Autumn–winter diet of three carnivores, European mink (*Mustela lutreola*), Eurasian otter (*Lutra lutra*) and small–spotted genet (*Genetta genetta*), in northern Spain

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Abstract

*Autumn–winter diet of three carnivores, European mink (*Mustela lutreola*), Eurasian otter (*Lutra lutra*) and small–spotted genet (*Genetta genetta*), in northern Spain.*— This study describes the autumn–winter diet of three carnivores (*Mustela lutreola*, *Lutra lutra* and *Genetta genetta*) in northern Spain. Diet composition was analysed from 85 European mink, 156 otter and 564 spotted genet fecal samples The European mink diet was based on small mammals (relative frequency of occurrences 38.1%), fish (30.9%) and birds (16.7%). Spotted genet consumed mainly small mammals, birds and fruits, whilst otter predated practically only fish (95%). Using Levins' index, trophic–niche widths in European mink, small–spotted genet and Eurasian otter were 3.76, 3.77 and 1.10, respectively. The trophic niche overlap by Pianka index for autumn–winter was 0.77 for European mink *vs.* small–spotted genet, and 0.60 for European mink *vs.* otter. The average size of brown trout taken by otter was larger than those consumed by European mink.

Key words: European mink (*Mustela lutreola*), Eurasian otter (*Lutra lutra*), Small–spotted genet (*Genetta genetta*), Diet, Spain.

Resumen

*Dieta otoño–invernal de tres carnívoros, visón europeo (*Mustela lutreola*), nutria euroasiática (*Lutra lutra*) y gineta común (*Genetta genetta*), en el norte de España.*— Se describe la dieta otoño–invernal de tres carnívoros (*Mustela lutreola*, *Lutra lutra* y *Genetta genetta*) en el norte de España. La dieta fue analizada a partir de 85 muestras de visón europeo, 156 de nutria euroasiática y 564 de gineta común. El visón europeo basó su dieta en micromamíferos (38,1% de frecuencia relativa), peces (30,9%) y aves (16,7%). La gineta común consumió principalmente micromamíferos, aves y frutos, mientras la nutria predó casi exclusivamente peces (95%). Los índices de Levins de la anchura del nicho trófico del visón europeo, la gineta común y la nutria fueron 3,76, 3,77 y 1,10 respectivamente. Los solapamientos del nicho trófico durante otoño–invierno del visón europeo (índice de Pianka) respecto a la gineta común y la nutria euroasiática fueron 0,77 y 0,60, respectivamente. El tamaño medio de las truchas consumidas por las nutrias fue mayor que el de las consumidas por el visón europeo.

Palabras clave: Visón europeo (*Mustela lutreola*), Nutria euroasiática (*Lutra lutra*), Gineta común (*Genetta genetta*), Dieta, España.

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Introduction

Eurasian otter (*Lutra lutra*) and European mink (*Mustela lutreola*), both members of the family Mustelidae, are semi–aquatic mammals. The Eurasian otter is the most widely distributed otter species in the world, and it can be found in Europe, North Africa and Asia. European mink, however, is one of the most critically endangered mammals in the world (Schreiber et al., 1989). Furthermore, its distribution in Europe has declined dramatically since the 19th century (Youngman, 1982; Braun, 1990; Camby, 1990; Tumanov, 1999) and its range has been greatly fragmented. There remain only a few isolated populations in Eastern Europe and one population in south–west France / northern Spain, over 2,300 km away (Palazón & Ruiz–Olmo, 1997; Palazón, 1998; Palazón et al., 2003).

The small–spotted genet (*Genetta genetta*), family Viverridae, is widely distributed in Africa and the Middle East, but it is also found in the Iberian peninsula and southern France. It generally inhabits forested areas, but in northern Spain it lives in riparian habitats, sharing habitat with Eurasian otter and European mink. In this range the small–spotted genet feeds not only on terrestrial prey but also on aquatic prey (Ruiz–Olmo & López–Martín, 1993), potentially competing with the native European mink, that consumes both terrestrial and aquatic prey, and the otter, that feeds mainly on aquatic prey (Ruiz–Olmo & Palazón, 1997; Clavero et al., 2003).

The aim of this study was to show the diet of three species that share the same riparian habitat and whose ranges overlap. Understanding the factors that may affect European mink populations is specially important due to their endangered status.

