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Diet of Eurasian otters (*Lutra lutra*) in natural habitats of the Gemenc Area (Danube-Drava National Park, Hungary) in early spring period

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Lanszki, J., Mórocz, A. & Conroy, J. W. H.: *Diet of Eurasian otters (Lutra lutra) in natural habitats of the Gemenc Area (Danube-Drava National Park, Hungary) in early spring period.*
Abstract: The relationship between the food web and interspecific trophic levels are less well understood along the Hungarian section of the Danube River. In this study, the diet composition of the Eurasian otter (*Lutra lutra*) as mammalian top predator species of wetlands was examined by spraint analysis, in an early spring period at six oxbow lakes of the Gemenc Area. The primary food of otters was fish (min-max 83.9-100.0%, biomass estimation), characteristically gibel carp. Besides fish, amphibians, crayfish and water beetles were eaten in low proportions, therefore the trophic niche was very narrow in all areas. Otters preyed primarily (>56%) on small-sized (<100g) fish, but at three areas, the consumption ratio of 100-500 g fish was also considerable. The main fish prey was eurytopic (>69%), but stagnophilic or reophilic fishes were also eaten considerably on some areas. Consumption of fish in high proportions indicates that their availability might be satisfactory for otters. However fish surveys ocassionally indicated low fish densities. Diet composition and feeding habits of otters differed between areas. It draws attention to the possible need for different conservation and management objectives of the sensitive valley flat-habitats of the Danube, an important European ecological corridor.

Keywords: oxbow, food habits, prey size, fish guild, spraint analysis, conservation

Introduction

The Gemenc Area of the Danube-Drava National Park is characteristically a floodplain - a largely forest-covered landscape (Fig. 1). In this area numerous branch and close to 30 relatively large oxbow lakes are located along the Danube River which is an important European ecological corridor. Due to the high biodiversity, large parts of the Gemenc Area is strictly protected and designated a Ramsar site, but local food web and interspecific trophic links have hardly been examined. The area supports a number of protected species such as: barbastelle bat (*Barbastella barbastellus*), pond bat (*Myotis dasycneme*), black stork (*Ciconia nigra*), white-tailed eagle (*Haliaëtus albicilla*), black kite (*Milvus migrans*), wildcat (*Felis silvestris*), European beaver (*Castor fiber*) (Iványi & Lehman 2002, authors' observations).

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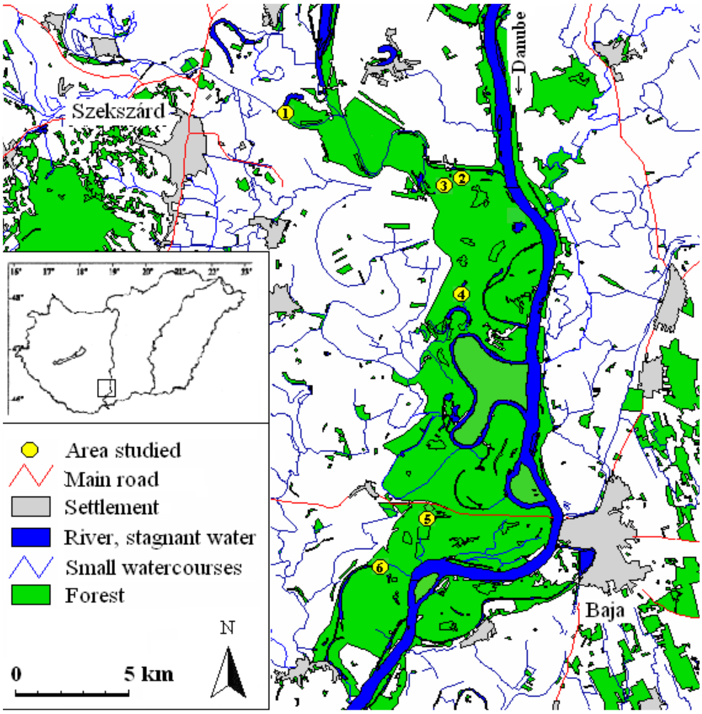

Fig. 1: Geographic locality of oxbow lakes studied in the Gemenc Area, Hungary
1 – Taplósi-Holt-Duna (or TD), 2 - Holt-Sió (or HS), 3 - Hátfői kobolya (or HK), 4 - Decsi-Kis-Holt-Duna (or DD), 5 - Nyéki Holt-Duna (or ND), 6 - Bátai Holt-Duna (or BD).

