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THE FOOD OF COMMON BREAM (*ABRAMIS BRAMA* L.) IN A BIOMANIPULATED WATER SUPPLY RESERVOIR

T. Zapletal, J. Mareš, P. Jurajda, L. Všetičková

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Abstract

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Food composition of common bream (*Abramis brama,* L.) was studied in the shallow, meso–eutrophic, Hamry reservoir (Czech Republic). Fish were sampled during the daytime in the pre-spawning period (April), the post-spawning (June), summer (July) and autumn (October) in 2011. The bream sampled comprised two main size groups: small, 124–186 mm; and large, 210–315 mm standard length. Twenty specimens of each size group (except April – 40 large fish) were taken for analysis on each sampling occasion. Food composition was evaluated using gravimetric methods. Over the whole season, detritus and aquatic vegetation were the dominant dietary items taken. During summer, the diet of large bream comprised mainly aquatic vegetation. Benthic macroinvertebrates and zooplankton formed a minor part of bream diet over the whole season. Specific food habits of bream could be explained by specific conditions within the reservoir and available food resources.

diet, *Abramis brama*, impoundment, biomanipulation

Common bream (*Abramis brama,* Linnaeus, 1758) is a fish species that often forms a substantial part of the fish stock in many reservoirs (Baruš, Oliva, 1995; Vašek *et al.*, 2006) and lakes (e.g. Lammens, 1999), and is usually termed an "accompanying species" by reservoir management bodies. Many authors (e.g. Prejs *et al.*, 1994; Lammens, 1999) have considered bream to have a negative impact on water quality in reservoirs, and have linked the species with eutrophication processes. The bream's benthivorous and/or planktivorous feeding habits are frequently a cause of bioturbation, which can increase nutrient release from the reservoir bottom (Adámek, Maršálek, 2012). Through intensive feeding on large zooplankton, bream are also capable of affecting the trophic cascade through a top-down effect, i.e. as the density of large zooplankton decrease, so phytoplankton density increases (Vijverberg *et al.*, 1990). As such, knowledge of bream diet at a site can be important in determining causes of decreasing water quality.

According to Vašek *et al.* (2006), the main constituents in the diet of bream >18 cm in the deep valley reservoir at Římov were *Daphnia* and *Diaphanosoma*. Pociecha, Amirowicz (2003) also described the dominance of zooplankton in bream diet in a eutrophic reservoir in Poland. Macrozoobenthos are also known to form a large part of bream diet, as described by Biro *et al.* (1991) for the shallow Lake Balaton (Hungary), Martyniak *et al.* (1987) for the Pierzchaly reservoir (Poland), and Naumenko (2011) in a Baltic Sea lagoon. Kokeš, Gajdůšek (1978) described bream with a predominantly benthivorous diet in the Mostiště reservoir (Czech Republic). Other food items, such as Diptera (Zadorozhnaya, 1977), grass seeds (Kokeš, Gajdůšek, 1978) and algae (Dyk, 1956) are mentioned rarely. Detritus has sometimes also been mentioned as forming a significant proportion of bream's food by weight, e.g. in the Volgograd Reservoir in Russia (Nebolsina, 1968, Martyniak *et al.*, 1987). Zeman (2011) found that, in spring, the major part of bream's food in the Hamry reservoir was composed of plant fragments (38–77% by weight).

Since this final study took place, the Hamry reservoir has been subjected to a period of biomanipulation, whereby large numbers of cyprinids have been removed in order to affect the reservoir's food cascade. Excessive consumption of zooplankton by common bream can lead to algal blooms, seriously affecting drinking water quality. Removal of large numbers of bream, along with large-scale stocking of predatory fish (e.g. asp, pike or pikeperch), is expected to result in an increase in zooplankton and improvements in water quality.

The aim of this study was to analyse the present diet of common bream in the Hamry reservoir, two years after their large-scale removal, and assess any changes in diet following biomanipulation. As such, this study of bream diet will provide important information on the mosaic of complex factors involved in this biomanipulation project, and may help explain wider relationships within the hydrological food web.

