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Contemporary State of the Bottom Invertebrate Communities of the Tundzha River Basin (South-East Bulgaria)

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Abstract: This paper presents the results of species content and structure of the macroinvertebrate communities alongside Tundzha River (South-East Bulgaria) and some of its tributaries for two periods of investigations: 1987 and 2009. The changes of macrozoobenthos community in Tundzha River are not just related with appearance or disappearance of the species but also with the restructuring of the quantitative and qualitative parameters. The dynamics of the benthos community is related with the improving of the water quality in the last two decades.

Key words: macrozoobenthos, species structure, Tundzha River basin

Introduction

The distribution of some groups of aquatic invertebrates in Tundzha River and some of its tributaries has been studies by several authors (Konsulov 1912, Drensky 1947, Kaneva-Abadjieva 1966, Bulgurkov 1961, Russev 1957, 1971, Janeva 1981). The bottom invertebrate communities (the macrozoobenthos) within Tundzha River basin have not been subject of intensive studies until the beginning of the 80s of the last century. Russev *et al.* (1984) made a summary of previous hydrobiological studies of the Tundzha. They reported in total 198 known species of bottom invertebrates, of which 55 species of mayflies (Ephemeroptera), 36 ones of chironomids (Diptera: Chironomidae), 22 ones of caddisflies (Trichoptera), 16 ones of dragonflies (Odonata), etc. Relatively high number of benthic invertebrates was an indication for a clean river with numerous and diverse ecological niches. A full taxa list of the macrozoobenthos of Tundzha has been published by Janeva *et al.* (1981). They noted that for the period of their study (May-November 1981) the macrozoobenthos consisted of 177 taxa. Groups of chironomids (45 taxa listed), mayflies (31) and aquatic oligochets (30) were the most abundant in the taxa list of the bottom invertebrates. These authors concluded that both dams of Koprinka Reservoir and Zhrebchevo Reservoir have had a negative effect on the riverine zoocoenoses despite they contributed to the water quality improvement.

After investigations of Kovachev, Uzunov (1981) and Russev, Janeva (1984), the macrozoobenthos of Tundzha River basin has not been studied for the next 3 decades. The last available data on full species content of the macrozoobenthos as obtained in 1987 remained still unpublished (Uzunov *et al*. 1987). The recent information on Nematoda in Tundzha was reported consequently by STOICHEV (1996, 1996, 2001, 2006).

The present paper aimed at assessment of the actual species content and structure of the macroinvertebrate communities alongside Tundzha River and some of its tributaries.

Material and Methods

The present study was based upon two main data massifs. The first one contained results of a study have been undertaken on 9 sampling points in July 1987 (Uzunov *et al.* 1989). The second massif contained data as obtained in summer samplings on 14 point, 7 of which situated alongside the main river course and 7 on its tributary. Common for both periods were 9 sites as shown on Table 1.

The sampling techniques were similar for both periods of comparison, mainly using the adapted version of multi-habitat samplings (Cheshmedjiev *et al.* 2011) according to the accepted standard procedures (EN 27828: 1994, EN 28265: 1994, AQEM/STAR). Environmental parameters like pH, dissolved oxygen (mg.L^{-1}), oxygen saturation (%) and conductivity (µS.cm^{-1}) were measured *in situ* using portable Windaus Lab package.

In order to compare changes in the species diversity and dominant structure of the macroinvertebrate communities three coenotic indices were used: Shannon's species diversity index (HIND), Simpson's index of dominancy (DOMN) and Pielou's index of evenness (EVNS). Indices are standardized for water quality assessment according to Bulgarian environmental legislation (Ordinance N 7/1986, State Gazette N 96/1986).

The processing of samples and data in the Lab of the Lotic ecosystems Section to Department of Aquatic Ecosystems followed the ISO 5667-3: 1995 'Water Quality-Sampling. Part 3: Guidance to the preservation and handling of samples'.

Cluster analyses (PAST) was used to assess similarity between different studied periods.

Results and Discussion

Physical-chemical parameters

In present paper only physical-chemical data as obtained in July 2009 are under discussion (Fig. 1A to 1D).

Water conductivity (Fig. 1A) in Tundzha River and its tributaries varied within I category of water quality (according to Ordinance N 7/1986): from 32.3µS.cm^{-1} at Panizite site, to 626 µS.cm^{-1} at Popovska River. The relatively lower values were measured at cleaner sites such as Tundzha at sites of Panizite and Pavel Banya, and in Tuzha River. All the rest sampling sites had higher conductivity (Tundzha at sites of Hanovo and Srem, and the tributaries Popovska, Mochuritsa, Dereorman, Manastirka and Melnishka Rivers). All sites did not leave the ranges of I category.

Measured values of **pH** (Fig. 1B) did not show any aberration and changed in a narrow range: between 7.82 at the site of Pavel Banya and 8.68 for the mouth of Belenska River. In the upper course of Tundzha the water was slightly alkaline and closer to the neutral point while in the middle stretch, especially downstream the large reservoirs of Koprinka and of Zhrebchevo, the pH values were higher. It was impossible to detect the value at the site of Samuilovo, possibly due the very high level of pollution.

The amount of **dissolved oxygen** (Fig. 1C) were measured in a wide range of values: between 3.36 mg.L^{-1} at the site of Hanovo and up to 11.2 mg.L^{-1} in Belenska River. Relatively low oxygen concentrations as measured at the sites of Samuilovo and Dereorman R. (5.8 and 6.08 mg.L^{-1}, respectively) were due to the local pollution (lack of sewage treatment facilities). The highest values of dissolved oxygen were measured at sites close to I category (Panizite, Pavel Banya, Belenska and Tuzha Rivers).

