Fish community structure of the middle course of the Bečva River

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ABSTRACT: Fish communities of the Bečva River were studied in summer and autumn 2000 and 2001. Electric fishing gear (Honda EX 1000, DC 230 V, 0.75–0.9 kW) was used for sampling. Four sampling sites (Grymov 19.6 r. km, Rybáře 35.8 r. km, Hustopeče 50.7 and Choryně 54.7 r. km) were selected. Total of 23 fish species representing 5 families were determined. The family Cyprinidae with 15 species was dominant while Salmonidae, Balitoridae, Percidae and Gadidae were the other recorded families. Species diversity ranged from 9 at Hustopeče to 20 at Grymov localities. The lowest biomass and abundance were observed at Hustopeče locality (28.93 kg/ha and 336 fishes/ha) and the highest at Choryně locality (612.90 kg/ha and 7 367 fishes/ha). *Barbus barbus*, *Chondrostoma nasus* and *Leuciscus cephalus* contributed 87.73–97.55% and 60.5%–87% to total biomass and abundance in different samplings, respectively. The *Chondrostoma nasus* population was dominated by fish of total length over 300 mm. We believe that river fragmentation, trapping and blockade of fish are the main reasons for this irregular distribution. Index of diversity ranged from 0.811 to 2.05 and equitability index from 0.449 to 0.821. Physical and chemical parameters were also measured, pH value ranged from 7.8 to 9.8, DO (7.62–12.15 mg/l), conductivity (450–639 μS/cm), N-NH_4 (0.65–2.39 mg/l), P-PO_4 (0.12–0.68 mg/l) and alkalinity (2.55 to 3.40 mg/l).

Keywords: weirs; fish species; Bečva River; Czech Republic

Rivers are dynamic open systems with interactive pathways along three dimensions: longitudinal, lateral, vertical. Humans have impacted one or more of these dimensions and exerted stresses to the river ecosystems. Studies of some large European rivers such as Danube (Bacalbasa-Dobrovici, 1989), Rhine (Lelek, 1989), and Volga (Pavlov and Ya Vilenkin, 1989) describe the extent of these impacts.

Petts *et al.* (1989) studied the history of European river development and demonstrated the anthropogenic impacts on riverine fish communities. The structure of fish communities in rivers changed considerably during the last century. Many long-distance migratory fish species disappeared from river systems and tolerant eurytopic species dominate at the expense of specialist rheophilic and limnophilic species (Bacalbasa-Dobrovici, 1989; Lelek, 1989). Important causes of decline are migratory barriers and loss of habitat. Oliva (1952) studied fish species at Lipník nad Bečvou. Kupka (1966) carried out a detailed ichthyological study on the Vsetínská Bečva. Princ (1882) reviewed fish species of the Bečva River at Valašské Meziříčí reach and in recent years Hohausová *et al.* (1996) accomplished similar studies. Spurný *et al.* (2000) studied the Bečva River from 1–19.6 river km at 4 localities to evaluate disturbances of fish communities caused by cormorant invasion. In this study effects of weirs and river fragmentation on fish communities will be assessed.

MATERIAL AND METHODS

The study was conducted in summer and autumn in 2000 and 2001. The Bečva River originates at an elevation of about 288 m above sea level as a confluent of Vsetínská Bečva and Rožnovská Bečva and flowing 119.6 km drains into the Morava River at 195 m above sea level (Bulíček, 1972). The watershed area of the river is 1 625.7 km^2 and average annual discharge 17.5 m^3/sec (Vlček