In this study, we investigated the diets of the American mink, the spotted genet, and the Eurasian otter in an area of northern Spain in order to determine their trophic niche breadth and overlap, and examine the potential for these species to compete.

Material and methods

The study area is located in Navarra and La Rioja in Northern Spain (latitude: 42º 10' N–43º 14' N; longitude: 1º 30' O–3º 03' O) (fig. 1), and the samples were collected from Mediterranean and Atlantic rivers. These Mediterranean rivers have a low flow during the summer. They are bordered by dense riparian cover, but surrounded by extensive dry and irrigated agricultural lands. In the Atlantic basin, the water flow is more constant year around. In both areas, the riparian vegetation is composed of black alders (*Alnus glutinosa*), white (*Populus alba*) and black poplars (*P. nigra*), white willows (*Salix alba*), ashes (*Fraxinus angustifolia*) and elms (*Ulmus minor*).

The fish present in the study area are Cyprinidae, Cobitidae, Anguillidae and Salmonidae (Doadrio, 2002). Amphibians and reptiles are common (Pleguezuelos et al., 2002) and in the Mediterranean rivers, American crayfish (*Procambarus clarckii*) are found. The riparian vegetation in the study area is also the habitat of several species of waterfowl, raptors, and small birds. Besides the three species of carnivores studied here, fox (*Vulpes vulpes*), weasel (*Mustela nivalis*), stoat (*Mustela erminea*), European polecat, stone marten (*Martes foina*) and badger (*Meles meles*) are also present (Palomo & Gisbert, 2002). Other mammals in the area are lagomorphs (the European rabbit *Oryctolagus cuniculus* and hares *Lepus europaeus* and *L. granatensis*), rodents (Arvicolids, Murids and Glirids) and insectivores (Palomo & Gisbert, 2002).

To study the autumn–winter diet of the three study species we used 85 European mink and 564 spotted genet faecal samples collected between 1992 and 1996 in the Ega River (Navarra), and 156 otter scats collected in the Ebro, Najerilla and Iregua (La Rioja) Rivers between 1996 and 1997 (fig. 1). All the samples came from within the range of this isolated population of European mink. Samples were collected at different sites and times. Genet samples were gathered from latrines typically used for scent communication. Otter and European mink samples were easily differentiated by smell. Besides, most European mink samples were collected inside traps or from the dens of radio–tracked minks.

Samples were cleaned, classified and identified to the level of major taxa, according to the authors' own field collections and published keys: fish pharyngeal teeth, vertebrae and flakes (Conroy et al., 1993; Ruiz–Olmo, 1995), amphibian skeletons (Rage, 1974), mammalian hairs (Debrot et al., 1982) and mammalian teeth and bones (Gosálbez, 1987), assuming the errors associated to this analysis, especially for otters (Carss & Parkinson, 1996).

To quantitatively describe the diet of three species we used the index: relative frequency of occurrence of each food item

$$RF_i = \frac{\text{Number of prey–items of prey taxa } i}{\text{Total prey–items}}$$

Fork length and weight of three consumed fish species (*Barbus* sp., *Salmo trutta*, and *Chondrostoma miegii*) were estimated using the functional relationship found by Ruiz–Olmo (1995). To compare the food–niche breadth of three mammals species, the B index was calculated for the nine established food categories, according to Levins (1968):

$$B = 1 / \Sigma p_i^2$$

ranging from 1 to 9 prey groups, where p_i is the relative frequency of prey–category *i* in the diet, and *n* is the number of prey–categories. Trophic niche overlap between the three species (European mink, spotted genet and otter) was calculated by means of the Pianka (1976) index:

$$\alpha = \Sigma (p_i \cdot q_i) \times (\Sigma p_i^2 \cdot \Sigma q_i^2)^{-1/2}$$

where p_i is the proportion of prey–item *i* in the diet of the predator *p*, and q_i is the proportion of prey item *i*

