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New Data on Bottom Invertebrates of the Negovan Marshes and the Adjacent Lesnovska River

Galia N. Georgieva[1], Kamelia L. Radeva[2] & Yordan I. Uzunov[1]

[1]Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 2 Gagarin Street, 1113 Sofia, Bulgaria; E-mails: tsambi@abv.bg, uzunov@ecolab.bas.bg
[2]EcoTeam Consult, 69-71 Dimitar Hadjikotsev Street, Sofia; E-mail: ecoteam_consult@mail.bg

Abstract: The current study presents recent data of the benthic macroinvertebrate fauna of two pit lakes (the Big Lake and the Small Lake) and the adjacent sector of the Lesnovska River near Negovan Village, western suburb area of the capital city of Sofia, western Bulgaria. The two pit lakes are under different degree of degradation. The Big Lake is still used for excavation of inert materials, while the Small Lake has been abandoned years ago and has slowly restored its quality of a natural wetland. Both lakes have never been studied hydrobiologically apart from several faunistic contributions. In the present study, parameters, indices and metrics indicating the cenotic structure of the benthic community and ecological state of the water bodies were used following the national regulations. The macrozoobenthos density in the Big Lake was lower in comparison to the Small Lake and the Lesnovska River. The river and the Small Lake had high level of faunistic similarity. Some non-indigenous and invasive species were registered in both lakes.

Key words: macrozoobenthos, natural and artificial lakes, invasive species

Introduction

The regulation of the Lesnovska River started in the 30s of the 20th century and resulted with the cut-off of the channel that connects the adjacent Negovan Swamp with the river. The channel was the main feeding source of water for the swamp. A road connecting Negovan Village and Sofia divided the lake into two parts: the Small and the Big Lake. For years they were used as a gravel and sand pit that provided materials for the constructions in the region, mainly for the capital city of Sofia. Presently, a company still exploits the larger lake (the Big or Eastern Lake with 66.0 ha open surface), while the excavation of bottom material from the Small (Western) Lake (13.4 ha) has been stopped. After the exploitation of bottom material was ended, the lake started to improve gradually the status and became a wetland of conservation value. Currently, the Small Lake is of interest for recreation and angling.

Due to the permanent water circulation when extracting the sand and gravel, the Big Lake used to freeze quite rarely and for short periods of time in winters. This explains its high conservation value for nesting and wintering of birds and especially waterfowl, which follow the migration road Via Aristotelis.

Studies of the bottom invertebrate communities of these pit lakes remain scarce. There are some data (from 1956) about findings of several dragonflies (Odonata) in the Negovan pit lakes (Beshovski 1964), but it was not clear if these were larvae (component of the bottom fauna, i.e. zoobenthos) or imago/adults which are aerobionts. The Negovan Swamp Lakes were mentioned into the Catalogues of aquatic molluscs (snails and mussels) of Angelov (2000) and in Inventory of Bulgarian wetlands and their biodiversity (Michev & Stoyneva 2007). Some locations were mentioned only by the names of close suburbs (Krivina, Kazichane, Svetovrachane, etc.) without specifying the adjacent water bodies.

Studies on the macrozoobenthos community have been carried out only in the context of zebra-mussel invasion (Kozuharov *et al.* 2008; Trichkova *et al*. 2009). Both Negovan Lakes were objects of a study on biodiversity but the bottom invertebrates were not included (Tsonev *et al.* 2012).

The zoobenthos of several closer pit lakes (at Dolni Bogrov, Chepintsi, and Chelopechene) was studied by Kovachev & Stoichev (1996) who reported several annelid species (Oligochaeta and Hirudinea), water hog louses (*Asellus aquaticus*), larvae of phantom-midges (Diptera: Chaoboridae) and midges (Diptera: Chironomidae), nematodes, etc., or between nine and 13 benthic species in a lake (data after Trichkova 2007).

We present recent data of the bottom invertebrates fauna in two pit lakes and the adjacent sector of the Lesnovska River, also known as Stari Iskar in this stretch. Our objectives were to discuss the ecological status/ potential classification and the current conservation value for restoration and protection as a priority wetland along the migration road Via Aristotelis in the suburb region of Negovan Village, a project of the Sofia Municipality supported by EU funds.

