

## Echinodermata of Kaštela Bay (Adriatic Sea, Croatia)

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*Records of the Kaštela Bay benthic fauna are reviewed with special regard to Echinodermata. Thirty three echinoderm species and one ecophenotype are listed among which eight species are newly recorded in the area. Morphological and ecological notes are provided for few selected taxa.*

**Key words:** Echinodermata, Kaštela Bay, Adriatic Sea

### INTRODUCTION

The Kaštela Bay is one of the most studied coastal areas in the eastern Adriatic Sea. The area became a subject of the special interest about seventy years ago when, at that time named as the Oceanographical Institute was built at the cap of Marjan promontory (ZORE-ARMANDA and ALAJBEG, 1995). Initial basic hydrographic and biological research was soon enlarged by fishery, and recently pollution and nature preservation studies.

Many informations are available about the overall characteristics and seasonal dynamics of physical and chemical parameters, phyto- and zooplankton, and fish in the Bay (i.e. GAMULIN, 1938; ERCEGOVIĆ, 1940; JUKIĆ and ŽUPANOVIĆ, 1965; VUČETIĆ, 1965; ALFIREVIĆ, 1966; PUCHER-PETKOVIĆ, 1966, 1971; KAČIĆ, 1972; JUKIĆ, 1973; ZORE-ARMANDA, 1976; KRŠINIĆ, 1980; PUCHER-PETKOVIĆ and MARASOVIĆ, 1980; REGNER and VUČETIĆ, 1980; REGNER, 1980; ZORE-ARMANDA *et al.*,

1991; etc.). On the contrary, in spite of a fair diversity of bottom habitats (GRUBELIĆ and ŠIMUNOVIĆ, 1997), information about the benthos is rather scarce. Benthic macroflora was studied in particular by ERCEGOVIĆ (1932, 1952), ŠPAN (1964), ANTOLIĆ (1996) and ŠPAN and ANTOLIĆ (1997). Only the few heigh groups of benthic invertebrates attracted special attention of scientists: protozoans (HADŽI, 1938 a; STILLER, 1946), sponges (BREITFUSS, 1938; HADŽI, 1938 b), cnidarians (BROCH, 1933, 1935; PAX and MÜLLER, 1953, 1962; KORNMANN, 1968), molluscs (HORVATH, 1963; SALVINI - PLAWEN, 1972; ŠIMUNOVIĆ and GRUBELIĆ, 1992; ŠIMUNOVIĆ, 1992, 1995) and arthropods (VIETS, 1939, 1940; ZAVODNIK, 1960; KARLOVAC, 1969, 1970; PETKOVSKI and APOSTOLOV, 1974). Only the few records of echinoderms were published (ZAVODNIK, 1960; GAMULIN-BRIDA *et al.*, 1971; ŠIMUNOVIĆ, 1992, 1995; GRUBELIĆ and ŠIMUNOVIĆ, 1997; ŠIMUNOVIĆ and GRUBELIĆ, 1998).

With regard to Kaštela Bay benthic communities above all, attention was paid to rocky littoral (ŠIMUNOVIĆ, 1970), coarse sand and fine gravel (ŠIMUNOVIĆ, 1992), and terrigenous muddy habitats (GAMULIN-BRIDA *et al.*, 1971; GAMULIN-BRIDA, 1974, 1979; ŠIMUNOVIĆ, 1992). No attempt has ever been made to map the distributional pattern of benthic communities in the area.

As the echinoderm fauna in Kaštela Bay was never reviewed, with regard to biodiversity studies I think it is opportune to complete the list of GRUBELIĆ and ŠIMUNOVIĆ (1997) by my personal data not published so far.

