THE DISTRIBUTION OF THE GASTROPOD POPULATIONS ALONG THE CHARACTERISTIC SECTORS OF THE DANUBE

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Abstract. The Danube represents one of the European areas with the richest fauna of gastropods (81 species). There appear 3 zoogeographical sectors (the upper sector, the middle sector, the lower sector), characterised by their own structure of gastropod populations. Duo to their ecological valences, in the upper sector, there are characteristic 6 species, in the middle sector 5 species, in the lower sector 14 species. Most of the species display an ubiquist character (35 species) as they are present within all the three aforementioned sectors. The global evaluation of the Gastropod populations from the Danube established that they represent 32 per cent of the European malacofauna.

Keywords: gastropods, distribution, the Danube, the global evaluation.

Rezumat. Distribuţia populaţiilor de gastropode în sectoare caracteristice Dunării. Dunărea reprezintă unul din fluviile europene cu cea mai bogată diversitate a populaţiilor de gastropode (81 specii). Se disting trei sectoare zoogeografice (superior, mijlociu, inferior) caracterizate prin structura populaţiilor de gastropode. Prin valenţele ecologice în sectorul superior sunt caracteristice 6 specii, în sectorul intermediar 5 specii, în sectorul inferior 14 specii. Cele mai multe specii au un caracter ubicvist (35 specii) fiind prezente în cele trei sectoare. Evaluarea globală a populaţiilor de gastropode din Dunăre reprezintă 32% din malacofauna europeană.

Cuvinte cheie: gastropode, distribuţie, Dunăre, evaluare globală.

INTRODUCTION

The Danube represents one of the European areas with the richest fauna of gastropods (RUSSEV, 1998; CIOBOIU, 2008). Its geographical position and ecosystem structure represent main factors that ensure the conditions necessary for the development of gastropod populations (CIOBOIU CODOBAN, 2003; BREZEANU et al., 2011).

There appear 3 zoogeographical sectors (the upper sector, the middle sector, the lower sector), characterized by specific populations of gastropods (Fig. 1). The upper or alpine sector that refers to the spring area and the torrent-like course (Km 2857 – 1880); The middle or Pannonian sector characterized by a rapid flow of the river (Km 1879 – 1103); The lower or Carpathian-Balkan sector, where the river has a large bed, slow flowing speed, and variable depths (Km 1102 – 0) (ARDELEAN et al., 1967; CIOBOIU, 2006, 2010; CIOBOIU & BREZEANU, 2000).

Figure 1. The Danube (Km 2826 – 0) (after ICPDR, Vienna).

MATERIAL AND METHODS

According to the data rendered in the literature in the field and according to my own research, there has been made a synthesis that allowed a global evaluation of the species from the Danube (BREZEANU et al., 2011; CIOBOIU, 2006, 2010; CSANYI, 1996; CUTTELOD et al., 2011; FRANK, 1987; GROSSU, 1987, 1993; JURGEN et al., 1988; LIASHENKO et al., 2010; LIASHENKO & ZORINA-SAKHAROVA, 2012; IVANYI et al., 2012; OERTEL & NOSEK, 2006; RUSSEV, 1998; TITTIZER et al., 1997; ZIERITZ & WARINGER, 2006; Fauna Europaea, 2013).

RESULTS AND DISCUSSIONS

The populations of gastropods from the Danube totalize 81 species (Table 1).

Table 1. Taxonomic composition of the Gastropods from the Danube.

