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Review of the Distribution of the Family Gobiidae (Pisces) in the Bulgarian Danube Tributaries

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Abstract. The current study aims to give in detailed information on the actual distribution of the species from family Gobiidae in the Bulgarian Danube tributaries. All known literature has been revised and with the new data collected is given complete and actual information on their distribution. In the period 2010-2012 were sampled a total of 41 sites alongside each one of the Bulgarian Danube tributaries. The sampling started from the river mouths to upstream in order to discover what is the southern (upstream) distribution of each one goby species. Four goby species were recorded from the tributaries – the round goby (*Neogobius melanostomus* Pallas, 1814), the monkey goby (*Neogobius fluviatilis*), the racer goby (*Neogobius gymnotrachelus*) and the tubenose goby (*Proterorhinus marmoratus*). Further analysis showed preference of mixed substrates and silt in addition of homogenous ones. The occurrence of gobies in the studied tributaries decreased inversely proportional to distance from Danube.

Key words: freshwater gobies, distribution, invasive species, family Gobiidae, the Danube River tributaries

Introduction

The Danube River is the second longest river in Europe with length of 2850 km. Its springs are located in Germany. It flows through 10 countries, having more than 300 tributaries and mouths into the Black Sea. The Bulgarian sector of the Danube River is located between 845 and 375 river kilometers and is typical low river stretch. The major tributaries in Bulgarian sector are 12 (Fig. 1).

The saprobic characteristics of the different Bulgarian Danube tributaries in their middle and low sections vary between alpha to I or II beta-mesosaprobic conditions (RUSEV, 1994). The main factors that influence the saprobic index are the season, proximity to cities and villages, industrial and agricultural pollution.

Danube is one of the water bodies with highest biodiversity and ecological significance in Europe. The main reasons for this are the huge water flow, diverse ecological conditions and the geographical location (BĂNĂRESCU, 1964).The ichthyo-fauna of the Bulgarian sector of the Danube consists of 68 species (VASSILEV & PEHLIVANOV, 2005) and it is heterogeneous – consists of native pre-Pleistocene fish forms and post-glacial immigrants (BĂNĂRESCU, 1991).

The distribution of the freshwater gobies along the Danube is relatively well known, as the first researches on the topic

for the Bulgarian section of the river have been done in the beginning of the XX century.

DRENSKY (1948, 1951) reported for the presence of the stellate tadpole goby (*Benthophilus stellatus* Sauvage, 1874) in the Bulgarian parts of the Danube – near the towns of Svishtov and Nikopol.

The monkey goby (*Neogobius fluviatilis* Pallas, 1814) was recorded for the first time in the Bulgarian Danube by DRENSKY (1921). Later the author confirmed the presence of the species in Danube (DRENSKY, 1948, 1951).

DRENSKY (1948, 1951) found the racer goby (*Neogobius gymnotrachelus* Kessler, 1857) in the Danube up to Ruse. Later GHEORGHIEV (1966) reported that the racer goby can be found up to Vidin.

The Kessler's goby (*Neogobius kessleri* Günther, 1861) was found in the past in the Danube up to the city of Vidin (DRENSKY, 1921, 1948, 1951), as the same author also stated that he got evidence for the presence of the species up to the city of Vienna.

The natural distribution of the round goby (*Neogobius melanostomus* Pallas, 1814) covered the lower sections of Danube River upstream to the town of Vidin (DRENSKY, 1948, 1951).

In the Danube the presence of the tubenose goby (*Proterorhinus marmoratus* Pallas, 1814) was registered by DRENSKY (1948). He stated that the species can be found upstream to Bratislava (1869 river km). Later GHEORGHIEV (1966) discovered the tubenose goby near the cities of Ruse, Svishtov and Vidin.

MARINOV (1966) reported the presence of 5 species of gobies in the Danube - *N. kessleri, N. fluviatilis, Pr. marmoratus, B. stellatus* and mis-determinated and currently not present in the Danube *Neogobius cephalarges constructor* Nordmann, 1840.

