

# Occurrence and Distribution of Crustacean Decapoda Species in Montenegrin Territorial Waters with Special Attention to the Most Significant Species



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**Abstract** An annotated species of crustacean Decapoda list is provided for the Montenegrin territorial waters according to the available scientific literature, official reports, and from data collected from the MEDITS trawl surveys performed on continental shelf and continental slope in summer months from 2008 to 2018. Species are collected mainly by bottom trawl net but also with other various sampling methods such as trammel nets, gillnets, crustacean traps as well as scuba diving techniques. A total of 95 species belonging to 37 families is reported. Data on distribution and findings in Montenegrin territorial waters, Adriatic distribution, literature, and potential commercial interest for fishery are presented for the most significant species.

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## 1 Introduction

### 1.1 Study Area

The Montenegrin coast is a part of the Southern Adriatic, which is the oldest and deepest part (up to 1,330 m) of the Adriatic Sea [1]. Generally, the Adriatic is a shallow sea. Most of the bottom (about 73%) is on the continental shelf and a significantly smaller portion belongs to the continental slope (sea bottom under 200 m depth); thus, the major part of the bottom of the Adriatic Sea belongs to the circalittoral zone [2].

Coastal waters of Montenegro occupy about 360 km<sup>2</sup> and territorial waters (extending 12 nautical miles, or 22.22 km, from the coastline) cover a surface of about 2000 km<sup>2</sup> and the epicontinental belt occupies around 3,900 km<sup>2</sup>. The total sea area of Montenegro is about 6,400 km<sup>2</sup> [3].

In bathymetric terms, the investigated study area is characterized by a rapid increase in depth going from the coastal area to the central part of the South Adriatic Pit, so that the range of depths in that direction and in a relatively narrow study area is as much as 110 m [4]. Muddy and sandy sediments are present on the largest part of the continental shelf and they almost cover the entire southern bottom. The following biocoenoses are characteristic for the study area (Fig. 1):

- the biocoenosis of *Posidonia* meadows which is often developed in the infralittoral zone at a depth of 10 to 50 m [5].
- the biocoenosis of the coastal terrigenous mud is well established along almost the entire south-eastern Adriatic coast and is particularly well established in areas with relatively weak bottom currents [6]. Two facies are established: – facies *Labidoplax* and facies of sessile forms.
- the biocoenosis of detritic bottoms of the open Adriatic Sea is developed at a depth of 80 m to 200 m. Two facies of this biocenosis were identified in the study area: facies *Ostrea cochlear* and facies *Pinna pectinata* [7].
- the biocoenosis of muddy bottoms of the open sea which is one of the most important benthic biocoenosis of the Adriatic Sea and is known as the *Nephrops norvegicus* – *Thenaea muricata* biocoenosis.
- the biocoenosis of bathyal muds is developed in the form of two facies. In the upper part of the biocenosis at depths of 200 to 350 m there is facies of soft silt with a fluid surface characterized by species *Nephrops norvegicus*, *Thenaea muricata*, *Funiculina quadrangularis*. In the deeper part of the biocenosis, at depths of 400 to 500 m there is a facies of sandy muds and fine gravels [1].