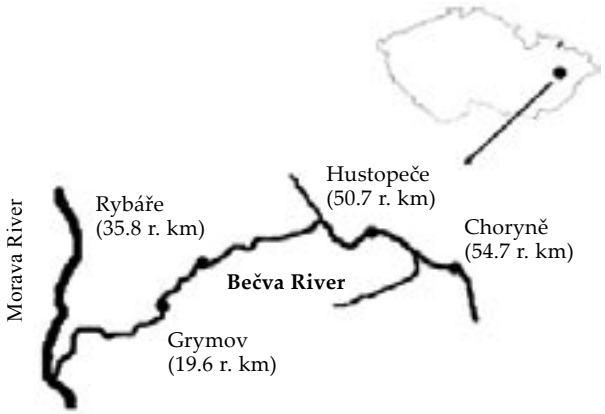

Figure 1. Study area of the Bečva River and sampling sites

et al., 1984). Four sampling sites (Grymov 19.6 r. km, Rybáře 35.8 r. km, Hustopeče 50.7 r. km and Choryně 54.7 r. km) were selected (Figure 1). The riverbed at Grymov (1st sampling site) is 17 m in width with ca. 12 m usually under water. In the period of low water flow a small land mass occurs in the middle of this site. Water depth is up to 80 cm. The bottom structure is heterogeneous, built of sand and small pebbles. Deciduous trees (alder, willow, bushes) are dominants in riparian vegetation. Rybáře (2nd sampling site) is 10–12 m in width and both banks are covered with deciduous trees. Water depth is up to 170 cm. The bottom structure consists of silt to small stones. Hustopeče (3rd sampling site) is a shallow stream with 20–40 cm depth and 13–15 m width. The bottom structure is homogeneous containing pebbles and small stones. Riverbank vegetation is composed of willow, alder and poplar. Choryně (4th sampling site) is 100–120 cm in depth and about 45 m regulated channel width with 15–17 m under water. The bottom structure is heterogeneous with particles ranging from silt to large stones. There are six weirs at the studied course of the river: Osek nad Bečvou weir (ca. 24.3 river km) with 3.2 m height of dike, 36 m length and 100 000 m^3 capacity; Lipník nad Bečvou weir (ca. 24.8 river km) with 4.5 m height of dike and 92 m length; Hranice weir (38.3 river km) with 5 m height of dike, 32 m length and 140 000 m^3 capacity; a hydropower generation unit at 45.5 river km with 55 m length and 0.8 m height of dike and two small weirs located between the 49th and 50th river km.

An electrofishing gear (Honda EX 1000, DC 230 V; 0.75–0.9 kW) was used for sampling. One-run and

Table 1. Overview of fishing efforts in different localities of the Bečva River

Sampling site	Date	Time	Water temperature (°C)	Covered area (m^2)	Number of caught fishes	Number of species
Grymov	3. 7. 2000	11:45	22.4	3 467	926	13
	11. 9. 2000	14:00	19.5	1 749.5	481	12
	16. 7. 2001	10:30	24.6	2 897.5	284	12
	23. 10. 2001	12:45	13.0	1 824.4	472	15
Rybáře	3. 7. 2000	15:00	22.7	1 785	101	7
	12. 9. 2000	9:00	18.1	1 785	96	9
	16. 7. 2001	14:00	25.6	1 462.5	67	7
	23. 10. 2001	16:00	12.3	1 219	148	8
Hustopeče	3. 7. 2000	16:45	26.7	2 400	205	8
	12. 9. 2000	12:30	19.0	2 002.5	119	6
	16. 7. 2001	16:00	25.3	3 712.5	93	7
	23. 10. 2001	17:45	12.2	2 329	210	8
Choryně	4. 7. 2000	9:30	23.1	1 549.1	913	10
	12. 9. 2000	14:15	18.2	1 312.5	602	8
	16. 7. 2001	17:15	24.6	3 150	223	11
	23. 10. 2001	13:00	10.6	1 470	608	11

two-run methods were applied for summer and autumn samplings, respectively. The study was qualitative in summer and quantitative in autumn. In summer samplings only species, abundance and total length (TL) and in autumn samplings total length (TL), standard length (SL), height and width (to the nearest 1 mm), weight (to the nearest 1 g) of all collected fish were measured and biomass was determined. Fishing data is presented in Table 1. Portable equipment (Hanna-H 1 9025C) was used to measure water temperature, pH and Hanna-H 1 9145 equipment was used to determine conductivity and dissolved oxygen concentration (DO). Values of $N\text{-}NH_4$, $N\text{-}NO_3$, $N\text{-}NO_2$, $P\text{-}PO_4$, chemical oxygen demand (COD) and alkalinity were determined in the laboratory using standard analytical methods. Shannon and Weaver (1963) index of diversity (H') and Sheldon (1969) index of equitability (E) were used to estimate the prosperity and stability of the whole fish community in the studied reach.