MATERIAL AND METHODS

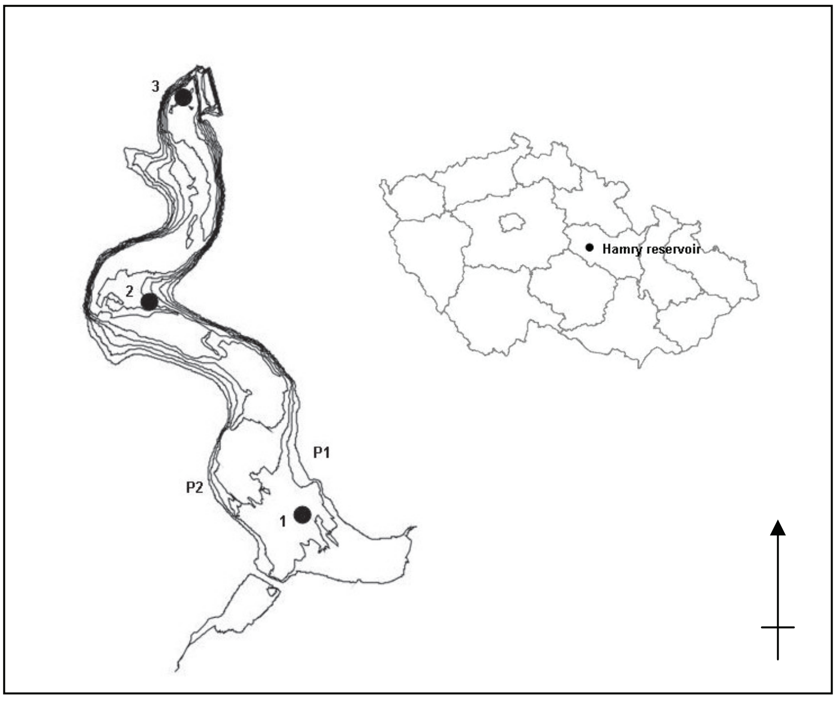
This study was carried out at the 42.3 ha Hamry water supply reservoir (49°43'51.654"N, 15°55'1.391"E); near the town of Hlinsko in the Bohemian-Moravian Highlands. Built between 1907 and 1912, the reservoir is fed by the River Chrudimka and was originally intended as a single-purpose structure for protecting Hlinsko and its surroundings against flooding (Trejtnar, 1975). The dam is 17.4 m high and its crest is at an elevation of 602.86 m (Bws). Average depth is 2 m, with a maximum depth by the dam of 7.5 m. It has a catchment area of 56.8 km^2. The reservoir presently serves as a drinking water source for Hlinsko and its surroundings.

Littoral macrozoobenthos and periphyton were monitored independently on April 14, May 5, June 6, July 25, September 5 and October 11, 2011. At the same time, zooplankton samples were taken from three points of differing depth along the course of the former riverbed (Fig. 1).

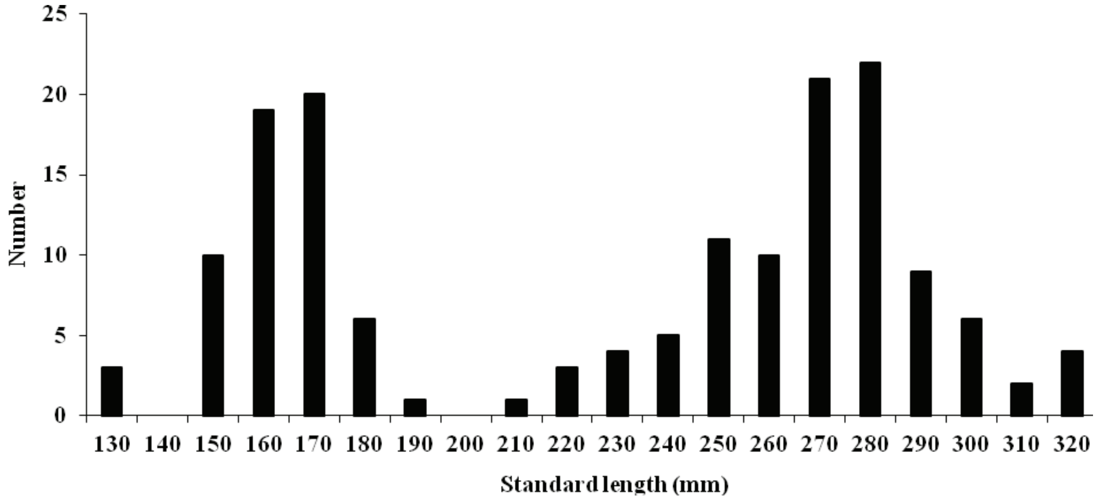
Samples of zooplankton from sample site 1 were taken using a 20 cm diameter, 6 m zooplankton net, towed horizontally. Zooplankton samples from sites 2 and 3 were taken with the same equipment, except that the net was hauled vertically 4 and 6 m, respectively (see Přikryl, 2006).