Accordingly, the values of the **oxygen saturation** (Fig. 1D) changed between 41% at the site of Hanovo and 129% as measured Belenska River. Generally, the levels of saturation were high at most of the studied site, some of them had lower values as at the sites of Samuilovo, Mochuritsa and Popovska Rivers. (67%, 82% and 87.5% respectively) mostly due to local pollutions of the main river and its tributaries.

The physical-chemical parameters of the water in 2009 did not show serious aberrations from the normative values for I-II water quality category. The only exceptions were the sites of Samuilovo and Hanovo on the main river course where the values demonstrated the worse for second and third category respectively. Lower values were obtained also at some tributary sites as Dereorman, Popovska, Mochuritsa Rivers as influenced by local pollution sources.

Table 1. Studied sampling sites within the Tundzha River basin (common sampling points are bolded).

Studied sites	1987*	2009**	Code***
1. Tundzha River, Panicite site, upstream the town of Kalofer	285	BG3TU00999MS0380	285
2. Tundzha River, downstream the town of PavelBanya (upstream the Koprinka Reservoir)	073	BG3TU00975MS0350	073
3. Tundzha River, at Nova Mahala village (upstream the Jrebchevo Reservoir)	149	BG3TU00799MS0270	149
4. Tundzha River, at Gavrailovo village (downstrem the Belenska River)	nn	BG3TU00075MS0190	TGAV09
5. Tundzha River, at Samuilovo village (downstream the town of Sliven)	077	BG3TU00013MS0010	077
6. Tundzha River, at Hanovo village (downstream the town of Yambol)	nn	BG3TU00579MS0090	THAN09
7. Tundzha River, at Srem village (downstream the town of Elhovo)	274	BG3TU00013MS0010	274
8. the tributary Tuzha River, upstream the mouth in Tundzha River	470	BG3TU00900MS0055	470
9. the tributary Belenska River, upstream the mouth in Tundzha River	150	BG3TU00761MS0200	150
10. the tributary Mochuritsa River, upstream the mouth in Tundzha River (upstream the town of Yambol)	152	BG3TU00061MS0100	152
11. the tributary Dereorman River, upstream the mouth in Tundzha River	**nn**	BG3TU00552MS0080	DER09
12. the tributary Popovska River, upstream the mouth in Tundzha River	480	BG3TU05211MS0030	480
13. the tributary Melnishka River, upstream the mout in Tundzha River	**nn**	BG3TU00149MS0011	MEL09
14. the tributary Manastirska River, upstream the mouthing Tundzha River	**nn**	BG3TU00123MS0006	MAN09

Legend: * codes of the study in 1987, partly of the national water quality monitoring network (**nn** = outside the network);** actual national codes of the water bodies (category of rivers); ***codes used in all tables and figures

Species diversity of the macrozoobenthic communities.

The number of bottom invertebrate species established in common stations for two periods of study (1987 and 2009) are presented in Fig. 2.

The total number of the species established during the summer period 1987 was 191. During 1987 the highest number have been recorded for the groups of Diptera – 37 species, Oligochaeta – 24, and Ephemeroptera – 15, etc. During the present study (July 2009) the total number of the species which were established was 122 (Table 2). The less number of the species during the 2009 probably can be explaining with the fact that not all groups were determinated at the species level.

The dominant groups in July 2009 were Trichoptera (18), Diptera (18), Oligochaeta (17), Gastropoda (13) and Odonata (11). The species number of the main taxonomic groups of bottom invertebrates for the two periods of study is shown in Fig. 3.

The total number of the species in the common sites for both periods were 117 (1987) and 115 (2009). Only 33 species were common for the both periods of study. This result could be explained with the changes and restructuring of the macrozoobenthos communities in Tundzha. The same situation was established in Mesta River (Kovachev & Uzunov 1986, Varadinova & Uzunov 2002) after removal the heavy organic pollution and recovery of the bottom invertebrate communities. In Tundzha, the number of the macrozoobenthos group was almost the same periods but completely different species composition was found during the both periods of study.

Cluster analysis was used in order to estimate level of similarity for common sampling sites in 1987 and 2009, respectively (Fig. 4).

The dendrograme shows two main periods of formation of macrozoobenthos community. The results could be explained with the full changes and restructuring of the macrozoobethos community within these two last decades after elimination of some industrial activities within the river basin. In the past, Tundzha was subjected by various impacts both from point (industrial, municipal) and non-point (agricultural) sources. The new improved environmental conditions and the resulting selfpurification potential of Tundzha River leads to significant changes in species composition, and enrichment of species diversity. These changes Uzunov *et al.* (2005) termed as a ‘regime-shift’ – rapid reorganization of

