

Additions to the echinoderm (Echinodermata) fauna of Montenegro (Adriatic Sea)

Slavica Petović^{1*}, Jasmina Krpo-Ćetković²

¹ Institute of Marine Biology, Dobrota bb, 85330 Kotor, Montenegro

² Faculty of Biology, University of Belgrade, Studentski trg 16, 11000 Belgrade, Serbia

*E-mail: kascelanslavica@gmail.com

ABSTRACT

*The results of the first extensive investigation of echinoderms from the continental shelf of the Montenegrin coast are presented. The research area is provisionally divided into two zones with different ecological conditions – the Boka Kotorska Bay and the open sea zone. A total of 50 echinoderm species were found. The species *Brissus unicolor* (Leske, 1778), *Echinocardium fenauxi* Péquignat, 1963, *Schizaster canaliferus* (Lamarck, 1816), *Arbacia lixula* (Linnaeus, 1758), *Holothuria mammata* Grube, 1840, *H. sanctori Delle Chiaje, 1823*, and *Mesothuria intestinalis* (Ascanius, 1805) are new findings for the marine fauna of Montenegro.*

Keywords: echinoderms, continental shelf, Montenegrin coast, Adriatic Sea

INTRODUCTION

Studies of echinoderms in the Adriatic Sea date from the end of the 18th century (Olivi, 1792). Despite that, a relatively small number of authors were involved in determination of echinoderm species from the continental shelf of Montenegro. Several scientific expeditions ("Pola" 1890-1894; "Najade" 1913-1914; "Hvar" 1948-1949) explored benthic biocoenoses of the Adriatic Sea, including its southeastern part, but none of these expeditions included the shallow infralittoral zone of Montenegro. This zone can be conditionally divided into two subzones with different

geomorphological characteristics: the Boka Kotorska Bay and the open sea zone. These subzones differ in physical and chemical parameters of water and sediments, which results in the presence of different species of echinoderms. The compilation of literature data, mostly collected from papers related to benthic biocoenoses, shows that the Boka Kotorska Bay is inhabited with 39 species of echinoderms (Kolosváry, 1938; Karaman and Gamulin-Brida, 1970; Bruno, 1972; Stjepčević and Parenzan, 1980; Milojević, 1979, 1984; Kaščelan et al., 2006); the same number of species inhabit the shelf area of the open sea, but the list of species is different (Kolosváry, 1936/37; Gamulin-Brida, 1963, 1983; Milojević, 1982, 1986).

This study has been conducted with the aim to deepen our knowledge of the diversity of echinoderms at the Montenegrin continental shelf. A significant number of identified species have a wide ecological distribution and are tolerant to differences in environmental conditions, thus inhabiting both the area of the Bay and the open sea continental shelf. The total number of species of echinoderms in the Montenegrin part of the south Adriatic, based on historical data, is 57 (Kaščelan et al., 2009).

MATERIAL AND METHODS

Material was collected by SCUBA diving from 12 transects and 16 randomly chosen locations on the southeastern continental shelf of the Adriatic Sea, and additional 7 sites were sampled by otter trawling (Fig. 1). Maximum depth reached by SCUBA diving was about 30 m along transects and 40 m on randomly chosen locations, while trawl nets sampled deeper, up to 120 m. Samplings were done in the period 2005-2010, during spring, summer and autumn.

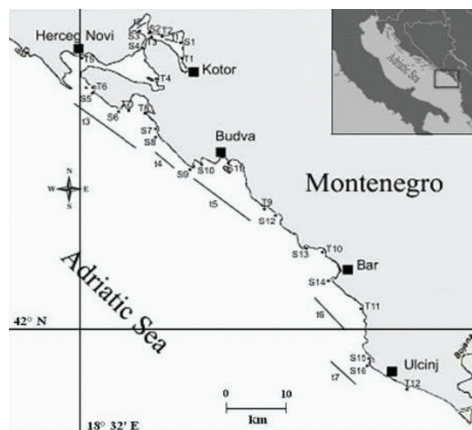


Figure 1. Studied area (T – transect; S – randomly chosen locations; t – trawling).

Collected material was immediately anesthetized with saturated solution of menthol in sea water and later preserved in 70% alcohol. For the identification of sea cucumbers, microscopic plates of ossicles were prepared. The identification was done according to Koehler (1924) and Tortonese (1965), and corrected by ERMS (Hansson, 2001). All collected specimens are deposited at the Institute of Marine Biology in Kotor, Montenegro.

RESULTS AND DISCUSSION

The analysis of collected material revealed the presence of 50 species. The Boka Kotorska Bay is inhabited by 31 species, while the open sea shelf zone is inhabited by 43 species of echinoderms. The comparison of our results with previous findings indicates clear differences in the presence of species at different research positions. The two explored areas (the Boka Kotorska Bay and the open sea) differ in environmental factors, such as physical and chemical characteristic of water and sediment type (Lepetić, 1965; Mandić, 1984). The research methodology used in this

study is substantially different than that used in previous studies, since it is mainly based on material collected by diving and trawl-fishing, while previous researches were done using grab and dredge, which partly explains the observed differences in detected species.

