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Diversity of Amphipoda (Crustacea) in Boka Kotorska Bay (Montenegro, Adriatic sea)
(Contribution to the knowledge of the Amphipoda 308)

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ABSTRACT

Diversity of the amphipods (Crustacea Peracarida, order Amphipoda) (except benthic Caprellidea and planctonic Hyperiidea) in Boka Kotorska Bay (Montenegro, Adriatic Sea) is presented and 2 suborders, 25 families, 38 genera and 59 species are cited. Among them, 6 marine species have type-locality Boka Kotorska [*Ampelisca dalmatina* G. Karaman, 1975; *Autonoe karamani* Myers, 1976, *Leptocheirus mariae* G. Karaman, 1973; *Leucothoe oboa* Karaman, G., 1971; *Maera sodalis* Karaman, G. & Ruffo, 1971; *Paraphoxus lincolni* Karaman, G., 1988. Three freshwater subterranean species have also type-locality in Bay of Boka Kotorska: *Niphargus abavus* G. Karaman, 2011, *N. kusceri* S. Karaman, 1950; *Niphargus brevicuspis brevicuspis* Schellenberg, 1937. *Niphargus abavus* is endemic species of Boka Kotorska Bay.

The species *Orchestia cavimana* Heller, 1865 is recently restricted to the Cyprus Island, eastern Mediterranean, under the name *Cryptorchestia cavimana* (Heller, 1865) by Ruffo, Tarocco & Latella (2014), and the species, cited over one century under name *Orchestia cavimana* Heller, 1865, for the coasts of Montenegro, basin of Adriatic and Mediterranean Sea and various continental waters (lakes and rivers), was recently described by the same authors as a different new species, *Cryptorchestia garbinii* Ruffo, Tarocco & Latella 2014.

Fauna of Amphipoda in Bay of Boka Kotorska is still only partially known and further studies are necessary to understand better the problem of biodiversity protection of Bay of Boka Kotorska.

Key Words: Amphipoda, Boka Kotorska, Adriatic Sea, Montenegro, type-localities, diversity

INTRODUCTION

The Bay of Boka Kotorska is part of Adriatic Sea, deeply inserted into the coast of Montenegro, nearly 28 km long, with shoreline 107 km long, and with sea surface 88 km^2, surrounded by Lovćen Mts and Orijen Mts. Boka Kotorska Bay is divided into four smaller bays [Kotor, Risan, Tivat, Hercegnovi). Origin of the Bay is river submersed during the Early Holocene. The depth of the Bay is under 50 meters, in front of the Bay-entrance the depth of the sea is increasing to over 100 meters (Fig. 1).

The marine bottom of the Bay is covered by layers of sand, mud, clay, algae, *Posidonia* and *Cymodocea* fields, submarine springs, rocks,

coastal sandy beaches, coastal springs, mouths of short rivers, interstitial fauna (meiobenthos) at beaches, and all these types of bottom are settled by various species of amphipods. The freshwater imput is from the sides of the surrounding mountains by numerous springs, caves, small torrents with their subterranean and epigean fauna of Amphipoda. This input has strong influence on the salinity, temperature and many other ecological conditions of the seawater in the Bay.

Fauna of Amphipoda in Boka Kotorska Bay was studied by several authors (S. Karaman, A. Myers, A. King, S. Ruffo, G. Karaman) during many years, and several new species have been described from marine bottom of the bay (*Autonoe karamani* Myers, 1976, *Leptocheirus mariae* G. Karaman, 1973, etc.). Various other interesting new species, described by various authors from coasts of the Mediterranean Sea (Italy, France, etc.) have been discovered later also in the Boka Kotorska Bay [*Harpinia crenulata* (Boeck, 1871), *Harpinia karamani* King, 2004; *Podoprion bolivari* Chevreux, 1891, *Rhipidogammarus karamani* Stock, 1971, etc).

