

## Observations on the predation behaviour of the otter *Lutra lutra* in NE Spain

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Adult and sub-adult otters *Lutra lutra* (Linnaeus, 1758) caught and consumed 3.36 prey (fish) per hour ( $n = 32$  captures). This represents 273.8 g of wet mass/h of activity outside the rest sites (10.5–13.1% of the day) and it is enough to get their daily needs. Otters ate the prey without hiding on average ( $n = 93$ ) 0.46 m from the bank (up to 3.9 m) and 0.25 m above water level (up to 2.05 m). Prey weighing less than 150–200 g were consumed entirely; for this reason prey remains are very rare (except large trout, American crayfish and gravide cyprinid females). Unpleasant tasting or toxic parts and sharp or wide parts of the bones, scales, teeth, claws, heads or leggs in large prey were not eaten.

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### Introduction

Many studies on the diet of otter *Lutra lutra* (Linnaeus, 1758) were published in the 1980's, including some from the Iberian Penninsula (see Mason and Macdonald 1986, Riuz-Olmo 1995). They show that this mustelid is a specialist in the consumption of aquatic and amphibian prey. Little is known on its foraging and hunting behaviours or on the energy balance it involves. Early studies were performed in captivity (Erlinge 1967, 1968, Wayre 1970) and were followed by others carried out in the wild, in mainland Scotland and on the Shetland Islands (Hewson 1973, Kruuk and Hewson 1978, Watson 1978, Jenkins 1980, Conroy and Jenkins 1986, Kruuk and Moorhouse 1990, Kruuk *et al.* 1990), generally favoured the diurnal behaviour of otters in these areas. Otters are largely nocturnal in freshwater (Mason and Macdonald 1986). Basic information about energetics, foraging and hunting in this species is lacking. In this paper I present data on foraging and feeding behaviour of the otter in mediterranean habitats.

### Methods

The data presented here were compiled in NE Spain during 1984–1994.

Otter were directly observed on six stretches of the rivers Noguera Ribagorçana, Noguera Pallaresa and Segre, in the Pre-Pyrenean mountains. A total of 801 vigils were carried out until 1993, lasting a total of 1414 h. Otters were observed 139 times during a total of 10 h 46 min.

The duration of every observation, number of prey caught, approximate size and, when possible, the place and the time taken to ingest fish were recorded, for each individual otter.

A total of 308 km of watercourses with otter populations were examined for estimating otter distribution. Otter surveys covered a total of 252.3 km between 1984 and 1992.

Monthly studies of marking behaviour and collecting of spraints (to study otter diet) were carried out in two stretches of 2.6 km and 2 km of rivers Noguera Pallaresa (highland, low productivity and salmonid community) and Noguera Ribagorçana (midland, high productivity and cyprinid community) respectively, over a 12-month period, 1989–1990. These represent a total of 55.2 km. In both rivers, fish constitute between 95 and 100% of prey consumed through the year (Ruiz-Olmo 1995).

In all the cases where remains of prey were found, the taxa of this prey, its distance from the water's edge and its height above water level were recorded. Other predators (mammals, birds, reptilia) consume fish in this area (Ruiz-Olmo and Lopez-Martin 1993). Only remains that could be attributed exclusively to otter, either by identification of spraints of tracks at place or by their direct observation of feeding, were collected.

## Results and discussion

### Frequency of capture and food requirements

The time spent on feeding was calculated from the moment the otter started to bite the prey until it had completely finished eating it (even if this involved a change of place). This was on average 152 sec ( $n = 15$ ,  $SD = 173$  sec, range 1–570 sec). Sixty percent of the fish were eaten in less than 1 minute, and 80% in less than 5 minutes.

On average, otters caught and consumed 3.11 fishes per hour ( $n = 33$  captures). A cub was seen fishing on only one occasion (it was a large cub). The adult and sub-adult otters captured 3.36 fish per hour (one fish every 17.9 minutes;  $n = 32$  captures).

We used average size of Spanish otters (adults and sub-adults, both sexes): 5.73 kg ( $n = 39$ ,  $SD = 1.79$ ) (J. Ruiz-Olmo and M. Delibes, in prep.). According to data of Kruuk *et al.* (1993) otters eat 12–15% body mass/day. Using all these data, on average, Spanish otters eat 0.69–0.86 kg of food per day. The average weight of the fish consumed by otters throughout the year in the study area is 81.5 g ( $n = 500$ ; Ruiz-Olmo 1995). Considering the mean biomass of fish consumed in the study area, this represents 273.8 g/h of activity outside the rest sites. Considering the average daily food requirements of Spanish otters, they need about 151–188 min of their daily activity to obtain this food.

