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THE ROLE OF SUPPLEMENTARY FEEDING IN FOOD COMPETITION BETWEEN COMMON CARP (*CYPRINUS CARPIO*) AND PERCH (*PERCA FLUVIATILIS*) IN A POND CULTURE

UTJECAJ DODATNOG HRANJENJA PRI ZAJEDNIČKOM UZGOJU ŠARANA (*CYPRINUS CARPIO*) I GRGEČA (*PERCA FLUVIATILIS*) U RIBNJAČKIM UVJETIMA

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SUMMARY

Food composition, selectivity and competition between carp (Cyprinus carpio) and perch (Perca fluviatilis) were studied under conditions of pond farming technology with the application of wheat as a supplementary feed. Carp preferred feed wheat, which composed 52.7-65.7% of food ingested. Positive selectivity was proved for copepods and chironomid larvae, whilst avoidance appeared for bioseston, rotifers, Bosmina longirostris, Daphnia galeata and many benthic invertebrates except above mentioned chironomids (Helobdella stagnalis, Hydracarina, Caenis robusta, Mystacides and Ceratopogonidae). Perch showed predatory (cannibalistic) feeding pattern with 83.9-2.6% of small fish in the food bulk. Perch did not consume the smallest food particles like bioseston and rotifers. Negative selectivity was also proved for copepods and small benthic animals like water mites and larvae of Caenis robusta, Mystacides, Chironomidae and Ceratopogonidae. On the other hand, bigger invertebrates (Asellus and larvae of Ephemera vulgata and Sialis lutaria) were positively selected although they were quite rare in macrozoobenthos assemblage. Carp and perch shared 1.9% food items (Mystacides, Chironomidae and Ceratopogonidae), which means that the level of food competition between them was very low.

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INTRODUCTION

The European perch (Perca fluviatilis) is a prospective fish species for pond fish culture under conditions of the temperate climate. This fish is in great demand for sport fishing and consumption purposes. Its importance in pond fish production, particularly in Czech highland farming enterprises is of increasing tendency at present, however little is known about its nutritive requirements and food composition in pond polycultures with common carp (Cyprinus carpio) and other commercial pond fish species. Many studies were devoted to perch food pattern in various natural waterbodies, like lakes, reservoirs and rivers (e.g. Horoszewicz 1964, Prejs 1976, Popova, Sytina 1977, Losos et al. 1980, Adamek et al. 1987, Koli et al. 1988) but no available study deals with perch food composition in a fishpond ecosystem. Similarly, the food composition of three-year-old and older common carp in a pond polyculture does not belong among the topics of any particularly frequent occurrence. Many studies deal with food composition of carp fry and fingerlings (e.g. Matlak, Matlak 1976, Sukop et al. 1989, Debeljak et al. 1993) and two-year-old fish (e.g. Haritonova, Abu-El Vafa 1977a,b). The role of supplementary feeds in the nutrition of pond farmed carp was mentioned by Janeček et al. 1984, Spataru et al. 1980 and Sukop et al. 1991.

Thus the aim of the study was to evaluate the level of food competition between common carp as the most important Czech pond fish species and perch which is of raising importance for its high commercial value. Since supplementary feeding is an important measure of the enhancement of fishpond production, a particular attention was paid to the role of feed supplied to carp in its feeding habits.

MATERIAL AND METHODS

Fish samples were taken during summer 1999 (15 June, 30 July, 31 Aug) from the pond Velké Dářko (206.33 ha, Kinsky's Fisheries Ltd., Žd'ár nad Sázavou, Czech Republic). The pond was stocked in spring 1998 with peled whitefish (Coregonus peled), pike (Esox Lucius), zander (Stizostedion lucioperca), carp and perch. Besides them, also roach (Rutilus rutilus) and ruffe (Gymnocephalus cernua) were registered in fish samples. In autumn 1999, marketable fish were harvested in amounts as follows: 49.1 t carp, 3.1 t pike, 1.5 t perch, 0.7 t peled whitefish and 0.3 t zander. Altogether 135 t feed cereals (wheat) were supplied to fish. The average yearly production amounts to 108 kg per ha.

