

# **Ships' ballast as a Primary Factor for 'Mediterranization' of Pelagic Copepod Fauna (Copepoda) in the Northeastern Black Sea**

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**Abstract:** Results of monitoring of ballast waters of commercial vessels and researches of alien copepods of the Novorossiysk, Tuapse, Gelendzhik and Anapa Bays have been reported. The list of alien copepod species which have been found in the Black Sea (104 taxa, including 100 taxa Mediterranean) is submitted. About 30% of finds fall on the northeast of Black Sea. It has been supposed, that ships' ballast water can become a primary factor for 'Mediterranization' of pelagic copepod fauna in the Northeast of Black Sea. It has been established that the most probable is the risk of introduction of Mediterranean copepods species into areas of the large seaports of Caucasus and Crimea.

**Key words:** Ships' ballast water, mediterranean copepods, introduction, the northeastern Black Sea

## **Introduction**

In recent years, the basic source of anthropogenic sea invasions is transportation of alien organisms with ships' ballast water. Holoplankton animals and meroplankton larvae of bottom invertebrates have the greatest chances for expansion, as not individuals, but whole communities and, it is possible to state, even entire ecosystems are transported with ships' ballast water. Cases of single finds and local abundance outbreaks of copepod species new to the Black Sea have become more frequent in the last years. Data on the distribution of alien copepods species in ports of the northeastern part of the Black Sea and ballast waters from the Novorossiysk Port are given.

## **Material and Methods**

Material was collected from January to December 2004-2010 at fixed sampling sites in ports in the sea ports of Novorossiysk, Tuapse and the resort town

Gelendzhik, Anapa. Zooplankton was sampled using a medium Judy net (the diameter of the opening was 25 cm and mesh size was 100  $\mu\text{m}$ ) by total catches. Samples were fixated with a 2-4% solution of neutral formaldehyde and processed using a standard method. Zooplankton in ships' ballast waters in the Port of Novorossiysk was investigated in 2004-2005 and 2009. Zooplankton samples were concentrated from ballast tanks by filtration of 80-100 L of water through gauze with mesh size of 100  $\mu\text{m}$ .

## **Results and Discussion**

In 2004 in the Novorossiysk port in ballast water of tankers the organisms unusual for Black Sea (14 taxa), including copepods *Calanopia elliptica* (DANA, 1849), *Clausocalanus arcuicornis* (DANA, 1849), *Corycaeus furcifer* CLAUS, 1863, *Ctenocalanus vanus* GIEBR., 1888, *Oithona decipiens* FARRAN, 1913,

*O. brevicornis* GIESBR. 1891, *Oncaea mediterranea* (CLAUS, 1863), *O. media* GIESBR., 1891, *Paracalanus nanus* SARS, 1907 and *Temora longicornis* (MÜLLER O.F., 1785) were found (SELIFONOVA, 2009a). The comparative analysis of ships' ballast water and biodiversity in Novorossiysk Bay revealed the key 'groups of risk' of invaders in the northeastern Black Sea. First of all, they are Copepoda, Polychaeta and Tintinnids (SELIFONOVA, 2010). The risk of invasion of species from the Mediterranean Sea (from which 62% of ships' ballast water comes in) is the most probable in Novorossiysk Bay. In Novorossiysk, the autumn 2005-2006 density outbursts (up to 1.6 thousands ind./m<sup>3</sup>) of the copepod *Oithona brevicornis*, new species of Black Sea fauna, inhabiting coastal waters of tropical and temperate latitudes, of Mediterranean Sea in particular, may serve as an illustrative example of such invasion. The literature (GUBANOVA, ALTUKHOV, 2007) and our data (SELIFONOVA, 2009b) evidenced for increase of *O. brevicornis* during autumn period in ports of Sevastopol, Novorossiysk and Tuapse. In 2007-2008 in Novorossiysk Bay *O. brevicornis* abundance was unexpectedly low (only a few ind./m<sup>3</sup>). Live individuals of *O. brevicornis* (4600 ind./m<sup>3</sup>) were found in samples taken from ballast water of 'Super Lady' tanker (SELIFONOVA, 2010). The population consisted of females without eggs and copepodites of older ages (CIV-V). The tanker came to Novorossiysk Port from Amsterdam in October 2009. We remind that replacement of water ballast is obligatory in Black Sea, if the ballast was taken has outside of that region. In November 2009 density of *O. brevicornis* in Novorossiysk Bay increased to 8000 ind./m<sup>3</sup>, in Tuapse and Gelendzhik Bays – 3000-5000 ind./m<sup>3</sup>, Anapa Bay – 1000 ind./m<sup>3</sup>. Hence, this copepod was distributed along Northeastern Black Sea. In February-June 2010 in the Novorossiysk and Tuapse Bays density of *O. brevicornis* decreased to 100-200 ind./m<sup>3</sup>. In the late August-November *Oithona* was predominated species in zooplankton, reaching 80-85% of its total amount. In September its maximal