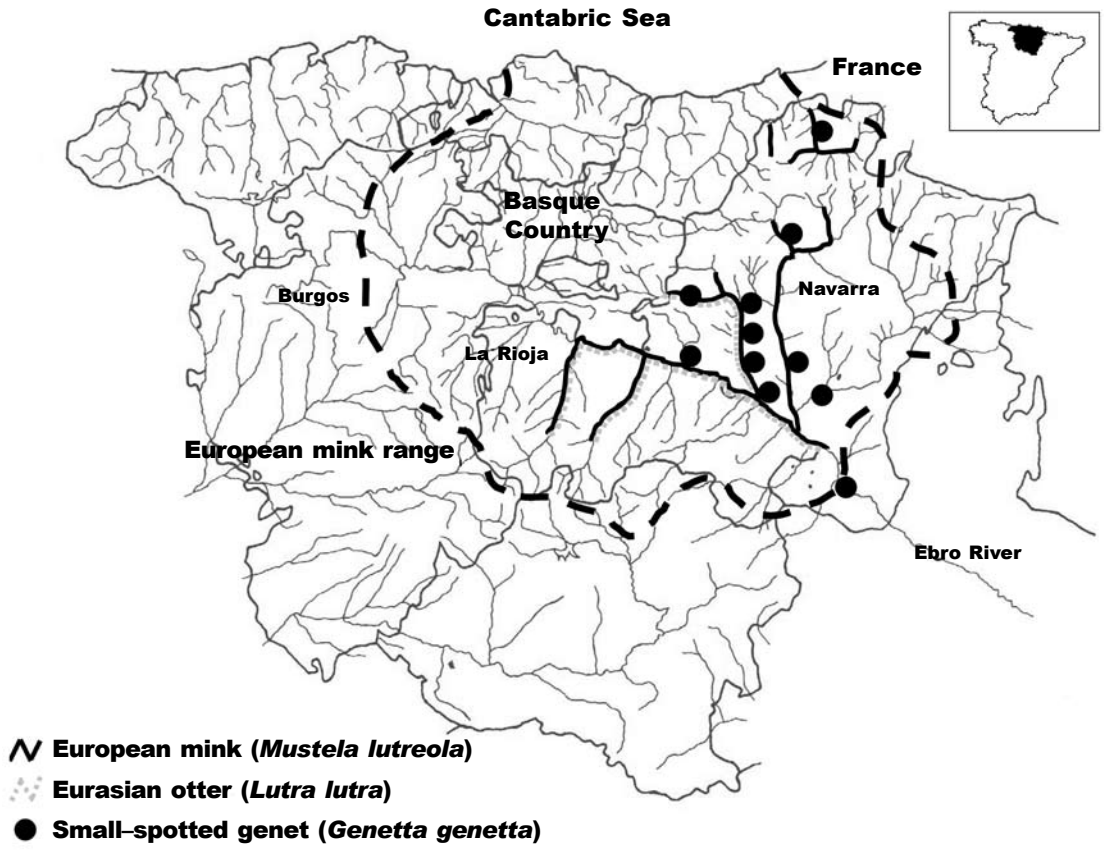

Fig. 1. Map of study area where the samples of European mink (*Mustela lutreola*), Eurasian otter (*Lutra lutra*) and small–spotted genet (*Genetta genetta*) were collected.

*Fig. 1. Mapa del área de estudio donde se recolectaron las muestras de visón europeo (*Mustela lutreola*), nutria euroasiática (*Lutra lutra*) y gineta común (*Genetta genetta*).*

in the diet of predator *q*. It ranges from 0 (exclusive niches) to 1 (complete overlap). Student *t*–test was used to compare the weight and length of different species of fish consumed by European mink and otter.

Results

Autumn–winter diet overlap between European mink and spotted genet was 0.77, between mink and otter 0.60, and between spotted genet and Eurasian otter 0.09. The autumn–winter food–niche breadth index (B) was 3.76 for European mink, 3.77 for spotted genet, and 1.10 for Eurasian otter (table 1). The three main prey categories in the European mink diet were small mammals (38%), fish (31%) and birds (17%) (table 1). All three together reached a relative frequency of 85.3%. Like European mink, small–spotted genet based their diet on three main items: small mammals (39%), birds (18%) and fruits (26%) (table 1). In contrast, Eurasian otter almost exclusively consumed fish (95%), a prey–item category which only represented a third of the prey–items consumed by European mink. In the case of the otter, the remaining prey–items were of minor importance. Fish caught by Eurasian otter were longer than those consumed by European mink, but we only found differences in fork length and in weight of brown trout (table 2). The average size of trout consumed by mink and otter was 16.36 cm (range = 11.9–21.6) and 23.52 cm (range = 7.7–48.0), respectively (table 2, fig. 2). There was a large difference between average weight of trout consumed by mink (59.52 g, range = 18.71–124.5) and by otter (234.68 g, range = 3.3–1,578.0) (table 2, fig. 2). Most brown trout consumed by otter (60.6%) were longer than the longest trout consumed by European mink, while 56.5% of brown trout consumed by otter were heavier than the heaviest samples consumed by European mink.