The Eurasian otter (*Lutra lutra* Linnaeus, 1758) is a piscivorous top predator, inhabit a wide variety of wetland habitats across Europe (CONROY & CHANIN 2002), provided the fish supply is sufficient and waterside vegetation gives sufficient cover (ERLINGE 1967, KRUUK 1995). In Hungary, the most important otter habitats are ponds, oxbow lakes (or backwaters) and rivers as fish are generally available throughout the year in these areas (KEMENES & DEMETER 1995, review: LANSZKI 2009). Reedbeds, shrubs and waterside forests usually surround such areas, all representing suitable habitat for otters. Although, the species is found throughout the wetlands of the Gemenc Area (BITE 2006, LANSZKI 2009), the diet composition and feeding habits of the otter are little known from this specific area.

The aim of this study was to examine differences in the early spring diet composition and feeding habits of otters living on six oxbow lakes along the Danube.

Material and methods

Study areas

During April 2007, the diet composition of otters was studied in six oxbow lakes in the Gemenc Area of the Danube-Drava National Park (Fig. 1, between 46˚ 21´ - 46˚ 10´ N and 18˚ 45´ - 18˚ 52´ E), These were:

1: Taplósi Holt-Duna (abbreviated as TD, 45 ha),
2: Holt-Sió (or HS, 38 ha),
3: Hátfői kobolya (or HK,10 ha),
4: Decsi Kis-Holt-Duna (or DD, 11 ha),
5: Nyéki Holt-Duna (or ND, 17 ha),
6: Bátai Holt-Duna (or BD, 50 ha).

These lakes and connecting wetlands support numerous hydrophilic macrophytes (such as *Nymphaea alba, Trapa natans, Nymphoides peltata, Salvinia natans*), and are surrounded by reed-beds (*Phragmites communis*) and a mosaic of different type of natural forests such as *Leucojo aestivi-Salicetum albae* (all six areas), *Carduo crispi-Populaetum nigrae* (BD, HK, HS), *Senecioni-sarracenici-Populaetum albae* (BD, HK, HS), *Scillo vindobonensis-ulmetum* (TD, DD, ND) and planted poplar and/or willow hybrids (BD, HK, HS, DD, ND) (IVÁNYI & LEHMAN 2002, STETÁK 2003).

Unusually, in 2007, during the cold (January-April) period, the mean temperature was +7.8 ˚C, the lakes were not covered with ice and the duration of snow cover lasted only two days.

During 2007, electrofishing took place on the Grébec-Duna (0.8 km north-east from the Decsi Kis-Holt-Duna) and Nyéki Holt-Duna. In both areas low fish numbers were recorded (Z. Sallai pers. comm.). The main species being giebel carp (*Carassius auratus*) (45.6%), bitterling (*Rhodeus sericeus*) (12.5%), roach (*Rutilus rutilus*) (11.0%), pumpkinseed (*Lepomis gibbosus*) (8.1%) and black bullhead (*Ameiurus melas*) (7.7%). On the Nyéki Holt-Duna, besides the dominant giebel carp (65.0%), black bullhead (15.0%), bleak (*Alburnus alburnus*) (10.0%), common carp (*Cyprinus carpio*) and rudd (*Scardinius erythrophthalmus*) (5.0-5.0%) were also caught.