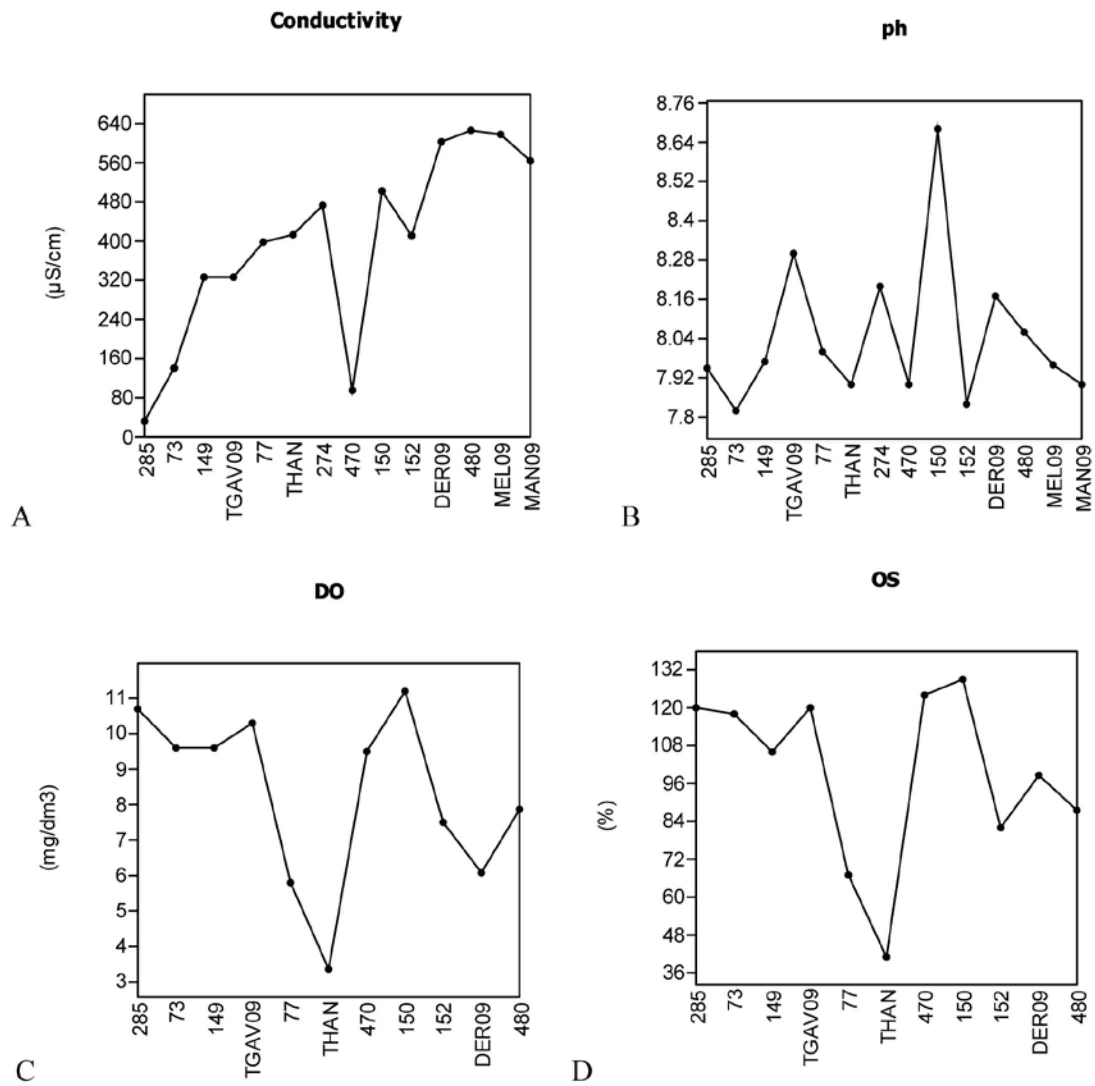

Fig. 1. Physical-chemical parameters at the stations in 2009: conductivity (1A), pH (1B), dissolved oxygen (1C), and oxygen saturation (1D).

the ecosystem as a result of significant changes in the aquatic environment.

Cenotic indices

The Cenotic indices that characterized species structure of macrozoobenthic communities in Tundzha were compared for the both period of study (1987 and 2009). In 1987 the site of Panizite was selected as a referent one in the frame of I category according its saprobiological assessment. In this site, the Shannon's index (HIND) had high value (Fig. 5).

During 2009, the value of HIND in this site was decreased due to the anthropogenic impact in this area, mostly by touristic activities in the site area. High value of HIND at the site Pavel Banya in 2009 showed a stable and optimal state of the benthic communities. It was observed a significant increasing of the index at the site of Nikolaevo from 1.664 in 1987 up to 2.986 in 2009, as a consequence of the decreasing of the upstream industrial activities in the river basins. The values at the site of Samuilovo demonstrated some worsening of the community structure due to pressure of the untreated sewage inflow from upstream district town of Sliven (through the tributary Assenitsa River). The values of HIND of the tributaries Tuzha and Belenska Rivers were assessed as optimal and stable for both periods of study.

The highest value of HIND in 1987 was founded in downstream at site Srem. Similar situation was established by Kovachev & Uzunov (1986) for Mesta River. The authors recorded a trend of increasing diversity and evenness indices, and decreasing dominance in the process of self-purification in down-