Table 1. European mink (*Mustela lutreola*), small–spotted genet (*Genetta genetta*) and otter (*Lutra lutra*) autumn–winter diet (relative frequencies of occurrences, RF) and food–niche breadth (B index) (Levins, 1968) in northern Spain.

*Tabla 1. Dieta otoño–invernal (frecuencia relativa de aparición, RF) de visón europeo (*Mustela lutreola*), gineta común (*Genetta genetta*) y nutria euroasiática (*Lutra lutra*) y anchura del nicho trófico (índice B) (Levins, 1968) en el norte de España.*

	M. lutreola (n = 85)		*G. genetta* (n = 564)		*L. lutra* (n = 156)	
Prey	N	RF	N	RF	N	RF
Small mammals	48	38.1	589	39.4	1	0.2
Birds	21	16.7	267	17.8	5	1.1
Fish	39	30.9	62	4.1	430	95.3
Reptiles	1	0.8	27	1.8	9	2.0
Amphibians	4	3.2	2	0.1	5	1.1
Crayfish	0	0.0	15	1.0	0	0.0
Insects	3	2.4	147	9.8	1	0.2
Fruits	5	4.0	386	25.8	0	0.0
Garbage	3	4.0	1	0.1	0	0.01
Total	124		1,496		451	
B index	3.76		3.77		1.10	

Table 2. Comparison of fork length (FL) and weight of barbels (*Barbus sp.*), brown trout (*Salmo trutta*) and nase (*Chondrostoma miegii*) consumed by European mink (*Mustela lutreola*) and otter (*Lutra lutra*) in northern Spain: N. Number of samples; X. Mean; SD. Standard deviation; * Significant differences.

*Tabla 2. Comparación de la longitud forcal (FL) y del peso de barbo (*Barbus *sp.), trucha común (*Salmo trutta*) y madrilla (*Chondrostoma miegii*) consumidas por el visón europeo (*Mustela lutreola*) y la nutria euroasiática (*Lutra lutra*) en el norte de España: N. Número de muestras; X. Media; SD. Desviación estándar; * Diferencias significativas.*

	Mustela lutreola			*Lutra lutra*			Student *t*–test	
	N	X	SD	N	X	SD	*F*	*p*
Barbus sp.								
FL	10	12.52	4.24	79	13.78	6.80	1.660	0.201
Weight	10	24.34	21.88	79	46.24	76.81	3.487	0.065
Salmo trutta								
FL	7	16.36	3.79	193	23.52	8.11	3.724	0.055
Weight	7	59.52	43.53	193	234.68	251.18	3.938*	0.049
Chondrostoma miegii								
FL	6	11.83	3.86	44	10.82	3.19	0.230	0.634
Weight	6	10.58	3.98	44	9.69	3.15	0.418	0.521