According to the latest data (VASSILEV & PEHLIVANOV, 2005; POLAČIK *et al*., 2008; VASSILEV *et al*., 2011) family Gobiidae in the Bulgarian sector of Danube is represented by three genera with six species: stellate tadpole goby, monkey goby, racer goby, Kessler's goby, round goby and tubenose goby. All of them are Ponto-Caspian relicts and are native in the Bulgarian section of the Danube. Recently there are clear indications for fast invasion of some of the gobies upstream (HEGEDIŠ *et al*., 1991; KAUTMAN, 2001; GUTI, 2004; PRASEK & JURAJDA, 2005; WEISNER, 2005; MANNÉ & POULET, 2008; POLAČIK *et al*., 2009).

The ichthyofaunistic studies of the Bulgarian Danube tributaries showed presence of gobies mainly in the lower sections of the rivers and in the river-mouths.

KARAPETKOVA (1985) reported the occurrence of *B. stellatus* in the Ogosta River, but only close to the river mouth in to the Danube.

According to DRENSKY (1932) *N. fluviatilis* was captured in lower and mid sections of the Osam River. Later DRENSKY (1948) discovered the monkey goby in the rivers Iskar, Osam, Yantra and Vit (up to Pleven, 41 km form Danube). DRENSKY (1951) found the species in Ogosta River. KARAPETKOVA (1985) report for the presence of *N. fluviatilis* in the Iskar, Ogosta, Vit, Rusenski Lom River, and in the Tsibritsa River near the village of Zlatiya (5 km from Danube). Later the species was reconfirmed for the Rusenski Lom River complex (MIHOV & KOEV, 2006). PEHLIVANOV *et al.* (2009) stated the presence of *N. fluviatilis* in the Vit River. According to another recent study (TRICHKOVA *et al.,* 2009) the monkey goby can be found in the rivers Vidbol (lower reaches), the Archar (Archar village), the Ogosta (near Mizia) and the Lom River (near Lom). The species is reconfirmed for the Yantra River (VASSILEV *et al.* 2009).

KARAPETKOVA & DIKOV (1986) reported for the presence of the racer goby in Vit River, after two years it was found also in the Rusenski Lom River complex (KARAPETKOVA & UNDZIAN, 1988). VASSILEV *et al.* (2009) confirmed the presence of the *N. gymnotrachelus* in Yantra River up to Polsko Kosovo village (52 km from Danube).

The Kessler's goby was registered in the lower sections of the Osam River by DRENSKY (1932) and in the Vit River by GHEORGHIEV (1966). KARAPETKOVA (1985) reported for the presence of the *N. kessleri* in

Ogosta. Some authors assume that in the past it reached upstream to the Iron Gates Dam (943 river km) in Serbia (BĂNĂRESCU, 1970, MILLER, 2003).

DRENSKY (1948) reported for the presence of the round goby in the Vit River up to Pleven (41 km from the Danube). Later the species was caught in the Iskar River (KARAPETKOVA, 1985). TRICHKOVA *et al.* (2009) found *N. melanostomus* in the Archar (close to Archar village) and the Ogosta River (found near Mizia village). The species was also found in the Yantra River (VASSILEV *et al.* 2009).

KARAPETKOVA (1985) reported for the presence of the *Pr. marmoratus* in the Ogosta River. The tubenose goby was registered for the Archar, Vidbol, and Skat (found near Galitsche village) and in the Ogosta River was confirmed for two locations – near Mihailovo village and near Hayredin village (TRICHKOVA *et al.*, 2009). Tubenose goby was registered for the Yantra River by Vassilev (VASSILEV *et al.* 2009).

Materials and Methods

The ichthyofaunistic survey was carried out during March, 2010 – April, 2012. A total of 41 sites were sampled alongside each one of the Bulgarian Danube tributaries (Fig. 1, Table 1, 2).

