The Natural Diet of Five Cyprinid Fish Species

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SUMMARY

The investigation of the ichthyofauna in the upper part of the Croatian section of the Sava river, the so called barbel zone, showed that very frequent and quite numerous fish species were chub (*Leuciscus cephalus* (L., 1758)), bleak (*Alburnus alburnus* (L., 1758)), spirlin (*Alburnoides bipunctatus* (Bloch, 1782)), barbel (*Barbus barbus* (L., 1758)) and stream barbel (*Barbus meridionalis petenyi* Heckel, 1847).

There are very few published papers on the biology of these fish species, and even less on their natural feeding in the open waters. Although these fish species economically less important, is play an important role in the open waters ecological niche.

One of the most important factors for the ecological niche is food web. Therefore, the purpose of this paper was to revise the research and written documentation collected on the feeding of chub, bleak, spirlin, barbel and stream barbel in Croatia and in Europe. More important results on recent research done for each fish species in various waters in Europe are also presented in this paper.

KEY WORDS

Leuciscus, Alburnus, Alburnoides, Barbus, natural diet

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Received: July 5, 2004

INTRODUCTION

The upper flow of the Croatian section of the Sava river belongs to the barbel zone. The investigation of the ichthyofauna in the upper part of the Sava river, showed that very frequent and quite numerous fish species were chub (*Leuciscus cephalus* (L., 1758)), bleak (*Alburnus alburnus* (L., 1758)), spirlin (*Alburnoides bipunctatus* (Bloch, 1782)), barbel (*Barbus barbus* (L., 1758)) and stream barbel (*Barbus meridionalis petenyi* (Heckel, 1847)) (Habeković *et al*., 1990; Habeković and Popović, 1991; Habeković *et al*., 1997; Piria, 2003; Treer *et al*., 2003).

There are three subspecies of chub in Croatia. One of them inhabits the Danube catchment area *L. cephalus cephalus* (L. 1758), while the other two inhabit the Adriatic region *L. cephalus albus* (Bonaparte, 1838) and *L. cephalus cebeda* (Risso, 1820) (Vuković and Ivanović, 1971; Vuković, 1982; Habeković *et al*., 1993).

Chub (*L. cephalus cephalus* L. 1758) can grow up to 80 cm in length and weigh up to 4 kg. It matures when 4 – 5 years old and 20 cm long. It has multiple spawning as soon as the temperature reaches 13°C. It deposits its eggs on water plants or stones. Chub inhabits all types of water, but more often prefers rivers to the lakes. Cub's abundance depends on the type of the bottom and configuration of the shore where there are natural hiding places like coastline made of stone with sporadic water plants or shores with the interwoven roots of macrophytes (Vuković and Ivanović, 1971; Baruš et al. 1995).

There are two subspecies of bleak (*A. alburnus* L., 1758) in Croatia. One of them *A. alburnus alburnus* (Linnaeus, 1758) can be found throughout Europe, while the other one *A. alburnus alborella* (de Filippi, 1844) is restricted to the Adriatic catchment area. Bleak inhabits upper parts of still waters, but the rivers, too. It can grow 15 to 20 cm long, seldom more than that. It matures when 3 year-old and 7 – 8 cm long. Spawns from April to June in shallow waters along the shore and it deposits its eggs on water plants or stony water beds (Vuković and Ivanović, 1971; Baruš et al. 1995).

There is only one subspecies of spirlin in Croatia *A. bipunctatus bipunctatus* (Bloch, 1782), which can also be found in the Western Europe. Spirlin's body length almost never exceeds 15 cm. It lives in still and running waters and stays near water level. It spawns from May to June at the temperature of 13.5°C – 15.5°C and it deposits its eggs on gravel or stony water beds (Vuković and Ivanović, 1971; Baruš et al. 1995).

Barbel is also represented by one subspecies *B. barbus barbus* (Linnaeus, 1758). It inhabits rivers with strong watercourse and stony or gravel water bed. Barbel enters water beds into surrounding lakes. It spawns during May and first half of June at the temperature of 15°C – 18°C. It spawns on the stony water beds. Males rarely mature before the end of the second year, more often when 3+.Females mature 2 or 3 years later than the males (Vuković and Ivanović, 1971; Baruš et al. 1995).