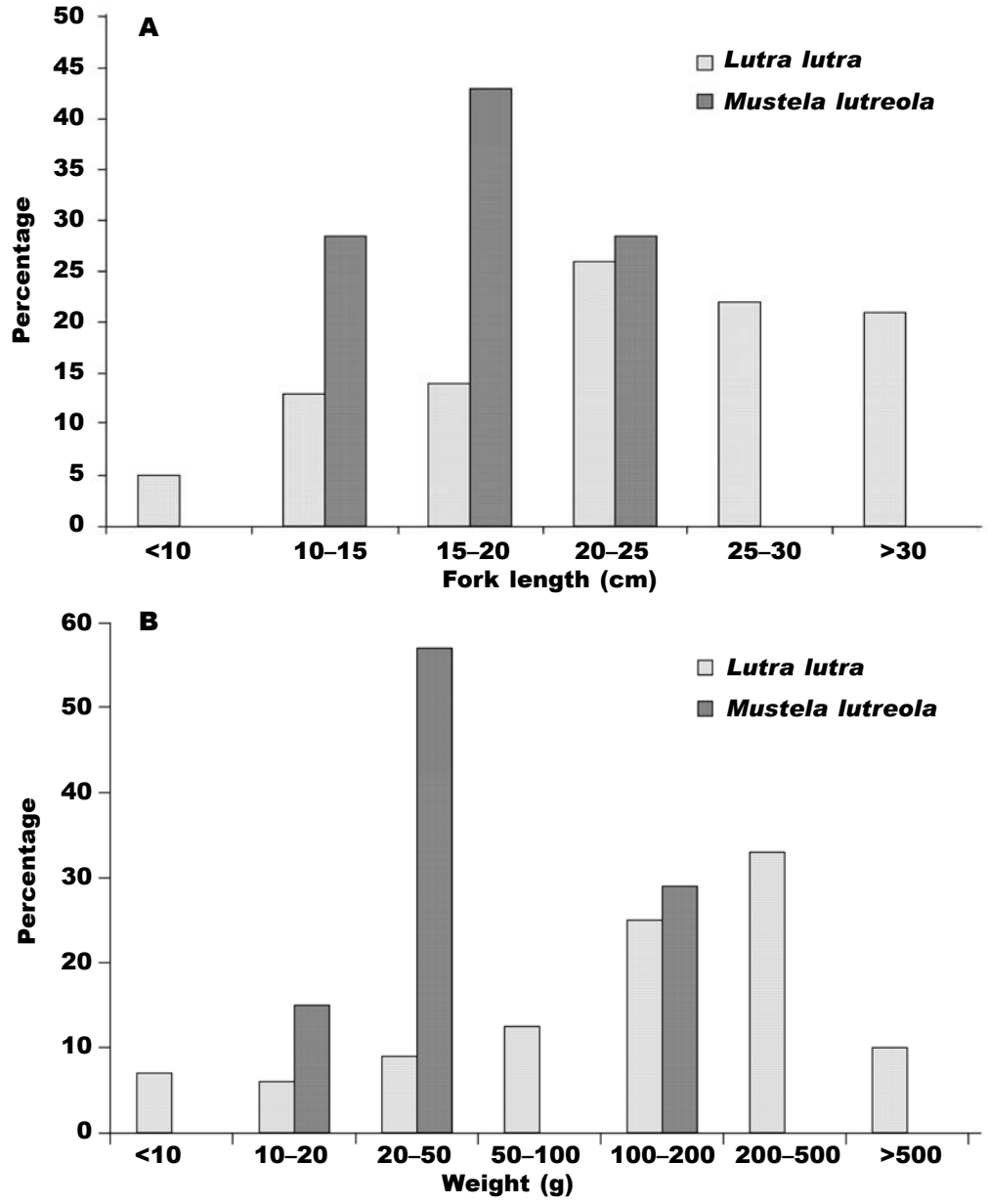

Fig. 2. Comparison of fork length (A) and weight (B) of brown trout (*Salmo trutta*) consumed by European mink (*Mustela lutreola*) and otter (*Lutra lutra*) in northern Spain.

*Fig. 2. Comparación de la longitud forcal (A) y del peso (B) de trucha común (*Salmo trutta*) consumidas por el visón europeo (*Mustela lutreola*) y la nutria euroasiática (*Lutra lutra*) en el norte de España.*

Discussion

Our results have shown that the American mink and the small–spotted genet tend to have a similar diet, partitioned between aquatic and terrestrial prey, while the otter fed almost exclusively on aquatic prey. These findings are similar to those in Belarus, where the food–niche breadth was higher for the European mink than for the otter (Sidorovich, 2000). In Spain the diet overlap between Eurasian otter and European mink was similar (Sidorovich, 2000), with otter consuming more than 50% fish, and European mink consuming more than 50% frogs. The diet overlap between European mink and spotted genet was slightly higher. The study of diet overlap should not be confused with competition in the diet.