RESULTS

A total of 23 fish species representing 5 families: Cyprinidae, Salmonidae, Balitoridae, Percidae and Gadidae (Table 2) were recorded. Of these 23 fish species three species are not native of the Bečva River *(Oncorhynchus mykiss, Pseudorasbora parva* and *Carassius auratus)*. The family Cyprinidae with 15 species was a dominant family. Species diversity ranged from 9 at Hustopeče to 20 species at Grymov sampling sites. The eight species *Barbus barbus, Chondrostoma nasus, Leuciscus cephalus, Alburnus alburnus, Alburnoides bipunctatus, Leuciscus leuciscus, Gobio gobio* and *Barbatula barbatula* were present in all sampling sites (Table 2).

The Choryně sampling site showed the highest abundance in 3 samplings with 1 011–7 367 fishes/ha and the Grymov sampling site in 4 samplings with 1 400–3 906 fishes/ha (Table 3). The lowest abundance was observed at the Hustopeče sampling site in summer 2001 with only 334 fishes/ha. Based on fish abundance, the sampling sites are categorized in descending order: Choryně, Grymov, Rybáře and Hustopeče.

The highest biomass was also obtained at the Choryně site with 613 kg/ha and the lowest at the Hustopeče sampling site with 29 kg/ha (Table 3). The three species *Barbus barbus, Chondrostoma nasus* and *Leuciscus cephalus* contributed 87.73%–97.55% to total biomass in different samplings. Maximum

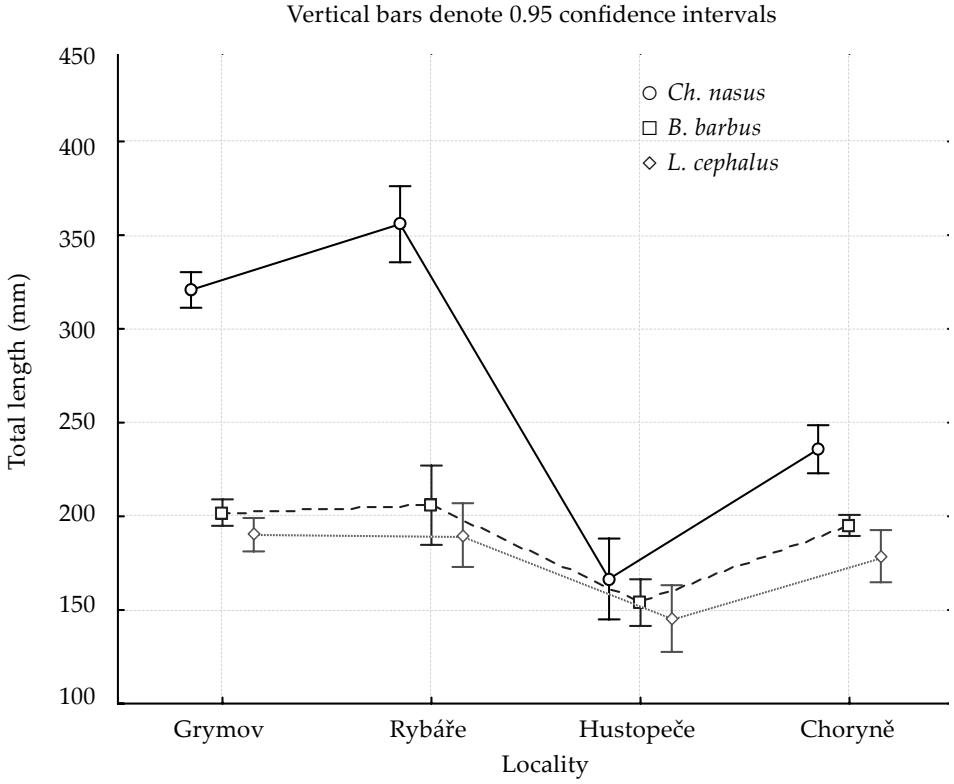

Figure 2. Total length (TL) distribution of three fish species in the Bečva River

