondylus gaederopus* and *Rocellaria dubia*), several echinoderms (*Holothuria tubulosa*, *Marthasterias glacialis*, *Echinaster sepositus*, *Ophiothrix fragilis*, *Ophioderma longicaudum*, *Sphaerechinus granularis*), various flat and bush-like polyzoans, several tunicates (especially the genus *Microcosmus*), and many fishes were often collected. Consequently, the diversity and abundance of marine flora and fauna in this biocoenosis are the best evidence of sea clarity which is not yet influenced by pollution.

On nearly all localities, especially in Osor Bay, the stony, gravely, or sandy sea bottom passes very steeply into larger depths. According to notings of SCUBA divers, these slopes are poor in epibenthic organisms. On the contrary, the isolated rocky steps and small walls which at some sites interrupt the continuation of the slope, are fairly overgrown by tiny cladophoras and sciaphilic red algae, polyzoans (*Hippodiplosia foliacea*), sponges (*Spirastrella*

cunctatrix) and solitary tunicates (*Halocynthia papillosa*). The praecorallinous aspect is normally well expressed in this habitat. Often, this community is also enclosed within the beds of marine phanerogams.

In the surroundings of Osor, two phanerogam species are fairly distributed: *Cymodocea nodosa* which grows mostly on fine sands in the shallow part of Osor Port, and *Posidonia oceanica* which is distributed somewhat deeper on sandy and gravelly bottoms. In shallow and sheltered habitats, the settlements of *Cymodocea nodosa* are usually well developed; that means the population is very dense (cr = 80% and more), and the leaves of plants are often longer than 25 centimeters. Epiphytic hydrozoans and spirorbids are numerous. Among phanerogam plants, on isolated pebbles, stones and dead shells, *Dasycladus vermicularis* and *Dictyota linearis* are abundantly settled. Here and there, within the continuous meadow of *Cymodocea*, small clearings

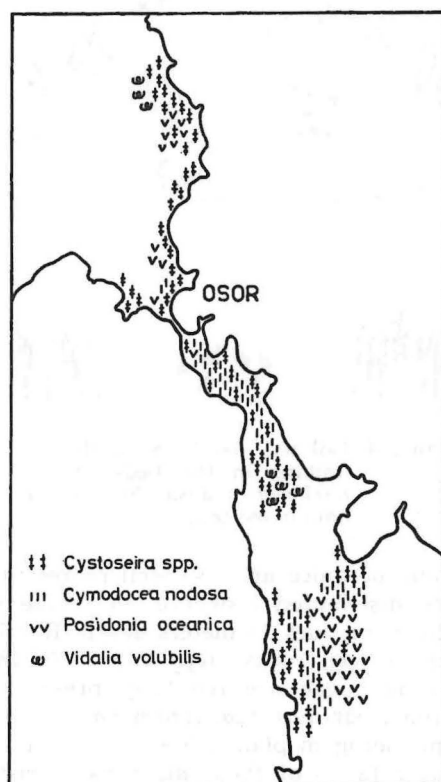


Figure 3. Distribution pattern of marine vegetation in Osor area

can be found which are completely occupied by heaps of loose thalli of the red alga *Halopithys incurvus*. Probably these algal accumulations prevent the expansion of phanerogams onto clearings in which, certainly, the composition of the sediment is identical to that which is overgrown by *Cymodocea*.

In the central part of Osor Port, at about 3 meters depth, some large isolated stones and small boulders are located within the continuous bed of *Cymodocea*. They are densely populated by big specimens of the common sea urchin *Paracentrotus lividus*. At a distance of 40–50 centimeters from each boulder, the sand is completely deprived of any algal or phanerogam vegetation. Further around the clearings, a normal dense settlement of *Cymodocea* is extended (Fig. 4). Without doubt, these small clearings with a central stone or boulder populated by *Paracentrotus*, originated through the feeding behaviour of echinoids.



Figure 4. Isolated boulders with sea urchins in the beds of *Cymodocea nodosa*. For explanation see text.