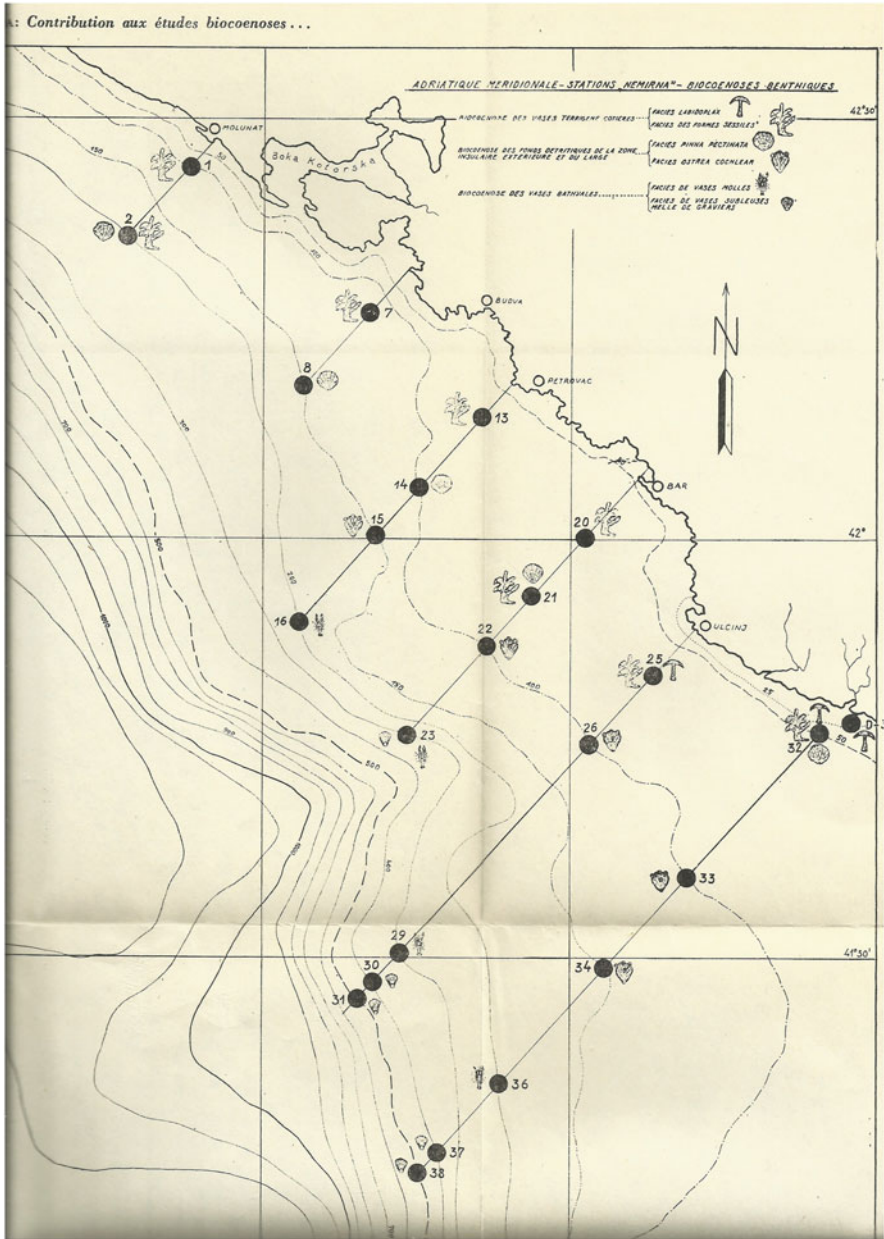


Fig. 1 The main biocoenosis in the South Adriatic (Montenegrin coast) (the biocoenosis of the coastal terrigenous mud, the biocoenosis of detritic bottoms of the open Adriatic Sea, and the biocoenosis of bathyal muds) according to Gamulin-Brida [1]

## 1.2 *Historic Review*

Although there is information on the decapod crustaceans in the Boka Kotorska Bay [8] which is the part of the Montenegrin territorial waters, there are a small number of references regarding the information about crustacean decapod species in the whole Montenegrin territorial waters.

These references mainly refer to occurrence and distribution of Natantia species investigated by trawls in the area of the Southern Adriatic on depths between 50 and 500 m [9, 10, 11]. During that investigation 15 Natantia Decapoda were recorded with two new species for the Adriatic Sea: *Aristeus antennatus* and *Plesionika heterocarpus*. The same author gave a list of decapod crustaceans caught by a trawl from a depth of 50 to 500 m including some localities at the mouth of the Bojana river [12, 13]. The list includes 80 species with some new species for the Adriatic Sea: *Pontocaris lacazei* (*Aegaeon lacazei*), *Ergasticus clouei*, *Parthenope macrochelos* (*Spinolambrus macrochelos*), and *Macropipus zariquieyi* (*Liocarcinus zariquieyi*). That list was changed because it contained some species whose presence was dubious for the Adriatic Sea and for the southern part of the Adriatic Sea. So according to the same author 77 species from 25 families were registered in South Adriatic [14]. It is worth to note that it was registered complete absence of Crustacea Decapoda species during trawling survey conducted in August 1973 year over the continental shelf in Montenegrin waters [15]. After that, references were related mainly to biology of deep-water pink shrimp and Norway lobster [16, 17, 18, 19].

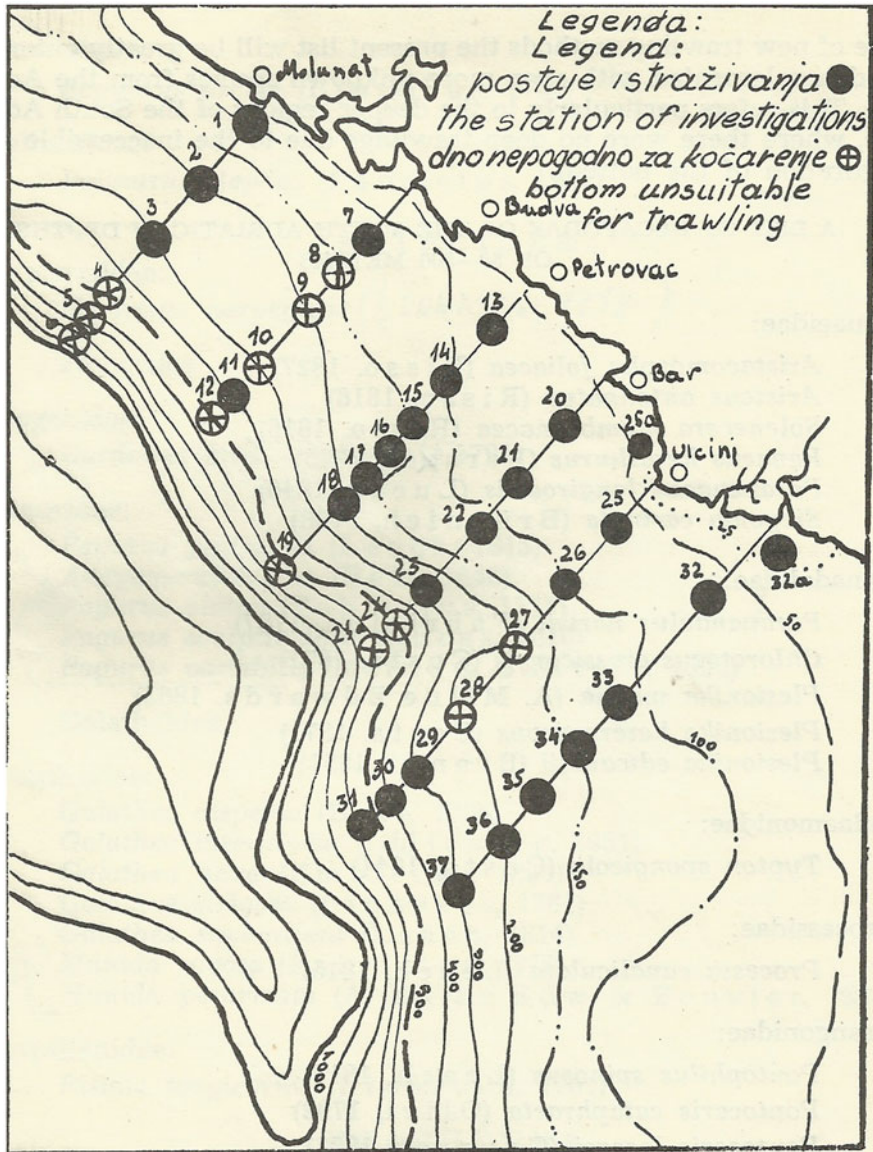
The main goal of this chapter is to summarize all previously published information about crustacean decapod species occurring in the Montenegrin territorial waters as well as to represent some species as important biological and commercial resource.

