

THE OCCURENCE OF ZOOPLANKTONIC MICROCRUSTACEANS IN THE DIET OF NATURAL FISH POPULATIONS FROM LAKE ȘTIUCII (NATURAL RESERVE, CLUJ COUNTY)

Karina Battes, Klaus Battes, Ionuț Stoica

Key words: cladocerans, cyclopoid copepods, natural fish populations, stomachs, Lake Știucii

INTRODUCTION

Lake Știucii is a natural waterbody situated at 274.5m a.s.l. in the Transylvanian Plateau (Pop 2001). Lake drainage area, measuring 17.5 km², is part of the Bonț Valley, a tributary to the Fizeș River, which connects it to the Someșul Mic River, upstream of Gherla. The lake is surrounded by hills with heights between 470 and 520 m, and unlike most of the lakes from the Plain of Transylvania, it has a natural origin. Lake Știucii is the deepest lake in the region (Șerban & Sorocovschi 2003), having a maximum depth of 6.8m, but can still be regarded as a shallow lake.

Previous studies concerning Lake Știucii biota included mostly algal communities, while ichthyofauna was ignored. This paper represents an attempt to reveal some aspects concerning the structure and characteristics of natural fish populations from Lake Știucii, together with their diet with emphasis on zooplanktonic microcrustaceans.

MATERIAL AND METHOD

Fish material was sampled using three gill nets with 14 mm, 20 mm and 45 mm mesh sizes. The sampling took place in July 2004 in a shallow region of the lake, no deeper than 2-4m, located just before the reed belt. The material was collected during night (for twelve hours). The species were identified in the field and fish guts were preserved in 96% ethanol.

Fifty-six fish stomachs were analyzed in the laboratory. Gut contents were studied scrupulously and the organisms present were identified using different key books (Godeanu 2002, Bres 1994, Sansoni 2001).

Simple statistics was used to illustrate the results. The selection index (Manly *et al.* 1993) was calculated in case of *Daphnia cucullata*, in order to show feeding preferences for bleak.

RESULTS AND DISCUSSIONS

The values of physical and chemical parameters were taken in the field. The pH recorded normal values for Lake Știucii (7.62); water temperature at

the surface was 23.1°C, dissolved oxygen recorded 4.3 mg/l and conductivity value reached 1434 μS/cm.

Ten fish species were identified (see table 1). However, the goldfish was not recorded in the capture due to the small sizes of individuals dwelling in shallow waters.

Table 2 presents the catch for every fish species, taking into consideration not only the number but also the biomass. Moreover, the capture was depicted for every mesh size. 169 individuals were collected, having a total weight of 11471 g.

The fishing effort (CPUE) is presented in table 3. The values were expressed as number of individuals captured / 100 ml gill net / (24) 12h; and as biomass / 100 ml gill net / (24) 12 h. These values were calculated for every species, for every gill net type and for every group (carnivorous or non carnivorous).

Rudd was the most abundant and frequent species. It was followed by roach and bleak. Large-bodied species were well represented too (bream and tench).

This particular species repartition and population structure was confirmed by the percentage repartition of fish individuals, depicted in table 4. Usually, the herbivore species (like rudd) had the highest abundance values, due to the rich aquatic vegetation from Lake Știucii. Omnivore species (bleak) and detritivore species (roach) had also favorable feeding conditions. These numerous species assured the presence of a well represented carnivorous population (of pike or perch), that represented about 15% from the existing biomass.

Table 5 depicts the size structure of the collected fish populations. The fish community consisted mainly of small-bodied species (like bleak or roach) or medium-bodied species (like rudd or tench), together with juveniles of large-bodied species. The individuals collected by means of 14 mm gillnet exceeded 50%; those caught with 20 mm gillnet represented about 27%, while the fishes collected with 45 mm gillnet represented about 15%.

Fish community structure showed balanced populations, with well defined feeding relationships and with an intact selfmaintenance, all this indicating an ecosystem in climax.

