THE CHANGE OF TROPHIC STATE DOWNSTREAM IN DNIEPER RIVER AND INFLUENCE OF IT ON FISH COMMUNITY

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PROMENE TROFIČKOG STANJA U RECI DNJEPAR I NJIHOV UTICAJ NA ZAJEDNICU RIBA

Abstrakt

Ispitivane su promene structure zajednica fitoplanktona i riba, kao i koncentracije azota i fosfora u međugraničnoj reci Dnjepar. Konstatovano je da je koncentracija mineralnog azota najvažniji factor akumulacije antropogenog zagađenja nizvodno u ispitivanim delovima reke Dnjepar. Ukupna količina riba se povećala nizvodno sa povećanjem trofičkog statusa reke. U isto vreme prosečna individualne težina se nizvodno smanjivala.

Ključne reči*: azot, fosfor, reka, trofičko stanjes, fitoplankton, zajednica riba*

INTRODUCTION

The lotic ecosystem is a very dynamic biological system. The forming of certain community composition depends on the influence of many factors. This influence adversely affect on whole river system non-uniformly. At the same time, we can't deny the integrity of river system, like ecological system. The processes existent on whole columbine (D a v i e s & W a l k e r, 1986) and the change of biotic and abiotic factors in river continuum both influence on the structure of biological community in river. There are some conceptions of regularity of change of biota downstream. In the basis of conceptions is the principle that in stream systems take place the regular change of environmental quality in the process of movement of water mass from upstream to downstream owing to abiotic factors and vital functions of streams organisms. Any stream community depends on superincumbent section of stream more than on underlying. The river continuum concept RCC (V a n n o t e et al. 1980)., stated on this basis,

and often cited as reference work, have in mind, that one of most important factors of the influence on structure and functioning of stream communities the geomorphological changes from upstream to downstream. The strength of plankton development changes depend upon change of level (size) of streams. As it is stated by P r o t a s o v (2008) this model is made for average nature of relief and temperate climate streams.

At the same time, in most of the works, dealing with the regularity of community changes downstream, was noted the departure from conceptual rules, even for temperate climate streams. (B o g a t o v, 1995; S t a t z n e r & H i g l e r, 1985).

Thus, RCC have in mind, that studied stream is natural “untouched” ecosystem, i.e. ecosystem without anthropogenic influence. There is practically impossibly to find the river with natural catchment area and river valley. Anthropogenic influence consists both in mechanical change of geomorphological structure of stream and pollution the whole of river of certain parts by organic and toxic substances. As the results as hydrobuilding, industry and residential water consumption, chemical and temperature pollution, aquatic trade, at present most of great rivers in Europe are transformed (P a s s i n o, 2000; O h a p k i n, 1999). It should take into consideration, that most of anthropogenic organic waste comes into rivers in the area of great cities, industry and agricultural regions. Such local entry of organic matter can break natural energy balance along the stream. For one’s turn, it compels us to consider the anthropogenic influence like one of the most important factors determining regularity of changes of biological community structure. The Serial Discontinuity Concept (SDC) (S t a n f o r d & W a r d, 2001) is created on basis of this conclusion. The Serial Discontinuity Concept predicts that dams or other anthropogenic variables (i.e., pollution, erosion, etc.) should disrupt the underlying continuum, causing longitudinal shifts in the river’s abiotic and biotic parameters and processes.

The creation of models of possible changes in community structure downstream is interesting. The models are created on data bulk. But, obviously, it is difficult to made the universal model for all stream systems. The analysis of existent conceptions shows, that it can to reflect adequately the situation on part of river, when the stream undergo the great geomorphological changes (current velocity, water discharge, opacity of riverbed etc.). But many of rives don’t undergo great changes for long distance.

Obviously, the interaction of biotic and abiotic factors, organic and toxic pollution, create the complex of fit species. Anthropogenic pollution is the key factor in the modern conditions. It especially important for great transboundary rivers receiving manufacturing water, sewage of cities, storm run-off from agricultural lands.

It is interesting to consider that the changes of main hydrochemical indices (nitrogen and phosphorus) characterized the level of man’s impact downstream. The change of hydrochemical condition is connected. Change of the structure of plankton communities, and, therefore, with structure of following links of trophic pyramid, included fish. Fish community is the last link in the process of utilization of energy in water ecosystem.

Phytoplankton is convenient object for revelation of regularity of succession, because the components of community have the short living cycle (H u s z a r & R e y n o l d s, 1997). This is the cause of quick response of algae community to change of environment (R o m a n o v, 2006).