Submerged vegetation was sampled manually at sites P1 and P2 in order to examine periphyton. Macrozoobenthos samples were taken simultaneously using a modified version of the PERLA method (Kokeš, Němejcová, 2006). This method is based on multi-habitat sampling, with all habitats being sampled proportionally. Samples were collected using a benthos net and kick-sampling for 3-minute intervals. All zooplankton and macrozoobenthos samples were preserved in 4% formaldehyde.

Macrozoobenthos samples were processed by removal of all organisms present in the sample or, if the sample was large, from a representative part (minimum 25%). Organisms were determined to the lowest possible taxonomical level and number



1: *Map of the Hamry water supply reservoir, with food source sampling sites indicated (Sites 1, 2, and 3 indicate zooplankton sampling sites; P1 and P2 indicate macrozoobenthos and periphyton sampling sites)*



2: *Length-frequency distribution of common bream sampled from the Hamry reservoir in 2011*

of individuals per sample expressed as relative abundance, using the formula:

$$\left(\frac{\text{(No. of individuels n in the sample} \times 100)}{\text{No. of all individuels in the sample}}\right).$$

In addition to typical benthic organisms (e.g. Oligochaeta, Trichoptera, etc), large (> 700 µ) littoral cladocerans (e.g. *Eurycercus lamellatus*, *Sida crystalina* or *Simocephalus vetulus*), Hydrachnellae, bryozoan statoblasts (Bryozoa) and gemmules of fresh water sponges (Porifera) were also analysed.

Four, 5 or 6 mls, depending on volume of zooplankton, was taken from a known volume of each plankton sample and placed into a counting cell. Organisms present were counted, determined and expressed as number of individuals per m^3. Organisms in the sample were separated by size class, i.e. those > 700, 100–700 µm, for future analysis.

Fish were sampled using a 100 m long beach seine (maximum depth 4 m, mesh size 20 mm) along shallow banks at both the lower and upper parts of the reservoir. Fish sampling took place on April 26, June 6, July 20, and October 3, 2011. On each occasion, 20 specimens of bream form the two dominant size categories (small bream of 124–186 mm and large bream of 236–315 mm standard length; SL) were taken for diet analysis. The length frequency distribution of all bream sampled over 2011 is displayed in Fig. 2.

Fish were weighed (to the nearest 0.1 g) and measured (total length [TL] and standard length [SL]; to the nearest 1 mm). Shortly after capture, the fish were dissected and the gut contents separated. The gut contents were weighed (to the nearest 0.1 g) and preserved in 4% formaldehyde for later laboratory analysis. A modification of the gravimetric method used by Hyslop (1980) was used to analyse food content in the laboratory. Mucus and mineral particles were separated from the sample and not included in further food analysis. The bulk of the sample, which consisted of macro-vegetation fragments and detritus, was separated from determinable taxa under a binocular microscope; taxa were then examined under a 40–450x magnification microscope for determination. The proportion of total food intake represented by each category was evaluated using the indirect method of Hyslop (1980), using the following formula:

$$\%\, W_i = 100 \times (W_i / \Sigma W_i),$$

where W_i is the weight of a particular food component and ΣW_i is the weight of all food components combined.