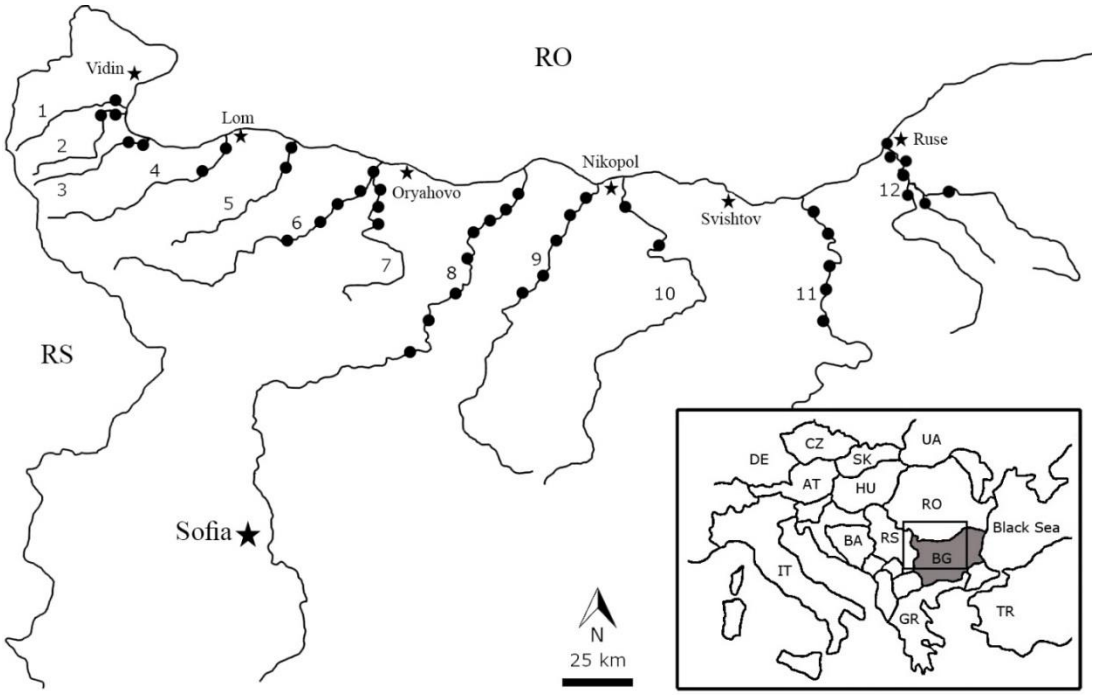

Fig. 1. Map of the Bulgarian Danube tributaries with the sampling sites. In the presented map the Danube River is water border between Bulgaria and Romania. The numbers correspond to the rivers as follow: 1 – Voynishka, 2 – Vidbol, 3 – Archar, 4 – Lom, 5 – Tsibritsa, 6 – Ogosta, 7 – Skat, 8 – Iskar, 9 – Vit, 10 – Osam, 11 – Yantra, 12 – Rusenski Lom River complex.

Two rivers were excluded of the sampling – the heavily polluted, water border with Serbia – Timok River and the Topolovitsa River, which has low water flow and is heavily vegetated and canalized. The sampling in each tributary started from the river mouth and continues upstream in order to give actual information about the southern distribution of the gobies in these rivers. Fishes were captured by standard portable electrofishing device. A transect of 100 m was sampled at each site, as if there were some obstacles in the river course we sampled the river section below and above them in order to complete the transect. Seine nets were used for sampling in the Ogosta Reservoir. The applied sampling methods have been focused on capturing gobies.

Almost all fish species were identified *in situ* and released back. Some of the captured specimens were preserved in 95% ethanol for further analyses. The percentages of occurrence on both the given substrate and given distance from Danube on the basis of the whole occurrences of each species on all registered substrate types and distances from Danube respectively, have been calculated.

