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Marine fauna of Mljet National Park (Adriatic Sea, Croatia) 2. Echinodermata

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Echinoderms of Mljet National Park from all kinds of environments were reviewed. Research was carried out during the summers from 1995 to 2002 at 63 sites by SCUBA and skin divers to a maximum depth of 58 m. At 21 deep stations, specimens were collected by a Van VEEN grab. At 6 sites, echinoderms were obtained from commercial trammel bottom sets or lobster pots. Earlier published records were reviewed and old collections were examined. In total, 53 species and one ecophenotype were recorded. General distribution, depth range, habitat and ecological notes are listed for each species. The morphology, behaviour and distributional patterns are discussed for a number of species. Specimens of Holothuria *sp. cf.* mammata, Arbaciella elegans, *and* Brissopsis *aff.* mediterranea *are described in detail and illustrated. Echinofauna of Mljet National Park is less diverse than in some other Adriatic Sea areas.*

Key words: Echinodermata, national park, Mljet Island, Adriatic Sea, zoogeography

INTRODUCTION

The Mljet National Park was established in 1960 with the aim of protecting the luxurious Aleppo pine (*Pinus halepensis*) forests that grow in the northwestern part of an island famous for its geological phenomena (BRALIĆ, 1990). The marine environment had not been included, except for two karstic depressions flooded by a sea and known as Veliko and Malo Jezero (Great and Small seawater lakes). In January 1996, the limits of the national park were extended 500 meters into the sea, only after our preliminary research (BELAMARIĆ *et al.*, 1995). The present paper deals with echinoderms collected in Mljet National Park.

Few areas in the eastern part of the central and southern Adriatic Sea have been the subjects of echinological studies. HELLER (1863) provided the first report on echinoderms from the Hvar and Vis Islands. KOLOSVÁRY (1938b) and BRUNO (1972) studied echinoderms in Boka Kotorska Bay. ZAVODNIK (1977a, b) reported on echinoderms from Vir Island, the Murter Sea, and Kornati National Park. Information on echinoderms collected in central or southern Adriatic offshore localities was provided by MARENZELLER (1895), LEIDENFROST (1917),

KOLOSVÁRY (1937, 1940), VATOVA (1949), GAMULIN-BRIDA (1972), SALVINI-PLAWEN (1972a, b; 1977) and ŠIMUNOVIĆ (1997).

Until now, few reports on echinoderms in the study area have been published. BABIĆ (1913) reported on three starfish species (i.e. *Astropecten bispinosus, Asterina gibbosa* and *Hacelia attenuata*) collected at Mljet Island and deposited at the Zagreb Natural History Museum. Much later, records were published on *Holothuria tubulosa* by VATOVA (1950), on *Hacelia attenuata* by GAMULIN-BRIDA (1963a, b) and VIDOVIĆ-MATVEJEV (1978), and on *Leptopentacta elongata* by PANNING (1966). In a short note on the benthos of Veliko Jezero by VIDOVIĆ (1955), no echinoderms were recorded. The 1956 collection of Mrs. I. MUNDA of *Astropecten aranciacus, A. platyacanthus* and *A. spinulosus* from Malo Jezero was recorded by ZAVODNIK (1988). In 1980, DRAGANOVIĆ reported on 9 echinoderm species collected at 7 stations in the Jezera seawater lakes and at one station on the southern coast of Mljet Island. Unfortunately, the thesis of DRAGANOVIĆ was never published and made accessible to the scientific community, except for records of macroflora summarized by ANTOLIĆ *et al.* (1995). Targeted research programmes on the macrobenthos were undertaken by the Institute of Oceanography and Fisheries in Split (ZORE-ARMANDA & ALAJBEG, 1995) and its Department in Dubrovnik, but no echinoderms were included in the published papers (VIDOVIĆ, 1955; MOROVIĆ, 1958; ONOFRI & MARGUŠ, 1995; ŠIMUNOVIĆ, 1995; PEHARDA *et al.*, 2002a, b). However, some excellent colour photographs of echinoderms in the Mljet National Park were reproduced in a guidebook by ANDRIĆ (1999).

In 1995, a trial coastal survey of macrobenthos in the Mljet littoral was carried out (BELAMARIĆ *et al.*, 1995). Since then, field trips have been undertaken every year until 2002 by the Thais Society for Exploration and Conservation of Nature, Zagreb, and the Center for Marine Research of the Ruđer Bošković Institute, Rovinj, Croatia. As few incidental data on echinoderms appear elsewhere (BELAMARIĆ *et al.*, 1995; OREPIĆ *et al.*, 1997; KRUŽIĆ, 2001; ŠILETIĆ & PEHARDA, 2003) and a diver's account (MIKAC, 2001) has not been prepared for publication, the aim of the present paper is to provide a full account of the known Echinodermata fauna of Mljet National Park.

INVESTIGATED AREA

Mljet National Park encompasses the land and near-shore waters of the western part of the Mljet Island (BRALIĆ, 1990). Fifteen islets and reefs scattered in the area are included. Along the northern coast, i.e. between Polače village and Kula Cape, four islets (Moračnik, Ovrata, Tajnik, and Kobrava) encircle a channel-like part of the sea, about five kilometres long. This channel, the Jezera seawater lakes, the Soline Channel, and part of the Pomena village environs are the only well-sheltered calm waters surveyed. Other coastal areas of Mljet National Park are fully exposed to the open sea, especially when waves are generated by the three most characteristic Adriatic Sea winds: the bora, the schirocco (jugo) and the maestral (MILETA *et al.*, 1995; SIJERKOVIĆ & MILKOVIĆ, 1995).

Mljet Island, the encircling islets and reefs offer a great variety of topographic and geomorphologic features (BOGNAR & CURIĆ, 1995; RIĐANOVIĆ & ŠIMUNOVIĆ, 1995). The land and submarine landscape vary from gently inclined slopes to vertical walls, and to a more or less flat sea bottom in deeper waters. The submarine cliffs are much more impressive than those on land. At Vanji Školj Islet, Lenga and Rastupa Capes, and Moračnik and Ovrata Islets, the vertical submarine cliffs reach a depth of about 40-80 m. At a greater depth, the cliffs give way to a moderately sloping sedimentary bottom which, at the survey sites, extends to a maximum depth of 72-112 m. Deposits consist mainly of coarse or fine sand rich in shell debris. Within the national park boundary, sand containing a greater amount of silt is distributed

only along the south part and in the Jezera seawater lakes. The geological past and recent geomorphologic and sediment features of the lakes and Soline Channel are described elsewhere (VULETIĆ, 1953; SEIBOLD, 1958; CIMERMAN *et al.*, 1988; BOGNAR & CURIĆ, 1995; JURAČIĆ *et al.*, 1995, 1998; OREPIĆ *et al.*, 1997; WUNSAM *et al.*, 1999; GOVORČIN *et al.*, 2001; PEHARDA *et al.*, 2002a).

The hydrography of the coastal sea of Mljet National Park is little known (BULJAN & ŠPAN, 1976; ZORE-ARMANDA *et al.*, 1991). According to our database at the end of July 1995, the transparency of the sea measured with a white SECCHI disc near the southern coast was 25-27 m; the surface temperature was 23.0-23.5°C; the temperature at 48 m (near the bottom) was 13.8°C; the thermocline occurred at a depth of 13-15 m. However, in October 1985, the thermocline occurred at 30-35 m (CIMERMAN *et al.*, 1988). More complete hydrographical data are available for the sheltered areas of Polače Cove (BENOVIĆ *et al.*, 1995) and the Jezera seawater lakes (ERCEGOVIĆ, 1935; BULJAN & ŠPAN, 1976; BENOVIĆ & ONOFRI, 1995; CARIĆ & JASPRICA, 1995, 1998; BENOVIĆ *et al.*, 2000). CVIIĆ (1955, 1960) reported on the "red water" phenomena. Occasionally, H_2S (BULJAN, 1956) and short term hypoxic and anoxic conditions have been recorded in the bottom layers of Veliko Jezero (CIMERMAN *et al.*, 1988; BENOVIĆ *et al.*, 2000).

There are three villages (Goveđari, Polače and Pomena), two hamlets (Babine Kuće and Soline), a population of about 400 (RIĐANOVIĆ & ŠIMUNOVIĆ, 1995), a limited amount of tourist accommodations, yacht moorings and anchorages in Mljet National Park. As household waste is not treated, slight organic pollution was noted in the Sv. Marija Islet and Babine Kuće areas (DRAGANOVIĆ, 1980). Anthropogenic waste accumulated in some places. In general, however, the sea off Mljet Island is sparkling clear.

In the past, the sea around Mljet Island was not a popular area for biological research (ZAVODNIK, 1995b). Partial information on benthic communities in the national park was provided by VIDOVIĆ (1955), DRAGANOVIĆ (1980), BELAMARIĆ *et al.* (1995), OREPIĆ *at al.* (1997), and KRUŽIĆ (2001). CIMERMAN *et al.* (1988) and VANIČEK *et al.* (2000) analysed benthic foraminiferal assemblages at Lenga Cape and in the Jezera seawater lakes. Organisms in core samples were recorded by GOVORČIN *et al.* (2001). Recent research by students of Zagreb University and members of the Thais Society on peculiar taxocoenes and benthic communities (VIDMAR *et al.*, 1996; VIDMAR & RADIŠA, 1997, respectively), resulted in about ten B.Sc. theses. In accordance with PÉRÈS & PICARD (1964), eleven communities of recent macroflora and macrofauna were noted. Everywhere in the supralittoral and midlittoral zones, communities characteristic of Mediterranean rocky shores were noted. Widely distributed communities in the infralittoral and circalittoral zones present several facies, or aspects, of the biocoenosis of photophilic algae, coralligenous biocoenosis, meadows of sea grasses *Posidonia oceanica* and *Cymodocea nodosa*, and communities characteristic of coarse sandy and sandy-detrital deposits. While lists of marine flora and fauna have been compiled for several sites or stations, and some interesting details at attractive sites within the park boundary are available in a divers' manual (OSTOIĆ, 2000), no comprehensive analysis of any Mljet marine benthic community has yet been published.

MATERIAL AND METHODS

Most of the research was carried out by skin and SCUBA divers along 100 m transect lines, perpendicular to the shore. Sixty-three sites were surveyed to a maximum depth of 58 m, one to eight times each during the summers of 1995-2002 (Fig. 1, Table 1). Two to nine divers participated in each survey. During night dives, research did not focus on echinoderms. Cave and creek environments were not prospected.

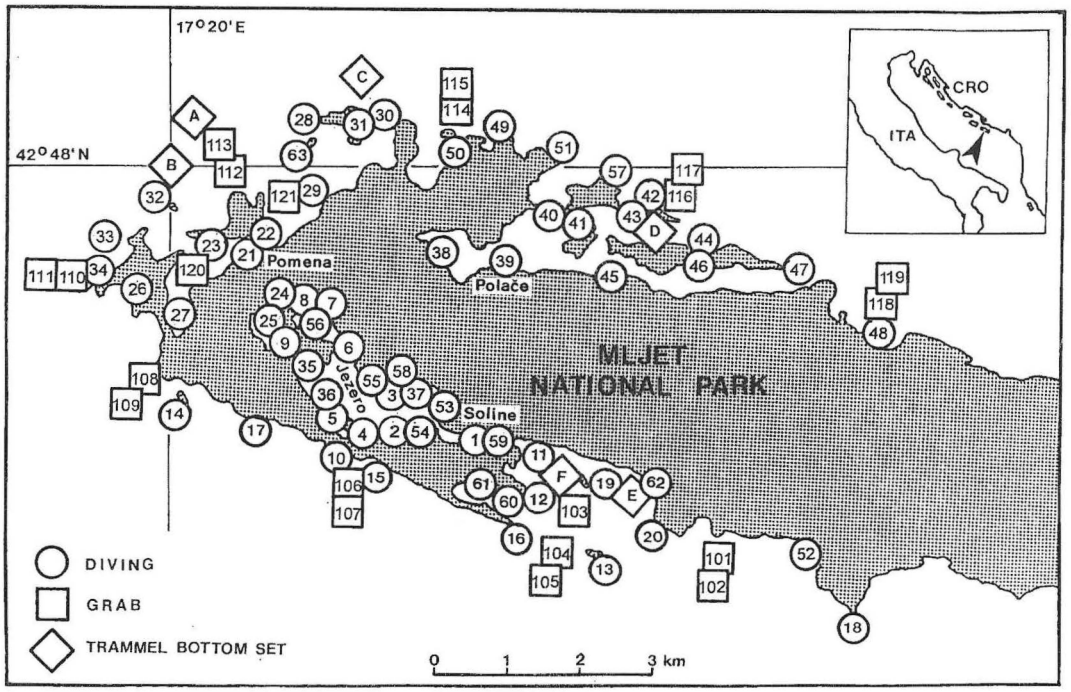

Fig. 1. Research area and surveyed stations

Table 1. Diving stations (MLJ-).Relief codes: c - cove; i - islet. Bottom type codes: D - organogenic detritus, shell litter; G - gravel, pebbles; M - mud, silt; R - rock; S - sand. Community codes: Alg - algal associations; Cor - coralligenous community; Cym - Cymodocea nodosa meadow; Det - communities of detrital sand; Pos - Posidonia oceanica bed

Station MLJ-No.	Locality	Bottom slope type	Bottom	No. surveys	Depth (m)	Dominant communities
1	Solinski kanal	gentle	GRS	4	0-3	Alg, Cym
2	c. Kavalo	gentle	DMRS	3	0-28	Alg, Cym, Det
3	Sladingradac cape	gentle	GRS	2	0-34	Alg, Det
4	Praćarica	gentle	GMRS	3	0-4	Alg, Cym
5	i. Sv. Marija	gentle	RS	4	0-8	Alg, Cym
6	Babine kuće	gentle	RS	1	0-28	Alg, Det
7	Punta od Gočuha	gentle	RS	1	0-11	Alg, Cym
8	Malo Jezero channel	plain	GRS	1	0-1	Alg
9	Malo jezero	gentle	MRS	4	0-20	Alg, Cym
10	Gornja Zakamenica	steep	GRS	1	0-28	Alg, Cor, Pos
11	Vratosolina	gentle	GRS	4	0-23	Alg, Pos
12	Srednji rat (cape)	steep	R	2	0-9	Alg
13	i. Vanji Školj	steep, cliff	R	10	0-48	Alg, Cor
14	i. Štit	steep	RS	6	0-42	Alg, Cor, Pos
15	Velika Priveza	cliff	R	2	0-40	Alg, Cor
16	Lenga cape	cliff	RS	10	0-57	Alg, Cor
17	Zavrti	steep, cliff	R	2	0-32	Alg, Cor

Table 1. cont'd.

18	Tojsti cape	steep	GR	1	0-40	Alg, Pos
19	i. Utrnji Školj	gentle	GR	2	0-15	Alg, Pos
20	Hljeb cape	gentle	R	3	0-7	Alg, Pos
21	c. Pomena	gentle	GRS	5	0-11	Alg, Pos
22	Sikjerica cape	gentle	GR	8	0-7	Alg, Cym, Pos
23	i. Galijica	gentle	GRS	2	0-8	Alg, Pos
24	c. Pod Mala Poma	gentle	GRS	1	0-6	Alg, Cym
25	Glavica od Mosta (cape)	gentle	DMRS	1	0-23	Alg, Cym, Det
26	c. Lastovska	gentle	GRS	1	0-3	Alg, Pos
27	c. Lokva	gentle	MRS	2	0-16	Alg, Pos
28	i. Glavat (W)	steep	GRS	2	0-44	Alg, Cor, Pos
29	Debeli rat (cape)	steep	GRS	1	0-47	Alg, Cor, Pos
30	Glavat cape	gentle	RS	1	0-45	Alg, Cor, Det, Pos
31	i. Glavat (E)	gentle	GRS	3	3-20	Alg, Pos
32	i. Crna seka donja	gentle	RS	1	0-43	Alg, Pos
33	i. Šij	gentle	R	1	0-4	Alg, Pos
34	Goli rat (cape)	gentle	GRS	1	0-24	Alg, Cor, Pos
35	c. Prieža	gentle	RS	2	0-8	Alg, Cym
36	Podvrti	gentle	DMRS	1	0-42	Alg, Det
37	Velo Jezero	plain	MS	2	45-47	Det
38	c. Polače (Gundulišta)	gentle	GRS	1	0-13	Alg, Cym, Pos
39	c. Polače (Debela Ponta)	gentle	RS	2	0-30	Alg, Cym, Pos
40	Rat Lenga (cape)	gentle	RS	1	0-16	Alg, Pos
41	Tijesno	gentle	RS	3	0-32	Alg, Cor, Pos
42	i. Ovrata (N)	steep, cliff	GRS	1	0-45	Alg, Cor, Det
43	i. Ovrata (W)	gentle	GRS	3	0-23	Alg, Pos
44	i. Kobrava (N)	steep	RS	1	0-57	Alg, Cor, Pos
45	Tatinica	gentle	RS	1	0-29	Alg, Det
46	i. Kobrava (S)	gentle	RS	1	0-40	Alg, Det, Pos
47	i. Kula	gentle, cliff	GRS	1	0-40	Alg, Cor, Pos
48	c. Vela Tatinica	gentle	RS	1	0-45	Alg, Cor, Det, Pos
49	Zazupci cape	steep, cliff	R	2	0-58	Alg, Cor
50	c. Stupe	gentle	GRS	1	0-40	Alg, Det, Pos
51	Rastupa cape	steep, cliff	R	3	0-45	Alg, Cor
52	c. Procjep	gentle	GRS	3	0-42	Alg, Pos
53	Veli Most (N)	gentle	RS	4	0-27	Alg, Cor, Det
54	Veli Most (W)	gentle, steep	GMRS	1	0-35	Alg, Det
55	c. Pristanište	gentle	GRS	2	0-18	Alg, Cym, Det
56	c. Njivice	gentle	RS	2	0-13	Alg, Cym
57	i. Moračnik (N)	steep, cliff	GRS	2	0-45	Alg, Cor
58	c. Vrbovačka	gentle	MS	1	5-20	Cym
59	Solinski kanal	gentle	GRS	2	0-2	Alg, Cym
60	c. Velike Blace	gentle	GR	2	0-17	Alg, Pos
61	c. Male Blace	gentle	GRS	1	0-6	Alg, Cym
62	Vranje garme	gentle	GR	1	0-5	Alg, Pos
63	Crna seka i.	gentle	DRS	1	35	Det

At 21 stations, sediment was collected using a 0.1 m² Van VEEN grab (Fig. 1, Table 2). Two or three replicates per station were taken. In the Jezera seawater lakes and Polače Channel, where the grab could not be employed with success, sediment was collected with a ZAHTILA sampler handled by divers (OREPIĆ *et al.*, 1997).

Occasionally, echinoderms were caught by trammel bottom nets or lobster pots set by fishermen (Fig. 1, Table 3) or in the course of "clean up actions" in the crude anthropogenic wastes at Soline Channel, Hotel Melita (Sv. Marija islet) and Pristanište Cove. At nine stations no echinoderms were recorded. As it was impossible to study the seasonal dynamics of

Table 2. Grab stations (MLJ-). Bottom type codes: G - gravel, pebbles; M - mud, silt; R - rock; S - sand

Station MLJ-No.	Depth (m)	Bottom type	Surface (m²)	Sediment volume (l)	Remark
101	60	S	0.3	5	*Spongites fruticulosus*
102	83	S	0.2	30	
103	49	S	0.2	10	Shells
104	104	MS	0.2	50	
105	110	SM	0.2	50	
106	101	SM	0.2	50	Bryozoan debris
107	103	MS	0.2	50	
108	99	R	0.3	0	
109	102	MS	0.1	25	Bivalvian shells
110	64	R	0.2	0	
111	65	R	0.1	0	
112	70	S	0.2	14	
113	68	S	0.1	15	*Lithothamnion* debris
114	82	SM	0.2	50	
115	86	M	0.2	50	
116	87	SM	0.2	50	
117	89	M	0.2	29	
118	85	SM	0.2	50	Fragment of amphora
119	87	SM	0.1	25	Small shells
120	39	MS	0.2	16	
121	70	SM	0.2	20	

Table 3. Localities of trammel bottom set surveys

Station (MLJ-)	Locality	Depth (m)	Bottom type	Number of surveys
A	1 Nm W Glavat i.	70-80	Detrital Sand	2
B	500 m N Crna seka donja i.	70-80	Detrital Sand	1
C	500 m NE Glavat i.	60-80	Detrital Sand, Rock	1
D	S Kobrava i.	54	Detrital Sand	1
E	Utrnji školj i.-Vranje garme	10-45	Gravely Sand with *Posidonia*, Rock	4
F	Srednji rat - Utrnji školj i.	30-50	Rock	1

the echinoderm populations, this report focuses on qualitative, not quantitative, data.

All sampling sites (stations) were given the arbitrary code MLJ to differentiate them from other stations in the Adriatic Sea.

At diving sites, large echinoderms were collected by hand. Tiny organisms inhabiting seaweed thalli and seagrass leaves and stems were extracted later macroscopically or using a dissecting microscope. Sediment-living animals were extracted by sieving sediment through 2 and 1 mm sieves.

Specimens were dried or preserved in 70% alcohol or 4% buffered formol solution. Final processing and taxonomic studies were carried out in the Laboratory for Ecology and Systematics of the Center for Marine Research, Ruđer Bošković Institute (CMRR), Rovinj, Croatia. Voucher specimens and slides with mounted holothurian ossicles were deposited in the CMRR collection. In this paper, specimen catalogue numbers are quoted only for some specimens. Taxonomic nomenclature based on ERMS (HANSSON, 2001) and the biocoenological terminology of PÉRÈS & PICARD (1964), PÉRÈS (1967) and BELLAN-SANTINI *et al.* (1994) is used.

