Acta Theriologica 41 (2): 127–136, 1996.
PL ISSN 0001–7051

Otter diet in relation to fish availability in a fish pond in Hungary

József LANSZKI and Sándor KÖRMENDI

Lanszki J. and Körmendi S. 1996. Otter diet in relation to fish availability in a fish pond in Hungary. Acta Theriologica 41: 127–136.

The food composition of otters *Lutra lutra* (Linnaeus, 1758) was investigated in an artificially established fish pond of 12 ha in south-western Hungary between December 1991 and November 1994. In the fish pond fish farming was carried out with the introduction of different species during the first two years of the investigations, while the filling up of the pond with water and its planting did not come about in the third year. The diet of otters was examined by spraint analysis (873 samples). The most important prey of otters was fish amounting 40 to 100%; the variation was due to season, method of farming and density and composition of the fish stock available. There was a close relationship between the frequency of occurrence of different fish species in the otter diet and the amount of fish available to the otters. The correlation coefficients (r_p) were 0.56 ($p < 0.05$), 0.87 ($p < 0.0001$) and 0.93 ($p < 0.0001$) in the three years. Fish species that are predominant in the fish pond were the most frequent in the otter diet. Most of the fish eaten were below 50 g, ie 55, 88 and 90% respectively in the three years. Prey fish weighing more than 1000 g were found in scats only in the second year, and in a low proportion (1%). Economically important fish species constituted 33, 9 and 3% of the otter diet in the three years. The economic consequences of otter predation on fish are discussed.

PANNON Agricultural University, Faculty of Animal Science, Kaposvár, P. O. Box 16, 7401-Hungary

Key words: *Lutra lutra*, diet, prey selection, spraint analysis, Hungary

Introduction

Otter *Lutra lutra* (Linnaeus, 1758) is a protected species in Hungary. The population seems to be stable in areas where there are several but usually small (10–50 ha) fish ponds and in storage lakes of 100–250 ha surface area. The otter can almost always be found in such places. However, the deterioration of the fish ponds and the uncertainty about their further use is unfavourable to the otter. Illegal hunting also occurs. There are tense conflicts between the interests of fish farming and nature protection, there is a great need for efforts to evaluate the role of otter predation in fisheries.

Several publications report on the otter diet. These investigations give evidence of the fact that the otter tailors its food consumption to the food available in the individual seasons (Erlinge 1967). It has also been proven that the dominant food of otter are fish (Erlinge 1969, Wise *et al.* 1981, Kemenesné and Nechay 1990, Harna 1993). Investigations in south-eastern Poland suggest that there are no considerable seasonal differences in the fish consumption of otters (Harna 1993). In these surveys the frequency of occurrence of fish fell between 54.0 and 69.8% in the diet of otters. Similar observations were reported by Wise *et al.* (1981) in a small eutrophic pond and by Erlinge (1969) in a throut water. The fish ratio in the otters' stomach, investigated by Tumanov and Smelov (1980), was however extremely low (19.8%).

To judge the role of otter in fisheries, the economic analysis of the fish composition in the otter diet is important. Several fish species mentioned by foreign authors do not live in Hungary. Furthermore, the yields of our fisheries are in many cases different from those of other countries due to the different ecological conditions. The results of investigations conducted in protected areas or in areas used for purposes other than fish production are only partly applicable to food habits of otters living in fish ponds.

The objective of this paper is to examine the role of otters in fisheries in more detail under the conditions of a model fish pond. Monthly and seasonal composition of the otter diet were studied in three subsequent years. To describe its food preferences the weight of the food and the ratio of economically important fish species were taken into account.

Study area, material and methods

The fish pond at Fonó (FFP) as our model area is located in south-western Hungary. It is actually an artificial lake with the brook nourishing the lake. Although the fish pond itself is not protected, it is the living, nesting and feeding place for several protected and strongly protected animal species. The closest fish ponds are at a distance of 3–5 km along the waterflows situated parallel with the brook nourishing the FFP. There are also otters living there. The surface area of the pond is 12 ha, the pond is eutrophic, the total area is ca 30 ha with all the attacted watery habitats. There are no fish preserves in the neighbourhood of this pond. One third of the water surface and the strip of land around is covered by reed (*Scirpo-Phragmitetum*). Forest (*Quercetum petraeae-cerris*), arable lands, pastures and fields for game food can be found within the boundary area.