Table 2. Dominance (%) of fish species of the Bečva River in the summer and autumn seasons of 2000 and 2001

Species	Grymov				Rybáře				Hustopeče				Choryně			
	2000		2001		2000		2001		2000		2001		2000		2001	
	S	A	S	A	S	A	S	A	S	A	S	A	S	A	S	A
Salmo trutta m. *fario*				0.21		1.04							0.11			
Oncorhynchus mykiss														0.33		
Thymallus thymallus		0.21												0.33		0.16
Rutilus rutilus	0.11	0.21		0.85	1.19	2.08							1.75	1.83	1.79	1.64
Leuciscus leuciscus			0.35	0.21		1.04		14.86	0.5	0.84		0.95	0.11	0.66		3.78
Leuciscus cephalus	16.74	18.71	21.13	36.23	9.9	38.54	50.75	58.78	17.91	2.52	20.43	41.43	2.41	5.15	3.14	31.09
Phoxinus phoxinus																0.16
Leucaspius delineatus	0.44		0.35													
Tinca tinca		0.21		0.21												
Chondrostoma nasus	16.19	13.31	9.86	9.96	40.59	7.29	10.45	4.05	12.94	3.36	4.3	12.38	9.09	15.95	10.76	11.51
Pseudorasbora parva	0.99	0.42							0.5	0.84	1.08					0.66
Gobio gobio	14.21	2.70	0.35	5.72			1.49	5.41	2.49		1.08	4.29	0.11	0.33	1.79	2.14
Gobio kessleri	0.33		0.35	0.21									0.22			
Barbus barbus	31.28	53.64	50	27.12	25.74	40.63	13.43	13.51	35.82		50.76	27.62	54.33	61.63	65.02	18.26
Alburnus alburnus	18.17	4.16	4.93	1.69	14.85	4.17		1.35	25.37	74.79		0.95	30.56	0.17	4.48	0.49
Alburnoides bipunctatus		4.78	10.21	15.25		4.17	20.9			17.65	13.98	11.9		13.46	12.56	30.1
Abramis brama				0.21			1.49									
Vimba vimba	0.66	1.25	1.76	0.21	5.94	1.04		1.35								
Carassius auratus				0.21												
Barbatula barbatula	0.22		0.35		0.99				4.48		5.38	0.48	1.31		0.45	0.16
Lota lota								0.68								
Perca fluviatilis	0.22	0.42	0.35	1.69			1.49						0.11	0.17		
Sander lucioperca	0.44															

Table 3. Index of diversity, equitability and the abundance of fish community of the Bečva River

Date	Sampling site	Index of diversity	Index of equitability	Abundance* (fishes/ha)	Biomass* (kg/ha)
S. 2000	Grymov	1.73	0.673	3 906.3	–
	Rybáře	1.52	0.780	808.3	–
	Hustopeče	1.57	0.754	1 067.7	–
	Choryně	1.16	0.506	7 367.2	–
A. 2000	Grymov	1.43	0.449	3 043.4	423.8
	Rybáře	1.41	0.621	632	43.3
	Hustopeče	0.81	0.453	659.7	29.0
	Choryně	1.19	0.499	5 095.7	613.0
S. 2001	Grymov	2.07	0.821	1 400.4	–
	Rybáře	1.37	0.704	610.8	–
	Hustopeče	1.32	0.678	334.0	–
	Choryně	1.20	0.577	1 011.3	–
A. 2001	Grymov	1.52	0.560	2 639.9	274.2
	Rybáře	1.30	0.625	1 278.0	108.0
	Hustopeče	1.48	0.712	1 001.9	63.0
	Choryně	1.64	0.683	4 595.6	174.6

*the values of abundance and biomass are based on 100% catch efficiency

individual biomass of these three species was 414.89 kg/ha (Choryně), 174.53 kg/ha (Grymov) and 65.70 kg/ha (Rybáře), respectively. Cumulative dominance of these three species was 60.5%–87% of the total abundance. Index of diversity (*H'*) ranged from 0.810 (Hustopeče) to 2.070 (Grymov) and index of equitability from 0.449 (Hustopeče) to 0.821 at the Grymov sampling site (Table 3). Total length (TL) distribution of three dominant species is given in Figure 2. Physical and chemical parameters of water are presented in Table 4.

