

The actual state of relict Pontic-Caspian invertebrate fauna of the Lower Danube within the area of Ukraine

LYASHENKO ARTEM, ZORINA-SAKHAROVA KATERYNA, MAKOVSKYI VADIM, SANZHAK YURYI¹

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1 Introduction

The close attention of biologists, zoologists dealing with faunistic research, hydrobiologists and hydroecologists to the study of the relict Pontic-Caspian invertebrate fauna is attributed to the uniqueness and the old history of this faunistic complex. Its species can be used as the reliable indicators of the ecological state of aquatic ecosystems taking into account their adaptability to the specific salinity and oxygenation (Zenkewitsch, 1947, Mordukhai-Boltovskoi, 1960). Although this faunistic complex has been studied for more than a century starting from the research of Sowinskyi (1902), the various authors do not assess unanimously the assignment of many invertebrate species of the lower reach of the Danube to the complex under study. While several species are in fact ubiquitous, other species seem to be included into the complex by mistake. The aim of the study consisted in the revision of the faunistic summaries for the lower reach of the Danube followed by the analysis of the changes in the composition of the Pontic-Caspian invertebrate fauna in the delta front of the Kyliya branch.

2 Materials and methods

The major faunistic summaries of the Pontic-Caspian invertebrate fauna for the lower reach of the Danube are contained in the works of Mordukhai-Boltovskoi (1960), Polischuk (1974) Polischuk & Shepa (1994) and Kharchenko (2004). These summaries upon the thorough analysis of the findings relevant to zoogeographic distribution and the origin were used as the reference sources for assigning the species studied to the Pontic-Caspian complex. Furthermore, we have also used the works of Markovskiy (1955), Moroz (1993) as well as the results of our own study of invertebrate macrofauna in the Kyliya branch in 1988-2009.

3 Results

First, the following species were excluded as being non-related to the Pontic-Caspian complex: 1) cosmopolites – *Plumatella emarginata* Allman (Braiko, 1983), *Paranais litoralis* Muller (Chekanovskaia 1962), *Nais elinguis* Muller, *Isochaetides michaelsoni* Lastockin (Chekanovskaia, 1962); 2) disputable species if their origin was doubted – *Victorella pavidata* S.Kent (Polischuk 1974; Vinogradov, 2008), *Manayunkia caspia* Annenkova (Mordukhai-Boltovskoi 1960), *Tubifex svirenkoi* (Lastochkin) (Phinogenova 1968); 3) species that were included into the complex by mistake – the freshwater Danube endemic species *Theodoxus danubialis* (G. Pfeiffer) (Mordukhai-Boltovskoi 1960), the Mediterranean Amphipoda *Corophium volutator* (Pallas) (Mordukhai-Boltovskoi 1978).

The gastropod *Theodoxus euxcinus* (Clessin) should be particularly noted. Such a species is given in the summaries of Polischuk (1974) Polischuk & Shepa (1994) and Kharchenko (2004). Nevertheless, as it has been recently shown, only two species of the genus inhabit the delta front of the Kyliya branch, namely *Th. fluviatilis* and *Th. danubialis* (Zhalay et al. 2008). As to *Th. euxcinus*, it was attributed to the delta front by mistake.

¹ Institute of Hydrobiology NAS of Ukraine, Geroyiv Stalingrada prospect, 12, Kyiv-210, 04210-UA, Ukraine, e-mail: artemlyashenko@bigmir.net

We have also supplemented the faunistic lists of the lower reach of the Danube with the species, which were omitted earlier and discovered in the branches of the delta in the 1980s (Hydroecology 1993; Biodiversity 1999): *Cystobranthus fasciatus* Kollar, *Pontogammarus subnudus* (G. Sars) and *Amathillina cristata* Grim.

The final revised list of invertebrate Pontic-Caspian macrofauna for the lower reach of the Danube comprises 94 species (Table 1). According to Mordukhai-Boltovskoi (1960), 66 species inhabited this region. Polischuk (1974) has extended the list by including the species of Bivalvia, Gastropoda and Oligochaeta. Further revisions (Polischuk & Shepa 1994, Kharchenko 2004) were insignificant.