Materials and Methods

The study was carried out in the region of the Negovan Village (Fig. 1). Five sampling points (two in each lake and one in Lesnovska River) were sampled in July and September of 2013.

Approved methods for field work were used, e.g. the zoobenthos collection followed Cheshmedjiev & Varadinova (2013), some of which have been later included into the Ordinance No H-4/14.09.2012 (see State Gazette № 22/05.03.2013). All sampling methods and processing of the zoobenthos material were in correspondence to both international (ISO/EN) and national (BDS) standard systems. The Petersen grab sampler (covering area 225 cm^2) was used for sampling from the pit lakes (**ISO 10870:2012**); samples from the Lesnovska River were collected by standard method **EN/ISO 10870:2012**. Further processing of the benthos samples (species identification and quantification) and data (calculation of relevant cenotic indices) followed **EN/ISO EN ISO 5667-3:2012**, as well as the best laboratory practice of the Department of Aquatic Ecosystems, the Institute of Biodiversity and Ecosystem Research. As far as the subject of the present study was species diversity of bottom invertebrate fauna of the two pit lakes with potentially high conservation value, the sampling and data processing were considered also with the current method from the document "*Practical Guidance of the National System of biodiversity monitoring*" issued by the Executive Environmental Agency of Bulgaria (EEA) in 2007.

Amongst the array of metrics for studying the macrozoobenthos structure and the water bodies status, the following ones were selected, based on the system adopted by the Ministry of the Environment & Waters for biomonitoring and ecological classification of the water bodies in Bulgaria:

Total Number of Taxa (*TNT*) after Adapted Biotic Index: a simplified metric from the protocol for hydrobiological monitoring of rivers and lakes carried out by the Regional Environmental Labs and EEA in that country;

Adapted Biotic Index (ABI, after Cheshmedjiev & Varadinova 2013): applied for the last two decades in the routine biomonitoring procedures in the country for assessment of water quality and ecological status of rivers; and *Percentage Share of the*

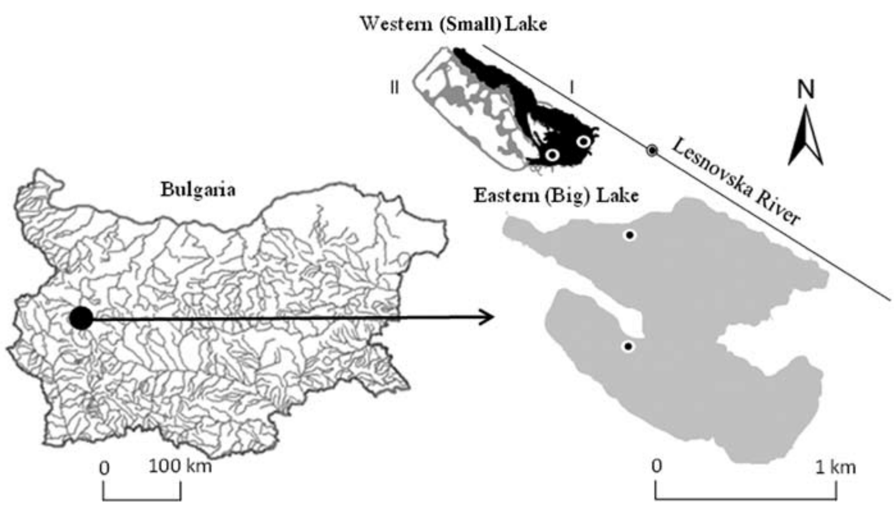

Fig. 1. Study area. The sampling points are marked by circles. The surface of the Small Lake is marked as "I" before and with "II" respectively after the restoration

Table 1. List of taxa of the bottom invertebrates found in the studied water bodies near Negovan Village. Abbreviations: BL - Big Lake; SL - Small Lake; LR - Lesnovska River