## 2 *Material and Methods*

According to the available literature, decapod specimen has been collected mainly by trawl net but also with trammel nets, gillnets, traps. Merker Poček [10] gives the data about some economically important Natantia species which were collected during trawling survey performed at 27 sampling stations on continental shelf and continental slope in June–July and November–December 1968 year in the area of South Adriatic (Montenegrin waters) on depths between 50 and 500 m. The continental slope was investigated for the first time in this area of investigation (Fig. 2).

In the framework of MEDITS project (Mediterranean Trawl Survey), scientific bottom trawl surveys were carried out in Montenegrin territorial waters during every summer from 2008 to 2018 on 10 sample stations from 40 to 800 m depth.

The site “World Register of Marine Species” (<http://www.marinespecies.org>) was consulted for scientific nomenclature.



The sampling stations in the southern open Adriatic

Fig. 2 The sampling stations in the southern open Adriatic performed in 1968 (from Merker-Poček [13])

### 3 Results

Crustacean fauna in Montenegrin territorial waters does not show a high diversity like in Boka Kotorska Bay. Special attention was dedicated to the most significant and interesting species. For that species, the following information was given: valid name according to WoRMS [20], common names, distribution in Montenegrin territorial waters, Adriatic distribution according to Števcíć [21], some remarks and interest to fishery.

The list of species gathered from available literature is presented in Table 1, while species caught during MEDITS surveys conducted from 2008 to 2015 is presented in Table 2.

#### 3.1 List of Species

Superfamily PENAEOIDEA Rafinesque, 1815

Family ARISTEIDAE Wood-Mason in Wood-Mason & Alcock, 1891

*Aristaeomorpha foliacea* (Risso, 1827) (Fig. 3).

Common names: Velika crvena kozica (MNE), Giant red shrimp (E), Gambero rosso (I), Gambon rouge (F).

Distribution: Merker Poček [10] sampled this species (only three specimen) by trawl on depths of 530 m, while during MEDITS survey it was sampled on depths of 700–800 m.

Adriatic: According to Števcíć [21], this species is recorded in the central part of the mid and southern area.

Remarks: Deep-water benthopelagic shrimp with a reported depth distribution of 120–1,300 m, generally on muddy bottoms [26].

Interest to fishery: Commercially very important species. While it is heavily exploited in other Mediterranean countries, in Montenegro there is no exploitation due to Montenegrin trawl fleet which is old and poorly equipped.

Literature: Merker Poček [10, 11, 13, 14].

*Aristeus antennatus* (Risso, 1816) (Fig. 4).

Common names: Crvena kozica (MNE), Blue and red shrimp (E), Gambero viola (I), Crevette rouge (F).

Distribution: This species was recorded for the first time in Adriatic Sea during investigations conducted in 1968 in South Adriatic Sea [11, 13]. Among Natantia species it was represented with the lowest number [14]. As previous species, it was found on depth between 700 and 800 m during MEDITS survey.

Adriatic: Known only from the southern deep basin.

Remarks: Benthopelagic species which lives on soft muddy bottoms on depth between 200 and 1,440 m.

Interest to fishery: Species is not exploited by the Montenegro bottom trawl fishery.

**Table 1** A list of Decapoda Crustacea in territorial Montenegrin waters according to the available scientific literature (previously used names are bold)

Family	Species	Literature
<b>(Penaecidae)</b> = Aristeidae	<i>Aristaeomorpha foliacea</i> (Risso, 1827)	Merker-Poček [10, 11, 13, 14]
	<i>Aristeus antennatus</i> (Risso, 1816)	Merker-Poček [11, 13, 14]
Penaecidae	<i>Penaeus aztecus</i> Ives, 1891	Marković et al. [22], Marković and Đurović [23]
	<i>Parapenaeus longirostris</i> (Lucas, 1846)	Merker-Poček [10, 11, 13, 14]
	<i>Penaeus kerathurus</i> (Forskål, 1775)	Merker-Poček [10, 11, 13, 14], Merker-Poček and Radujković [24]
<b>(Penaecidae)</b> = Sycioniidae	<i>Sicyonia carinata</i> (Brünnich, 1768)	Merker-Poček [13]
<b>(Penaecidae)</b> = Solenoceridae	<i>Solenocera membranacea</i> (Risso, 1816)	Merker-Poček [10, 11, 13, 14], Merker-Poček and Radujković [24]
Pandalidae	<i>Chlorotocus crassicornis</i> (A. Costa, 1871)	Merker-Poček [10, 11, 13, 14]
	<i>Plesionika edwardsii</i> (J.F. Brandt, 1851)	Merker-Poček [9, 10, 11, 13, 14]
	<i>Plesionika heterocarpus</i> (A. Costa, 1871)	Merker-Poček [9, 10, 11, 13, 14]
	<i>Plesionika martia</i> (A. Milne-Edwards, 1883)	Merker-Poček [9, 10, 11, 13, 14]
	<b><i>Parapandalus narval</i></b> (Fabricius, 1787) = <i>Plesionika narval</i> (Fabricius, 1787)	Merker-Poček [13, 14]
Palaemonidae	<i>Typton spongicola</i> (O.G. Costa, 1844)	Merker-Poček [13, 14]
Processidae	<i>Processa canaliculata</i> Leach, 1815	Merker-Poček [10, 11, 13, 14]
Crangonidae	<b><i>Pontocaris cataphracta</i></b> (Olivi, 1792) = <i>Aegaeon cataphractus</i> (Olivi, 1792)	Merker-Poček [10, 11, 14]
	<b><i>Pontocaris lacazei</i></b> (Gourret, 1887) = <i>Aegaeon lacazei</i> (Gourret, 1887)	Merker-Poček [12, 13, 14]
	<i>Pontophilus spinosus</i> (Leach, 1816)	Merker-Poček [13, 14]
Polychelidae	<i>Polycheles typhlops</i> Heller, 1862	Merker-Poček [13]
Scyllaridae	<i>Scyllarus arctus</i> (Linnaeus, 1758)	Merker-Poček [13]
Palinuridae	<i>Palinurus elephas</i> (Fabricius, 1787)	Merker-Poček [13]
Nephropidae	<i>Nephrops norvegicus</i> (Linnaeus, 1758)	Merker-Poček [10, 13]
Diogenidae	<i>Dardanus arrosor</i> (Herbst, 1796)	Merker-Poček [13]