Table 1. The species list of relict invertebrate Pontic-Caspian macrofauna in the lower reach of the Danube and in the delta front of the Kyliya branch in different periods of study.

NN	Taxa	The Lower Danube (summary data)*				Dynamic of species richness within the fore delta of the Kilia arm**					
		1960	1974	1994	2004	1948- 1950	1963- 1969	1972- 1977	1987- 1998	2003- 2009	
1	2	3	4	5	6	7	8	9	10	11	
Hydrozoa											
1.	<i>Cordylophora caspia</i> (Pallas)	+	+	+	+		+		+	+	
2.	<i>Polypedium hydriforme</i> Uss.	+	+	+	+						
3.	<i>Moerisia maeotica</i> (Ostr.)	+	+	+	+		+				
Polychaeta											
4.	<i>Hypania invalida</i> (Grube)	+	+	+	+	+	+	+	+	+	
5.	<i>Hypaniola kowalewskii</i> (Grimm)	+	+	+	+	+	+	+	+	+	
Oligochaeta											
6.	<i>Paranais simplex</i> Hrabe		+	+	+	+				+	
7.	<i>Paranais frici</i> Hrabe		+	+	+	+		+			
8.	<i>Potamothenis bavaricus</i> Stephenson		+	+	+	+		+			
9.	<i>Potamothenis vejvodskyi</i> (Vejvodsky)		+	+	+	+		+			
10.	<i>Potamothenis caspicus</i> Lastockin			+	+						
11.	<i>Potamothenis mrazeki</i> (Mrazek)		+	+	+	+		+			
12.	<i>Potamothenis danubialis</i> (Mrazek)		+	+	+	+		+			
Hirudinea											
13.	<i>Caspiobdella fadejewi</i> (Epstein)		+	+	+				+	+	
14.	<i>Archaeobdella esmonti</i> Gr.				+					+	
15.	<i>Cystobranthus fasciatus</i> Kollar.								+		
Bivalvia											
16.	<i>Dreissena polymorpha</i> (Pallas)	+	+	+	+	+	+	+	+	+	
17.	<i>Dreissena bugensis</i> Andr.		+				+			+	
18.	<i>Hypanis caspia grossui</i> Scarlat et Starob.		+	+	+			+			
19.	<i>Hypanis pontica</i> (Eichw)	+	+	+	+	+		+	+		

*1960 – (Mordukhai-Boltovskoi, 1960), 1974 – (Polischuk, 1974), 1994 – (Polischuk, 1994), 2004 – (Kharchenko, 2004);

**1948-1950 – (Markovskiy, 1955; Phinogenova, 1970), 1963-69 – (Polischuk, 1974), 1972-1977 – (Moroz, 1993), 1987-1998 – (Hydroecology..., 1993; Biodiversity..., 1999; own data), 2003-2009 – own data.