№	Taxa		BL	SL	LR
		TURBELLARIA			
1		*Dendrocoelum lacteum* Öersted, 1844		*	*
2		*Dugesia polychroa* (Schmidt, 1861)	*	*	*
3	**NEMATODA** g.sp.indet				*
		ANNELIDA			
	OLIGOCHAETA				
4		*Stylaria lacustris* (Linnaeus, 1767)	*		
5		*Ophidonais serpentina* (Muller, 1774)	*		
6		*Dero digitata* (Muller, 1773)	*		
7		*Slavina appendiculata* (d'Udekem, 1855)		*	
8	IAS	*Branchyura sowerbyi* Beddard, 1892	*		
9		*Limnodrilus hoffmeisteri* Claparede, 1862	*	*	*
10		*Limnodrilus udekemianus* Ratzel, 1868	*		
11		*Limnodrilus* spp. juv.	*	*	*
12		*Rhyacodrilus coccineus* (Veidovsky, 1885)			*
13	R	*Rhyacodrilus falciformis* Bretscher, 1901		*	
14		*Potamothrix hammoniensis* (Michaelsen, 1901)		*	
15		*Psammoryctides albicola* Michaelsen, 1901)			*
16		*Tubifex tubifex* (Muller, 1774)	*		*
17		Tubificidae g. sp. juv.	*	*	*
18		*Rhynchelmis tetratheca* Michaelsen, 1920			*
19		*Stylodrilus heringianus* Claparède 1862			*
20		*Criodrilus lacuum* Hoffemister, 1845			*
21		*Eiseniella tetraedra* (Savigny, 1826)			*
		HIRUDINEA			
22		*Erpobdella octoculata* (Linnaeus, 1758)			*
23		*Hellobdella stagnalis* (Linnaeus, 1758)		*	*
24		*Glossiphonia heteroclite* (Linnaeus, 1758)		*	*
25		*Glossiphonia complanata* (Linnaeus, 1758)		*	*
26	R	*Caspiobdella fadejewi* Epshtein, 1961		*	*
		MOLLUSCA			
		GASTROPODA			
27		*Acroloxus lacustris* (Linnaeus, 1758)	*		
28		*Physa fontinalis* (Linnaeus, 1758)			*
29		*Physella acuta* (Draparnaud, 1805)	*	*	*
30		*Lymnaea stagnalis* (Linnaeus, 1758)	*		
31		*Radix auricularia* (Muller, 1774)		*	*
32		*Planorbis planorbis* (Linnaeus, 1758)		*	
33		*Planorbis carinatus* Muller, 1774			
34		*Planorbarius corneus* (Linnaeus, 1758)		*	*
35	M	*Fagotia esperi* (Ferussac, 1823)	*		
		BIVALVIA			
36	M IAS	*Dreissena polymorpha* (Pallas, 1771)	*	*	
37	M IAS	*Corbicula fluminea* (Muller, 1774)	*		
38		*Pisidium cf. amnicum* (Muller, 1774)			*
		CRUSTACEA			
	ISOPODA				
39		*Asellus aquaticus* (Linnaeus, 1758)	*	*	*
40	OSTRACODA indet.			*	