(continued)

**Table 1** (continued)

Family	Species	Literature
Paguridae	<i>Anapagurus laevis</i> (Bell, 1845)	Merker-Poček [13]
	<i>Pagurus alatus</i> Fabricius, 1775	Merker-Poček [13]
	<i>Pagurus sculptimanus</i> (Lucas, 1846) = <i>Pagurus forbesii</i> Bell, 1845	Merker-Poček [13]
	<i>Pagurus prideaux</i> Leach, 1815	Merker-Poček [13]
	<i>Pagurus variabilis</i> (Milne-Edwards & Bouvier, 1894) = <i>Pagurus alatus</i> Fabricius, 1775	Merker-Poček [13]
Galatheidae	<i>Galathea dispersa</i> (Bate, 1859)	Merker-Poček [13]
	<i>Galathea intermedia</i> (Lilljeborg, 1851)	Merker-Poček [13]
	<i>Galathea nexa</i> Embleton, 1836	Merker-Poček [13]
	<i>Galathea squamifera</i> Leach, 1814	Merker-Poček [13]
	<i>Galathea strigosa</i> (Linnaeus, 1761)	Merker-Poček [13]
<b>(Galatheidae)</b> = Munididae	<i>Munida perarmata</i> (A. Milne-Edwards & Bouvier, 1894)	Merker-Poček [13]
	<i>Munida rugosa</i> (Fabricius, 1775)	Merker-Poček [13]
Porcellanidae	<i>Pisidia longicornis</i> (Linnaeus, 1767)	Merker-Poček [13]
Dromiidae	<i>Dromia personata</i> (Linnaeus, 1758)	Merker-Poček [13]
Homolidae	<i>Homola barbata</i> (Fabricius, 1793)	Merker-Poček [13]
Latreilliidae	<i>Latreillia elegans</i> P. Roux, 1830	Merker-Poček [13]
Dorippidae	<i>Dorippe lanata</i> (Linnaeus, 1767) = <i>Medorippe lanata</i> (Linnaeus, 1767)	Merker-Poček [14]
Parthenopidae	<i>Parthenope angulifrons</i> Latreille, 1825 = <i>Derilambrus angulifrons</i> (Latreille, 1825)	Merker-Poček [13]
	<i>Parthenope massena</i> (P. Roux, 1830) = <i>Parthenopoides massena</i> (P. Roux, 1830)	Merker-Poček [13]
	<i>Parthenope macrocheles</i> (Herbst, 1790) = <i>Spinolambrus macrochelos</i> (Herbst, 1790)	Merker-Poček [12, 13]
	<i>Parthenope miersi</i> (A. Milne-Edwards & Bouvier, 1898) = <i>Spinolambrus macrochelos</i> (Herbst, 1790)	Merker-Poček [13]
<b>(Portunidae)</b> = Polybiidae	<i>Bathynectes longipes</i> (Risso, 1816)	Merker-Poček [13]
	<i>Macropipus arcuatus</i> (Leach, 1814) = <i>Liocarcinus navigator</i> (Herbst, 1794)	Merker-Poček [13]
	<i>Macropipus corrugatus</i> (Pennant, 1777) = <i>Liocarcinus corrugatus</i> (Pennant, 1777)	Merker-Poček [13]

(continued)