The pond was cultivated extensively during the first year and semi-intensively during the second year of the investigations. Fish farming was given up in the third year, the pond was not filled up with water, and the water bed started to be become weedy. Due to its well-definable location, varying fish composition from one year to the other and the easily detectable changes in the habitat, the FFP proved to be suitable for the model-type analysis of the food composition of otters.

The food composition of the otters was studied by microscopic spraint analysis. Fresh spraints were collected for 3 years (between December 1991 and November 1994) from standard defecation and feeding places of the otters from a coastal region, ca 1200 m long. A collection of scales and teeth was made from the fish collected at times of harvest and trial fishings. In addition, taxonomic keys were used for the identification of the fish species included in the spraints (Berinkey 1966, Pintér 1989). The other general prey taxons were identified based on the indigestible (skeletal) remains, eg dentition, hair, feather, bones and scales of reptiles. The invertebrates were identified by their integuments. The frequency of occurrence of the prey animals belonging to different categories was determined as the minimum number of individuals found in the spraints (tooth, number and size of opercula).

The fish available as food for the otters was surveyed qualitatively and quantitatively based on the results of the fish harvests carried out in November in the first two years, and also by trial fishings using square fishing nets in November of the third year. In the list of the fish harvest the percentage frequency of the weights of the fish species refers to the fish biomass (% Biom). Calculating the individual fish weights by species the frequency according to occurrence was obtained (% Occur), which expresses the ratio of the number of fish belonging to different species (prey density). The various fish species occurring in the pond or in the fish consumption of the otters were divided in the same way into three classes according to their economic importance (Berinkey 1966, Kemenesné and Nechay 1990) and were also sorted according to weight.

Calculations of the food niche breadth [$B = 1 / \Sigma p_i^2$, where p_i – percent occurrence of a general prey taxa] were made according to Levins (1968), whereas those of the standardized niche breadth [$BS = (B - B_{min}) / (B_{max} - B_{min})$, where B_{min} – minimum value of niche breadth (= 1), B_{max} – maximum value of niche breadth (= number of a general prey taxa)] were made according to Colwell and Futuyma (1971) for every season.

The data were evaluated by T-test, χ^2-test and correlation analysis (MS Office, version 4.2). The percentage data of occurrence in the fish supply of the pond and in the fish diet available for the otters were submitted to an arcsin transformation (Steel and Torrie 1980).

Results

Seasonal composition of the diet

During the three years of the investigations 873 otter spraints (166, 594 and 113 samples) were analysed. The number of the individuals of different prey animals was 1242. Fish was the dominant food of the otters in every season with a frequency of occurrence of 40–100% (Table 1). The occurrence of amphibian was relatively high in the second and third years, and this was also the case for insects. Birds occurred in the food mainly in spring and summer, while mammals, reptiles and molluscs were in a lower proportion only occasionally. The number of prey items per spraint (i/s) was between 1.2 and 1.8. The food of the otters varied little seasonally during the first year, while the diet was more diversified during the third year. This latter observation could be related to the low density of the fish population.

Considering the fish prey classes, the samples collected in winter in the three years showed a similar picture as concerns the relative importance (χ^2 = 2.50, df = 2, p > 0.05). There were significant differences in spring during the first two years (χ^2 = 7.51, df = 2, p < 0.05). In summer there were significant differences; in the available fish supply between the first and the second year (χ^2 = 29.56, df = 2, p < 0.0001), the years in which the structure of the introduced fish population was different. Fish constituted the otter diet during the summer of the third year. In autumn, the first two years were similar, but the third year differed (χ^2 = 8.86, df = 2, p < 0.05).

The niche breadth (B) was similar in every season of the first year (Fig. 1). However, it was high in the spring and summer of the second year, paralleled with the decline in the frequency of occurrence of the fish available (Lanszki and Körmendi 1995). The food niche showed an uneven picture from one season to the

Table 1. The seasonal frequency of occurrence (in %) of main prey categories in the otter diet (data for 1991/1992–1993/1994 from FFP). i/s – number of prey items per scat, n – number of sprints analysed, [a, b, c] – significant differences between the data in the same column.