### MATERIAL AND METHODS

In the Kaštela Bay I collected echinoderms at occasional excursions in 1956-1988 (Fig. 1). At coastal stations, down to about 8 meters

depth, echinoderms were collected by skin diving. Samplings by PETERSEN grab (0.1 m<sup>2</sup>), the dredge of the "mušular" type (GAMULIN-BRIDA *et al.*, 1968), and the commercial bottom-trawl were applied at greater depth. All major types of the bottom were surveyed: bedrock covered with algal turf, loose stones, cobbles, gravel, rough sand and sand mixed with shell debris and detritic clumps, silty sand and terrigenous ooze. The material was processed by standard methods and preserved in 70 % alcohol or 4 % buffered formol solution, or specimens were dried. The M.V. HVAR cruises protocol records for the station Nr. 83 (KARLOVAC, 1956) have also been considered. Voucher specimens are kept in reference collections of the Institute of Oceanography and Fisheries, Split, the Center for Marine Research of the "Ruder Bošković" Institute, Rovinj, and the Croatian Natural History Museum, Zagreb, Croatia.

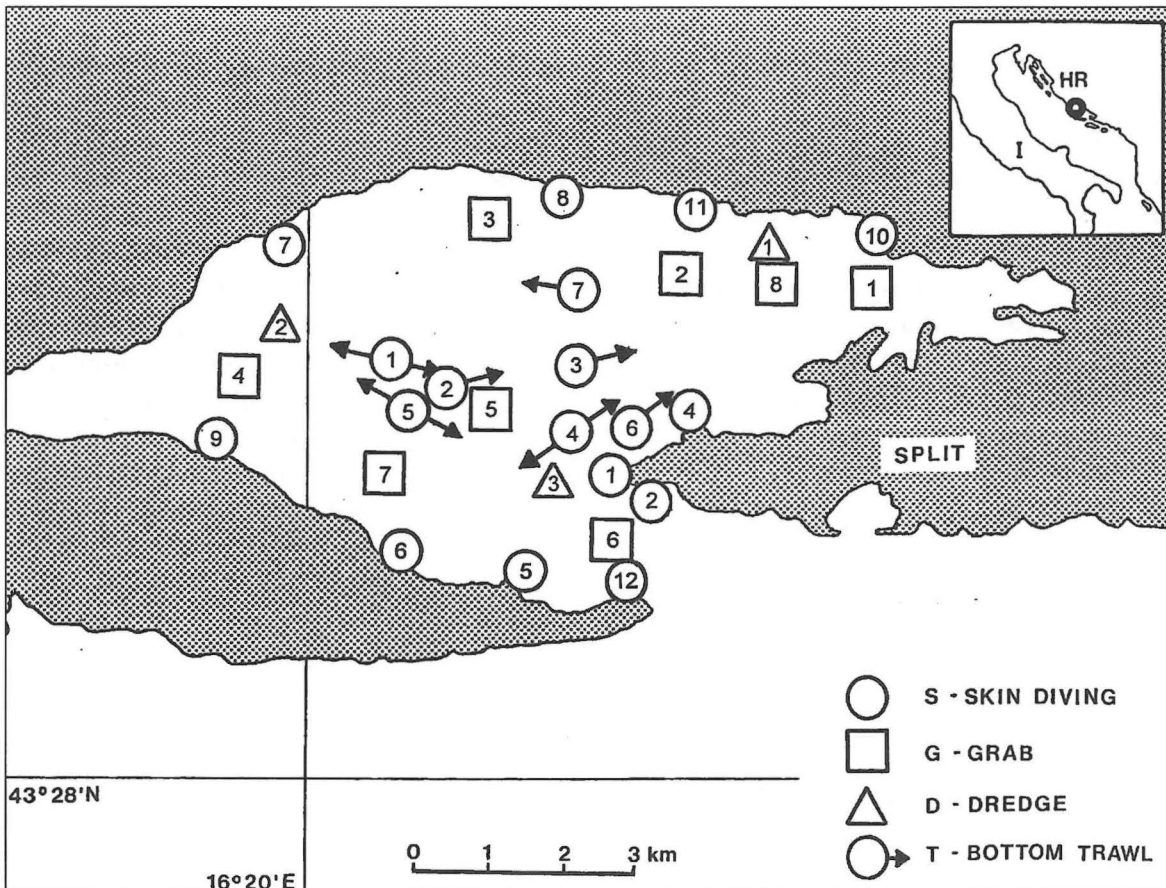


Fig. 1. Research area and stations

## RESULTS

In the material studied 31 echinoderm species and one ecophenotype were identified (Table 1). Most of them are well known and

quite common in the shallow water of the Adriatic and Mediterranean benthic communities (TORTONESE, 1965). Therefore, with an aim to economize the space comments are made only on selected taxa.