density in the Novorossiysk Bay attained 30 000 ind./m<sup>3</sup>, the Gelendzhik and Anapa Bays - 22 000-27 600 ind./m<sup>3</sup>. Thus it is highly likely that *O. brevicornis* have been successfully established in new location due to ballast water transport.

We are reminded, that 36 species of Mediterranean copepods were revealed in Novorossiysk Bay for 2004-2005 (SELIFONOVA, SHMELEVA, 2007). It is quite probable, that many of the specified species are a casual find (were brought with ships' ballast water). The total number of alien Copepoda, found in Black Sea, reaches 104 taxa, including 100 taxa Mediterranean (Table 1). About 30% of finds fall on the northeast of Black Sea. Numerous finds of Mediterranean copepods in the west of Black Sea are related to the inflow through Bosphorus with water exchange (KOVALEV, 1971; KOVALEV *et al.*, 1976, 1987; PAVLOVA, 1965; PAVLOVA, BALDINA, 1969; PORUMB, 1980). However, the water exchange is not only way of invasion of alien fauna to the basin. The significant number of Mediterranean species at ship routes and in areas of large seaports of Crimea and Caucasus, most likely, is possible to explain for the account of their transfer with ballast water of commercial ships to these regions (VINOGRADOV *et al.*, 2000; ZAGORODNYAYA, 2002; MURINA *et al.*, 2002; SELIFONOVA *et al.*, 2006; SELIFONOVA, SHMELEVA, 2007; SHMELEVA *et al.*, 2008; GUBANOVA, ALTUKHOV, 2007; SELIFONOVA *et al.*, 2008; SELIFONOVA, 2009a; SELIFONOVA, 2009b; SELIFONOVA, 2010). Especially it is worth to note the species regularly occurring in plankton in areas of Ports of Sevastopol, Novorossiysk and Tuapse. They are *Centropages kroyeri* GIESBR., 1892, *Paracalanus indicus* WOLFENDEN, 1905, *P. aculeatus* GIESBR., 1888, *Oithona brevicornis* GIESBR., *Oithona decipiens* FARRAN, *Oncaea media* GIESBR., *O. mediterranea* (CLAUS) and *O. venusta venella* FARRAN, 1929.

Biological invasion with ship traffic undoubtedly enhance the 'Mediterranization' of Black Sea fauna pelagic copepods that can entail a change of the historically developed native faunistic complex.