Sample collection and diet analysis

To study the diet and feeding habits of the otter, individual spraints (faeces) samples were collected from all the areas in April 2007; corresponding to the cold (partially winter and early spring) period. Spraints were soaked in water and then washed through a 0.5 mm sieve and dried at room temperature. All recognisable prey remains were separated. These were then examined under a microscope and fish species identified based on the morphological differences of scales and bones, e.g. pharyngeal teeth, operculae, dentaries, maxillaries (e.g. BERINKEY 1966, KNOLLSEISEN 1996; and personal collection). Both amphibians and fish have single and paired bone structures around the head that allow an assessment of the minimum number of individuals in a sprint through the pairing of left and right sided bones of the same size. To avoid overestimating the importance of the given fish taxa (CARSS & NELSON 1998), different fish bones, combined with scale characters, were used to distinguish and identify fish species (and weight categories). The estimation of actual biomass consumed provides a more realistic measurement of the nutritive value of a prey, emphasizing the importance of larger prey. Weight category was recorded on the basis of comparative measurement of the available pharyngeal teeth, operculae, praeoperculae, maxillaries, vertebrae or other fish bones from the sprint and using a reference collection. Individual fish were divided into the following categories: < 100 g, 100-500 g, 500-1000 g and > 1000 g. The riverine habitat of the various fish species were based on observations by to SALLAI (2002a, 2002b) and LANSZKI and SALLAI (2006): reophilic (characteristically flow preferring), eurytopic (tolerant of both rivers and standing waters) and stagnophilic (characteristically preferring stagnant waters).

The fish species were also categorised into native and non-native species according to SALLAI (2002). Other species preyed upon by otters were identified by microscope from characteristic skeletal remains, and integuments (PAUNOVIC 1990, KNOLLSEISEN 1996, and reference collections).

All dried preyremains for each prey group recovered from the spraints were weighed and their weight multiplied by an appropriate coefficient of digestibility (amphibians - 18, fish - 25, molluscs and crayfish - 7, insects - 5; summarised in JEDRZEJEWSKA & JEDRZEJEWSKI 1998) to obtain an estimate of the percentage fresh weight of food consumed (%B).

Statistical analysis

The following four main prey taxa were used in the calculations: 1 fish; 2 amphibians; 3 crayfish and 4 other invertebrates. Trophic niche breadth (B) was calculated according to Levins (1986 in KREBS 1989): $B = 1/ \Sigma p_i^2$, where p_i = is the proportion of the biomass of a given taxon (expressed as a percentage) present in the diet; and standardized across the four main food taxa: $B_A = (B-1)/(n-1)$, rating from 0 to 1.

The Chi-square test was used for distribution analysis of genaral and fish diet composition of the otters. Hierarchical cluster analysis (cluster method: between-groups linkage; interval of measure: Euclidean distance) was used to compare data of diet compositions (%B) recorded for different study locations. The SPSS (1999) statistical package was used for the processing of the data obtained.

Results and discussion

Distribution of the four main food types eaten by otters differed significantly between areas (Chi-square test: $\chi^2_{15} = 70.19$, $P<0.001$). During the cold period, the principal prey of otter in all six areas studied was fish (>80%), with, in some areas, this was closer to 100% (Table 1, Fig. 2a). In four areas the main prey was gibel carp, but pike dominated in the fish diet in DD and consumption of this species was also high on ND. Roach (HS), bleak (HK), nase (BD), and common carp (TD, HS, BD) were also of considserable importance.

The secondary food of otters was amphibians, including frogs (*Rana* spp.) and toads (*Bufo* spp.), but consumption of these food items was not considerable (Table 2). Other foods such as crayfish (*Astacus* spp. in TD), water beetles e.g. *Dytiscus marginalis,*

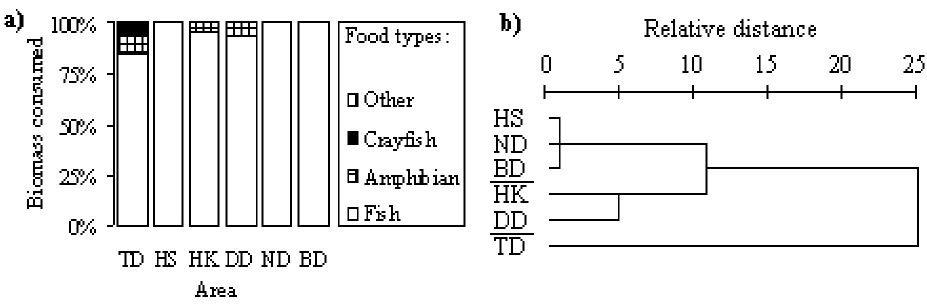

Fig. 2: Distribution of prey types in the diet of otters (a) and dendogram of diet similarity (b) in the Gemenc area, Hungary. For locations see Fig. 1. Calculation was performed with hierarchical cluster analysis on the basis of estimated percentage biomass (%B) data. Short horizontal lines (—) are separate clusters.