MATERIAL AND METHODS

The data in this work are presented based on our personal investigations and published data by various authors over entire Bay of Boka Kotorska and its coastal zone (Stock, 1971, Karaman, 1971; 1973; 1982; 1993; 2011; Myers, 1976; King, 2004, etc.).

The taxonomical classification of Amphipoda vary very much in papers of various authors: from classic taxonomy with order Amphipoda divided into 4 suborders: Gammaridea, Caprellidea, Hyperidea, Ingolfiellidea [S. Ruffo (editor), 1982-1998, Barnard, J.L., 1958; Barnard & Karaman, G., 1991] to new classification based on partial genetic/ molecular investigations, with introducing of various new high taxonomical categories (parvorder, infraorder, superorder, etc) (Lowry & Myers, 2013; 2017) used also in this work. By this way, taxonomy of Amphipoda is now in the process of recognition of all taxonomical categories in general, and probably will undergo significant changes.

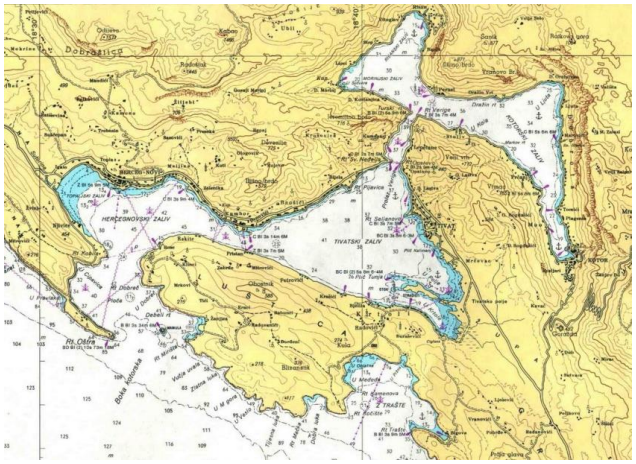

Fig. 1. Boka Kotorska Bay, source: internet

RESULTS

Superorder PERACARIDA
Order Amphipoda Latreille, 1816
Suborder **Amphilochidea** Boeck, 1871
Family AMPELISCIDAE: Costa, A., 1857
Genus *Ampelisca* Kroyer, 1842
1. Ampelisca dalmatina Karaman, G., 1975
2. Ampelisca diadema (Costa, A., 1853)
3. Ampelisca intermedia Bellan-Santini & Diviacco, 1990
4. Ampelisca sarsi Chevreux, 1887
5. Ampelisca typica (Bate, 1856)

Family ARISTIIDAE Lowry & Stoddart, 1997
Genus *Perierella* Chevreux & Bouvier 1892
6. Perrierella audouiniana (Bate, 1857)

Family ATYLIDAE Liljeborg, 1865
Genus *Atylus* Leach, 1815
7. Atylus guttatus (Costa A., 1851)
Family DEXAMINIDAE Leach, 1814
Genus *Dexamine* Leach, 1814
8. Dexamine spinosa (Montagu, 1813)
Genus *Guernea* Chevreux, 1887
9. Guernea coalita (Norman, 1868)

Family LEUCOTHOIDAE Dana, 1852
Genus *Leucothoe* Leach, 1814

10. Leucothoe oboa Karaman, G., 1971

Family LYSIANASSIDAE Dana, 1849
Genus *Lysianassa* Milne Edwards, 1830
11. Lysianassa pilicornis Heller, 1866

Genus *Hippomedon* Boeck, 1871
12. Hippomedon denticulatus (Bate, 1857)

Genus *Orchomene* Boeck, 1871
13. Orchomene humilis (Costa, A., 1853)
14. Orchomenella nana (Kroyer, 1846)

Genus *Tryphosites* Sars, 1891
15. Tryphosites longipes (Bate & Westwood, 1861)

Family MELPHIDIPPIDAE Stebbing, 1899
Genus *Melphidippella* Sars, 1894
16. Melphidippella macra (Norman, 1869)