Table 1. Fish species list from Lake Știucii (according to Nalbant 2003)

Taxa
Family Esocidae
1. <i>Esox lucius</i> (Linnaeus, 1758) – pike
Family Cyprinidae
2. <i>Carassius carassius</i> (Linnaeus, 1758) – crucian carp
3. <i>Carassius gibelio</i> (Bloch, 1783) – goldfish
4. <i>Rutilus carpathorossicus</i> (Vladykov, 1930) – roach
5. <i>Scardinius erythrophthalmus</i> (Linnaeus, 1758) – rudd
6. <i>Alburnus alburnus</i> (Linnaeus, 1758) – bleak
7. <i>Abramis brama</i> (Linnaeus, 1758) – bream
8. <i>Tinca tinca</i> (Linnaeus, 1758) – tench
Family Percidae
9. <i>Perca fluviatilis</i> (Linnaeus, 1758) – perch
Family Centrarchidae
10. <i>Lepomis gibbosus</i> (Linnaeus, 1758) – pumpkinseed sunfish

Table 2. Total capture (number of individuals and total biomass depending on the gill net mesh size)

No.	Species	Total number (capture) (ind.)			Total /species	Total biomass (capture) (g)			Total /species
		14 mm gill net	20 mm gill net	45 mm gill net		14 mm gill net	20 mm gill net	45 mm gill net	
1.	Pike	3	-	-	3	1184	-	-	1184
2.	Crucian carp	-	2	2	4	-	51	324	375
3.	Roach	39	10	1	49	934	545	-	1484
4.	Rudd	10	21	11	42	231	1566	2351	4148
5.	Bleak	44	-	-	44	1260	-	-	1260
6.	Tench	-	-	7	7	-	-	1836	1836
7.	Bream	-	6	1	7	-	293	375	668
8.	Perch	3	6	-	9	69	359	-	428
9.	Pumpkinseed sunfish	1	1	1	3	9	21	58	88
Total Non-carnivorous		93	39	22	153	2430	2455	4886	9771
Carnivorous		7	7	1	15	1262	380	58	1700
TOTAL		100	46	23	169	3692	2835	4944	11471

Table 3. Fishing effort (CPUE) (ind. /100 ml / 12 h; g / 100 ml / 12 h) for fish populations in Lake Știucii

No.	Species	Fishing effort (CPUE) (number)				Fishing effort (CPUE) (biomass)			
		14 mm gill net	20 mm gill net	45 mm gill net	Total /species	14 mm gill net	20 mm gill net	45 mm gill net	Total /species
1.	Pike	8.1	-	-	2.7	3196.8	-	-	1065.6
2.	Crucian carp	-	5.4	5.4	3.6	-	137.7	874.8	336.5
3.	Roach	105.3	27.0	-	44.1	2521.8	1471.5	-	1335.6
4.	Rudd	27.0	56.7	29.7	37.8	623.7	4228.2	6347.7	3733.2
5.	Bleak	118.8	-	-	39.6	3402	-	-	1134.0
6.	Tench	-	16.2	2.7	6.3	-	791.1	1012.5	601.2
7.	Bream	-	-	18.9	6.3	-	-	4957.2	1652.4
8.	Perch	8.1	16.2	-	8.1	186.3	969.3	-	385.2
9.	Pumpkinseed sunfish	2.7	2.7	2.7	2.7	24.3	56.7	156.6	79.2
Total Non-carnivorous		251.1	105.3	56.7	137.7	6561	6628.5	13129.2	8793.9
Carnivorous		18.9	18.9	2.7	13.5	3407	1026	156.6	1530
TOTAL		270.0	124.2	59.4	151.2	9968.4	7654.5	13348.8	10323.9