The pattern of structure changes of initial links of ecosystem reflects on following links including fish community. For example, it was marked for Amazonian fish (A r a u j o et al. 2007).

MATERIALS AND METHODS

Our research was carried out on the transboundary Dnieper river. We investigated the change of structure of phytoplankton and fish communities, as well as nitrogen and phosphorus concentration downstream.

The Dnieper river is third river in Europe by the length and square of columbine. Total length of river is 2201 км. The length in Belarus is 700 km, square of columbine – 63700 km^2. The Dnieper river is undergo considerable man-made pollution by organic maters. The main local source of pollution is situated in the area of cities Orsha, Mogilev and Rechitsa.

The phytoplankton and the nitrogen and phosphorus concentration of the Dnieper river was studied by us in 2001-2004 years on the 9 sites, located in the area of cities Orsha (sites №№ 1-3), Mogilyov (sites №№ 4-6) and Rechica (sites №№ 7-9) (Fig. 1). The collection and the processing of hydrobiological and hydrochemical materials was carried out with standard techniques.

The fishing was carried out by seine and nets. The seine had 50 m length with the 14 mm mesh in stern and 16 mm mesh in wings. The square of one submersion was 500 m^2. The mesh of nets was from 27-30 mm to 40-60 mm. Total length of nets was 600 m.

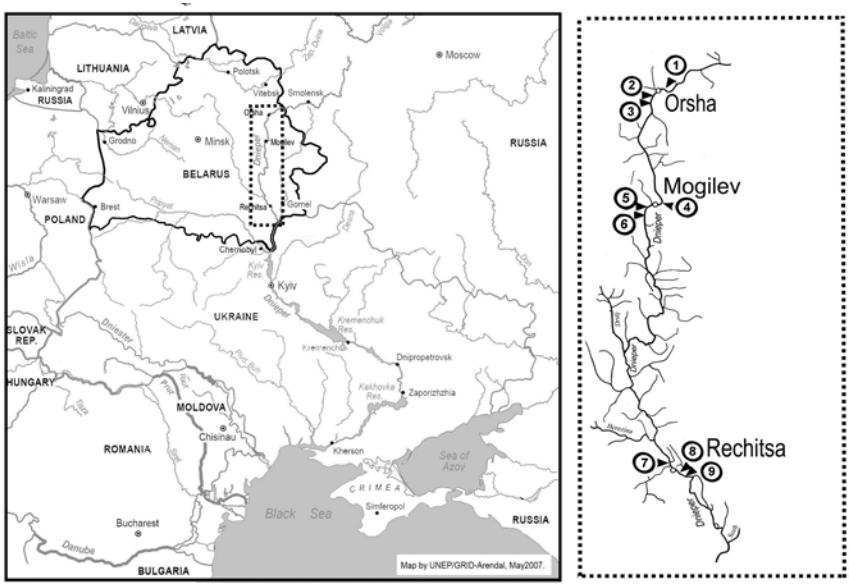

Figure 1. The area of investigation of Dnieper river in territory of Belarus.

RESULTS AND DISCUSSION

Hydrochemistry and phytoplankton.

The tendency of change of mineral nitrogen and phosphorus concentrations downstream the Dnieper river was diferent (Fig. 2). The phosphorus concentration average per year was relatively constant, with the exception of 5-th site. The great advance of phosphorus concentration in 5-th site was due to sewage of Mogilev city. Mogilev is

the greatest city in Belarus site of Dnieper river. The absence of increase of phosphorus concentration is due to phosphorus cycle. Phosphorus is consumed by primary producers and mud of river very quickly. The line of trend have small approximation index, and doesn't show the regular increase or decrease of phosphorus concentration. On the contrary, the tendency of increase of mineral nitrogen downstream, was expressed clearly (Fig. 2).

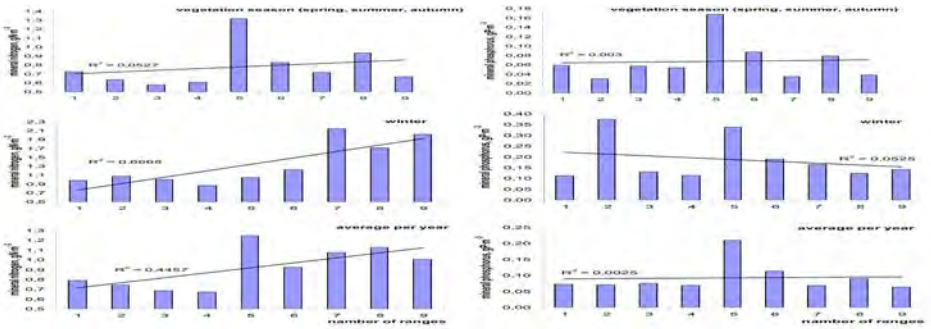

Figure 2. The concentration of mineral nitrogen and phosphorus in Dnieper river, 2001-2004 years.