Family PHOXOCEPHALIDAE Sars, 1891
Genus *Harpinia* Boeck, 1876
17. Harpinia antennaria Meinert, 1890
18. Harpinia crenulata (Boeck, 1871)
19. Harpinia dellavallei Chevreux, 1910
20. Harpinia karamani King, 2004
21. Harpinia pectinata Sars, 1891

Genus *Metaphoxus* Bonnier, 1896
22. Metaphoxus fultoni (Scott, 1890)
23. Metaphoxus simplex (Bate, 1857)

Genus *Paraphoxus* Sars, 1891
24. Paraphoxus lincolni G. Karaman, 1988

Family PODOPRIONIDAE Lowry & Stoddart, 1996
Genus *Podoprion* Chevreux, 1891
25. Podoprion bolivari Chevreux, 1891

Family STENOTHOIDAE Boeck, 1871
Genus *Stenothoe* Dana, 1852
26. Stenothoe valida Dana, 1852

Family UROTHOIDAE Bousfield, 1978
Genus *Urothoe* Dana, 1852
27. Urothoe elegans, Bate, 1857
28. Urothoe pulchella (Costa, A., 1853)

Suborder **Senticaudata** Lowry & Myers, 2013
Family AORIDAE Stebbing, 1899a
Genus *Aora* Kroyer, 1845
29. Aora gracilis (Bate,1857)

Genus *Autonoe* Bruzelius, 1859
30. Autonoe karamani (Myers, 1976)
Family BOGIDIELLIDAE Hertzog, 1936

Genus Medigidiella Stock, 1981
31. Medigidiella dalmatina (S. Karaman, 1953)

Family CARANGOLIOPSIDAE Bousfield, 1977
Genus *Carangoliopsis* Ledoyer, 1970
32. Carangoliopsis spinulosa Ledoyer, 1970

Family CHEIROCRATIDAE Bousfield & Shih, 1994
Genus *Cheirocratus* Norman, 1867
33. Cheirocratus sundevallii (Rathke, 1843)

Family COROPHIIDAE Leach, 1814
Genus *Leptocheirus* Zaddach, 1844
34. Leptocheirus mariae G. Karaman, 1973
35. Leptocheirus pectinatus (Norman, 1869)

Family CRANGONYCTIDAE Bousfield, 1973
Genus *Synurella* Wrzesniowski, 1877
36. Synurella ambulans ambulans (F. Muller, 1846)

Family GAMMARIDAE Leach, 1814
Genus *Echinogammarus* Stebbing, 1899
37. Echinogammarus foxi (Schellenberg, 1928)
38. Echinogammarus olivii (Milne Edwards, 1830)
39. Echinogammarus pungens (Milne Edwards, 1840)
40. Echinogammarus stocki G. Karaman, 1969
41. Echinogammarus veneris (Heller, 1865)

Genus *Gammarus* Fabricius, 1775
42. Gammarus aequicauda (Martynov, 1931)
43. Gammarus insensibilis Stock, 1966

Genus *Rhipidogammarus* Stock, 1871

44. Rhipidogammarus karamani Stock, 1971

Family HADZIIDAE S. Karaman, 1943
Genus *Hadzia* S. Karaman, 1932
45. Hadzia fragilis fragilis S. Karaman, 1932

Family MAERIDAE Krapp-Schickel, 2008
Genus *Maera* Leach, 1814
46. Maera sodalis G. Karaman & Ruffo, 1971

Genus *Othomaera* Krapp-Schickel, 2001
47. Othomaera schmidtii (Stephensen, 1915)

Family MELITIDAE Bousfield, 1973
Genus *Abludomelita* G. Karaman, 1981
48. Abludomelita gladiosa (Bate, 1862)

Genus *Melita* Leach, 1814
49. Melita hergensis Reid, 1939
50. Melita palmata (Montagu, 1804)

Family NIPHARGIDAE Bousfield, 1977
Genus *Niphargus* Schiödte, 1849
51. Niphargus abavus G. Karaman, 2011
52. Niphargus kusceri S. Karaman, 1950
53. Niphargus brevicuspis brevicuspis Schellenberg, 1937