20.	<i>Hypanis anguisticosta</i> (Borcea)		+	+	+			+		
21.	<i>Hypanis yalpuensis</i> (Borcea)		+	+	+			+		
22.	<i>Hypanis colorata</i> (Eichw.)		+	+	+		+	+	+	
23.	<i>Hypanis luciae</i> (Borcea)		+	+	+					
24.	<i>Hypanis laeviscula fragilis</i> (Milachavitch)	+	+	+	+	+			+	+
25.	<i>Hypanis plicata relicta</i> (Milachavitch)	+	+	+	+					
26.	<i>Hypanis dolosmiana</i> (Borcea)		+	+	+					
Gastropoda										
27.	<i>Theodoxus pallasi</i> Lidh.	+	+	+	+		+			
28.	<i>Caspiohydrobia eishcwaldiana</i> (Golic. et Starob.)		+	+	+					
29.	<i>Caspiohydrobia convexa</i> (Golic. et Starob.)		+	+	+		+	+		
30.	<i>Turricaspia triton</i> (Eichw.)		+	+	+					
31.	<i>Turricaspia ismailensis</i> (Golic. et Starob.) ^{***}		+	+	+	+				
32.	<i>Turricaspia lindholmiana</i> (Golic. et Starob.) ^{***}		+	+	+	+		+		
33.	<i>Turricaspia caspia lincta</i> (Milachevitch) ^{***}	+	+	+	+	+				
34.	<i>Turricaspia ostroumovi</i> (Golic. et Starob.) ^{***}		+	+	+	+		+		
35.	<i>Caspia logvinenkoi</i> (Golic. et Starob.)			+	+					
36.	<i>Caspia macarovi</i> (Golic. et Starob.)		+	+	+			+		
Isopoda										
37.	<i>Jaera sarsi</i> (Volkanov)	+	+	+	+	+		+	+	+
1	2	3	4	5	6	7	8	9	10	11
Corophiidae										
38.	<i>Corophium curvispinum</i> Sars	+	+	+	+	+	+	+	+	+
39.	<i>Corophium robustum</i> Sars	+	+	+	+	+			+	+
40.	<i>Corophium nobile</i> (G.O. Sars)	+	+	+	+		+	+	+	+
41.	<i>Corophium chelicorne</i> Sars	+		+	+	+				+
42.	<i>Corophium sowinskyi</i> Martynov	+	+	+	+					+
43.	<i>Corophium maeoticum</i> Sow.	+	+	+	+	+		+	+	
44.	<i>Corophium mucronatum</i> G.O.Sars				+				+	
Gammaridae										
45.	<i>Amathillina cristata</i> Grim.						+	+		
46.	<i>Cargiophilus baeri</i> G.Sars	+	+	+	+	+				
47.	<i>Chaetogammarus bechningi</i> (Bechningi)	+	+	+	+	+				+
48.	<i>Chaetogammarus ischnus</i> (Stebbing)	+	+	+	+		+	+	+	+
49.	<i>Chaetogammarus warpachowskyi</i> (Sars)	+	+	+		+		+	+	+
50.	<i>Chaetogammarus placidus</i> (Gr.)	+	+	+	+	+	+	+		
51.	<i>Gmelina costata</i> Sars, 1894	+	+	+	+	+	+	+	+	+

*** p. Micromelania.

52.	<i>Gmelina pussila</i> Sars	+	+	+	+	+	+	+	+
53.	<i>Niphargoides compactus</i> G.O.Sars.	+	+	+	+				
54.	<i>Niphargoides corpulentus</i> G.O.Sars.	+	+	+	+	+		+	+
55.	<i>Niphargoides spinicaudatus</i> Car.	+	+	+	+	+	+	+	+
56.	<i>Niphargoides motasi</i> Car.	+	+	+	+	+			
57.	<i>Niphargoides borodini intermedius</i> (G.O. Sars)	+	+	+	+	+	+	+	
58.	<i>Iphiginella shablensis</i> Car.	+	+	+	+	+		+	
59.	<i>Iphiginella andrussowi</i> Car.	+	+	+	+	+		+	+
60.	<i>Iphiginella acanthopoda</i> Gr.	+	+		+				+
61.	<i>Dikerogammarus haemobaphes</i> (Ehrenberg)	+	+	+	+	+	+	+	+
62.	<i>Dikerogammarus villosus</i> (Sowinsky)	+	+	+	+	+	+	+	+
63.	<i>Pontogammarus crassus</i> (Sars)	+	+	+	+	+	+	+	+
64.	<i>Pontogammarus robustoides</i> (Sars)	+	+	+	+	+	+	+	+
65.	<i>Pontogammarus sarsi</i> (Sowinsky)	+	+	+	+	+	+	+	+
66.	<i>Pontogammarus obesus</i> (G.O. Sars)	+	+	+	+	+	+	+	+
67.	<i>Pontogammarus maeoticus</i> (Sowinsky)	+	+	+	+	+	+	+	+
68.	<i>Pontogammarus subnudus</i> (G. Sars)								+
69.	<i>Pontogammarus weidemanni</i> (G.O. Sars)	+	+	+	+	+	+		
70.	<i>Pontogammarus abbreviatus</i> (G.O. Sars)	+	+	+	+	+		+	
71.	<i>Stenogammarus macrurus</i> (G.O. Sars)	+	+	+	+	+		+	+
72.	<i>Stenogammarus compresus</i> (G.O. Sars)	+	+	+	+	+		+	+
73.	<i>Stenogammarus carausui</i> (Derzhavin et Pjat.)	+	+	+	+			+	+
74.	<i>Stenogammarus similis</i> (G.O. Sars)	+	+	+	+	+	+	+	+
75.	<i>Stenogammarus deminutus</i> (Stebbig)	+	+	+	+	+		+	+
Mysidacea									
76.	<i>Hemimysis serrata</i> Bac.	+	+	+	+				
77.	<i>Hemimysis anomala</i> G.O.Sars	+	+	+	+			+	
78.	<i>Limnomysis benedeni</i> Czerniavsky	+	+	+	+	+	+	+	+
79.	<i>Katamysis warpachowskyi</i> G.O.Sars	+	+	+	+		+	+	
80.	<i>Paramysis ulskyi</i> (Czerniavskyi)	+	+	+	+	+		+	
81.	<i>Paramysis intermedia</i> (Czerniavskyi)	+	+	+	+	+	+	+	+
82.	<i>Paramysis baeri bispinosa</i> Martynov	+	+	+	+	+		+	+
83.	<i>Paramysis kessleri sarsi</i> (Derjavin)	+	+	+	+	+		+	
84.	<i>Paramysis lacustris</i> (Czerniavskyi)	+	+	+	+	+	+	+	+
Cumacea									
85.	<i>Schizorhynchus eudorelloides</i> (G.O.Sars)	+	+	+	+	+	+	+	+
86.	<i>Schizorhynchus scabriusculus</i> (G.O.Sars)	+	+	+	+	+	+	+	+
87.	<i>Pterocuma rostrata</i> G.O.Sars	+	+	+	+	+		+	+