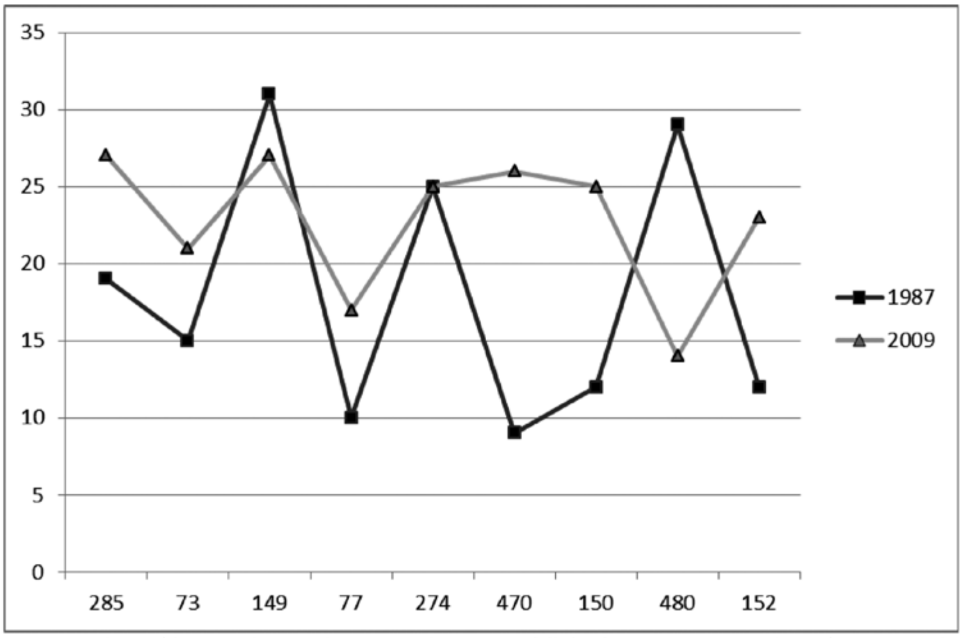

Fig. 2. Number of bottom invertebrate species as established in common stations for two periods of study (1987 and 2009).

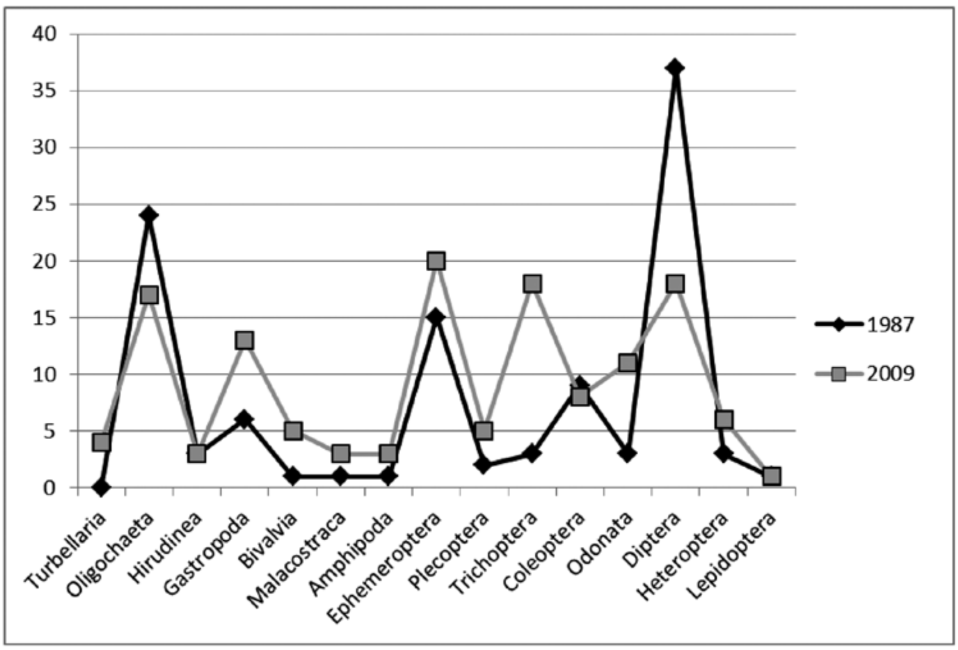

Fig. 3. Number of species of the main taxonomic groups of bottom invertebrates for two study periods of the Tundzha River.

stream sites. The decreasing of the HIND from I category (1987) to II category (2009) can be explained with increasing of the organic pollutions and lacking of plants wastewater treatment. From the other hand, according to the second principle of Thienemann, (1920) the β-mezosaprobity degree corresponding to the II category of water quality, which is natural tendency to reaching climax in developing of the benthic communities. Similar tendency was observed with the dynamics of two alternative indices – Pielou's index of evenness (EVNS) and Simpson's index of dominancy (DOMN) (Fig. 6). The lowest value of Simpson's index during the 1987 was 0.105 in the site of Srem, and the highest in the site of Nikolaevo – 0.570. Pielou's EVNS in 1987 shows minimal value for Nikolaevo site – 0.336, and maximum – 0.873 for Belenska River.

During 2009 the lowest dominancy index (DOMN) was founded in site on Tuzha R. – 0.117, corresponding to a relatively high value of EVNS –

Table 2. List of bottom invertebrate taxa established in the Tundzha River basin during the study in July-August 2009 (x) as compared with the findings in 1989 (y) [codes of sampling points as in Table 1].