DISCUSSION

Many researchers have studied fish communities in the Bečva River. Hohausová *et al.* (1996) reported 14 species from the upper course and Spurný *et al.* (2000) reported 23 fish species from the lower course of the Bečva River. Contrary to Hohausová *et al.* (1996) the two species *Cottus gobio* and *C. poecilopus* and to Spurný *et al.* (2000) the 6 species *Carassius carassius, Scardinius erythrophthalmus*, *Aspius aspius*, *Anguilla anguilla*, *Esox lucius* and *Cyprinus carpio* were not observed in the middle course of the river. Dominance of *Barbus barbus* at all sampling sites together with *Leuciscus cephalus* and *Chondrostoma nasus* documents that the investigated course of the Bečva River is a typical barbel zone. Brown trout *(Salmo trutta* m. *fario)* and *Thymallus thymallus*, typical upstream species, were sporadically observed at this river section.

Three rheophilic species *(Barbus barbus*, *Chondrostoma nasus* and *Leuciscus cephalus)* were present in all sampling sites and dominated fish communities by abundance and biomass throughout the study with 60%–86.5% contributions to total abundance and 87.73%–97.55% to total biomass. Predatory species represented by *Oncorhynchus mykiss*, *Perca fluviatilis* and *Sander lucioperca* did not have a significant part in the fish community of the Bečva River and were caught sporadically. *Tinca tinca* and *Carassius auratus* as the most tolerant species (Nikolski, 1961) occurred only once at the Grymov sampling site and probably entered the river from fisheries ponds located in the vicinity

Table 4. Physical and chemical parameters of the middle course of the Bečva River in this study

Year	Sampling site	E.C. (µs/cm)	pH	DO (mg/l)	N-NH_4 (mg/l)	N-NO_3 (mg/l)	N-NO_2 (mg/l)	P-PO_4 (mg/l)	COD (mg/l)	Alk. (mg/l)
S. 2000	Grymov	554	8.4	12.0	0.65	2.44	0.0010	0.590	13	2.85
	Rybáře	639	9.8	10.8	1.29	2.44	0.0020	0.680	48	2.95
	Hustopeče	488	8.5	8.9	1.21	2.30	0.0082	0.250	22	2.75
	Choryně	491	8.4	11.7	1.13	2.03	0.0061	0.340	15	2.60
A. 2000	Grymov	558	8.3	12.7	0.86	2.55	0.0015	0.240	10	2.75
	Rybáře	566	8.0	12.1	1.18	2.82	0.0021	0.350	8	2.80
	Hustopeče	524	8.6	11.5	0.78	2.94	0.0022	0.290	16	2.60
	Choryně	495	8.9	11.4	1.40	2.80	0.0023	0.310	14	2.60
S. 2001	Grymov	559	8.5	11.5	1.57	0.32	0.0536	0.180	7	2.75
	Rybáře	559	8.2	9.6	1.65	0.22	0.0852	0.230	42	2.70
	Hustopeče	519	8.4	9.2	1.60	0.22	0.0420	0.250	7	2.60
	Choryně	482	8.4	7.6	2.39	0.66	0.0475	0.290	35	2.55
A. 2001	Grymov	550	8.3	12.0	0.96	0.45	0.0130	0.120	4	3.00
	Rybáře	490	7.8	10.5	0.85	0.39	0.0120	0.203	20	3.40
	Hustopeče	450	8.5	10.6	1.01	0.34	0.0200	0.420	4	3.20
	Choryně	450	8.3	12.1	1.05	0.32	0.0130	0.370	28	3.30