Table 1. Continued

№	Taxa		BL	SL	LR
41	HYDRACARINA indet.				*
		INSECTA			
	ODONATA				
42		*Agrion (Calopterix) virgo* (Linnaeus, 1758)			*
43		*Anax imperator* (Leach, 1815),			*
44		*Aeschna affinis* Vander Linden, 1820			*
45	R	*Aeschna cyanea* (Müller, 1764)	*		
46		*Cordulegaster* sp.		*	
47	M	*Gomphus vulgatissimus* (Linnaeus, 1758)	*		
48	M	*Onychogomphus forcipatus* (Linnaeus, 1758)			*
49		*Platicnemis pennipes* (Pallas, 1771)	*	*	*
50		*Sympetrum* sp.	*		
51		*Libellula* cf. *fulva* (Muller, 1764) im		*	
	EPHEMEROPTERA				
52		*Baetis fuscatus* (Linnaeus 1761)			*
53		*Siphlonurus lacustris* (Eaton, 1870)	*	*	
54		*Caenis moesta* (Bengtsson, 1917)		*	*
	TRICHOPTERA				
55		*Hydropsiche* sp. la (cf. *pellucidula*)			*
56		*Hydroptilla* sp. la		*	*
57		*Ecnomus tenellus* (Rambur, 1842)	*	*	
	HETEROPTERA				
58		*Ilyocoris cimicoides* (Linnaeus, 1758)	*		
59		*Sigara* sp. (cf. *falleni*) la		*	
60		*Micronecta* sp.	*	*	
61		*Plea minutissima* Leach, 1817			
62		*Corixa* sp.		*	
63		*Gerris* sp. juv.			*
	COLEOPTERA la				
64		*Acillius* sp. la			
65		*Haliplus* sp. la		*	
66		*Gyrinus* sp.	*	*	*
	MEGALOPTERA				
67		*Sialis lutaria* (Linnaeus, 1758)	*		
68	DIPTERA: Culicidae g.sp.la			*	
	DIPTERA: Simuliidae g.sp.pp				*
69		*Boophthora erhythrocephala* (de Geer, 1776)			*
	DIPTERA: Chironomidae g.sp.la			*	*
70		*Rheocricotopus* sp.			*
71		*Diamesa* sp.	*		*
72		*Eukiefferiella* sp.			*
73		*Orthocladius* sp.	*		
74		*Cricotopus* sp.			*
75		*Tanytarsus gr. gregarius* Kieffer, 1909	*	*	*
76		*Chronomus gr. plumosus* (Linnaeus, 1758)	*	*	
77		*Chronomus gr. riparius* Meigen, 1804			*
78		*Diamesa* sp.	*		*
	DIPTERA: Stratiomyidae				
79		*Odontomyia* sp. la	*		
		Total number of taxa:	**33**	**35**	**46**

Notes: Δ protected species after the Biodiversity Act; M monitored species after the National System of Biodiversity Monitorng; IAS invaszive/alien species; R rare species;

Aquatic Oligochaetes (%Oligochaeta): an experimentally tested metrics to classify the ecological status/ potential of lakes/ reservoirs and various stagnant water bodies.

Results and Discussion

During the present study, 100 species were recorded in total (46 taxa in the Lesnovska River, and 54 in two pit lakes: 33 in the Big Lake and 35 in the Small one, respectively; Table 1). While the number of species in the qualitative and quantitative samples of the Lesnovska River was the same (46 taxa recorded), in the two lakes the qualitative samples (from fringing communities and lake littoral) contained twice as much species as compared to the deeper samples from the lake bottom, especially in the Big Lake. This is likely owing to the excavation of gravel and sand from the bottom which is destroying drastically the poor invertebrate bottom communities. In fact, the Big Lake has no littoral; there are almost vertical walls with poor macrophytes in the lake fringe.

A moderate level of species similarity between the macroinvertebrate fauna of the two lakes was recorded – 41.2% (after Sorensen's coefficient). The similarity between the bottom fauna of the Big Lake and the Lesnovska River was lower (30.4%). At the same time, the similarity between the samples from the river and from the Small Lake was quite high (59%). There could be several possible explanations of these similarity levels. Firstly, the studied objects are different in their category/typology: river (Lesnovska River), lake/ swamp (the Small Lake) and heavily modified water body (the Big Lake, which is still exploited intensively as sand and gravel pit). Secondly, this exploitation is extracting the bottom material, which leads to a systematic devastation and degradation of bottom microhabitats. Thirdly, both lakes have been stocked with fish in the past, and it is possible that benthic invertebrates could be under fish pressure and a large part of its secondary production could be eliminated by fish.

We recorded similar macrozoobenthos densities in the two lakes: 825 ind.m^{-2} in the Big Lake and 1,014 ind.m^{-2} in the Small Lake, while the density in the Lesnovska River was assessed to be ten-fold higher in August (10,985 ind.m^{-2}; Table 2). The macrozoobenthos density was almost equal in the two lakes in September (1,185 for the Big Lake and 1,587 ind.m^{-2} for the Small Lake, respectively), while in the Lesnovska River the abundance was lower when comparing with previous samplings probably due to summer diapause of aquatic insects and very low water levels.