Sampling points codes / Taxa	**285**	**73**	**149**	**TGAV09**	**77**	**THAN09**	**274**	**470**	**150**	**152**	**DER09**	**480**	**MEL09**	**MAN09**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
TURBELLARIA														
Crenobia alpina (Dana 1766)	x													
Dendrocoelum lacteum (O.F. Muller 1774)										x			x	x
Dugesia gonocephala (Duges 1830)									x					
Dugesia lugubris Schmidt 1861)		x		x			x	x					x	x
OLIGOCHAETA		y												
Chaetogaster diaphanus Gruithuisen 1828)							y							
Criodrilus lacuum Hoffmeister 1845			y											
Lumbricus rubellus Hoffmeister 1843				x										
Stylodrilus heringianus Claparede 1862								x		x				
Dero obtusa Udekem 1855							y							
Lumbricidae g.sp.juv.					y									
Eiseniella tetraedra (Savigny 1826)		y	y					x				y		
Haplotaxis gordioides (Hartmann 1821)			y											
Lumbriculidae g.sp.juv.				x				x						
Nais alpina Sperber, 1948	y													
Nais barbata Muller 1774			y				y		y					
Nais elinguis Muller 1774									y					
Nais communis Piguet 1906	y		y											
Nais variabilis Piguet 1906			y				y		y					
Nais pardalis Piguet 1906							y					y		
Nais simplex Piguet 1906		x												
Nais sp.								x						
Ophidonais serpentina (Muller 1774)			y									y		
Paranais frici Hrabe 1941							y							
Pristina (Pristinella) rosea (Piguet 1906)			y											
Aulodrilus pigueti Kowalewsky 1914		x												
Limnodrilus claparedianus Ratzel 1869		x			x	x	x							
Limnodrilus hoffmeisteri Claparede 1862		x		x		x	xy			y		y		
Limnodrulus profundicola (Verrill 1871)					x									
Limnodrilus udekemianus Claparede 1862										y				
Limnodrilus sp. juv.				x	x	x								
Embolocephalus velutinus (Grube 1879)				x										
Rhyacodrilus coccineus (Vejdovsky 1876)			x									y		
Rhynchelmis sp. juv. (cf. tetratheca)									x					
Tubifex tubifex (Müller 1774)			x		x		y			x	x			
Psammoryctidies albicola (Michaelsen 1901)										xy			x	
Psammoryctidies moravicus (Hrabe 1934)							x					y		
Tubificidae g. sp.juv			x											
Stylaria sp.							y		y					
Fridericia sp.								y						
HIRUDINEA														
Erpobdella octoculata (Linnaeus 1758)			y	x	xy	x	y			xy		y	x	

Table 2. Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Helobdela stagnalis (Linnaeus 1758)			y			x	y							
Glossiphonia complanata (Linnaeus, 1758)										y				
Glossiphonia paludosa (Carena 1824)													x	
GASTROPODA														
Ancylus fluviatilis O.F. Müller 1774				x								y		
Anisus sp.				x								x	x	
Bithynia tentaculata (Linnaeus 1758)						x							x	
Bythinia sp.						*x*								
Planorbariuscorneus (Linnaeus 1758)					xy		x			x		y		x
Fagotia sp. (cf. esperi)										x				
Galba sp.							x				x			
Physella acuta (Draparnaud 1805)						x								
Planorbis planorbis (Linnaeus 1758)									y				x	
Radix balthica (Linnaeus 1758)					x		y				x			
Teodoxus fluviatilis Linnaeus 1758							y			x				
Valvata sp.	x			x		x	x		y				x	x
Viviparus sp.					x									
BIVALVIA														
Pisidium sp.						x							x	
Pseudanodonta complanata Rossmässler 1835							x							
Unio sp. (cf. pictorum)							x							
Unio tumidus (Linnaeus 1758)			x									xy		
Unio sp.											x			
MALACOSTRACA														
Asellus aquaticus (Linnaeus 1758)			y		x		x			y			x	
Limnomysis benedeni Czerniavsky 1882					x									
Potamon potamius (Olivier 1804)	x						x							
AMPHIPODA														
Gammarus cf. *arduus*				x						x				
Gammarus balcanicus Schaefferna 1923		x			x	x	x			x				
Gammarus fossarum Koch 1835			y											
Gammarus sp.				x							x		x	x
EPHEMEROPTERA														
Baetis fuscatus (Linnaeus 1761)	y													
Baetis melanonyx (Picket 1843)	y							y						
Baetis scambus (Eaton 1870)	y								y					
Baetis rhodani (Picket 1843)		y					y		y					
Baetis sp.		xy		x	x		x		x					
Caenis gr. *macrura*					y									
Caenis luctuosa					y									
Caenis sp.		x	x	x				x	x			x		*x*
Cloeon simile Eaton 1870							y							
Ephemera danica Muller 1764									xy					
Ephemera sp.				x				x						
Serratella ignita (Poda 1761)	*y*	*xy*	*y*					y	xy	y		y	x	x

Table 2. Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ecdyonurus sp.	xy	x	y	x				x	x				x	x
Heptagenia flava Rostock 1878												y		
Heptagenia sp.								y						
Electrogena quadrilineata (Landa 1969)		y												
Potamanthus luteus (Linnaeus 1767)			y											
PLECOPTERA														
Capnia sp.									x					
Leuctra sp.								x						
Perla sp.									x	x				x
Isoperla grammatica (Poda 1761)								y						
Protonemura sp.	x		y	x										
TRICHOPTERA														
Trichoptera g. sp. pp	x													
Potamophylax cingulatus (Stephens 1837)	x													
Rhyacophilla gr. vulgaris Picket 1834				x				x			x		x	
Rhyacophila sp.		x					x	x	x				x	
Psychomyia pusilla (Fabricius 1781)							x							
Oecismus monedula (Hagen 1859)								x						
Sericostoma sp.								x				x		
Hydropsyche bulbifera McLachlan 1878									y			y		
Hydropsyche contubernalis McLachlan 1865							x							
Hydropsyche exocellata Dufour 1841							x							
Hydropsyche fulvipes Curtis 1834			x											
Hydropsyche incognita Pitsch 1993									x					x
Hydropsyche instabilis (Curtis 1834)									x					
Hydropsiche modesta Navas 1925	x											y		
Hydropsyche sp.		xy										x		
Helicopsyche sp.								x					x	
Hydroptilla sp.							x							
Neureclipsis sp.								x						
Odontocerum hellenicum Malicky 1972												x		
Polycentropus flavomaculatus (Pictet 1834)			x											
COLEOPTERA														
Agabus (*Agabus*) *labiatus* (Brahm 1791)			y											
Agabus sp. la			x											
Coleoptera g. sp.im.	x							x		x			x	
Coleoptera sp.													x	
Elmis aenea (Muller 1906)		x												x
Elmis sp. la	x			x				x	x	x		y	x	
Haliplus fluviatilis Aube 1836			y											
Helophorus sp.			y											
Hydraena sp.												y		
Hydaticus grammicus (Germar 1830)			y											
Laccophilus minutus (Linnaeus 1758)												y		
Laccophilus sp.										x				
Stenelmis sp.la	x	y												