Item	Winter	Spring	Summer	Autumn	Average
		1991/1992			
Mammals	–	1.9	–	–	0.5
Birds	3.3	9.4	17.1	1.6	6.9
Reptiles	–	–	–	–	–
Amphibians	–	–	–	–	–
Fish	85.0[a]	83.0[a]	80.5[a]	84.1[a]	83.8[a]
Insects	11.7	5.7	2.4	12.7	8.3
Molluscs	–	–	–	1.6	0.5
i/s	1.8	1.2	1.2	1.3	1.3
n	39	46	33	48	166
		1992/1993			
Mammals	–	2.9	1.6	2.1	1.7
Birds	2.3	7.0	14.7	2.8	7.3
Reptiles	–	1.3	0.8	2.1	1.0
Amphibians	15.1	13.7	24.5	2.8	15.3
Fish	74.0[a]	63.9[b]	40.8[b]	77.5[a]	62.1[b]
Insects	8.2	11.2	16.3	12.7	12.1
Molluscs	0.5	–	1.2	–	0.5
i/s	1.5	1.4	1.5	1.3	1.4
n	143	178	165	108	594
		1993/1994			
Mammals	–	–	–	2.0	0.6
Birds	–	–	–	–	–
Reptiles	–	–	–	–	–
Amphibians	17.0	20.0	–	7.8	14.5
Fish	71.6[a]	71.4[ab]	100[a]	60.8[b]	69.3[c]
Insects	11.4	5.7	–	29.4	15.0
Molluscs	–	2.9	–	–	0.6
i/s	1.5	1.5	1.8	1.8	1.6
n	57	24	4	28	113

other, which is in relation to the variations in the number of taxons and the number of individuals of the available prey animals.

Fish selection by otters

The fish community in the pond differed between years quantitatively and in years of composition. The results of the fish harvest in November 1992 (Table 2)

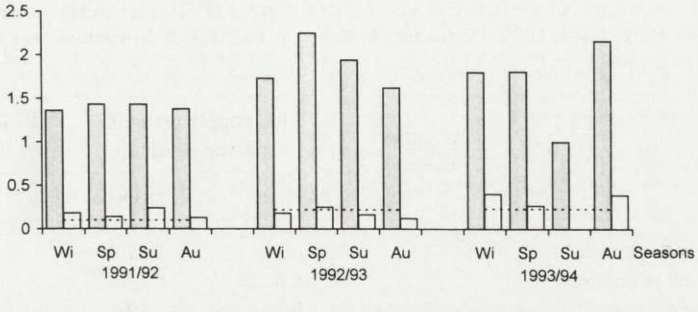

Fig. 1. Food niche breadth (B, open bars) and standardized food niche breadth (BS, shaded bars) in FFP. Seasons: Wi – winter, Sp – spring, Su – summer, Au – autumn, --- – average BS.

Table 2. Relative occurrence of various fish species in the pond (FFP) and in the otter diet in the 1st year of study (Dec 1991 – Nov 1992). The fish pond data in terms of biomass and numbers are from fish harvests in November. "+" – occurrence altogether 0.1%, "–" – no occurrence, * – occurred in the otter diet only, % Biom – % of biomass, % Occur – % of occurrence. Total fish biomass at harvest was 0.31 t/ha. Weight classes of fish: 1 – below 50 g, 2 – 50–100 g, 3 – 100–500 g, 4 – 500–1000 g, 5 – above 1000 g.

Fish species	Weight category	Fish supply present in the pond		Fish composition in otter diet
		% Biom	% Occur	% Occur
Cyprinus carpio				
> 3 yrs old	5	1.9	0.1	–
3 yrs old	5	70.3	23.7	–
2 yrs old	4	13.0	10.5	33.1
total		85.2	34.3	33.1
Stizostedion lucioperca, 1 yr old	3	11.0	27.8	–
Silurus glanis	5	1.0	0.4	–
Lepomis gibbosus	1	2.7	36.5	24.9
Pseudorasbora parva	1	+	0.2	14.4
Carassius auratus gibelio	3	+	0.2	7.2
Carassius carassius	3	+	+	0.6
Abramis ballerus	3	+	+	–
Abramis brama	3	+	+	1.1
Scardinius erythrophthalmus	2	+	+	–
Rutilus rutilus	2	+	+	–
Alburnus alburnus	1	+	0.2	0.6
Tinca tinca	1	+	+	–
Rhodeus sericeus amarus	1	+	+	–
Perca fluviatilis	1	+	+	3.3
Misgurnus fossilis	1	+	0.3	–
Cobitis taenia	1	+	+	–
Unidentified fishes	1*	–	–	14.8

Table 3. Relative occurrence of various fish species in the pond (FFP) and in the otter diet in the 2nd year of study (Dec 1992 – Nov 1993). Total fish biomass at harvest in November was 0.48 t/ha. Other explanations as in Table 2.