The Velke Darko pond is an important site for recreation and water sports with camping, swimming and sailing activities during the summer holiday period. The bottom is sandy with gravel and organic particles of plant origin (debris) near the liedge. The pond is considered as strongly oligotrophic (Heteša et al. 1999).

On the days of fish sampling, basic determinants of water environment were monitored as well (Table 1) using DO meter Horiba OM14 and pH meter HI1295. Bioseston (phytoplankton - Table 5) was assessed quantitatively from 50 ml sample taken from pooled 10 1 pond water. The mean number of sestonic organisms was 10,649 ± 3,204 cells per ml. Microplanktonic community was composed of 66 taxa with the dominance of Chrysophyceae and Bacillariophyceae (28.2 and 20.6%, respectively, on average).

Table 1. The range of environmental determinants on sampling days
Tablica 1. Vanjski čimbenici tijekom istraživanja

Parameter - Pokazatelj	Unit - Jedinica	Mean± SD - Prosjek±SD	Range - Granica
Water temperature - Temp. vode	°C	18.2 ± 1.9	16.3 -20.1
DO - Otopljeni kisik	$mg.l^{-1}$	8.56 ± 1.58	6.95-10.11
O_2 saturation - Saturacija O_2	%	93.4 ± 13.7	79.1-106.4
pH		6.96 ± 0.23	6.70-7.08
Transparency - Prozirnost	cm	36 ± 6	31 - 43
Colour - Boja		brown - smeđa	Brownish-yellow-brown - Smeđe-žuto-smeđa

Table 2. Feed composition (F in %) and frequency of occurrence (O in %) in common carp (*Cyprinus carpio*)
Tablica 2. Sastav hrane (F u %) i učestalost ponavljanja (O u %) u šarana (*Cyprinus carpio*)

Feed item/Date - Hrana/dan	15 June - Lipanj 1999		30 July - Srpanj 1999		31 August - Kolovoz 1999	
	F	O	F	O	F	O
Bacillariophyceae g.sp.div.			+	30	+	20
Chlorophyceae g.sp.div.			+	10	+	10
Pisidium sp.			0.5	10		
Daphnia galeata	+	10	+	40	+	10
Moina sp.			+	20		
Copepoda g.sp.div	+	10	1.7	40	+	10
Ostracoda g.sp.div.	+	10	+	30		
Corixa affinis	+	10				
Naucoris cimicoides	+	10				
Mystacides sp.	0.2	20	+	10		
Sialis lutaria	+	10				
Chironomidae g.sp.div.	6.4	90	6.0	100	2.0	100
Ceratopogonidae g.sp.div.	0.9	30				
Terrestrial insects	0.7	10				
Fontinalis antipyretica	+	10				
Plant debris	13.6	100	12.9	100	6.6	86
Detritus	20.1	100	26.2	100	25.7	100
Feed wheat	58.1	90	52.7	100	65.7	100
n fish	10		10		7	
n empty guts	0		0		0	
Index of fullness ($^0/_{000}$)	342 ± 109		212 ±133		336 + 85	
TL (mm)	399 ± 39		411 ± 21		427 + 34	
SL (mm)	329 + 36		340+18		353 ± 29	
W(g)	1345 ± 424		1384 ± 293		1410 ± 307	

For Zooplankton sampling, the total volume of 10 l pond water was taken by 2 l Patalas sampler and filtered by 53 μ. net. The abundance of planktonic animals amounted to 807±352 ind.l^{-1}. Among 1l taxa of Zooplankton, rotifers, Bosmina and copepods were most numerous (Table 5). Macrozoobenthos samples were taken by Ekman's grab (20 x 20 cm) from littoral soft substrate. Five sub-samples were pooled from each sampling date. The density and biomass of benthic animals were 181±134 ind.m^{-2} and 0.1937±0.087 g.m^{-2} respectively. Macrozoobenthos consisted of 6 taxa only (Table 5).