of the Bečva River. *Abramis brama*, *Perca fluviatilis*, *Rutilus rutilus* and *Sander lucioperca*, typical eurytopic species, were very rare at the studied localities. A promising fact was frequent occurrence of *Gobio kessleri*, an endangered species at the Grymov and Choryně sampling sites. The length distribution of three important species that is shown in Figure 2 suggests that *Barbus barbus* and *Leuciscus cephalus* are less affected by river regulation compared to *Chondrostoma nasus*, which shows irregular length distribution and being a typical migratory species, it seems weirs can hamper its successful reproduction. Holčík (2001) reported 446 km as the longest migratory distance for *Chondrostoma nasus* in European rivers. Considering the existence of 5 weirs and one with almost 5-meter dike height it is unlikely that *Chondrostoma nasus* could further migrate upstream for reproduction. Lusková *et al.* (1997) explained a decrease in the nase (*Chondrostoma nasus*) population by destruction of riverine habitat including barriers and pollution. Holčík (2001) also stated that the weir constructions blocked upstream and downstream migrations, reduced stock recruitment and population density of species having the spawning ground upstream from dams. The lowest diversity (9 species) and the smallest individual size of fish (Table 2, Figure 2) were observed at the Hustopeče locality. The homogeneous bottom structure of this locality is the main reason, which is in agreement with Parasiewicz *et al.* (1998), who stated that low diversity of stream structure could be a reason for low species diversity in a river system and Jungwirth *et al.* (1993), who stressed that the reduction of riverbed complexity was responsible for the decrease in both benthos and fish fauna stock density.

Index of diversity at monitored localities ranged from 0.810 to 2.070 and index of equitability from 0.449 to 0.821. Shannon index (H') is the value that combines species diversity and evenness where >3.99 is considered as non-impacted; 3.00–3.99, slightly impacted; 2.00–2.99, moderately impacted; and <2.00, severely impacted (Bode *et al.*, 1993). Based on this category the studied reach of the Bečva River is categorized as moderately to severely impacted.

Water quality of the Bečva River improved from highly and extremely polluted water (Bulíček, 1972) to polluted water in 1995 (www.env.cz). Most physical and chemical parameters did not exceed admissible levels, pH values slightly shifted toward alkalinity. Only the values of nitrites at Grymov and Rybáře localities and concentration of P-PO_4 slightly exceeded the standard limits indicating progressive anthropogenic impacts and euthrophication risk of the monitored course of the river. High values of COD (chemical oxygen demand) at the Rybáře site in summer 2000 and 2001 are due to the presence of point sources of pollution.

CONCLUSION

The monitored reach of the Bečva River is inhabited by typical fish species of the barbel zone. The actual fish community of the studied course of the Bečva River consists of 23 species from 5 families. *Barbus barbus*, *Chondrostoma nasus* and *Leuciscus cephalus* are dominant species by their number and biomass. The frequent occurrence of *Gobio kessleri*, which was reported for the first time in the 50s of the last century (Oliva, 1952), was important from ecological aspects in this study. A single specimen of this species was reported by Jurajda *et al*. (1996). Later on Lusk *et al.* (2000) and Spurný *et al.* (2000) reported its presence in the Bečva River. A repeated catch of this fish species in our study is a sign of successful establishment of the species in the river. The fish size structure is relatively balanced except for *Chondrostoma nasus*, which indicates progressive ageing of its population (individuals with TL over 300 mm are dominant). The weir construction and longitudinal regulation of the Bečva River and subsequent disturbances of its natural hydrologic regime are considered the main reason for this situation, which coincides with Holčík and Macura (2001).