Table 4. Percentage repartition of species number and biomass in the capture

No	Species	Number (capture) (ind.)				Biomass (capture) (g)			
		14 mm gill net	20 mm gill net	45 mm gill net	Total capture	14 mm gill net	20 mm gill net	45 mm gill net	Total capture
1.	Pike	3.0	-	-	1.80	32.1	-	-	10.30
2.	Crucian carp	-	4.3	9.1	2.40	-	1.8	6.6	3.30
3.	Roach	39.0	21.7	-	29.20	25.4	19.2	-	12.9
4.	Rudd	10.0	45.7	50.0	25.70	6.3	55.2	47.6	36.20
5.	Bleak	44.0	-	-	26.20	34.1	-	-	11.00
6.	Tench	-	-	31.8	4.20	-	-	37.1	16.00
7.	Bream	-	13.0	4.5	4.20	-	10.3	7.6	5.80
8.	Perch	3.0	13.0	-	5.36	1.9	12.7	-	3.73
9.	Pumpkinseed sunfish	1.0	2.2	4.6	1.80	0.2	0.7	1.2	0.80
TOTAL		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total	Non-carnivorous	93.0	84.8	95.4	91.04	65.8	86.6	98.8	85.17
	Carnivorous	7.0	15.2	4.6	8.96	34.2	13.4	1.2	14.83

Table 5. Size structure of fish populations in Lake Știucii (percentages)

No.	Species	Number (ind.)			Total /species	Biomass (g)			Total /species
		14 mm gill net	20 mm gill net	45 mm gill net		14 mm gill net	20 mm gill net	45 mm gill net	
1.	Pike	100.00	-	-	100.00	100.0	-	-	100.00
2.	Crucian carp	-	50.0	50.0	100.00	-	13.6	86.4	100.00
3.	Roach	79.6	20.4	-	100.00	63.3	36.7	-	100.00
4.	Rudd	23.8	50.0	26.2	100.00	5.6	37.6	56.8	100.00
5.	Bleak	100.00	-	-	100.00	100.0	-	-	100.00
6.	Tench	-	85.7	14.3	100.00	-	43.8	56.2	100.00
7.	Bream	-	-	100.0	100.00	-	-	100.0	100.00
8.	Perch	33.3	66.7	-	100.00	16.1	83.9	-	100.00
9.	Pumpkinseed sunfish	33.3	33.3	33.6	100.00	10.4	23.7	65.9	100.00
Total Non-carnivorous		60.8	25.5	13.7	100.00	24.9	25.1	50.0	100.00
Carnivorous		46.7	46.7	6.6	100.00	74.2	22.4	3.4	100.00
TOTAL		59.5	27.4	13.9	100.00	32.2	24.7	43.1	100.00

Fish populations play a major role in the regulation of prey populations. Fish species collected from Lake Știucii were carnivorous or non carnivorous; planktivorous or benthivorous, depending on age and feeding preferences. These aspects are synthesized in table 6.

Several groups of organisms were observed in the fifty-six fish stomachs, as presented in table 7: algae, macrophytes, rotifers, nematodes, mollusks, water mites, crustaceans, insects and fishes. The identification and counting of some of these taxonomic groups was difficult due to their intense fragmentation. Thus, a relative appreciation of their abundance was preferred (table 7).

Forty six algal taxa belonging to 6 phyla were identified in the 56 fish stomachs, as depicted in table 8. Detritus was observed in every stomach with the majority being made from small pieces of macrophytes.

The present study focused on zooplanktonic microcrustacean community because zooplankton represents an important link in lacustrine food chains. In mesotrophic lakes the predatory impact of planktivorous fish is usually low, as they are usually controlled by a high density of piscivorous fish, and because of the availability of both food and macrophyte refuges for zooplankton. In eutrophic lakes on the other hand, where fish community is dominated by planktivorous species, pressure of vertebrate predators on microcrustacean populations is high (Wojtal 2004).

All eight fish species stomachs contained zooplanktonic microcrustaceans. Figure 1 presents the percentage of fish guts that included cladocerans and copepods. In case of bleak, bream, tench and crucian carp the percentage of occurrence for these groups exceeded 50%, while the lowest value was recorded for perch.