**Table 1** (continued)

Family	Species	Literature
	<i>Macropipus depurator</i> (Linnaeus, 1758) = <i>Liocarcinus depurator</i> (Linnaeus, 1758)	Merker-Poček [13], Jardas and Županović [4]
	<i>Macropipus puber</i> (Linnaeus, 1767) = <i>Necora puber</i> (Linnaeus, 1767)	Merker-Poček [13]
	<i>Macropipus pusillus</i> (Leach, 1816) = <i>Liocarcinus pusillus</i> (Leach, 1816)	Merker-Poček [13]
	<i>Macropipus tuberculatus</i> (P. Roux, 1830)	Merker-Poček [13]
	<i>Macropipus zariquieyi</i> (Gordon, 1968) = <i>Liocarcinus zariquieyi</i> (Gordon, 1968)	Merker-Poček [12, 13]
Portunidae	<i>Callinectes sapidus</i> Rathbun, 1896	Marković and Đurović [25, 23]
(Xanthidae) = Pilumnidae	<i>Pilumnus hirtellus</i> (Linnaeus, 1761)	Merker-Poček [13]
	<i>Pilumnus spinifer</i> H. Milne Edwards, 1834	Merker-Poček [13]
	<i>Pilumnus villosissimus</i> (Rafinesque, 1814)	Merker-Poček [13]
Xanthidae	<i>Xantho incisus granulicarpus</i> (Forest, 1953) = <i>Xantho granulicarpus</i> (Forest, 1953)	Merker-Poček [13]
	<i>Xantho poressa</i> (Olivi, 1792)	Merker-Poček [13]
	<i>Monodaeus couchi</i> (Couch, 1851)	Jardas and Županović [4]
Goneplacidae	<i>Goneplax rhomboides</i> (Linnaeus, 1758)	Merker-Poček [13], Jardas and Županović [4]
(Pinnotheridae) = Ethusidae	<i>Ethusa mascarone</i> (Herbst, 1785)	Merker-Poček [13]
Pinnotheridae	<i>Pinnotheres pisum</i> (Linnaeus, 1767)	Merker-Poček [13]
Leucosiidae	<i>Ebalia cranchii</i> Leach, 1817	Merker-Poček [13]
	<i>Ebalia granulosa</i> H. Milne Edwards, 1837	Merker-Poček [13]
	<i>Ebalia tuberosa</i> (Pennant, 1777)	Merker-Poček [13]
Calappidae	<i>Calappa granulata</i> (Linnaeus, 1758)	Merker-Poček [13]
(Majidae) = Inachidae	<i>Achaeus cranchii</i> (Leach, 1817)	Merker-Poček [13]
(Majidae) = Epialtidae	<i>Anamathia rissoana</i> (P. Roux, 1828)	Merker-Poček [13]
	<i>Lissa chiragra</i> (Fabricius, 1775)	Merker-Poček [13]
	<i>Pisa armata</i> (Latreille, 1803)	Merker-Poček [13]
	<i>Pisa nodipes</i> Leach, 1815	Merker-Poček [13]
	<i>Pisa tetraodon</i> (Pennant, 1777)	Merker-Poček [13]
(Majidae) = Oregoniidae	<i>Ergasticus clouei</i> (Studer, 1883) = <i>Ergasticus clouei</i> (A. Milne-Edwards, 1882)	Merker-Poček [12, 13]

(continued)

**Table 1** (continued)

Family	Species	Literature
(Majidae) = Inachidae	<i>Inachus communissimus</i> Rizza, 1839	Merker-Poček [13]
	<i>Inachus dorsettensis</i> (Pennant, 1777)	Merker-Poček [13, 14]
	<i>Inachus leptochirus</i> Leach, 1817	Merker-Poček [13, 14]
	<i>Inachus phalangium</i> (Fabricius, 1775)	Merker-Poček [13]
	<i>Inachus thoracicus</i> P. Roux, 1830	Merker-Poček [13]
	<i>Macropodia longirostris</i> (Fabricius, 1775)	Merker-Poček [13, 14]
	<i>Macropodia longipes</i> (A. Milne-Edwards & Bouvier, 1899)	Merker-Poček [13]
	<i>Macropodia rostrata</i> (Linnaeus, 1761)	Merker-Poček [13]
Majidae	<i>Euryonome aspera</i> (Pennant, 1777)	Merker-Poček [13, 14]
	<i>Maja squinado</i> (Herbst, 1788)	Merker-Poček [13]
	<i>Maja verrucosa</i> (H.M. Edwards, 1834) = <i>Maja crispata</i> Risso, 1827	Merker-Poček [13]

Literature: Merker Poček [11, 13, 14].

*Penaeus aztecus* Ives, 1891 (Fig. 5).

Common names: Astečka kozica (MNE), Northern brown shrimp (E), Mazzancola tropicale (I), Crevette royale grise (F).

Distribution: According to Marković et al. [27] this species was recorded in trawl nets in open sea of Montenegro, near Platamuni area at depths around 100 m.

Adriatic: The first record of this species was in Boka Kotorska Bay (Marković et al. [22]), South Adriatic Sea. After that, Zava et al. [28] collected this species by bottom trawlers off Termoli, on the central Adriatic coast of Italy.

Remarks: Valuable fishery resource.

Interest to fishery: Edible species which is often sold together with native commercial shrimps *Parapenaeus longirostris* and *Penaeus kerathurus* [23].

Literature: Marković et al. [23, 27]

*Penaeus kerathurus* (Forskål, 1775) (Fig. 6).

Common names: Tigrasti gambor (MNE), Caramote prawn (E), Mazzancolla (I), Caramote (F).

Distribution: Merker-Poček [10] recorded this species off the mouth of the river Bojana. As it was found also in Boka Kotorska Bay, this author assumed that this species prefers the primary production regions and the low salinity environment. The average size of the individuals caught was 161 mm. It was not observed at depths below 100 m [11]. Based on the obtained data, Merker-Poček and Radujković [24] conclude that the catch of caramote prawn in the area of the Bojana estuary is the highest in the period from November to January and from March to May.

Adriatic: Known from the entire area but more frequent from the southern part.

Remarks: Occurs in shallower depths between a few and 100 m on sandy-muddy bottoms.