Otters have a higher rate of fish capture than mink. This is likely because they are better adapted to an aquatic life–style due to their larger surface of interdigital membranes, greater diving capacity, better under–water vision, higher percentage of milk fat, and the vibrissae on muzzle and elbows that help them detect fish in murky waters. (Dunstone, 1993; Conroy & Jenkins, 1986; Estes, 1989; Kemenes & Nechay, 1990; Brzezinski et al., 1993). There are no studies on the swimming behaviour of European mink, although it is likely similar to American mink (Dunstone, 1993). Due to their larger size, and their adaptations to aquatic life, otter can prey on fish of different species and sizes. European mink, however, have a limited capacity for swimming and can only prey on small fish. Otter and European mink share some fish. When they concur on the same river, could there be a competitive relationship between the two species? Could otter attack or predate on European mink? Since the 1990s Spanish otter populations are increasing and spreading (Ruiz–Olmo & Delibes, 1998). Could this lead to a decrease in European mink populations in a similar way to the American mink in England (Strachan & Jefferies, 1996; Crawford, 2003)? We consider it would be interesting to study the ecological relations between European mink, otter and small–spotted genet in the Mediterranean areas of sympatry in depth. Such studies should also be extended to the European polecat and American mink in Spain as in the near future, this invasive species could become a major competitor of European mink not only in Spain but also in other European countries (Maran et al., 1998; Sidorovich et al., 1998, 2000, 2001).

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References

Braun, A. J., 1990. The European mink in France: past and present. *Mustelid & Viverrid Conservation,* 3: 5–8.

Brzezinski, M., Jedrzejewski, W. & Jedrzejewska, B., 1993. Diet of otters (*Lutra lutra*) inhabiting small rivers in the Bialowiza National Park, eastern Poland. *J. Zool. Lond*., 230: 495–501.

Camby, A., 1990. Le Vison d'Europe (*Mustela lutreola* Linnaeus, 1761*).* In: *Encyclopédie des Carnivores de France,* vol 13: 1–18. Societé Francaise pour l'´Étude et le Protection des Mamifères (SFEPM), París.

Carss, D. N. & Parkinson, S. G., 1996. Errors associated with otter *Lutra lutra* faecal analysis: I. Assessing general diet from spraints. *Journal of Zoology* (London), 238: 301–317.

Clavero, M., Prenda, J. & Delibes, M., 2003. Trophic diversity of the otter (*Lutra lutra*) in temperate and Mediterranean fresh habitat. *J. Biogeog.*, 30: 761–769.

Conroy, J. W. H. & Jenkins, D., 1986. Ecology of otters in northern Scotland. VI. Diving times and hunting sucess of otter (*Lutra lutra*) at Dinnet lochs, Aberdeen and in Yell Sound, Shetland. *J. Zool. Lond*., 209: 341–346.

Conroy, J. W. H., Watt, J., Webb, J. B. & Jones, A. P., 1993. A guide to the identification of prey remains in otter spraint. *An Occasional Publication of the Mammal Society*, 16: 1–52.

Crawford, A., 2003. *Fourth Otter Survey of England 2000–2002*. Environment Agency, Bristol.

Debrot, S., Fivaz, G., Mermod, C. & Weber, J. M., 1982. *Atlas des Poils de Mammifères d'Europe*. Institut de Zoologie de l"Université de Neuchatel, Neuchatel.

Doadrio, I., 2002. *Atlas de los Peces Continentales de España.* DGCNA–SECEM–SECEMU, Madrid.

Dunstone, N., 1993. *The mink*. T. & A. D. Poyser, London.

Estes, J. A., 1989. Adaptations for Aquatic Living by Carnivores. In: *Carnivores, Behavior, Ecology and Evolution:* 242–282 (J. L. Gittleman, Ed.). Cornell University Press, Cornell.

Gosàlbez, J., 1987. *Insectívors i Rossegadors de Catalunya. Metodologia d"estudi i Catàleg faunístic*. Ketres, Barcelona.

Kemenes, I. & Nechay, G., 1990. The food of otters *Lutra lutra* in different habitats in Hungary. *Acta Theriologica,* 35: 17–24.

Levins, R., 1968. *Evolution in changing environments*. Princeton University Press, Princeton.

Maran, T., Kruuk, H., MacDonald, D. W. & Polma, M., 1998. Diet of two species of mink in Estonia: displacement of *Mustela lutreola* by *M. vison*. *J. Zool. Lond.,* 245: 218–222.

Palazón, S., 1998. Distribución, morfología y ecología del visón europeo (*Mustela lutreola* L. 1761) en la Península Ibérica. Ph. D. Thesis, Universitat de Barcelona.

Palazón, S. & Ruiz–Olmo, J., 1997. *El visón europeo (*Mustela lutreola*) y el visón americano (*Mustela vison*) en España*. Ministerio de Medio Ambiente, Madrid.