Stream barbel (*B. meridionalis* Risso, 1826) has two subspecies in Croatia. One *B. meridionalis caninus* (Valenciennes, 1842) inhabits only northern parts of the Adriatic region, while stream barbel *B. meridionalis petenyi* (Heckel, 1847) is widespread in the Sava and Danube rivers of Croatia, as well as in other parts of Europe (catchments of the rivers Dnepr, Vistula, Pasargua, Oder, then in Skadar and Ohrid lakes and Albanian waters of the Adriatic cathchment, as well as in the catchments of the Aegean sea).

Stream barbel can grow up to 30 cm. Grown specimens appear in shallow stony water beds. It shares with barbel the same type of habitat for spawning. (Vuković and Ivanović, 1971; Baruš et al. 1995).

There are very few published papers on the biology of these fish species, and even less on their natural feeding in the open waters. Despite being less important economically, these fish species play an important role in the ecological niches of open waters.

One of the most important factors for the ecological niche is food web. Therefore, the purpose of this paper was to revise the research and written documentation collected on the feeding of chub, bleak, spirlin, barbel and stream barbel in Croatia and in Europe. More important results on recent research done for each fish species in various waters in Europe are also presented in this paper.

DIET OF CHUB

The food of chub depends on the habitat. Thus, the chub from the upstream tide of the river Bosna belongs to zoophytophagous type with small portion of plant material (Vuković, 1968). Mihailova (1964) stated that the main food of the chubs from the

Table 1. Diet composition of chub from the Vrbanja river (Šenk and Aganović, 1968)

Food item	Number (%)
Hirudinea	6.72
Plecoptera	38.81
Ephemeroptera	14.93
Odonata	1.49
Trichoptera	25.37
Coleoptera	2.98
Diptera N. Det.	1.49
Insects Terrestrial	3.73
Crustacea	0.75
Pisces	3.73

Table 2. Diet composition of chub from the Oslava river (Adámek and Obrdlík, 1977)

Food item	Location 1		Location 2		Location 3	
	Weight (%)	Frequency of occurrence (%)	Weight (%)	Frequency of occurrence (%)	Weight (%)	Frequency of occurrence (%)
Detritus	36	33	40	63	35	90
Bacillariophyceae	15	13	14	23	19	40
Filamentous Algae	14	25	12	12	24	35
Macrophytes Terrestrial	25	25	19	33	5	25
Water Macrophytes	+	2	+	3	-	-
Nectobenthos	10	8	-	-	+	20
Pisces	+	3	-	-	13	15
Mammalia	+	2	-	-	-	-
Macrozoobenthos	+	32	11	26	4	25

Table 3. Diet composition of chub from the Jihlava river (Losos et al., 1980)

Food item	Weight (%)
Periphyton	16.2
Detritus	+
Macrophytes	10.1
Fish Seed	+
Animal Food	73.7

Table 4. Composition of animal food items in stomach content of chub from the Jihlava river (Losos et al., 1980)

Food item	Frequency of occurrence (%)	Weight (%)	Number (%)
Bryozoa	+	+	+
Ephemeroptera	30.0	0.7	2.2
Trichoptera	63.9	3.3	5.2
Chironomidae	46.8	0.3	25.1
Simulidae	54.6	0.6	65.7
Nectobenthos	18.9	0.1	0.7
Pisces	4.5	95.0	0.2

Table 5. Diet composition of chub from the tributary streams of the lake Balaton (Frankiewicz et al., 1991) (weight in percentage)

Food item	Location 1	Location 2
Lumbricidae	-	29.6
Copepoda	5.0	-
Heteroptera	33.3	-
Ephemeroptera	33.3	5.8
Culicidae	25.0	-
Chironomidae	3.3	0.7
Tipulidae	-	64.0

Struma river in Bulgaria was the plant component of the groups *Cyanobacteria* and *Conjuagatae* and that there were also insects of the groups *Diptera* and *Coleoptera*.

