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Consumption of plant material by perch (*Perca fluviatilis*)

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Abstract. While removing fish during reservoir biomanipulation, it was noted that the diet of normally piscivorous 5+ to 7+ perch was dominated by macrophyte fragments, with fish eggs sub-dominant. To the best of our knowledge, macrophytes have not previously been reported as a food item in perch. Here, we briefly discuss this finding and its significance for perch diet studies.

Key words: dietary preference, diet breadth, biomanipulation, accidental feeding

Introduction

While 0+ perch (*Perca fluviatilis*) feed almost exclusively on zooplankton (Adámek et al. 2004, Kratochvíl et al. 2008), juvenile fish (1+) usually switch to other feeding strategies (Persson & Greenberg 1990), with a shift to piscivory/benthivory at 100-150 mm standard length (SL) (Jacobsen et al. 2002) and almost obligatory piscivorous feeding habits at >155 mm SL (Horpilla et al. 2000). In addition to predation on other fish species, perch are also known to consume fish eggs and several studies have examined this feeding behaviour in more detail. Zick et al. (2006), for example, reported up to 168 eggs (67 % of digestive tract content) in one perch at Grundlsee (Austria). As far as we are aware, however, there have been no previous reports of macrophytes as a significant dietary item in normally piscivorous perch. During an ongoing biomanipulation project to improve drinking water quality at a reservoir in the Czech Republic (Jurajda et al. 2014), we observed a surprisingly high percentage of macrophyte fragments in the digestive tracts of adult perch in spring. In this short note, we assess the degree to which macrophytes are consumed by perch in the reservoir and discuss its possible significance.

Material and Methods

This study was carried out at the Hamry drinking water reservoir (49°43′52″ N, 15°55′1″ E; elevation 603 m a.s.l.) in the Bohemian-Moravian highlands of the Czech Republic. About half of the 42 ha reservoir's shoreline comprises bankside meadows with a low slope and littoral macrophytes that are flooded during higher spring water levels. The rest of the shoreline comprises coniferous forest with steep to vertical gravel banks with limited or absent vegetation. The inlet area is shallow with soft sediment and a thick layer of detritus from decaying flooded vegetation and littoral macrophyte beds (principally reed canary grass, *Phalaris arundinacea*).

During an ongoing biomanipulation experiment (Jurajda et al. 2014), roach, bream and perch were removed using a 100 m beach seine (max. depth 4 m, mesh 20 mm) and Nordic gillnets in spring (May) and late summer (August and September) of 2012. Of the fish caught, 33 were perch aged 5+ to 7+. These were taken for diet analysis as part of the biomanipulation experiment to assess predation rates on small cyprinids. All fish were weighed to the nearest 0.1 g and measured to the nearest 1 mm using digital callipers. Number, mean SL and mean total biomass (WT) of the perch were relatively balanced between spring and summer – spring n = 20, mean SL 213 (162-273), mean WT 189 (65-342); summer n = 13, mean SL 219 (175-300), mean WT 204 (99-525). After measuring, the fish were dissected and the digestive

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tract contents preserved in 4 % formaldehyde for later analysis in the laboratory.

A modified gravimetric method was used to determine diet composition. Mucus and mineral particles were removed from the sample and discarded. All macrophytes and detritus were then separated out from other taxa under a 40× magnification binocular microscope and determined under a 40-450× magnification microscope. Data are presented as relative percentage biomass (% W; Hyslop 1980) and frequency of occurrence (% FO; Pivnička 1981).

All aspects of this study were carried out in accordance with Czech regulations regarding animal care and protection.

Table 1. Relative percentage biomass (% W) and frequency of occurrence (% FO) of main dietary components in the diet of perch collected from the Hamry Reservoir in spring and summer of 2012; spring = May, summer = Aug/Sep.

	Spring % W	Spring % FO	Summer % W	Summer % FO
Zooplankton				
Cladocera	0.09	5.00	1.76	28.57
Invertebrates				
Astacus astacus	-	-	1.44	14.29
Ephemeroptera	0.16	10.00	-	-
Trichoptera	0.47	10.00	3.20	14.29
Diptera	1.04	20.00	-	-
Total Invert.	1.76	45.00	6.40	57.14
Fish	15.91	15.00	93.60	57.14
Fish eggs	28.44	75.00	-	-
Macrophyte	53.89	90.00	-	-

Results and Discussion

While all fish sampled in spring (20) had food in their digestive tracts, six of the 13 fish sampled in summer had empty digestive tracts. There was a clear difference in perch diet between spring and summer (Table 1), with summer diet comprised almost entirely of fish and spring diet dominated by macrophytes (*Alopecurus* sp.) and fish eggs. There was no difference in the quantity of detritus, plankton or aquatic invertebrates taken between spring and summer. These results should be treated with some caution, however, as both the relatively high number of fish with empty tracts in summer and the low number of 5+ to 7+ fish caught overall mean that the data could be easily skewed by outliers. Overall, spring perch ate approximately the same number/biomass of fish as summer perch, the only difference being that summer perch diet was restricted almost solely to fish while spring perch diet included a large quantity of macrophytes and fish eggs. Hence, while the data intuitively suggest diet switching in perch between spring and summer, i.e. switching to a more profitable (in this case stationary) prey source (fish eggs) for a limited time when their absolute density is high (see Stephens & Krebs 1986), it would be more correct to talk of a widening of the diet spectrum in spring to include fish eggs, and possibly macrophytes. In this sense, the inclusion of eggs and vegetation into perch diet is still of interest.

Fish eggs have occasionally been reported as an important perch dietary item (Zick et al. 2006), their consumption being related to availability during the spring spawning season. To the best of the authors' knowledge, however, macrophytes have not been reported as a significant food item in perch diet. Though fragments of vegetation have frequently been noted, they tend to be found at low frequencies and are usually assumed to have been accidentally consumed, either when preying on aquatic insects or as part of the previous meal of fish prey (Adámek & Sukop 2001, Adámek et al. 2006). As many fish eggs were still attached to fragments of littoral vegetation when removed from the gut, much of the macrophyte would appear to have been taken accidentally. Note, however, that macrophytes were found at higher levels than fish eggs, both by % W and % FO (Table 1). Whether this plant material was actively grazed upon as a separate preferred dietary item, however, or taken accidentally during non-specific grazing for eggs, cannot be judged. Similarly, the degree to which plant material is consumed accidentally when preying on aquatic insects or as part of a fish's previous meal is also unknown. The fact that macrophytes were absent from the diet in summer, when perch returned to an almost exclusively piscivorous diet, suggests that plant consumption is strongly associated with egg consumption.

As the perch digestive system is specialised toward animal nutrition, it is not clear whether the fish gains any nutritional benefit from consuming macrophytes. Indeed, it is possible that large-scale macrophyte consumption (accidental or otherwise) may impact on perch body condition by limiting the presumed profitability of egg predation. For example, fish could potentially reach satiation and cease to feed before reaching a critical energy level, or energy used to digest low-benefit macrophyte material may outweigh any energy gained by eating more profitable fish eggs. In conclusion, our data support the concept of a widening of perch diet in spring in the Hamry

Reservoir to take advantage of a seasonal increase in an easily obtained and profitable prey source (fish eggs). As a result, submerged aquatic macrophytes, whether by accident or intentionally, also become a part of the diet. Further studies are needed to assess whether this pattern is general in large perch or the result of individual specialisation, and to fully assess the implications of such behaviour on perch body condition.

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