Table 2. Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Gyrinus sp. im.					x					x				
Hydrophilidae la.							y							
ODONATA														
Aeshna sp.											x			
Calopterix splendens (Harris 1782)			y				x					x		
Calopterix virgo (Linnaeus 1758)	x													
Anax imperator Leach 1815								x				x		
Coenagrionidae g.sp.juv.la					x									
Epallage fatime (Charpentier 1840)							x							
Gomphus flavipes (Charpentier 1825)														x
Gomphus vulgatissimus (Linnaeus 1758)		x							x					
Onychogomphus forcipatus (Linnaeus 1758)		x	xy				x		xy					
Ophiogomphus cecilia (Fourcroy 1785)			x						x					
Platycnemis pennipes (Pallas 1771)			x			x	xy							
DIPTERA														
Chironomidae g. sp. la	x			x	y							x		x
Chironomidae g. sp. pp	y				y			x		x				
Chironomus riparius Meigen 1804		y						x						
Chironomus gr. *plumosus*	y		y							y				
Chironomus sp.										x		x		
Dicrotendipes nervosus (Staeger 1839)							y							
Parachironomus sp.												y		
Cricotopus (C.) gr. algarum (Kieffer 1911)					x									
Cricotopus bicincus (Meigen, 1818)	y							y						
Cricotopus trifascia Edwards 1929	y				y							y		
Cricotopus sylvestris (Fabricius 1794)							y							
Cricotopus zavreli Szadziewski & Hirvenoja 1981			x					x						
Cricotopus sp.	y	y			y		y		y					
Criptochironomus gr. Defectus (Kieffer 1913)											x			x
Orthocladius sp.			y					y						
Psectrocladius obvius (Walker 1856)			y									y		
Psectrocladius sp.					y			y						
Macropelopia sp.														
Microspectra sp.									y					
Diamesa sp.	y	x	x											
Eukiefferiella sp. la	x									y				
Polypedilum pedestre (Meigen 1830)		x												
Polypedilum nubeculosum (Meigen 1804)	y						y							
Polypedilum convictum (Walker 1856)							y					y		
Polypedilum sp.	y											y		
Tanytarsus gr. Gregarious Kieffer 1909		x	x				x							
Tanytarsus sp.	y													
Glyptotendipes glaucus (Meigen 1818)							y							

Table 2. Continued.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Simulium (Wilhelmia) balcanicum (Enderlein 1924)		y										y		
Simulium (Wilhelmia) pseudequinum Seguy 1921		y										y		
Boophthora erythrocephalum (De Geer 1776)												y		
Simullidae g. sp.la	x						x						x	
Simulium ornatum (Meigen, 1818)		y												
Simulium trifasciatum (Doby et Deblock 1957)		y												
Ibisia marginata (Fabricius 1781)												y		
Atherix sp.	x			x										
Blephariceridae g. sp.la	x			x										
Beris sp.	y													
Dicranota sp.	xy	x							x					
Limonia sp.			y											
Ephydra sp.			y											
Stratiomyidae g.sp.la	x		y											
Tabanus sp.			x						xy					
Tonnoiriella sp la													x	
Tipula sp.												y		
Hexatoma sp.			y											
Culicoides sp.										y				
HETEROPTERA														
Aphelocheirus aestivalis (Fabricius 1794)										x				
Sigara falleni (Fieber 1848)					x					x	x			
Gerris lacustris (Linnaeus 1758)						x								
Gerris sp.			y											
Hydrometra sp. (cf. stagnorum)	x				x			x						
Nepa cinerea Linnaeus 1758			y	x						x				
Plea minutissima Leach 1817	x													
Ilyocoris cimicoides (Linnaeus 1758)										y				
LEPIDOPTERA														
Acentria ephemerella (Denis & Schiffermuller 1775)										x				
Bezzia sp.												y		

0.763. The highest value of DOMN– 0.748, and the lowest EVNS – 0.168, respectively, were registered in the site of Mochuritsa River.

Several sites beyond the common ones were studied in July 2009 too: Gavrailovo, Hanovo (in the main river) and the tributaries – Dereorman, Manastirska and Melnishka Rivers. The Cenotic indices (Fig. 7) were corresponding to the II category, with the only exception of the site on Dereorman River. In this site, the water quality was established on III category. The possible reason for that could be the local sources of upstream urban pollution and low water flow.