Seine netting (mesh size 40 mm) in the littoral was applied for fish sampling. Fish were measured and weighed to nearest mm and g respectively. In carp, fresh gut contents were preserved in 4% formaldehyde, whilst the whole stomach and gut were removed and preserved in case of perch. Stomach and gut contents were processed in the laboratory after 4 months. The proportion of separable food items was assessed by indirect volumetric estimation (Hyslop 1980). Food weight was assessed to nearest 0.1 g and 1 mg in carp and perch respectively. The index of stomach fullness was assessed as a proportion of food weight on fish total weight. The index of food similarity according to Shorygin (1952) was used to evaluate the level of food competition between carp and perch. This index represents the sum of percentages of shared food items consumed by both species evaluated. Food selectivity was assessed according to Ivlev's electivity index E (Jacobs 1974)

$$E = (r-p)/(r + p),$$

where r = fraction of certain food item taken by fish and p = fraction of that food item present in the environment.

Index of fullness (IF) was calculated as a ratio between food (w) and fish (W) weight:

$$IF(\text{in } {}^{0}/_{000}) = 10^{4} x (w/W)$$

Altogether 27 carp (22 scaly and 5 mirror carp) and 26 perch were examined for food composition. Only fish with food in their alimentary canals were included among those evaluated. The infestation by gut parasites was noticed in 6 carp (Khawia sinensis in the intensity 1-3 individuals, and small unidentifiable nematods in higher numbers) and 10 perch - Acanthocephalus anguillae in the intensity 1-5 individuals.

Table 3. Feed composition (F in %) and frequency of occurrence (O in %) in perch (*Perca fluviatilis*)
Tablica 3. Sastav hrane (F u %) i učestalost ponavljanja (O u %) u grgeča (*Perca fluviatilis*)

Feed item/Date - hrana/dan	15 June - Lipanj 1999		30 July - Srpanj 1999		31 August - Kolovoz 1999	
	F	O	F	O	F	O
Leptodora kindtii	+	13				
Copepodag.sp.div			+	29		
Asellus aqauticus					0.3	20
Ephemera vulgata					0.3	20
Mystacides sp.	1.8	25				
Sialis lutaria					0.7	20
Chironomidae g.sp.div.	0.3	25	0.7	29	2.1	80
Ceratopogonidae g.sp.div.	0.2	13				
Perca fluviatilis	57.5	25	61.4	57	90.7	20
Cyprinidae g.sp.div.	+	13				
Fish unidentifiable	35.1	50	22.5	29		
Plant debris					0.4	20
Detritus	2.8	38	15.4	86	5.1	60
Sandy particles	2.3	13			0.4	20
n fish	11		7		5	
n empty guts	3		0		0	
Index of fullness ($^{0}/_{000}$)	219 ± 304		147 ± 115		126 ± 206	
TL (mm)	182 ± 40		178 ± 22		121 ± 47	
SL (mm)	152 ± 38		148 ± 19		101 ± 39	
W(g)	86 ± 79		67 ± 29		24 ± 22	

RESULTS

Carp food consisted of 18 separable food items, which were consumed with the effort corresponding to index of fullness from 212 to 342 ‰ on average (Table 2). The biggest proportion of the food bulk was represented by the items collected from the bottom. Feed wheat supplied to fish was composed of more than one half (52.7 - 65.7%) of food ingested and was found in 96% of carp examined. The percentages of detritus and plant debris (fragments and seeds of terrestrial macrophytes) were 20.1-26.2 and 6.6-13.6 respectively. Among native food components, midge fly larvae (Chironomidae) were regularly registered with the proportion corresponding to 2.0-6.4%. Carp consumed copepods during the whole season but rather occasionally because their share amounted to maximum 1.7% only in the July sample. Remaining food items, like molluscs (Pisidium), cladocerans (Daphnia and Moina), Ostracoda, water bugs (Corixa and Naucoris), insect water larvae (Mystacides, Sialis and Ceratopogonidae) and terrestrial adults and water plants did never exceed the level of 1%. In several fish, also phytoplanktonic microorganisms (Chlorophyceae and Bacillariophyceae) were recognised under higher magnification.