No.	Species	The Danube		
		Upper sector	**Middle sector**	**Lower sector**
1.	*Theodoxus (Th.) danubialis* (C. PFEIFFER 1828)	+	+	+
2.	*Theodoxus (Th.) d. stragulatus* (C. PFEIFFER 1828)		+	+
3.	*Theodoxus (Th.) euxinus* (CLESSIN 1887)			+
4.	*Theodoxus (Th.) fluviatilis* (LINNAEUS 1758)	+	+	+
5.	*Theodoxus (Th.) pallasi* LINDHOLM 1924			+
6.	*Theodoxus (Th.) prevostianus* (C. PFEIFFER 1828)			+
7.	*Theodoxus (Th.) transversalis* (C. PFEIFFER 1828)		+	+
8.	*Viviparus acerosus* (BOURGUIGNAT 1862)	+	+	+
9.	*Viviparus ater* (DE CRISTOFORI & JAN 1832)	+		
10.	*Viviparus contectus* (MILLET 1813)		+	+
11.	*Viviparus mamillatus* (KUSTER 1852)		+	+
12.	*Viviparus viviparus* (LINNAEUS 1758)			+
13.	*Viviparus viviparus penthicus* (SERVAIN 1884)	+		
14.	*Valvata (Cincinna) piscinalis* (O. F. MULLER 1774)		+	+
15.	*Valvata (Cincinna) studeri* BOETERS & FALKNER 1998	+		
16.	*Valvata (Cincinna) piscinalis antiqua* MORRIS 1838			+
17.	*Valvata (Tropidina) macrostoma* MORCH 1864	+		
18.	*Valvata (Valvata) cristata* O. F. MULLER 1774	+	+	+
19.	*Borysthenia naticina* (MENKE 1845)		+	+
20.	*Pseudamnicola (P.) dobrogica* GROSSU 1986			+
21.	*Pseudamnicola (P.) penchinati* (BOURGUIGNAT 1870)			+
22.	*Bythinella austriaca* (FRAUENFELD 1857)	+		
23.	*Bythinella cylindrica* (FRAUENFELD 1857)	+		
24.	*Bythinella hungarica* HAZAY 1880		+	
25.	*Potamopyrgus antipodarum* (J. E. GRAY 1843)			+
26.	*Lithoglyphus apertus* (KUSTER 1852)			+
27.	*Lithoglyphus fuscus* (C. PFEIFFER 1828)		+	
28.	*Lithoglyphus naticoides* (C. PFEIFFER 1828)	+	+	+
29.	*Lithoglyphus pygmaeus* FRAUENFELD 1863			+
30.	*Bithynia (Bithynia) mostarensis* MOELLENDORFF 1873		+	
31.	*Bithynia (Bithynia) tentaculata* (LINNAEUS 1758)	+	+	+
32.	*Bithynia (Codiella) troschelii* (PAASCH 1842)	+	+	+
33.	*Bithynia (Codiella) leachii* (SHEPPARD 1823)	+		+
34.	*Turricaspia (Clessiniola) variabilis* (EICHWALD 1838)			+
35.	*Turricaspia (Oxypyrgula) ismailensis* (GOL. & STAROB. 1966)			+
36.	*Turricaspia (Turricaspia) dimidiata* (EICHWALD 1841)			+
37.	*Esperiana esperi* (A. FERUSSAC 1823)		+	+
38.	*Esperiana (Microcolpia) daudebardii* (PREVOST 1821)		+	+
39.	*Esperiana (M.) daudebardii acicularis* (A. FERUSSAC 1823)		+	+
40.	*Amphimelania holandri* (C. PFEIFFER 1828)		+	+
41.	*Physa fontinalis* (LINNAEUS 1758)	+	+	+
42.	*Physella (Costatella) acuta* (DRAPARNAUD 1805)			+
43.	*Physella (Costatella) heterostropha* (SAY 1817)		+	+
44.	*Aplexa hypnorum* (LINNAEUS 1758)		+	+
45.	*Lymnaea stagnalis* (LINNAEUS 1758)		+	+
46.	*Stagnicola corvus* (GMELIN 1791)	+	+	+
47.	*Stagnicola fuscus* (C. PFEIFFER 1821)	+		
48.	*Stagnicola palustris* (O. F. MULLER 1774)		+	+
49.	*Stagnicola turricula* HELD 1836	+	+	+
50.	*Radix ampla* (W. HARTMANN 1821)	+	+	+
51.	*Radix auricularia* (LINNAEUS 1758)		+	+
52.	*Radix balthica* (LINNAEUS 1758)		+	+
53.	*Radix labiata* (ROSSMASSLER 1835)		+	+