Fish species	Weight category	Fish supply present in the pond		Fish composition in otter diet
		% Biom	% Occur	% Occur
Hypophthalamichthys molitrix	5	86.1	11.6	1.3
Hypophthalamichthys nobilis	5	0.3	+	–
Cyprinus carpio	4	5.1	2.2	4.9
Stizostedion lucioperca	3	2.5	7.1	3.0
Pseudorasbora parva	1	3.4	56.5	55.7
Lepomis gibbosus	1	1.7	18.9	19.4
Carassius auratus gibelio	3	0.6	0.4	0.4
Perca fluviatilis	2	+	0.1	2.1
Abramis ballerus	1	+	0.1	0.2
Abramis brama	1	+	0.1	0.2
Scardinius erythrophthalmus	2	+	0.1	0.2
Rutilus rutilus	1	+	0.1	0.8
Alburnus alburnus	1	+	0.4	1.9
Misgurnus fossilis	2	+	0.6	–
Cobitis taenia	1	+	1.8	0.8
Unidentified fishes	1*	–	–	9.1

demonstrated that *Cyprinus carpio* was the dominant fish species (85.2%) according to the biomass, together with some planted species, such as the pre-reared *Stizostedion lucioperca* and *Silurus glanis*. The frequency of occurrence was highest in the case of *Lepomis gibbosus*, *C. carpio* and *S. lucioperca*, the accumulated value of frequency was 98.6%. The fish food of the otters was also made up of *C. carpio and L. gibbosus*, the species most frequent in the food supply (58% in total). No *S. lucioperca* occurred in the diet (Lanszki and Körmendi 1993). There were no significant differences between the fish food supply of the pond and the fish food of the otters according to frequency of occurrence ($p > 0.05$). The correlation between these is intermediate and positive ($r = 0.56$, $p < 0.05$).

During the second year mainly *Hypophthalamichthys molitrix* was introduced into the pond (Table 3). This was the predominant assemblage species (86.1%) in the fish food supply as far as the biomass was concerned. In terms of the frequency of occurrence, however, the *Pseudorasbora parva* proved to be the most common (56.5%). *P. parva* also formed the most important food item of the otters (55.7%). At the same time, the occurrence of *H. molitrix* in the otter diet was very low. There were no significant differences between the fish food supply available in the pond and the fish consumption of the otters in terms of frequencies of occurrence ($p > 0.05$), the correlation between them was close and positive ($r = 0.87, p < 0.0001$).

Table 4. Relative occurrence of various fish species in the pond (FFP) and in the otter diet in the 3rd year of study (Dec 1993 – Nov 1994). Estimated total fish biomass was 0.24 t/12 ha. Other explanations same as in Table 2.

Fish species	Weight category	Fish supply present in the pond		Fish composition in otter diet
		% Biom	% Occur	% Occur
Pseudorasbora parva	1	83.4	89.5	64.5
Lepomis gibbosus	1	12.5	9.0	17.8
Alburnus alburnus	1	0.8	0.9	0.8
Cyprinus carpio	3*	–	–	3.2
Scardinus erythrophthalmus	2	0.8	0.2	–
Carassius auratus gibelio	3*	–	–	0.8
Carassius carassius	3*	–	–	4.8
Misgurnus fossilis	2	1.7	0.4	1.6
Cobitis taenia	1	0.8	+	–
Unidentified fishes	1*	–	–	6.5

In the third year no fish were introduced into the pond (Table 4). Fish species originating in other places occurred in the otter diet in several months (eg in Feb, Jun, Jul, Aug, Sep, Oct). The most significant fish species was *P. parva*, similarly to the previous year. This time there was no significant difference between the fish food supply and the fish consumption of the otters in terms of the relative frequency of occurrence, either ($p > 0.05$), and the correlation between these proved to be close and positive ($r = 0.93$, $p < 0.0001$).