Positive values of food selectivity index in carp were registered for copepods (+0.073) and chironomids (+0.387) and negative selectivity was proved for phytoplankton (-0.998), daphnia (-0.714), Mystacides sp. (-0.879) and Ceratopogonidae (-0.208). Rotifers, cladoceran Chydorus, leeches (Helobdella), water mites (Hydracarina) and mayfly larvae Caenis were not consumed by carp (E = -1.000). On the other hand, several food items, which were not registered in the environment, appeared in carp guts - cladocerans Moina, water bugs Corixa and Nancoris, bivalve molluscs Pisidium, crustaceans Ostracoda and Sialis larvae (E = +1.000).

Among 26 perch examined, food did not, appear in 3 of them. The indices of gut fullness decreased from 219 ± 304 ‰ in June to 126 ± 206 ‰ in August but their values fluctuated very considerably. Altogether 14 food items were recognised in perch diet. Fish appeared to be the dominant food item with 83.8 - 92.6% contribution to the bulk. 0+ perch were the most important among them - despite their low frequency of occurrence (20-57%) they amounted to 57.5-90.7%. Many fish were found at various level of destruction by digestive processes in perch stomach and could not be identified (up to 35.1% of the bulk). Various organic and inorganic components (detritus, plant debris and sandy particles) were found in 51-100% fish examined. The food items of benthic origin consisted of 6 taxa with generally low proportion on the bulk ingested (0.7-3.4%) but quite high frequency of occurrence (29-100%). This group of food organisms consisted of crustaceans (Asellus) and water larvae of terrestrial insects (Ephemera, Mystacides, Sialis, Chironomidae and Ceratopogonidae). Zooplankton (Leptodora and copepods) was registered only sporadically in the food of perch.

The competition for food between carp and perch was proved only for caddisfly larvae Mystacides sp. (1.1%) and larvae of Chironomidae and Ceratopogonidae (0.7 and 0.1% respectively). Some signs of food similarity occurred also in case of copepods and Sialis larvae but their level was very low. Summary value of food similarity, which represents the competition between these two fish species was 1.9%.

DISCUSSION

The parameters of water environment during the period of sampling fluctuated within the range, which is considered as normal under fishpond conditions. Only temperature and pH values were lower in comparison with usual level of these determinants as measured in carp ponds. This was due to the low trophic level, near peat-bogs and high altitude (617 m) of the Velke Darko pond. Their impact consists also in low transparency and unfavourable brown colour of pond water (Heteša et al. 1999).

Table 4. **Summary food composition in common carp (*Cyprinus carpio*) and perch (*Perca fluviatilis*) and competition between them as expressed in food similarity (FS). Mean values of food composition calculated from pooled samples only for native items excluding feed wheat, detritus, plant debris and sand as items of no consequence for food competition**

Tablica 4. **Analiza sastava hrane u šarana i grgeča i međusobna usporedba kao pokazatelj sličnosti hranidbe (FS). Srednje vrijednosti sastava hrane dobivene iz uzoraka sredine uključujući pšenicu, detritus, biljne tvari i pjesak kao elemente koji nemaju utjecaj na analizu prirasta**

Feed item/Fish species Vrsta ribe	Carp Šaran	Perch Grgeč	FS
Bacillariophyceae g.sp.div.	+		
Chlorophyceae g.sp.div.	+		
Pisidium sp.	2.3		
Daphnia galeata	+		
Moina sp.	+		
Leptodora kindtii		+	
Copepoda g.sp.div	7.4	+	
Ostracoda g.sp.div.	+		
Asellus aquaticus		+	
Corixa affinis	+		
Naucoris cimicoides	+		
Ephemera vulgata		+	
Mystacides sp.	1.4	1.1	1.1
Sialis lutaria	+	0.1	
Chironomidae g.sp.div.	78.7	0.7	0.7
Ceratopogonidae g.sp.div.	5.7	0.1	0.1
Terrestrial insects	4.5		
Fontinalis antipyretica	+		
Perca fluviatilis		68.0	
Cyprinidae g.sp.		+	
Fish unidentifiable		30.0	
Total feed similarity			1.9