54.	*Radix lagotis* (SCHRANK 1803)	+		
55.	*Galba truncatula* (O. F. MULLER 1774)	+	+	+
56.	*Ancylus fluviatilis* O. F. MULLER 1774	+	+	+
57.	*Ferrissia (Pettancylus) clessiniana* (JICKELI 1882)	+	+	+
58.	*Acroloxus lacustris* (LINNAEUS 1758)		+	+
59.	*Planorbis (Planorbis) carinatus* O. F. MULLER 1774	+	+	+
60.	*Planorbis (Planorbis) planorbis* (LINNAEUS 1758)	+	+	+
61.	*Anisus (Anisus) calculiformis* (SANDBERGER 1874)		+	+
62.	*Anisus (Anisus) leucostoma* (MILLET 1813)		+	
63.	*Anisus (Anisus) spirorbis* (LINNAEUS 1758)			+
64.	*Anisus (Disculifer) vortex* (LINNAEUS 1758)		+	+
65.	*Anisus (Disculifer) vorticulus* TROSCHEL 1852		+	+
66.	*Bathyomphalus contortus* (LINNAEUS 1758)	+	+	+
68.	*Gyraulus (Armiger) crista* LINNAEUS 1758		+	+
69.	*Gyraulus (Gyraulus) acronicus* (A. FERUSSAC 1807)	+	+	+
70.	*Gyraulus (Gyraulus) albus* (O. F. MULLER 1774)	+	+	+
71.	*Gyraulus (Gyraulus) chinensis* (DUNKER 1848)	+		
72.	*Gyraulus (Lamorbis) riparius* (WESTERLUND 1865)	+	+	
73.	*Gyraulus (Lamorbis) rossmaessleri* (AUERSWALD 1852)	+		
74.	*Gyraulus (Torquis) laevis* (ALDER 1838)			+
75.	*Hippeutis complanatus* (LINNAEUS 1758)		+	+
76.	*Segmentina nitida* (O. F. MULLER 1774)		+	+
77.	*Planorbarius corneus* (LINNAEUS 1758)	+	+	+
78.	*Oxyloma (Oxyloma) dunkeri* (L. PFEIFFER 1865)		+	+
79.	*Oxyloma (Oxyloma) elegans* (RISSO 1826)		+	+
80.	*Oxyloma (Oxyloma) pinteri* GROSSU 1987			+
81.	*Oxyloma (Oxyloma) sarsii* (ESMARK 1886)	+		

According to the analysis of the taxonomic composition of the populations of gastropods it can be noticed that there have been identified 33 species within the upper sector, so far (Table 1). The species *Viviparus ater* (DE CRISTOFORI & JAN 1832), *Valvata (Cincinna) studeri* BOETERS & FALKNER 1998, *V. (Tropidina) macrostoma* MORCH 1864, *Bythinella austriaca* (FRAUENFELD 1857), *B. cylindrica* (FRAUENFELD 1857), *Stagnicola fuscus* (PFEIFFER 1821), *Radix lagotis* (SCHRANK 1803) are characteristic to torrents and mountain streams. These represent 3.6 percent of the populations of gastropodspresent into the Danube (BREZEANU et al., 2011; FRANK, 1987; TITTIZER et al., 1997; ZIERITZ & WARINGER, 2006). Besides these, within the mentioned sector, there also appear the species *Theodoxus (Th.) danubialis* (PFEIFFER 1828), *Th. (Th.) fluviatilis* (LINNAEUS 1758), *Viviparus acerosus* (BOURGUIGNAT 1862), *Valvata (V.) cristata* MULLER 1774, *Lithoglyphus naticoides* (PFEIFFER 1828), *Bithynia (B.) tentaculata* (LINNAEUS 1758), *Physa fontinalis* (LINNAEUS 1758), *Stagnicola corvus* (GMELIN 1791), *S. turricula* HELD 1836, *Radix balthica* (LINNAEUS 1758), *Galba truncatula* (MULLER 1774), *Planorbarius corneus* (LINNAEUS 1758) that display a more or less ubiquist character (CIOBOIU, 2008; GROSSU, 1993).

