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NORTH ADRIATIC INTER-ISLAND SHELF ECOSYSTEMS OF THE ROVINJ AREA

(21 Figs., 1 Tab.)

Abstract: Following the presentation of basic hydrographic data, the methods of research, quantitative ecosystem analysis of the North and South Adriatic Shelf and of the character of benthic biocenoses of the Banjole island area near the town Rovinj (North Adria), this contribution deals with ecosystems from inter-island areas near Rovinj and it gives a description of some of the typical facies of recent infra- and circalittoral. The lithologic character and biological content of the biotops presented in the paper are very well applicable in the reconstruction of fossile sedimentation environments.

Резюме: После описания основных гидрографических условий, методов изучения, количественного анализа экосистем Северного и Южного Адриатического шельфа и описания характера бентозных биоценозов области острова Баньоле недалеко г. Ровинь (Северная Адрия), настоящая статья занимается экосистемами из междуостровной области недалеко г. Ровинь и дает описание некоторых типических фаций рецентной инфра- и циркулитторальной зоны. Литологический характер и биологическое содержание изучаемых биотопов можно хорошо применить в реконструкции древних условий образования осадков.

In earlier papers concerning recent marine ecosystems of the North and South Adriatic Shelf I have dealt except with a general hydrographic characteristics of this region and the description of the methods of our study (Seneš, 1988a) also with the analysis of the quantitative distribution especially of benthic organisms in individual sea-floor biotops (Seneš, 1988b). On the basis of the data presented in these two papers I gave a description and an analysis of typical biocenoses from the area of the island Banjole on the North Adriatic Shelf (Seneš, 1988c).** I have chosen the areas on this island because they represent a classical grouping of ecosystems, applicable also in the reconstruction of the origin of fossile sediments.

Another interesting region for the application in actuogeology are the inter-island areas on the shore of the Istria peninsula near the town Rovinj. (For space distribution of the islands, bathymetry, direction and numerical denotation of the profiles — see Seneš, 1988a). I shall analyse above all sea-floor profiles from the inter-island areas containing occurrences of littoral biocenoses which are not represented in the Banjole island region; I shall further describe inter-island profiles with a prevalence of biocenoses typical of muddy, circalittoral environments.

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** Note: I denote a group of biocenoses (thanatocenoses) belonging to individual zones (horizons), e.g. infralittoral, circalittoral, as ecosystems, and their individual variants as biocenoses (thanatocenoses-biofacies).

From the over 20 profiles with a total length of 8000 m I have chosen the following ones: two profiles leading from the island St. Katarina to the island Banjole (Profile No. XXVII) and to the peninsula Montaura on the mainland (Profile No. XXVIII), further the mutually linked N-S profiles from the island Valmascim (Crveni Otok) through the islands Sturago and St. Giovanni to the island Pelago (Profiles Nos. XV, XVI, XVII), then a short, but due to its faunal variability interesting additional profile No. XXXVI situated NW of the island St. Giovanni, and a chain of more or less linked profiles between the islands Crveni Otok—Pirozi (Profile No. XXXV) and Pirozi—Sestrice (Profile No. XXXVII).

The profiles leading from the island St. Katarina are noteworthy because of the presence of the biocenose I-6a with *Pitaria rudis*-*Tellina pulchella*, as well as the variability of the biocenose with *Hippodiplosia* and in the direction towards Montaura the presence of the transitory facies IC-1a.

I shall describe the inter-island profiles Valmascim—Sturago—St. Giovanni—Pelago for several reasons. Between the islands there is a very strong current, reaching down to the sea-floor even in the deepest part of the profiles between Valmascim and Sturago and between Sturago and St. Giovanni. It appears that this current makes possible the abundant occurrences of the biocenose with *Lithophyllum racemosum* (I-5a). Sporadically there is an exceptionally dense growth of *Udotea petiolata* also in channels between these islands. The profile passes between St. Giovanni and Pelago through the deepest parts of the studied North Adriatic Shelf regions. In place of the facies with *Hippodiplosia*, another, bryozoan community occurs here — the biocenose *Scrupocellaria*—*Porella*—*Hornera* (C-1b).

The additional profile No. XXXVI NW of St. Giovanni provided the largest and most typical occurrence of eucoralligene from the studied North Adriatic Shelf regions.

The inter-island chain of profiles Crveni Otok—Pirozi—Sestrice is represented by ecosystems extraordinarily important from the viewpoint of their application in geology. On one hand, the biocenose with *Pecten jacobaeus* contains such a prevalence of the genus *Glycymeris* as it is usually seen only on the Middle and South Adriatic Shelf littoral. On the other hand, the most important one is the profile Pirozi—Sestrice, representing by its lithology as well as biological content a recent example of the very frequent fossile "gray marls" and perhaps also the "Schlier" facies.

Profile XXVII., St. Katarina—Banjole (1100 m), section St. Katarina (600 m)

The profile was studied in the year 1969 and in spring of 1971. The St. Katarina section was controlled and completed in autumn of 1971. The profile reached the depth —35 m in the distance of 450 m. from St. Katarina (Fig. 1). In comparison with the Banjole section, we found noteworthy the occurrence of the biocenosis with the leading species *Pitaria rudis* and *Tellina pulchella* already in depths of —17, —18 m, in sandy-muddy environment (I-6a).

To a distance of 90 m from the island, to a depth of —17 m, the prevailing biocenose are those of rocky, debris-covered, detrital sandy-fragmental infralittoral floor. In shallower horizons it is the facies with *Padina pavonia* (I-1b), deeper a relatively scarce growth of *Cystoseira* with typical accompanying

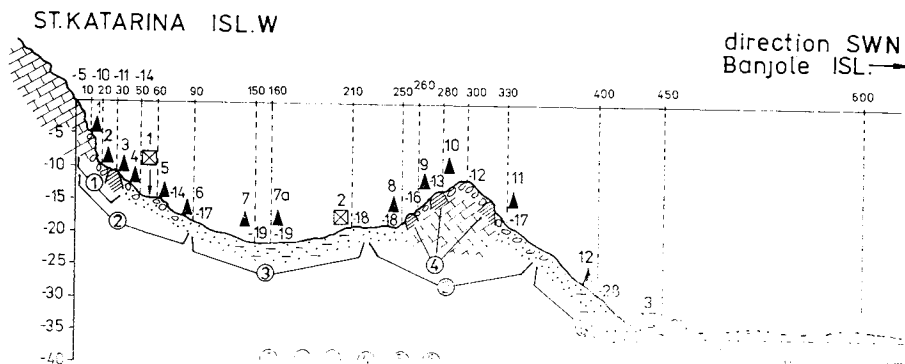


Fig. 1. Profile XXVII-K, St. Katarina—Banjole.

Explanations: 1 — *Padina pavonia* (I-1b), 2 — *Cystoseira* (I-1c), 3 — *Pitaria rudis*—*Tellina pulchella* (I-6a), 4 — *Infracoralligene* (I-2a,b), 5 — *Pecten jacobaeus* (I-5a), 6 — *Hippodiplosia foliacea* (C-1a).

benthic fauna (I-1c). This facies is developed together with infracoralligene (I-2a, b) on a submarine elevation of the profile in a distance between 250 and 330 m. This section is elevated by as much as —12 m. The quadrant No. 1 in the *Cystoseira* growth is characterized by an uncommonly frequent occurrence of *Balanophyllia italica*, *Acanthochiton communis*, *Venus verrucosa* and *Sphaerechinus granularis*.