The beds of *Posidonia oceanica* are also well represented in the surroundings of Osor. They are distributed elsewhere on coarse sands, pebbles, and gravels, from about 5 to more than 25 meters depth. Rarely, some plants take roots also in the cracks in deep rocky steps and cliffs. In the complex community of *Posidonia*, some algae are regularly present, especially *Dictyota linearis*, *Dictyota dichotoma* var. *implexa*, *Halimeda tuna* and *Udotea petiolata*. On some sites, among phanerogam plants, free living thalli of *Vidalia volubilis* also accumulate. The macrofauna of *Posidonia* beds consists mainly of various annelids, crustaceans, echinoderms (especially *Holothuria forskali*, *Echinaster sepositus* and *Sphaerechinus granularis*), some tunicates (*Microcosmus* sp.), numerous polyzoans (*Schizoporella*, *Electra posidoniae*, *Sertella beaniana*), and fishes, especially labrids.

On sheltered sites, at depths from about 12 to over 30 meters, besides sandy particles, the silty fractions are somewhere quite important. In such habitats, the red alga *Vidalia volubilis* which otherwise is characteristic for the biocoenosis of coastal detritic bottom, is very much distributed. However,

usually, *Vidalia* population is mixed with other algae, especially cystoseiras, which settle on large dead shells and isolated loose stones. On these silty sands some animals common on coastal detritic bottoms were also collected by SCUBA divers; among them, *Suberites domuncula* and *Eupagurus prideauxi* seem most abundant.

At the greatest depths in Osor Bay, on sandy silts a benthic community was located which is obviously mixed and transitive to communities of genuine silty bottoms. It is populated by *Maldane glebifex*, *Upogebia deltaura*, *Amphiura filiformis*, *Amathia semiconvoluta*, and others, which are otherwise distributed in the entire Kvarner Gulf. When compared to shallow water communities, the overall scarcity of the noted deep silty bottom is evident.

CONCLUSIONS

- 1.— The area of Osor is populated by benthic communities which are characteristic of and distributed everywhere in the Kvarner region of the Adriatic Sea.
- 2.— The local distribution of benthic communities depends before all on the composition of the sediment, and much less on the topographical features and the depth of the habitat.
- 3.— Except in the townlet harbour, benthic communities in the area of Osor are still unaffected by any kind of pollution.

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ISTRAŽIVANJE BENTONSKIH ZAJEDNICA NA PODRUČJU OSORA

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KRATAK SADRŽAJ

Biološke karakteristike područja Osora su slabo poznate. Najviše podataka o morskoj fauni dao je Grube (1864), dok morske alge i cvjetnice, kao i životne zajednice morskog dna uopće nisu istraživane. Kako se na tom području predviđa izgradnja turističkih objekata, pristupilo se letimičnoj biocenoškoj analizi tog akvatorija.

Na morskom dnu tog područja ustanovljene su životne zajednice, i inače značajne i široko rasprostranjene u drugim dijelovima Kvarnera pa i sjevernog Jadrana. Obzirom na donekle različite geomorfološke i hidrodinamske razlike između dubokog Osorskog zaljeva na sjeveru, te pliće Osorske luke na jugu, utvrđena je i raznolikost rasprostranjenja zajednica na morskom dnu. U zaštićenom području između Osora i Nerezina, na hridinastom dnu su dobro razvijena naselja različitih vrsta viših fotofilnih alga, a na pjeskovitim kao i djelomično zamuljenim tipovima morskog dna široko su rasprostranjeni travnjaci morskih cvjetnica *Cymodocea nodosa* i *Posidonia oceanica*. U Osorskom zaljevu, međutim, vrsta *Cymodocea nodosa* se tek rijetko susreće, a i naselja *Posidonia oceanica* razvijena su tek mjestimično. Često se tu nailazi na ruderalna staništa s degradiranom vegetacijom viših alga, podmorske špilje i usjekline, a vrlo su rasprostranjene životne zajednice na dnu krupnih pijesaka i finih šljunaka. U najdubljem dijelu Osorskog zaljeva dolazi do prijelaza prema zajednici obalnog terigenog mulja.

Općenito, more okolice Osora još je vrlo čisto. Izvjesne posljedice umjerenog zagađivanja vidljive su gotovo samo u gradskoj luci.