Family PHLIANTIDAE Stebbing, 1899
Genus *Pereionotus* Bate & Westwood, 1863
54. Pereionotus testudo (Montagu, 1808)

Family PSEUDONIPHARGIDAE G. Karaman, 1993
Genus *Pseudoniphagus* Chevreux, 1901
55. Pseudoniphargus adriaticus S. Karaman, 1955

Family TALITRIDAE Rafinesque, 1815
Genus *Cryptorchestia* Lowry & Fanini, 2013
56. Cryptorchestia garbinii Ruffo, S., Tarocco, M. & Latella, L., 2014
Genus *Orchestia* Leach, 1814
57. Orchestia gammarella (Pallas, 1766)
58.Orchestia mediterranea Costa, A., 1853

Genus *Platorchestia* Bousfield, 1982
59. Platorchestia platensis (Kroyer, 1845)

DISCUSSION

The known fauna of Amphipoda in Bay of Boka Kotorska is relatively very rich regarding its relatively small area, consisting of marine, brackish water and freshwater taxa, but still only partially known. For this reason we presented here the actual known diversity of Amphipoda in Boka Kotorska Bay region.

Among numerous species mentioned above, 6 marine new species were described from this Bay [type-locality: bottom of Bay of Boka Kotorska]: *Ampelisca dalmatina* Karaman, G., 1975, *Autonoe karamani* (Myers, 1976), *Leptocheirus mariae* Karaman, G., 1973, *Leucothoe oboa* Karaman, G., 1971, *Maera sodalis* Karaman, G. & Ruffo, 1971 and *Paraphoxus lincolni* Karaman, G., 1988. Later all these species have been discovered also in some other localities along the Adriatic and Mediterranean Sea (coast of France, Italy, Greece, etc.).

On the other hand, some very interesting species described from other parts of the Mediterranean Sea, we have collected later in Boka Kotorska Bay [*Podoprion bolivari*, *Harpinia karamani*, *Echinogammarus stocki*, *Medigidiella dalmatina*, *Othomaera schmidtii*, *etc.*].

Three subterranean freshwater species have locus typicus in region of Boka Kotorska: *Niphagus abavus* G. Karaman, 2011 [subterranean waters of springs in Markov Rt, mentioned also in springs in Muo, and in temporary waters in Lepetane (Fig. 3)]; *Niphargus kusceri* S. Karaman, 1950 [springs of Ljuta near Orahovac (Fig. 2), found also in Gurdić and Skurda in Kotor] and *Niphargus brevicuspis brevicuspis* Schellenberg 1937 [cave Gornja Pokljuka above Risan].

Fig. 2. Spring of Ljuta near Orahovac, type-locality of *Niphargus kusceri* S. Kar. 1950

In the caves near Risan appear subterranean fresh- and brackish water species *Hadzia fragilis fragilis* [locus typicus: Vjetrenica Cave in Popovo polje, Herzegovina).

In the freshwater springs above Kotor appears semisubterranean species *Synurella ambulans ambulans* [springs on Troica] and epigean species *Echinogammarus veneris* [in numerous springs in Boka Kotorska].

In the springs in Škurda and Gurdić are present semisubterranean species *Rhipidogammarus karamani* mixed with epigean species *Echinogammarus veneris* and *E. pungens* (Fig. 4).

Fig. 3. Temporary water in Lepetane, locality of *Niphargus abavus* G. Kar. 2011

On the sandy beaches along the Bay appear species of genus *Orchestia,* and in the shallow coastal zone covered with gravel and stones, appear various species of genera *Echinogammarus* and *Gammarus*, as well as members of genus *Melita*.

The species *Niphargus abavus* is endemic species of Boka Kotorska Bay.