**Table 2** Crustacea Decapoda species caught during MEDITS survey performed in Montenegrin territorial waters (2008–2015)

Family	Species	Genus and species code
Nephropidae	<i>Nephrops norvegicus</i> (Linnaeus, 1758)	NEPR NOR
Dromiidae	<i>Dromia personata</i> (Linnaeus, 1758)	DROM PER
Polybiidae	<i>Liocarcinus depurator</i> (Linnaeus, 1758)	MCPI DEP
	<i>Macropipus tuberculatus</i> (P. Roux, 1830)	MCPI TUB
Geryonidae	<i>Geryon longipes</i> A. Milne Edwards, 1882	GERY LON
Goneplacidae	<i>Goneplax rhomboides</i> (Linnaeus, 1758)	GONE RHO
Xanthidae	<i>Xantho couchii</i> Couch, 1851 = <i>Monodaeus couchii</i> (Couch, 1851)	XANT COU
Pilumnidae	<i>Pilumnus hirtellus</i> (Linnaeus, 1761)	PILU HIR
	<i>Pilumnus spinifer</i> H. Milne Edwards, 1834	PILU SPI
	<i>Pilumnus villosissimus</i> (Rafinesque, 1814)	PILU VIL
Pandalidae	<i>Chlorotocus crassicornis</i> (A. Costa, 1871)	CHLO GRA
	<i>Plesionika acanthonotus</i> (Smith, 1882)	PLES ACA
	<i>Plesionika antigai</i> Zariquiey Álvarez, 1955	PLES ANT
	<i>Plesionika edwardsii</i> (J.F.Brandt, 1851)	PLES EDW
	<i>Plesionika gigliolii</i> (Senna, 1903)	PLES GIG
	<i>Plesionika heterocarpus</i> (Costa, 1871)	PLES HET
	<i>Plesionika martia</i> (A. Milne-Edwards, 1883)	PLES MAR
Pasiphaeidae	<i>Pasiphaea multidentata</i> Esmark, 1866	PASI MUL
	<i>Pasiphaea sivado</i> (Risso, 1816)	PASI SIV
Crangonidae	<i>Pontocaris cataphracta</i> (Olivi, 1792) = <i>Aegaeon cataphractus</i> (Olivi, 1792)	PONT CAT
Homolidae	<i>Homola barbata</i> (Fabricius, 1793)	HOMO BAR
	<i>Paromola cuvieri</i> (Risso, 1816)	PARA CUV
Latreillidae	<i>Latreillia elegans</i> Roux, 1830	LATR ELE
Munididae	Munida sp.	MUNI SPP
	<i>Munida intermedia</i> A. Milne Edwards & Bouvier, 1899	MUNI INT
	<i>Munida iris</i> A. Milne Edwards, 1880	MUNI IRI
Inachidae	<i>Macropodia longipes</i> (A. Milne-Edwards & Bouvier, 1899)	MACR LON
Majidae	<i>Maja squinado</i> (Herbst, 1788)	MAJA SQU
	<i>Maja goltziana</i> d'Oliveira, 1888 = <i>Neomaja goltziana</i> (d'Oliveira, 1889)	MAJA GOL
Epialtidae	<i>Lissa chiragra</i> (Fabricius, 1775)	LISS CHI
	<i>Pisa armata</i> (Latreille, 1803)	PISA ARN
	<i>Pisa nodipes</i> Leach, 1815	PISA NOD
Parthenopidae	<i>Parthenope macrochelos</i> (Herbst, 1790) = <i>Spinolambrus macrochelos</i> (Herbst, 1790)	PART MAC
Calappidae	<i>Calappa granulata</i> (Linnaeus, 1758)	CALA GRA
Dorippidae	<i>Dorippe lanata</i> (Linnaeus, 1767) = <i>Medorippe lanata</i> (Linnaeus, 1767)	DORI LAN
Diogenidae	<i>Dardanus arrosor</i> (Herbst, 1796)	DARD ARR

(continued)

**Table 2** (continued)

Family	Species	Genus and species code
Paguridae	<i>Pagurus alatus</i> Fabricius, 1775	PAGU ALA
	<i>Pagurus excavatus</i> (Herbst, 1791)	PAGU EXC
	<i>Pagurus cuanensis</i> Bell, 1845	PAGU CUA
Palinuridae	<i>Palinurus elephas</i> (Fabricius, 1787)	PALI ELE
Polychelidae	<i>Polycheles typhlops</i> Heller, 1862	POLC TYP
Aristeidae	<i>Aristaeomorpha foliacea</i> (Risso, 1827)	ARI FOL
	<i>Aristeus antennatus</i> (Risso, 1816)	ARIT ANT
Penaeeidae	<i>Parapeaneus longirostris</i> (Lucas, 1846)	PAPE LON
Solenoceridae	<i>Solenocera membranacea</i> (Risso, 1816)	SOLO MEM
Sergestidae	<i>Sergestes arcticus</i> Krøyer, 1855 = <i>Eusergestes arcticus</i> (Krøyer, 1855)	SERG ARC

**Fig. 3** *Aristeidae* caught during MEDITs survey (Photo by Olivera Marković)

Interest to fishery: It is interesting to note that Štević [21] mentioned that this species is edible, but of little commercial importance. Nowadays it has high importance to fishery. It is exploited by trawls and pots.

Literature: Merker Poček [10, 11, 13, 14], Merker-Poček and Radujković [21].

*Parapeaneus longirostris* (Lucas, 1846).

Common names: Kozica (MNE), Deep-water pink shrimp (E), Gambero rosa (I), Crevette rose du large (F).