Table 1. Echinoderms recorded in Kaštela Bay. Taxa not noted previously in the area are marked with an asterisk (\*)

Records	HVAR Stn 83	ŠIMUNOVIĆ & GRUBELIĆ (1997)	Author's stations	Bottom Habitat	Ecological significance
<b>CRINOIDEA</b>					
<i>Antedon mediterranea</i> (LAMARCK, 1816)	+	+	D2,3; T1,2, 3,4,5,6	D,M,MD,S	Wed.
<b>HOLOTHUROIDEA</b>					
<i>Holothuria forskali</i> DELLE CHIAJE, 1823		+	D2; T5	M,MD	Wed.
* <i>Holothuria impatiens</i> (FORSSKÅL, 1775)			S9; T1	R, S	Wed.
<i>Holothuria polii</i> DELLE CHIAJE, 1823		+	S2,9	S	Sand tol.
* <i>Holothuria</i> sp.			T1,2,4,5	MD,MS,S	
<i>Holothuria tubulosa</i> GMELIN, 1788	+	+	D1,2,3;S1,2, 3,4,5,6,7,9, 10,11; T1,2, 3,4,5,6	M,S,R	Wed.
<i>Eostichopus regalis</i> CUVIER, 1817	+	+	T1,2,3,4,5,6	MD,S,SM	Wed.
<i>Ocnus planci</i> (BRANDT, 1835)	+	+	D1,2; T1,3,4	MS,S	pr. CD
<i>Leptopentacta elongata</i> (DÜBEN&KOREN, 1844)		+			Silt tol.
<i>Leptopentacta tergestina</i> (M.SARS, 1857)		+			pr. CTO
<i>Labidoplax digitata</i> (MONTAGU, 1815)		+	G1,3,5,7	M,SM	ex. CTO
* <i>Leptosynapta inhaerens</i> (O.F.MÜLLER, 1776)			G1	SM	pr. CTO
<b>ASTEROIDEA</b>					
<i>Astropecten aranciacus</i> (LINNAEUS, 1758)	+	+	D2; S7; T1,3, 4,5,6	MD,MS,S	Wed.
* <i>Astropecten bispinosus</i> (OTTO, 1823)			D2	S	Sand tol.
<i>Astropecten irregularis</i> (PENNANT, 1777)		+	D1; T1	MS,S	Min.
* <i>Astropecten platyacanthus</i> (PHILIPPI, 1837)			S7	S	pr. SG
<i>Asterina gibbosa</i> (PENNANT, 1777)		+			Crypt.
<i>Anseropoda placenta</i> (PENNANT, 1777)	+	+	T1,3,4,5,6	MD,MS,S,SM	ex. CD
<i>Echinaster sepositus</i> (RETZIUS, 1783)	+	+	D1; S1,5,9;T1,6	MD,MS,R,S	Wed.
<i>Coscinasterias tenuispina</i> (LAMARCK, 1816)		+	S1,2,9	R	pr. PSW
<i>Marthasterias glacialis</i> (LINNAEUS, 1758)	+	+	S1,2,5,10; T1,2,3,5,6	D,G,M,R,S	Wed.
<b>OPHIUROIDEA</b>					
* <i>Ophiomyxa pentagona</i> (LAMARCK, 1816)			T1,2,3	MD,MS,S	pr. CD
* <i>Amphiura chiajei</i> FORBES, 1843			G7,8	M,MS	Silt tol.