The occurrence of zooplanktonic microcrustaceans in fish stomachs together with their average number are depicted in table 9.

Five species of cladocerans were identified in fish stomachs from Lake Știucii: *Daphnia cucullata*, *Bosmina longirostris*, *Ceriodaphnia pulchella*, *Alona rectangula* and *Chydorus sphaericus*. Most of the cladoceran individuals were well preserved and easy to recognize. All of them were parthenogenetic females. Copepods were represented by *Mesocyclops crassus*, *M. leuckarti* and copepodites, but the

majority of copepod individuals were partly destroyed probably due to their particular body morphology. That is the reason why in table 9 they were considered only as a group. Nauplii were not observed.

Daphnia cucullata was the only microcrustacean species found in rudd stomachs because rudd is known to be mainly an herbivorous fish. Similarly, only one individual of *Mesocyclops leuckarti* (♀) was present in case of pumpkinseed sunfish, a predatory fish. As for perch, only juvenile fish (one year and a half old) had consumed zooplankton. The perch stomach included four cladoceran species (see table 9), copepodites, *Mesocyclops leuckarti* ♀ and *M. crassus* ♀).

Roach usually feeds on bottom and mid-water organisms, but only two species of cladocerans were identified in roach stomachs (see table 9). *Daphnia cucullata* reached up to 105 individuals counted in one stomach. Six out of ten roach stomachs were infected with *Ligula intestinalis* (Plathelminthes, Cestoda).

Bream is a bottom feeder, favoring deep and still waters (Greenhalgh 2003). That is why zooplanktonic cladocerans and copepods were not well represented (see table 9).

The crucian carp is almost exclusively a bottom feeder, though in summer it will take plankton from mid-water (Greenhalgh 2003). All microcrustacean groups were found in crucian carp stomachs. Copepods were relatively well represented, (*Mesocyclops* sp. ♀ and ♂) but the individuals were strongly damaged, probably due to digestion.

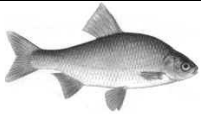
In case of tench, almost all food is taken from the bottom, where it grubs in mud and silt for invertebrates (Greenhalgh 2003). Mostly small-bodied cladocerans were identified in tench stomachs but they did not reached high numbers. Copepods were represented by *Mesocyclops leuckarti* ♀ and copepodites. All three tench stomachs were infected with trematodes (Plathelminthes, Trematoda). The intensity of infection ranged between 94 and 119 individuals in one host.

Bleak is mainly a zooplanktivorous fish. The highest number of cladoceran *Daphnia cucullata* was recorded in bleak stomachs (reaching up to 671 individuals in one stomach). The selection index calculated for this particular species ranged between 1.93 and 2.39, showing the preference of bleak for

this large-bodied species. This aspect might be explained by the fact that planktivorous fish prey selectively on conspicuous zooplankton, selecting large, pigmented, actively moving individuals

(Slusarczyk 1997). Smaller-bodied cladocerans and copepods (copepodites, *Mesocyclops crassus* ♀ and *M. leuckarti* ♀; ♂) were also identified, but in smaller numbers.

Table 6. A general overview of the diet of the eight fish species from Lake Știucii