The results revealed nine new records for the Boka Kotorska Bay (Tab.1). The largest number of new records belongs to the class Echinoidea (*Cidaris cidaris*, *Brissus unicolor*, *Echinocardium fenauxi*, *Schizaster canaliferus*, and *Arbacia lixula*).

During the study, a single specimen of *C. cidaris* was collected from the silt-sandy substrate at the entrance of the Boka Kotorska Bay, while a larger number of specimens were collected from the bedrock of coralligenous communities in the open part of the Montenegrin continental shelf. Literature data (Tortonese, 1965; Vidović-Matvejev, 1978; Milojević, 1982) cite that this species lives at depths from 50 m to 2000 m, while our results revealed its presence at depth of 7 m.

The finding of *B. unicolor*, from the subgroup of irregular sea urchins, is the first record both for the Boka Kotorska Bay and for the echinoderm fauna of Montenegro. The dead tests collected from the silt-sandy substrate dominated in the samples. Zavodnik (2003) lists this species as rare in the Adriatic Sea. Specimens of this species were also found on sandy beds at open sea sites.

The species *S. canaliferus* is specific for the biocoenoses of detritus bottoms and it prefers muddy-sandy substrates (Zavodnik, 2003). Twelve specimens were recorded during the study only at sites within the Boka Kotorska Bay. This Mediterranean subendemic species is a new finding both for the Boka Kotorska Bay and for the echinoderm fauna of Montenegro. Dead tests dominated in the collected material.

Table 1. List of new records of echinoderms on Montenegrin continental shelf (southeaster part of Adriatic Sea) with emphasis to substrate type, depth range (m) and sampling method

Taxa	Boka Kotorska Bay	Open sea	Substrate type	Depth range (m)	Sampling method
Classis: Asteroidea					
<i>Coscinasterias tenuispina</i> (Lamarck, 1816)	T5, T6	T7, T9, T12, S6, S8	Rocks, stones	1-25	Diving
<i>Hacelia attenuata</i> Gray, 1840	S5	T7, T9, S6, S7, S8	Rocks, stones,	5-35	Diving
Classis: Echinoidea					
<i>Arbacia lixula</i> (Linnaeus, 1758)	T5, T6, S6	T7, T8, T9, T10, T11, T12, S7, S8, S9, S10, S11, S15	Rocks, stones	0-15	Diving
<i>Brissus unicolor</i> (Leske, 1778)	T3, T5, T6, S3	T7, S7	Sandy-muddy	5-30	Diving
<i>Cidaris cidaris</i> (Linnaeus, 1758)	T6	S6, S8, t5	Mud, sand, rocks	7-120	Diving, trawl
<i>Echinocardium fenauxi</i> Péquignat, 1963	T5		Well sorted coarse sand	15-20	Diving
<i>Schizaster canaliferus</i> (Lamarck, 1816)	T6		Sandy-muddy	5-35	Diving
Classis: Ophiuroidea					
<i>Ophioderma longicauda</i> (Bruzellius, 1805)	T6	T8, T12, S8, S11, S12, S15, t3, t7	Stones, sand, mud, algae	2-120	Diving, trawl
<i>Ophiomyxa pentagona</i> (Lamarck, 1816)		T8, S11, S14, t3, t4, t5, t6, t7	Stones, sand, mud, detritus, <i>Posidonia</i>	6-120	Diving, trawl
Classis: Holothuroidea					
<i>Ocnus planci</i> (Brandt, 1835)	T4, t2	S14, t6	Sandy-muddy	5-50	Diving, trawl
<i>Holothuria</i> (<i>Panningothuria</i>) <i>forskali</i> Delle Chiaje, 1823		T8, S6, S8	Sandy-muddy, <i>Posidonia</i> meadows,	10-40	Diving
<i>Holothuria</i> (<i>Thymiosycia</i>) <i>impatiens</i> (Forskål, 1775)	T6	T8	Sandy-muddy, <i>Posidonia</i> meadows	5-25	Diving
<i>Holothuria</i> (<i>Holothuria</i>) <i>mammata</i> Grube, 1840	T2, T3, T4, T5, T6	T7, T9, T10, S11, S15	Sandy-muddy, <i>Posidonia</i> ,	5-30	Diving
<i>Holothuria</i> (<i>Platyperona</i>) <i>sanctori</i> Delle Chiaje, 1823	T6	T7, T8, S8	In rock cavities	4-35	Diving
<i>Mesothuria intestinalis</i> (Ascanius, 1805)	T4		Sandy-muddy	8-10	Diving

The sea urchin *A. lixula* was recorded at new localities on the rocky ground at the entrance of the Boka Kotorska Bay. It inhabits practically all research sites along the open sea coast where rocky substrate dominated. This infralittoral species, related solely to biocoenoses of photophilous algae, common in the Adriatic Sea (Tortonese, 1965; Vidović-Matvejev, 1978, Zavodnik, 2003), does not appear in the literature for the Montenegrin coast, apart from the oral communication by D. Zavodnik; hence this finding represents a new official record for the marine fauna of Montenegro.