Concerning the protection status of the found species (as listed in Table 1), during the present study no such representatives of the bottom invertebrate fauna were registered. The expert in ichthyology Dr. Vladimir Pomakov reported a personal communication of an angler about the crayfish catch in September 2009: most likely *Astacus leptodactylus* Eschscholtz, 1823, but it could have been also *A. astacus* (Linnaeus, 1758), the last one classified as "vulnerable" in the 2006 Red List of IUCN. Probably the big flood in the summer of 2005 was not able to eliminate crayfish from the lakes and its population is restoring. The migration (or colonisation) of bottom invertebrates and/ or their reproductive stages (eggs, cysts, larvae, etc.) from the Lesnovska River to the Small Lake then was quite possible and could explain the relatively high level of their faunistic similarity (59%).

The presence of the invasive zebra mussel was mentioned above, together with another one invasive species Corbicula fluminea, which during the last decade actively invaded bottom habitats of numerous

Table 2. Some metrics of the macrozoobenthos and ecological status/ potential of the studied water bodies. Abbreviations: BL - Big Lake; SL - Small Lake; LR - Lesnovska River; EQR/MEP - Ecological Quality Ratio (for runninig water bodies) /Maximum Ecological Potential (for standing water bodies). In parentheses: the total number of the taxa registered, incl. qualitative samples.

		07 August 2013			**05 September 2013**		
№	Indexes	BL	SL	LR	BL	SL	LR
1	Number of registered taxa *	13 (29)	14 (29)	26 (33)	11 (12)	16 (21)	30 (34)
	EQR/MEP**	0.188	0.125	> 1.0	1.00	1.00	> 1.0
2	Abundance/Density (ind.m-2)	825	1 014	10 985	1 185	1 587	6 380
3	Adapted Biotic Index	n.a.	n.a.	**4**	n.a.	n.a.	**4**
	EQR			0,8			0,8
4	% OLIGO	**74.5%**	**41.4%**	n.a.	**34.2%**	**3.9%**	n.a.
	EQR	0,255	0,586		0,658	0,96	

water bodies in the country, including the Big Lake (Hubenov 2005). The presence of large population of invasive mussels in the Negovan Lakes may geopardize the reintroduction of the thick shelled river mussel (Unio crassus Philipson, 1788) which is a subject of restoration activities within this project.

The aquatic oligocheta *Branchiura sowerbyi*, already acknowledged as a potentially invasive species, was recorded for the first time in the Big Lake. As mentioned above, both lakes were stocked with fish (carp, silver carp, zander, etc.) and are still used for angling, especially the Small/ Western Lake. Possibly, not only invasive and exotic fish species invaded the lakes (i.e. pumpkinseed sunfish *Lepomis gibbosus* (Linneaus, 1758), eastern mosquito-fish *Gambusia holbrooki* Girard, 1859) and the river (topmouth gudgeon *Pseudorasbora parva* Temminck & Schlegel, 1846) but also invasive invertebrates.

The finding of the rare species *Rhyacodrilus falciformis* (Oligochaeta: Tubificidae) known from only few localities in Bulgaria (Uzunov 2010) is of interest. Also, the finding in both the Small Lake and in the Lesnovska River of the blood-sucking leech *Caspiobdella fadejewi* (Hirudinea: Piscicollidae) which is known as a fish parasite along the Danube River and its adjacent wetlands, confirms the importance of planting rivers and ponds with fish for distribution of invasive aquatic invertebrates together with the possible contribution of waterfowl for invasion spread.

Conclusions

The study demonstrated the current state of the macrozoobenthos in three quite different types of water bodies. Different management of the two lakes are the major reason for degradation of the lakes' ecosystems. On one hand, there is practically no direct surface hydraulic connection between the two lentic water bodies, which prevents the migration of fish and invertebrates, except for the aerobiont adult forms of the insects. On the other hand, the excavation of gravel and sand from the bottom of the Big Lake leads to degradation of the bottom microhabitats. For this reason not only the number of species in the samples from the deeper lake bottom is lower than those in the narrow littoral zone, but the macrozoobenthos density is lower compared to this in the Small Lake and in the Lesnovska River. Further, there is no connection with the Lesnovska R., which is very important not only as water source for the lakes, but also for migrations and exchange of bottom invertebrates and fish.

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