Table 1. Sampling sites coordinates and recorded gobies for the period 2009 – 2012.The following abbreviations were used: Nf – *Neogobius fluviatilis*, Ng – *Neogobius gymnotrachelus*, Nm – *Neogobius melanostomus*, Pm – *Proterorhinus marmoratus*.

River	Site	Elevation	Substrate	Distance form Danube (km)	Gobies	River	Site	Elevation	Substrate	Distance from Danube (km)	Gobies
Voynishka	N 43.92624 E 22.80028	40	stone, gravel	3		Iskar	N 43.56292 E 24.2987	49	stone, sand	26	Nf, Nm
Vidbol	N 43.9033 E 22.80565	38	stone, sand	3		Iskar	N 43.51865 E 24.22502	48	stone, clay	35	Nf
Vidbol	N 43.901017 E 22.786767	52	stone, sand	5		Iskar	N 43.45607 E 24.23109	57	stone, sand	48	Nf
Archar	N 43.81265 E 22.91817	37	stone, gravel	1	Ng, Pm	Iskar	N 43.35268 E 24.16523	68	stone, clay	65	Nf
Archar	N 43.81119 E 22.90156	50	stone, gravel	3	Pm	Iskar	N 43.24875 E 24.04523	125	stone, clay	85	Nf
Lom	N 43.80059 E 23.24433	41	stone, sand	4	Pm	Iskar	N 43.18782 E 23.97203	149	stone, clay	102	
Lom	N 43.44492 E 23.11125	57	stone, sand	15		Vit	N 43.63378 E 24.6982	27	stone, clay	7	Nf, Nm
Tsibritsa	N 43.79763 E 23.50196	30	sand, silt	2	Nf	Vit	N 43.57147 E 24.6344	38	stone, clay	15	Ng, Nm
Tsibritsa	N 43.7499 E 23.48806	39	stone, sand	10		Vit	N 43.49338 E 24.5644	69	stone, clay	32	Nf, Nm
Ogosta	N 43.69185 E 23.82625	35	stone, sand	7	Nf, Nm, Pm	Vit	N 43.40639 E 24.51908	62	stone, clay	42	Ng
Ogosta	N 43.63233 E 23.71578	48	stone	20	Nf, Pm	Vit	N 43.33977 E 24.42632	101	stone ,clay	56	
Ogosta	N 43.5754 E 23.63588	54	stone, sand	32	Pm	Osam	N 43.62907 E 24.85043	29	stone, clay	9	
Ogosta	N 43.52543 E 23.53873	79	stone, sand	45		Osam	N 43.51005 E 25.00729	42	silt	32	
Ogosta	N 43.51877 E 23.44722	76	stone, sand	55		Yantra	Krivina	21	silt	5	Nf, Ng, Nm
Ogosta Reservoir	N 43.394133 E 23.185833	192	sand	85	Nf	Yantra	Beltsov	28	gravel, silt	25	Ng, Nm
Skat	N 43.62753 E 23.85772	46	stone, sand	16	Pm	Yantra	Byala	32	gravel, sand	60	Ng, Nm , Pm
Skat	N 43.55843 E 23.86247	73	stone	30		Yantra	Polsko Kosovo	34	gravel	70	Ng, Nm , Pm
						Yantra	Petko Karavelovo	44	gravel, sand	100	Nm , Pm
Skat	N 43.69399 E 23.84452	33	sand, silt	51		RusenskiLom	Ruse	19	stone, silt	2	Nf
						RusenskiLom	Basarabovo	25	stone, silt	11	Nf
Iskar	N 43.64363 E 24.42472	33	silt	11	Nf, Nm	RusenskiLom	Krasen	40	stone, silt	24	Nf
						RusenskiLom	Ivanovo	48	stone, silt	42	Nf
Iskar	N 43.58192 E 24.35618	40	stone, clay	20		RusenskiLom	Koshov	60	stone, silt	50	
						RusenskiLom	Nisovo	67	stone, silt	55	
						RusenskiLom	Pisanets	99	stone, silt	69	