Frequency of occurrence of food items was calculated according to Pivnička (1981), using the formula:

$$\%\, FO_i = 100 \times (n_i / \Sigma n_i),$$

where n_i is the number of guts containing a particular dietary component and Σn_i is the number of all guts.

These two criteria are combined in order to express an index of preponderance (IP), using the following formula:

$$IP = 100 \times ((W_i \times FO_i) / \Sigma(W_i \times FO_i)),$$

where W_i is the weight percentage of a particular food component and FO_i is the frequency of occurrence of that food component. This provides a relevant measurable basis for sorting particular components and presents results that are a combination of frequency of occurrence and weight contribution of particular components (Natarajan, Jhingran, 1961).

Fish condition was evaluated using condition factor (CF), as described by Treer *et al.* (2003), using the formula:

$$CF = (W \times L^{-3}) \times 100,$$

where *W* is the weight of a fish in g and *L* represents TL in cm.

Food bulk weight was assessed to the nearest mg and presented as the index of gut fullness (IF) in o/ooo. It was calculated as a ratio between food (w) and fish (W) weights: $IF = 10^4 \cdot (w/W)$.

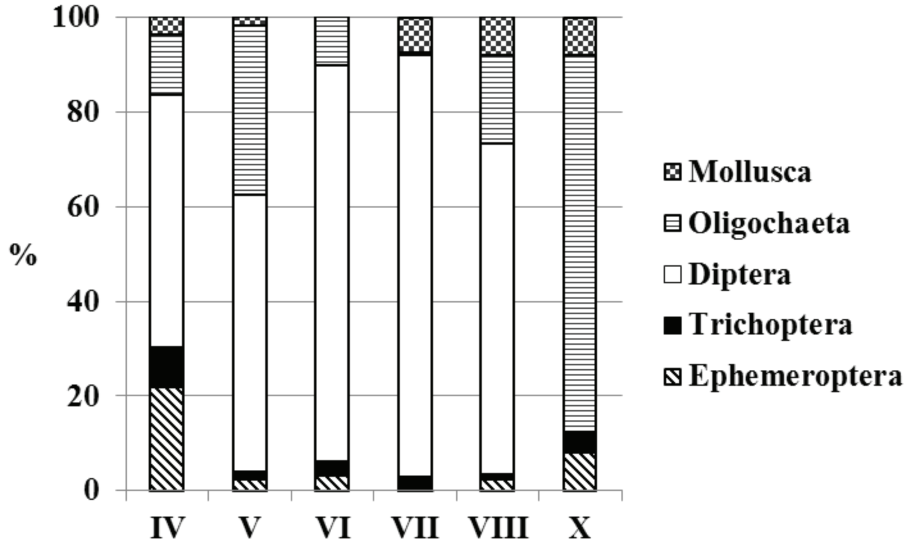
RESULTS

Between April and August, Diptera larvae represented the largest proportion of macrozoobenthos, while in October, Oligochaeta predominated (Fig. 3). Monthly development of the main zooplankton species (Cladocera and Copepoda) over 2011, with Cladocera peaking in May is presented in Fig. 4.