SYSTEMATIC ACCOUNTS

Class CRINOIDEA Miller, 1821

Order: **COMATULIDA A.H. Clark, 1908**

Family: **Antedonidae Norman, 1816**

***Antedon mediterranea* (Lamarck, 1816)**

STATIONS: MLJ-13, 14, 16, 17, 21, 28, 30, 31, 41, 45-50, A, B (about 100 individuals recorded by divers, 12 specimens collected).

DEPTH: 10-80 m.

HABITAT: Algal assemblages, *Posidonia oceanica* and *Cymodocea nodosa* meadows, and assemblages of encrusting organisms.

ECOLOGY: Species with a wide ecological distribution (PICARD, 1965). Common in *Posidonia* beds, exposed especially during the night when gathered on tips of seagrass leaves. Rare on bare outcrops.

REMARKS: Only red specimens were noted at the surveyed sites. A detailed morphometric population analysis was not performed but individual variation was noted. For example, in the specimen collected at 60-70 m by a bottom trammel net west of Glavat Islet (station MLJ-A), the calyx diameter was 7.3 mm and cirri (XXXV) were rather short with the outer cirri being only 10-13 mm. Except for one cirrus, all curled dorsally (Fig. 2A). Cirri comprised 15-19 segment, which were centrally constricted and compressed laterally in the distal half, differing in shape to those characteristic of *Antedon bifida*. Terminal claws had an opposing spine that ranged from pointed to blunt (Fig. 2B). The breadth of the Ibr1 was about three times the length. The Ibr2 was almost right-angled and triangular (Fig. 2D), similar to specimens of TORTONESE (1976a) from Messina and Milazzo, and described by CLARK & CLARK (1967) in *A. adriatica* which they were inclined to consider (p. 262) a subspecies of *A. mediterranea*. The centro-dorsal plate was usually low hemispherical (Fig. 2C), unlike in *A. adriatica* f. *petasoides* described by KOLOSVARY (1937, 1938a). The high number of cirri and Ibr1 structures, however, were consistent with the species *A. adriatica* (but see remarks by A.M.C. in CLARK & CLARK, 1967: 262). Other morphometric features were characteristic of *A. mediterranea*: the convex bare pole of the centro-dorsal and arrangement of cirri sockets, the number of segments in the distal cirri 17-24 (usually 20-22), P1 12-18 (8-10.5 mm long), P2 8-10 (5-6.5 mm long), P3 7-10 (4-6 mm long). The suggestion that *A.*

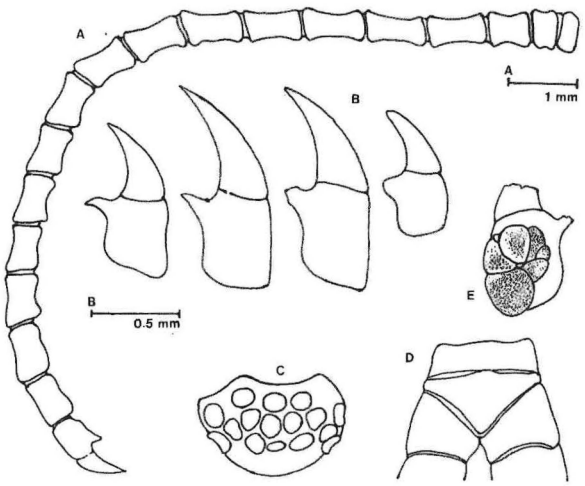

Fig. 2. Antedon mediterranea. *A = cirrus; B = terminal claws; C = centrodorsale plate; D = IBr2; E = an epizoic foraminiferan settled on a terminal cirrus claw*

adriatica is synonymous with *A. mediterranea* (KOEHLER, 1927; TORTONESE, 1965, 1976a; A. M. CLARK in CLARK & CLARK, 1967; ZAVODNIK, 1977a) appears to be justified. No myzostomid polychaetes were noted on inspected *Antedon* specimens. In the specimen described above, a planorbulid foraminiferan had settled on a slightly damaged terminal cirrus claw (Fig. 2E).

Class HOLOTHUROIDEA de Blainville, 1834

Order: ASPIDOCHIROTIDA Grube, 1840

Family: Holothuriidae Ludwig, 1894

Holothuria (Holothuria) helleri Marenzeller, 1878

STATIONS: MLJ-11, 17, 22, 29 (4 specimens collected).

DEPTH: 9-35 m.

HABITAT: Not noted by divers.

ECOLOGY: The ecological significance of the species was not defined. In the Adriatic Sea, individuals have been collected only in the seaweed canopy and beneath loose stones in the upper infralittoral zone (MARENZELLER, 1878; TORTONESE, 1965, 1984a; ZAVODNIK, 1990, 1997b).

REMARKS: Specimens preserved in alcohol were 32-45 mm long. All tables were characteristically high, slender and spired (KOEHLER, 1927; PANNING, 1935a; TORTONESE, 1965; IBAÑEZ & SALO, 1975). Smooth rimmed discs were most common; only a few were knobbed or subspinose, as figured by ZAVODNIK (1997b).

Holothuria (Holothuria) stellati Delle Chiaje, 1823

STATION: MLJ-1 (1 specimen).

DEPTH: 2 m.

HABITAT: Well-sorted sand under strong tidal currents occupied by a sparse *Cymodocea nodosa* meadow.

REMARKS: *H. stellati* is frequently either not recognized or misidentified as *H. tubulosa* (PANNING, 1934; TORTONESE, 1965; GUSTATO & VILLARI, 1980). Accordingly, the species ecological preferences, and its distribution in the Adriatic Sea are unclear.

Holothuria (Holothuria) tubulosa Gmelin, 1788

STATIONS: MLJ-1, 2, 4-8, 11, 14, 19, 21-30, 32, 34-36, 38-48, 50, 52-55, 57-59 (more than 400 individuals recorded, about 30 specimens collected and studied).

DEPTH: 1-43 m.

HABITAT: Abundant on all kinds of sandy deposits. Occasionally noted on narrow cliff shelves covered by a thin layer of sandy deposit. At station MLJ-53 in the Velo Jezero inlet, it was noted frequently between stone coral (*Cladocora caespitosa*) colonies. In Babine Kuće (station MLJ-6) and the Pristanište area (MLJ-55), large specimens were hidden in waste tins, jugs, containers, etc.

ECOLOGY: Species with a wide ecological distribution (PICARD, 1965; MASSIN & JANGOUX, 1976; ZAVODNIK, 1979b).

Holothuria (Holothuria) sp. cf. *mammata* Grube, 1840

STATIONS: MLJ-45, 46 (2 specimens collected by Mrs. B. MIKAC. Anatomical analysis completed by C. MASSIN).

DEPTH: 20-25 m.

ECOLOGY: The diver did not describe the habitats of these specimens in detail. Specimen No. 1 was collected from an enclave of well-sorted detrital sand mixed with shell litter and isolated rocks in a bed of dense Neptunegrass (*Posidonia oceanica*) accompanied by *Rytiphloea tinctoria, Axinella damicornis, Petrosia ficiformis, Balanophyllia europaea, Cerithium vulgatum,* and *Pecten jacobaeus.* Specimen No. 2 was collected from silty detrital sand characterised by *Vidalia volubilis* and accompanied by *Rytiphloea tinctoria, Tethya aurantium, Suberites domuncula, Balanophyllia europaea,* and *Pecten jacobaeus.* Patches of precoralligenous community and *Posidonia oceanica* stems were recorded in the station area.

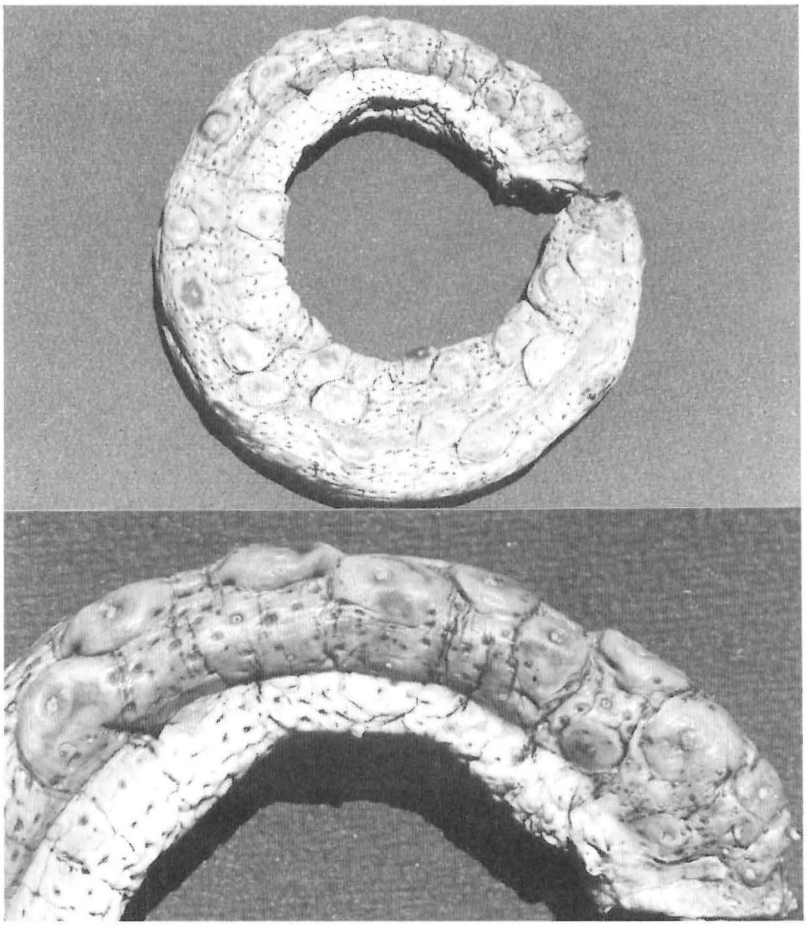

Fig. 3. Holothuria *sp. cf.* mammata. *Specimen No. 1 (IRSNB IG.29494). Above: Side view of a specimen preserved in alcohol (L 190 mm). Below: A detail*

DESCRIPTION OF SPECIMEN NO. 1. Collected at station MLJ-46 near the southern shore of Kobrava Islet on 1 July 1997. Body wall cylindrical, slightly flattened ventrally; living specimen 277 x 28 mm, preserved in alcohol 190 x 15 mm. Colour of bivium similar to milky coffee, trivium lighter beige, persistent in alcohol. On the bivium, large mamillate papillae or warts 5-9 mm across, 2.5-4 mm high, arranged more or less in three longitudinal rows (Fig. 3). The mamillate papillae end in a conical point less than 1 mm high, slightly buried in the centre of the papilla, white with a light brown or orange tip. Between the mamillate papillae, small papillae (retracted in the preserved specimen) appear as dark brown or blackish dots on a brown-beige background. Ventrally, rather sparse tube feet, 1-2 mm apart, are present in ambulacral and interambulacral areas. Mouth is subterminal, tentacles 19, yellowish beige. Anus is terminal, dark brown, encircled by five tufts of 3-5 anal papillae.

The calcareous ring with radial plates twice the length of the interradial plates is very similar to those in *Holothuria tubulosa*. Three Polian vesicles and 18 short stone canals (8 on the right side of the dorsal mesentery and 10 on the left). Tentacular ampullae are 1/14 of body length. Cloaca is large, 27 mm x 6 mm. Specimen autoeviscerated and only the right respiratory tree and part of the gonads remained in place. Thus, the presence or absence of Cuvierian tubules could not be ascertained.

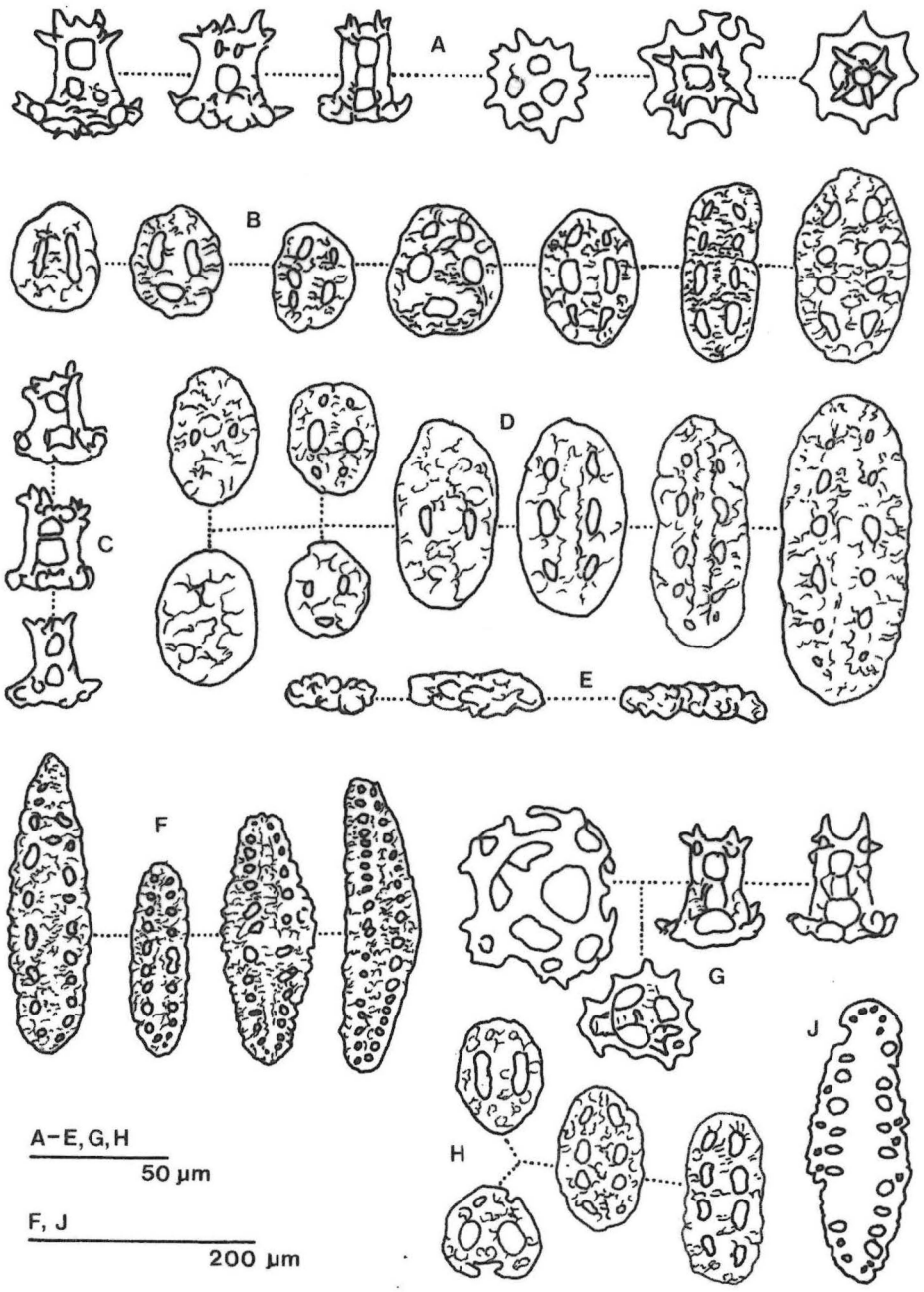

Fig. 4. Holothuria *sp. cf.* mammata *ossicles. Specimen No. 1. Dorsal body wall: A = tables; B = buttons. Ventral body wall: C = tables; D = buttons; E = buttons from side; F = long buttons. Mamillate warts: G = tables; H = buttons; J = perforated plate*

Ossicles in body wall tables and buttons (Fig. 4). Dorsal tables with discs 31-55 µm across and spires 31-53 µm high. Ventral tables rather rare, 24-44 µm across and 27-32 µm high. The edge of the disc spinose: disc perforated by four large central holes and 4 pillars forming the spire, usually with 2 cross beams ending in a crown of blunt spines. Body wall buttons (Fig. 4B,D) ranging from small (subcircular not perforated or with 2-6 holes mostly paired) to large (oval to ellipsoidal with 6-12 pairs of holes). The buttons are knobbed giving the ossicles a fairy rugose appearance, clearly visible from the side (Fig. 4E). Small buttons

are 25-56 μm long and much more numerous ventrally than dorsally. Large dorsal and ventral ellipsoidal buttons are similar in size: 60-111 x 31-50 and 54-114 x 31-48 μm, respectively. Some very long buttons are present: 155-260 x 50-83 μm (Fig. 4F). Perforated plates are rare and 200-220 μm long (Fig. 4J).

In the dorsal mamillate papillae there are buttons and tables similar to those of the body wall and large perforated rods (195-310 μm; Fig. 5A). In the ventral tube feet there are perforated plates (117-330 μm long; Fig. 6D), rods (220-280 μm long; Fig. 6E), buttons (80-280 μm long), tables similar to those of the body wall (Fig. 6A-C) and a terminal plate (about 420-500 μm across; Fig. 6F). Tentacles have rods only (Fig. 5B-E). Thick giant spiny rods are 410-530 μm long, navicular, 130-150 μm wide at the middle, very rugose and spiny with numerous small holes concealed or obliterated in part by the thickening of the rod. Large rods are thick, elongate, rugose or spiny, 225-490 μm long, 45-60 μm wide, not perforated or only with a few small holes along the edges. Medium rods are thick, straight or slightly curved, 160-230 μm long, 15-28 μm wide, rugose, with 1-3 holes at both extremities. Small rods (early developmental stage) are 108-200 μm long, curved, with a few spines and without terminal

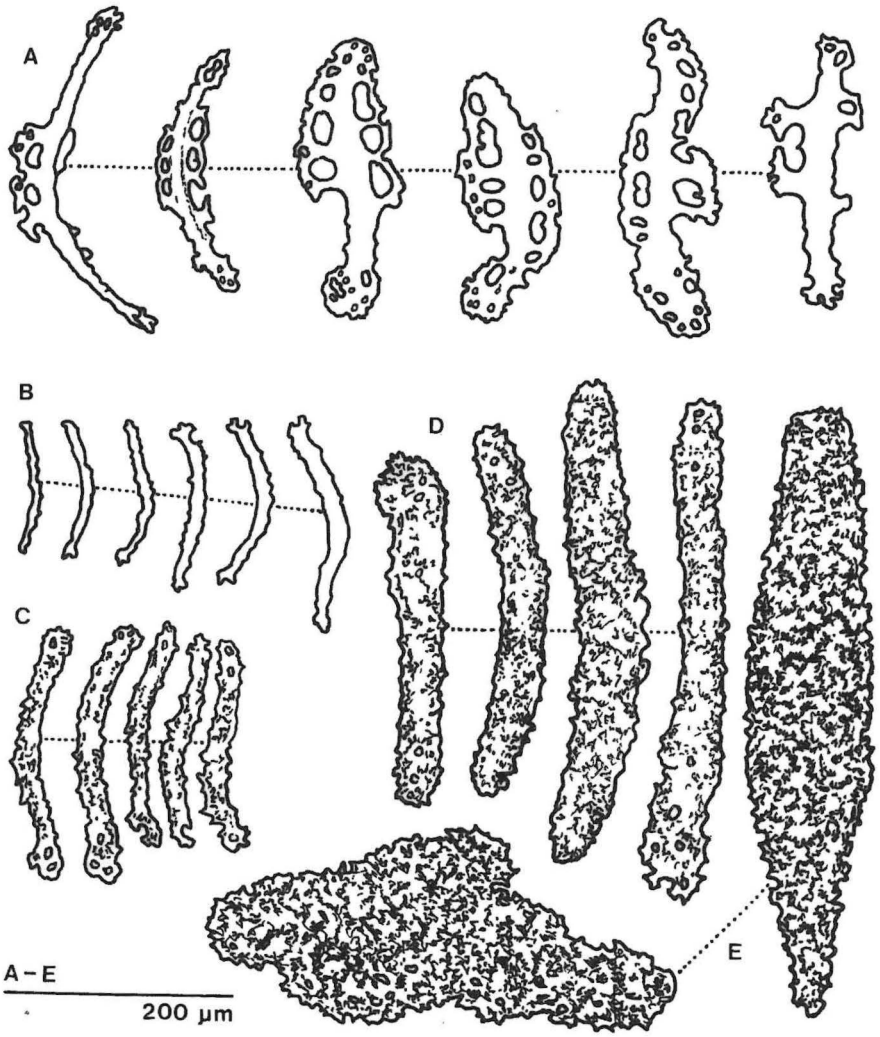

Fig. 5. Holothuria *sp. cf.* mammata *ossicles. Specimen No. 1. Dorsal papillae: A = rods. Tentacle rods: B = small rods; c = medium rods; D = big rods; E = giant rods*

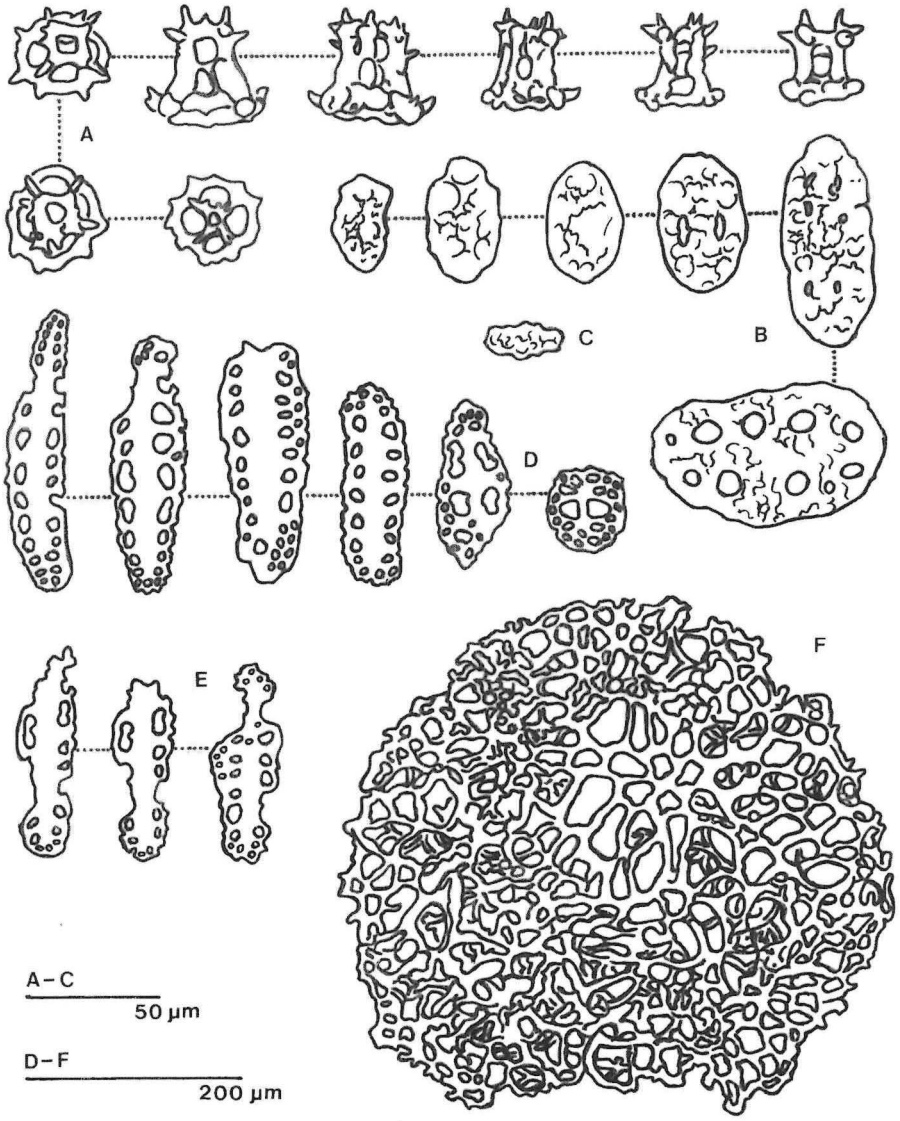

Fig. 6. Holothuria *sp. cf.* mammata *ossicles. Specimen No. 1. Ventral tube feet: A = tables; B = buttons; C = button from side; D = perforated plates; E = rods; F = terminal plate*

holes. This specimen is deposited in the Belgian Royal Institute of Natural Sciences in Bruxelles, Belgium (IRSNB IG.29494).