Conclusions

A trend towards an enrichment of the species diversity of the bottom invertebrates was registered when compare two periods of study – 1987 and 2009. The total number of species established during the periods

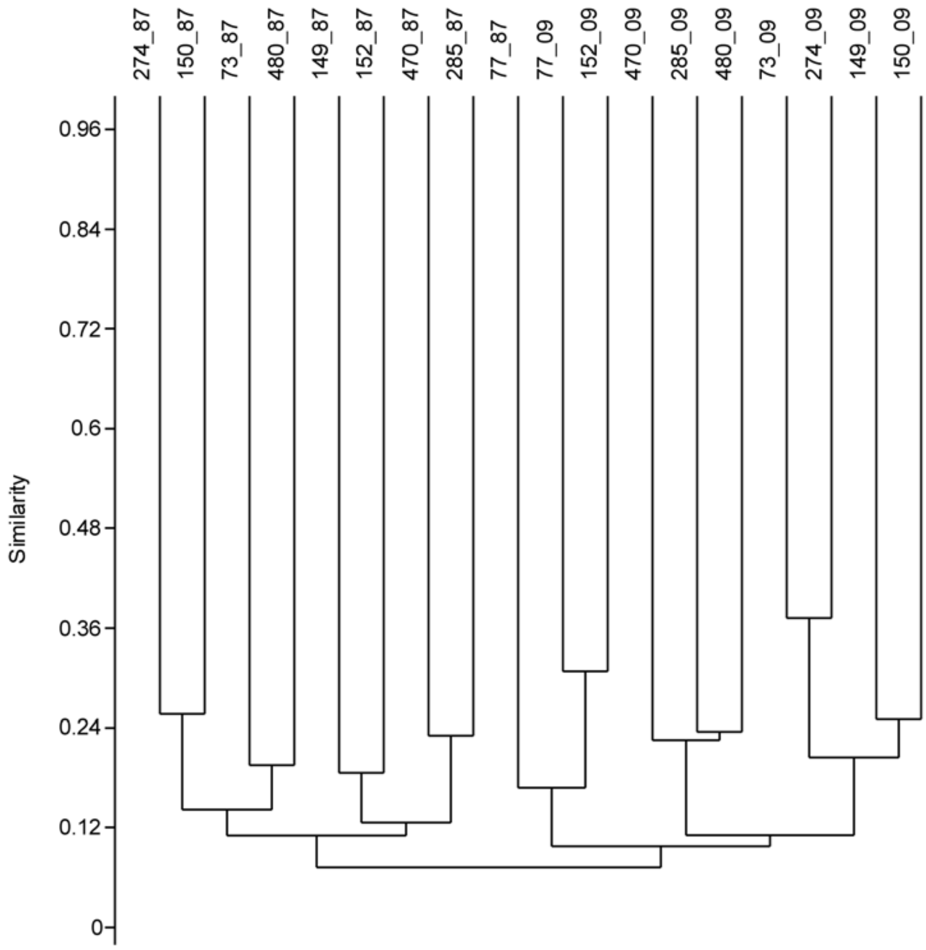

Fig. 4. Dendrogram of similarity for two periods of study (1987 and 2009).

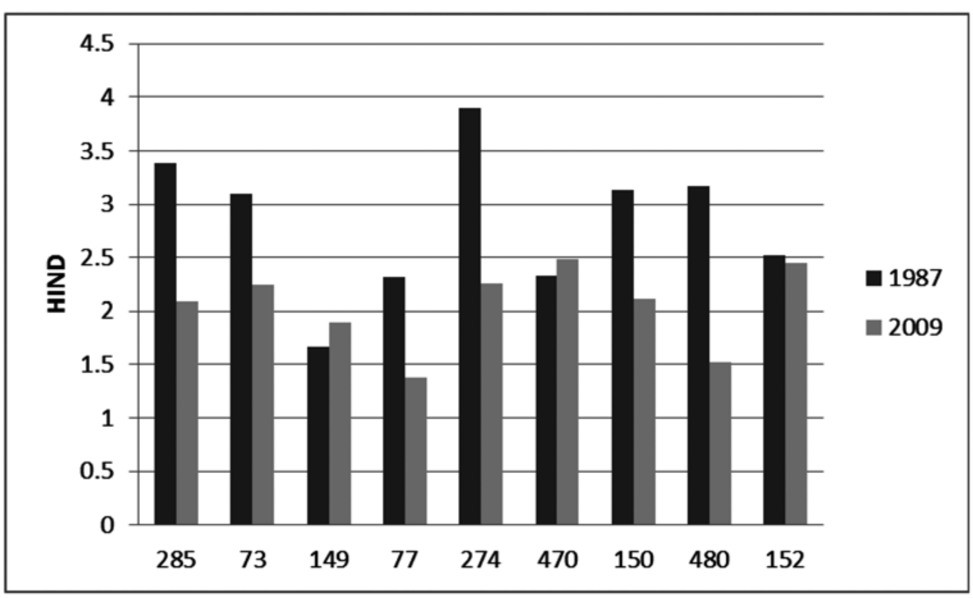

Fig. 5. Shannon's index of diversity (HIND) as established in common stations for two periods of study(1987 and 2009).