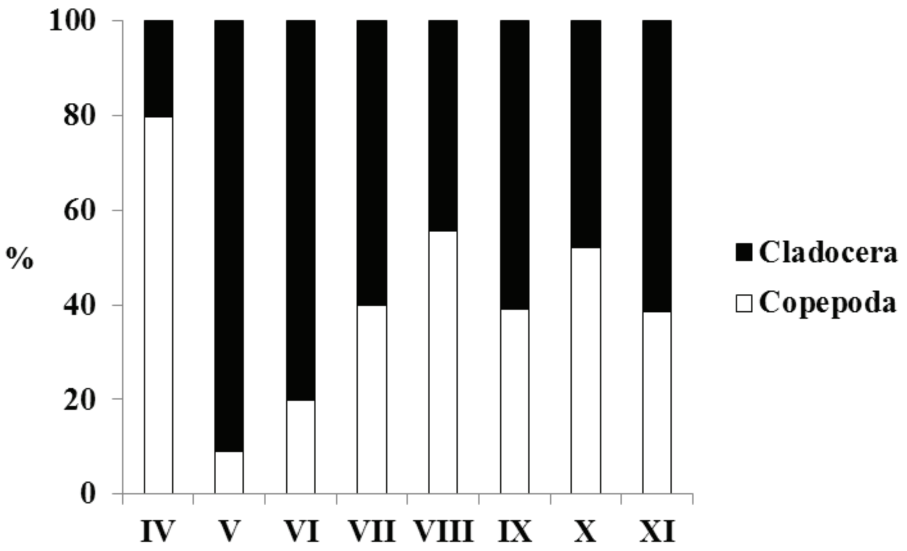
In April, the pre-spawning period, only large bream were analysed for dietary composition The diet at this time comprised mainly detritus and macrophyte fragments (Tab. I). Cladocera and Mollusca were subdominant and the remaining groups were recedent. Parasitic organisms, such as *Caryophyllaeus fimbriceps* and *Pomporhynchus laevis*, were also observed in the gut contents.

During the summer (June, July), detritus dominated the diet of small bream, while vegetation remains dominated in the diet of larger fish (Tabs. II and III). Detritus was dominant of vegetation in the small bream group, while the converse was true in the large bream group. Diptera were a subdominant prey in July samples and other food items were rare throughout the year. The parasitic *Caryophyllaeus fimbriceps* was also observed in gut contents in June samples.

In October, detritus dominated in the food of both groups of fish; with macrophyte fragments supplemental (Tab. IV). Cladocera



3: *Relative monthly composition of food resources (macrozoobenthos) at the Hamry reservoir in 2011*



4: *Relative monthly composition of food resources (zooplankton) at the Hamry reservoir in 2011*

I: *Food composition of common bream (large size group only) during the pre-spawning period (April) at the Hamry reservoir in 2011 (Wi – % weight of particular food items; FOi – frequency of occurrence of particular food items; IP – index of preponderance)*

Group	W_i (%)	FO_i (%)	IP
		large bream	
Cladocera	3.4	12.9	0.8
Copepoda	1.1	6.5	0.1
Ephemeroptera	0.5	3.2	0.0
Trichoptera	1.1	9.7	0.2
Crustacea	1.0	3.2	0.1
Diptera	1.8	9.7	0.3
Mollusca	2.4	16.1	0.7
other parts	3.1	25.8	1.4
macrophyte fragments	30.0	54.8	28.6
detritus	55.6	70.1	67.8
No. fish		40	
No. fish without food		9	
mean TL in mm (SD)		338.7 (27.2)	
mean SL in mm (SD)		267.6 (19.9)	
range of SL (mm)		235–315	
mean WT in g (SD)		319.7 (81.1)	
mean CF		1.7	

II: *Food composition of common bream during the post-spawning period (June) at the Hamry reservoir in 2011 (Wi – % weight of particular food items; FOi – frequency of occurrence of particular food items; IP – index of preponderance)*

Group	W_i (%)	FO_i (%)	IP	W_i (%)	FO_i (%)	IP
		small bream			large bream	
Cladocera	0.5	22.2	0.1	0.3	11.1	0.0
Copepoda	0.1	5.6	0.0	0.1	5.6	0.0
Ephemeroptera	0.6	5.6	0.0	0.2	5.6	0.0
Trichoptera				0.6	22.2	0.2
Diptera	3.1	33.3	1.2	6.1	72.2	5.1
Coleoptera				0.5	5.6	0.0
Oligochaeta				0.3	5.6	0.0
Mollusca	0.3	5.6	0.0	1.1	5.6	0.1
other parts	0.4	11.1	0.1	3.9	5.6	0.3
macrophyte fragments	15.0	44.4	7.6	68.2	100.0	79.7
detritus	80.0	100.0	91.0	18.7	66.7	14.6
No. fish		20			20	
No. fish without food		2			2	
mean TL in mm (SD)		208,4 (8,9)			346.0 (28.15)	
mean SL in mm (SD)		163.4 (8.1)			279.2 (17.8)	
range of SL (mm)		154–186			236–314	
mean WT in g (SD)		96.3 (19.9)			450.1 (74.8)	
mean CF		2.2			2.1	

were subdominant for small bream, and Diptera subdominant for large bream. Other groups were recedent. Parasitic organisms were not detected.