Judgement of the otters' fish diet from the economic point of view

Among the economically important fish species only the *C. carpio* was present in the otter spraints in a considerable amount. The relative frequency of *C. carpio*

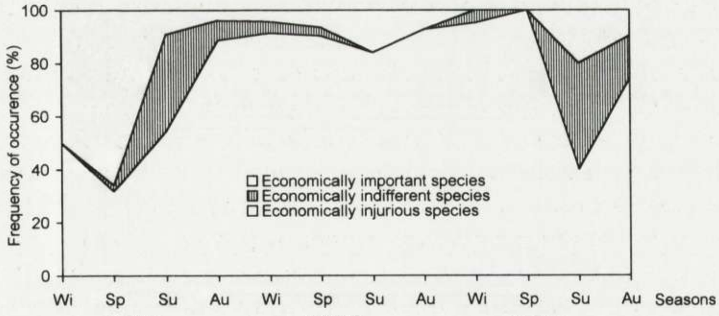

Fig. 2. Seasonal distribution of the otter's fish diet from the economic viewpoint. Seasons are the same as in Fig. 1.

was high in winter and in spring, but low during the main fish producing period and not present at all in the otter diet in several months. Concerning the other economically important species the occurrence of *S. lucioperca* and *H. molitrix* were low, and *S. glanis* and *H. nobilis* did not occur at all. The frequency of occurrence of the economically important species fluctuated greatly between years, constituting 33, 9 and 3% of the otters' yearly fish diet.

The economically injurious fish species that compete with the useful species for food were present in great numbers in winter and in spring after the fish harvests and in autumn. Their relations of frequency of occurrence in the otter diet were 43, 25 and 82% in the three years.

The economically indifferent species were represented by Cyprinidae and a protected species called *Misgurnus fossilis*. While the Cyprinidae were common more particularly in summer and in autumn, the *M. fossilis* occurred in the diet in winter and in spring. Their frequencies in the otter diet were 24, 66 and 15% in the three years.

Figure 2 shows the seasonal distribution of the otters' fish diet from the economic viewpoint. In the class of unidentifiable fishes the *P. parva*-sized fishes of mixed ages were detected in all three years, and these belong to the economically injurious species.

The relative occurrence of fish of different weight categories (Tables 2, 3 and 4) suggests that otters mostly consumed fish weighing less than 50 g, these being the most frequently occurring species. The ratio of such fish amounted to 55, 88 and 90% of the otter diet. Fish weighing over 1000 g were eaten only occasionally during the second year (*H. molitrix*, 1.3%; Fig. 3).

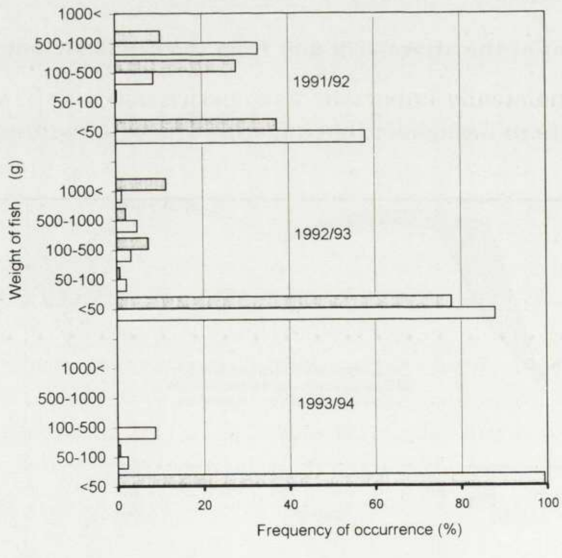

Fig. 3. Relative occurrence of fish of different weight categories in the pond (shaded bars) and in the otter diet (open bars).

Discussion

According to our investigations performed in an active fish pond the otters prefer those fish species and body sizes in the food they obtain that show highest frequencies of occurrence. This statement has been supported by the close correlation values. Although *P. parva* occurred in a ratio of 0.2% in the pond, its ratio was as high as 14.4% in otters' fish diet during the first year of the experiments. In this year *C. carpio* and *L. gibbosus* were the most important fish prey of the otters. In the second year the ratio of *P. parva* increased considerably as compared to the ratio of *L. gibbosus* both in the pond and in the fish diet of the otters, which can be traced back to the introduction *of S. lucioperca* into the pond, which differed greatly in the two years in question (Tables 2 and 3). It is worth noting that *S. lucioperca* could not be found in the otter diet in spite of the fact that it was relatively common in the water (27.8%). In the second year *H. molitrix* composed barely more than 10% of the fish supply of the pond, which seems to give evidence to support the theory that otters do not prefer the bigger-sized fish species. Other authors report similarly in this respect (Erlinge 1968, Wise *et al.* 1981, Gittleman 1985, Kemenesné and Nechay 1990).