Distribution: According to Merker-Poček [10] this species was the most numerous species among *Penaeeidae* and constitutes the most interesting species from a



**Fig. 4** *Aristeus antennatus* (Risso, 1816) (Photo by O. Marković)



**Fig. 5** Northern brown shrimp, *Penaeus aztecus* Ives, 1891 caught by trawl net (Photo by O. Marković)

commercial point of view from surveys conducted in 1968. It was found at depths between 100 and 500 m. According to same author the frequency of *P. longirostris* below the isobaths of 100 m was not significant, while the highest frequency occurs in the isobaths of 500 m. Investigations conducted by Kasalica [29] showed that this species was very numerous on shallower depths even on 20 m on muddy and sandy bottoms.

Adriatic: Reported from the entire area except the northern part.



**Fig. 6** *Penaus kerathurus* (Forskål, 1891) (Photo by O. Marković)

Remarks: Lives on muddy and sandy bottoms between 20 and 750 m.

Interest to fishery: Very important commercial target species.

Literature: Merker Poček [10, 11, 13, 14], Kasalica [29], Kasalica et al. [18]

*Solenocera membranacea* (Risso, 1816).

Common names: Kozica iz mulja (MNE), Atlantik mud shrimp (E), Gamberetto di fango (I), Salicoque des vases (F).

Distribution: This species found at a depth between 150 and 500 m but it is more frequent on shallower depths. Average length and weight increase with depth. Merker-Poček and Radujković [24] found that this species is nocturnal substitute of *Melicertus kerathurus* caught in the mouth of the Bojana river.

Adriatic: Recorded from the entire area, except the northern part.

Remarks: Inhabits muddy and sandy-muddy bottoms on depths between 50 and 300 m.

Interest to fishery: Edible species but does not have commercial importance.

Literature: Merker Poček [10, 11, 13, 14].

*Plesionika edwardsii* (J. F. Brandt in von Middendorf, 1851).

Common names: Edwardsijeva kozica (MNE), Striped soldier shrimp (E), Gobbetto striato (I), Crevette édouard (F).

Distribution: This species as *Plesionika edwardii* was found for the first time in the Adriatic during the trawl survey carried out in 1968 [9, 10, 11]. This species was less represented in the catch than *P. heterocarpus*.

Adriatic: Recorded only in the southern deep basin.

Remarks: Found on muddy bottoms on depths between 100 and 500 m.

Interest to fishery: Rare and no commercial importance.

Literature: Merker Poček [9, 10, 11, 13, 14].

*Plesionika heterocarpus* (A. Costa, 1871) (Fig. 7).

Common names: Streličasta kozica (MNE), Arrow shrimp (E), Gobbetto freccia (I), Crevette flèche (F).



**Fig. 7** *Plesionika heterocarpus* (with broken rostrum) caught during MEDITS survey performed in Montenegrin territorial waters in 2010 (Photo by O. Marković)

**Distribution:** This species was found for the first time in the Adriatic during the trawl survey carried out in 1968 [9]. It was found on isobaths between 200 m and 500 m. The greatest number of specimen was caught at 260 m of depth. It is interesting to note that no one male specimen was found on all sampling stations, while females were numerous.

**Adriatic:** Found in the middle and southern parts.

**Remarks:** Occurs on muddy bottoms.

**Interest to fishery:** This species is edible but does not have commercial value in Montenegrin territorial waters.

**Literature:** Merker Poček [9, 10, 11, 13, 14].

*Plesionika martia* (A. Milne-Edwards, 1883).

**Common names:** Zlatna kozica (MNE), Golden shrimp (E), Gobbetto (I), Crevette dorée (F).

**Distribution:** Merker Poček [10] collected this species (56 specimen) by trawl on depths of 530 m.

**Adriatic:** Reported from the middle and southern parts.

**Remarks:** This species lives on muddy bottoms, depths 180 to 2,100 m [30].

**Interest to fishery:** In Montenegrin waters this species is very rare and occasionally caught by trawls and does not have any interest to fishery, while in other parts of South Adriatic (Italian waters and Albanian waters), this species along with *P. heterocarpus* represented more than 95% of the total species catch from the surveys [31] and has fairly good commercial value.

**Literature:** Merker Poček [9, 10, 11, 13, 14].



**Fig. 8** *Palinurus elephas* (Fabricius, 1787) (Photo by Vesna Mačić)

*Processa canaliculata* Leach, 1815.

Common names: Žljebasta kozica (MNE), Processa shrimp (E), Guernade processe (F).

Distribution: Merker-Poček [10] recorded this species (97 specimen) on depths between 100 and 500 m, while Merker and Ninčić [32] found this species on izobaths from 10 to 40 m.

Adriatic: Recorded in the middle and southern parts.

Interest to fishery: No interest to fishery.

Literature: Merker Poček [10, 11].

*Palinurus elephas* (Fabricius, 1787) (Fig. 8).

Common names: Jastog (MNE), Common spiny lobster (E), Aragosta (I), Langouste rouge (F).

Distribution: This species lives on rocky bottoms near coast.

Adriatic: Reported from the east side, especially the middle and southern areas.

Remarks: Spring is the best period for catching Spiny lobster and the European lobster. The average weight range was 0.3–0.8 kg, which is significantly less than the weights reported a decade ago (up to 2 kg). According to fishermen the main reason for this situation is a large number of illegal SCUBA divers with underwater lights, particularly in the period May–August, when literally lobsters are harvested from the rocks along the entire area of Montenegrin coast [33]. According to IUCN this species is VU (vulnerable) [34].

Interest to fishery: Highly prized species.

Literature: Merker-Poček [13].

*Scyllarides latus* (Latreille, 1803) (Fig. 9).





**Fig. 9** *Scyllarides latus* (Latreille, 1803) (Photo by V. Mačić)

Common names: Kuka (MNE), Mediterranean slipper lobster (E), Cicala grande (I), Grande cigale (F).

Distribution: On rocky bottoms, close to shore.