When examining gut content of carp under higher magnification (250 - 500 times), also phytoplanktonic organisms - like Pediastrum, Coelastrum and Scenedesmus (Chlorophyceae) and Melosira, Nitzschia, Eunotia and Navicula (Bacillariophyceae) were recognisable. These organisms probably originated from guts of ingested planktonic animals and were liberated during digestive processes. Some of them might also have been ingested from the bottom as sedimented particles in detritus.

Carp consumed intensively supplied feed wheat, which composed approximately two thirds of food ingested and was found in almost all fish (96%) examined. A considerable portion of food bulk consisted of bottom items of low nutritive value like detritus and fragments of terrestrial macrophytes. Only single 140 mm long Fontinalis thallus appeared as a representative of water plants in the gut of one fish. With regard to bottom feeding behaviour of common carp, the above mentioned food items might have been ingested together with supplied wheat or collected when feeding benthic animals. These were represented mainly by larvae of dipterans - Chironomidae and Ceratopogonidae with 96 and 11% frequency of occurrence respectively. Some fish consumed chironomids quite intensively - the maximum found in the gut of a single fish (1,256 g) was 3,380 larvae. The role of chironomids in carp nutrition was also documented by Guziur and Wielgosz (1975) who noticed their considerable decrease after the introduction of two-year-old carp into the Lake Klawoj (Poland).

Copepods appeared in bigger amounts in several fish - the maximum ingested by a single fish was 4.35 g (approx.10%) in 1645 g carp, which means that even this size carp were capable to filter small copepods. Carp were also very probably able to find out sites of their higher concentration because the abundance of copepods in zooplankton samples did not exceed 37 nauplii and copepodits per litre (no adults were registered). Representatives of Daphnia in carp food occurred mostly as ephipia, which were consumed with wheat, detritus or plant debris from the bottom.

A considerable portion of copepods (5.8% of animal food ingested) in the diet of carp from the Lake Mutek (Poland) is also reported by Martyniak (1990).

Table 5. Percentage composition of food items in the environment and food selectivity (E) of common carp (*Cyprinus carpio*) and perch (*Perca fluviatilis*) as expressed for particular native food items

Tablica 5. Sastav hrane (u %) u proizvodnoj sredini i izbor hrane (E) za šarana (*Cyprinus carpio*) i grgeča (*Perca Fluviatilis*) kao pokazatelji stanja prirodne hrane

Food item/Fish species Hrana/vrsta ribe	Environment Sredina-okoliš	Carp (E) Šaran	Perch (E) Grgeč
Bioseston			
Reducers	19.6	-1.000	-1.000
Producers	80.2	-0.998	-1.000
(Bacillariophyceae)	(20.6)	-0.995	
(Chlorophyceae)	(17.2)	-0.994	
Consumers	0.2	-1.000	-1.000
Zooplankton			
Polyarthra sp.	48.8	-1.000	-1.000
Keratella cochlearis	18.4	-1.000	-1.000
Keratella quadrata	0.6	-1.000	-1.000
Asplanchna sp.	6.0	-1.000	-1.000
Lecane sp.	0.3	-1.000	-1.000
Filinia sp.	1.4	-1.000	-1.000
Kellicottia longispina	0.6	-1.000	-1.000
Bosmina longirostris	17.3	-1.000	-1.000
Daphnia galeata	0.3	-0.714	-1.000
Moina sp.		+1.000	
Leptodora kindtii			+1.000
Chydorus sphaericus	+	-1.000	-1.000
Copepoda g.sp.div	6.3	+0.073	-0.984
Corixa affinis		+1.000	
Macrozoobenthos			
Helobdella stagnalis	4.3	-1.000	-1.000
Pisidium sp		+1.000	
Ostracoda g.sp.div.		+1.000	
Asellus aquaticus			+1.000
Hydracarina g.sp.div.	13.0	-1.000	-1.000
Naucoris cimicoides		+1.000	
Caenis robusta	17.4	-1.000	-1.000
Ephemera vulgata			+1.000
Mystacides sp.	21.7	-0.879	-0.906
Sialis lutaria		+1.000	+1.000
Chironomidae g.sp.div.	34.8	+0.387	-0.961
Ceratopogonidae g.sp.div.	8.7	-0.208	-0.977