Šenk and Aganović (1968) investigated the fish feeding habits (chub included) in the Vrbanja river. The dominant food of chub was mainly *Plecoptera*, *Trichoptera* and *Ephemeroptera*. Remnants of terrestrial insects, crabs, fish and plant material were also present (Table 1).

The nutrition of the chub in the river and the accumulation of Turia was studied by Djinova (1976). She stated that the chubs from the river were fed by *Diptera* (*Chironomidae, Simullidae* and *Tipulidae*) while those from the accumulation fed on cladocerans. The dominant components in the nutrition of the chub from the Skadar Lake in the summer period were the *Trichoptera* and in the spring period they fed on plant material (Janković and Trifunac, 1978).

The effect of warm and nonwarm water upon the biomass of the Oslava river was studied by Adámek and Obrdlík (1977). They investigated relationship between the fish stomach content and available food at increased water temperature. Analyses were performed on 123 individual of chub. Allochthonous elements, organic and inorganic detritus, were the major part of chub's food which also included some virtually undistinguishable wastes frequently consumed by chubs with no nutritive value (e. g. pieces of rubber, cotton-wool, paper). Periphyton (both diatoms and filamentous algae) was relatively frequent component of the diet. Alimentary tracts of many individuals were filled with grass and soil vegetation and some individuals with aquatic plants. Surprising was very low proportion of zoobenthos which was consumed only sporadically by chubs (Table 2). The analyses showed the presence of *Trichoptera*, *Ephemeroptera*, *Plecoptera*, *Chironomidae*, *Simuliidae* and *Heteroptera*. Parasites, *Acantocephala* and *Nematoda* which were found in approximately 20 per cent of the fish investigated.

Losos et al. (1980) investigated food and growth of 16 fish species of the Jihlava river. Stomach content analyses were performed on 125 individual of chub. The food of chub varied: zoobenthos constituted the greatest part of the mass, fish was found in 5 specimens while vegetable components were less frequent (Table 3 and 4).

Table 6. Seasonal aspects of feeding chubs from the Babuna river (Nastova –Gjorgjioska et al., 1997)

Food item	Spring	Summer	Autumn	Winter
Plant food				
Chrysophyceae	1			
Chlorophyceae		1	1	
Bacillariophyceae	3	2		1
Macrophytes	3			
Animal Food				
Plecoptera	1	1		
Ephemeroptera	1	3	2	2
Chironomidae	2	1		1
Pisces			2	2

1 = preferent food, 2 = secondary food, 3 = food present in traces

Frankiewicz et al. (1991) investigated the food of fish from streams of the northern part of the catchment area of the Lake Balaton. They showed food consumption of chub at two locations. The main food present in alimentary tract was zoobenthos while there is no data on vegetable components (Table 5).

According to Nastova-Gjorgjioska et al., (1997) chub from the river Babuna is omnivorous although its diet is predominantly of the plant material. The dominant components in the nutrition of chub in the spring period were *Chrysophyceae*, *Ephemeroptera* and *Plecoptera*. Dominant role in the nutrition of the chub from the Babuna river in the summer period has the group *Chlorophyceae*. From the food of animal origin, the presence of the group *Plecoptera* and *Ephemeroptera* is important. In the autumn period the nutrition of the chub was identical with nutrition during the summer. In the winter period food of plant origin was represented by the group *Bacillariophyceae* and food of animal origin by the *Chironomidae* (Table 6).

The juvenile fish fed themselves with *Bacillariophyceae* and *Chlorophyceae* equally. The main component in the nutrition of the age classes 4+ and 5+ was of animal origin.

DIET OF BLEAK

Bleak fingerlings fed on zooplankton component while adults preferred larvae of *Chironomidae* and insects from the surface (Vuković and Ivanović, 1971). Bohl (1980, 1982) who studied the diet rhythms of young cyprinids (bleak included) in small Bavarian lakes, informed that cyprinids fed on insects and plant material. According to Losos et al. (1980) the bulk of bleak food was mainly zoobenthos and no vegetable component was found (Table 7).