Fish species		The fish diet	References
Roach		Algae, weeds, midge larvae, water hog-lice, insect pupae, mollusks	(1); (2)
Rudd		Plant debris, algae, worms, small invertebrates, midges, small flies, zooplankton (cladocerans)	(1); (2); (3)
Bleak		Plant material (algae and weed leaves); insect pupae and nymphs; planktonic crustaceans, small adult insects	(1); (2)
Bream		Aquatic vegetation, insect larvae, crustaceans, midge larvae, worms, snails, pea mussels, water hog-lice, other fish roes	(1); (2); (4)
Tench		Aquatic vegetation, invertebrates (midge larvae and water hog-lice), small mollusks, crustaceans, water mites, ostracods	(1); (2); (5)
Crucian carp		Juveniles: planktonic organisms (especially crustaceans) Adults: algae, detritus, ostracods, aquatic worms, true fly larvae, midge larvae, water hog-lice, snails, plankton.	(1); (2)
Pumpkinseed sunfish		Juveniles: littoral microcrustaceans (especially cladocerans) Adults: damselfly and other insect larvae, snails, amphipods, fish juveniles and roes, worms	(1); (6)
Perch		Juveniles: crustaceans, worms, invertebrates, smaller fishes Adults: mollusks, fish roes and juveniles, smaller fish (including tiny perch)	(1); (2)

(1) Bușniță & Alexandrescu 1971; (2) Greenhalgh 2003; (3) García-Berthou & Moreno-Amich 2000a; (4) Vinni et al. 2000; (5) Maitland & Campbell 1992; (6) García-Berthou & Moreno-Amich 2000b.

Table 7. The frequency of occurrence of food organisms observed for eight fish species caught in Lake Știucii

Food items	Fish species							
	Roach	Rudd	Bleak	Bream	Tench	Crucian carp	Pumpkinseed sunfish	Perch
Algae/plant debris	★	★★★★	★★	★★	★★★	★★★	★★	★★★
Rotifers	-	-	★	-	-	-	-	-
Nematodes	-	-	-	-	?	★	-	-
Mollusks	-	-	-	★	★★	-	★★	-
Water mites	-	-	-	★	-	-	-	-
Cladocerans	★★★	★	★★★★	★★	★★	★★★	-	-
Copepods	-	-	★★	★★	★★	★★★	★	-
Ostracods	★	-	★	★★★	★★	★★	-	-
Mayfly larvae (Ephemeroptera)	-	★	-	-	★	-	★	-
Dragonfly larvae (Odonata)	★★	★	★	★★★	★	-	★★	★
True bugs (Heteroptera)	-	-	★	-	-	-	?	-
Caddis fly larvae (Trichoptera)	-	-	-	★	★	-	★	-
True fly larvae (Diptera: <i>Chaoborus</i> sp.)	★★	★	★	★	-	-	-	-
True fly larvae (Diptera: midges)	-	-	★	★★★	★★★	★	★★	?
Adult insects	★	-	★	★★	★	-	-	★
Fish parts	-	-	-	-	-	-	-	★★★
Others (cladoceran ephippia)	★	-	★	★★	★★	-	-	-

Legend: ? uncertain; - absent; ★ incidental; ★★ common; ★★★ frequent; ★★★★ very abundant

Table 8. The number of algal taxa per phylum identified in the fish stomachs from Lake Știucii

Phylum	Number of algal taxa/fish species							
	Roach	Rudd	Bleak	Bream	Tench	Crucian carp	Pumpkinseed sunfish	Perch
CYANOPROKARIOTA	-	3	2	5	2	3	1	3
DINOPHYTA	-	1	1	-	1	-	-	1
CHRYSOPHYTA	-	2	1	2	-	2	-	-
BACILLARIOPHYTA	-	13	4	6	2	8	3	3
XANTHOPHYTA	-	1	-	-	-	-	-	-
CHLOROPHYTA	7	12	4	4	-	4	5	2