The mineral nitrogen concentration is the most significant factor of accumulation of man-made pollution downstream of investigated part of great Dnieper river. Moreover, the investigation of transboundary transfer of pollution substances in the Zapadnaja Dvina river (K o l m a k o v a & M a s l o v a, 2008) achieved, that mineral nitrogen concentration in the territory of Belarus was increased, while mineral phosphorus concentration, on the contrary, was decreased.

The tendency of increase of phytoplankton concentration downstream in the Dnieper river is shown on figure 3. It is interesting to compare the fig. 3 with fig. 2 indicating the increase of nitrogen concentration. The maximum of algae concentration was registered in 6-th site in the area of sewage influence of Mogilev. The similarities under review indicates, that gradual accumulation of nitrogen have an influence on change of quantitative composition of phytoplankton community. Accordingly, the trophic state of Dniper downstream increases too.

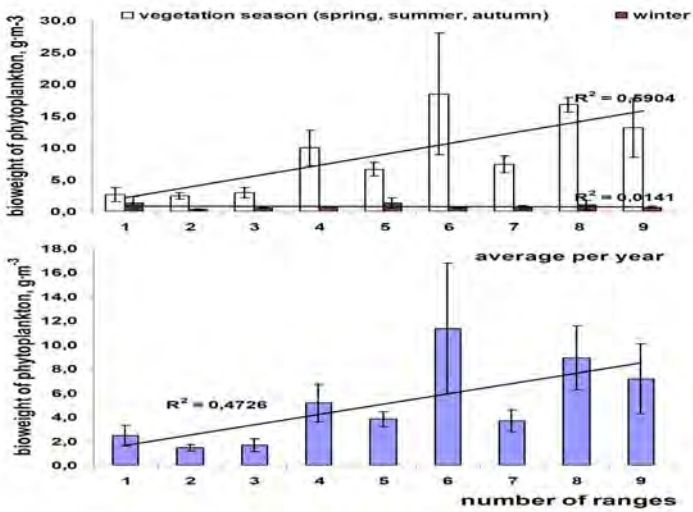

Figure 3. The biomass of phytoplankton in Dnieper river for 2001-2004 years.

Fish community.

Our researches have shown, that fish community of the investigated part of the Dnieper river consists of 30 species. The species belong to 9 families – *Cyprinidae, Ecosidae, Percidae, Gadidae, Siluridae, Cobitidae, Gobiidae, Cottidae, Gasterosteidae.* The most numerous family is *Cyprinidae* (20 species).

Fish species structure was not uniform along the length of the river in the territory of Belarus. Such species like *Abramis brama* L., *Esox lucius* L., *Rutilus rutilus* L., *Blicca bjoercna* L., *Perca fluviatilis* L. predominated in the fish community in the area of Orsha and Mogilev. Sufficiently great density of *Leuciscus leuciscus* L. was registered in the upper site of river near Orsh sity. Species *Rutilus rutilus* L., *Scardinius erythrophthalmus* L., *Perca fluviatilis* L., *Abramis ballerus* L., Abramis brama L., *Blicca bjoercna* L., *Tinca tinca* L., *Rhodeus sericeus amarus* Bloch, *Esox lucius* L., *Leuciscus idus* L. constituted the basis of fish community in the lower site of river in the area of Rechitsa sity. (tabl. 1).

Table 1. Species structure and quantity of caught fish (ind.) in Dnieper river, 2002-2003 гг.