In the sporadically occurring biocenose I-6a with *Pitaria rudis* and *Tellina pulchella* we have determined also the presence of *Nucula nitida*, *Venus verrucosa*, *Abra* sp., *Cerithium vulgatum*, *Turbonilla lactaea*, *Apporhais pes-pelecani* and more abundant also *Psammobia* and *Aloidis*. The prevailing echinoderm is *Amphiura chiajei*. The more abundant benthic foraminifers are *Ammonia beccari*, *Elphidium* and *Cibicides* div. sp., from ostracods there are above all *Cythereis antiquata* and *Cythereis jonesi**

The biocenosis with *Pecten jacobaeus* (I-5a) is as everywhere in the Rovinj area — developed typically on this section of the profile as well. In contrast to the Banjole section it lacks the mass occurrence of larger *Cladocora cespitosa* bioherms.

The biocenosis with *Hippodiplosia foliacea* is documented in the quadrant No. 3 (—34 m) and basically it is characteristic for the greater part of the profiles in depths about —35 m. However, in the area of the quadrant No. 4 near Banjole it reaches up to —32, —31 m. This biocenosis of muddy, sandy-muddy circalittoral detritus (C-1a) is nevertheless not totally homogeneous on the extensive, almost equally deep inter-island areas. On the now described pro-

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file, for example, *Hippodiplosia* colonies occur in the form of extensive, but more or less restricted areas. The size of the specimens and partially also the species characteristics of the accompanying benthic fauna vary from place to place. In one case the prevailing species is *Aloidis gibba*, another time it is *Pitaria rudis*, *Arca lactaea*, *Leda fragilis* or *Tritonalia aciculata* and *Cerithium vulgatum*. On the western foot of the St. Katarina infralittoral, on the boundary of the biocenose with *Pecten jacobaeus*, the facies with *Hippodiplosia* is represented sporadically, together with smaller colonies of other bryozoans, above all *Retepora beaniana*, *Schizoporella sanguinea*, *Cellopora pumicosa* or *Crisia eburnea*.

Profile XXVIII, St. Katarina—Montaura (600 m)

The profile was studied in 1968, 1970 and 1971, with four quadrants and 12 documentation stations. No local current has been observed on the profile. Considering the rather protected character of the area with numerous bays, the sedimentation environment can be assumed to have been undisturbed during long periods and thus we can expect deeper occurring ecosystems. Significant is the occurrence of muddy-detrital sea floor almost on the whole profile in depths under —21 m. (It is interrupted only in one place by a limestone "klippe" in a depth of —26 m, in the middle of the profile.) This muddy substrate develops with progressing depth from a sandy and organodetrital-sandy infralittoral floor, beginning near St. Katarina in a depth of —17 m and near Montaura already in —13 m (Fig. 2). This detrital, sandy sea-floor is on both sides of the profile characterized by the biocenose I-6a with *Pitaria rudis*—*Tellina pulchella*, but in comparison with the same biocenosis on the profile XXVII K it is enriched by a conspicuously high number of *Cerithium vulgatum* and *Venus verrucosa*. Except these characteristic species, the quadrant No. 1 (—18) and partially also the quadrant No. 4 (—23) contained from living benthic organisms above all *Chiton olivaceus*, *Chlamys opercularis*, *Venus fasciata*, *Nucula nitida*, *Leda fragilis*, *Circe minima*, *Abra alba*, *Aloidis gibba*, *Turbonilla lactaea*, *Murex brandaris* and *Apporhais pes-pelecani*. The prevailing foraminifers on the quadrant No. 1 are *Ammonia beccari*, *Elphidium advenum*, *Elphidium crispum*, *Planorbulina mediterraneensis*, *Cibicides lobatulus*, *Cibicides boueanus* and *Textularia calva*. The lithologic component of the quadrant contains a large amount of redeposited Cretaceous and Paleogene foraminifers. The material from the quadrant No. 4 contains also a rich elphidio—ammonian association, with marked representation of species from the tribus *Miliolidae*.

From the viewpoint of its composition, a very interesting one and in the rest of the profiles of the Rovinj area in shallow depths (between —21 and —28 m) only sporadic is the occurrence of a deeper "infralittoral" ecosystem with the presence of the genera *Apporhais*, *Dentalium*, *Nucula* and *Leda* in the whole middle part of the profile. I cannot exclude the possibility of this being a bionomic equivalent of the transitory biocenose IC-1a (*Apporhais pes-pelecani* facies), enriched by benthic elements of the *Hippodiplosia* as well as *Tellina* ecosystem.

The quadrant No. 4 represents by its biological content already a transition to this muddy-detrital facies with *Apporhais*. This ecosystem is documented by

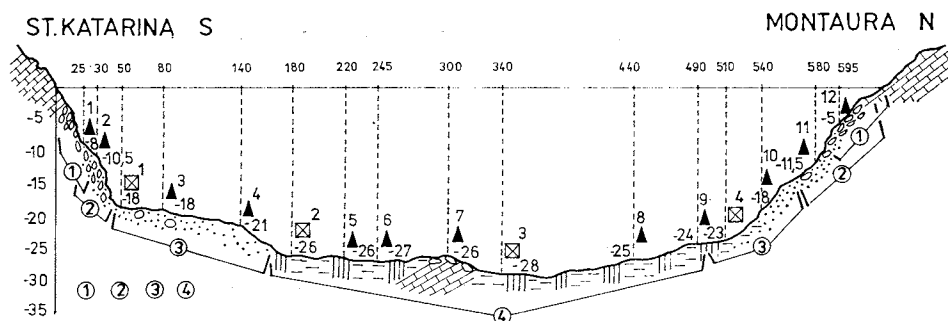


Fig. 2. Profile XXVIII, St. Katarina—Montaura.

Explanations: 1 — *Padina pavonia* + *Acetabularia* (I-1b), 2 — *Cymodocea* (I-7a), 3 — *Pitaria rudis*—*Tellina pulchella* (*Cerithium vulgatum*—*Venus verrucosa*) (I-6a), 4 — *Apporhais*—*Dentalium*—*Leda*—*Nucula* (I-?).

a more complete fauna on the quadrants No. 2 (—26) and 3 (—28). It is characterized except by *Apporhais* above all by *Dentalium dentale*, *Nucula nitida*, *Nucula nucleus*, *Leda pella*, *Leda fragilis*, *Cardium paucicostatum*, *Tellina pulchella*, *Tellina distorta*, *Aloidis gibba*, but the occurrence of the species *Scala communis*, *Turbonilla lactaea* and *Circe minima* is also not infrequent. From echinoderms the most frequently occurring ones are *Amphiura chiajei* and *Schizaster canaliferus*. From foraminifers the dominant ones are except *Ammonia beccari*, *Elphidium advenum*, *Elphidium crispum*, *Rotalia granulata*, *Nonion boueanum* also *Reussella spinulosa*, *Rosalina obtusa*, *Textularia calva*, *Textularia conica*, various species of *Miliolidae*, as well as evidently redeposited plankton, most frequently *Globigerinoides* div. sp. Ostracods are represented mostly by *Cythereis antiquata*, *Cythereis jonesi*, *Falunia turbida*, *Crithe similis*, *Calistocythere adriatica* as well as *Loxoconcha decipiens*.

Profile XV, Valmascim—Sturago (275 m)

The work on the profile was done in the year 1967, the reambulations in 1968 and again in 1971, because of an expected disturbance of the sea-floor by a strong inter-island current and orbital wave effects. The illustration and description corresponds to the situation in the year 1971. The profile connected the above-mentioned islands along a relatively shallow (max. —18 m), to physical effects exposed sea-floor (Fig. 3).