Table 1: Early spring fish diet of otters living in the Gemenc Area, Hungary.

Locations: TD – Taplósi-Holt-Duna, HS - Holt-Sió, HK – Hátfői kobolya, DD - Decsi-Kis-Holt-Duna, ND - Nyéki Holt-Duna, BD - Bátai Holt-Duna. N = number of items, %B = percentage biomass of each prey species consumed. Empty cells mean that the given taxon was not detected.

Food item	TD		HS		HK		DD		ND		BD	
	N	%B	N	%B	N	%B	N	%B	N	%B	N	%B
Common carp *Cyprinus carpio*	3	7.4	5	11.1			1	2.4			10	10.8
Giebel carp *Carassius auratus*	16	65.1	25	47.0	18	52.6	2	1.3	7	43.9	34	42.6
Crucian carp *Carassius carassius*					1	3.7			1	4.1		
Carassius spp.	6	4.8			1	2.9	8	28.7	2	1.6	1	0.4
Bream *Abramis ballerus* / *A. brama*			2	3.9			2	3.4				
Rudd *Scardinius erythrophthalmus*			1	0.8			1	1.1	1	0.6	2	0.4
Roach *Rutilus rutilus*			14	15.6	2	4.0	2	3.4	1	0.4	1	0.2
Chub *Leuciscus cephalus*			7	7.8			1	0.5	1	3.8	2	1.8
Bleak *Alburnus alburnus*			6	5.2	6	14.8	3	4.4			7	2.7
Nase *Chondostroma nasus*	2	2.6									10	11.3
Bitterling *Rhodeus sericeus*									1	1.1	3	1.6
Tench *Tinca tinca*									1	6.6		
Gudgeon *Gobio* spp.							1	3.2			1	0.6
Other cyprinids	1	0.5	1	0.4	1	0.6	1	0.6	1	0.6	1	0.2
Brown bullhead *Ameiurus nebulosus*			2	2.3	8	8.2					6	3.0
Pumpkinseed *Lepomis gibbosus*					2	3.4					23	9.5
Perch *Perca fluviatilis*	1	1.3	2	0.2	1	0.2	3	4.6			3	0.4
Ruffe *Gymnocephalus cernuus*											1	0.9
Pike-perch *Sander lucioperca*			1	0.4			1	0.5			3	0.9
Pike *Esox lucius*			4	4.6			20	37.9	10	37.5	25	12.3
Unidentified fish	4	2.2	2	0.6	7	5.6	3	1.7			1	0.1
Fish, total	33	83.9	72	100.0	47	96.0	49	93.7	26	100.0	134	99.7

Table 2: Early spring non-fish diet of otters living in Gemenc Area, Hungary.
*fish and non-fish items together, + = biomass under 0.05%, B_A = standardized trophic niche breadth, for abbreviations see Table 1.

Food item	TD		HS		HK		DD		ND		BD	
	N	%B	N	%B	N	%B	N	%B	N	%B	N	%B
Frog *Rana* spp.	1	2.4			2	1	1	3				
Toad *Bufo* spp.					1	0.8						
Unidentified amphibians	6	6.8	1	+	6	2.1	6	3.3			4	0.1
Crayfish *Astacus* spp.	5	6.6										
Water beetles	3	0.2	2	+	4	+					9	0.2
Molluscs (Mollusca)	1	+									1	+
Number of spraints	34		55		45		39		21		85	
Number of items*	49		75		60		56		26		148	
Trophic niche breadth (B_A)		0.13		0.00		0.03		0.05		0.00		0.00