ANNEX

List of identified species — Spisak vrsta

RHODOPHYTA

Gelidium latifolium (Grev.) Thur. et Born.
Catenella caespitosa (With.) Dixon et L. Irvine
Jania rubens (L.) Lam.
Amphiroa rigida Lamour.
Dermatolithon cystoseirae (Hanck.) H. Huve
Fosliella farinosa (Lamour.) Howe
Lithophyllum incrustans Phil.
Lithophyllum racemus (Lam.) Fosl.
Phymatolithon lenormandii (Aresch. in J. Ag.) Adey
Phymatolithon calcareum (Pall.) Adey et McKibbin
Hypnea musciformis (Wulf.) Lamour.
Peyssonnelia squamaria (Gmel.) Decne.
Champia parvula (C. Ag.) Harv.
Spyridia filamentosa (Wulf.) Harv. in Hook.
Wrangelia penicillata C. Ag.
Nitophyllum punctatum (Stackh.) Grev.
Dasyopsis plana (C. Ag.) Zanard.
Chondria tenuissima (Good. et Woodw.) C. Ag.
Laurencia obtusa (Huds.) Lamour.
Dipterosiphonia rigens (Schousb.) Falk.
Halopithys incurvus (Huds.) Batt.
Rytiphloea tinctoria (Clem.) J. Ag.
Vidalia volubilis (L.) J. Ag.
Polysiphonia elongata (Huds.) Spreng.
Polysiphonia fruticulosa (Wulf.) Spreng.
Polysiphonia opaca (C. Ag.) Mor. et De Not
Polysiphonia subulifera (C. Ag.) Harv.

PHAEOPHYTA

Colpomenia sinuosa (Mert.) Derb. et Sol.
Sphacelaria cirrosa (Roth) C. Ag.
Halopteris filicina (Grat.) Kütz.
Halopteris scoparia (L.) Sauv.
Zanardinia prototypus Nardo
Dictyota dichotoma (Huds.) Lamour
Dictyota dichotoma v. *implexa* (Desf.) J. Ag.
Dictyota linearis (C. Ag.) Grev.
Dilophus fasciola (Roth) Howe
Padina pavonia (L.) Lamour.
Sporochnus pedunculatus (Huds.) C. Ag.
Cystoseira corniculata Hauck
Cystoseira corniculata s. *laxior* Erceg.
Cystoseira barbata J. Ag.
Cystosira adriatica Sauv.
Cystoseira ercegovicii Giacc.

CHLOROPHYTA

Cladophora prolifera (Roth.) Kütz.
Valonia utricularis (Roth.) C. Ag.

Anadyomene stellata (Wulf.) C. Ag.
Acetabularia acetabulum (L.) Silva
Dasycladus vermicularis (Scop.) Krass
Udotea petiolata (Turra) Börges
Halimeda tuna (Ell. et Sol.) Lamour.
Codium bursa (L.) C. Ag.

ANGIOSPERMAE

Zosterella noltii Hornem.
Cymodocea nodosa (Ucr.) Asch.
Posidonia oceanica (L.) Del.

CNIDARIA

Plumularia sp.
Parazoanthus axinellae (O. Schmidt)
Condylactis aurantiaca (Delle Chiaje)
Anemonia sulcata (Pennant)
Aiptasia mutabilis (Gravenhorst)
Calliactis parasitica (Couch)
Cereus pedunculatus (Pennant)
Cladocora caespitosa (Linnaeus)
Caryophyllia inornata (Duncan)
Balanophyllia europaea (Risso)

SPONGIARIA

Clathrina coriacea (Montagu)
Geodia cydonium (Jameson)
Tethya lyncurium (Linnaeus)
Chondrilla nucula O. Schmidt
Suberites domuncula (Olivi)
Spirastrella cunctatrix O. Schmidt
Cliona celata Grant
Cliona vastifica (Hancock)
Cliona viridis (O. Schmidt)
Hemimycale columella (Bowerbank)
Clathria coralloides (Olivi)
Haliclona cratera O. Schmidt
Petrosia ficiformis (Poirlet)
Dysidea sp.
Ircinia fasciculata Pallas
Ircinia muscarum (O. Schmidt)
Verongia aerophoba (O. Schmidt)

MOLLUSCA

Acanthochiton fascicularis (Linnaeus)
Haliotis lamellosa (Lamarck)
Diodora italica (Defranche)
Patella rustica (Gmelin)
Patella aspera (Philippi)
Patella coerulea (Linnaeus)
Gibbula divaricata (Linnaeus)
Monodonta articulata Lamarck
Monodonta turbinata (Born)
Monodonta mutabilis (Philippi)
Littorina neritoides (Linnaeus)
Turritella communis Risso
Lemintina arenaria (Linnaeus)
Bittium reticulatum Da Costa
Gourmya vulgata (Bruguère)
Aporrhais pes-pelecani (Linnaeus)
Trunculariopsis trunculus (Linnaeus)