To a depth of —8 to —10 m the prevailing one is the facies with predominant *Padina pavonia*, less frequently the facies with *Acetabularia mediterranea* (I-1a, b). The more abundant species in this biocenose is above all *Gibbula divaricata*, a less abundant one *Gibbula varia*, *Cerithium rupestre*, *Pusia tricolor*. The occurrence of the red algae *Amphiroa rigida* is not rare. A more complete representation could be obtained from the quadrant No. 1 (—8) and station No. 9 (—5). For a complete list of organisms from this biocenose see Senes (1988b).

The quadrants 1a, 2, 2a and the stations 5 to 8 in depths between —8 and —18, especially those under —13 m, are characterized by a mass occurrence of the solitary red alga *Lithophyllum racemus*, lump-like in form. This species is probably ecologically connected with strongly moving water. In the whole North Adriatic Shelf region it occurs only in biotops exposed to a stronger current. This is most evident in the Rovinj region on very exposed terrains of inter-island channels. They almost never occur in biotops connected with more sandy, organodetrital or muddy environment without currents. Their occurrence is thus probably related neither to the depth, nor to the lithologic character of the sea-floor, but to the movement of water. For this reason I have classified their mass occurrence as a separate infralittoral biocenose denoted I-5c.

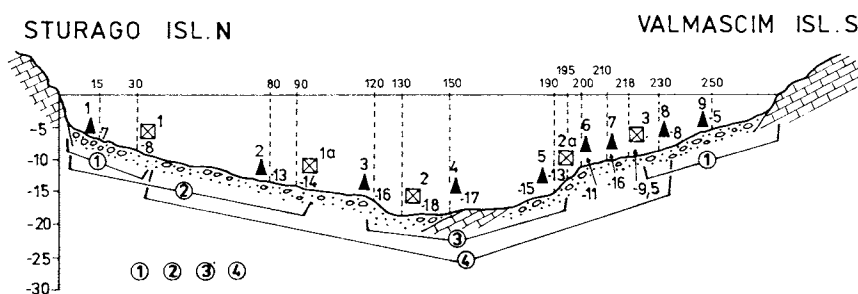


Fig. 3. Profile XV, Valmascim—Sturago.

Explanations: 1 — *Padina pavonia* + *Acetabularia mediterranea* (I-1a,b), 2 — *Cystoseira* (I-1c), 3 — *Udotea petiolata* (in the biocenose I-5c), 4 — *Lithophyllum racemus*.

Only few algae species occur sporadically in this environment. Considerably more abundant are *Mollusca*, above all *Murex trunculus*, *Arca noae*, *Arca teragona*, *Dosinia exoleta*, *Tapes rhomboideus*, *Donax variegatus* and *Psammobia depressa*. *Pecten jacobaeus* and *Anomia ephippium* occur in low numbers. Echinoderms are in this facies represented by relatively low numbers of *Echinocardium cordatum* and *Schizaster canaliferus*. From bryozoans only *Scrupocellaria reptans* has been determined. Small clusters of *Cladocora cespitosa* have been found sporadically.

Profile XVI., Sturago—St. Giovanni (435 m)

The work on the profile was done in June 1967. The profile was controlled and reambulated already in October of the same year and for the last time in the year 1971. The reason for the reambulation was similarly as on the profile XV, a strong inter-island current. The description and graphical representation of the profile reflects the character and extent of biocenoses in the year 1971 (Fig. 4). These are more complicated and variable than the biocenoses from the inter-island section between Valmascim and Sturago.

In the area of a shallow slope to a depth of —18 m, on a debris- and partly boulder-covered, coarse-arenaceous to gravel sea-floor there is except the fa-

cies with *Padina pavonia* (I-b) also an extensive *Cystoseira* growth (I-1c) with its typical accompanying fauna and flora. In deeper parts, on a more fine-arenaceous substrate, this facies is replaced by a thick field of the *Cymodocea nodosa* biocenose (I-7a), having quite clear borders. Standard biocenoses of the *Cystoseira* and *Cymodocea* ecosystems have already been presented in the description of profiles of the island Banjole (Seneš, 1988c) and as a part of the quantitative analysis of the Adriatic Shelf benthic biocenoses (Seneš, 1988b). Since they correspond to a considerable extent to the composition of ecosystems from the now presented profile, I do not consider it necessary to repeat here the list of their representatives. Nevertheless, I would like to stress the prevailing presence of *Cardium tuberculatum*, *Sphaerechinus granularis*, *Echinocyamus pusillus* and *Schizaster canaliferus*, as well as sporadic occurrences of *Dentalium dentale* and *Nucula nitida*.

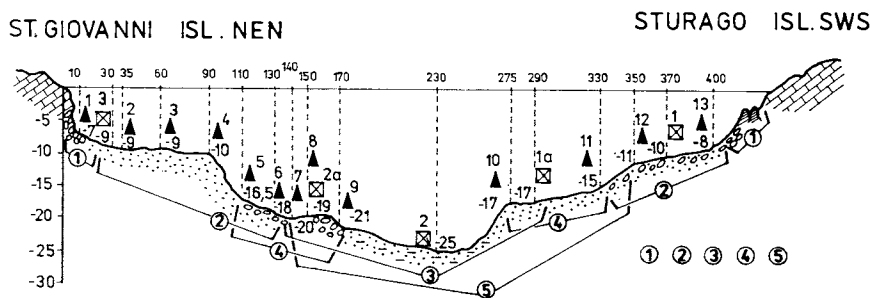


Fig. 4. Profile XVI, Sturago—St. Giovanni.

Explanations: 1 — *Padina pavonia* (I-1b), 2 — *Cystoseira* (I-1c), 3 — *Udotea petiolata* (in biocenose with *Pecten jacobaeus* and *Lithophyllum racemus*), 4 — *Cymodocea nodosa* (I-7a), 5 — *Pecten jacobaeus* (I-5a) + *Lithophyllum racemus* (I-5c).

The well-documented quadrants No. 2a (—19) and No. 2 (—25) show, mostly from —20 m deeper on, the occurrence of a common biocenose of *Pecten jacobaeus* and *Lithophyllum racemus* (I-5a + I-5c). Its biological content is attached to sandy, detrital-sandy sea-floor. Except the leading species, *Venus ovata* and *Schizaster canaliferus* occur here as well relatively frequently.

A noteworthy feature of these deeper horizons of the inter-island channels is the mass occurrence of Chlorophyta *Udotea petiolata*, on the profile XV as well as XVI. This suggests a possible dependence of the conditions optimal for this alga on a stronger current. However, we cannot exclude other, probably objective and partially perhaps unknown reasons for their mass occurrence, related to changes in population cycles, or e. g. to some effects of other macro- or microorganisms in these regions. Their abundant occurrence e. g. on the profile XXXVIII P, in substantially calmer conditions is namely at variance with the dependence of their mass occurrence on water current.

The following foraminifers have been found on the quadrant No. 2a: *Ammonia beccari*, *Ammonia perlucida*, *Rotalia granulata*, *Cassidulina subglobosa*, *Cibicides lobatulus*, *Cibicides boueanus*, *Elphidium advenum*, *Elphidium crispum*, *Gyroidina soldanii altiformis*, *Gyroidina* sp., *Rosalina* sp.