DESCRIPTION OF SPECIMEN NO. 2. Collected at station MLJ-45 in the Tatinica area on 3 Aug 1997. Specimen preserved in alcohol measuring 140 x 32 mm (Fig. 7). Body wall cylindrical, flattened ventrally. Bivium light brownish similar to milky coffee. Trivium whitish with a median milky coffee longitudinal stripe that stretches from the tentacles to the anal area, dark brown. Dorsally, large mammilate papillae or warts are dome-like, 8 mm across, arranged in mutual contact or a maximum of 3 mm apart. In the anterior part of the body, papillae are elliptical, separated or arranged contiguously. In lateral rows, papillae are arranged irregularly or some rows are irregular or incomplete. Colours of papillae and their tips are similar to those in specimen no. 1. Tube feet about 1-2 mm apart, 40-60 per square cm. Tentacles and tube feet brownish. One Polian vesicle and 20

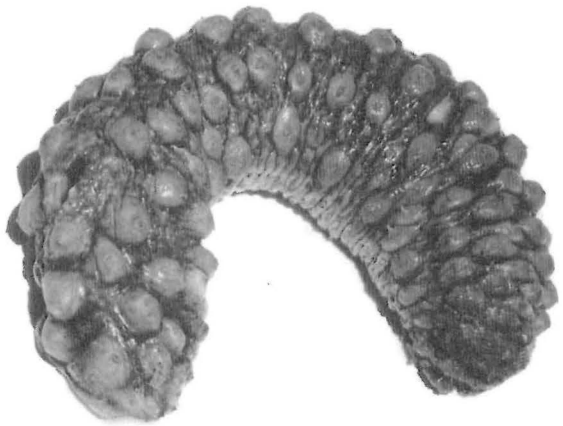

Fig. 7. Holothuria *sp. cf.* mammata. *Specimen No. 2 (CMRR 2290). Dorso-lateral view of a specimen preserved in alcohol (L 140 mm)*

(12 + 8) stone canals. Cloaca oblong, 15 mm long. Specimen autoeviscerated leaving respiratory tree and part of gonad in place. The presence of Cuvierian tubules could not be ascertained.

Ossicles in body wall similar to those in specimen no. 1. Buttons, more or less knobbed with, at most, 3-4 pairs of holes. In mammilate warts, buttons 18-40 mm long, rugose, many with a median ridge (Fig. 8A). Buttons with 3-4 pairs of holes were a dominant type. In large dorsal papillae rods (180-300 mm long), lateral wing-like extensions were absent or narrow or incomplete or had few perforations (Fig. 8C).

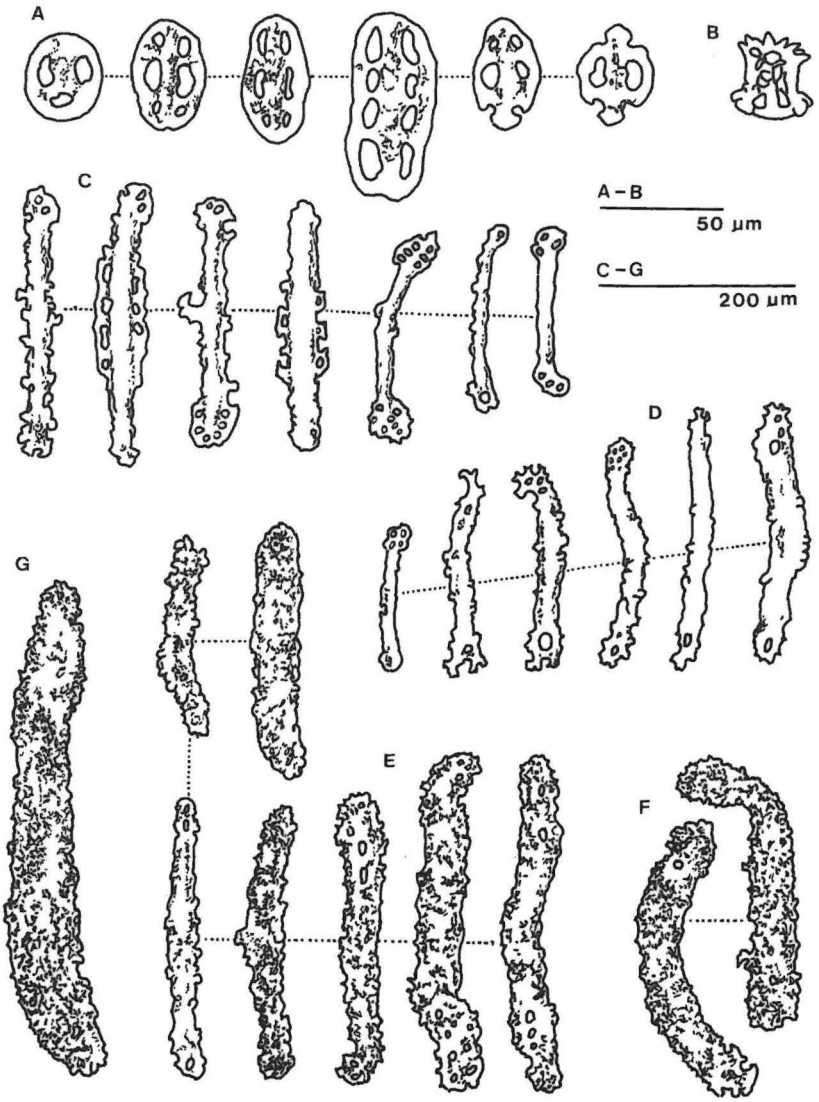

Fig. 8. Holothuria *sp. cf.* mammata *ossicles. Specimen No. 2. Mamillate warts: A = buttons; B = table. Dorsal papillae: C = rods. Tentacle rods: D = medium rods; E = big rods; F = curved big rods; G = giant rod*

Both ends of rods were perforated or massive. Tentacles provided by very rugose large slender rods (210-360 μm; Fig. 8E). Curved rods (Fig. 8F) and giant rods (Fig. 8G), rugose, about 500 μm long, were rare. Medium rods, 125-270 μm, more or less smooth, not rugose, with knobs along their body and 1-6 perforations at both ends (Fig. 8d). In the ventral tube feet, tables were similar to those in the body wall, 40-50 μm high and same across (Fig. 9A). Buttons (100-215 μm long) in general with paired perforations (Fig. 9B), Suboval, elongated, perforated smooth plates, 90-220 μm long (Fig. 9C). Rods had perforations along the ridge and at both extremities (Fig. 9D). The terminal plate had small subcircular perforations, 500 μm across (Fig. 9E). This specimen is deposited in the Center for Marine Research in Rovinj, Croatia (CMRR 2290).

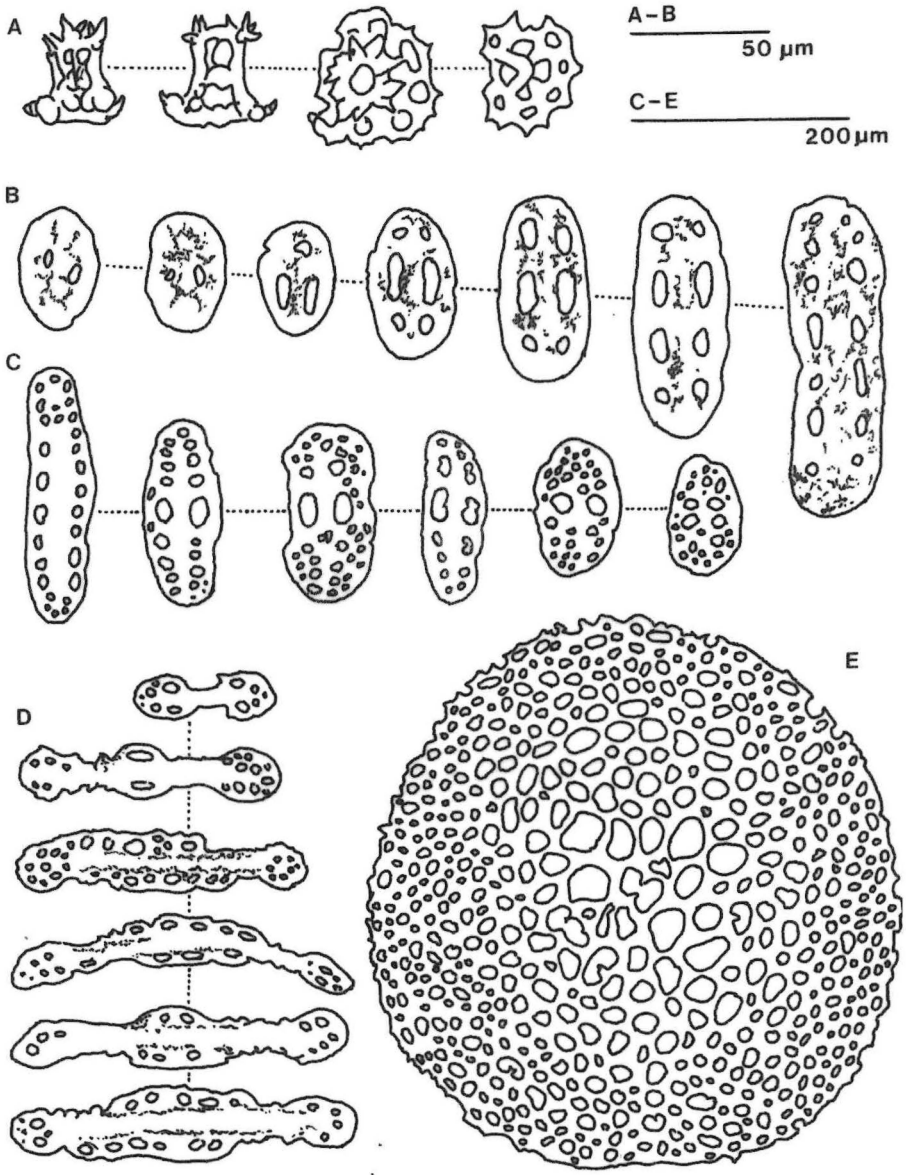

Fig. 9. Holothuria *sp. cf.* mammata *ossicles. Specimen No. 2. Ventral tube feet: a = tables; b = buttons; c = perforated plates; d = rods; e = terminal plate*

REMARKS: The studied specimens present a problem. In external appearance and anatomical structure they are not identical. The specimens differed in many characters such as body wall colour pattern, arrangement of the large dorsal papillae, lateral perforations in the large ossicles of the dorsal papillae, perforation patterns in the tube feet ossicles and terminal plates. Externally, both specimens look like *H. mammata* illustrated by KOEHLER (1921) and NOBRE (1938). Large prominent mamillate warts and sparse well-separated ventral tube feet support identification as this species. In contrast, the large size of the studied specimens, their pigmentation, rather thick skin, large cloacae and high number of Polian vesicles and stone canals do not fit the description of *H. mammata* (LUDWIG, 1880; KOEHLER, 1927; CHERBONNIER, 1960; TORTONESE, 1965). Variation in stone canals and number of Polian vesicles has long been known in *Holothuria tubulosa* (MARENZELLER, 1874) and this may be the case in *H. mammata*. Regrettably, the most significant character, i.e. the presence or absence of Cuvierian tubules, could not be ascertained due to autoevisceration of the specimens. The study of ossicles, in particular in specimen no. 1, resulted in a rather confusing mixture of ossicles characteristic of *H. mammata* and ossicles characteristic of *H. stellati*. Ossicles in the studied specimens were rather senescent and the form and size of the dorsal buttons were, in general, more similar to those in *H. stellati* (F.W.E. ROWE, personal communication). However, characteristic ellipsoidal buttons with a median ridge (GUSTATO & VILLARI, 1980) and pyramid-like ossicles described by PANNING (1939) in *H. stellati mammata* were not found in my specimens. Tables were less numerous than recorded by CHERBONNIER (1960) in specimens 50-95 mm long. The difference probably can be attributed to the process of age metamorphosis of spiculation noted in many holothurians (ROWE, 1969; MASSIN, 1994; CUTRESS, 1996), i.e., an increase in the number of buttons and decrease in number of tables with increasing body size. A close affinity of ossicles in the three congeneric species, *H. tubulosa*, *H. stellati* and *H. mammata*, led PANNING (1939) to recognize only *Holothuria stellati* with four subspecific taxa *stellati*, *tubulosa*, *mammata* and a newly described *dakarensis*. Despite the fact that most authors treat *stellati*, *tubulosa*, *mammata* and *dakarensis* as valid species (KOEHLER, 1927; PANNING, 1934; CHERBONNIER, 1950, 1960; TORTONESE, 1965; ROWE, 1969; GUSTATO & VILLARI, 1980), the studied specimens, once again, shed doubt on their status as species. Although the taxa concerned can be recognized by the relative abundance and size of the ossicles (ROWE, 1969) and *H. mammata* is distinguished by the presence of Cuvierian tubules, specimens pertaining to this taxonomical group have often been misidentified because of confusion in recognizing (sub)specific characters (CHERBONNIER, 1956; TORTONESE, 1965). For this reason, in accordance with the personal suggestions of F.W.E. ROWE and C. MASSIN, identification of the specimens from Mljet Island and their systematic position will remain in doubt until comparable non-eviscerated specimens from the study area are available.

Both specimens were collected from about the same depth in the northern part of Mljet National Park at neighbouring stations MLJ-45 and MLJ-46. A detailed description of the holothurian microhabitat at the collection sites was not available. However, general features of the sediment and accompanying benthic flora and fauna in the area suggest that my specimens prefer a coarse grained sediment, as CHERBONNIER (1960) suggested for *H. mammata*. This species has rarely been recorded in the western Mediterranean (GRUBE, 1840; LUDWIG, 1880; CARUS, 1895; PANNING, 1939; CHERBONNIER, 1960; CHERBONNIER & GUILLE, 1967; LOPEZ-IBOR *et al.*, 1982; TORTONESE, 1984a; PEREZ-RUZAFA & LOPEZ-IBOR, 1988; RINELLI, 1998; Fig. 10). In the eastern Mediterranean, it was recorded in Cyprus (HADJICHRISTOPHOROU *et al.*, 1997) and seems common in the Aegean Sea (KOUKOURAS & SINIS, 1981; PANCUCCI-PAPADOPOULOU, 1996). In the Adriatic Sea, this species was found near Rovinj (SELLA & SELLA, 1940, det. A. PANNING), at Triest (TORTONESE, 1965) and in the area of Puglia (UNGARO, 1995). I believe that *H. mammata* is rare in the Adriatic Sea. Amongst the

many thousands of holothurians I have noticed during forty years of skin and SCUBA diving, I have not recorded any specimens whose external appearance and size (at least) conform to the typical *H. mammata*.

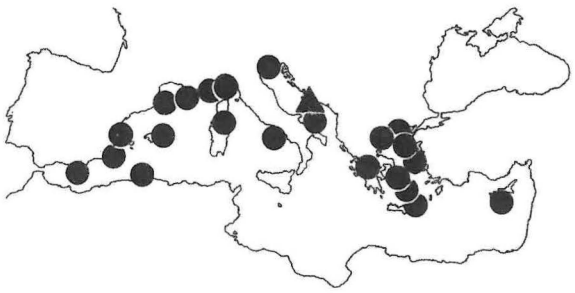

Fig. 10. Records of Holothuria mammata *in the Mediterranean Sea. ● from the literature, ▲ present study*

Holothuria (Roweothuria) polii Delle Chiaje, 1823

STATIONS: MLJ-16, 26, 27, 32, 38-40, 49, 61 (14 specimens noted and collected).

DEPTH: 2-30 m.

HABITAT: Gravel and coarse sand within *Posidonia* beds and rocks covered by algal canopy.

ECOLOGY: Considering present records and information of TORTONESE (1965) and MASSIN & JANGOUX (1976), *H. polii* has a wide ecological distribution.

Holothuria (Thymiosycia) impatiens (Forskål, 1775)

STATIONS: MLJ-3, 6, 7, 21, 22, 24, 26, 27, 29, 35 (18 specimens collected).

DEPTH: 0.3-3 m.

HABITAT: Spaces between large loose stones and rocky depressions under boulders. One individual was collected with a "janka" hand net towed by a diver through the leaf-layer of a dense *Posidonia oceanica* meadow.

ECOLOGY: A circumtropical (MASSIN, 1996, 1999) shade-seeking holothurian, inhabiting cryptic habitats in shallow water algal settlements (KOEHLER, 1921), under boulders over a sandy deposit and under coral heads (SLOAN *et al.*, 1997; MASSIN, 1999).

REMARKS: At Mljet Island, a maximum of three individuals were noted in the same niche beneath a boulder. Live animals were brownish, rich in fine blackish dots and irregular dark brownish speckled beige papillae. Specimens conformed to a typical colour variant described by CLARK (1921: 179, T. 19; PANNING, 1935b). *H. impatiens* is easily recognized by its ossicles (PANNING, 1935a; MASSIN, 1996). According to MARENZELLER (1874), it was first noted in the Adriatic Sea by SEMPER (1868) who cited preserved specimens in the collection of the Vienna Hofmuseum (Court-Museum). MARENZELLER (1874) and STOSSICH (1883) discussed the record. Regrettably, MARENZELLER did not record locations of other specimens he collected in the Adriatic Sea. Sixty years later, MAYER (1937) reported on a specimen collected at Primošten (Italian Capocesto) and kept in the Triest zoological collection. MARCUZZI (1972) recorded a specimen collected at Rovinj in 1942 and kept in the Rovinj Institute collection. *H. impatiens* has been recorded in Bokakotorska Bay (KOLOSVÁRY, 1938b, 1939; BRUNO, 1972) and at Lokrum Island near Dubrovnik (BELAMARIĆ & ŠERMAN, 1989; ŠPAN *et al.*, 1989; Fig. 11) in the southern Adriatic Sea. In addition to the present

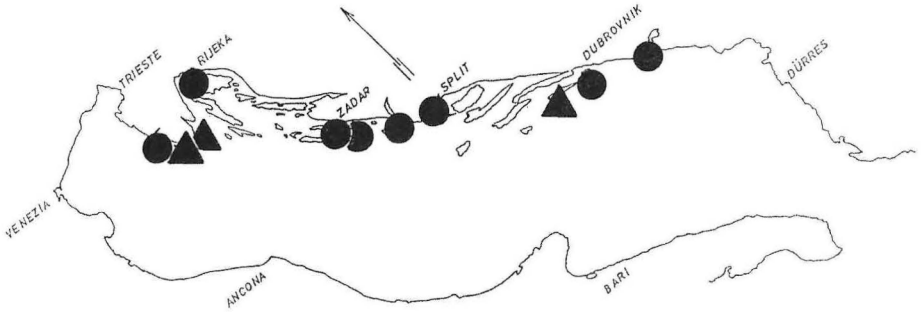

Fig. 11. Records of Holothuria impatiens *in the Adriatic Sea. ● from the literature, ▲ present study*

research, I have seen this species while diving at Rovinj, in Soline Cove near Pula, in Budava Cove (eastern Istria; unpublished results), in Omišalj Cove (ZAVODNIK, 1998), in Kornati National Park (ZAVODNIK, 1997b) and in Kaštela Bay (ZAVODNIK, 1999; Fig. 11).