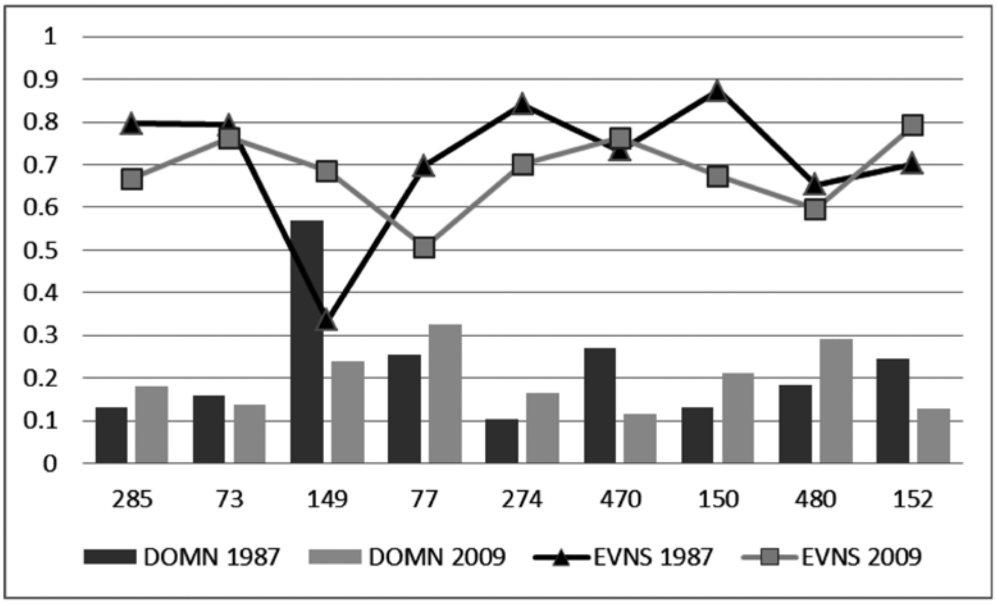

Fig. 6. Pielou's eveness index (EVNS) and Simpson's index of dominancy (DOMN) as established in common stations for two periods of study(1987 and 2009).

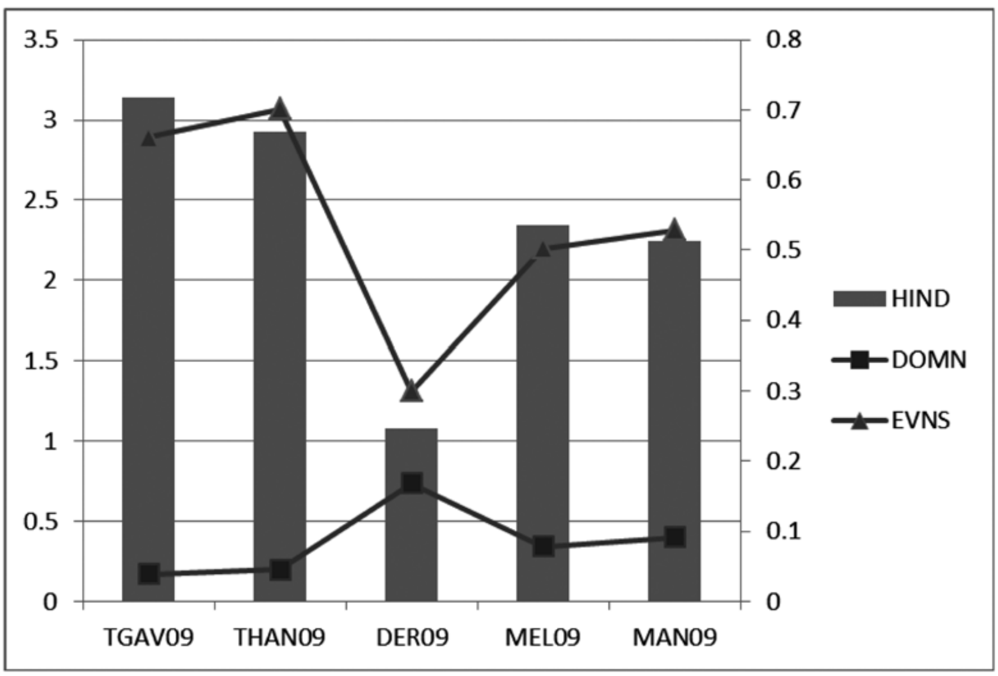

Fig. 7. Shannon's index of species diversity (HIND), Pielou's evenness index (EVNS) and Simpson's index of dominancy (DOMN) in 2009.

of investigations was almost the same. The HIND and evenness indices' increasing and dominance decreasing at the studied sites could be interpreted as an improvement of ecological state of the river during the last two decades. Diversity indices reflecting changes in species structuring stayed high enough during both periods of comparison and characterized benthic community structure as a balanced one with high stability. The only exception was the sites of Nikolaevo in 1987 and Dereorman River in 2009, probably due to some unidentified local pressures and impacts. The relatively stable community structure maintained its capacity for mitigate the inflowing pressures and impacts up to the two large district centers – Sliven and Yambol. Downstream, the structure of the bottom invertebrate communities seemed to be recovered. This result was recorded in the last site of Srem situated close to the state border.

It could be assumed that Tundzha is going to establish a relatively constant composition of the macrozoobenthos and further enrichment may be expected from both insufficiently studied groups and some rare or quite specialized species.

The changes of macrozoobenthos community in Tundzha are not just related with appearance or disappearance of the species but also with the restructuring of the quantitative and qualitative parameters. The dynamic of the benthos community is related to the improving of the water quality in the last two decades. The process of self-purification has been accompanied by a trend of a steadily growing complexity of community organization.

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