Some general information is given by Vøllestad (1985) in a study of partitioning of roach (*Rutilus rutilus*) and the bleak of Norway. He observed that besides zooplankton, bleak consumed high quantities of surface insects and blue-green algae. Chappaz et al. (1987) reported high presence of algal debris in the guts of the bleak. Along with the results, information on diet rhythms, monthly qualitative and quantitative diet in northern Greece is given by Politou et al. (1993). The analyses of gut contents of bleak showed a high and constant consumption of zooplankton and low abundance of *Hydracarina* and insect nymphs (Table 8).

Table 7. Composition of animal food items in stomach content of bleak from the Jihlava river (Losos et al., 1980)

Food item	Frequency of occurrence (%)	Weight (%)	Number (%)
Ephemeroptera	33.3	2.3	0.3
Trichoptera	55.6	5.9	0.3
Chironomidae	88.9	4.7	5.6
Simulidae	44.4	56.5	49.2
Nectobenthos	94.4	30.6	44.6

Table 8. Diet composition of bleak from the Koronia lake (Politou et al., 1993)

Food item	Frequency of occurrence (%)	Number (%)
Copepoda	46.75	73.75
Copepoda	46.68	73.50
Nauplii	0.07	10.25
Cladocera	53.12	80.50
Bosmina longirostris	38.56	70.50
Diphanosoma sp.	11.78	38.00
Sida crystalina	0.01	0.50
Moina sp.	1.95	16.75
Daphnia sp.	0.72	17.00
Ceriodaphnia pulchella	-	0.75
Alona sp.	0.05	7.75
Leptodora kindtii	0.04	9.25
Chydorus sphaericus	-	1.25
Iliocryptus sordidus	-	1.00
Rotifera	0.04	2.75
Branchionus sp.	0.04	2.25
Keratella quadrata	-	1.00
Asplanchna sp.	-	0.25
Ostracoda	-	1.25
Hydracarina	0.06	15.00
Insecta	0.02	8.50
Larvae Chironomidae	-	1.25
Larvae Chaoborus	-	0.50
Larvae Trichoptera	-	0.25
Nymphs Insecta	0.02	7.00
Nymphs Odonata	-	0.75
Nymphs Ephemeroptera	-	0.75
Nymphs Diptera	-	0.50
Nematoda	-	1.00
Oligochaeta	-	0.25
Decapoda	-	0.50

DIET OF SPIRLIN

The gut length and stomach content of the spirlin from Zujevina and Ljubina rivers (tributaries of the upper flow of the river Bosna) proves spirlin to be predominantly zoophagous (Vuković, 1968). According to Vuković and Ivanović (1971) the main food of spirlin are planktonic and nektobenthic organisms.

The main food of spirlin in Jihlava river in Czech Republic consists of zoobenthic organisms while, especially in spring, it can feed on filamentous algae, diatoms and detritus (Losos et al., 1980) (Table 9 and 10). According to Filipović and Janković (1978) the spirlin in the eastern Serbian Mirovštica river feeds mostly on insects of *Trichoptera* and *Chironomidae* taxons.

Mirovštica river feeds mostly on insects of *Trichoptera* and *Chironomidae* taxons.

Table 9. Diet composition of spirlin from the Jihlava river (Losos et al., 1980)

Food item	Frequency of occurrence (%)	Weight (%)
Perifiton	4.5	4.6
Macrophytes	1.8	2.0
Detritus	22.7	1.4
Animal Food	81.1	92.0

Table 10. Composition of animal food items in stomach content of spirlin from the Jihlava river (Losos et al., 1980)

Food item	Frequency of occurrence (%)	Weight (%)	Number (%)
Ephemeroptera	19.7	8.1	5.3
Trichoptera	45.5	62.9	8.5
Chironomidae	65.8	9.7	39.1
Simulidae	31.8	12.9	27.6
Nectobenthos	30.3	6.4	19.5

DIET OF BARBEL

It seems that barbel, and no other fish, has the access to the food under the stones. Thus, barbel feeds on benthic organisms, small fish and spawn items, usually during the night (Vuković and Ivanović, 1971). The diet of the barbel from the river Vrbanja is domineered by *Chironomidae, Ephemeroptera* and *Plecoptera* (Šenk and Aganović, 1968) (Table 11). Apart from those, large amount of moss and algae with mollusc shells and *Chironomidae* larvae were found in the gut. This indicates that barbel took in such food by taking in subaqueous plants, the content of which was not analysed in detail.