Profile XVII., St. Giovanni—Pelago (450 m)

The profile has been studied and sampled only in some of its sections. The work was done on two quadrants in the year 1967. This is one of the few profiles in the Rovinj region where the depth of shelf exceeds —35 m. Infralittoral descents relatively steeply on both sides of the profile, so that in comparison with other sections relatively little space was left for the development of phytal infralittoral with *Padina*—*Cystoseira*—*Sargassum*—*Cymodocea*. However, on the St. Giovanni section of the profile coarse-grained detrital sand occurs even in a distance of 80 m from the shore in a depth of —23 m. The here sampled quadrant provided nevertheless only few living organisms. The composition of thanatocenoses indicates that the biological content of the quadrant belongs to the biocenose I-5a (*Pecten jacobaeus*) corresponding thus to the lithologic and bathymetric conditions of the occurrence of this facies on other profiles (Fig. 5).

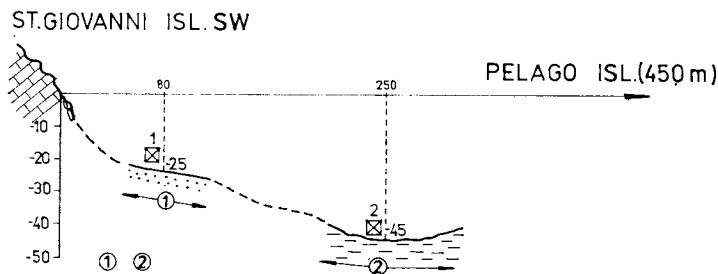


Fig. 5. Profile XVII, St. Giovanni—Pelago.

Explanations: 1 — *Pecten jacobaeus* (I-5a), 2 — *Scrupocellaria*—*Porella*—*Hornera* (C-1b).

The quadrant No. 2 was situated in the middle of the profile between the two islands in a distance of 250 m from St. Giovanni, on the lowest point of the profile, in a depth of —45 m. The sea-floor is on this section organodetrital-muddy and on a relatively large area there is a prevalence of bryozoans. This quadrant was determined as a type of the *Scrupocellaria*—*Porella*—*Hornera* biocenose (C-1b). The prevailing species of the community are *Scrupocellaria reptans*, *Porella cervicornis* and *Hornera frondiculata*. Except these bryozoans, *Modiolus barbatus*, *Venus ovata* and *Tapes rhomboideus* are dominant as well. Other prevalent extinct species are *Dentalium dentale*, *Nucula nitida*, *Leda fragilis*, *Lima hians* and *Gastrochaena dubia*. From foraminifers I would like to mention the common *Amonia*, *Elphidium*, *Nonion* and *Cibicides* div. sp., as well as *Planorbulina mediterraneensis*, *Textularia calva*, *Textularia conica* and *Rosalina obtusa*. Ostracods are represented only by a few specimens of *Krithe similis*, *Loxoconcha decipiens*, *Cathareis antiquata* and the planktonic species *Conchoecia spinirostris*.

Profile XXXVI., St. Giovanni — NW (300 m)

I mention this short, additional profile because it documents one of the most significant occurrences of eucoralligene in the studied North Adriatic Shelf region. The profile was made in the year 1971 and documented by 12 sampling stations. 7 typical shelf biocenoses have been determined (Fig. 6).

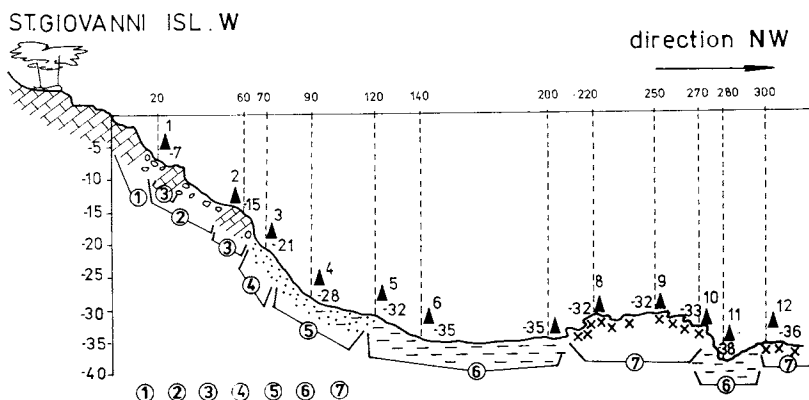


Fig. 6. Profile XXXVI, St. Giovanni — NW.

Explanations: 1 — *Padina pavonia* (I-1b), 2 — *Cystoseira* (I-1c), 3 — Infracoralligene (I-2a, b), 4 — *Cymodocea* (I-7a, b), 5 — *Pecten jacobaeus* (I-5a), 6 — *Hippodiplosia* (C-1a), 7 — Eucoralligene (C-4).

As far as lithology is concerned, a talus fan prevails to a depth of —20 m, often containing large boulders. The space between them is filled by finer fragmental material or coarse sand. In upper parts of this shore zone the prevailing one is the biocenose with *Padina pavonia* (I-1b), in lower parts the biocenose with *Cystoseira* (I-1c). I would like to mention that the shallow infralittoral phytal environment with *Sargassum* (I-1a) occurs in these inter-island regions south of Rovinj to a lesser extent than in the surroundings of the islands Banjole or Figarola where it occurs as a rule mixed or together with the biocenose with *Cystoseira*. The infralittoral sections of this profile characterized by boulders contain partially the biocenose with *Lithothamnium lenormandi*—*Halimeda tuna*—*Amphiroa rigida* (I-1e); on the station No. 2 (—15) there is already a prevalence of infracoralligene with *Lithothamnium* and *Pseudolithophyllum* (I-2a, b).

A narrower section under —21 m on a more or less sorted sandy substrate is covered by a sparse atypical *Cymodocea* growth (I-7a) passing gradually into a typical facies with *Pecten jacobaeus* (I-5a). The latter has been found on the station No. 4, in a depth of —28 m. Sandy sea-floor reaches as far as this depth, passing gradually in deeper parts into a detrital, partly even muddy-detrital one. The facies I-5a is reaching down to a depth of almost —32 m, where the biocenose with *Hippodiplosia foliacea* (C-1a) appears on a organo-detrital, muddy-fine arenaceous sea-floor. However, it is not characterized by the usual abundance of this leading species. On the profile it can be followed in a length of about 80 m, and it is reaching down to a depth of —35 m in

a distance of 200 m from the island. This development is documented by the stations No. 6 and No. 7 (—35 m) and it is characterized by the presence of almost all typical representatives of this biocenose. It appears once more on this profile, in the form of an islet on the lowest point (—38), in a distance of 280 m, where the sandy-muddy substrate is more organodetrital, evidently due to biological erosion of the surrounding eucoralligene.