In terms of the judgement of the otters from the point of view of fishing it is favourable that the otters consumed high ratios of economically indifferent or injurious species, the total yearly ratios of these were 67, 91 and 97% in the three years.

The bed of the pond was not filled up with water in the third year of the experiments, so the area covered with water was limited to the brook nourishing the pond and the brook's temporary inundations. The otters could not choose prey other than the small-sized fish that remained in the water. The otters must have obtained their food in one of the neighbouring fish ponds, and lived there during a certain part of the year (Erlinge 1968). This hypothesis gains support from the following observations: species not characteristic in this area were found in the spraints collected; extremely large-bodied individuals of the species, which are common here, were detected in the spraints; extremely few spraints could be collected in the summer.

There is a relationship between the predators' (such as otters) strategy for obtaining a supply of food, characteristics of the habitat, the pond farming system, and the occurrence and reproduction of otters (Powell 1979, Kruuk and Hewson 1978, Gittleman 1985, Kruuk *et al.* 1986), so we emphasize the need for further investigations on this subject.

Here arises the possibility to predict the otters' fish food composition in the knowledge of the structure of the fish population of the pond. This way the damage would become reduceable by means of proper protective measures.

Acknowledgements: Many thanks are due to two anonymous reviewers for their comments on earlier version of this paper.

References

Berinkey L. 1966. Halak – Pisces. Akadémiai Kiadó, Budapest: 1–138. [In Hungarian]

Colwell R. K. and Futuyma D. J. 1971. On the measurement of niche breadth and overlap. Ecology 52: 567–576.

Erlinge S. 1967. Food habits of the fish-otter *Lutra lutra* L. in South Swedish habitats. Viltrevy 4: 371–443.

Erlinge S. 1968. Territoriality of the otter *Lutra lutra* L. Oikos 19: 81–98.

Erlinge S. 1969. Food habits of the otter *Lutra lutra* L. and the mink *Mustela vison* Schreber in a trout water in southern Sweden. Oikos 20: 1–7.

Gittleman J. L. 1985. Carnivore body size: Ecological and taxonomic correlates. Oecologia 67: 540–554.

Harna G. 1993. Diet composition of the otter *Lutra lutra* in the Bieszczady Mountains, south-east Poland. Acta Theriologica 38: 167–174.

Kemenesné K. I. and Nechay G. 1990. The food of otters *Lutra lutra* in different habitats in Hungary. Acta Theriologica 35: 17–24.

Kruuk H. and Hewson R. 1978. Spacing and foraging of otters (*Lutra lutra*) in a marine habitat. Journal of Zoology, London 185: 205–212.

Kruuk H., Conroy J. W. H., Glimmerveen U. and Ouwerkerk E. J. 1986. The use of spraints to survey populations of otters *Lutra lutra*. Biological Conservation 35: 187–194.

Lanszki J. and Körmendi S. 1993. Data on the role of the otter (*Lutra lutra L.*) in fish-farming. Halászat 4: 190–192. [In Hungarian with English summary]

Lanszki J. and Körmendi S. 1995. Examination of food ecology of four carnivorous species in the district of Fonó fish-pond (Somogy county). Állattani Közlemények. (in press)

Levins R. 1968. Evolution in changing environment. Princeton University Press, Princeton: 1–120.

Pintér K. 1989. [Fish of Hungary]. Akadémiai Kiadó, Budapest: 1–202. [In Hungarian]

Powell R. A. 1979. Mustelid spacing patterns: Variations on a theme by *Mustela*. Zeitschrift für Tierpsychologie 50: 153–165

Steel R. G. D. and Torrie J. H. (eds) 1980. Principles and procedures of statistics. A biometrical approach. McGraw-Hill Publishing Co., New York: 592–593.

Tumanov I. L. and Smelov V. A. 1980. The food connections of the Mustelidae in the north-west of the RSFSR. Journal of Zoology, London 10: 1536–1544.

Wise M. H., Linn I. J. and Kennedy C. R. 1981. A comparison of the feeding biology of mink *Mustela vison* and otter *Lutra lutra*. Journal of Zoology, London 195: 181–213.

Received 16 August 1995, accepted 11 December 1995.