**Table 1.** The list of alien copepod species established in the Black Sea.

<b>Taxa</b>	<b>Authors that established the species</b>
Calanoida	
<b>Heterorhabdidae</b> Sars, 1902	
<i>Heterorhabdus</i> sp.	Selifonova <i>et al.</i> , 2008
<b>Lucicutiidae</b> Sars, 1902	
<i>Lucicutia flavicornis</i> (Claus, 1863)	Kovalev <i>et al.</i> , 1971
<i>Lucicutia gemina</i> Farran, 1926	Kovalev <i>et al.</i> , 1987
<i>Lucicutia</i> sp.	Selifonova <i>et al.</i> , 2008
<b>Metridinidae</b> Sars, 1902	
<i>Metridia lucens</i> Boeck, 1864	Kovalev <i>et al.</i> , 1998
<i>Metridia</i> sp.	Selifonova <i>et al.</i> , 2008
<i>Pleuromamma abdominalis</i> (Lubbock, 1856)	Kovalev <i>et al.</i> , 1987
<i>Pleuromamma gracilis</i> (Claus, 1863)	Kovalev <i>et al.</i> , 1987; Kovalev <i>et al.</i> , 1998; Selifonova, Shmeleva, 2007; Vinogradov <i>et al.</i> , 2000
<i>Pleuromamma indica</i> Wolfenden, 1905	Selifonova <i>et al.</i> , 2008
<i>Pleuromamma</i> sp.	Kovalev <i>et al.</i> , 1976; Selifonova <i>et al.</i> , 2008
<b>Calanidae</b> Dana, 1846	
<i>Calanus gracilis</i> Dana, 1849	Porumb, 1980
<i>Calanus minor</i> Claus, 1863	Kovalev <i>et al.</i> , 1987
<i>Calanus tenuicornis</i> Dana, 1849	Porumb, 1980
<i>Canthocalanus C. pauper</i> (Giesbr., 1888)	Selifonova <i>et al.</i> , 2008
<b>Mecynoceridae</b> Andronov, 1973	
<i>Mecynocera clausi</i> Thompson, 1888	Porumb, 1980; Kovalev <i>et al.</i> , 1987; Shmeleva <i>et al.</i> , 2008
<b>Paracalanidae</b> Giesbr., 1892	
<i>Arcocalanus monachus</i> Giesbr., 1888	Selifonova <i>et al.</i> , 2008
<i>Arcocalanus gibber</i> Giesbr., 1888	Selifonova <i>et al.</i> , 2008
<i>Calocalanus gracilis</i> Tanaka, 1956	Selifonova <i>et al.</i> , 2008
<i>Calocalanus gresei</i> Shmel., 1973	Selifonova <i>et al.</i> , 2008
<i>Calocalanus plumulosus</i> (Claus, 1863 )	Porumb, 1980
<i>Calocalanus pavo</i> (Dana, 1849)	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1987; Porumb, 1980; Shmeleva <i>et al.</i> , 2008
<i>Calocalanus pavoninus</i> Farran, 1936	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971; Selifonova, Shmeleva, 2007; Shmeleva <i>et al.</i> , 2008
<i>Calocalanus plumatus</i> Shmel., 1965	Kovalev <i>et al.</i> , 1976
<i>Calocalanus tenuis</i> Farran, 1926	Kovalev <i>et al.</i> , 1971; Shmeleva <i>et al.</i> , 2008
<i>Calocalanus</i> sp.	Мурина и др., 2002; Selifonova <i>et al.</i> , 2008
<i>Delius nudus</i> (Sewell, 1929)	Selifonova <i>et al.</i> , 2008
<i>Paracalanus aculeatus</i> Giesbr., 1888	Porumb, 1980; Selifonova, Shmeleva, 2007; Shmeleva <i>et al.</i> , 2008
<i>Paracalanus indicus</i> Wolfenden, 1905	Selifonova <i>et al.</i> , 2006; Selifonova, Shmeleva, 2007; Selifonova <i>et al.</i> , 2008; Shmeleva <i>et al.</i> , 2008
<i>Paracalanus. denudatus</i> Swell, 1929	Selifonova, Shmeleva, 2007
<i>Paracalanus quasimodo</i> Bowman, 1971	Shmeleva <i>et al.</i> , 2008; Selifonova <i>et al.</i> , 2008
<i>Paracalanus nanus</i> Sars, 1907	Porumb, 1980; Kovalev <i>et al.</i> , 1987; Selifonova, Shmeleva, 2007; Selifonova <i>et al.</i> , 2008
<i>Paracalanus pygmaeus</i> Claus, 1863	Selifonova, Shmeleva, 2007; Shmeleva <i>et al.</i> , 2008
<i>Parvocalanus crassirostris</i> (Dahl, 1894)	Selifonova, Shmeleva, 2007; Selifonova <i>et al.</i> , 2008

Table 1. Continued.