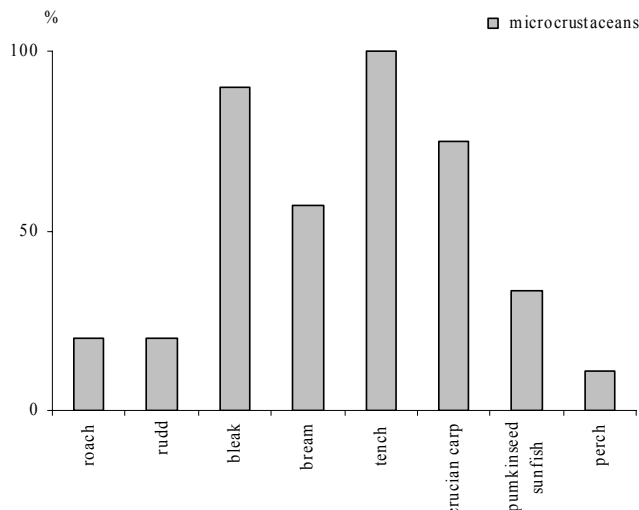


Fig. 1. Zooplanktonic microcrustaceans identified in the eight fish species, shown as a percentage of total stomachs they were observed in

Table 9. Number of fish stomachs containing cladocerans and copepods (in brackets: the average number of individuals/stomach)

Taxa	Number of stomachs with microcrustaceans / fish species							
	Roach	Rudd	Bleak	Bream	Tench	Crucian carp	Pumpkinseed sunfish	Perch
<i>Daphnia cucullata</i>	2 (58.00)	2 (2.50)	10 (187.40)	2 (1.50)	-	2 (1.00)	-	1 (1.00)
<i>Bosmina longirostris</i>	-	-	7 (11.14)	-	-	3 (8.67)	-	1 (22.00)
<i>Ceriodaphnia pulchella</i>	1 (1.00)	-	6 (5.67)	1 (3.00)	3 (4.67)	2 (38.00)	-	1 (7.00)
<i>Alona rectangula</i>	-	-	-	2 (2.50)	1 (6.00)	2 (13.50)	-	-
<i>Chydorus sphaericus</i>	-	-	2 (1.50)	4 (4.00)	2 (2.50)	1 (147.00)	-	1 (2.00)
Copepods	-	-	5 (2.40)	4 (2.00)	3 (4.00)	2 (30.50)	1 (1.00)	1 (64.00)
TOTAL FISH STOMACHS	10	10	10	7	3	4	3	9

CONCLUSIONS

Ten fish species were identified in Lake Știucii. Rudd, an herbivorous species, recorded the highest abundance. Omnivore and detritivore species were also well represented, thus assuring a numerous carnivorous population.

Five species of cladocerans were identified in the eight fish species stomachs taken into consideration. Bleak, a zooplanktivorous fish, showed feeding preferences for the cladoceran *Daphnia cucullata*. Copepods were harder to identify and quantify, due to their intense fragmentation.

Even if the collected data was insufficient to construct a scientifically based aquatic food web, however, conspicuous interactions between the identified organisms could be distinguished.

REZUMAT

Lucrarea de față își propune elucidarea unor aspecte privitoare la dieta populațiilor de pești din Lacul Știucii (rezervație naturală- județul Cluj), cu

accent asupra comunității de microcrustacee zooplanctonice. Colectarea materialului ihtiologic s-a realizat în luna iulie a anului 2004. Conținutul stomacal s-a analizat la 8 din cele 10 specii capturate. Alături de microcrustacee, au mai fost identificate neverterate bentonice, insecte adulte, viermi, gastropode, rotifere, resturi de plante, detritus etc.

60% din indivizii de babușcă au prezentat liguloză, în timp ce 100% din exemplarele de lin au fost infectate cu trematode. La 4 specii (oblete, plătică, lin și caracudă) microcrustaceele zooplanctonice au fost prezente în mai mult de 50% din stomacurile analizate.

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AUTHORS' ADDRESS

KARINA BATTES – “Babeș-Bolyai” University, Faculty of Biology and Geology, Department of Taxonomy and Ecology, Clinicilor Street, No 5-7, 400006, Cluj-Napoca, Cluj, Romania, e-mail: kbattes@yahoo.com

KLAUS BATTES, IONUȚ STOICA – University of Bacău, Faculty of Sciences, Calea Mărășești No 157, 600115, Bacău, România, e-mail: battes@ub.ro, klaus_battes@yahoo.com, ionut_stoica23@yahoo.com