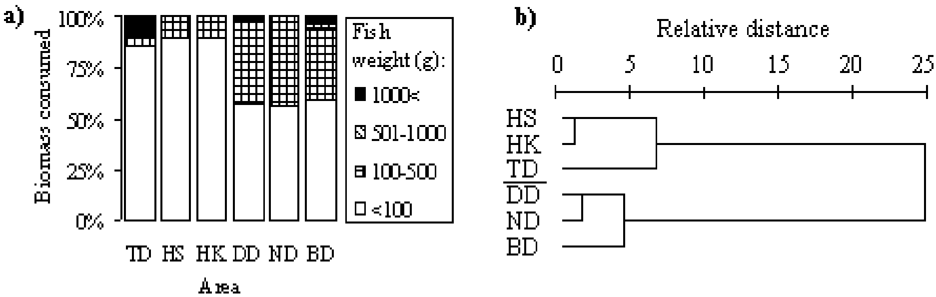

Fig. 3: Distribution of fish weight categories in the diet of otters (a) and dendogram of diet similarity (b) in the Gemenc Area, Hungary. For locations and other explanation see Fig. 1 and Fig. 2.

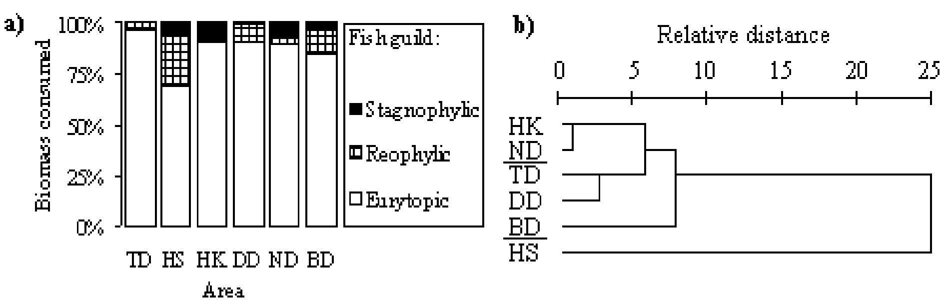

Fig. 4: Distribution of fish guild categories in the diet of otters (a) and dendogram of diet similarity (b) in the Gemenc Area, Hungary. For locations and other explanation see Fig. 1 and Fig. 2.

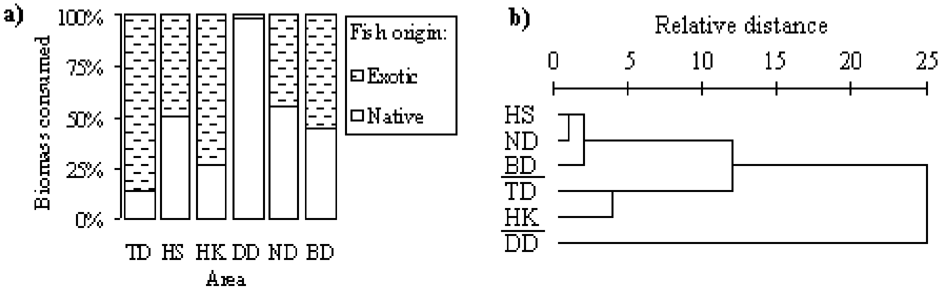

Fig. 5: Distribution of fish origin categories in the diet of otters (a) and dendogram of diet similarity (b) in the Gemenc Area, Hungary. For locations and other explanation see Fig. 1 and Fig. 2.

Hydrous piceus), molluscs (zebra mussel *Dreissena polymorpha* in TD, and snail *Cepaea* spp. on BD) were rare and consumed in low quantities.

Reptiles, birds and mammals were not detected in the spraint samples.

The low trophic niche values (Table 2) showed high specialization in fish. Although the principal fish prey indicates that fish availability might be satisfactory for otters, fish survey by electrofishing indicated relatively low fish densities (Z. Sallai unpubl. data). According to KRANZ (2000), fish availability does not fluctuate as strongly as on the fish ponds as on rivers. High winter and spring fish consumption was found on fish ponds and water reservoirs, as well as on the rivers and oxbow lakes of Hungary which are abundant in fish (KEMENES & NECHAY 1990, review: LANSZKI 2009). When the availability of fish is low or the ability of otters to catch fish is restrained, e.g., during the cold period, otters switch to 'buffer' foods (review: CHANIN 1985, MASON & MACDONALD 1986, CARSS 1995, KRUUK 1995, JEDRZEJEWSKA et al. 2001, CLAVERO et al. 2003). However, spring is also the main period of spawning of amphibians, and in numerous studies frogs and toads are important buffer preys for otters (WEBER 1990, DELIBES et al. 2000, review for Hungary: LANSZKI 2009), but the importance of these (and all non-fish food types) was generally low during the period of study - the early spring period.