Holothuria (Platyperona) sanctori Delle Chiaje, 1823

STATIONS: MLJ-12-14, 16-20, 22, 23, 28-30, 33, 39, 42, 43, 45, 47-49, 51, 57 (about 100 specimens recorded or collected).

DEPTH: 1-25 m.

HABITAT: Rocky substrate, especially in cryptic habitats. Sometimes noted on vertical cliffs. Only one individual was recorded on a sandy detrital bottom mixed with stones (station MLJ-39).

ECOLOGY: Species ecological preference is not yet defined. Noted in the biocoenosis of photophilic algae and precoralligenous facies of coralligenous biocoenosis (ZAVODNIK, 1985).

REMARKS: At some sites, this was the most abundant holothurian species in the upper infralittoral zone. A maximum population density of 15 individuals per 10 square metres was noted at Glavat Cape (station MLJ-30) at a depth of about 3 m. Gregarious behaviour is characteristic. For example, in rocky depressions under large loose stones and in bedrock crevices on the slope of Utrnji Školj Islet (station MLJ-19), 4-6 individuals were found together in mutual contact. Numerous large whitish or beige rings encircling the bases of the dorsal and lateral papillae usually vivified the uniformly dark brown or brown-reddish integument. There were rarely less than 20 rings per individual and only one specimen (collected at Gonotur Cape, station MLJ-12) completely lacked these characteristic rings. The variously coloured and ornamented individuals inhabiting a single ecological niche suggest that the phenomenon is subject to individual variation. No specimen of a uniformly pale brown colour as noticed by PANNING (1939) was recorded.

Holothuria (Panningothuria) forskali Delle Chiaje, 1823

STATIONS: MLJ-2, 14, 22, 27, 30, 39, 42, 43, 45-51 (about 30 specimens noted or collected).

DEPTH: 2-46 m.

HABITAT: Sandy silt and fine sandy deposit, at some sites not rare in the *Posidonia oceanica* bed. Only exceptionally noted on outcrops and steep bedrock. One specimen was collected on clean sand deposited in a small cave at a depth of the 4-6 m.

ECOLOGY: Species with a wide ecological distribution (MASSIN & JANGOUX, 1976), most common at Adriatic Sea trawling grounds (ŽUPANOVIĆ & JARDAS, 1989; ŠIMUNOVIĆ, 1997).

Family: **Stichopodidae Haeckel, 1886**

Eostichopus regalis (Cuvier, 1817)

STATIONS: MLJ-14, 48, A (3 specimens).

DEPTH: 36-80 m.

HABITAT: Silty sand. In Vela Tatinica Cove (station MLJ-48), one individual was noted on a rocky outcrop occupied by a precoralligenous association.

ECOLOGY: This species is characteristic on silty deposits but tolerant of the sandy fraction and fine shell debris. It is common and abundant in the Adriatic Sea and on trawling grounds (GAMULIN-BRIDA, 1962, 1972; ŽUPANOVIĆ & JARDAS, 1989; JARDAS, 1990; ŠIMUNOVIĆ, 1997).

Order: **DENDROCHIROTIDA Grube, 1840**

Family: **Cucumariidae Ludwig, 1894**

Ocnus planci (Brandt, 1835)

STATION: MLJ-A (1 specimen).

DEPTH: 60-70 m.

HABITAT: Silty sandy deposit.

ECOLOGY: Considering the abundance of *O. planci* at some Adriatic Sea localities (FEDRA *et al.*, 1976; FEDRA, 1978) this cucumarian perhaps prefers the biocoenosis of coastal detrital bottoms.

REMARK: Our specimen was collected by a bottom trammel net, set by a fisherman.

***Leptopentacta elongata* (Düben & Koren, 1846)**

REMARKS: In the course of the present research, no specimens were collected. PANNING (1966) reported that two specimens were collected at Mljet Island by the Dutch Jugoslav Zoological Expedition on 6 Aug. 1958. Those specimens were deposited in the Hamburg Natural History Museum (NHMH 6717). The exact sampling locality and sediment type were not indicated by the author, nor were the specimens labelled (H. RUHBERG, personal communication). However, considering a frequent boat destination at Mljet Island and the common collection practices of half a century ago, the sampling presumably occurred in the Polače environs, i.e. within Mljet National Park. Consequently, until new reference material is collected, the presence of this species in the study area remains dubious.

Order: **APODIDA Brandt, 1835**

Family: **Synaptidae Brandt, 1835**

***Labidoplax digitata* (Montagu, 1815)**

STATIONS: MLJ-9, 25, 104, 114 (6 specimens).

DEPTH: 17-104 m.

HABITAT: Fine sandy silt and silty deposits.

ECOLOGY: The species is exclusive to the biocoenosis of coastal terrigenous ooze (PICARD, 1965; ZAVODNIK, 1979b).

REMARK: No abnormally structured ossicles were observed as noted elsewhere in the Adriatic Sea (ZAVODNIK, 1997b, 1999).

Class ASTEROIDEA de Blainville, 1830

Order: **PAXILLOSIDA Perrier, 1884**

Family: **Luidiidae Verrill, 1899**

***Luidia ciliaris* (Philippi, 1837)**

STATIONS: MLJ-13, 30, 46, 48, 52 (5 specimens).

DEPTH: 12-35 m.

HABITAT: Coarse sand and gravel mixed with shell debris and loose stones overgrown here and there by tufts of the brown seaweed *Cystoseira corniculata* ssp. *laxior*.

ECOLOGY: Published accounts (TORTONESE, 1965; BRUN, 1972; VIDOVIĆ-MATVEJEV, 1978) and present results show the preference of this species for a bottom of stones, gravel and shells.

REMARKS: *L. ciliaris* is a voracious carnivore whose main food items are echinoderms (BRUN, 1972). No commensal polychaetes (TORTONESE, 1965) were noticed in starfish ambulacral grooves.

Family: **Astropectinidae Gray, 1840**

***Astropecten aranciacus* (Linnaeus, 1758)**

STATIONS: MLJ-9, 46 (2 specimens).

DEPTH: 3-6 m.

HABITAT: Well-sorted sand in a *Cymodocea nodosa* meadow and a patch of coarse sand enclosed by bedrock not far from a *Posidonia oceanica* bed.

ECOLOGY: PICARD (1965) noted this species inhabits a gravel deposit and suggested it prefers the biocoenosis of coarse sands influenced by bottom currents. The preference of the species for coarse sandy deposits was also stressed by BURLA *et al.* (1976). In the Adriatic Sea, specimens have also been recorded in muddy bottom trawl catches (GAMULIN-BRIDA, 1962; CRNKOVIĆ, 1970; ŠIMUNOVIĆ, 1997) and in some sites they were common in *Posidonia oceanica* and *Cymodocea nodosa* beds (author's unpublished results). Therefore, I have suggested that *A. aranciacus* has a wide ecological distribution in the Adriatic Sea (ZAVODNIK, 1979 b).

***Astropecten irregularis* (Pennant, 1777)**

STATIONS: MLJ-112, 120. The exact location of the catch by a fisherman's bottom trawl net off the southern border of Mljet National Park was not noted (4 specimens studied).

DEPTH: 39-80 m.

HABITAT: Fine sand and sand mixed with ooze.

ECOLOGY: Regarding the habitat (VATOVA, 1928, 1949; TORTONESE, 1985; ŠIMUNOVIĆ, 1997; author's unpublished results), this species is perhaps not exclusive to the biocoenosis of coastal detrital bottoms as suggested by PICARD (1965).

REMARKS: All specimens studied (R/r 3.25-3.40) belong to a typical latibrachiate *pentacanthus* (Delle Chiaje, 1825) form without SM armament. A few enlarged granules were distinguished on the superomarginal plates in only one of the specimens. The form of the largest adambulacral spine varied between pointed and truncate at its tip, as figured by TORTONESE (1985).

Astropecten platyacanthus (Philippi, 1837)

STATIONS: MLJ-9, 16, 22, 25, 39, 41, 45 (7 specimens).

DEPTH: 5-15 m.

HABITAT: Fine sand and gravel sand, open areas or areas within *Posidonia oceanica* beds. At the Lenga Cape (station MLJ-16) and in Tijesno Strait (station MLJ-41), individuals were collected on bedrock covered by algal turf.

ECOLOGY: Considering reference data and the author's unpublished records, *A. platyacanthus* prefers coarse sands occupied by sea grasses (*Cymodocea nodosa* and *Posidonia oceanica*) and is tolerant of the silty fraction.

REMARKS: The R/r of the studied specimens was 3.2-4.0. In the R 56 mm specimen from Malo Jezero (station MLJ-9), 2-3 proximal superomarginals were armed with two enlarged spines, the lower one was shorter. In other morphometric features, this specimen was concordant to the species description. However, some confusion arose with a specimen with narrow arms (R 29 mm, r 9 mm) that was collected at Lenga Cape (station MLJ-16). The vertical side and apical parts of the superomarginal plates were characterised by a vast bare area deprived of spinelets or squamulae, thus it highly resembled the SMs of *Astropecten bispinosus*. In accordance with DÖDERLEIN (1917) and TORTONESE (1947), this specimen was identified as *A. platyacanthus* because R/r = 3.2 and because of the shape of the superomarginal plates, nos. SMS 20, R/SM 1.6/1, the insertion of an enlarged spine in the tumid upper part of the proximal SMs and on the outer edge of the distal plates, the presence of a few squamose spinelets scattered along bare areas, the shape of the inferomarginal fringe spine and the position of pointed spines on the actinal face of the inferomarginals. A similar variation was recognized by LORENZ (1860) as var. *flanaticus*, but this variety is no longer considered valid (TORTONESE, 1965).

Astropecten spinulosus (Philippi, 1837)

STATIONS: MLJ-9, 21, 22, 28, 39, 41, 56 (7 specimens).

DEPTH: 2-10 m.

HABITAT: Clinging to *Posidonia oceanica* leaves and noticed between *Cystoseira* stems.

ECOLOGY: Since this species was recorded several times in settlements of large photophilic algae (ZAVODNIK, 1967a; present results), *A. spinulosus* apparently prefers, but not exclusively, *Posidonia oceanica* biocoenosis, as suggested by PICARD (1965).

Order: VALVATIDA Perrier, 1884

Family: Asterinidae Gray, 1840

Asterina gibbosa (Pennant, 1777)

STATIONS: MLJ-8, 22, 31, 47 (4 specimens).

DEPTH: 0.3-50 m.

HABITAT: A cemented stone wall, a *Posidonia oceanica* leaf, and among bryozoans scraped from bedrock.

ECOLOGY: Species prefers shaded habitats in the shallow water biocoenosis of photophilic algae.

REMARKS: In young specimens (R 3 mm, R/r 1.8-2.0) one small suboral spine was encountered. In the largest specimen (R 20 mm, R/r 2.5) two large suboral spines were present. In Veliko Jezero Lake, *A. gibbosa* was also noted by BABIĆ (1913) and collected by Mrs. I. MUNDA, but exact data on collection sites and habitat were not provided.

Asterina pancerii (Gasco, 1870)

STATIONS: 12, 26, 29, 31, 52 (6 specimens).

DEPTH: 10-29 m.

HABITAT: This species is typically found on leaves of *Posidonia oceanica* (BAUER, 1929). One of the studied specimens was picked from the upper surface of a loose stone on the border of an eelgrass meadow.

ECOLOGY: Exclusive with the biocoenosis of *Posidonia oceanica*.

REMARKS: The species is clearly different from *A. gibbosa* (TORTONESE, 1952). The armament of oral plates is perhaps subject to individual growth variation as noted in *A. gibbosa* by CLARK & DOWNEY (1992). In the smallest studied specimen (R 2 mm, R/r 1.5-1.7), none or only one small suboral spine and three furrow spines per plate were present. In the largest specimen (R 6 mm, R/r 1.3), two suboral spines and 4-5 oral furrow spines were encountered. No specimen was armed with 3-4 suboral spines as characteristic of mature specimens (TORTONESE, 1960, 1965; CLARK & DOWNEY, 1992). In the eastern Adriatic, *A. pancerii* was previously recorded at Zadar (BRUSINA, 1907), Novi and Karlobag (BABIĆ, 1913), and a few localities in Kornati Archipelago (ZAVODNIK, 1997a, b). In addition to present records, I have collected specimens at Lastovo Island, 1.5 Nm south of Dolin Island, and at Vele Srakane Islet (author's unpublished results; Fig. 12).

Family: **Goniasteridae Forbes, 1841**

Peltaster placenta (J.P. Müller & Troschel, 1842)

STATIONS: MLJ-13, 16 (7 specimens).

DEPTH: 20-80 m.

HABITAT: Vertical cliff and rocky plain.

ECOLOGY: *P. placenta* is not exclusive to the biocoenosis of detrital bottoms of open insular zones and the open Adriatic Sea, as suggested by GAMULIN-BRIDA (1967). VIDOVIĆ-MATVEJEV (1978) reported it on mud and muddy sand. According to our previous (ZAVODNIK, 1997b; ZAVODNIK *et al.*, 2000) and present data, this starfish is widely distributed on rocky and sedimentary surfaces in the Adriatic Sea, although it has not yet been recorded on fine-grained sandy and gravel deposits. In the Mediterranean, *P. placenta* has frequently been noted on sandy and muddy bottoms (TORTONESE, 1984b). Occasionally it was collected in a coralligenous community rich in melobesians (PÉRÈS & PICARD, 1958).

REMARKS: At station MLJ-16 (Lenga Cape), one specimen was collected in a fish basket set to catch fish and lobsters at a depth of 80 m. All studied specimens were middle-sized (R 74-77 mm) and easily recognisable by their outlines (Fig. 13A). In comparison to specimens from Vis Island (HELLER, 1863), neighbouring Hvar Island and several Mediterranean areas (KASPIRIS & TORTONESE, 1982; TORTONESE, 1984

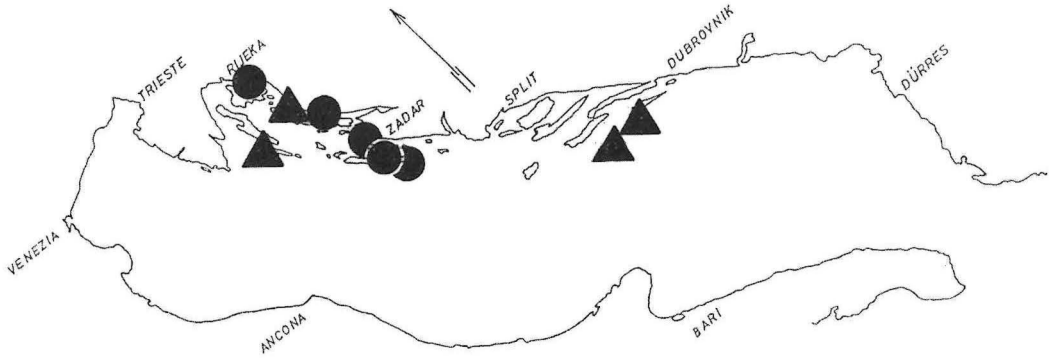

Fig. 12. Records of Asterina pancerii *in the Adriatic Sea.* ● *from the literature,* ▲ *present study*

b), arms in specimens from Mljet Island were distally rounded. The arm tips were not acutely pointed as described in some mid-Dalmatian specimens by HELLER (1863) and LEIDENFROST (1917). Both variants were discussed by MARENZELLER (1875). In most specimens, the two distal pairs of the superomarginal plates were in partial or full contact. In one specimen (CMRR 1089), the position of the distal superomarginal plates was unique: only the last pair of plates was in full contact while the preceding (penultimate) large superomarginals were still associated with the "swollen" radial end and widely separated (Fig. 13B). The madreporite was kidney-shaped and slightly larger than the surrounding abactinal plates.

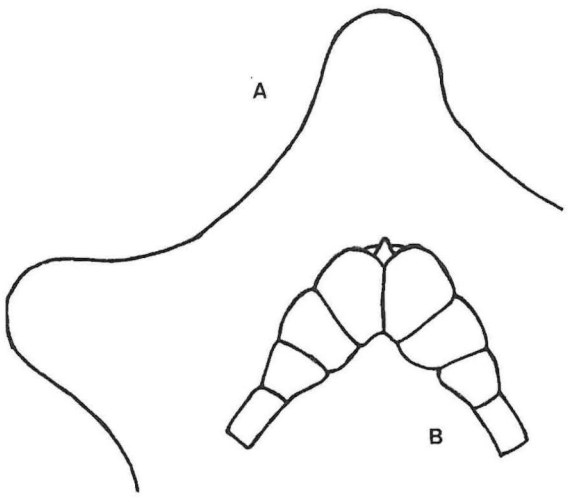

Fig. 13. Peltaster placenta. *A: General outline of specimens; B: Radial end of the CMRR 1089 specimen*

P. placenta was first recorded in the Adriatic at Vis Island and Dubrovnik (HELLER, 1863, 1868; STOSSICH, 1883). BRUSINA (1907) noted it at Komiža, Vis Island. KOLOSVÁRY (1937) reviewed earlier records of this species in the Adriatic Sea. According to unpublished field diaries (ANONYMOUS, 1948-1949) of the M.V. HVAR cruises in 1948-1949 (KARLOVAC, 1956; ŠOLJAN, 1977), *P. placenta* was one of the most widely distributed starfish in the Adriatic; it was recorded at 35 offshore otter trawl stations located from about 44°N (Dugi Otok Island) in the north to off the shore of Škumbi Estuary (41°N) in the south (Fig. 14). More recently, specimens were collected on silty offshore deposits in the mid-Dalmatian area and, particularly, in the Jabuka depression (ŽUPANOVIĆ & GRUBIŠIĆ, 1958; GAMULIN-BRIDA, 1965; ŽUPANOVIĆ & JARDAS, 1989). *P. placenta* was also recorded at many sites in the coastal waters of Albania including the Otranto Strait area (GJIKNURI, 1985). Recently published reports (TORTONESE, 1984a, b; BAKRAN-PETRICIOLI *et al.*, 1997; ŠIMUNOVIĆ, 1997; ZAVODNIK, 1997b; ANDRIĆ, 1999; POŽAR-DOMAC *et al.*, 2000; ZAVODNIK *et al.*, 2000) confirm the suggestion of VIDOVIĆ-MATVEJEV (1978) that the species occurs in the Adriatic Sea only in the central and southern parts (Fig. 14). One may conclude that the absence of this species in the northern Adriatic is not due to the relative shallowness of the area since the bathymetric range of the Adriatic *P. placenta* is about 20-280 m (ŠIMUNOVIĆ, 1997; author's unpublished results).

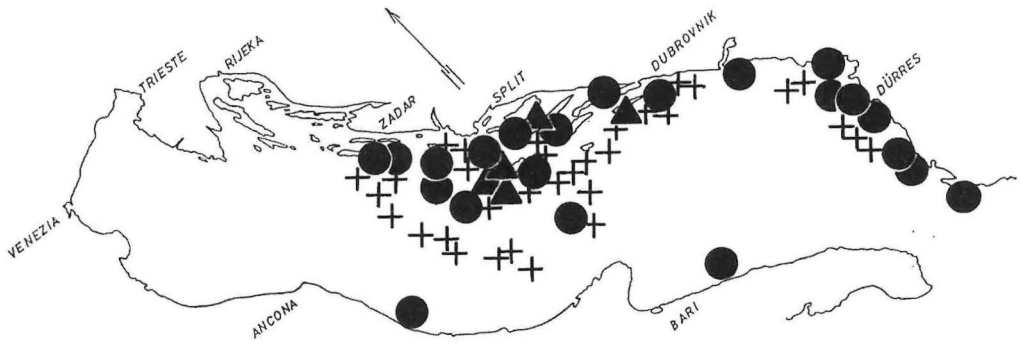

Fig. 14. Records of Peltaster placenta *in the Adriatic Sea. + MV HVAR voyages, ● from the literature, ▲ present study*

Family: **Ophidiasteridae Verrill, 1867**

Ophidiaster ophidianus (J. P. Müller & Troschel, 1842)

STATIONS: MLJ-13, 14, 16, 18, 19, 42, 48, 57 (8 specimens).

DEPTH: 2-30 m.

HABITAT: Bedrock, gently sloped or inclined to a vertical cliff. At shallow depths, individuals often crawl into rock fissures.

ECOLOGY: At the studied stations, this species was regularly noted in the upper infralittoral zone on rocky substrates covered by algal turf. At Lokrum Island, GAMULIN-BRIDA (1972) recorded specimens at a depth of 1 m. In the Albanian littoral, the shallowest depth of 0.5 m was noted by GJIKNURI (1985). According to TORTONESE (1949, 1965) and CLARK & DOWNEY (1992), specimens were recorded from the shore (i.e., 0 m) to about 100 m depth. Consequently, *O. ophidianus* is not exclusive to the circalittoral coralligenous biocoenosis, as suggested by GAMULIN-BRIDA & ŠPAN (1978).

REMARKS: All individuals were large (arms about 160-200 mm long) and most uniformly reddish violet. Only in one specimen collected at Štit Islet (station MLJ-14, 6 m depth), irregularly outlined blackish specks were noted which turned to violet when the starfish was dried. Long ago, it was believed that this thermophilic species (KOEHLER, 1924a; TORTONESE, 1957b, 1965) was distributed only in the southern part of the Adriatic. However, two years ago, Mrs. J. VIDMAR-KRUŽIĆ recorded it at Mežanj Islet (44°05.5'N; 14°55.3'E; personal communication). Apparently, the area of *O. ophidianus* extends southwards from Dugi Otok Island, Kornati Archipelago (BAKRAN-PETRICIOLI *et al.*, 1997; ZAVODNIK, 1997a, b) and Palagruža Island to the Montenegrine littoral (BABIĆ, 1913; KOLOSVÁRY, 1937; GAMULIN-BRIDA, 1972; Fig. 15). It is a common sea star species inhabiting rocky bottoms and coralligenous biocoenosis in south Albania, i.e., Otranto Strait, and the northern Ionian Sea (GJIKNURI, 1985; VASO & GJIKNURI, 1992).