88.	<i>Pterocuma pectinata</i> Sowiskyi	+	+	+	+	+	+	+	+	+
89.	<i>Caspiocuma campilastoides</i> (G.O.Sars)	+	+	+	+		+			
90.	<i>Pseudocuma cercaroides</i> G.O.Sars	+	+	+	+	+		+	+	
1	2	3	4	5	6	7	8	9	10	11
91.	<i>Pseudocuma laevis</i> G.O.Sars	+	+	+	+		+	+		
92.	<i>Pseudocuma graciloides</i> G.O.Sars	+	+	+	+	+	+	+	+	+
93.	<i>Pseudocuma tenuicauda</i> G.O.Sars	+	+	+	+	+		+		
Decapoda										
94.	<i>Astacus leptodactylus</i> (Echsholtz)	+	+	+	+	+	+	+		+
In total		66	88	87	89	59	38	63	38	42

Taking into account the revised list of the species, we have analyzed the literature data on the species composition of invertebrate Pontic-Caspian macrofauna in the delta front of the Kyliya branch since 1948 until the present (Table 1). The fauna under study was most abundant in the 1948-1950 and 1972-1977 (59 and 63 species, respectively).

The analysis of the dynamics of the particular groups of invertebrate Pontic-Caspian macrofauna in the delta front of the Kyliya branch of the Danube (Table 1) has demonstrated the absence of several taxons according to the findings of recent research. For example, only one of seven species of Oligochaeta, namely *Paranais simplex* was found in the samples of recent years. Until 1972, several species of Gastropoda were identified in the samples of invertebrate Pontic-Caspian macrofauna (*Theodoxus pallasii*, *Caspihydrobia convexa*, *Turricaspia lindholmiana*, *T. ostroumovi*, *Caspia macarovi*). Meanwhile, more recent summaries of the Pontic-Caspian invertebrate fauna do not mention such species. It should be noted that the shells of *Turricaspia* genus representing the typical psammophilous species are highly susceptible to the organic contamination of the water preferring oligo- β -mesosaprobic waters (Moroz 1993).