№	Species	Orsha area		Mogilev	Rechitsa area			Total
		Number of ranges						
		1	2	5	6	7	9	
1	2	3	4	5	6	7	8	
1	*Abramis brama* L.	1	41	143	221	8	34	448
2	*Leuciscus idus* L.	-	2	1	24	11	2	40
3	*Leuciscus cephalus* L.	8	2	-	-	-	-	10
4	*Vimba vimba* L.	1	-	-	-	-	-	1
5	*Chondrostoma nasus* L.	-	-	-	2	-	-	2
6	*Tinca tinca* L.	-	1	-	1	-	11	13
7	*Carassius auratus gibelio* Bloch	-	-	10	202	-	-	212
8	*Cyprinus carpio* L.	-	-	-	7	-	-	7
9	*Rutilus rutilus* L.	8	24	66	462	19	708	1287
10	*Scardinius erythrophthalmus* L.	-	-	10	4	2	65	81
11	*Leuciscus leuciscus* L.	3	-	4	6	-	-	13
12	*Alburnoides bipunctatus* Bloch	8	-	4	-	-	-	12
13	*Abramis sapa* L.	-	-	1	4	-	1	6
14	*Blicca bjoercna* L.	-	10	6	167	-	27	210
15	*bramis ballerus* L.	-	-	2	6	-	26	34
16	*Alburnus alburnus* L.	-	-	28	2	-	8	38
17	*Gobio gobio* L.	-	2	-	-	-	-	2
18	*Rhodeus sericeus amarus* Bloch	2	17	2	11	-	32	64
19	*Esox lucius* L.	1	6	3	41	3	19	73
20	*Nemachilus barbatus* L.	-	1	-	1	-	-	2
21	*Cobitis taenia* L.	1	1	-	2	-	16	20
22	*Misgurnus fossilis* L.	-	-	-	2	-	-	2
23	*Lota lota* L.	-	-	-	5	-	1	6
24	*Gasterosteus aculeatus* L.	1	3	1	1	-	-	6
25	*Lucioperca lucioperca* L.	-	-	-	14	-	-	14
26	*Perca fluviatilis* L.	1	17	4	43	3	19	87
27	*Gymnocephalus cernua* L.	-	-	10	14	-	3	27
28	*Gymnocephalus baloni (Holuik et Hensel*	-	-	-	-	-	1	1
29	*Gymnocephalus acerina* Guild.	-	-	-	1	-	-	1
30	*Neogobius fluviatilis* Pall.	1	8	-	6	-	-	15
	Total: ind. species	36 12	135 14	295 16	1249 25	4 6	9 7	2734 30

The total quantity of fish increased downstream (Fig. 4, A) with the increasing of trophic state of river (increasing of concentration of nitrogen and biomass of phytoplankton). At the same time the average individual weight of fish decreased downstream from 100 g in the area of Orsha to 37 g in the area of Rechitsa (Fig. 4, B). The decrease of average individual weight is connected to anthropogenic pollution in almost all biological communities, including fish community in Dnieper.

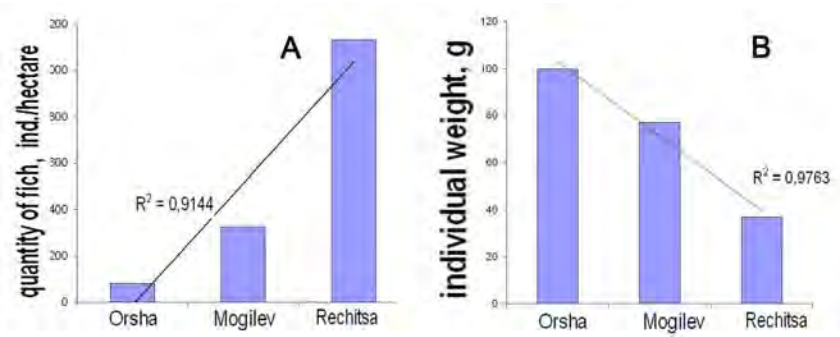

Figure 4. The quantity (A) and average individual weight (B) of fish in Dnieper river, 2002-2003 years.

These data show that the quantity of valuable food for fish decrease with the increase of organic pollution. The species with lesser individual weight replace them in community.

CONCLUSIONS

The lotic ecosystem is a very dynamic biological system, and the forming of certain of community composition is under the influence of many factors. Carried out research on the transboundary Dnieper river have shown, that the tendency of change of mineral nitrogen and phosphorus concentration in the Dnieper river was different. The phosphorus concentration average per year was relatively constant. The mineral nitrogen concentration is the most significant factor of accumulation of man-made pollution downstream of investigated part of the great Dnieper river. The similarity of tendencies studied indicates that gradual accumulation of nitrogen downstream has an influence on change on quantitative composition of phytoplankton community. The trophic status of Dniper downstream increases too. The pattern of structure changes of initial links of ecosystem reflects on following links including fish community. The quantity of valuable food fish decrease with the increase of organic pollution. The species with lesser individual weight replace their place in community.

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