Muricopsis cristatus (Brocchi)
Pisania maculosa (Lamarck)
Pusia tricolor (Gmelin)
Conus mediterraneus Bruguière
Tyrodina citrina Joannis
Nucula turgida nitidosa Winckworth
Arca noae Linnaeus
Mytilaster minimus (Poli)
Mytilus galloprovincialis Lamarck
Pinna nobilis Linnaeus
Spondylus gaederopus Linnaeus
Ostrea edulis Linnaeus
Rudicardium tuberculatum Linnaeus
Callista chione (Linnaeus)
Venus verrucosa Linnaeus
Corbula gibba (Oliv)
Rocellaria dubia (Pennant)
Octopus vulgaris Lamarck

ARTHROPODA (Crustacea)

Chthamalus depressus (Poli)
Chthamalus stellatus (Poli)
Balanus perforatus Bruguière
Squilla mantis Fabricius
Thorulus cranchii (Leach)
Homarus gammarus (Linnaeus)
Callinassa subterranea (Montagu)
Paguristes oculatus (Fabricius)
Clibanarius erythropus (Latreille)
Galathea bolivari Zariquiey Alvarez
Pisidia longimana (Risso)
Maja verrucosa (H. Milne Edwards)
Ligia italica Fabricius

ECHINODERMATA

Antedon mediterranea (Lamarck)
Holothuria tubulosa Gmelin
Holothuria polii Delle Chiaje
Holothuria forskali Delle Chiaje
Leptosynapta inhaerens (O. F. Müller)
Astropecten aranciatus (Linnaeus)
Echinaster sepositus (Retzius)
Marthasterias glacialis (Linnaeus)
Amphiura filiformis (O. F. Müller)
Amphipholis squamata (Delle Chiaje)
Ophiothrix fragilis (Abildgaard)
Ophioderma longicaudum (Retzius)
Arbacia lixula (Linnaeus)
Sphaerechinus granularis (Lamarck)
Psammechinus microtuberculatus (Blainville)
Paracentrotus lividus (Lamarck)
Spatangus purpureus (O. F. Müller) — tests
Echinocardium cordatum (Pennant) — tests
Schizaster canaliferus (Lamarck) — tests

VERTEBRATA

Raja (Raja) miraletus Linnaeus
Conger conger (Artedi/Linnaeus)
Serranus hepatus (Linnaeus)
Mullus barbatus Linnaeus
Diplodus annularis (Linnaeus)
Diplodus vulgaris (Saint-Hilaire)

Oblada melanura (Linnaeus)
Sarpa salpa (Linnaeus)
Spicara maena maena (Linnaeus)
Chromis chromis (Linnaeus)
Labrus bimaculatus Linnaeus
Coris julis (Linnaeus)
Symphodus (*Symphodus*) *rostratus* (Bloch)
Symphodus (*Crenilabrus*) *cinereus* (Bonnaterre)
Symphodus (*Crenilabrus*) *ocellatus* (Forsk.)
Gobius bucchichi Steindachner
Gobius cruentatus Gmelin
Chromogobius quadrivittatus (Steindachner)
Deltentosteus quadrimaculatus (Valenciennes)
Blennius ocellaris Linnaeus
Blennius gattorugine Brünich
Blennius pavo Risso
Blennius rouxi Cocco
Scorpaena scrofa Linnaeus

VARIA

Sternaspis scutata (Renier)
Pomatoceros triqueter Linnaeus
Spirorbis sp.
Protula tubularia (Montagu)
Salmacina incrustans Claparede
Spirographis spallanzani Viviani
Electra posidoniae Gautier
Schizoporella spp.
Hippodiplosia foliacea (Ellis et Solander)
Sertella beaniana (King)
Cellepora pumicosa Hincks
Myriapora truncata (Pallas)
Lichenopora radiata Audouin
Amathia semiconvoluta Lamouroux
Clavellina lepadiformis (O. F. Müller)
Halocynthia papillosa (Linnaeus)
Microcosmus claudicans (Savignyi)
Microcosmus sp.