Within the middle sector, the structure of which is characterized by relatively uniform biotopes, with a benthal facies, mostly sandy-clayish, the populations of gastropods are represented by the species *Theodoxus (Th.) transversalis* (PFEIFFER 1828), *Valvata (C.) piscinalis* (MULLER 1774), *Borysthenia naticina* (MENKE 1845), *Bythinella hungarica* HAZAY 1880, *Lithoglyphus fuscus* (PFEIFFER 1828), *Bithynia (B.) mostarensis* MOELLENDORFF 1873, *Esperiana esperi* (FERUSSAC 1823), *Amphimelania holandri* (PFEIFFER 1828), *Lymnaea stagnalis* (LINNAEUS 1758), *Stagnicola palustris* (MULLER 1774), *Ferrissia (P.) clessiniana* (JICKELI 1882), *Anisus (A.) leucostoma* (MILLET 1813), *Gyraulus (Lamorbis) riparius* (WESTERLUND 1865), *Hippeutis complanatus* (LINNAEUS 1758), *Segmentina nitida* (MULLER 1774), *Oxyloma (O.) elegans* (RISSO 1826) (BOSCHKE, 1990; CSANYI 1996; OERTEL, 2000; OERTEL & NOSEK, 2006; IVANYI et al., 2012). As it can be noticed, some of them also appear within the upper sector (Table 1). In other words, 10.8 percent of the total number is characteristic to this area (Table 1, Fig. 2).

Within the lower sector, due to the relation between the river and its liable to floods area and due to the influence of its many tributaries, the diversity of the gastropods species is higher (BREZEANU & GRUIŢĂ, 2002; CIOBOIU, 2006, 2010; LIASHENKO & ZORINA-SAKHAROVA, 2012; RUSSEV, 1998). Within the river, there develop both species characteristic to the eutrophic lacustrine ecosystems: *Theodoxus (Th.) danubialis stragulatus* (PFEIFFER 1828), *Th. (Th.) pallasi* LINDHOLM 1924, *Viviparus acerosus* (BOURGUIGNAT 1862), *V. viviparus* (LINNAEUS 1758), *Valvata (C.) piscinalis* (MULLER 1774), *Lymnaea stagnalis* (LINNAEUS 1758), *Stagnicola corvus* (O. F. MULLER 1774), *Radix auricularia* (LINNAEUS 1758), *Planorbis planorbis* (LINNAEUS 1758), *Gyraulus (G.) acronicus* (FERUSSAC 1807) and species that prefer the conditions of the rheophilic ecosystems: *Lithoglyphus naticoides* (PFEIFFER 1828), *L. pygmaeus* FRAUENFELD 1863, *Esperiana (M.) daudebardii acicularis* (FERUSSAC 1823), *Radix ampla* (HARTMANN 1821), *Segmentina nitida* (MULLER 1774).

On the other hand, a series of species prefer the sandy facies *Theodoxus (Th.) prevostianus* (PFEIFFER 1828), *Turricaspia (Oxypyrgula) ismailensis* (GOL. & STAROB. 1966), *Radix balthica* (LINNAEUS 1758), while others the clayish facies *Lithoglyphus apertus* (KUSTER 1852), *Galba truncatula* (MULLER 1774). Within the areas characterized by rocky banks, there appear the species *Potamopyrgus antipodarum* (GRAY 1843), *Bythinella austriaca* (FRAUENFELD 1857), *Amphimelania holandri* (PFEIFFER 1828). Thus, it results that the variable environmental factors of the Danube (the water flowing velocity, the nature of the bed, the trophic state) determine this distribution of the populations of gastropods (BREZEANU & ENĂCEANU, 1969; BUȘNIȚĂ & BREZEANU, 1970; BREZEANU et al., 2011; CIOBOIU & BREZEANU, 2000; CIOBOIU, 2008; CUTTELOD et al., 2011; GROSSU, 1987, 1993; JURGEN et al., 1988; MARINESCU, 1992; NEGREA & MARINESCU, 1992; NEGREA, 1994; OERTEL, 2000).