The species commonly known (sensu auct.) as *Orchestia cavimana* Heller, 1865 [type locality: Mt. Olimp, Cyprus island, eastern Mediterranean] was widely cited for many localities in the basin of Mediterranean and Adriatic Seas and for various continental freshwaters [Dojran and Ohrid Lakes in N. Macedonia, Garda Lake in Italy, Danube river in Serbia, Romania, etc.] [Ruffo, 1937; Ruffo, 1946; Carausu et al., 1955; Bellan-Santini, 1993; G. Karaman, 1993; 2001; 2011; etc.), was recently restricted by Ruffo et al. (2014) to the type-locality only (Olympus Mts., Cyprus island] under the name *Cryptorchestia cavimana* (Heller, 1865), and specimens mentioned from other localities under name "*cavimana*" are removed to the different new species *Cryptorchestia garbinii* Ruffo, S., Tarocco, M. & Latella, L., 2014 [type-locality: Lago di Garda, Italy].

Fig. 4. Spring Gurdić, Kotor, locality of *Rhipidogammarus karamani* Stock 1971, *Echinogammarus veneris* (Heller, 1865) and *Echinogammarus pungens* (Milne Edwards, 1840)

In the Mediterranean Sea are known over 400 species and subspecies of Gammaridean Amphipoda, belonging to over 170 genera and nearly 70 families. In the Adriatic Sea are known over 285 distinct species and subspecies belonging to nearly 140 genera and nearly 59 families, respectively. In Boka Kotorska Bay are mentioned here 25 families, 38 genera and 59 species.

As fauna of Amphipoda in Bay of Boka Kotorska is still only partially known, further studies of this group of animals are recommended, because the intense anthropogenic activity in Boka Kotorska conduct to fast degradation and disappearance of numerous ecological niches and animal and plants in it, and consequently, to degradation of entire biodiversity of Boka Kotorska Bay.

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Raznovrsnost Amphipoda (Crustacea) u Bokokotorskom zalivu (Crna Gora, Jadransko more)
(Prilog poznavanju amfipoda 308)

Gordan S. KARAMAN

SAŽETAK

Raznovrsnost amfipoda (Crustacea Peracarida, red Amphipoda) (osim bentoskih Caprellidea i planktonskih Hyperiidea) u Bokokotorskom zalivu (Crna Gora, Jadransko more) je predstavljen i navedena su 2 podreda, 25 porodica, 38 rodova i 59 vrsta. Među njima 6 morskih vrsta ima tip-lokalitete u Boki Kotorskoj [*Ampelisca dalmatina* G. Karaman, 1975; *Autonoe karamani* Myers, 1976, *Leptocheirus mariae* G. Karaman, 1973; *Leucothoe oboa* Karaman, G., 1971; *Maera sodalis* Karaman, G. & Ruffo, 1971; *Paraphoxus lincolni* Karaman, G., 1988. Takođe, tri slatkovodne podzemne vrste imaju tip-lokalitet u Boki Kotorskoj: *Niphargus abavus* G. Karaman, 2011, *N. kusceri* S. Karaman, 1950; *Niphargus brevicuspis brevicuspis* Schellenberg, 1937. *Niphargus abavus* je endemska vrsta za Bokokotorski zaliv.

Vrsta *Orchestia cavimana* Heller, 1865 je od nedavno ograničena na ostrvo Kipar, istočno Sredozemlje, pod imenom *Cryptorchestia cavimana* (Heller, 1865) prema Ruffo, Tarocco & Latella (2014) i vrsta je preko jednog vijeka citirana pod imenom *Orchestia cavimana* Heller, 1865 za obalu Crne Gore, jadranski bazen, Sredozemno more i različite kontinentalne vode (rijeke i jezera) a nedavno je bila opisana od istih autora kao različita nova vrsta *Cryptorchestia garbinii* Ruffo, Tarocco & Latella 2014.

Fauna Amfipoda u Bokokotorskom zalivu je još uvijek samo djelimično poznata i dalja istraživanja su neophodna za bolje razumijevanje problema zaštite biodiverziteta u Bokokotorskom zalivu.

Ključne riječi: Amphipoda, Boka Kotorska, Jadransko more, Crna Gora, tip-lokaliteti, raznovrsnost