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Short Note

Diet of the Eurasian otter *Lutra lutra* on small watercourses in Western Poland

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The Eurasian otter (*Lutra lutra*) mainly depends on water systems with dense riparian vegetation and high prey availability (Harna 1993, Pedroso and Santos-Reis 2006). However, during the 20th century riparian habitats have been drastically altered by human activities, particularly in plain areas, where urbanization and agriculture have deeply modified the original landscape. Nonetheless, in the past decades the otter has recovered in several areas of Central and Western Europe (Conroy and Chanin 2000). In Poland, otter expansion coincided with the use of low-quality small watercourses, which are considered as suboptimal habitat from the perspective of the ecological requirements of this species (Romanowski 2006).

Obviously, to enable these ecological adaptations the otter is flexible in its feeding habits (Brzeziński et al. 1993, Carss 1995, Lanszki and Körmendi 1996, Jędrzejewska et al. 2001, Clavero et al. 2003). Although there is no doubt that the otter is a piscivorous (Chanin 1981, Lanszki and Molnár 2003, Brzeziński et al. 2006), it is characterized by flexibility in the type of prey caught (Lanszki et al. 1999). This ''specialist'' species appears to have a large potential adaptive capacity and can switch to a wide variety of alternative riparian prey when faced with disturbances in the environment, interspecific competition and reduced fish availability (Mason 1995, Lanszki et al. 1999, Prigioni et al. 2006).

Otter diet varies according to the local availability of their main prey. Differences can be seen in relation to the alternative to the main prey, as well as the preferred fish species and their sizes (Lanszki and Sallai 2006). Moreover, river size, water discharge and riparian vegetation cover can influence the composition of the diet of otters. As an example, Jędrzejewska et al. (2001) reported that the river type can affect the quantity of amphibians in its diet. Furthermore, the alteration of riparian habitats is often accompanied by the reduction of fish biomass, forcing otters to forage upon alternative prey (Weber 1990, Lanszki et al. 1999, Clavero et al. 2003).

In landscapes with high anthropogenic pressure, mammals display distinct behavioural responses related to dietary habits (Dotta and Verdade 2007). Although otter diet has been widely investigated in a variety of habitats (for reviews, see: Jędrzejewska et al. 2001, Clavero et al. 2003), there is a lack of research focusing on feeding habits of otters living in small watercourses with high anthropogenic pressure in agricultural landscapes.

Thus, the main aim of this study was to investigate diet composition of the otter in small artificial channels in an extensively cultivated agricultural landscape.

The study was conducted in Western Poland (51°34′ N, 17°40′ E) in River Barycz Valley and four of its tributaries (Kuroch, Świeca, Polska Woda and Olszówka). Main land use is grassland. River banks have been deeply modified by embankment and canalisation and riparian shrubs and woods are almost absent.

The diet of otters was studied by spraint analysis. Otter spraints were collected monthly, during two winter seasons (from December 2006 to February 2007 and from October 2007 to March 2008). Temperature during both seasons of the study period ranged from 4°C in November to 7°C in March.

In total, 2422 samples (2269 spraints and 153 prey remains) were collected on five transects along the river banks (range: from 4.5 to 13.8 km, in total 45.2 km). All otter spraints, food remains and other traces of their presence were collected. Analysis followed the standard procedure (Goszczyński 1974, Jędrzejewska et al. 2001): faeces were dried, washed on a sieve with a mesh diameter of 0.5 mm and dried again. Identification of the prey was made using a binocular microscope (10×2–4 magnification). Undigested food remains were segregated into fractions and weighed with 0.1 g accuracy. The following groups of prey were separated: fish, amphibians, reptiles, birds, mammals, crayfish and other invertebrates (snails, clams and insects). Fish were identified based on scales and bones (jaws, teeth) using a fish atlas (Brylińska 1991) and by comparison with our own reference collection of fish scales. Identification of mammals

Table 1 Contribution of prey in the food of otters.

Prey type	n	RFO (%)	FO (%)	B (%)
Fish	2263	63.8	93.4	97.8
Cyprinidae	634	46.4	26.2	–
Percidae	514	37.7	21.2	–
Esocidae	217	15.9	9.0	–
Mammals	244	6.9	10.	0.5
Birds	95	2.7	3.9	0.2
Reptiles	8	0.2	0.3	0.1
Amphibians	549	15.5	22.7	1.2
Insects	152	4.3	6.3	–
Crayfish	148	4.2	6.1	0.2
Snails	46	1.3	1.9	–
Clams	39	1.1	1.6	–
Total	3544	–	–	–

RFO, relative frequency of occurrence–the percentage of instances of the prey category in relation to the total occurrences of all groups of prey; FO, frequency of occurrence – percentage of occurrence of each category of food in all the samples analyzed; B, biomass – the percentage of weight of food eaten.

(based on bones and teeth) was done based on the key for mammals of Poland (Pucek 1984). Crustaceans, molluscs and insects were identified based on their breastplates. The occurrence of different types of prey was calculated in two further ways, such as frequency of occurrence (or FO) and relative frequency of occurrence (or RFO). Using appropriate coefficients of digestibility, which for individual groups of prey included fish – 25, amphibians – 18, birds – 12, rodents – 9, crayfish and molluscs – 7, insects – 5 (Jędrzejewska et al. 2001, after Lockie 1961), we calculated the percentages of the biomass of food eaten.

To test the equality of frequency of fish families eaten by otters we used G-tests. Spearman’s rank correlation test (r_s) was used to check for any relationship between the monthly occurrence of the different families of fish. We used Levin’s index (B) to calculate niche breadth in each month.

The results showed no statistically significant differences in frequency and biomass of the prey between the two seasons of research, thus material was analysed jointly for both seasons.