Palazón, S., Ruiz–Olmo, J., Gosálbez, J, Gómez–Gayubo, A., Ceña, J. C. & Ceña, A., 2003. Trends in distribution of the European mink (*Mustela lutreola* L., 1761) in Spain: 1950–1999. *Mammalia,* 67(4): 473–484.

Palomo, J. & Gisbert, J., 2002. *Atlas de los Mamíferos Terrestre de España*. DGCNA–SECEM–SECEMU, Madrid.

Pianka, E. R., 1976. Competition and niche theory. In: *Theoretical ecology*, *Principles and aplications*: 114–141 (R. M. May, Eds.) Oxford Blackwell Scientific Publications, Oxford.

Pleguezuelos, J. M., Márques, R. & Lizana, M., 2002. *Atlas y Libro Rojo de los Anfibios y Reptiles de*

España. DGCNA–SECEM–SECEMU, Madrid.

Rage, J. C., 1974. Batraciens fossiles du quaternaire. *Bull. Soc. Linn. Lyon,* 43: 276–289.

Ruiz–Olmo, J., 1995. Estudio bionómico de la nutria (*Lutra lutra* L., 1758) en el nordeste de la Península Ibérica. Ph. D. Thesis, Universidad de Barcelona.

Ruiz–Olmo, J. & Delibes, M., 1998. *La nutria en España*. SECEM, Barcelona–Sevilla–Málaga.

Ruiz–Olmo, J. & López–Martín, J. M., 1993. Note on the diet of the Common Genet (*Genetta genetta* L.) in mediterranean riparian habitats of N.E. Spain. *Mammalia,* 57(4): 607–610.

Ruiz–Olmo, J. & Palazón, S., 1998. The diet of the European otter (*Lutra lutra* L., 1758) in Mediterranean freswater habitats. *Journal of Wildlife Research*, 2(2): 171–181.

Ruiz–Olmo, J., Palazón, S., Bueno, F., Bravo, C., Munilla, I. & Romero, R., 1998. Distribution, status and colonization of the American mink *Mustela vison* in Spain. *Journal of Wildlife Research,* 2(1): 30–36.

Saint–Girons, M. C., 1991. Le vison sauvage (*Mustela lutreola*) en Europe. In: *Collection Sauvegarde de la nature*. Consejo de Europa, Strasburgo, 54: 1–41. Conseil d'Europe, Strasburg.

Schreiber, A., Wirth, R., Riffel, M. & Van Rompaey, H., 1989. *Weasels, Civets, Mongooses and Their relatives: An Action Plan for the Conservation of Mustelids and Viverrids*. UICN, Gland.

Sidorovich, V. E., 2000. Seasonal variation in the feeding habits of riparian mustelids in river valleys of NE Belarus. *Acta Theriologica,* 45(2): 233–242.

Sidorovich, V. E., Kruuk, H., MacDonald, D. W. & Maran, T., 1998. Diets of semi–aquatic carnivores in northern Belarus, with implications for populations changes. In: *Behaviour and ecology of riparian mammals:* 177–189 (N. Dunstone & M. L. Gorman, Eds.). Symposia of the Zoological Society of London 71, London.

Sidorovich, V. E., MacDonald, D. W., Kruuk, H. & Krasko, A., 2000. Behavioural interactions between the naturalized American mink *Mustela vison* and the native riparian mustelids, NE Belarus, with implications for population changes. *Small Carnivore Conservation,* 22: 1–5.

Sidorovich, V. E., MacDonald, D. W., Pikulik, M. M. & Kruuk, H., 2001. Individual feedings specializations in the European mink, *Mustela lutreola* and the American mink *Mustela vison* in north–eastern Belarus. *Folia Zool*., 50(1): 27–42.

Strachan, R. & Jefferies, D. J., 1997. *Otter survey of England 1991–1994*. The Vincent Wildlife Trust, London.

Tumanov, I. L., 1999. The modern state of European mink (*Mustela lutreola* L.) populations. *Small Carnivore Conservation*, 21: 9–11.

Youngman, P. M., 1982. Distribution and systematics of the Europen Mink, *Mustela lutreola* Linnaeus, 1761. *Acta Zool. Fenn.,* 166: 1–48.