<b>Taxa</b>	<b>Authors that established the species</b>
<b>Aetideidae</b> Giesbr., 1892	
<i>Aetideus armatus</i> (Boeck, 1872)	Kovalev <i>et al.</i> , 1998
<i>Euchirella</i> sp.	Selifonova <i>et al.</i> , 2008
<b>Clausocalanidae</b> Giesbr., 1892	
<i>Clausocalanus arcuicornis</i> (Dana, 1849)	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Porumb, 1980
<i>Clausocalanus furcatus</i> (Brady, 1883)	Kovalev <i>et al.</i> , 1976; Selifonova, Shmeleva, 2007
<i>Clausocalanus mastigophorus</i> (Claus, 1863)	Kovalev <i>et al.</i> , 1987
<i>Clausocalanus parapergens</i> Frost, Flem., 1968	Kovalev <i>et al.</i> , 1976; Selifonova <i>et al.</i> , 2008
<i>Clausocalanus paululus</i> Farran, 1926	Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1987
<i>Clausocalanus pergens</i> Farran, 1926	Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1987; Kovalev <i>et al.</i> , 1998
<i>Clausocalanus</i> sp.	Selifonova <i>et al.</i> , 2008
<i>Microcalanus pusillus</i> , Sars, 1903	Kovalev <i>et al.</i> , 1998
<b>Ctenocalanidae</b>	
<i>Ctenocalanus vanus</i> Giebr., 1888	Porumb, 1980; ; Kovalev <i>et al.</i> , 1998
<i>Ctenocalanus</i> sp.	Selifonova <i>et al.</i> , 2008
<b>Euchaetidae</b> Giesbrecht, 1892	
<i>Euchaeta marina</i> (Prestandrea, 1833)	Kovalev <i>et al.</i> , 1998; Vinogradov <i>et al.</i> , 2000
<b>Phaenidae</b> Sars, 1902	
<i>Phaenna spinifera</i> Claus, 1863	Porumb, 1980
<b>Scolecithricidae</b> Giesbr., 1892	
<i>Scolecithricella</i> sp.	Selifonova <i>et al.</i> , 2008
<i>Scolecithrix danae</i> (Lubbock, 1856)	Kovalev <i>et al.</i> , 1976; Vinogradov <i>et al.</i> , 2000; Selifonova <i>et al.</i> , 2008
<b>Acartiidae</b> Sars, 1902	
<i>Acartia danae</i> Giesbr., 1889	Selifonova <i>et al.</i> , 2008
<i>Acartia josephinae</i> Crisafi, 1974	Selifonova, Shmeleva, 2007
<i>Acartia negligens</i> Dana, 1849	Selifonova, Shmeleva, 2007
<i>Paracartia grani</i> Sars, 1904	Selifonova <i>et al.</i> , 2008
<b>Candaciidae</b> Giesbr., 1892	
<i>Candacia ethiopica</i> Dana, 1849	Kovalev <i>et al.</i> , 1976
<i>Candacia</i> sp.	Selifonova <i>et al.</i> , 2008
<b>Centropagidae</b>	
<i>Centropages bradyi</i> Wheeler, 1901	Selifonova <i>et al.</i> , 2008
<i>Centropages kröyeri</i> Giesbr., 1892	Selifonova <i>et al.</i> , 2006; Selifonova, Shmeleva, 2007; Shmeleva <i>et al.</i> , 2008
<i>Centropages typicus</i> Kröyer, 1849	Ковалев и др., 1987; Kovalev <i>et al.</i> , 1998
<i>Centropages violaceus</i> (Claus, 1863)	Selifonova, Shmeleva, 2007; Selifonova <i>et al.</i> , 2008
<b>Pontellidae</b> Dana, 1853	
<i>Calanopia kideysi</i> Ünal, Shmel., 2002	Shmeleva <i>et al.</i> , 2008
<i>Pontellina</i> sp.	Selifonova <i>et al.</i> , 2008
<b>Temoridae</b> Giesbr., 1892	
<i>Temora discaudata</i> Giesbr., 1889	Selifonova <i>et al.</i> , 2008
<i>Temora stylifera</i> (Dana, 1849)	Kovalev <i>et al.</i> , 1987; Selifonova, Shmeleva, 2007

Table 1. Continued.