Eucoralligene bioherms have developed here probably always on *Hippodiplosia* substrate, in the form of marked and varied elevations in depths between —32 and —36 m, in a distance of 210 m from St. Giovanni and further towards NW. They could be followed only to a distance of 320 m, but they continue to occur further in the direction of this profile. According to the character of other profiles in the Rovinj region we can assume that they alternate with the biocenose with *Hippodiplosia* or with a variety of *Hippodiplosia*—*Arca noae*. This eucoralligene (C-4) is on the profile documented by the stations Nos. 8, 9 and 10 (—32, —33 m) as well as by the station No. 12 (—36). Bioherms were formed above all by red calcareous algae — *Pseudolithophyllum expansum* and *Neogoniolithon mamillosum*, but some other species from the genera *Neogoniolithon*, *Peyssonnelia* and *Mesophyllum* are present as well. From green algae there are only sporadic *Halimeda tuna* and *Udotea petiolata*. Sciaphylic *Demospongiae* (*Silicospongiae*) occur especially on overhanging shadowed parts of the bioherms. From anthozoans only small groups of *Parazoanthus axinellae* and small *Cladocora cespitosa* clusters participate in the formation of eucoralligene. The surface of the eucoralligene is sometimes covered by *Caryophyllia clavus*. An important role in the strenghtening of the bioherms have the Polichaeta *Serpula vermicularis*, *Pomatoceras triqueter* and *Protula tubularia*. The bryozoans *Myriozeugum truncatum* and *Porella cervicornis* are not rare. Mollusca are abundant — vagile and endolithic forms directly on the bioherms and a part in the form of infauna in organogenic rhodophyte detritus around the bioherms. The most frequent ones are *Acmaea virginea*, *Gibbula magus*, *Vermetus arenarius*, *Cerithium vulgatum*, *Murex brandaris*, *Murex trunculus*, *Trophon muricatus*, *Nassa reticulata*, *Mitra eburnus*, *Arca barbata*, *Arca tetragona*, *Modiolus barbatus*, *Lima inflata*, *Lima hians*, *Anomia ephippium*, *Petricola lithophaga*. The occurrence of some echinoderm species on these bioherms is not rare.

Profile XXXV., Crveni Otok—Male Pirozi (460 m)

I shall mention this profile because it is a part of the inter-island series of profiles situated in the direction of the islands Male and Velke Sestrice, as well as because of the conspicuously concentrated occurrence of the tunicate *Phallusia mamillata*. The profile was made in 1972, in spring and autumn, but in both cases in unfavourable weather conditions. For this reason samples were collected from only 8 sampling stations, and no quadrants (Fig. 7).

The shallower part of the rocky, debris-covered, partially sandy infralittoral is on both wings of the profile characterized like everywhere in this region by the biocenose with *Padina pavonia* and *Cystoseira* and on shadowed sides of boulders sometimes with infracoralligene. It is reaching down to a depth of —10, —12 m. The lower infralittoral horizons of this profile (between —11 and —15 m) show and exceptional concentration of the *Halimeda tuna* growth, as

well as a thick settlement of *Myrionozoum truncatum*. A community of such a composition has not been observed on any other profile. This development was documented on the Crveni Otok section by the station No. 3 (—12) and on the Male Pirozi wing by the station No. 7 (—13).

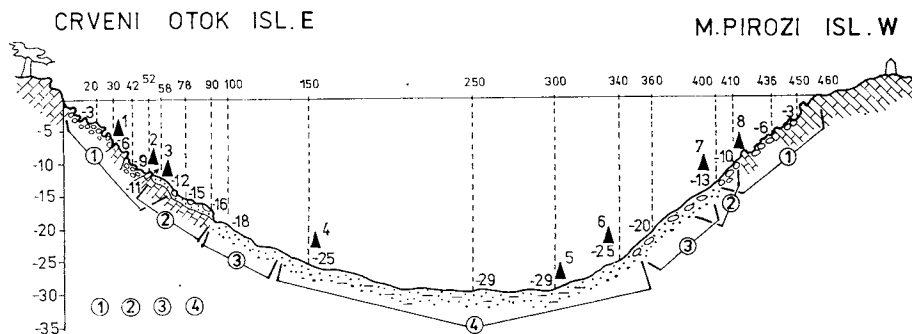


Fig. 7. Profile XXXV, Crveni Otok—Pirozi.

Explanations: 1 — *Cystoseira* (I-1c) + *Padina* (I-1b), 2 — *Infracoralligene* (I-2) together with *Halimeda tuna* + *Myrionozoum truncatum* 3 — zone with *Phallusia mamillata*, 4 — *Pecten jacobaeus* (I-5a) + *Glycymeris* (I-4b).

The specificity of this profile is even more conspicuous on the section in depths of —15 and —23 m, where *Phallusia mamillata* occurs in exceptionally large number on a fine- to coarse-arenaceous, detrital substrate (corresponding approximately to the most shallow part of the biocenose with *Pecten jacobaeus*). Mass occurrence of this species can be found on both wings of the profile. Such a thick settlement has not been observed on other profiles. The lower part of the profile between these bilateral tunicate zones is formed already by fine detrital sand (from —23 to —29 m) corresponding to the biocenose with *Pecten jacobaeus* (I-5a). However, in contrast to the majority of other profiles in the Rovinj area, it contains an enormous prevalence of *Glycymeris glycymeris*.

Profile XXXVII., Velke Pirozi—Mala Sestrica (3300 m)

This profile belongs to the most important ones from the viewpoint of the application of its thanatocenoses on fossil sediments. Lithologically as well as biologically it represents muddy circalittoral, probably equivalent to many fossil so-called “gray marly” and “Schlier” sediments. Of course, it is necessary to point out in advance the fact that the sediments of this profile have their origin in shallow circalittoral (max. —35 m) and they contain also benthic organisms which are in recent conditions attached usually to shallower horizons (e.g. *Turritella*) than the deeper lateral parts of “large” shelf slopes. The material from our profile also does not contain zooplankton in amounts typical of open shelves. Thus it is possible that the hereafter mentioned environment does not completely represent the paleotypes in geological literature denoted as “deep-neritic” or perhaps bathyal, corresponding perhaps to some Cainozoic “Schlieren”. However, this profile provided evidence in favour of the primary importance of the lithologic character and some other physical properties of the

environment for the composition of biocenoses, in contrast to the in the past much preferred factor of the dependence of benthic fauna on bathymetry.

The work on the profile was done in the years 1972 and 1973, on the infralittoral slope of Velke Pirozi on 9 stations and on the infralittoral slope of the island Mala Sestrica on 5 stations and one quadrant (No. S-300). Except the stations, 5 quadrants were laid out in depths between —32 and —35 m on the circalittoral plain between the islands.

The character of the whole length of the profile is schematically represented on Fig. 8; the lateral infralittoral parts of the island Velke Pirozi are depicted on Fig. 9. This island differs only by its steeper slope from the morphology, lithology, biocenoses and thanatocenoses of the slope on the other wing of the profile on the island Mala Sestrica.

Water current has not been measured, but a slow E-W motion was determined in the Pirozi infralittoral region. On the other hand, a strong current was observed almost in the whole length of the sandy infralittoral around the islands Sestrice.

The infralittoral slope attains on both sides of the profile a depth of —27, —30 m, with a very gentle descent. On the Velke Pirozi section the boulder-covered, deeper, sandy sea-floor attains a depth of —27, in a distance of 150 m from the island, on the Mala Sestrica side even 700 m from the shore. Because of this, the biocenose with *Cystoseira* accompanied by a frequent occurrence of *Vidalia volubilis*, *Arca noae* and *Venus gallina* is developed in the latter area on a wide sandy belt. An evidence of this can be found on the quadrant S-300 in the depth —15 m, in a distance of 300 m from the island.

In the coarse-detrital sandy infralittoral of Velke Pirozi in depths between —15 and —22 m, an approximately 70 m long belt with a very dense occurrence of *Udotea petiolata* could be observed. The density of growth of these green algae is similar to the inter-island channels Valmascim—Sturago and Sturago—St. Giovanni, even though in the time of our research no stronger current could be observed on this profile. The relatively dense occurrence of the green alga *Halimeda tuna* in the infralittoral of this island in depths from —3 to —20 m is also very interesting. Such density of this species is not known from other profiles near Rovinj. Deeper, flat infralittoral (—27 to —30 m, station No. 9) is on this profile represented in the facies of *Pecten jacobaeus* by abundant occurrence of *Glycymeris*, *Venus fasciata*, *Pitaria rudis*, *Cardium papillosum* and *Psammechinus microtuberculatus* (see also profile No. XXXV).