Table 1. Cont' d

* <i>Amphiura filiformis</i> (O.F.MÜLLER, 1776)			G1,3,5,7	M,SM	Min.
<i>Amphipholis squamata</i> (DELLE CHIAJE, 1828)			S1,2,4,6,9,10,12	A,R	Wed.
<i>Ophiothrix fragilis</i> (ABILDGAARD, 1789)	+		D2; S1,2,4,5, 6,8,9,11	A,R,S	Wed.
<i>Ophiothrix quinque maculata</i> (DELLE CHIAJE, 1828)			T1,2,3,4,5,6	MD,MS,S,SM	Mix.
<i>Ophioderma longicaudum</i> (RETZIUS, 1805)		+	S1,5,9,11; T3	MS,R	pr. PSW
<i>Ophiura ophiura</i> (LINNAEUS, 1758)	+	+	T1,3,4,5,6	MD,MS,S,SM	Wed.

## ECHINOIDEA

<i>Arbacia lixula</i> (LINNAEUS, 1758)		+	S2,5	R	ex. PSW
<i>Sphaerechinus granularis</i> (LAMARCK, 1816)	+	+	D2,3; S1,7,9; T1	D,G,R,S	Wed.
<i>Echinus acutus</i> LAMARCK, 1816		+	T4	SM	Wed.
<i>Psammechinus microtuberculatus</i> (BLAINVILLE, 1825)+		+	D1,2; T1,2	MD,MS,S	pr. CD
<i>Paracentrotus lividus</i> (LAMARCK, 1816)	+	+	S1,2,5,6,7,8, 9,10,11,12; T1,4	R,G,S,SM	pr. PSW
* <i>Echinocyamus pusillus</i> (O.F.MÜLLER, 1776)			D3	DS	Grav.

## ABBREVIATIONS

## Bottom - Habitat:

- A = Algal thalli  
 D = Organogenic detritic deposits  
 G = Gravel, cobbles and loose stones  
 M = Muddy bottom  
 R = Bedrock with algal turf  
 S = Sandy deposits

## Ecology:

- CD = Community of coastal detritic bottom  
 CTO = Community of coastal terrigenous ooze  
 SG = Meadows of sea-grasses  
 PSW = Community of photophilic seaweeds  
 ex. = Species exclusive to a specific community  
 pr. = Community preferential species  
 Crypt. = Species preferring concealed habitats  
 Grav. = Species living in rough sand and fine gravels  
 Min. = Species living in fine sand and silts  
 Mix. = Species living on mixed bottoms  
 Sand tol. = Species living in sands and tolerant to other fractions  
 Silt tol. = Species living in silts and tolerant to other fractions  
 Wed. = Species with a wide ecological distribution

*Holothuria impatiens* (FORSSKÅL, 1775)

South of the Kaštel Novi, one specimen was collected from the sandy bottom by dredge, at about 25 meters depth. This is the maximum depth noted in the Adriatic Sea (BELAMARIĆ and ŠERMAN, 1989). Usually, specimens were collected in the shallow water at only 0-4 meters depth (MAYER, 1937; ZAVODNIK, 1997).

*Holothuria* sp.

By their body and coloration characteristics, some holothurians recorded in trawl catches long ago conformed with the description of *Holothuria stellati* DELLE CHIAJE, 1923 by KOEHLER (1921, 1927). Regrettably, the identification could not be proved before the ossi-

cles had deteriorated. However, due to wide ranged variation in external features and ossicles in closely related species of *tubulosa* group (PANNING, 1939; MASSIN, personal communication), in spite of GUSTATO and VILLARI (1980) standpoint the systematic position of *H. stellati* is still dubious (ROWE, 1969, personal communication).