Results

Four goby species from two genera were recorded from the studied sites – *N. fluviatilis, N. gymnotrachelus, N. melanostomus* and *Pr. marmoratus* (Tab. 2). In the most western studied rivers – the Voynishka and the Vidbol River we did not found any goby species. In the Archar River the presence of two species was registered – *N. gymnotrachelus* and *Pr. marmoratus*. In the Lom River we found only *Pr. marmoratus.* Two sites were sampled along the Tsibritsa River and in the closest to the river mouth-sampling site we found *N. fluviatilis*. In the Ogosta River we sampled 5 sites and we found gobies (*N. fluviatilis, N. melanostomus* and *Pr. marmoratus*) in only three of them. We also sampled in the Ogosta Reservoir, which is located further upstream, and we confirmed the presence of the *N. fluviatilis* in it. In the Skat River we found only *Pr. marmoratus.* In the longest river in Bulgaria – Iskar we sampled 8 sites and registered the presence of two goby species – *N. fluviatilis* and *N. melanostomus.* In the Vit River we recorded the presence of three goby species – *N. fluviatilis, N. gymnotrachelus* and *N. melanostomus*. In the Osam River we took samples from two locations but did not found any gobies. For the Yantra River we compared our data (Table 2) with a previous study on the ichthyofauna of this river (VASSILEV *et al.*, 2009), and did not found any changes. In the Rusenski Lom River complex we sampled 7 locations (Fig. 1, Table 2). We registered the presence of the monkey goby in 4 of them – up to the Ivanovo village (42 km from the Danube).

The calculated percentages of occurrence of the registered gobiid species on a given substrate on the basis of all types of substrates where the species is discovered showed that all of them prefer mixed substrates or the border between different substrates, rather than one type of substrate (Fig. 2). A deviation has been established for silt bottoms, where the percentage of occurrence for three species is rather higher than on gravel, sand or rock.

From the other side, as distance increases upstream from the Danube River, the occurrence of gobies decreases respectively (Fig. 3). There is a gap between 70 and 80 km from the Danube, where gobies have not been established. The registrations between 85 and 100 km have been accomplished in the Iskar and the Yantra Rivers.

Table 2. Distribution of the gobies in the Bulgarian Danube tributaries.

River	Goby species				Additional species
	Ng	Nf	Nm	Pm	
Voynishka					
Vidbol		X		X	
Archar	X	X	X	X	
Lom		X		X	
Tsibritsa		X			
Ogosta and Ogosta Reservoir		X	X	X	Bs, Nk
Skat				X	
Iskar		X	X		
Vit	X	X	X		
Osam		X			Nk
Yantra	X	X	X	X	Nk
Rusenski Lom	X	X			

The following abbreviations were used: Bs – *Benthophilus stellatus*, Nf – *Neogobius fluviatilis*, Ng – *Neogobius gymnotrachelus*, Nk – *Neogobius kessleri*, Nm – *Neogobius melanostomus*, Pm – *Proterorhinus marmoratus*.

Discussion

The species inhabiting the tributaries of the Danube River are determined in general by the Danubian fish fauna, which is the most abundant ichthyocomplex in Europe consisting of more than 100 species (BĂNĂRESCU, 1964) and 136 species for the Danube delta. The gobies inhabiting the Danube are freshwater or euryhaline, autochthonous Ponto-Caspian relicts. Their distribution is relatively well known and all the available literature on this topic was studied.

For the Yantra River we also summarized the data from KARAPETKOVA (1972) and VASSILEV *et al.* (2009).