Fish were the main food resource in the diet of otters (%FO=93.4, %RFO=63.8), constituting 97.8% in terms of biomass (Table 1). Amphibians (*Rana* sp.) were present in 22.7% (FO) of samples and accounted for 15.5% of all prey (RFO); however, their biomass was estimated at 1.2%. The other food items did not exceed 1% of biomass. Otters relatively frequently consumed small mammals (mainly *Microtus* sp.), but in terms of biomass, they formed a negligible part of diet (approximately 0.5%). Birds, crayfish, insects (mainly *Dytiscidae*), molluscs and reptiles were rarely recorded in the diet (Table 1). Plant material (mainly grass) and garbage (such as fragments of glass and aluminium foil) were found sporadically. Otters were fed on fish from three different families, where Cyprinidae and Percidae were the most common (46.4% and 37.7%, respectively) compared with 15.9% of share for Pike (*Esox lucius*).

During the cold period the contribution of individual groups of prey was varied. Otters showed the most diversified diet in the coldest month: October (B=2.31) and December (B=2.47). By contrast, in March, when temperature was the highest, otters preyed exclusively on fish (B=1) (Table 2).

The abundance of cyprinids and percids in the diet of otters was similar, and rather consistent during all months, except March, when we observed their decline and the abun-

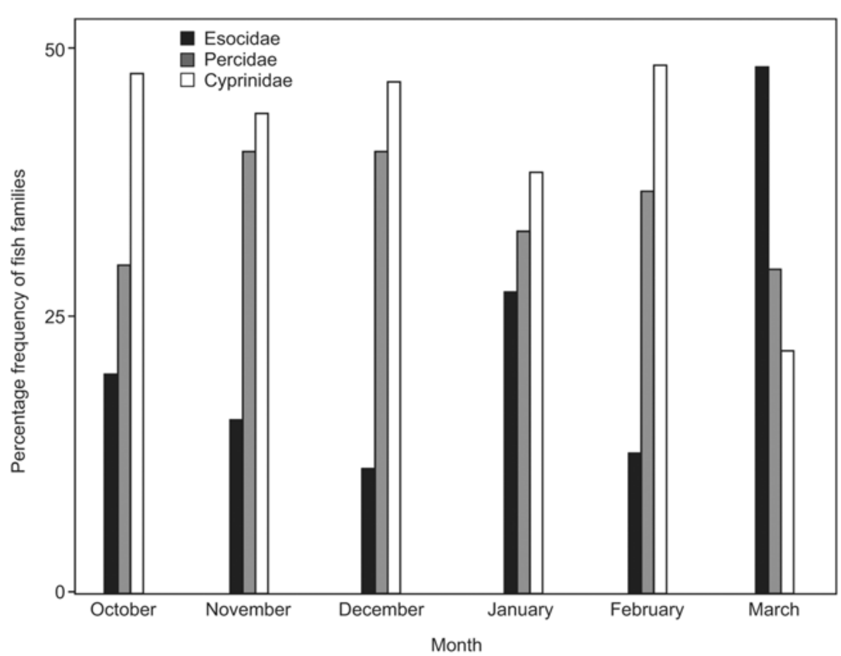

Figure 1 Percentage of fish families in otter diet represented for each month.

Table 2 Food niche breadth in the following months and temperature distribution during the study period.

	October	November	December	January	February	March
B	2.59	2.31	2.47	1.94	1.56	1.00
Mean temperature (°C)	5.2	4.0	4.8	5.5	6.2	7.0

B, Levin's index.

dance of pikes increased (Figure 1). The frequency of pikes in the diet was negatively correlated with the amount of percids (r_s=-0.841; p=0.036) and cyprinids (r_s=-0.886; p=0.019).

In comparison with other studies conducted in Poland (Brzeziński et al. 1993, Harna 1993, Jędrzejewska et al. 2001) the dominance of fish in the winter diet of otters was overwhelming, whereas the consumption of amphibians was sharply lower. For instance, Jędrzejewska et al. (2001) found the diet of otters was 58% amphibians in a small river in the Białowieża Forest in Poland, which was associated with a high availability of frogs in the area and a poor availability of fish, especially in frozen water bodies. Similarly, Weber (1990) indicated a positive correlation between the number of frogs in the diet of otters and their availability in the environment. A small share of frogs in the winter diet of otters from the Barycz Valley indicated that in our study area amphibians do not constitute an alternative source of food, thus their biomass (1.2%) is very small in comparison with the biomass of fish. Similar findings were reported from Biebrza Wetlands, where amphibians never occurred in the diet of otters during harsh winter seasons, and even during mild conditions its share in the diet did not exceed 8% of biomass (Skierczyński and Wiśniewska 2010).

With regard to fish, otter diet reflected the composition of the fish assemblage of River Barycz catchment (Błachuta et al. 1993). The increase of the occurrence of pike in the diet of otters in March probably depended on the spawning period of this species, as reported by Chanin (1981). Pike often spawn in shallow, flooded meadows, which are common in the study area. Fish spawning in such micro-habitats are probably easily preyed upon by otters.

Our study confirms the generalist feeding pattern of the otter, which used fish species according to their local and seasonal availability (Lanszki and Körmendi 1996, Jędrzejewska et al. 2001, Lanszki et al. 2001, Poledník et al. 2004).

We showed a variation in the diet of otters depending on the temperature and changes in the dominance of the families of fish eaten in each month in winter season.

Our findings confirm that otters are able to inhabit areas strongly transformed by humans and otter diet is then significantly dependent upon the prevailing conditions. Moreover, in such an environment we observed a high food specialisation, directed towards fish.

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