Taxa	Authors that established the species
<i>Temora turbinata</i> (Dana, 1849)	Selifonova <i>et al.</i> , 2008
<b>Eucalanidae</b> Giesbr., 1892	
<i>Eucalanus</i> sp.	Porumb, 1980
<b>Rhincalanidae</b> Geletin, 1976	
<i>Rhincalanus nasutus</i> Giesbr., 1888	Vinogradov <i>et al.</i> , 2000
<b>Cyclopoida</b>	
<b>Corycaeidae</b> Dana, 1852	
<i>Corycaeus clausi</i> F.Dahl, 1894	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971
<i>Corycacus flaccus</i> Giesbr., 1891	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971
<i>Corycaeus furcifer</i> Claus, 1863	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Selifonova, Shmeleva, 2007; Selifonova <i>et al.</i> , 2008
<i>Cocycæus lautus</i> Dana, 1849	Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1987
<i>Corycaeus limbatus</i> Brady, 1883	Kovalev <i>et al.</i> , 1987
<i>C. speciosus</i> Dana, 1849	Selifonova <i>et al.</i> , 2008
<i>Corycaeus typicus</i> (Krøyer, 1849)	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971
<i>Corycaeus</i> sp.	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Selifonova <i>et al.</i> , 2008
<i>Corycella gracilis</i> Dana, 1849	Kovalev <i>et al.</i> , 1976
<i>Corycella rostrata</i> Claus, 1863	Kovalev <i>et al.</i> , 1987; Selifonova, Shmeleva, 2007
<i>Corycella</i> sp.	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1976; Selifonova <i>et al.</i> , 2008
<b>Oithonidae</b> Dana, 1852	
<i>Oithona brevicornis</i> Giesbr., 1891	Zagorodnyaya, 2002; Gubanova, Altukhov, 2007; Selifonova, Shmeleva, 2007; Selifonova <i>et al.</i> , 2008; Shmeleva <i>et al.</i> , 2008; Selifonova, 2009a
<i>Oithona decipiens</i> Farran, 1913	Shmeleva <i>et al.</i> , 2008; Selifonova, 2009b
<i>Oithona plumifera</i> Baird, 1843	Selifonova, Shmeleva, 2007
<i>Oithona simplex</i> Farran, 1913	Selifonova, Shmeleva, 2007; Selifonova <i>et al.</i> , 2008
<i>Oithona</i> sp.	Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1998; Selifonova, Shmeleva, 2007
<i>Paroithona parvula</i> Farran, 1908	Kovalev <i>et al.</i> , 1987
<i>Paroithona</i> sp.	Selifonova, Shmeleva, 2007
<b>Oncaeidae</b> Giesbr., 1892	
<i>Oncaea</i> (Oncaeidae): <i>O. clevei</i> Früchtl, 1923	Selifonova, Shmeleva, 2007
<i>Oncaea conifera</i> Giesbr., 1891	Kovalev <i>et al.</i> , 1976; Selifonova, Shmeleva, 2007; Shmeleva <i>et al.</i> , 2008
<i>Oncaea curta</i> Sars, 1916	Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1987
<i>Oncaea dentipes</i> Giesbr., 1891	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1987; Kovalev <i>et al.</i> , 1998; Murina <i>et al.</i> , 2002; Selifonova, Shmeleva, 2007
<i>Oncaea ivlevi</i> Shmel., 1966	Selifonova <i>et al.</i> , 2008

Table 1. Continued.