Hacelia attenuata (Gray, 1840)

STATIONS: MLJ-12-17, 22, 23, 30, 34, 48, 49, 51, 52, 57 (about 40 specimens noted or collected).

DEPTH: 5-43 m.

HABITAT: Hard substrates, i.e., bedrock and cliffs.

ECOLOGY: Common in precoralligenous and typical facies of the coralligenous community. Noted also in the biocoenosis of photophilic algae covering steep slopes and in submarine caves (RIEDL, 1966; TORTONESE, 1976b). Never hidden in narrow crevices or beneath loose stones - the behaviour is perhaps conditioned by the rigidity of the starfish skeleton.

REMARKS: At some sites in the central and southern Adriatic and in offshore islands, *H. attenuata* is a rather common starfish species.

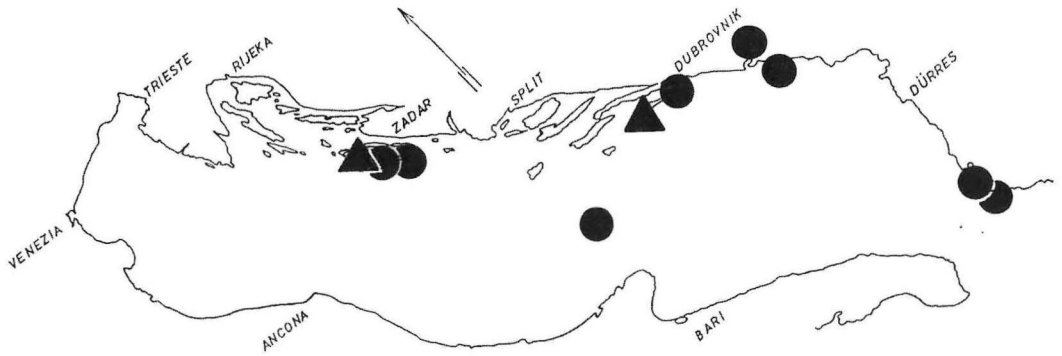

Fig. 15. Records of Ophidiaster ophidianus *in the Adriatic Sea.* ● *from the literature,* ▲ *present study*

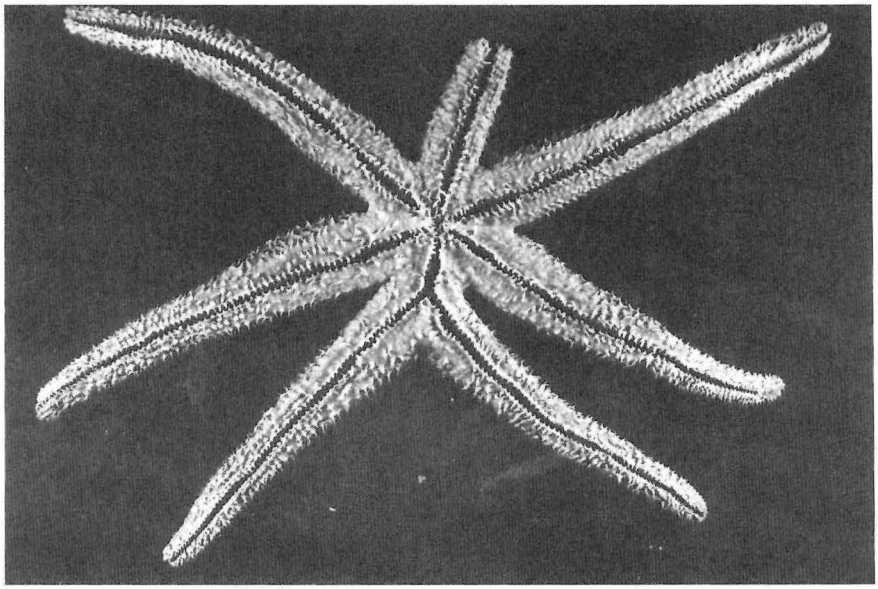

Fig. 16. Echinaster sepositus. *A six rayed specimen with a bifurcated arm (CMRR 1687, R 110 mm)*

Apparently it is not rare in the study area although usually only a single or a few individuals were noted per dive. A maximum population density of five specimens per square metre was recorded at Štit Islet (station MLJ-14) on a steep bedrock slope at a depth of 10 m. The red colour form was typical.

Order: **SPINULOSIDA Perrier, 1884**

Family: **Echinasteridae Verrill, 1870**

***Echinaster sepositus* (Retzius, 1783)**

STATIONS: MLJ-1, 3, 6, 9, 11-13, 15, 17, 18, 21-23, 27-32, 34, 38-53, 57, 63, A, B, C (about 150 specimens noted or collected by divers and trammel bottom sets).

DEPTH: 2-44 m.

HABITAT: Common on rocky substrates covered by algal turf and encrusting organisms. Occasionally on gravel and coarse sandy detrital deposits, also those mixed with the silty fraction.

ECOLOGY: Species of wide ecological distribution (ZAVODNIK, 1979b). In the study area, it was noted in the biocoenosis of photophilic algae, in precoralligenous and typical facies of the coralligenous biocoenosis, in *Posidonia oceanica* and *Cymodocea nodosa* meadows, in the biocoenosis of coastal detrital bottoms, and on detrital bottoms mixed with ooze.

REMARKS: A maximum population density of 7 individuals per 10 square metre was noted around Kula Crag (station MLJ-47) at a depth of 20 m. Occasionally non-pentamerous specimens were collected: two four-rayed specimens came from station MLJ-41, one six-rayed specimen was recorded at station MLJ-B, and a six-rayed specimen with one Y-bifurcated arm (CMRR 1687) was collected in Veliko Jezero at station MLJ-3 (Fig. 16). It appears that in the Adriatic, *E. sepositus* is most liable to symmetrical variation and theratological curiosities (NACCARI, 1826; GRUBE, 1861; ANNICHIARICO, 1979; ZAVODNIK, 1992, 1995a). A bifurcated ray in a hexagynian specimen figured above had not been previously recorded.

Order: **FORCIPULATIDA Perrier, 1884**

Family: **Asteriidae Gray, 1840**

***Coscinasterias tenuispina* (Lamarck, 1816)**

STATIONS: MLJ-1, 11-14, 16, 17, 19, 22, 23, 26, 39, 41-44, 46-55, 57 (about 50 individuals noted or collected).

DEPTH: 2-40 m.

HABITAT: Rocky bottoms. Not rare in cryptic habitats such as crevices in calcareous rocks, beneath loose stones and between stony coral (*Cladocora caespitosa*) colonies. One specimen was recorded on a dead fan shell (*Pinna nobilis*; ŠILETIĆ & PEHARDA, 2003).

ECOLOGY: Prefers the biocoenosis of photophilic algae. Occasionally noted in *Posidonia oceanica* meadows and precoralligenous community.

REMARKS: In the study area, *C. tenuispina* was widely distributed in sheltered and high-energy localities but usually only single specimens were recorded. Rarely, two or three individuals occurred together beneath large loose stones. Most specimens of this representative fissiparous asteriid (HOTCHKISS, 2000) had 7 or 8 arms. Straight pedicellariae, especially large ones, were scarce. Compared to available information from other parts of the Adriatic, this feature is perhaps characteristic to the area, in contrast to variations noted in the western Mediterranean (TORTONESE, 1982). It seems that the abundance of crossed pedicellariae encircling aboral spines is subject to individual variation. In young specimens of about R 12 mm, pedicellarian tufts were considerably less dense than in adults. Specimens possessed two or more madreporites but in one 4+3 specimen (maximum R 48 mm), there was only one madreporite plate. Coloration of the aboral side varied within the known range (TORTONESE, 1965). Some specimens, however, were distinguished by a dominant dark reddish-brown hue and the absence of light rings and speckles along the arms.

Marthasterias glacialis (Linnaeus, 1758)

STATIONS: MLJ-4, 13-15, 22, 28, 29, 32, 34, 41-43, 45-47, 52, 54, D (about 50 specimens noted or collected).

DEPTH: 3-54 m.

HABITAT: Rocky, gravel and sandy detrital bottoms. Noted on outcrops, in rock crevices and in crude anthropogenic wastes (i.e., discarded containers), very rarely under loose stones.

ECOLOGY: Species with a wide ecological distribution. In the studied area, it was noted in the biocoenosis of photophilic algae, in precoralligenous and typical facies of the coralligenous biocoenosis, in communities of coastal detrital bottoms, and in *Posidonia oceanica* beds.

REMARKS: *M. glacialis* is a well-known non-specialized carnivore of the Mediterranean benthos (SAVY, 1987). At station MLJ-32, I observed one individual feasting on a large *Paracentrotus lividus*. The starfish had spread itself over the prey and embraced it with its arms in a manner similar to that described by SCHIEMENZ (1896) for an attack on a *Venus* shellfish. The spines of the sea urchin had been pushed aside and some had fallen off, but the prey was not turned upside down. I noticed similar behaviour of *Marthasterias* in Rijeka Bay when a big *Sphaerechinus granularis* was attacked.

Class OPHIUROIDEA Gray, 1840

Order: **OPHIURAE Müller & Troschel, 1840**

Family: **Ophiomyxidae Ljungman, 1866**

Ophiomyxa pentagona (Lamarck, 1816)

STATIONS: MLJ-40, 42 (2 specimens).

DEPTH: 5-10 m.

HABITAT: Rocky slopes and sandy detrital deposits.

ECOLOGY: In the study area, *O. pentagona* was noted in the biocoenosis of photophilic algae and in a community of the coastal detrital bottom. According to reference data (TORTONESE, 1965) and the author's unpublished results of recent research at other sites in the eastern Adriatic Sea, it seems that this species has a wide ecological distribution and probably is not preferential to coastal detrital bottoms as previously suggested (ZAVODNIK, 1979b).

REMARKS: The specimen collected in Polače Cove (station MLJ-40), in which the

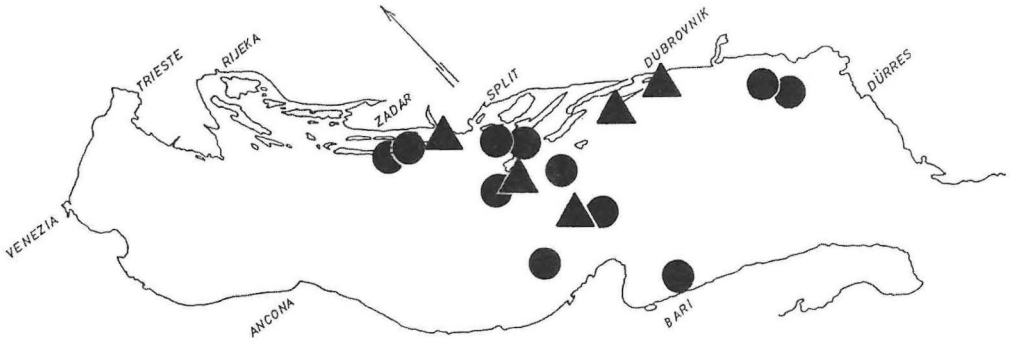

Fig. 17. Records of Ophiacantha setosa *in the Adriatic Sea.* ● *from the literature,* ▲ *present study*

disk diameter was 8 mm and undamaged arms were 59 mm, regenerated two arms to a length of only 13 mm. The animal preserved in alcohol is dorsally uniformly dark brown but the regenerated part of the disk and the two small arms are lightly coloured. The ventral coloration of the regenerated parts does not differ from the undamaged parts of the specimen.

Family: **Ophiacanthidae Perrier, 1891**

***Ophiacantha setosa* (Retzius, 1805)**

STATIONS: MLJ-A, C (4 specimens).

DEPTH: 60-80 m.

HABITAT: Sandy detrital deposits intermittent by rocky outcrops.

ECOLOGY: This species has been described as characteristic of the biocoenosis of offshore detrital bottoms (PÉRÈS & PICARD, 1964), the biocoenosis of offshore rocks and detrital bottoms of open insular zones and the open sea (GAMULIN-BRIDA, 1967, 1972). Our specimens were collected from a mixed community comprising species typical to the coralligenous biocoenosis and species particularly found in the detrital bottom *Atrina pectinata* facies. *O. setosa* was recently collected at the offshore Palagruža Island by divers in a well-developed typical facies of the coralligenous biocoenosis (author's unpublished results).

REMARKS: Two specimens took hold of the radioles of *Cidaris cidaris*. This brittle star behaviour is comparable to previous records (TORTONESE, 1965). In the smallest studied specimen, the disk diameter was only 2.8 mm. *O. setosa* was recorded in the Adriatic Sea by MARENZELLER (1895), KOLOSVÁRY (1937), GAMULIN-BRIDA (1963b), JARDAS (1990), UNGARO (1995) and ZAVODNIK (1992, 1997a, b). Specimens were collected in the Biševski and Zlarinski Channels and the Dubrovnik area and are deposited in the CMRR reference collection. Apparently, this species is absent in the shallow northern Adriatic (Fig. 17).

Family: **Amphiuridae Ljungman, 1867**

***Amphiura (Amphiura) chiajei* Forbes, 1843**

STATIONS: MLJ-9, 25, 27, 53, 121 (12 specimens).

DEPTH: 9-70 m.

HABITAT: Coarse sand, silty sand and silty detrital sediments. Also extracted from sediment deposited between *Cladocora caespitosa* corallites.

ECOLOGY: In the study area, this species was recorded in sparse *Posidonia oceanica* meadows, in *Cladocora* bioherms, and in the biocoenosis of detrital bottoms mixed with ooze. According to PICARD (1965), *A. chiajei* lives in silty deposits and is tolerant of other fractions.

Amphiura (Amphiura) filiformis (O.F. Müller, 1776)

STATIONS: MLJ-104, 105, 107, 114, 115, 118, 119, 120 (12 specimens).

DEPTH: 39-110 m.

HABITAT: Silty sand, sandy silt and terrigenous ooze.

ECOLOGY: Collected from a community of the detrital bottom mixed with ooze and in the biocoenosis of coastal terrigenous ooze. PICARD (1965) considered this brittle star an accompanying species with a wide ecological distribution.

REMARKS: One of the most characteristic external features of *A. filiformis* is the naked oral side of the disk, i.e., it is not covered by scales or, occasionally, only a few rudimentary scales occur, scattered in the interradial areas. Significantly, in one specimen (DD 3.1 mm) collected from the Gonoturska area (station MLJ-104, 104 m depth; CMRR 2032), the oral side of the disk is well-scaled; one interradius is completely covered by small suboval scales while the other interradii have very limited areas of naked skin that were noted when the specimen was dried (Fig. 18). The specimen fully conforms with other specific characters of *A. filiformis* (KOEHLER, 1924a; TORTONESE, 1965) such as the absence of tentacular scales, the axe-shaped second arm spine from below, the absence of a rosette of primary plates, the shape and position of dorsal shields, etc. In a second specimen found in the same sample, the ventral scale covering was distinct although areas of non-scaled interradial skin were also distinguishable. The variable scale covering of the oral side of the disc in *A. filiformis* was noted by MORTENSEN (1925).

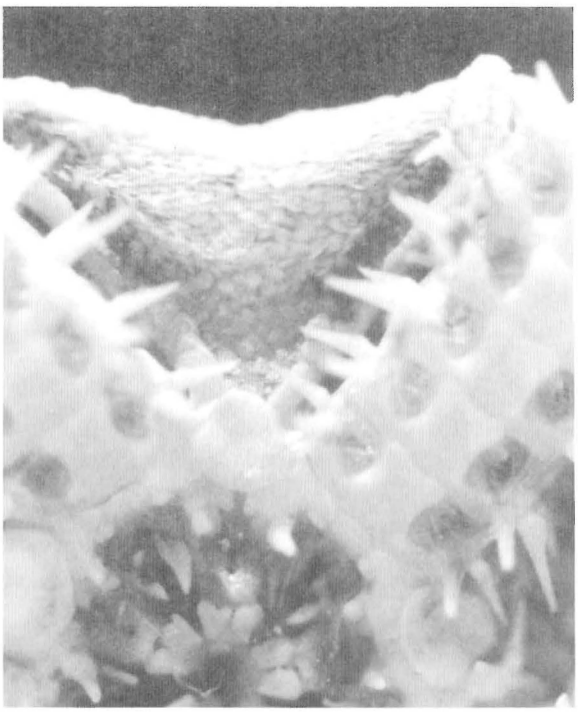

Fig. 18. Detail of a scaled oral side of Amphiura filiformis *(CMRR 2032, DD 3.1 mm)*

Amphiura (Ophiopeltis) securigera (Düben & Koren, 1846)

STATION: MLJ-101 (1 specimen).

DEPTH: 60 m.

HABITAT: Pure sand mixed with lithothamnian debris, for the most part of *Spongites fruticulosus*.

ECOLOGY: Sampling took place in the biocoenosis of the coastal detrital bottom, probably in the facies of *Spongites fruticulosus* (= *Lithothamnium fruticulosum* by PÉRÈS & PICARD, 1964). This species is apparently associated with detrital coarse sand and gravel with shells beneath turbulent water (GUILLE, 1972; GLÉMAREC, 1973). JESUS & FONSECA (1999) collected *A. securigera* on muddy sand.

REMARKS: The disk diameter of the specimen preserved in alcohol (CMRR 1944) is 3.5 mm. The tips of all arms were broken off, the longest remnant of an arm being 28 mm in length. No tentacle scales were present. Lateral arm plates bear three spines, the tip of the median spine is characteristically axe shaped. This is the fourth record of *A. securigera* in the Adriatic Sea. It was collected previously in the Velebitski Canal, Kornati Archipelago and near Silba Island (ZAVODNIK, 1973, 1997a, b, unpublished record). The present finding greatly extends the range of this boreal-atlantic species (D'JAKONOV, 1954) in the Adriatic Sea (Fig. 19) contradicting the regional distribution pattern

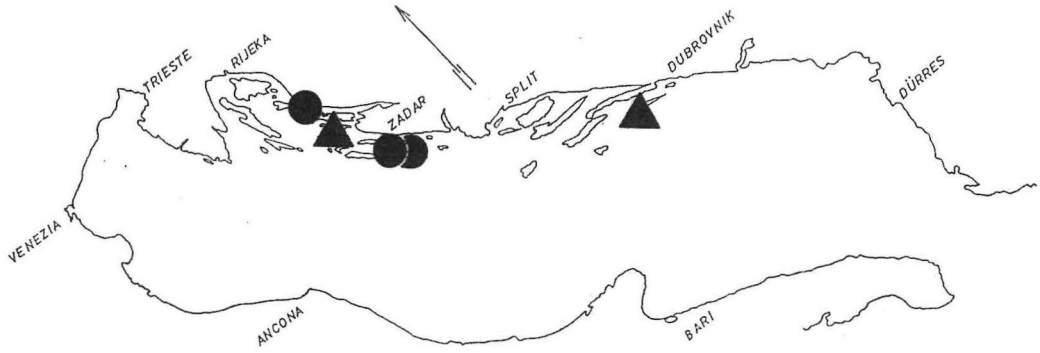

Fig. 19. Records of Amphiura securigera *in the Adriatic Sea.* ● *from the literature,* ▲ *present study*

suggested by ZAVODNIK (1997b). Considering published records (GUILLE, 1972; ALBERTELLI & CATTANEO, 1983; RINELLI & SPANÓ, 1997; RINELLI, 2000), the Adriatic locations are the easternmost in the Mediterranean. As far as I know, *A. securigera* has not yet been included in reports of the Ionian and Aegean Seas (MARENZELLER, 1893, 1895; TORTONESE, 1946; TORTONESE & DEMIR, 1960; KASPIRIS & TORTONESE, 1982; PANCUCCI-PAPADOPOULOU, 1996), Cyprus (DEMETROPOULOUS & HADJICHRISTOPHOROU, 1976; HADJICHRISTOPHOROU *et al.*, 1997), or the Levantine (TORTONESE, 1953-54, 1957a, 1966).

Amphipholis squamata (Delle Chiaje, 1828)

STATIONS: 9, 12-15, 18, 27, 28, 34, 41, 43, 48, 49, 53, 107, 113 (25 specimens).

DEPTH: 0-103 m.

HABITAT: Within fronds of large photophilic algae and on *Posidonia oceanica* leaves and rhizomes, among corallinacean thalli, *Cladocora caespitosa* corallites and bryozoan colonies, in sand rich in lithothamnian debris, in silty sand, and in bedrock mediolittoral pools.

ECOLOGY: A cosmopolitan species with a wide ecological distribution. In the Mljet area it was recorded in the biocoenosis of mediolittoral rocks, in communities of photophilic algae, in a *Posidonia oceanica* bed, in the precoralligenous facies of the coralligenous biocoenosis, and in the biocoenosis of coastal detrital bottoms.

REMARKS: None of the collected specimens was infested by the ectoparasitic copepod *Cancerilla tubulata* as recorded elsewhere in the eastern Adriatic (ZAVODNIK, 1960a, b, 1997b).

Family: **Ophiothricidae Ljungman, 1866**

Ophiothrix fragilis (Abildgaard, 1789)

STATIONS: MLJ-4, 7, 8, 11, 13-18, 22, 23, 26-28, 32, 35, 39, 41-43, 45-48, 50-53, 57-59, 103, A, B, C (more than 400 specimens noted or collected).

DEPTH: 1-80 m.

HABITAT: All kinds of hard substrates such as bedrock and outcrops, bare substrates or those covered with algal or faunal turf, beneath loose stones and in anthropogenic litter, on secondary hard bottoms preferably within aggregations of encrusting algae and sessile animals, in stony coral (*Cladocora caespitosa*) colonies, and in bedrock crevices. Common in algal fronds and *Posidonia oceanica* rhizomes. The ecophenotype *O. quinquemaculata* was noted only on sandy detritic bottoms.