The precise data on carp feeding patterns in ponds with supplementary feeding regime are quite rare in the fisheries literature. Sukop et al. (1989, 1990, 1991) confirmed that feeds (pellets) are the most important food item of carp even in eutrophic ponds with rich natural food resources. Carp utilised various food items (max. 17) but supplied feed prevailed in the food bulk with 108-579 $^{0}/_{000}$ index of filling.

The proportion of individual food items on the total volume of native food consumed by carp corresponds to their frequency of occurrence and electivity indices (Table 5). Phytoplankton and small zooplankton (rotifers, Bosmina, Chydorus) were almost completely avoided. Daphnia galeata also belonged among avoided organisms (E = -0.714). Copepods were consumed in the proportion corresponding to their density in the food supply (E = + 0.073). Among macrozoobenthos, chironomids were preferred by carp (E = +0.387) whilst two other important food items, Ceratopogonidae and Mystacides, were slightly avoided (E = -0.208 and -0.879 respectively). Remaining taxa found in zoobenthos samples, i.e. Helobdella, Hydracarina and Caenis were not consumed at all.

Carp from pond-type Mušov reservoir (Adamek, Jirasek 1986) also consumed big amounts of low-value material like detritus and plant debris (50 - 67%), zooplankton (15 -23%) and macrozoobenthos (19-33%). Contrary to the data from the Velke Darko pond, carp from the Mušov reservoir preferred Daphnia (E = +0.82 to +0.84) but avoided copepods (E = -0.75 to -1.00) and chironomids (E = -0.23 to -0.25). Prejs (1973) concluded that carp food in the pond type Lake Warniak (Poland) consisted of 84% animal origin and 16% plant origin.

Small fish (0+ perch in particular) dominated in the food bulk ingested by perch (Table 3). The smallest perch cannibal was 144 mm TL.. A considerable part of fish, which were unidentifiable in the stomach of perch, belonged very probably to their recruitment because only one single item (scale) was found to belong to any other family (Cyprinidae). In a good agreement with our observations, other authors (e.g. Dubois et al. 1993, Persson and Ekloev 1995) also consider adult perch as a piscivorous predator with particular impact, among others, upon its own recruitment. Piscivory and cannibalism are a typical food pattern in perch not only under conditions of low trophy waterbodies. In the meso-eutrophic waterbodies in the same region as the Velke Darko pond, adult perch above 200 mm TL fed also predominantly on their own recruitment and small cyprinids (75.2% on the Dalešice reservoir - Adamek et al. 1987 and 98.8% on the Jihlava river - Losos et al. 1980). Besides predatory nutrition, perch fed benthic (Chironomidae, Mystacides, Sialis, Asellus, Ephemera and Ceratopogonidae) invertebrates and very sporadically also zooplankton (Copepoda and Leptodora). Bregazzi and Kennedy (1982) think that perch below 90-100 mm TL feed mostly on zooplankton and chironomid larvae whilst those above 150 mm become piscivorous. Similar results also present Koli et al. (1988) who conclud that perch predatory behaviour is more pronounced in autumn and winter in comparison to spring and summer periods.

Detritus, sand and plant debris were quite frequent but unimportant items occurring in perch alimentary tract. Organic particles were probably consumed passively with benthic animals, and sandy particles usually originated from shells of midge fly larvae Mystacides sp. These items may also liberate through digestion from the stomachs and guts of small fish consumed by perch. The actual liberation of ingested chironomids and copepods from prey fish was observed in several samples. The biggest sandy particle found in the stomach of perch (230 mm TL) was 11x 7 mm and this size sandy grain was unable to pass through the gut. Not one corn of wheat supplied to carp was found in the content of perch alimentary tract.