Adriatic: Recorded on the southern part of the area and occasionally on the middle one.

Remarks: One of the largest decapod crustaceans in the Mediterranean Sea and is well known as a gourmet sea food [35].

Interest to fishery: Edible. Its market price is less than the price of common spiny lobster or European lobster.

Literature: UNEP/MAP-RAC/SPA [36].

*Scyllarus arctus* (Linnaeus, 1758) (Fig. 10).

Common names: Zezavac (MNE), Lesser slipper lobster (E), Magnosella (I), Petite cigale (F).

Distribution: Found on Platamuni and Ratac area [36].

Adriatic: Occurs in the entire area.

Remarks: It is found in the infra- and circalittoral zones, mainly on rocky substrates with holes and hiding places, at depths from five down to 50 m [37].

Interest to fishery: Edible but it has no commercial importance.

Literature: Merker-Poček [13].

*Homarus gammarus* (Linnaeus, 1758) (Fig. 11).

Common names: Hlap (MNE), European lobster (E), Astice (I), Homard européen (F).

Distribution: Occurs on rocky bottoms close to the entire Montenegrin coast.

Adriatic: Recorded over the entire area.



**Fig. 10** *Scyllarus arctus* (Linnaeus, 1758) (Photo by V. Mačić)



**Fig. 11** *Homarus gammarus* (Linnaeus, 1758) (Photo by V. Mačić)

Remarks: Like Spiny lobster, this species is overfished, thanks to illegal divers who almost harvested their population RAC/SPA-UNEP/MAP [33]. According to the Article 18, item 3 of the Law on marine fisheries and aquaculture, the Ministry of Agriculture, Forestry and Water Management has issued the order on prohibition of



**Fig. 12** *Nephrops norvegicus* (Linnaeus, 1758), female with eggs (Photo by O. Marković)

catch and trade in fish juveniles, undersized fish, and other marine organisms (OG of Montenegro No. 8/11). As the Oder specifies, it is forbidden to catch and place on market European lobster individuals with total lengths of less than 28 cm. All caught specimens shorter than 28 cm and females with eggs, regardless of their length, must be returned to the sea.

Interest to fishery: Highly prized species.

Literature: RAC/SPA-UNEP/MAP [33], UNEP/MAP-RAC/SPA [36].

*Nephrops norvegicus* (Linnaeus, 1758) (Fig. 12).

Common names: Škamp (MNE), Norway lobster (E), Scampo (I), Langoustine (F).

Distribution: During survey in 1968 this species was found on depths between 300 and 500 m in very small quantities (50 specimen) so Merker-Poček [10] claimed that it is more interesting from a commercial point of view in the other regions of the Adriatic.

Adriatic: Found throughout the area, in particular in channels of northern and middle area and off the coast in the south.

Remarks: It is characteristic and also dominant species in the biocoenosis of the muddy bottoms of the open Adriatic named *Nephrops norvegicus-Thenea muricata* [38].

Interest to fishery: Although it is not a target species in Montenegrin trawl fishery, this species has considerable economic importance to fishery. It is mainly targeted by bottom trawls and baited traps but in lesser degree [39].

Literature: Merker Poček [10, 13].

*Callinectes sapidus* Rathbun, 1896 (Fig. 13).



**Fig. 13** *Callinectes sapidus* (Rathbun, 1891) (Photo by O. Marković)

Common names: Plavi rak (MNE), Blue crab (E), Granchio blu (I), Crabe bleu (F).

Distribution: From Boka Kotorska Bay to the mouth of the Bojana river (whole Montenegro coast).

Adriatic: This species is recorded in the whole Adriatic.

Remarks: Its exploitation is limited and localized only on Bojana River mouth.

Interest to fishery: Commercially important species.

Literature: Mačić and Kljajić [40], Marković and Đurović [25].

## 4 Discussion

A total of 95 species belonging to 37 families were recorded. Among the species, two are aliens: *Penaeus aztecus* and *Callinectes sapidus* and two are Mediterranean endemic species: *Maja squinado* and *Macropodia longirostris*. Four species are protected under the Bern Convention: *Homarus gammarus*, *Scyllarides latus*, *Palinurus elephas*, and *Maja squinado*. This present number is very small compared to number of Decapoda known (more than 90 species) from the region around the Piran Gulf in Northern Adriatic reported by Manning and Štević [41] and much smaller than the number of the Adriatic decapods which is 241 [42]. We must take this information with caution because this number is not final and exact because it is based only on available published literature and reports. We must stressed that many crustacean decapod species reported for Boka Kotorska Bay live also in shallower depths close to the whole Montenegro coast. So, the conclusion is that the final number is bigger and further investigation must be performed.

Many factors affect crustacean biodiversity and abundance such as pollution, marine litter, climatic global changes, environmental factors (bottom temperature and salinity, sediment texture), alien species. According to Petović et al. [43] in Montenegro, the last 20 years have been characterized by a building boom, especially in the narrow coastal zone which led to rapid degradation of natural habitats of all marine organisms. The physical variables and the amounts of pollutants in sea environment are considerable factors in knowing benthic community structure and the waters polluted have mostly the communities with low species diversity [44]. Crustaceans are the most sensitive group among benthic assemblages affected by sewage pollution [45, 46] and are mostly known as bioindicators in various aquatic ecosystems, especially for polluted waters [47]. Besides eutrophication, activities known to affect significantly the biodiversity of coastal ecosystems include shipping (oil spills, exotic species), industry (chemical effluents), dredging and dumping, fishing and mariculture, biological invasions, tourism, etc. [48]. Pollution and marine litter are having strong attention because of the several indirect and direct impacts on both stocks and fisheries [49].

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