On the basis of hierarchical cluster analysis (Fig. 2b), three separate groups were identified. Those locations (from top to bottom on the dendogram) where fish consumption was high (around 100%) fell into one group, those where consumption of amphibians was in higher ratios (3.9-6.3%) into the second, while at Taplósi Holt-Duna (TD), where consumption of amphibians and crayfish was considerable, fell into the third group.

A significant area-dependent difference was found in the distribution of fish weights (Chi-Square test, $\chi^2_{15} = 57.88$, $P<0.001$). However, the fish consumed by otters were small sized (<100 g) [in all areas above 50%](Fig. 3a), but in three areas (TD, HS, HK, first cluster on Fig. 3b) consumption of these was determinant, while on the other three areas (DD, ND, BD, second cluster on Fig. 3b) consumption of 100-500 g fish was also considerable (min-max 35.1-43.5%). Specimens weighing more than 1000 g were rarely taken by otters, consumed only on TD (9.6%), DD (1.7%) and BD (3.5%).

Otters living by oxbow lakes near to the Danube River consumed mostly small light-weight fish. These results are similar to those from studies at other similar locations, other oxbow lakes and river sections, along the Drava and large rivers in Hungary (LANSZKI & SALLAI 2006), as well as most other studies in freshwater habitats (ERLINGE 1969, WISE et al. 1981, CARSS et al. 1990, KRUUK & MOORHOUSE 1990, SIDOROVICH

1997, ROCHE 1998, KLOSKOWSKI 1999, TAASTRØM & JACOBSEN 1999, RUIZ-OLMO et al. 2001, COPP & ROCHE 2003, REMONTI et al. 2008). In contrast with these, some studies performed along productive salmon rivers in Scotland showed that, at least in some times of the year, otters consumed primarily large-sized catadromous spawning fish, which were readily available at that time (CARSS et al. 1990).

A significant difference was found in the distribution of fish guilds preyed upon by otters living in the different areas (χ^2_{12} = 402.90, P<0.001). However, the most frequent fish prey were eurytopic species (>69%, Fig. 4a), but consumption of stagnophilic fish species was also considerable in two areas (HK: 9.1% and ND: 7.2%, first cluster on Fig. 4b). There was also one area where consumption of reophilic fish species was considerable (HS: 24.5%) and in this it differed from all other areas. Despite the proximity of the Danube River, otters consumed reophilic fish in relatively low ratios, as was also found on oxbow lakes of the Drava River (LANSZKI & SALLAI 2006) and, depending on area, consumed considerable numbers of euritopic fish.

Significant area-dependent difference (χ^2_5 = 52.05, P<0.001) was found in the distribution of fish origin (Fig. 5a). Consumption of native and non-native fish species was approximately 50-50% in three areas (HS, ND és BD, first cluster on Fig. 5b), while in two areas, consumption of non-native fish was greatest (TD: 86.0% and HK: 73.8%, second cluster in Fig. 5b) and in one area the consumption of native fish (DD: 98.0%, third cluster on Fig. 5b) was greatest. Although, in some areas otters consumed largely native species, taken as a whole main the fish eaten by otters were, from nature conservation point of view, the problematic non-native species.

In summary, the main food of otters living on all six oxbow lakes in the Gemenc Area was fish. On the basis of diet composition, the feeding habits of otters differed between these areas, this may have arise from different environmental conditions. It draws attention to the necessity of differential habitat management of the sensitive valley flat. The results may be useful in the conservation of the Eurasian otter and management of the habitats in flood-plain of the Danube River.

Acknowledgements

Thanks to Zoltán Sallai for the fish data.

Fig. 6: Otter (*Lutra lutra*) (Photos: J. Lanszki)

Fig. 7: Nyéki Holt-Duna in May

Fig. 8: Holt-Sió in early spring period

Fig. 9: Bátai Holt-Duna in early spring period

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