Table 11. Diet composition of barbel from the Vrbanja river (Šenk and Aganović, 1968)

Food item	Number (%)
Oligochaeta	4.48
Hirudinea	0.37
Gastropoda	2.99
Plecoptera	18.28
Ephemeroptera	25.37
Trichoptera	1.87
Coleoptera	6.71
Chironomidae	31.72
Diptera N. Det.	6.72
Fish Seed	0.37
Pisces	1.12

Adámek and Obrdlík (1977) analysed stomach content on 57 individuals of barbel from the Oslava river. Zoobenthos, namely *Trichoptera*, *Chironomidae* and *Ephemeroptera* played the most important role in the diet. Furthermore, filamentous algae and diatom periphyton were relatively frequent components of nutrition, which can be seen from tables 12 and 13 for the locality 2. In locality 2, diatom periphyton was an important part of diet indicating a low availability of zoobenthos.

The vegetable and animal components in Jihlava river were more or less regularly represented in the food of the barbel in the ratio 46%:54%. The dominant vegetable components were diatoms and filamentous algae and the dominant animal components were zoobenthic organisms (Losos et al., 1980) (Table 14 and 15).

Previous to this study the scientists considered barbel to be typical benthophagous fish feeding on zoobenthos, small fish and eggs of other fishes (according to Berg, 1949 from Losos et al., 1980; Vuković and Ivanović, 1971). Afterwards, investigation showed that barbel has both, vegetable and animal items in the stomach content (according to Gyurko

Table 12. Diet composition of barbel from the Oslava river (Adámek and Obrdlík, 1977)

Food item	Location 1		Location 2		Location 3	
	Weight (%)	Frequency of occurrence (%)	Weight (%)	Frequency of occurrence (%)	Weight (%)	Frequency of occurrence (%)
Detritus	7	6	8	10	15	11
Bacillariophyceae	+	6	49	45	8	11
Filamentous Algae	11	17	-	-	10	16
Nectobenthos	+	6	+	5	-	-
Macrozoobenthos	82	83	43	70	67	58

Table 13. Composition of macrozoobenthos from the Oslava river and barbel stomach content (Adámek and Obrdlík, 1977) (weight in percentage)

Food item	Location 1		Location 2		Location 3	
	Barbel	Benthos	Barbel	Benthos	Barbel	Benthos
Oligochaeta	+	2.0	+	7.4	-	0.5
Hirudinea	+	15.0	+	17.6	-	4.0
Mollusca	17	11.4	-	0.4	-	0.1
Trichoptera	38	55.4	44	26.9	58	51.1
Ephemeroptera	21	6.0	+	19.1	24	26.4
Plecoptera	+	3.4	-	0.1	+	8.2
Chironomidae	24	5.9	56	27.4	18	3.2
Simuliidae	-	0.6	-	0.4	+	-
Coleoptera	+	0.1	-	-	-	-
Heteroptera	+	0.1	-	0.7	+	-

Table 14. Diet composition of barbel from the Jihlava river (Losos et al., 1980)

Food item	Frequency of occurrence (%)	Weight (%)
Periphyton	10.7	35.0
Macrophytes	34.5	5.0
Detritus	5.9	+
Fish Seed	36.6	+
Sand	19.8	6.0
Animal Food	-	54.0

Table 15. Composition of animal food items in stomach content of barbel from the Jihlava river (Losos et al., 1980)

Food item	Frequency of occurrence (%)	Weight (%)	Number (%)
Oligochaeta	19.8	2.5	+
Mollusca	8.8	+	+
Hydracarina	0.9	0.4	+
Isopoda	1.9	+	+
Ephemeroptera	75.3	25.2	18.3
Plecoptera	1.9	+	+
Odonata	2.9	0.3	+
Heteroptera	4.9	0.1	+
Trichoptera	84.1	55.2	5.7
Chironomidae	65.3	6.7	30.9
Simulidae	57.4	9.5	44.9
Diptera n. det.	11.8	0.1	+

and Kaszoni, 1964 from Losos et al., 1980; Šenk and Aganović, 1968; Losos et al., 1980).