The Pontic-Caspian Bivalvia fauna has also changed substantially. Three species of Hypanis genus (*H. caspia grossui*, *H. angusticosta* and *H. yalpuensis*) have been lacking in the waters of the delta front of the Kyliya branch since 1972, *H. pontica* and *H. colorata* – since 1992. *Dreissena bugensis*, recorded by Polischuk (1974) had not been mentioned in faunistic summaries until 2004 when it has been found in the Romanian part of the Delta (Micu & Telembici 2004). Since 2008, this species is found systematically in the delta front of the Kyliya branch (Lyashenko et al. 2009).

Gammaridae are quite abundant, while only 8 of 31 species, namely *Gmelina costata*, *Dikerogammarus haemobaphes*, *D. villosus*, *Pontogammarus crassus*, *P. robustoides*, *P. sarsi*, *P. obesus*, *P. maeoticus* are encountered consistently for the last 50 years. Since 1948, *Cargiophilus baeri* and *Niphargoides motasi* have not been reported in the delta front of the Kyliya branch. Only in the period of 1987-1992, *Iphiginella acanthopoda* and *Pontogammarus subnudus* were found.

The maximal number of Misidacea species (7) was recorded in the delta front of the Kyliya branch in the period of 1972-1977. In our studies, only four species were found in the period of 2003-2009, with two species *Limnomysis benedeni* and *Paramysis lacustris* being encountered over the whole study period. Among Cumacea, four species *Schizorhynchus scabriusculus*, *Pterocuma rostrata*, *P. pectinata* and *Pseudocuma graciloides* were sampled consistently over the whole study period. *Pseudocuma laevis* and *P. tenuicauda* have not been found since the beginning of in the period of 1972-1977. *Caspiocuma campilastoides* has not been sampled since 1969.

The comparison of the taxonomic composition of Pontic-Caspian fauna in the waters of the delta front of the Kyliya branch (Table 2) has demonstrated the similarity of the overall species richness in the different study periods. Nevertheless, at present the number of Gammaridae, Misidacea and Cumacea species in the branches has been reduced. The reduction of the Crustacea species is much more pronounced in the waters of the Delta (from 6 to 1 species for Misidacea and from 7 to 3 species for Cumacea. Meanwhile, the overall number of Gammaridae species has been increased.

Table 2. Taxonomic composition of invertebrate Pontic-Caspian macrofauna complex in different aquatic systems in the delta front of the Kyliya branch in the various study periods.

Water bodies type	Period of investigation	Polychaeta	Hirudinea	Bivalvia	Isopoda	Corophiidae	Gammaridae	Mysidacea	Cumacea	Decapoda	In total
Water courses	1948-1950 (Markovskiyi 1955)	2	–	3	1	4	24	6	4	1	45
	2003-2009	2	2	3	1	5	18	4	3	1	39
Water reservoirs	1948-1950 (Markovskiyi 1955)	1	–	–	–	2	12	6	7	1	29
	2003-2009	2	1	2	1	4	14	1	3	–	28

4 Conclusions

The revised species list of invertebrate Pontic-Caspian macrofauna complex in the lower reach of the Danube comprises 94 species. This list is rather exhaustive with 28 species being added to the first list given in Mordukhai-Boltovskoi (1960). Meanwhile, the findings of more than 60 years of systematic observations in the delta front of the Kyliya branch of the Danube are indicative of the serious changes in the patterns of invertebrate Pontic-Caspian macrofauna. At present, no species representing the entire Gastropoda class are found; several species of Cumacea, Misidacea and Bivalvia have not been sampled for several decades. The populations susceptible to anthropogenic impacts are reduced. The exploitation of the Delta and its resources as well as the increasing eutrophication of the water and increasing content of the toxic pollutants, especially within the 80s of previous century (Romanenko et al., 2008) affected negatively the richness of the invertebrate macrofauna. Nevertheless, one should not consider such losses as irreversible. The Delta served as the refuge of species for thousands of years. At present, the diversity of the landscape and terrestrial-aquatic habitats of the Delta provides a good environment to preserve the resident populations. However, the increase of species richness and frequency of occurrence depend largely on human activities. To sum up, the invertebrate Pontic-Caspian macrofauna complex in the lower reach of the Danube is still an abundant faunistic complex.

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