This deeper infralittoral “*Jacobaeus*” facies (I-5a) passes only gradually on both sides of the profile in depth of about —30, —32 m, into a more and more pelitic sea-floor. From a distance of 300 m SE of Velke Pirozi and approx. 730 m NW of Mala Sestrica, the sea-floor is formed everywhere by bluish or bluish-gray fine organodetrital mud. Ecosystems of this facies, denominated generally as “*Tellina—Aloidis—Turritella facies*” can be distinguished according to the prevalence of these leading genera on the individual sections of the profile, however, they do not have sharp boundaries and they pass one into another. It is indicated by the composition of living communities as well as thanatocenoses, collected and evaluated in the quadrants P-300, P-600, P-900, P-1400 and P-2000 (Fig. 8). As far as its area is concerned, the decidedly prevailing biocenosis is the one with the leading species *Turritella communis*—*Aloidis gibba* (C-3a) and with typical species *Scala communis*,

Apporhais pes-pelecani, *Nassa incrassata*, *Fusus rostratus*, *Entalina quinquangularia*, *Dentalium vulgare*, *Dentalium dentale*, *Dentalium rubescens*, *Nucula nucleus*, *Nucula nitida*, *Leda pella*, *Propeamussium hyalinum*, *Myrtea spinifera*, *Cardium paucicostatum*, *Abra nitida*, *Tellina pulchella*, *Tellina pulchella* ssp.?, *Angulus* sp., *Cultellus adriatica*, *Cuspidaria cuspidata*. From foraminifers, except allochthonous planktonic forms, the prevailing ones are here also the representatives of the genera *Ammonia*, *Elphidium*, *Nonion*, *Cibicides* and *Textularia*. Less frequent are *Miliolidae*, further the species *Rosalina obtusa*, *Reussella spinulosa*, *Gyroidina soldani*. Redeposited Cretaceous and Paleogene forms, such as *Globigerina triloculinoides*, are also not missing.

In the middle part of the profile documented by the quadrant P-1400 the biocenose with the leading role of *Aloidis gibba* taken over by *Turritella communis* and especially by *Myrtea spinifera* (C-3b) becomes more significant. The biocenosis with a prevalence of *Leda fragilis* and *Tellina pulchella* or *Tellina* div. sp. (C-3c) starts to appear further on towards the island Mala Sestrica. Other typical and accompanying species of the biocenoses 3b and 3c are basically identical with the composition of C-3a; the most marked differences are in the quantitative representation of leading forms.

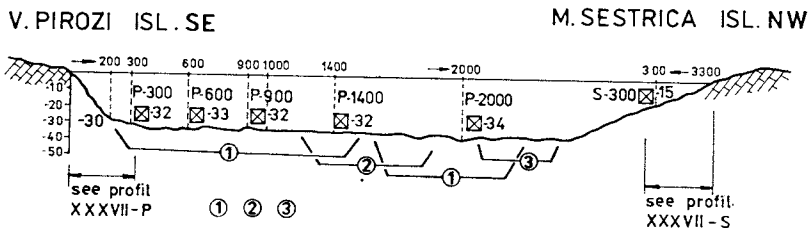


Fig. 8. Profile XXXVII, V. Pirozi—M. Sestrica.

Explanations: 1 — *Turritella communis*—*Aloidis gibba* (C-3a), 2 — *Turritella communis*—*Myrtea spinifera* (C-3b), 3 — *Leda fragilis*—*Tellina* div. sp. (C-3c).

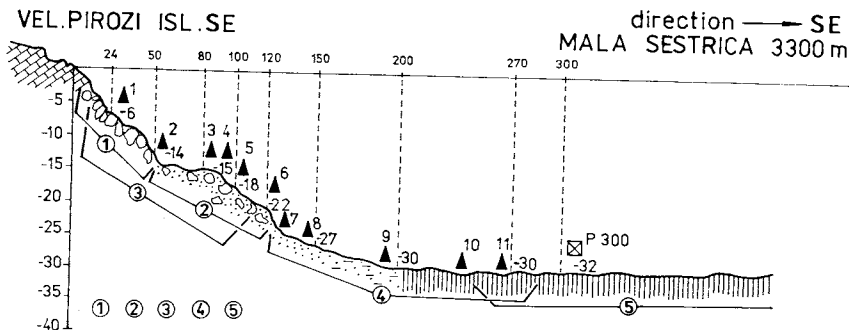


Fig. 9. Profile XXXVII-P, V. Pirozi—direction M. Sestrica.

Explanations: 1 — *Padina pavonia* (I-1b), 2 — *Udotea petiolata*, 3 — *Halimeda tuna*, 4 — *Pecten jacobaeus* (I-5a) + *Glycymeris* (I-4b), 5 — *Turritella communis*—*Aloidis gibba* (C-3a).



Fig. 10. Slope debris covered mostly by the brown alga *Padina pavonia* (I-1b) on the profile XV between the islands Valmascim and Sturago, in a depth of —5 m near the station No. 9.

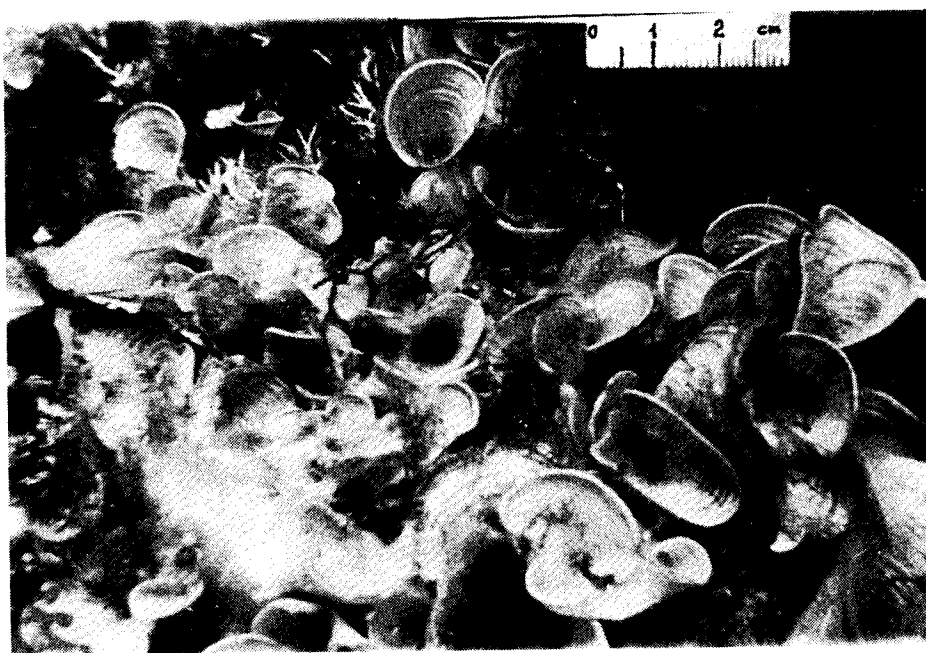


Fig. 11. Detail from the biocenose *Padina pavonia* on the profile XV, station No. 9 (—5). In the upper part of the picture there are sporadic ramified bushes of the red alga *Amphiroa rigida*.