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ABSTRAKT

Stav rybího společenstva na středním toku Bečvy

V letních a podzimních obdobích let 2000 a 2001 bylo prováděno terénní sledování stavu rybího společenstva středního toku řeky Bečvy, který se vyznačuje přerušovanou biologickou kontinuitou a kolísavým průtokovým režimem v důsledku výstavby několika jezů, na nichž jsou provozovány malé vodní elektrárny. Ichtyologický průzkum probíhal pomocí elektrolovu (agregát Honda EX 1000) na čtyřech lokalitách mezi obcemi Grymov a Choryně (Grymov – ř. km 19,6, Rybáře – ř. km 35,8, Hustopeče – ř. km 50,7 a Choryně – ř. km 54,7). Kvantitativní (abundance, biomasa) a kvalitativní (druhová dominance, diverzita a ekvitabilita) parametry rybího společenstva byly hodnoceny s využitím základních ichtyologických metod. V rámci sledování kvality vodního prostředí bylo prováděno měření pH, koncentrace rozpuštěného kyslíku, vodivosti, koncentrace $N\text{-}NH_4$, $N\text{-}NO_3$, $N\text{-}NO_2$, $P\text{-}PO_4$, kyselinové neutralizační kapacity a chemické spotřeby kyslíku dichromanem. Cílem tohoto sledování bylo zachycení aktuálního stavu rybího společenstva s ohledem na vodohospodářské úpravy a využití toku a získání údajů o ekologické stabilitě ichtyocenózy před zprovozněním průmyslového komplexu firmy Philips v Hranicích na Moravě. Ve sledovaném říčním úseku byla zjištěna přítomnost 23 druhů ryb z 5 čeledí. Druhy cejn velký, lín obecný, karas stříbřitý, pstruh duhový, candát obecný a mník jednovousý byly zachyceny jen po jednom exemplář. Nejpočetněji byla zastoupena čeleď kaprovitých s 15 druhy. Druhová diverzita kolísala od 9 (Hustopeče) po 20 (Grymov) zjištěných druhů. Nejnižší abundance (336 ks/ha) a biomasa (28,93 kg/ha) rybího společenstva byla zjištěna na lokalitě Hustopeče, nejvyšší hodnota abundance (7 367 ks/ha) a biomasy (612,90 kg/ha) na lokalitě Choryně. Parma obecná, ostroretka stěhovavá, jelec tloušť, ouklej obecná a ouklejka pruhovaná s abundancí 4 002, 812, 1 429, 2 251 a 1 382 ks/ha představovali druhy s nejvyšší početnostní dominancí. Na lokalitě Grymov bylo uloveno 5 exemplářů hrouzka Kesslerova, který je vyhláškou MŽP č. 395/1992 Sb. zařazen mezi kriticky ohrožené druhy, ve dvou exemplářích byl tento druh zjištěn také na lokalitě Choryně. Nejvyšší hodnota biomasy parmy obecné (414,89 kg/ha) byla zaznamenána na lokalitě Choryně, ostroretky stěhovavé (174,53 kg/ha) a jelce tlouště (65,70 kg/ha) na lokalitě Grymov. Uvedené druhy tvořily 87,73–97,55 % biomasy a 60,5–87,0 % abundance celého rybího společenstva. Zastoupení délkových kategorií (TL) jedinců druhových populací parmy obecné, jelce tlouště a ostroretky stěhovavé může signalizovat začínající ekologické narušení populace (stárnutí) ostroretky stěhovavé. Tento stav může být u místní populace způsoben právě dlouhodobým přerušením biologické kontinuity říčního toku vodními stavbami, znemožňujícími delší reprodukční migrace. Index diverzity rybího společenstva (H') se na jednotlivých lokalitách pohyboval v rozmezí 0,811–2,050 a ndex ekvitability (E) mezi 0,449–0,821. Sledované kvalitativní parametry vodního prostředí dosahovaly v případě pH hodnot 7,8–9,8, rozpuštěného kyslíku 7,62–12,15 mg/l, vodivosti 450–639 μS/cm, $N\text{-}NH_4$ 0,65–2,39 mg/l, $P\text{-}PO_4$ 0,12–0,68 mg/l a kyselinové neutralizační kapacity (alkalita) 2,55–3,40 mg/l.

Klíčová slova: vodní stavby; rybí společenstvo; diverzita; řeka Bečva; Česká republika

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