DIET OF STREAM BARBEL

Based on the gut length analyses of the stream barbel from the rivers Ljubinja and Zujevina, it is evident that stream barble belongs to the zoophagous group with considerable portion of plant component in the diet (Vuković, 1968).

Filipović and Janković (1978) state that the stream barbel form Crni Timok feeds on benthos organisms,

Table 16. Diet composition of stream barbel from the Gradac river (Lenhardt et al., 1996)

Food item	Number (%)
Gastropoda	0.4
Gammaridae	0.5
Simuliidae	15.8
Chironomidae	60.8
Coleoptera	1.9
Trichoptera	17.3
Plecoptera	0.6
Ephemeroptera	2.2
Diptera n. det.	0.3

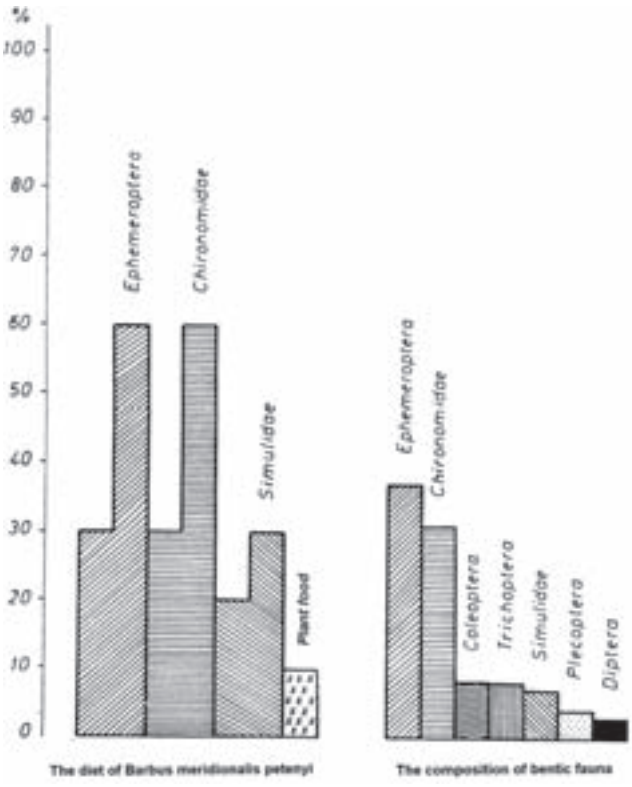

Figure 1. Diet composition of stream barbel from the Radovanska river (Filipović and Janković, 1978)

mainly *Chironomidae* and *Simuliidae*, and less on *Trichoptera* and *Ephemeroptera*. Plant and zooplankton diet components were not investigated. Parallel diet investigation of stream barbel in river Radovanska showed the presence of *Ephemeroptera*, *Chironomidae* and *Simulidae* in the gut. Fig 1 is comparative example of organisms available in the river and prey consumed.

According to Gyurko and Nagy, (1965) from Baruš et al., (1995) stream barbel feeds mainly on bottom fauna. It also consumes algae and higher water plants, while plant food predominates in more adult specimens (2-7 years of age).

Lenhardt *et al*, (1996) investigated age, growth, sexual maturity and diet of the stream barbel in the river Gradac. Main food in the diet was *Chironomidae* although high quantity of *Simuliidae* and *Trichoptera* was also present (Table 16). There is no data on the presence of plant material.

CONCLUSIONS

Chub's main diet consists of plant material, zooplankton, benthos, surface insects, small fish and small vertebrates. According to nutrition, chub is a fish of great adaptability.

Bleak's main diet are avertebrates, plant material and zooplankton.

Spirlin's diet consists of benthic avertebrates, zoooplankton organisms in combination with filamentous algae and diatoms.

Barbel is benthophagous fish that feeds on high percentage of benthic avertebrates and plant material.

If available, stream barbel prefers benthic avertebrates and plant material.

All of the five investigated species proved to be omnivorous in their diet. Besides, chub is a distinct opportunist, while other four species are benthophagous, especially where barbell and stream barbell are concerned.

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