This result (one prey every 17.9 minutes) reveals a greater fish catching frequency than that reported by Watson (1978) in Scotland, with one food item every 29 minutes. This could be related to the difference in the size of the prey or their abundance. The average weight (81.5 g) of our *Barbus graellsii* and *Chondrostoma toxostoma* is low. However it could also bear some relation to the different energetic requirements: less energy expenditure for thermoregulation,

different spatial requirements etc. Also Spanish otters are smaller than those of central and northern Europe (J. Ruiz-Olmo *et al.*, in prep.).

### Eating places

In some cases it was impossible to see where fish were eaten since the otter moved far away, out of the field of view. In the remaining instances ( $n = 22$ ), fish were taken to a fixed spot (stone, rock, gravel or earth) where they could be supported or held firmly, although this was sometimes achieved whilst part of the otter's body was in the water. On only one occasion did the otter hide prey partially in the heliophytic vegetation, composed of *Typha* and *Enea* spp. (but close to the water, having been observed eating). In the rest of cases, the otter ate the prey

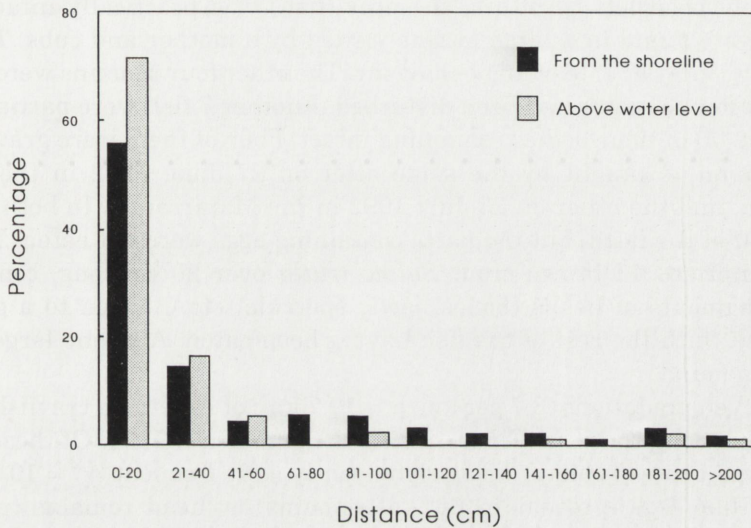


Fig. 1. Distribution of distance from the bank and above water level of positions of prey consumption ( $n = 93$ ).

(fish), without hiding, at the nearest suitable landing place. This indicates that, in cases where the prey was abandoned, it would most likely be found on the river bank or a gravel, or a rock or a stone in the river. For this reason, information on 71 remains of predation found during the itineraries was added to the data derived from direct observation of otters. In total, 93 positions of prey consumption were recorded. Prey were eaten, on average ( $n = 93$ ), at a distance of 0.46 m from the bank (SD = 0.74, range 0–3.9 m) and 0.25 m (SD = 0.45, range 0–2.05 m) above water level. The frequency and distribution of places where otters consumed their prey (Fig. 1) shows that 70% of these were consumed at less than 0.4 m away from the shoreline and 88% at less than 0.4 m above the water level ( $n = 93$ ).

The results obtained contrast with those of Kruuk *et al.* (1990) in marine habitats, who found that the fish are usually consumed in water (86.2%). The

results obtained by Erlinge (1967) are more similar to those presented in this paper. Perhaps the origin of this difference, is in the differences in the structure of the habitat and the distance from the riverbank at which the otter fishes. Our data indicate that the otters ingest their prey near water at the nearest suitable site. On 6 occasions we found the remains of more than one prey at the same eating place, with 3 American crayfish *Procambarus clarki* on one occasion, 3 French noses *Chondrostoma toxostoma* on another, and 2 prey at each of the others. This could show that otters have some site preference.