Overall, large bream consumed significantly higher proportion of macrophyte fragments Ephemeroptera, Trichoptera and other parts, compared to small bream (Mann-Whitney test, P all < 0.005). Small bream consumed significantly higher proportion of detritus, compared to large bream (Mann-Whitey test, P < 0.001). No difference was observed in other groups (Mann-Whitney test, P > 0.05).

Highest feeding rates were observed in small bream during June and in July for the large size

III: *Food composition of common bream in the summer period (July) at the Hamry reservoir in 2011 (Wi – % weight of particular food items; FOi – frequency of occurrence of particular food items; IP – index of preponderance)*

Group	W_i (%)	FO_i (%)	IP	W_i (%)	FO_i (%)	IP
		small		large		
Cladocera	0.7	12.5	0.1	0.5	25.0	0.2
Copepoda	0.9	18.8	0.1	0.1	10.0	0.0
Ephemeroptera				1.2	50.0	0.8
Trichoptera	0.6	12.5	0.1	3.7	65.0	3.3
Crustacea				0.2	5.0	0.0
Diptera	10.9	87.5	10.4	9.8	75.0	10.1
Coleoptera				1.1	15.0	0.2
Mollusca				0.9	30.0	0.4
other parts	0.6	12.5	0.1	1.1	30.0	0.3
macrophyte fragments	11.6	62.5	7.9	52.4	85.0	60.9
detritus	74.7	100.0	81.3	29.0	60.0	23.8
No. fish		20			20	
No. fish without food		4			0	
mean TL in mm (SD)		214.1 (10.4)			343.9 (13.7)	
mean SL in mm (SD)		163.9 (8.9)			271.1 (10.1)	
range of SL (mm)		146–180			255–304	
mean WT in g (SD)		94.7 (12.6)			291.3 (46.2)	
mean CF		2.1			2.0	

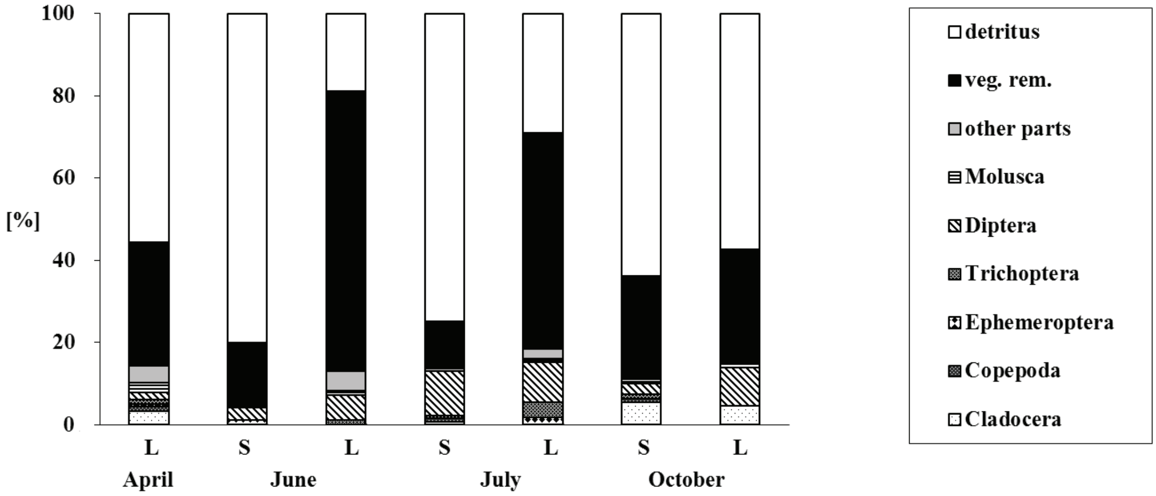
IV: *Food composition of common bream during autumn (October) at the Hamry reservoir in 2011 (Wi – % weight of particular food items; FOi – frequency of occurrence of particular food items; IP – index of preponderance)*