*Labidoplax digitata* (MONTAGU, 1815)

Not rare in the Kaštela Bay. In eight specimens studied no giant anchors were noted, the anchor flukes were not serrated, and a concave shaped anchor apex rarely occurred. One specimen rich in abnormal anchor ossicles was collected by grab at station G1 at 25 metres depth. Among 219 anchors analysed 56 (i.e. about 25 %) were peculiar for their variously shaped

apical part (Fig. 2). The B type anchors were most common. The C and D types were recorded only in one and two anchors, respectively. The additional two pointed apical flukes (E type) may join creating thus an intermediate drop-like hole (F type). Only one anchor ossicle was distinguished by its abnormally formed stock (G type).

*Amphiura filiformis* (O.F. MÜLLER, 1776)

In three specimens small rudimentary scales were visible on the disc oral side - an occurrence rarely noted in this species. It seems that in the area studied the population density does not exceed about 10 individuals per square metre. Apparently this species is more common in the Bay than is the congeneric *Amphiura chiajei*.

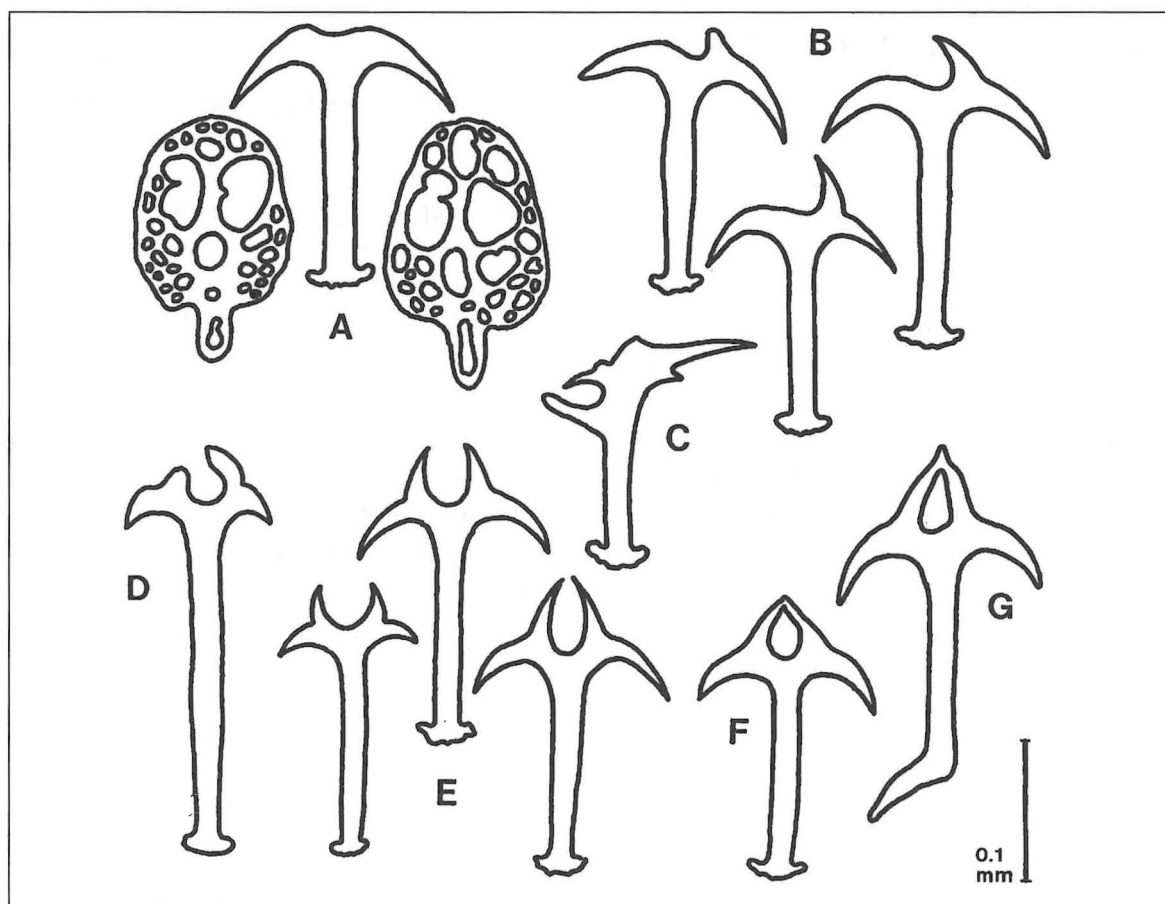


Fig. 2. Ossicles in *Labidoplax digitata*. A = normal anchor and anchor plates, B-G = aberrant ossicles. For explanation see text