The class Holothuroidea is characterized by three new findings (*Holothuria mammata*, *Holothuria sanctori*, and *Mesothuria intestinalis*), both for the Boka Kotorska Bay and for the marine fauna of Montenegro. During the survey, *H. mammata* was recorded for first time recorded in the Boka Kotorska Bay and at the Montenegrin continental shelf. This Mediterranean endemic species was numerous in the study area. Ecology of this species is not completely known (Tortonese, 1965; Zavodnik, 2003). Specimens inhabit mainly silt-sandy substrate from shallow water to depths of 30 m. This finding is new for the echinoderm fauna of Montenegro.

Species *H. sanctori* was for the first time registered at studied sites along the Montenegrin coast. The total of 18 specimens were recorded in cavitations in the rocks with "flakes" of sand and boulders. The species is a part of the biocoenosis of photophilous algae and of the precoralligenous facies of the coralligenous community (Zavodnik, 2003).

Specimens of *M. intestinalis* were recorded in shallow waters inside the Boka Kotorska Bay, on sandy-muddy substrate with coarse stones. The species inhabits the seabed where the currents are weak, up to 2000 m in depth (Tortonese, 1965).

The class Asteroidea is represented by one new record for the Boka Kotorska Bay – *Hacelia attenuata*. This thermophilic sea star is relatively common in coralligenous biocoenoses of southern and central Adriatic Sea (Tortonese, 1965; Vidović-Matvejev, 1978; Milojević, 1986; Zavodnik, 2003), as well as at the open sea shelf (Milojević, 1986).

Ten new findings were recorded at the continental shelf of the open sea zone of Montenegrin coast. Most of the new findings belong to the class Holothuroidea (*Holothuria forskali*, *H. impatiens*, *H. mammata*, *H. sanctori*, and *Ocnus planci*), two new records belong to the class Echinoidea (*A. lixula*, *B. unicolor*) and class Ophiuroidea (*Ophioderma longicauda*, *Ophiomyxa pentagona*), and one species belong to class Asteroidea (*Coscinasterias tenuispina*).

The species *H. forskali* is described as rare in the south-western part of the Adriatic seabed (Ungaro, 1995), while at the east side of the Adriatic it is present along the whole coast (Zavodnik, 2003; Zavodnik et al., 2005). Samples were collected only at the sites with the rocky seabed in the open sea. *H. impatiens* was already noted inside the Boka Kotorska Bay (Bruno, 1972; Milojević, 1979), but it is for the first time found in the shelf zone of the open sea. The total number of 9 specimens of this species was recorded during the study. This species mostly inhabits sandy-muddy bottom.

Literature data indicate the presence of *O. planci* at the muddy-sandy bottom in the Adriatic Sea (Kolosváry, 1938; Tortonese, 1965; Bruno, 1972; Milojević, 1979), while our finding is the first one for the open sea zone of the Montenegrin part of the south Adriatic Sea. Specimens were collected both by SCUBA diving and by trawl.

Within the class Ophiuroidea, *O. longicauda* was numerous at almost all studied sites along the coast. This species prefers biocoenoses of

photophilous algae (Zavodnik, 2003) and it was collected mostly under stones and boulders in the shallow waters and also by trawling. *O. pentagona* was present in the material from fishing nets both in the Bay and in the open sea.

The sea star *C. tenuispina* was recorded as predator of shellfish farms within the Boka Kotorska Bay (Stjepčević, 1974), but our finding is the first record for the open sea. Fifteen specimens were registered at seven sites in the studied area.

Most of the new recorded species have an Atlantic-Mediterranean zoogeographical characterization. Two of them, *E. fenauxi* and *S. canaliferus*, are Mediterranean subendemics (Koukouras *et al.*, 2007). Four identified species (*B. unicolor*, *A. lixula*, *H. mammata*, and *H. sanctori*) have wide ecological distributions and tolerance to diverse environmental conditions, so they inhabit both the Boka Kotorska Bay and the open sea. Thermophilic species *H. sanctori* and *H. attenuata*, which prefer warm waters, inhabit southern and central parts of the eastern Adriatic coast (Gjijknuri, 1979/80; Pancucci-Papadopoulou, 1996; Bakran-Petricioli *et al.*, 1997).

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