ECOLOGY: Species with a wide ecological distribution recorded in all hard bottom communities in the infralittoral and circalittoral zones. In the study area, it was extremely rare in fine sand and absent in muddy bottom communities.

REMARKS: TORTONESE (1959) recognized six colour varieties on the aboral side of the disc in *O. fragilis* collected from the Gulf of Genova, Tyrrhenian Sea. LUMARE (1966) described twelve (a-n) colour varieties in brittle stars inhabiting *Cladocora caespitosa* colonies in the Italian Mediterranean. In the Mljet population,

only the a, c, h and n varieties were noted (KRUŽIĆ, 2001). Each of the first three varieties was recorded in roughly one third to one quarter of the population while the n variety was recorded in only 7% of the collected specimens. Divers noticed the cryptic behaviour typical of *O. fragilis* individuals (arbitrary "shallow water form", not noted below 49 m). Individuals were rarely noted adhering to the surface of large sponges such as *Euspongia officinalis* and *Spirastrella cunctatrix*. In contrast, specimens of the "deep ecophenotype" *O. quinquemaculata* (GUILLE, 1965; BARIĆ, 1999) were recorded only in coastal detrital bottom communities at stations MLJ-A, B and C at a depth of 60-80 m, taking hold of trammel nets and benthic organisms. An extreme *O. fragilis* population density, comparable to that noted by BRUN (1969) at the Isle of Man in the Irish Sea, has never been recorded in the eastern Adriatic Sea.

Family: **Ophiocomidae Ljungman, 1867**

***Ophiopsila aranea* Forbes, 1843**

STATION: MLJ-32 (only one live arm found in the sample).

DEPTH: 15 m.

HABITAT: Extracted from a hollow loose stone in a dense *Posidonia oceanica* meadow.

ECOLOGY: Species with a wide ecological distribution (PICARD, 1965) preferring cryptic environments.

REMARKS: This species seems to be rare in the study area. Despite searching a great number of loose stones, hammered bedrock fragments and organogenic clumps, no other specimens of the genus *Ophiopsila* were found.

Family: **Ophiodermatidae Ljungman, 1867**

***Ophioderma longicaudum* (Retzius, 1805)**

STATIONS: MLJ-1, 11, 13, 14, 17, 20, 22, 26, 28-31, 34, 41, 43, 44, 47-49, 51, 59 (about 100 specimens noted or collected).

DEPTH: 2-30 m.

HABITAT: Bedrock covered by algal turf, in fissures and under loose stones. Only once noted on a coarse sandy deposit.

ECOLOGY: This species prefers the biocoenosis of photophilic algae. Noted occasionally on bare deposits and outcrops in *Posidonia oceanica* beds.

REMARKS: The studied specimens varied with regard to disk and arm colour patterns (TORTONESE, 1983). Green and dark brown were the basic colours, reddish and black were not noted. The maximum measured disk diameter was 29 mm. Compared to the report of TORTONESE (1983), the oral shields in all adult specimens from the Mljet area were naked, i.e., they were completely deprived of granules. Arm spines numbered 9, and only rarely 10 spines were counted in proximal joints. The number of arm spines was lower in juveniles as reported by MADSEN (1970): 5-6 spines were present in a specimen of 5 mm disk diameter, its dorsal arm plates were not subdivided but the greater part of the oral shields already lacked granule cover. *O. longicaudum* is a well-known voracious carnivore (TORTONESE, 1965; DESCHUYTENEER & JANGOUX, 1978). Its feeding behaviour and stomach contents were not studied in the present survey but I observed the attack of a brittle star on a large tubiform sabellid polychaete at a depth of 8 m at Ošljak Islet in the Zadar Archipelago. The brittle star grasped the worm in its jaws just below the tentacle crown. The ophiuroid pulled steadily until the body of the worm was about 20 cm out of its tube. Simultaneously the parapodia were torn away. The exposed part of the polychaete body was simply bitten through and devoured by the ophiuroid using only its jaws without any involvement of its arms. The operation took about 3 min. The aboral bulge of the disk of the brittle star remained the only evidence of the banquet.

***Ophioconis forbesi* (Heller, 1863)**

STATION: MLJ-D (2 specimens).

DEPTH: 50 m.

HABITAT: Sandy deposit trapped in an old fish net cast on a sandy detrital bottom rich in shell litter.

ECOLOGY: *O. forbesi* is confined to sandy detrital sediment and tolerant of the silty fraction (ZAVODNIK, 1977b).

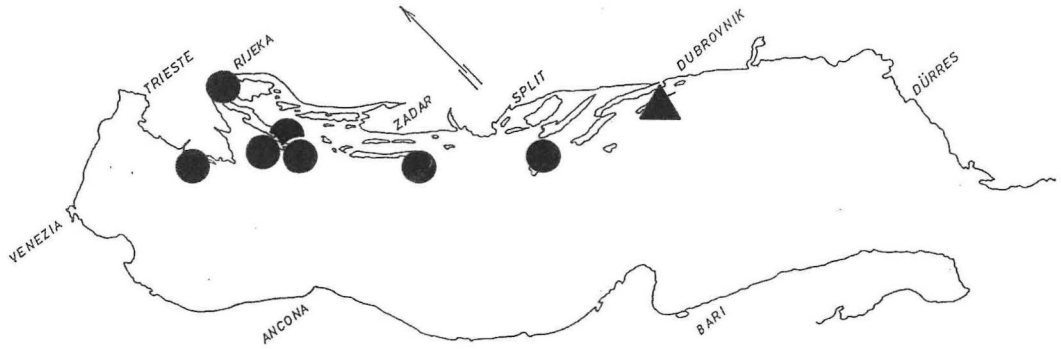

Fig. 20. Records of Ophioconis forbesi *in the Adriatic Sea.* ● *from the literature,* ▲ *present study*

REMARKS: This easily recognizable species has been noted in few localities in the eastern Atlantic and western Mediterranean (TORTONESE, 1956, 1965, 1984a; FREDJ, 1974). The Adriatic Sea records (HELLER, 1863, 1868; GRUBE, 1864; ZAVODNIK, 1977b, 1979a, 1997a, b) are plotted in Fig. 20. The present record of *O. forbesi* is the first in the southern Adriatic since the holotype was collected at Vis Island 140 years ago (HELLER, 1863).

Family: **Ophiuridae Lyman, 1865**

***Ophiura albida* Forbes, 1839**

STATIONS: MLJ-9, 25, 28, 63 (15 specimens).

DEPTH: 15-35 m.

HABITAT: Sandy silt.

ECOLOGY: *O. albida* is a species with a wide ecological distribution that prefers the coastal detrital bottom community (PICARD, 1965).

REMARK: All specimens were small, the maximum recorded disk diameter was 4.7 mm.

***Ophiura ophiura* (Linnaeus, 1758)**

STATION: MLJ-63 (1 specimen).

DEPTH: 35 m.

HABITAT: Coarse sand.

ECOLOGY: Species with a wide ecological distribution (PICARD, 1965).

REMARK: The disk of this specimen was only 9.8 mm across but one could readily recognize the species by its principal characters such as the shape of the dorsal and oral shields and the shield combs.

Class ECHINOIDEA Bronn, 1860

Order: **CIDAROIDA Claus, 1880**

Family: **Cidaridae Gray, 1825**

***Cidaris cidaris* (Linnaeus, 1758)**

STATIONS: MLJ-13, A , C (3 specimens).

DEPTH: 47-80 m.

HABITAT: Sandy detrital deposits.

ECOLOGY: Apparently, this species prefers deep detrital sands and sandy silt (TORTONESE, 1965).

REMARKS: In large specimens (maximum ambitus diameter 46-48 mm), the radioles were patchily encrusted by sessile organisms, especially European wing oysters (*Pteria hirundo*) and polychaete worms (*Serpula vermicularis*, *Pomatoceros triqueter, Hyalopomatus marenzelleri, Josephella* sp., *Filogranula* sp.). Foraminiferans, erect and flat bryozoans (*Crisia* sp., *Smittoidea marmorea*, *Scrupocellaria scruposa*) and cirriped crustaceans (*Scalpellum scalpellum*, *Paralepas minuta*) were rarely encountered. The finding of *P. minuta,* at a depth of about 70-80 m at station MLJ-A, is the first record of this species in the Adriatic Sea. The epifauna on cidaroid radioles was occasionally noted in the Mediterranean (LO BIANCO, 1909; MORTENSEN, 1928; TORTONESE, 1965). It appears that in the Adriatic, the only notes on the matter are those of PAX (1952), BROCH (1953) and PAX & MÜLLER (1962) who recorded the *Epizoanthus arenaceus* colony and *Scalpellum* specimens settled on *C. cidaris* at HVAR station no. 130 off the shore of Dubrovnik. At Glavat Islet (station MLJ-31), a cidaroid specimen was

noted on steep bedrock at a depth of only 38 m but it was not collected by the diver. Regarding habitat features and the relatively shallow depth, one cannot exclude the presence of the allied species *Stylocidaris affinis* that has rarely been recorded in the Adriatic (VIDOVIĆ-MATVEJEV, 1978). Additional voucher material would be appreciated.

Order: **ARBACIOIDA Gregory, 1900**

Family: **Arbaciidae Gray, 1855**

***Arbacia lixula* (Linnaeus, 1758)**

STATIONS: MLJ-11-23, 26, 28-31, 33, 34, 42-44, 46-52, 60-62 (some 300 specimens noted or collected).

DEPTH: 1-20 m.

HABITAT: Inclined bedrock and vertical walls usually well exposed to sunlight.

ECOLOGY: Species exclusive to the biocoenosis of photophilic algae and its facies *Lithophyllum incrustans*.

REMARKS: When cohabitant with *Paracentrotus lividus* at the same site, *Arbacia* is dominant in the upper horizon of the infralittoral zone, i.e., between sea level and a depth of about 1.5-2 m, while the *P. lividus* population becomes dense only below this depth. In the surveyed area, a maximum of 11 adult *A. lixula* were encountered per square metre. This population density is similar to that noted by KEMPF (1962) in the environs of Marseille. However, it is much higher than reported for Corsica (FRANCOUR *et al.*, 1994), and the Medes Islands Marine Reserve and adjacent coast (SALA *et al.*, 1998). A great majority of sea urchins inhabited exposed bedrock but only about 10% of the individuals were sheltered in shallow depressions. A few juveniles up to 8.0 mm ambital diameter were collected at a depth of 3-10 m. The smallest individual, collected at station MLJ-44 at 3 m, had a 5.5 mm ambitus diameter. Lacking in primary spines on its aboral side, the specimen was similar to *Arbaciella elegans*. However, the microstructure of cylindrical rod-like primary spines (REGIS, 1982) and the absence of gonopores and leaf-like spines suggest the present identification.

***Arbaciella elegans* Mortensen, 1910**

STATIONS: MLJ-16, 52 (2 specimens collected).

DEPTH: 10-16 m.

ECOLOGY: *A. elegans* prefers cryptic habitats (SCHEMBRI, 1978; SALAS & HERGUETA, 1994; GRUBELIĆ & ANTOLIĆ, 2000) in infralittoral and circalittoral zones to a depth of about 70 m. It was recorded in an epibiosis of live fan shellfish (*Pinna nobilis*) in the Messina Straits (GIACOBBE & RINELLI, 1991). Specimen CMRR 2772 was collected on a vertical cliff at the entrance of a submarine tunnel-like cave 45 m long. The area was occupied by a precoralligenous aspect of the coralligenous biocoenosis. Specimen CMRR 2773 was collected in an area dominated by a *Posidonia oceanica* bed. Regrettably, divers did not specify specimen microhabitats.

DESCRIPTION OF SPECIMEN CMRR 2772 (dried; Fig. 21): Collected by Mr. D. PETRICIOLI at the Lenga Cape (MLJ-16) at a depth of 16 m on 3 July 2002. Ambital diameter 10.6 mm, test height 5.0 mm, peristome 7.0 mm across, i.e., 66% ambitus diameter. Aboral area deprived of primary spines, spineless primary tubercles typically cauliflower-shaped. Primary spines of the ambitus and oral side 4-7 mm long, 0.65-0.72 mm wide, subcylindrical, flattened in the oral-aboral plane, pointed distally. Spine surface typically sculptured as described by REGIS (1982: Pl. I). The absence of broad leaf-like spines suggest "adult" morphology (SALAS & HERGUETA, 1994). Ophiocephalous pedicellariae present, tridactyle absent. Apical plates rough sculptured (REGIS, 1982: Pl. III). Madreporite with 32 openings, all 5 gonopores present. The test is black, primary spines blackish violet, distal tips glossy transparent.

DESCRIPTION OF SPECIMEN CMRR 2773 (preserved in 60% alcohol): Collected by Mrs. B. MIKAC in Procjep Cove (MLJ-52) at a depth of 10-15 m on 21 August 1998. Ambital diameter 5.2 mm, test height 3.0 mm. Spinulation and plate ornaments similar to those described in specimen CMRR 2772. Cauliflower-shaped primary tubercles well formed. A number of oral side primary spines subleaf-like, others subcylindrical, flat, transparent tips small or absent. Oral side of spines slightly convex, aboral side

subtriangular (REGIS, 1982: Pl. I) with 6 grooves. Madreporite with about 10 openings, gonopores absent. Colours of test and spines similar to specimen CMRR 2772.

REMARKS: The species holotype originated from Congolese waters (MORTENSEN, 1910). During the next few decades, the only records of *A. elegans* came from the African east Atlantic. In the early 1950s, the first specimen was collected in the Mediterranean (GAUTIER-MICHAZ, 1955). Now it is known from southeastern Spain (SALAS & HERGUETA, 1994) to Crete (PANCUCCI-PAPADOPOULOU, 1996). The Mediterranean records were summarized by REGIS (1982) and plotted by GRUBELIĆ & ANTOLIĆ (2000). Because of its small size and resemblance to juvenile *Arbacia lixula* (Fig. 21), the ecology and growth of *A. elegans* remained poorly known (TORTONESE, 1965) until the more recent studies of GIACOBBE & RINELLI (1991) and SALAS & HERGUETA (1994). The only published records of *Arbaciella* in the Adriatic were provided by GRUBELIĆ & ANTOLIĆ (2000) whose specimen of 4.5 mm ambitus diameter was collected among algae near Split at a depth of 5 m. Being stimulated by this paper, I reviewed old CMRR collections of small and juvenile echinoids. Only one *A. elegans* specimen was found (CMRR 538). It was collected at Rovinj (north Adriatic Sea) at 9 m depth. Other data were not noted. The specimen is dried, ambital diameter 4.3 mm, gonopores absent, primary spines flattened, slightly convex at the oral side, and subtriangular at the aboral side. A few juvenile *A. lixula* specimens were also found. To my regret, I did not locate two small specimens which I collected long ago from live *Pinna nobilis* shells (ZAVODNIK, 1967b). In all probability the specimens were lost in the Institute's collection when, for various reasons,

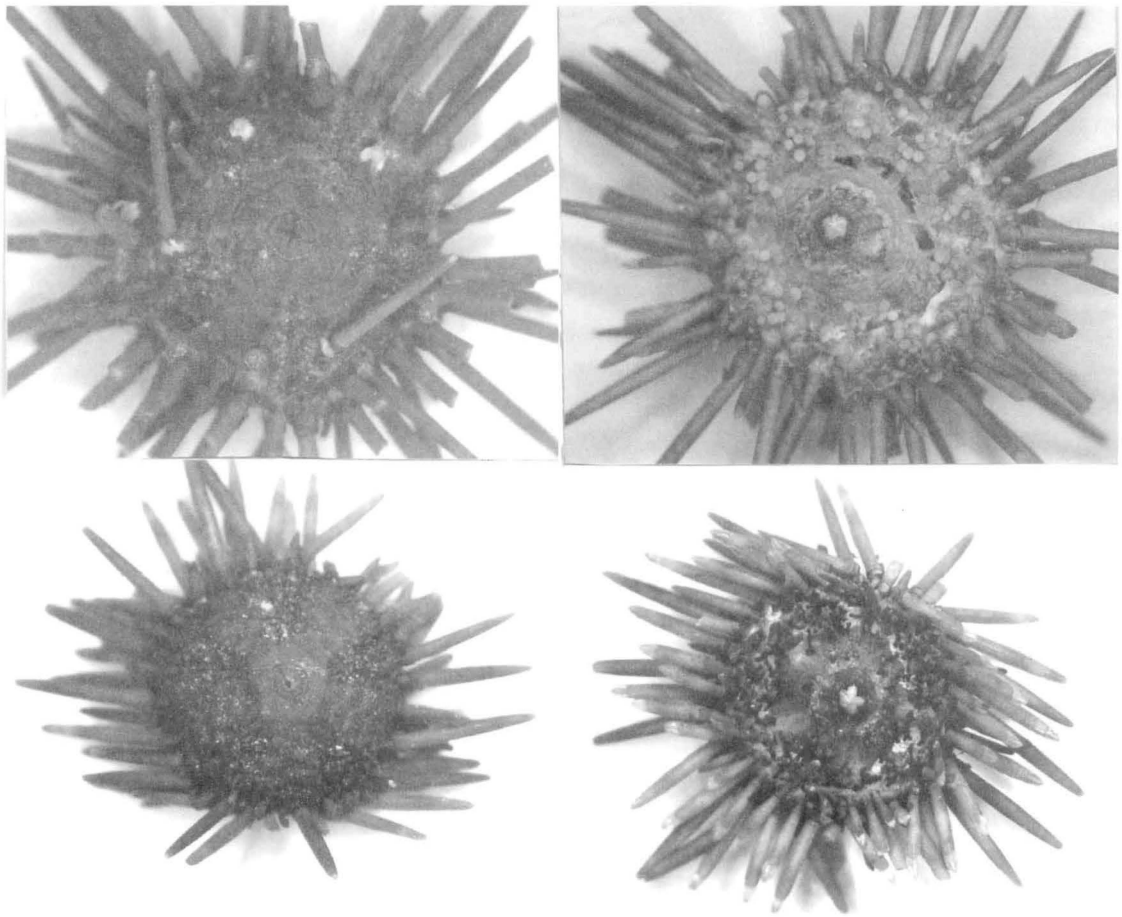

Fig. 21. Comparison of a juvenile Arbacia lixula *(Above: CMRR 1102, AD 10.8 mm) and an adult* Arbaciella elegans *(Below: CMRR 2772, AD 10.6 mm). Left: Aboral side Right: Oral side*

they were moved several times. Having no relevant literature or comparable biological material at my disposal at the time of collection forty years ago, I considered both specimens *A. lixula* juveniles. The arbitrary notes that the ambital diameter of the specimens was less than 4 mm, that the colour was blackish, and that the primary spines were flat, lead me to the supposition that my former identification was probably wrong and that the specimens collected from the *Pinna* shells were, in fact, *A. elegans*. In the Messina Straits, *Pinna* shells were recorded as a favourite substrate of *Arbaciella* (GIACOBBE & RINELLI, 1991).

Family: **Toxopneustidae Troschel, 1872**

***Sphaerechinus granularis* (Lamarck, 1816)**

STATIONS: MLJ-2, 3, 11-23, 28-30, 33-35, 39-54, 57, 59, 63, D (about 200 specimens noted or collected).

DEPTH: 2-54 m.

HABITAT: Rocky, gravel and sandy bottom. Rarely noted below shaded overhangs or at entrances to submarine caves.

ECOLOGY: This species prefers gravel and coarse sands influenced by bottom currents (PICARD, 1965). Not rare in *Posidonia oceanica* beds, occasionally noted in *Cymodocea nodosa* meadows, common at some sites in the biocoenosis of photophilic algae, recorded occasionally in the precoralligenous aspect of the coralligenous biocoenosis and in the community of coastal detrital bottoms.

REMARKS: The most abundant population was recorded by divers along the transect in the Procjep Cove area (station MLJ-52). Twenty individuals heaped together on the sandy bottom at a depth of 36 m were noticed. Similar aggregations, possibly related to spawning behaviour, were recorded elsewhere by PATZNER & ERHARDT (1991). Two aggregations of more than 200 individuals in an area of only 2-3 square metres were noted recently at Palagruža Island on a gravel deposit at 26 m depth (author's unpublished results). The ambitus diameter of the smallest specimen collected in Mljet National Park was 8.1 mm. The white tips of its primary spines extended over half of the spine length. At Vanji Školj Islet (station MLJ-13) and Debeli Rat (MLJ-29), at depths of 10 and 18 m, respectively, two specimens were collected in which all primary spines on oral and aboral sides were ivory white along their entire length while the skin was typically pigmented dark violet.

Family: **Echinidae Gray, 1825**

***Echinus acutus* Lamarck, 1816**

STATION: MLJ-A (1 specimen).

DEPTH: About 80 m.

HABITAT: Sandy detrital bottom.

ECOLOGY: Species is characteristic in the circalittoral community of detrital sand mixed with ooze, common somewhere on trawling grounds (ŠIMUNOVIĆ, 1997). Noted also in the coralligenous biocoenosis (RIEDL, 1966).

REMARKS: The specimen collected by a trammel bottom set was a juvenile with an ambitus diameter of 22 mm.

***Psammechinus microtuberculatus* (de Blainville, 1825)**

STATIONS: MLJ-2, 9, 16, 22, 25, 28, 29, 31, 48, 51, 53, 55 (12 specimens).

DEPTH: 10-30 m.

HABITAT: Although no specimens were noted at the time of collection, specimens were later extracted from a *Cystoseira corniculata* bush-like frond, from a *Posidonia oceanica* leaf, and a juvenile specimen from an encrusted *Pseudolithophyllum expansum* thallus. ŠILETIĆ & PEHARDA (2003) recorded one specimen on a live fan shell (*Pinna nobilis*). Other specimens were noted and collected in a precoralligenous community and on a silty detrital deposit.