*Amphipholis squamata* (DELLE CHIAJE, 1828)

Occasionally noted in algal turf. One specimen parasited by an ovigerous female of *Cancerilla tubulata* DALYELL, 1851, (Crustacea, Copepoda) was collected in the neighbourhood of the Institute of Oceanography and Fisheries campus (ZAVODNIK, 1960).

*Ophiothrix quinque maculata*  
(DELLE CHIAJE, 1828)

According to GUILLE (1965) and BARIĆ and STURMBAUER (1999) *Ophiothrix quinque maculata* is an ecologically well defined ecophenotype of *Ophiothrix fragilis* characteristic in mediterranean coastal detritic communities (PÉRÈS and PICARD, 1964). It is very common in the central area of Kaštela Bay.

## DISCUSSION AND CONCLUSIONS

Among 31 species and one ecophenotype recorded at present research, 8 taxa were not noted previously in the Kaštela Bay. With addition of three species (*Leptopentacta elongata*, *Leptopentacta tergestina* and *Asterina gibbosa*) listed by GRUBELIĆ and ŠIMUNOVIĆ (1997) but not recorded at present research, the total of 33 echinoderm species and one ecophenotype was established (Table 1). This is about 33% of the Adriatic Sea echinoderm fauna, and just 39% of taxa distributed within the depth range of the Bay, i.e. 0-51 meters. The absence of typical thermophilic and deep sea species is conceivable.

However, the species list composition proved insufficient endeavours in the research of cryptic habitats. Quite curious is the absence of irregular echinoid records. Until now, according to information available, only one live specimen and many *Echinocyamus pusillus* tests were noted whilst neither live individuals nor tests of greater species have ever been collected in the area. The phenomenon cannot be explained.

In previous taxonomic and biogeographical echinological papers the species locality area was sometimes noted by a toponomy "Split" (Ital. "Spalato") (HELLER, 1868; MARENZELLER, 1874; STOSSICH, 1883; CARUS, 1885; TORTONESE, 1935, 1965; MAYER, 1937; KOLOSVÁRY, 1940a, 1940b; ZAVODNIK, 1971; VIDOVIĆ-MATVEJEV, 1978). Because of a geographically uncertain position of the record, such notices were not considered in the present paper. However, there exists a possibility of collection inside the Kaštela Bay. The same procedure was applied for voucher specimens deposited in museum collections (TORTONESE, 1984; Zoological Museum in Zagreb - not published). One cannot exclude the possibility of future findings of at least some of the pertinent species in the Kaštela Bay. The voucher specimens are badly needed.

Little is known on echinoderm abundance in the area. A great share of *Eostichopus regalis* in trawl catches was noted by GAMULINBRIDA (1974). GRUBELIĆ and ŠIMUNOVIĆ (1998) noted great *Holothuria tubulosa* shoals in the northern part of the Bay at less than 10 meters depth. In ophiurans, perhaps the most important in turn over is the filter-feeder *Ophiothrix quinque maculata*, which in some trawl catches was recorded as a dominant taxon.

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## **Bodljikaši (Echinodermata) Kaštelanskog zaljeva**

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### **SAŽETAK**

Dat je pregled izvornih podataka o bentoskoj fauni Kaštelanskog zaljeva s posebnim osvrtom na bodljikaše. Utvrđena je nazočnost 33 vrste i jednog ekofenotipa bodljikaša, od kojih osam do sada nije bilo spomenuto za to područje. Navode se i značajniji podaci o ekologiji i morfologiji izabranih svojti.

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