Group	W_i (%)	FO_i (%)	IP	W_i (%)	FO_i (%)	IP
		small			large	
Cladocera	5.5	50.0	3.7	4.7	30.0	2.1
Copepoda	1.0	5.0	0.1			
Trichoptera	1.0	10.0	0.1			
Diptera	2.5	30.0	1.0	9.3	45.0	6.3
Mollusca	1.2	10.0	0.2	0.8	5.0	0.1
other parts				0.5	5.0	0.0
macrophype fragments	25.0	55.0	18.3	27.5	45.0	18.6
detritus	63.8	90.0	76.6	57.2	85.0	72.9
No. fish		20			20	
No. fish without food		0			0	
mean TL in mm (SD)		193.9 (13.8)			305.1 (22.3)	
mean SL in mm (SD)		149.3 (11.0)			241.4 (20.1)	
range of SL (mm)		124–170			210–283	
mean WT in g (SD)		72.3 (16.2)			310.5 (75.1)	
mean CF		2.1			2.2	

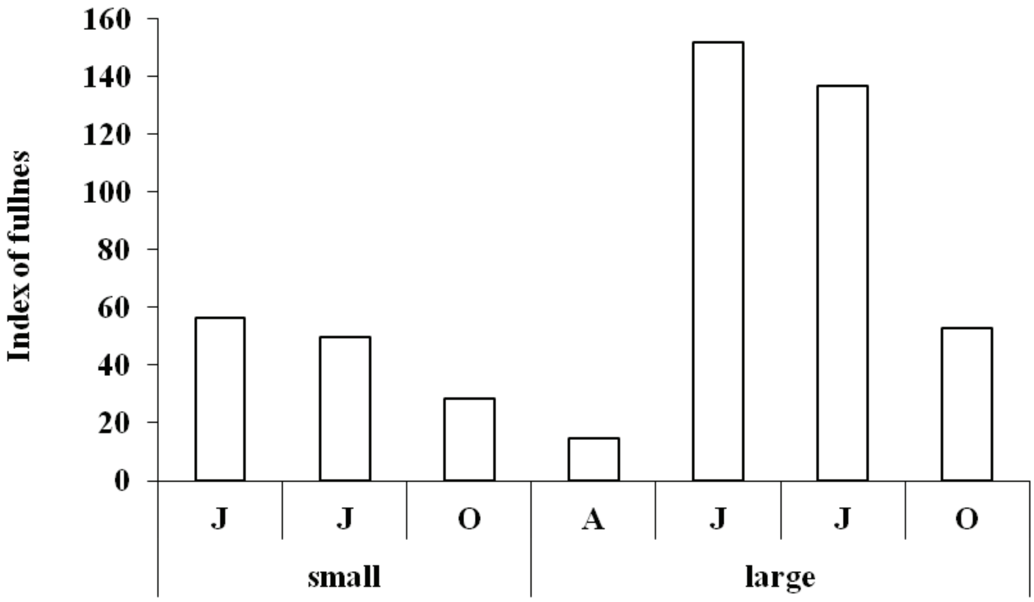
group. Lowest index of fullness was registered in large bream during the April pre-spawning period (Fig. 6).

DISCUSSION

We studied seasonal changes in the diet of two size classes of bream at the Hamry water supply reservoir in 2011. Unlike most previously published papers, we found that detritus and aquatic macrophytes formed the dominant dietary categories for both size classes of bream over the whole sampling season. Smaller bream of around 150 mm SL fed mainly on detritus, whereas larger breams of around 270 mm SL fed mainly on aquatic macrophytes (Fig. 5). We are convinced that macrophyte fragments were not eaten unintentionally, i.e. as a ballast food component, but formed one of the main and most important dietary items at the reservoir.