Figure 2. The Danube along the middle and the lower sectors (original).

Of course, there are not strict limits between these sectors; this is why it can be noticed an interference of the gastropod species between different sectors of the Danube, the most numerous, respectively 85.6 percent being characteristic to the lower sector (Table 1, Fig. 3).

- the upper sector 3.6 percent
- the middle sector 10.8 percent
- the lower sector 85.6 percent

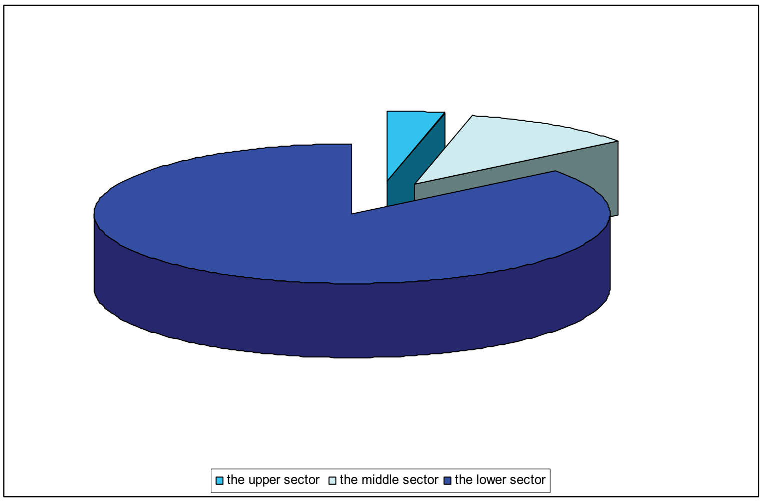

Figure 3. The distribution of the gastropod species in the Danube.

CONCLUSIONS

The global evaluation of the populations of gastropods from the Danube represents an important part of the European malacofauna (Fauna Europaea, 2013). Due to their ecological valences, the species *Viviparus ater* (DE CRISTOFORI & JAN 1832), *Valvata (Cincinna) studeri* BOETERS & FALKNER 1998, *V. (Tropidina) macrostoma* MORCH 1864, *Bythinella austriaca* (FRAUENFELD 1857), *B. cylindrica* (FRAUENFELD 1857), *Stagnicola fuscus* (PFEIFFER 1821), *Radix lagotis* (SCHRANK 1803) are cryophilic species and they are characteristic to the upper sector; the species *Bithynia (Bithynia) mostarensis* MOELLENDORFF 1873, *Amphimelania holandri* (PFEIFFER 1828), *Anisus (Anisus) leucostoma* (MILLET 1813) rheophilic along the middle sector; the species *Theodoxus (Th.) d. stragulatus* (PFEIFFER 1828), *Th. (Th.) euxinus* (CLESSIN 1887), *Valvata (Cincinna) piscinalis antiqua* MORRIS 1838, *Pseudamnicola (P.) dobrogica* GROSSU 1986, *Potamopyrgus antipodarum* (GRAY 1843), *Lithoglyphus apertus* (KUSTER 1852), *Gyraulus (Torquis) laevis* (ALDER 1838) are fluvial-lacustrine characteristic for the lower sector (Table 1, Fig. 3). It is worth mentioning that the highest diversity of species (Table 1, Fig. 1) characterizes the lower sector of the Danube, especially the Romanian part of the river, where the area liable to floods, the delta and the tributaries represent factors that enrich the diversity of populations.

The synthesis we made may represent a parameter in evaluating the distribution of the gastropods populations within the Danube basin.

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Received: March 31, 2013
Accepted: April 25, 2013