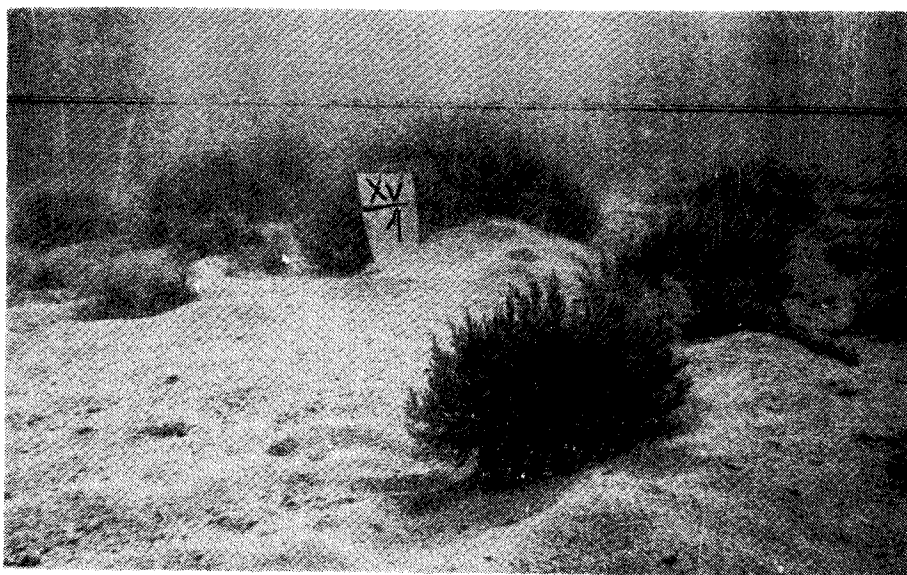


Fig. 12. The site of the quadrant No. 1 on the profile XV before sampling. In a shallow depth —8 m on a coarse-sandy sea-floor there are marked ripple marks formed by wave orbits. They are only slightly bound by a sparse *Cystoseira* growth. On the right side we can see projections of slope debris covered above all by *Padina pavonia* and *Acetabularia mediterranea*.



Fig. 13. Quadrant No. 2 on the profile XV in the depth —18 m. The coarse-sandy, often by fragments of slope debris varied sea-floor is characterized above all by nodules of the red alga *Lithophyllum racemosus*.

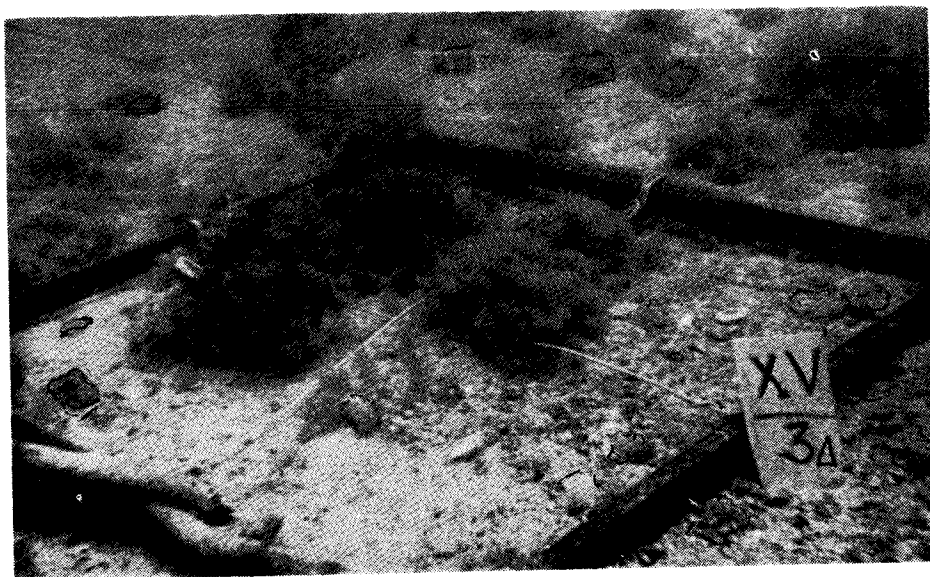


Fig. 14. Station No. 3 on the profile XV (—16 m) shows a sparse *Cystoseira* growth, but above all a thanatocenosis of benthic fossilizable molluscs and a more dense occurrence of *Lithophyllum racemus*.

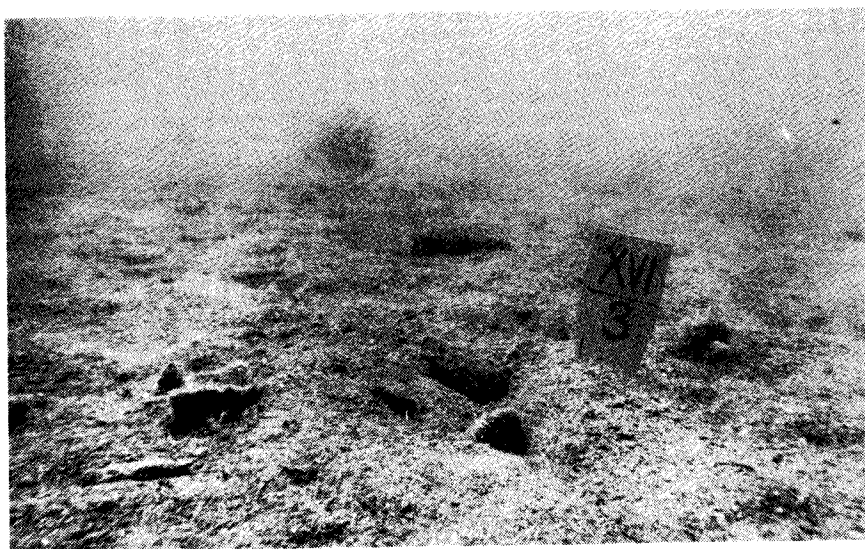


Fig. 15. The site of the quadrant No. 3 on the profile XV before sampling. Its depth is —9 m in a distance of 30 m from the shore of the island Valmascim. The coarse-sandy sea-floor is marked also by fragments of slope debris *Epibios* of the environment in strongly flowing water is very poor. The for this depth otherwise typical *Cystoseira* growth appears in the same depth a little further from the shore, near the station No. 2.



Fig. 16. Exceptionally dense field of the biocenose with *Cymodocea nodosa* (I-7a) on a gently sloping profile No. XVI in depths between —16 and —20 m. Station No. 6. The environment is exposed to a very strong inter-island current.



Fig. 17. Very sparse *Cymodocea* growth in the biocenose I-5c on coarse organodetrital substrate near the station No. 9 (—21 m) on the profile XVI. The abundant occurrence of the characteristic *Lithophyllum racemus* is on the picture marked by black arrows.