ECOLOGY: PICARD (1965) recognized this species as exclusive to the biocoenosis of coastal detrital bottoms. My recent (mostly unpublished) data from other Adriatic Sea areas support a previous suggestion (ZAVODNIK, 1979b) that *P. microtuberculatus* is not exclusive to but prefers this community.

***Paracentrotus lividus* (Lamarck, 1816)**

STATIONS: MLJ-1, 11-17, 19-23, 26, 28-31, 34, 41-43, 46-49, 51, 52, 59, 61, E. Dense populations were recorded at some sites but only about 20 specimens were collected.

DEPTH: 0-18 m.

HABITAT: Bedrocks, bare and covered by algal turf, gentle slopes formed of boulders and gravel, rarely on sandy deposits and in *Posidonia oceanica* meadows. Occasionally noted in shaded places, entrances to underwater caves and deep crevices, and cavities beneath large loose stones and boulders.

ECOLOGY: Species is exclusive to the biocoenosis of photophilic algae (PICARD, 1965; BELLAN-SANTINI, 1969). It is capable, however, of entering underwater caves until algal turf becomes available as food (RIEDL, 1966).

REMARK: No substrate-boring behaviour of sea urchins, as suggested by OTTER (1932) and MÄRKEL & MAIER (1967), was recorded in the area, even at high energy sites exposed to wave action.

Order: **CLYPEASTEROIDA L. Agassiz & Desor, 1846**

Family: **Fibulariidae A. Agassiz, 1873**

Echinocyamus pusillus (O.F. Müller, 1776)

STATIONS: MLJ-11, 15, 22, 29, 101, 103 (6 live specimens); 16, 22, 29, 30, 34, 36, 37, 39-43, 45-48, 50-53, 57, 101, 102, 107, 112-115, 120 (numerous tests).

DEPTH: Live specimens were collected at 47-60 m and tests at 4-103 m.

HABITAT: Sand and gravel deposits enriched at some sites by silt.

ECOLOGY: Specimens were collected in the study area in sand and gravel in *Cymodocea nodosa* and *Posidonia oceanica* meadows, in the biocoenosis of coarse sand and fine gravel influenced by bottom currents, and in the community of coastal detrital bottoms and those mixed with ooze.

REMARKS: The morphometric analysis of tests collected at station MLJ-37 in the Veliko Jezero seawater lake revealed variations in

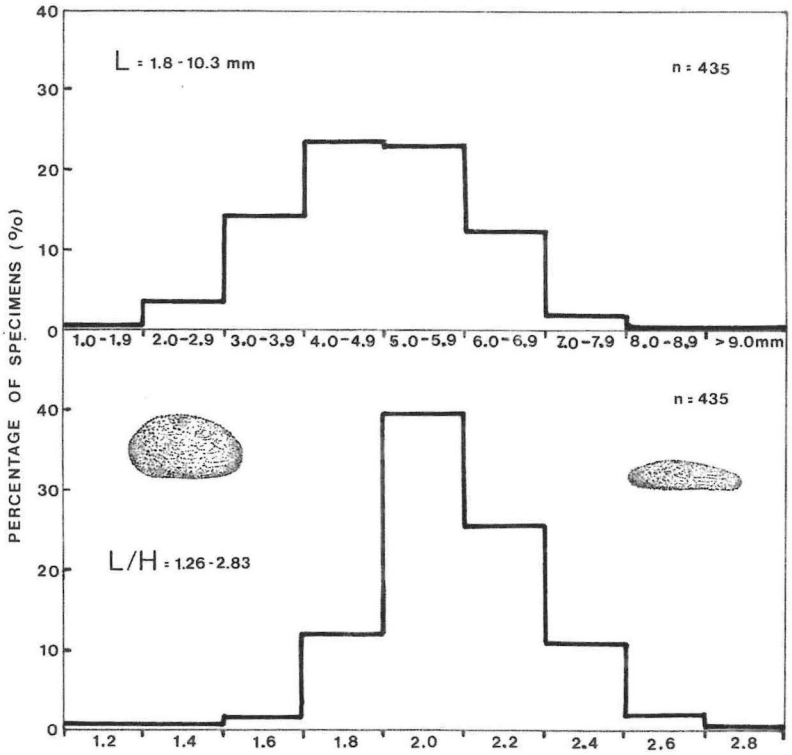

Fig. 22. Morphometry of the Echinocyamus pusillus *tests*

length, width and height (Fig. 22). Similar variations in proportional test height, noted by ERNST *et al.* (1973) in rock dwellers belonging to the genera *Arbacia*, *Paracentrotus* and *Sphaerechinus*, were explained by energy disposition of the sea urchin habitats. Despite the fact that extreme flattened (L/H ratio 2.83) and extreme convex (L/H 1.26) "dead" tests were collected at the same site, this hypothesis could not be checked in the Mljet *E. pusillus* because of the possibility that strong bottom currents transported tests, causing spatial accumulation. Minor variations were also noted in colours of live specimens. For example, in two live individuals collected at a depth of 49 m at station MLJ-103, the basic test and spine colour was similar to milky-coffee. In one individual, however, the petaloid areas were slightly darker, while in the second specimen all petaloid areas were dark brown compared to the basic colour of the animal. Among several hundred studied tests, only one was misshapen, having a deep longitudinal "wrinkle" on its oral side (Fig. 23) similar to a test reported by KOEHLER (1924b). MORTENSEN (1948), however, did not note test malformations in this species. At some sites, *E. pusillus* tests were a dominant component in local taphocoenosis that might have contributed essentially to the sediment characteristics as FISCHER (1869, according to MORTENSEN, 1948) and STUDER (1880) suggested long ago. The most abundant assemblage of dead tests was recorded at station MLJ-37 in the Veliko Jezero saltwater lake at a depth of 45-47 m: 148 tests per one litre of sediment were noted (I. RADIĆ, personal communication). Because of their small size, dead tests extremely rarely serve as a support for sessile organisms: small unidentified filamentous algae were noted on only one "old" test and about one third of its surface was encrusted by a tiny *Lithophyllum incrustans*.

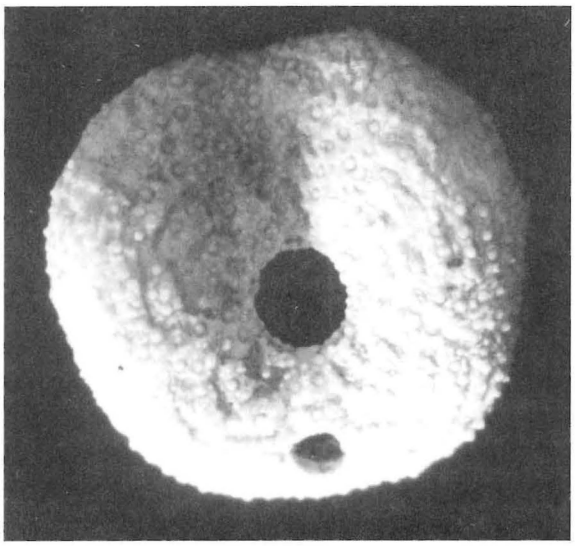

Fig. 23. A theratological Echinocyamus pusillus *specimen (CMRR 2104, TL 4.2 mm)*

Order: **SPATANGOIDA L.Agassiz, 1836**

Family: **Spatangidae Gray, 1825**

***Spatangus purpureus* (O.F. Müller, 1776)**

STATIONS: MLJ-32, 42, 50 (3 live specimens); 29-31, 34, 44, 46, 50-52, 63 (more than 200 tests noted or collected by divers).

DEPTH: 20-46 m.

HABITAT: Deposits of coarse sand and fine gravel.

ECOLOGY: According to PICARD (1965) this species prefers the biocoenosis of coarse sand

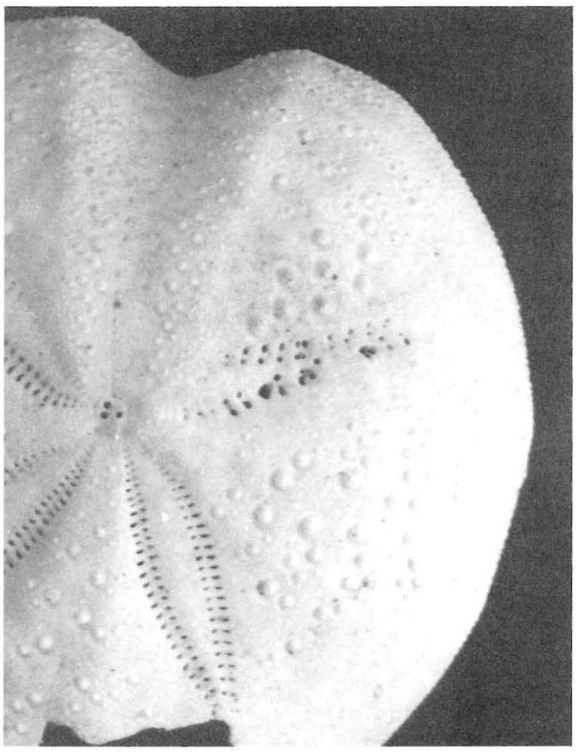

Fig. 24. Detail of a theratological Spatangus purpureus *test (CMRR 1675, TL 57 mm)*

and fine gravel influenced by bottom currents. In the study area, "fresh" tests were also noted in a *Posidonia oceanica* bed and in the biocoenosis of coastal detrital bottoms.

REMARKS: At some sites in Mljet National Park, for example in Stupe (station MLJ-50) and Procjep (station MLJ-52) Coves, the sea bottom was literally "sowed" by dead *S. purpureus* tests. Tubiform polychaetes (*Pomatoceros triqueter*, Spirorbids), the foraminiferan *Miniacina miniacea*, and the gastropod *Calyptraea sinensis* (up to four specimens per test) settled on some of them. One specimen of a hexacorallian *Hormathia coronata* found shelter inside a dead test collected at station MLJ-31 at a depth of 40 m (KRUŽIĆ, 2002). In one 61.4 mm test collected at station MLJ-52 (CMRR 1674), the posterior petals were narrowed in the distal half, confering a rather slim appearance (BONNET, 1926, Fig. 6b). In a 54 mm test collected at station MLJ-46 (CMRR 1675), the anterior petal II was oligoporous (Fig. 24). Both ambulacral rows were imperfect, pore pairs were irregularly aligned or unformed, or two adjoining pores were fused together creating a single much larger pore. Such malformation was not noted by KOEHLER (1924b) in irregular echinoids. Variations in proportional height were insignificant in the studied specimens. The highest was a 79 mm test collected at station MLJ-50 (CMRR 2289) where the height/length ratio (0.62) was within the range established by BONNET (1926) in the western Mediterranean.

Family: **Loveniidae Lambert, 1905**

***Echinocardium fenauxi* Péquignat, 1963**

STATIONS: MLJ-31, 41, 51 (5 tests).

DEPTH: 3 m.

HABITAT: Coarse sand mixed with shell debris.

ECOLOGY: Species exclusive to the biocoenosis of coarse sand and fine gravel influenced by bottom currents (PICARD, 1965).

REMARKS: Specimens were 46-65 mm long. In specimens collected in the Hvar Island area, morphometric variations in endopetalic fasciola, periproct position, plastron size, number of ambulacral pores, etc., were within ranges noted by WÖRHEIDE (1995). In Mljet specimens, the most remarkable variation was noted in height (7.0-10.0 mm) versus width (8.0-12.5 mm) of the periproct. Contours varied from subcircular (H/W 0.95) to widely elliptical (H/W 0.67) as figured by PÉQUIGNAT (1963). One can easily recognize typical *Echinocardium cordatum* and *E. fenauxi* tests (PÉQUIGNAT, 1963; TORTONESE, 1965) but the overlapping of several morphometric characters in many specimens (WÖRHEIDE, 1995) can make identification difficult. The close affinity of these sympatric species in the western Mediterranean is evident. They differ, however, in ecological preferences (PÉQUIGNAT, 1963; WÖRHEIDE, 1995) and, perhaps, genetically (FÉRAL *et al.*, 1998) - a phenomenon comparable to that in brittle stars *Ophiothrix fragilis* and *O. quinquemaculata*. The test of the largest *E. fenauxi* specimen (D 65 mm, W 67 mm, H 41 mm; CMRR 2033) was asymmetrical since the posterior part bent towards the right; the subanal fasciole and three subanal pore pairs at each side were oblique (Fig. 25). In this curious specimen, the ambu-

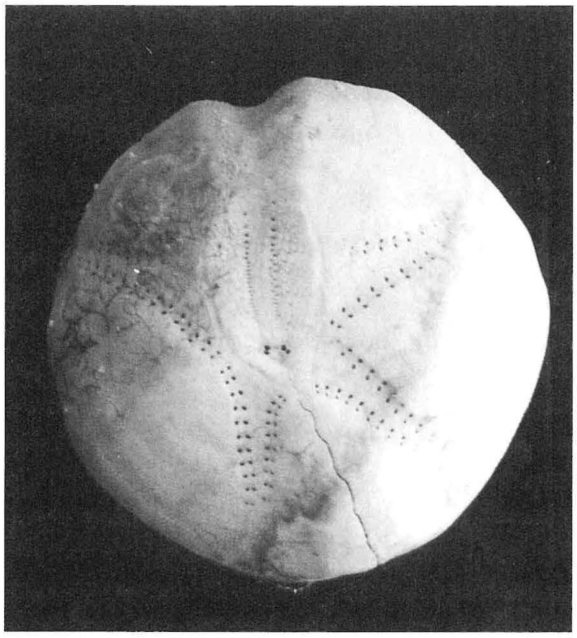

Fig. 25. A theratological Echinocardium fenauxi *specimen (CMRR 2033, TL 65 mm)*

lacrum I, II and V pore pairs were fewer in number (i.e., 21, 20, 21) than in normally shaped specimens (23-25, 21-22, 23-25). To my knowledge, this is the first record of test malformation in this species. However, similar malformations were described in *E. cordatum* by KOEHLER (1924 b) and in *Brissopsis lyrifera* by BRATTSTRÖM (1946).

Echinocardium mortenseni Thiéry, 1909

STATIONS: MLJ-30, 46 (2 tests).

DEPTH: 30-41 m.

HABITAT: Sandy deposit mixed with shell litter.

ECOLOGY: According to PICARD (1965), this is a companion species with a wide ecological distribution. It prefers mixed deposits enriched by silt (CATTANEO, 1981).

REMARKS: Collected tests measured 23 and 41 mm in length. The first Adriatic Sea record of this species was provided by ERNST *et al.* (1973) from the Hvar Island area. Recently, tests deprived of spines were collected in Rijeka Bay, near Grgur Islet, and at Silba Island at depths of 12-73 m (author's unpublished results). Consequently, the distributional range of this species is not limited in the western area of the Mediterranean Sea, as suggested by FREDJ (1974) and GIACOBBE *et al.* (1996).

Echinocardium sp.

STATIONS: MLJ-31, 48 (2 tests)

DEPTH: 6-10 m.

REMARKS: A diver noted tests as *Echinocardium cordatum* (see MIKAC, 2001) but, unfortunately, both were critically fragmented before analysis and precise identification was impossible.

Family: **Schizasteridae Lambert, 1905**

Schizaster canaliferus (Lamarck, 1816)

STATIONS: MLJ-9, 24, 25, 32 (4 live specimens, 6 tests collected).

DEPTH: 5-36 m (alive), 1-36 m (tests).

HABITAT: Sandy silt, fine sand, and fine gravel within the *Posidonia oceanica* meadow.

ECOLOGY: A silt-tolerating species (ZAVODNIK, 1979b) characteristic to the biocoenosis of detrital bottoms partly mixed with ooze. This community is most distributed in the shallow northern Adriatic Sea (GAMULIN-BRIDA, 1967, 1974). VATOVA's (1949) zoocoenoses *Schizaster chiajei litoranea* and *Schizaster chiajei pelagica* are included. A similar zoocoenosis *Schizaster-Turritella* (VATOVA, 1935) located in Limski Kanal (Istria Peninsula) belongs to the biocoenosis of coastal terrigenous ooze by its faunistic composition (ZAVODNIK, 1971).

REMARKS: Records of live individuals in deposits varying from soft silt to detrital sand (CATTANEO, 1981) and fine gravel do not support the suggestion of SCHINNER (1991) noted in laboratory experiments that this species is highly dependent on fine sediment particles. Apparently *S. canaliferus* prefers the biocoenosis of coastal detrital bottoms mixed with ooze (ERNST *et al.*, 1973) and is tolerant of other fractions (ZAVODNIK, 1971, 1979b). For this reason, it is abundant and widely distributed in the northern Adriatic Sea. Regrettably, in the Mljet Island area, due to the shortage of live specimens, the abundance of the species could not be estimated. In the Malo Jezero seawater lake (station MLJ-24 area), many "fresh" tests, some still bearing spines, were recorded in fine sand at only 1-4 m depth. This is the shallowest mark ever noticed in the Adriatic Sea. One can assume that the density of "fresh" taphocoenose indicates the presence of a recent population (KIDWELL & BOSENCE, 1991). Divers at this site, however, did not collect live individuals that normally live deeply buried in the sediment.

Family: **Brissidae Gray, 1855**

Brissopsis lyrifera (Forbes, 1841)

STATION: MLJ-115 (1 test)

DEPTH: 86 m.

HABITAT: Sandy silt.

ECOLOGY: This pelophilous species is tolerant of sandy fractions (PICARD, 1965). In the Adriatic Sea, it prefers the biocoenosis of

coastal terrigenous ooze (GAMULIN-BRIDA, 1967; ZAVODNIK, 1979b).

REMARKS: The single collected test was "fresh" but fragmented. However, the apical area, the petals and the fasciola were recognizable and there was no doubt about the identification of the species. Live voucher material would be appreciated to confirm the presence of this species within Mljet National Park.

Brissopsis sp. aff. *mediterranea* (Mortensen, 1913)

STATION: MLJ-57 (1 test collected by Mrs. B. MIKAC on 31 July 1998).

DEPTH: 45 m.

HABITAT: Coarse sand.

DESCRIPTION: The test lacks spines and pedicellariae and is thin and fragile (Fig. 26). The area of the periproct and subanal fasciole is broken off. Plates of the antero-lateral ambulacra (II and IV) bear small tubercules arranged in more or less distinct rows. There are very fine tubercles, both aligned in rows and scattered, between pore pairs in petals I, II, IV, and V. Measurements: total test length about 58 mm, test width 53 mm (91% of the total test length), test height 40 mm (69%), anterior petals 15 mm long (26%) and 4 mm wide, posterior petals 15 mm long and 5 mm wide. Posterior petals confluent proximally but diverge at about one half their length. Distal ends of the anterior petals are about 41% of the test length apart. Anterior and posterior petal curvatures are similar. Peripetalous fasciole are typically contoured (CHESHER, 1968), straight at the posterior end, and of more or less uniform width. It slightly widens only at the ends of petals II and IV and in the median area of the interambulacrum 5. The apical system is 27 mm from the anterior end of the test (46% of the total test length). Of 4 genital pores, the anterior pair is smaller than the posterior pair. The madreporite is drop-like and a bit longer than the distance between the outer edges of the posterior genital pores. The peristome is crescent-shaped and 13 mm (22% of the total test length) from the anterior end of the test. The labrum is well developed. The specimen is deposited in the Rovinj Center for Marine Research reference collection (CMRR 2286).