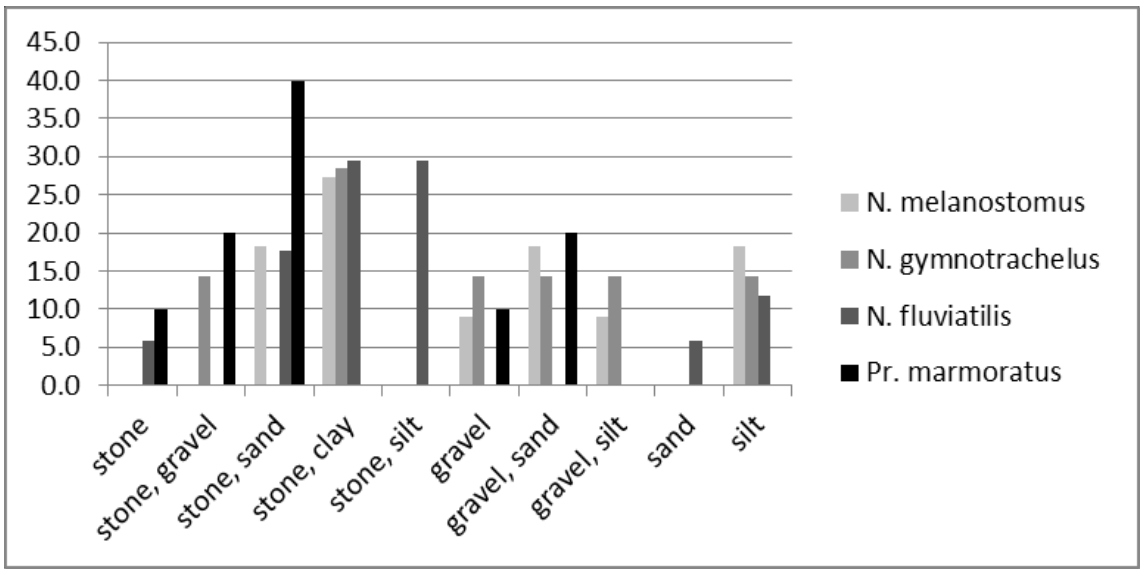

Fig. 2. Occurrence of the four discovered gobiid species in relation to the type of the substrate, where each given species is registered. On the y axis is illustrated the percentage of occurrence in given substrate, on the basis of the total number of occurrences.

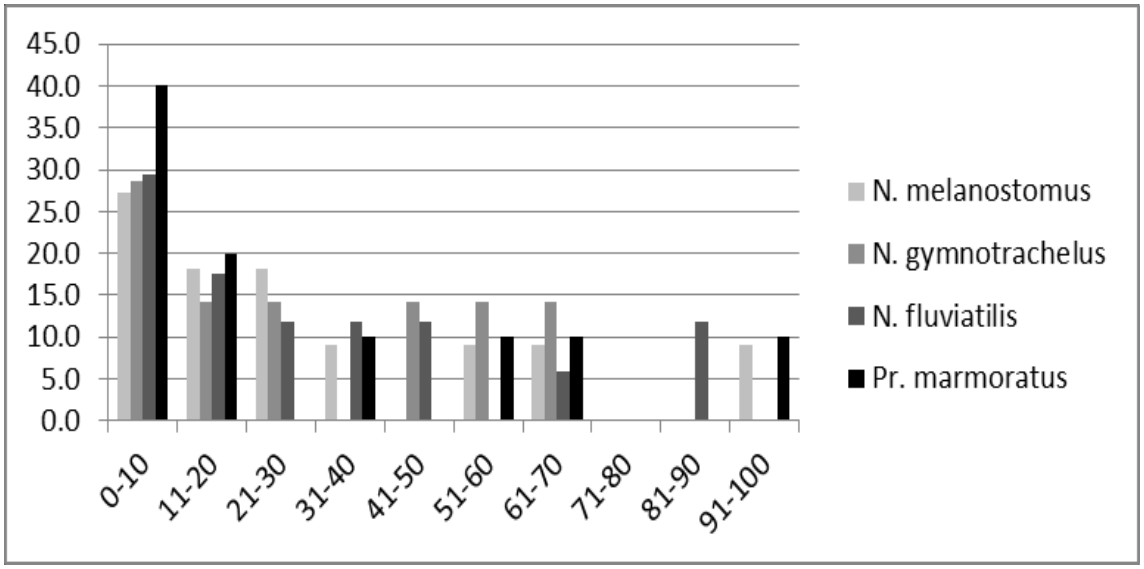

Fig. 3. Occurrence of the four discovered gobiid species in relation to the upstream distance from the Danube River, where each given species is registered. On the y axis is illustrated the percentage of occurrence in given distance, on the basis of the total number of occurrences.