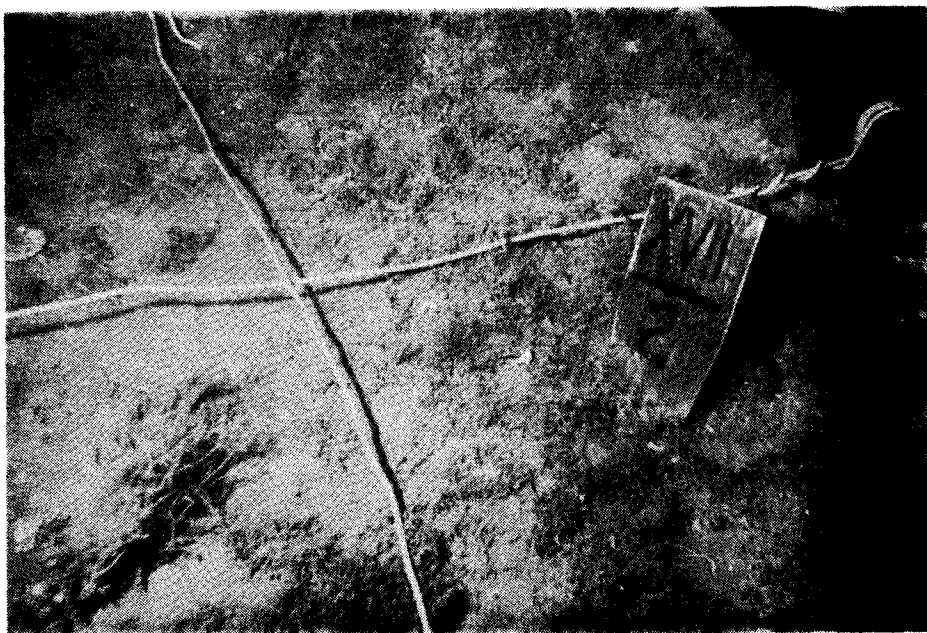


Fig. 18. Part of the quadrant No. 2 on the profile XVII between the islands St. Giovanni and Pelago in a depth of —45 m. The biocenose C-1b is represented above all by bryozoan epifauna of *Scrupocellaria reptans*, *Porella cervicornis*, and *Hornera frondiculata*. The in the facies C-1a dominant *Hippodiplosia foliacea* is almost completely missing.

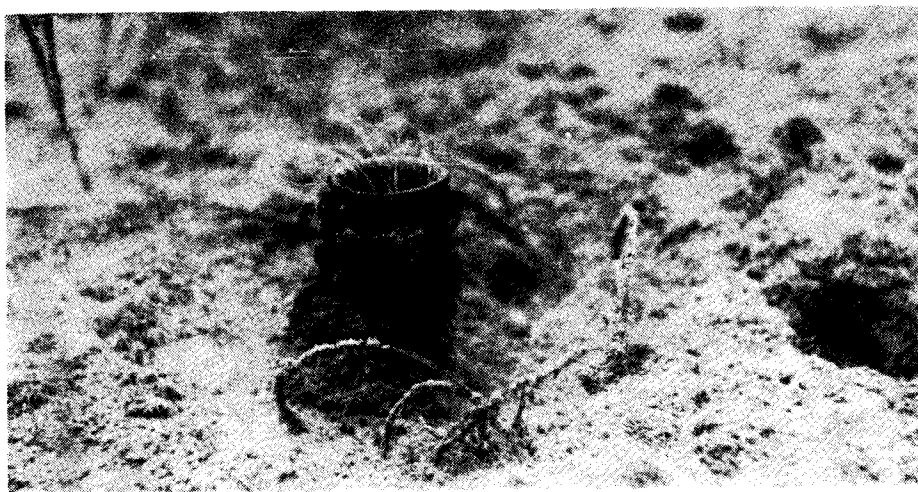


Fig. 19. *Cerianthus membranaceus* on detrital-sandy substrate in the environment of the biocenose with *Pecten jacobaeus* + *Glycymeris glycymeris* on the profile XXXVII-P, near the station No. 7 (—26 m).



Fig. 20. Typical development of an extensive submarine field of the grass *Cymodocea nodosa* (facies I-7a, b), frequently settled by *Pinna nobilis*. Profile XXXVII-S, near the station S-300, in the depth —16 m.

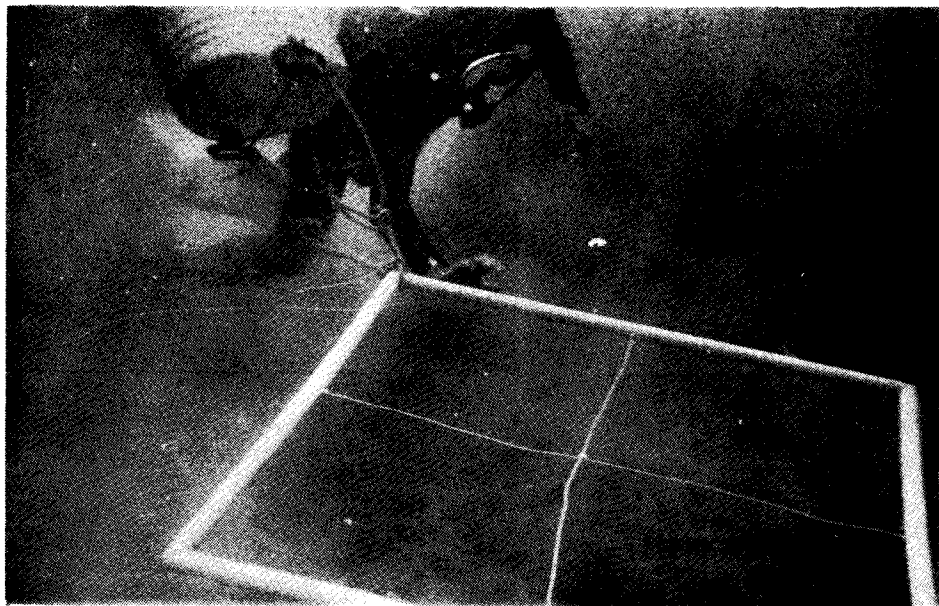


Fig. 21. Transport of a quadrant for sampling of the locality No. 1 on a plateau between the stations No. 4 and 5. (Profile XXVII in the depth —14 m).

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Table 1

Textural and mineralogical composition. Profiles XVI and XXVIII (Fejdiová, 1972)

Sample Composition		Profil XVI/2a	Profil XXVIII			
			Q.1	Q.2	Q.3	Q.4
Mean	M	0.2		1.6	5.9	0.9
Sorting	SI	1.62		2.5	1.4	1.5
Asymetry	Sk _I	0.09		-0.02	0.3	0.16
Kurtosis	K _G	0.37		0.0	0.8	1.3
CaCO ₃		98.63	93.67	40.6	51.0	98.60
Mineral composition	chlorite	+	+		+	+
	biotite	+		+		+
	muscovite	+	+	+	+	
	garnet	+	+	+	+	+
	rutile	+	+	+	+	+
	epidote	+	+	+		
	amphibole	+	+	+		+
	pyroxene	+	+		+	+
	glauconite			+		+
	ilmenite		+	+	+	+
	leucoxene					
	apatite					
	chromite					
	cinnabarite					
	bauxite		+	+	+	+
	zircon					
	corundum					
	tourmaline					
	magnetite	+				
	mocrys. quartz					
	carbonates	+				
Resulting sediment		coarse sand	gravel coarse sand	fine sand	clay	coarse sand

In four contributions published recently in this journal I have presented analyses of the benthic components of biotops and thanatocenoses from the studied North Adriatic Shelf regions. In the last two papers I have described those profiles of the broader Rovinj region leading through infra- and circalittoral parts of the sea-floor which are best applicable in the reconstruction of the origin of fossile sediments.

As far as the South Adriatic Shelf ecosystems and biocenoses are concerned, I intend to deal with them in a separate paper. I shall try to analyse them from the point of view of actuoecology and actuopaleontology (actuoecology, facial analysis), as well as to describe some of the studied profiles especially from the southwestern part of the Pelješac peninsula infra- and circalittoral.

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