REMARKS: There are few morphometric characters by which to distinguish between *Brissopsis atlantica* and *B. mediterranea* (MORTENSEN, 1951; CHESHER, 1968) that constitute a species group with little genetic divergence within the genus *Brissopsis* (CHESHER, 1968). Their ranges overlap in the Atlantic, but *B. mediterranea* is believed to be the only representative of the group in the Mediterranean (TORTONESE, 1980). The taxon was erected by MORTENSEN (1913) as *B. atlantica* var. *mediterranea*. It was considered a subspecies named *B. atlantica mediterranea* by TORTONESE (1965), FREDJ (1974), VIDOVIĆ-MATVEJEV (1978) and HANSSON (2001). After detailed morphometric analysis, CHESHER (1968) argued that *B. mediterranea* is a "good species". TORTONESE (1980) and I accepted this suggestion. Unfortunately, due to the damaged posterior of the test and the lack of spines and pedicellariae, precise identification of the Mljet specimen is impossible. The distinctly crescent shaped peristome and the position of the slightly widened portions of the peripetalous fasciole accord with *Brissopsis atlantica*. However, due to the probably vertically truncated posterior of the test, the tuberculation pattern of the antero-lateral ambulacra, the shape of peripetalous fasciole, the percentage range of some characters, and considering the known species distribution of *Brissopsis*, I consider that the studied specimen represents *B. mediterranea*. BRUNO (1972) noticed the confluence of posterior petals in some *Brissopsis* specimens collected in Boka Kotorska Bay. Following doubts expressed by TORTONESE (1965) and CARPINE (1970), she believed the specimens were *B. lyrifera*. *B. lyrifera* is a common echinoid species in the Mediterranean whilst *B. mediterranea* was recorded in few localities (MORTENSEN, 1913; TORTONESE, 1965; CARPINE, 1970; PANCUCCHI-PAPADOPOULOU, 1996; RINELLI & SPANÓ, 1997). The only Adriatic Sea record was provided by KOLOSVÁRY (1937) who studied three specimens (tests?) provided by the first Hungarian NAJADE voyage in 1913 (LEIDENFROST, 1914; STILLER-RÜDIGER & ZAVOD-

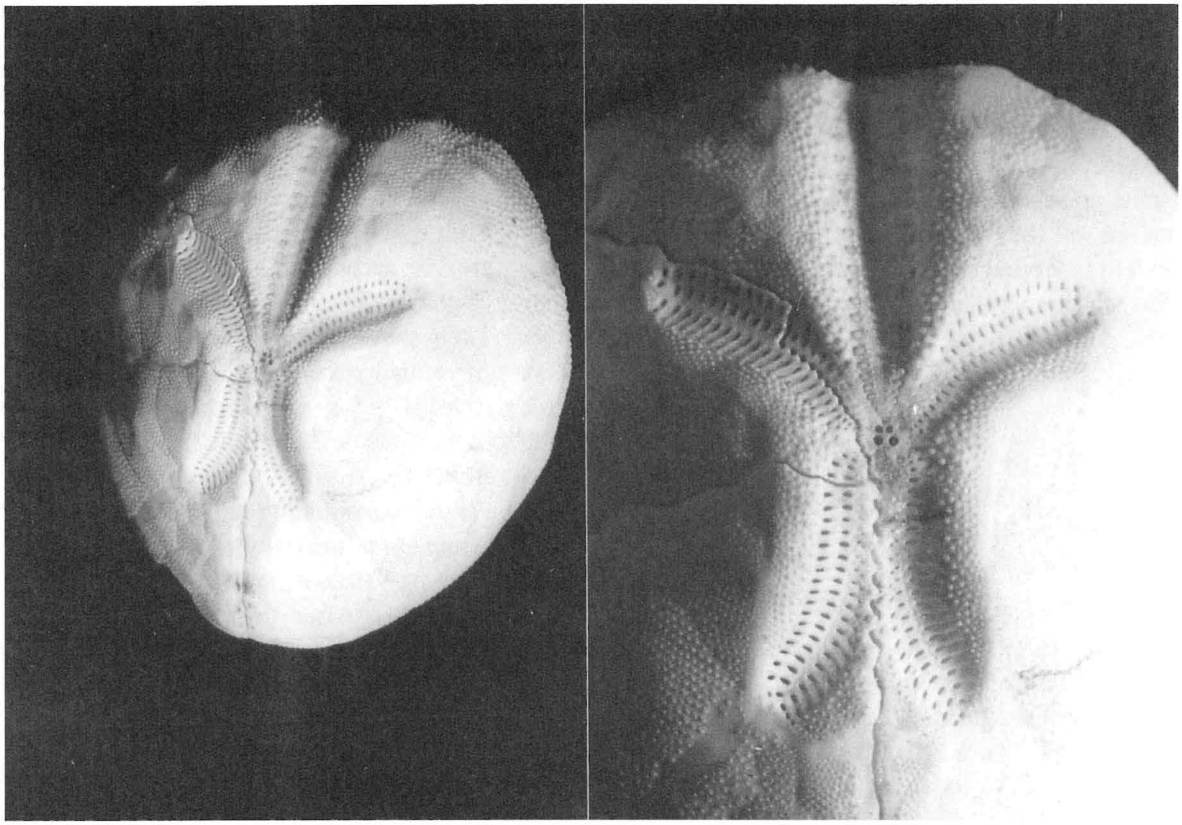

Fig. 26. A Brissopsis *sp.aff.* mediterranea *test (CMRR 2286, TL 58 mm). Left: Aboral-side view; Right: Petal area*

NIK, 1990) and identified them as *B. atlantica*. CHESHER (1968: 43) disagreed with this identification. Specimens were collected from a depth of 90-100 m in Krušije Channel between Cres and Plavnik Islands in the northern Adriatic at station B26 (erroneously noted B6 by KOLOSVÁRY, 1937). Probably, the second noted station (N.II B31), visited during the second NAJADE voyage in spring 1914, was identical to station B26. Specimens were deposited at the Budapest Natural History Museum. Study of these specimens, regrettably, is now impossible because the collections of the Hungarian NAJADE voyages were lost in a fire in 1956 (STILLER-RÜDIGER & ZAVODNIK, 1990). *B. mediterranea* is a species of muddy deposits (TORTONESE, 1965), recorded in the biocoenosis of coastal terrigenous ooze (RODRÍGUEZ & IBÁÑEZ, 1984). Accordingly, the occurrence of the Mljet test on coarse sand perhaps does not indicate an original habitat of live specimens.

Brissus unicolor (Leske, 1778)

STATIONS: MLJ-28, 31, 32, 42, 63 (7 tests).

DEPTH: 5-25 m.

HABITAT: Bare well-sorted sand and coarse sand within *Posidonia oceanica* beds.

ECOLOGY: This species probably has a wide ecological distribution (TORTONESE, 1965).

REMARKS: The studied tests were 38-105 mm in length. An "old" test (44 mm long) was collected at station MLJ-42 whose surface protruded from the sandy deposit and was marked with scratches similar to those generated by radulae of grazing gastropods or sea urchin teeth (Fig. 27). The true cause of the markings, however, remains unknown. In one of the two tests collected at station MLJ-63, the posterior petal V was bent outwards. This species has rarely been recorded in the Adriatic. TORTONESE (1965, 1984) reported it from Triest, Poreč, and the area of Puglia. In the Center for

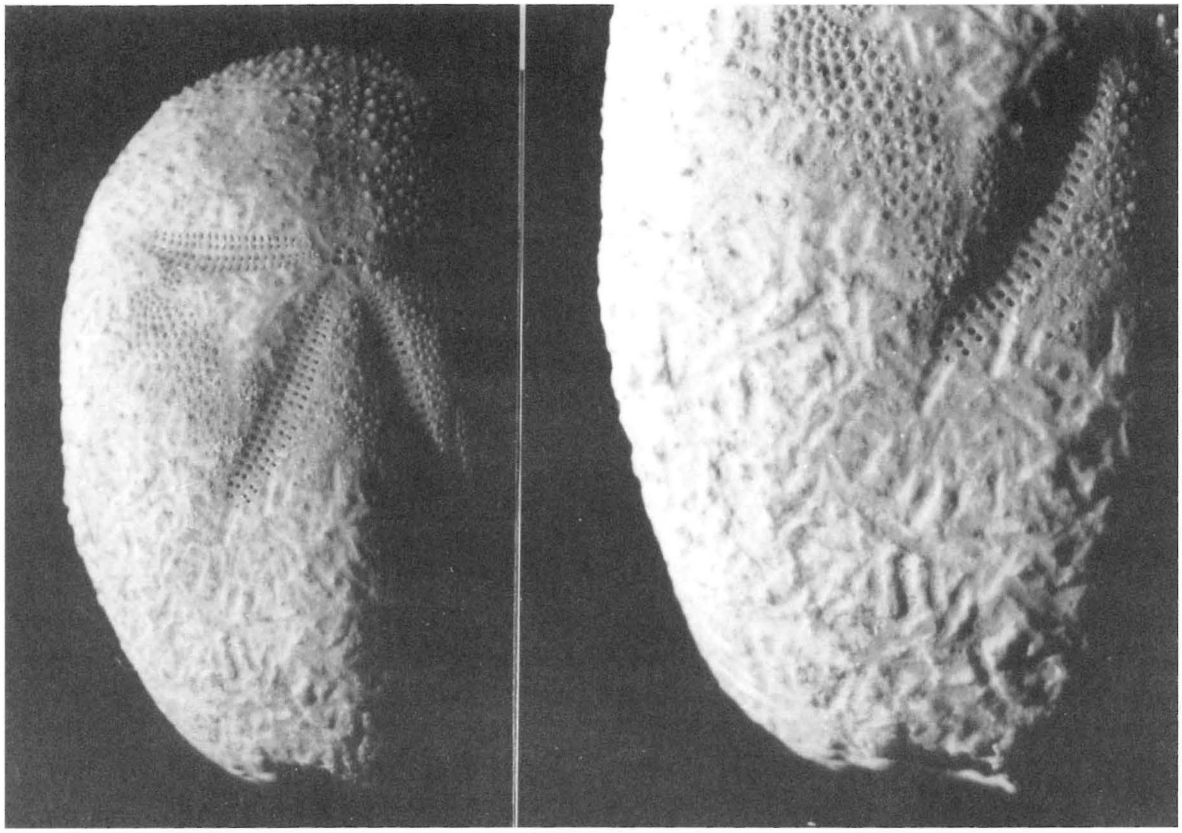

Fig. 27. Brissus unicolor. *A scratched test (CMRR 2287, TL 44 mm). Left: Aboral view; Right: A detail*

Marine Research Rovinj reference collection there is a test 131 mm long (CMRR 1910) that was collected by Mr. M. RICHTER near Orebić (Pelješac Peninsula) at a depth of only 6 m. The undocumented record of KOLOSVÁRY (1937) on the presence of *B. unicolor* at Rijeka could not be verified since no new records of this species have been made in the area during the past sixty years of thorough research (ZAVODNIK, 1998).

GENERAL DISCUSSION AND CONCLUSIONS

This paper is the first comprehensive report on echinoderms of the Mljet Island environs and, particularly, Mljet National Park. Of numerous protected areas and three national parks in the Croatian territorial sea (BRALIĆ, 1990; RADOVIĆ, 1999), similar reports or checklists of marine macrofauna are available only for bivalve molluscs (HRS-BRENKO, 1997), echinoderms (ZAVODNIK, 1997b), and fish (JARDAS *et al.*, 1997) in Kornati National Park. A comprehensive report on Mljet National Park anthozoans was recently prepared by KRUŽIĆ (2002).

In addition to *Leptopentacta elongata* recorded by PANNING (1966), 52 echinoderm species and one ecophenotype were identified during our 1995-2003 research (Table 4). Unfortunately, several specimens were not identifiable on a specific level or their records could not be compared with voucher specimens. Perhaps future research will remedy this problem.

Recognized taxa account for 50% of the echinoderms recorded in the Adriatic Sea. Most of the Mljet Island species (56%) belong to Atlantic-Mediterranean stock species. Boreal-Mediterranean echinofauna is represented by 11 (21%) species while 10 (19%) species are Mediterranean endemics and only two (i.e.,

Table 4. Echinoderms recorded in the Mljet National Park. Codes are explained at the bottom of table

Taxon	General distribution	Bottom habitat	Ecological significance
CRINOIDEA			
Antedon mediterranea	MM	A,P,R,S,	Wed.
HOLOTHUROIDEA			
Holothuria (Holothuria) helleri	AM	R	pref. PSW
Holothuria (Holothuria) cf. *mammata*	MM	?	?
Holothuria (Holothuria) stellati	MM	P,S	?
Holothuria (Holothuria) tubulosa	AM	S,R	Wed.
Holothuria (Roweothuria) polii	AM	G,S,R	Wed.
Holothuria (Thymiosicia) impatiens	C T	R (crypt.)	Wed.
Holothuria (Platyperona) sanctori	AM	R (crypt.)	pref. PSW
Holothuria (Panningothuria) forskali	MM	M,R,S	Wed.
Eostichopus regalis	AM	MS	Silt tol.
Ocnus planci	AM	MS	pref. CD
Leptopentacta elongata	BM	M,MS	Silt tol.
Labidoplax digitata	AM	M,MS	ex. CTO
ASTEROIDEA			
Luidia ciliaris	BM	G,R	Wed.
Astropecten aranciacus	AM	S	Wed.
Astropecten irregularis	AM	S,SM	Min.
Astropecten platyacanthus	MM	S,R	Mix.
Astropecten spinulosus	MM	A,P	pref. BMP
Asterina gibbosa	AM	R	pref. PSW
Asterina pancerii	MM	P	ex. BMP
Peltaster placenta	AM	R	Wed.
Ophidiaster ophidianus	AM	R	pref. C
Hacelia attenuata	AM	R	pref. C
Echinaster sepositus	AM	G,R	Wed.
Coscinasterias tenuispina	AM	R (crypt.)	pref. PSW
Marthasterias glacialis	BM	D,G,R	Wed.
OPHIUROIDEA			
Ophiomyxa pentagona	AM	D,R	Wed.
Ophiacantha setosa	AM	D	pref. OD
Amphiura (Amphiura) chiajei	BM	D,MS,S	Silt tol.
Amphiura (Amphiura) filiformis	BM	M,MS,SM	Min.
Amphiura (Ophiopeltis) securigera	BM	D	Sand tol.

Table 4. cont'd

Amphipholis squamata	CP	A,P,R,S	Wed.
Ophiothrix fragilis	AM	A,P,R	Wed.
(Ophiothrix quinquemaculata)	MM	D	ex. CD
Ophiopsila aranea	AM	S (R crypt.)	Wed.
Ophioconis forbesi	AM	S	Sand tol.
Ophioderma longicaudum	AM	R	pref. PSW
Ophiura albida	AM	SM	pref. CD
Ophiura ophiura	AM	S	Wed.
ECHINOIDEA			
Cidaris cidaris	BM	D	Sand tol.
Arbacia lixula	AM	R	ex. PSW
Arbaciella elegans	AM	R (crypt.)	?
Sphaerechinus granularis	AM	G,R,S	Wed.
Echinus acutus	BM	D	Wed.
Psammechinus microtuberculatus	MM	A	pref. CD
Paracentrotus lividus	AM	G,R,S	ex. PSW
Echinocyamus pusillus	BM	G,S	Grav.
Spatangus purpureus	BM	G,S	pref. SGBC
Echinocardium fenauxi	MM	S	ex. SGBC
Echinocardium mortenseni	MM	S	pref. DO
Schizaster canaliferus	MM	MS,S	pref. DO
Brissopsis lyrifera	BM	SM	pref. CTO
Brissopsis sp. aff. *mediterranea*	AM	S	?
Brissus unicolor	AM	S	Sand ex.

Distribution codes
AM - Atlantic Mediterranean; BM - Boreal Mediterranean; CP - Cosmopolitic; CT - Circumtropical; MM - Mediterranean (endemic).

Bottom & habitat codes
A - algae (epiphytic); D - Detrital sandy sediment rich in organogenic debris; G - gravel, pebbles, cobbles; M - mud, silt; P - marine phanerogams (epiphytic); R - rock, anthropogenic wastes; S - sand.

Ecology codes
BMP - beds of marine phanerogams; C - coralligenous community; CD - community of coastal detrital bottom; CTO - community of coastal terrigenous ooze; DO - community of coastal detrital bottom mixed with ooze; OD - community of offshore detrital bottom; PSW - photophilic seaweed settlements; SGBC - community of sand and gravel under bottom currents; crypt. - species preferring cryptic habitats; ex. - species exclusive to the community; pref. - species preferential to the community; Min. - species inhabiting fine sand and silt; Mix. - species living on mixed sediment; Grav.- species inhabiting gravel and pebbles; Sand ex.- species exclusive to sandy sediment; Sand tol. - species inhabiting sandy sediment and tolerant to other fractions; Silt tol. - species inhabiting silty sediment and tolerant to other fractions; Wed. - species of wide ecological distribution.

Holothuria impatiens and *Amphipholis squamata*; 4%) are distributed worldwide. Perhaps most interesting is the record of the brittle star *Amphiura securigera*, which was believed to be of boreal-Atlantic origin (KOEHLER, 1924a; D'JAKONOV, 1954). On the other hand, in the sea around Mljet Island - the southernmost large island in the Adriatic - an abundance of typical warm water species such as *Holothuria sanctori*, *Hacelia attenuata* and *Ophidiaster ophidianus* (KOEHLER, 1924a; TORTONESE, 1957b, 1965) was anticipated. The thermophilous diadematoid sea urchin *Centrostephanus longispinus*, however, was not recorded during the present research. This species was earlier collected at several localities in the central and southern Adriatic, i.e., off the Dubrovnik shore (LEIDENFROST, 1917), along the Montenegrine littoral (GAMULIN-BRIDA, 1963a, 1963b, 1972), in Vis Strait (GAMULIN-BRIDA, 1963b, 1965, 1979), and at Komiža (Vis Island; author's unpublished record). A specimen collected by F. STEINDACHNER at Hvar Island about a century ago is deposited at the Natural History Museum at Vienna (Mus. Vind. 10769). Considering the ecological preferences of this species (TORTONESE, 1975; FRANCOUR, 1986) and its distribution in the Adriatic, the future occurrence of *C. longispinus* in Mljet Island waters can be expected. The same can be said for *Genocidaris maculata*, although it has rarely been noted in the Adriatic Sea (ZAVODNIK, 1979c; GRUBELIĆ, 1993, 1998).

The diversity of echinoderm fauna at Mljet Island is apparently low, evidenced by the low occurrence of dendrochirote holothurians, astropectinid starfishes, and amphiurid brittle stars. Many of these taxocoenes are related to mixed and sandy detrital sediments (TORTONESE, 1965; RINELLI & SPANÒ, 1997) that are not abundant in the study area. Further, many species are inactive during the daytime when they burrow into the sediment or are concealed by loose stones, organogenic clumps, algal turf, etc., escaping a diver's attention. For various reasons, our research was mostly carried out during the daytime, thus the diving method was inevitably selective. In depths accessible to skin and SCUBA divers, a dominant deposit fraction in the study area is well-sorted or coarse sand and gravel rich in organogenic debris, a favourite environment for the majority of Adriatic astropectinid species. However, specimens of the genus *Astropecten*, for unknown reasons, were rather rarely recorded or collected by divers in Mljet National Park. The selective skin and SCUBA diving method was chosen since the principal goal of our research was to gather as much information as possible in an area that had not yet been studied.

The echinoderm diversity in ecological niches such as *Posidonia oceanica* beds and submarine cliffs was comparable to reports from Lokrum Island near Dubrovnik (BELAMARIĆ & ŠERMAN, 1989; ŠPAN *et al.*, 1989), Kornati Archipelago (GRUBELIĆ, 1992, 1997; ZAVODNIK, 1997b), and the offshore Jabuka Islet (ZAVODNIK *et al.*, 2000). However, an ecological niche unique to Mljet National Park appeared to be a stony coral (*Cladocora caespitosa*) bioherm (PEIRANO *et al.*, 1998) recently studied by KRUŽIĆ (2001, 2002) and KRUŽIĆ & POŽAR-DOMAC (2002). *Amphipholis squamata, Amphiura chiajei, Ophiothrix fragilis* and *Ophiura albida* were recorded between corallites of colonies about 30 cms in diameter. Some 20-30 ophiuroid individuals per colony were counted, half of which were *Ophiothrix fragilis*, a typical cryptic species and long-known cohabitant of stony coral. The presence of a very ecologically tolerant species such as *Amphipholis squamata* was anticipated, but the records of strictly sediment living *Amphiura chiajei* and *Ophiura albida* were a surprise. Individuals of the latter two species were extracted from the deposit accumulated between *Cladocora* corallites.

The comparison with echinoderm fauna from other eastern Adriatic areas is interesting (Table 5). For example, of 61 echinoderm species recorded in Kornati National Park (ZAVODNIK, 1997b), 180 km northwest of Mljet Island, 44 species are common to Mljet National Park. Geomorphic, sediment and hydrographic characteristics, ecological niches, and benthic communities are similar in both

Table 5. Echinoderms diversity in selected Adriatic Sea areas. Columns 2 and 4 refer to area and maximum depth explored

Area	Sea surface (km^2)	Maximum depth (m)	No. stations surveyed	Echinoderm species (No.)	Sources
1	2	3	4	5	6
Rijeka Bay	450	66	175	47	Zavodnik, 1998
Lošinj Archipelago	608	68	101	36	Zavodnik, 1992
Vir Island	104	72	26	35	Zavodnik, 1977
Kornati National Park	173*	109	102	61	Zavodnik, 1997
Kaštela Bay	51	51	30	33	Zavodnik, 1999
Hvar Island	?	73	?	33	Heller, 1863
Mljet National Park	53	110	90	53	This study
Boka Kotorska Bay	86	58	42	30	Kolosváry, 1938b Bruno, 1972

* Before the 1983

parks, except in the Jezera seawater lake area of Mljet, and identical working methods were applied. Yet the echinoderm diversity in Mljet was smaller than in Kornati, in spite of the rather dense station grid of the present research. The reason may be that the area studied in Kornati Archipelago was four times larger than the area in Mljet National Park.

Presently, none of the echinoderm species is commercially fished by Mljet inhabitants. In the past, the following nine species were reported to be consumed or marketed elsewhere in the Adriatic (ZAVODNIK, 1997c): *Holothuria forskali, H. polii, H. tubulosa, Eostichopus regalis, Arbacia lixula, Sphaerechinus granularis, Echinus acutus, Psammechinus microtuberculatus,* and *Paracentrotus lividus.*

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Morska fauna Nacionalnog parka Mljet
2. Echinodermata

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SAŽETAK

Obrađena je fauna bodljikaša (Echinodermata) Nacionalnog parka Mljet. Tijekom ljeta 1995-2002. godine na 63 obalne postaje ronioci su duž transekata bilježili i sakupljali ručno bodljikaše od površine mora do najveće dubine od 58 m. U većoj se dubini grabilom Van VEEN uzorkovalo na 21 postaji. Sa 6 su lokaliteta obrađene i lovine mljetskih ribara iz mreža poponica i vrša. Također su obrađeni primjerci iz drugih zbirki morske faune mljetskog područja. Korišteni su i literaturni navodi. Ukupno su nađene 53 vrste, t.j. 50 % bodljikaša poznatih iz Jadranskog mora. U svih se vrsta navode podaci o njihovom lokalnom rasprostranjenju, staništima i ekološkim značajkama, a u nekih se razmatraju i morfološke osobitosti, ponašanje jedinki i opća rasprostranjenost vrste. Detaljno se opisuju izabrani primjerci svojti *Holothuria* sp. cf. *mammata, Arbaciella elegans* i *Brissopsis* aff. *mediterranea*. Utvrđena je relativno slaba raznolikost ehinofaune Nacionalnog parka Mljet, u usporedbi s nekim drugim područjima Jadranskog mora.

Ključne riječi: Echinodermata, Nacionalni park, otok Mljet, Jadransko more, zoogeografija