5: *Monthly diet composition (in relative percentage biomass) for two size classes of bream at the Hamry reservoir in 2011 (S – small size group; L – large size group)*



6: *Seasonal dynamics in the index of fullness for two size classes of bream (small, large) at the Hamry reservoir in 2011 (small bream not sampled in April)*

Zooplankton only represented a minor food item for bream at Hamry, despite it usually forming the dominant part of food for young (0+) bream (e.g. see Kakareko, 2002; Vašek *et al.*, 2006). In the case of older bream, zooplankton has also been described as forming the main part of bream diet in a number of deep valley reservoirs (e.g. see Zadorozhnaya, 1977; Pociecha, Amirowicz, 2003; Vašek, Kubečka, 2004) and in Baltic Sea lagoons (Wolnomiejski, Grygiel, 2002, Naumenko, 2011). Zitenyeva (1974), however, did observe a higher proportion of detritus in the guts of small bream (10–20 cm TL) from the Ghorkhovskiy reservoir (Russsia), while Nebolsina (1968) found that detritus with benthos was the dominant food component in the Volgograd reservoir (Russia).

Macrozoobenthos, usually represented by chironomid larvae, were the dietary item most often found in sub-adult and adult bream after detritus and macrophytes. Zadorozhnaya (1977) found that Chironomidae were the dominant component of food of larger bream (300–370 mm) in the Mozhaysk reservoir (Russia), as did Martyniak *et al.* (1987) in the Pierzchaly reservoir (Poland) and Kokeš, Gajdůšek (1978) in the Mostiště water supply reservoir (Czech Republic).

Zeman (2011), also studying bream in the Hamry reservoir, also found macrophytes to be the dominant food component in spring 2009. The same author found similar results to ours in a second Czech reservoir near in the city of Brno (49°13’53.69”N 16°31’1.81”E), where macrophytes and detritus were dominant in bream diet during spring and zooplankton (cladocerans) dominated after the spawning season.

Bream, therefore, are clearly opportunistic feeder, varying their diet to suit different aquatic habitats. In deep valley reservoirs, the absence of littoral macrophytes in bream diet has previously been noted (Kokeš, Gajdůšek, 1978; Vašek *et al.*, 2003), presumably due to their rarity in the environment. In shallow, productive water supply reservoirs, such as that at Hamry, flooded macrophytes and their attached periphyton (e.g. diatoms) supply a rich food source for both sub-adult and adult bream and zooplankton played a minor role in the diet. Biomanipulation of fish stocks in the reservoir does not seem to have affected bream diet to any degree and relationships within the hydrological food web at Hamry may be more complex than once thought.

SUMMARY

Food of common bream (*Abramis brama* L.) from the Hamry reservoir comprises mainly detritus and macrophyte fragments. Macrophytes formed a dominant part of the diet of large bream (235–315 mm SL) in summer; whereas detritus formed the dominant part of the diet of small bream (124–186 mm SL) over the whole sampling period. Aquatic macroinvertebrates formed a minor part of the diet for both size classes of bream. At the Hamry water supply reservoir, therefore, bream mainly utilise the rich food sources found in the littoral zone, represented by macrophytes covered with periphyton (diatoms).

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Address

Ing. Tomáš Zapletal, doc. Dr., Ing. Jan Mareš, Ústav zoologie, rybářství, hydrobiologie a včelařství, Mendelova univerzita v Brně, Zemědělská 1, 613 00 Brno, Česká republika, Ing. Pavel Jurajda, Dr., Ing. Lucie Všetičková, Ústav biologie obratlovců, Akademie věd České republiky, v. v. i., Květná 8, 603 65 Brno, Česká republika, e-mail: zapletal.tomas@email.cz, mares@mendelu.cz, jurajda@brno.cas.cz, lucka.kocanda@seznam.cz