Taxa	Authors that established the species
<i>Oncaea mediterranea</i> (Claus, 1863)	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1987; Porumb, 1980; Murina <i>et al.</i> , 2002; Selifonova, Shmeleva, 2007
<i>Oncaea media</i> Giesbr., 1891	Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1987; Selifonova, Shmeleva, 2007; Selifonova, 2009b
<i>Oncaea minuta</i> Giesbr., 1892	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1987; Kovalev <i>et al.</i> , 1998; Selifonova, Shmeleva, 2007
<i>Oncaea obscura</i> Farran, 1908	Kovalev <i>et al.</i> , 1998
<i>Oncaea similis</i> Sars, 1918	Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1987
<i>Oncaea subtilis</i> Giesbr., 1892	Kovalev <i>et al.</i> , 1976; Murina <i>et al.</i> , 2002; Selifonova, Shmeleva, 2007
<i>Oncaea venusta</i> Philippi, 1843	Selifonova, Shmeleva, 2007; Shmeleva <i>et al.</i> , 2008; Selifonova <i>et al.</i> , 2008
<i>Oncaea venusta venella</i> Farran, 1929	Kovalev <i>et al.</i> , 1987; Murina <i>et al.</i> , 2002; Selifonova, Shmeleva, 2007; Shmeleva <i>et al.</i> , 2008
<i>Oncaea vodjanitskii</i> Shmel., Delalo, 1965	Selifonova, Shmeleva, 2007
<i>Oncaea zernovi</i> Shmel., 1966	Selifonova, Shmeleva, 2007; Shmeleva <i>et al.</i> , 2008; Selifonova <i>et al.</i> , 2008
<b>Sapphirinidae</b> Thorell, 1892	
<i>Copilia</i> sp.	Selifonova <i>et al.</i> , 2008
<b>Harpacticoida</b>	
<b>Tachydiidae</b> Sars, 1909	
<i>Euterpina acutifrons</i> (Dana, 1847)	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1987; Selifonova, Shmeleva, 2007
<b>Miraciidae</b> Dana, 1852	
<i>Macrosetella gracilis</i> (Dana, 1848)	Kovalev <i>et al.</i> , 1976
<b>Ectinosomatidae</b> Sars, 1909	
<i>Microsetella rosea</i> Dana, 1847	Pavlova, 1964; 1965; Pavlova, Baldina, 1969; Kovalev <i>et al.</i> , 1971; Kovalev <i>et al.</i> , 1976; Kovalev <i>et al.</i> , 1998; Selifonova, Shmeleva, 2007
<i>Microsetella</i> sp.	Selifonova <i>et al.</i> , 2008

## References

- VINOGRADOV M. E., S. V. VOSTOKOV, E. G. ARASHKEVICH, A.V. DRITS, E. A. MUSAIEVA, L. L. ANOKHINA, E. A. SHUSHKINA 2000. Features of biology of jelly fish invaders and their role in ecosystem of the Black Sea. – In: Species introducers in the European Seas in Russia. *Apatity* (Kola science centre RAS), 91-113. (In Russian).
- GUBANOVA A., D. ALTUKHOV 2007. Establishment of *Oithona brevicornis* GIESBR., 1882 (Copepoda: Cyclopoida) in the Black Sea. – *Aquatic invasions*, 2 (4): 407-410.
- KOVALEV A.V. 1971. On penetration of planktonic animals from the Mediterranean Sea in the Black Sea. – In: Oceanographic researches in Sicilian channel. Kiev (Naukova dumka), 120-123. (In Russian).
- KOVALEV A. V., L. V. GEORGIEVA, E. P. BALDINA 1976. Influence of water mass exchange from Bosphorus on the content and distribution of the plankton in the nearest seas. – In: Investigation of water mass exchange from Tunis channel and Bosphorus. Kiev (Naukova dumka), 68-73. (In Russian).