Considerable positive selectivity was found for bigger benthic animals like Asellus, Ephemera and Sialis, which were found in several cases in the gut of examined perch but did not appear in macrozoobenthos samples. This confirms perch preference for bigger food items. The selectivity for Mystacides, Chironomidae and Ceratopogonidae was considerably reduced by high proportion of fish food in perch nutrition and indicated even strong avoidance (E = -0.906, -0.961 and -0.977 respectively) although it is known from other studies that particularly chironomids are among preferred food items in perch (Giles et al. 1995). In plankton, the total avoidance was found for bioseston and zooplankton other than copepods. Perch also completely avoided the ingestion of the same benthic animals like carp did - i.e. leeches Helobdella, water mites Hydracarina and mayfly larvae Caenis robusta.

Perch (184 mm TL on average) examined in the Mušov pond-type reservoir showed similar feeding habits (Adamek, Jirasek 1986). The food bulk consisted mainly of small fish including young perch (43-58%) and detritus and biofilm (4-49%). Electivity indices proved that perch at this size utilised less zooplankton than available in food resources whilst macrozoobenthos was consumed more intensively.

The level of food competition between carp and perch as expressed in the index of food similarity was very low in conditions of pond farming with supplementary feeding. Even when omiting, feed, detritus, plant debris and sand from the evaluation of food composition, these two fish species share the same food components in only 1.9%. This means that there is no serious competition between them, which might affect their growth and production performance.

The indices of fullness were higher in carp in comparison with perch. This was due to the intensive ingestion of feed wheat by carp because it consists of about two thirds of the total food bulk. Among perch, several fish (14%) were found without any food in their alimentary tracts. In fish infested with Khawia sinensis (carp) and Acanthocephalus anguillae (perch), the intensity of food consumption was not influenced by the presence of parasites. The infestation did not affect the intensity of food consumption, which was significantly higher in perch infested in comparison with parasite-free fish (254±275 vs. 67±10 $^{0}/_{000}$, $P<0.05$). In carp, the indices of gut fullness did not differ in Khawia-infested and parasite-free fish (316±104 vs. 245±158 $^{0}/_{000}$, $P>0.05$).

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SAŽETAK

Sastav hrane, selektivnost i takmičenje između šarana (Cyprinus carpio) i grgeča (Perca fluviatilis) proučavani su u tehnologiji ribnjačkih uvjeta primjenom pšenice kao dodatnog krmiva. Šaran je preferirao pšeničnu hranu što je iznosila 52.7 do 65.7% konzumirane hrane. Pozitivna selektivnost dokazana je za dopepode i larve chironomida, dok se neselektivnost pojavila kod biosestona, rotifera, Bosmina longirostris, Daphnia galeata i mnogih bentičkih beskralježnjaka osim gore spomenutih kironomida (Hellobdela stagnalis, Hydracarina, Caenis robusta, Mystacides i Ceratopogonidae). Grgeč je pokazao grabežljivi (kanibalistički) model hranjenja s 83.9-92.6% udjela sitne ribe u ukupnoj hrani. Grgeč nije konzumirao vrlo sitne čestice hrane kao biosestone i rotifere. Negativna je selektivnost također dokazana kod copepoda i sitnih morskih životinja poput vodenih grinja i larva Gaenis robusta, Mystacides, Ghironomidae i Geratopogonidae. S druge strane, veći beskralježnjaci (Asellus i larve Ephemera vulgata i Sialis lutaria) bili su pozitivno selektirani iako prilično rijetki u makrozoobentničnoj skupini. Šaran i grgeč dijelili su 1.9% hrane (Mystacides, Chironomidae i Ceratopogonidae), što znači da je razina takmičenja za hranu bila vrlo niska.

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