KARAPETKOVA (1972) reports for the presence of *N. fluviatilis* and *N. kessleri,* while VASSILEV *et al.* (2009) found all four (*N. gymnotrachelus, N. fluviatilis, N. melanostomus, Pr. marmoratus)* gobies in different locations along the river (Table 2).

The southern points in these tributaries, in which we registered the presence of goby species, were in the Iskar River – 85 km upstream from the Danube (125 m a.s.l.) and in the Yantra River – 100 km from the Danube (44 m a.s.l.).

The calculation of percentages of occurrence on given substrate based on all substrates where given species registered showed preference for mixed substrates, rather than homogenous, with exception of silt bottoms. It is obvious that a more heterogeneous bottom discloses more opportunities for hiding/escaping from predators and finding food items. A rather

increased occurrence of three species on silt is not surprising-in such substrates are mostly appropriate for small benthic invertebrates on which the gobies prey, but do not give protection to gobies.

From the other side as distance from Danube decreases, the occurrence of gobies in the Danube tributaries decreases. This happens earlier in smaller rivers (Tsibritsa, Lom, Russenski Lom), in addition to the bigger Danube tributaries (the Iskar and the Yantra). The gobiid presence in the Ogosta reservoir should be considered as an isolated case; most probably *N. fluviatilis* have been introduced by accident in this particular water body.

Three of the studied gobies (*N. fluviatilis, N. kessleri* and *Pr. marmoratus*) are included in the IUCN Red List of threatened species with the status Least concern (LC) which indicates that they are not directly endangered. They are also included in the annex III (Protected fauna species) of the Bern Convention – "Convention on the conservation of European wildlife and natural habitats" which includes species that are in need of protection but can be hunted or exploited with regulations. Meanwhile these species are considered invasive, expanding their natural distribution rapidly and colonizing new territories far away from their native range.

In the past when the industry in Bulgaria was highly developed, the saprobic index of the rivers was worst. Now when most of the factories are not operational the saprobic index shows better values. This can be one of the reasons for the observed recent spreading of the gobies upstream in the tributaries – the ecological conditions are better and many of the pollutants are no longer present in the water.

There is also fast expansion upstream the Danube of the gobies recorded in the last two decades. The reasons for this are not still clarified. Some authors report that the global climate change can influence the invasion success (HARKA & BÍRÓ, 2007; KORNIS *et al.*, 2012), other the increased transportation and unregulated release of ballast waters (SAPOTA & SKÓRA, 2005; BROWN & STEPIEN, 2008; HAYDEN & MINER, 2009), some the changed environmental condition in the rivers and canalization (HARKA & BÍRÓ, 2007) and last but not least reason is given to the natural dispersion and migration capabilities of this species (WOLFE & MARSDEN, 1998; BRONNENHUBER *et al.*, 2011). Most probably, it is a combination of all these factors.

From their widespread distribution and recent invasions in new territories we can assume that in Bulgaria they are not in an urgent need of protection, as they are not endangered, but are very important part of the aquatic ecosystems in the Bulgarian Danube tributaries and lakes alongside the Danube like the world renowned Srebarna Biosphere Reserve (PEHLIVANOV, 2000) and are important study object for understanding the ecology of the invasive species and the reasons that leads up to this.

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†Associate prof. Dr. Milen Vassilev suddenly passed away on 30.05.2013. He left the article and much of his work uncompleted. His colleagues will continue his efforts.

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