- KOVALEV A. V., A. A. SHMELEVA, A. PETRAN 1987. Zooplankton of the western part of the Black Sea between Bosphorus and the estuary of Danube in May 1982. – In: Dynamics of the Water mass and productivity of the plankton of the Black Sea. Kiev (Naukova dumka), 356-367. (In Russian).
- KOVALEV A. V., S. BESIKTEPE, J. A. ZAGORODNYAYA, A. E. KIDEYS 1998. Mediterraneanization of the Black Sea zooplankton in continuing – In: Ivanov L. I., T. Oguz (Eds.): Ecosystem modeling as a management tool for the Black Sea. 1: 199-207.
- MURINA G., V. V. A. A. SHMELEVA, E. V. LISITSKAYA 2002. Annual Monitoring of Mero- and holoplankton in the oceanarium of Sevastopol bay. – *Hydrobiol. Journal*, **38** (3): 3-11. (In Russian, English summary).
- PAVLOVA E. V. 1964. About the founding Mediterranean species in the Black Sea zooplankton. – *Zoological Journal*, **43** (11): 1710-1713. (In Russian).
- PAVLOVA E. V. 1965. Penetration of the Mediterranean planktonic organisms into the Black Sea. – In: Basic features of geological structure, hydrological conditions and biology of Mediterranean Sea. Moscow (Nauka), 171-174. (In Russian).
- PAVLOVA E. V., E. P. BALDINA 1969. Influence of water exchange through the Bosphorus on distribution and composition of zooplankton of the Bosphorus region. – In: Water exchange through the Bosphorus and its influence on hydrology and biology of the Black Sea. Kiev (Naukova dumka), 208-232. (In Russian).
- PORUMB F. 1980. Présence de quelques espèces méditerranéennes dans le zooplankton de la Mer noire. – *Rev. roum ser. biol. animal. Acad. R.S.R.*, **25** (2): 167-170.
- SELIFONOVA ZH. P. 2009a. *Oithona brevicornis* Giesbrecht (Copepoda: Cyclopoida) in harborages of the Northeast part of the Black Sea shelf. – *Inland Water Biology*, **1**: 30-32.
- SELIFONOVA ZH. P. 2009b. Marine Biological invasions in waters of the port of Novorossiysk, Black Sea. – *Russian Journal of Marine Biology*, **35** (3): 242-249.
- SELIFONOVA ZH. P. 2010. On role ships' ballast waters in distribution of zooplankton species in the Northeastern Black Sea// Invasion of alien species in Holarctic (Borok – 3): the III International symposium (Borok – Myshkin-Borok Yaroslavl district, Russia, 5th – 9th October 2010), 82-83.
- SELIFONOVA J. P., E. V. YAKUSHEV, V. K. CHASOVNIKOV, E. A. ANTIPOVA 2006. Plankton of the Novorossiysk bay of the Black sea in July 2005: taxa, biomass, their connection with hydrochemical structure of waters. – In: Research of ecosystems of the Azov, Black and Caspian Seas. Apatity (Kola science centre RAS), **8**: 90-103. (In Russian).
- SELIFONOVA J. P., A. A. SHMELEVA 2007. Study of fauna copepods in the Novorossiysk Bay of the Black Sea and the Sea of Azov. – *Hydrobiol. Journal*, **43** (5): 27-35. (In Russian, English summary).
- SELIFONOVA J. P., A. A. SHMELEVA, A. E. KIDEYS 2008. Study of copepod species from the western Black Sea in the cruise r/v 'Knorr' during May-June 2001. – *Acta zool. Bulgarica*, **60** (3): 305-309.
- SHMELEVA A. A., V. V. MURINA, V. A. GRINTSOV, S. A. SHERBAN, L. A. GARLITSKAYA 2008. Invertebrates of from Black River estuaria (Sevastopol, Black Sea). – *Bulletin of Moscow society of naturalists. Biological series*, **113** (5): 31-35. (In Russian).
- ZAGORODNYAYA YU. A. 2002. *Oithona brevicornis* in the Sevastopol Bay: is it a single event of a new invader in the Black Sea fauna?. – *Ecology of sea*, **61**: 43. (In Russian).

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