#### Remains of prey

Prey remains were rarely found in this study area. This may indicate that the otters usually eat the whole prey. In only 6 of the 71 remains counted (8.4%) that had definitely been left by otters, the prey (fish) was practically intact. In two cases, fish were found in a large latrine visited by a mother and cubs. This could be the result of play or of learning behaviour. The other four remains were probably abandoned after the otter had been disturbed. Another 7 fish were partially eaten, with at least 1/3 of their bodies remaining intact. Four of them were gravid female of *C. toxostoma*, 3 caught by the same otter on 27 June 1992 in the Noguera Ribagorçana, and the other on 23 July 1992 in the Matarranya. In both cases the otter ate half of the head, but the parts containing eggs were not eaten. The above remains comprised 11 brown trout *Salmo trutta* over 20 cm long, consisting of heads or fragments of heads (bones, jaws, opercula, etc.), bitten to a greater or lesser degree, with the rest of the fish having been eaten. Also one large cyprinid (> 1 kg) was found.

Fourty seven predations (3.7 per km,  $n = 12.7$  km) of American crayfish *P. clarki* were detected along the river Cinca, during the summer of 1994. Of these remains 93.6% involved claws (Table 1), being significantly more frequent ( $\chi^2 = 10.73$ ,  $df = 1$ ,  $p < 0.001$ ) than legs (present in 65% of remains) or head remains (present in 40.4%;  $\chi^2 = 27.2$ ,  $df = 1$ ,  $p < 0.001$ ). Leg remains were significantly more frequent

Table 1. Frequency of each type of *Procambarus clarki* remains in the river Cinca during the summer of 1994.

Body part	<i>n</i>	%
Head + claws	3	6.4
Head + claws + legs	12	25.5
Head + claws + legs + tail	3	6.4
Head + legs	1	2.1
Claws	13	27.7
Claws + legs	12	25.5
Claws + legs + tail	1	2.1
Legs	1	2.1
Legs + tail	1	2.1
Total	47	100.0

than head remains ( $\chi^2 = 4.26$ ,  $df = 1$ ,  $p < 0.039$ ). These parts, with low digestibility rate and many sharp protuberances, were systematically left uneaten. This contrasts with the low rate of autochthonous crayfish remains (*Austropotamobius pallipes*; 0.05 per km,  $n = 37$  km) in other surveyed localities (rivers Montsant and Matarranya), where this decapod is important in the otter diet (Ruiz-Olmo 1995). The protuberances from the head and claws are less sharp in these species than in the American species.

Otters appeared to eat prey entirely (cf Erlinge 1967, 1968, Chanin 1985). In northern Spain, otter prey are normally smaller than 150–200 g (Callejo 1988, Ruiz-Olmo 1995) and can be consumed completely. The larger items and those which can damage the digestive tract (e.g. teeth of trout, heads and claws of crayfish) are left. Abandoning of the gravid French nases *Ch. toxostoma* could be caused by an unpleasant taste or the toxic content of the eggs. Cyprinid eggs were not found in the otter excrements ( $n = 1660$ ) studied in northeastern Spain (Ruiz-Olmo 1995). Otters do not eat frog eggs (Mason and Macdonald 1986) or toad skins (Fairley 1984, De Jongh 1988, Lizana and Perez-Mellado 1990). Duellman and Trueb (1986) show that the eggs of *Bufo* and other amphibian species contain toxic substances which are avoided by predators. Carss *et al.* (1990) demonstrated that salmon infected by *Saprolegnia*, were consumed less often by otters than healthy salmon.

#### Density of prey remains

In the Noguera Pallaresa stretch the density of prey remains was six times more abundant than in the Noguera Ribagorçana ( $\chi^2 = 6.21$ ,  $df = 1$ ,  $p = 0.013$ ) (Table 2). Low density of prey remains was found in the river Noguera Ribagorçana, just where fish [465.5 kg of fish with total length (TL) > 5 cm/ha,  $n = 5$  sites,  $SD = 472.8$ ; Ruiz-Olmo 1995] and otters (Ruiz-Olmo, in press) are more abundant than in the river Noguera Pallaresa (90.0 kg of fishes TL > 5 cm/ha,  $n = 3$ ,  $SD = 19.9$ ; Ruiz-Olmo 1995). This greater density of prey remains can be explained because eaten fish (*Salmo trutta*) in the Noguera Pallaresa river are bigger (on average 182.5 g,  $n = 233$ ,  $SD = 137.0$ ; Ruiz-Olmo 1995). Sharp or wide parts of the bones, scales and teeth in large prey are dangerous to the digestive system of otters. For this reason, these remains were more often found.

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Table 2. Abundance of prey remains in the two stretches surveyed monthly between November of 1989 and October of 1990.

River	Total surveyed length (km)	Remains per surveyed (km)	Total year remains/km
Noguera Pallaresa	31.2	0.51	6.15
Noguera Ribagorçana	24.0	0.08	1.00

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