

FEEDING TESTS ON CAPTIVE OTTERS *LUTRA LUTRA*

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ABSTRACT – The study was carried out during 1990-91 in "La Torbiera" Faunistic Park (Piemonte region, northern Italy). Feeding experiments were conducted on 4 pairs of otters (*Lutra lutra*) of 2-7 year old, housed in enclosures of 210-360 m² in size with ponds of 20-33 m² and about 1 m in depth. Three foraging tests were done on a pair using eels *Anguilla anguilla*, rainbow trout *Salmo gairdneri* and roach *Rutilus erythrophthalmus*, in order to collect data on dive duration and foraging success. Both parameters varied widely and were influenced by the behaviour of fish prey. For eels, slow moving fishes, the dive duration and the foraging success were lower than those of other fish species. Feeding correction factors, calculated as ratio between the weight of ingested fish and the dry weight of remains in spraints, were determined from a total of 21 experiments carried out on eels, rudd *Scardinius erythrophthalmus* and bleak *Alburnus alburnus alborella*. The factors differed widely between the fish species and the highest value was found for eels.

Key words: *Lutra lutra*, Captivity, Dive length, Foraging success, Feeding correction factors.

RIASSUNTO – *Test alimentari sulla lontra Lutra lutra in cattività* – Lo studio è stato effettuato nel 1990-91 presso il Parco Faunistico "La Torbiera" di Agrate Conturbia (Novara, Piemonte). I test alimentari sono stati condotti su 4 coppie di lontra (*Lutra lutra*) di età compresa tra 2 e 7 anni, tenute in recinti di 210-360 m² provvisti di vasche di 20-33 m² profonde 1 m circa. Tre test sono stati effettuati su una coppia somministrando quantità note di *Anguilla Anguilla anguilla*, Trota iridea *Salmo gairdneri* e Triotto *Rutilus erythrophthalmus*, al fine di valutare la durata delle immersioni e il successo di predazione. Entrambi i parametri variavano ampiamente tra le specie ittiche considerate ed erano influenzati dal comportamento delle stesse. Per l'*Anguilla*, specie dotata di bassa velocità natatoria, la durata delle immersioni e il successo di predazione erano più bassi di quelli registrati per le altre specie. I fattori alimentari di correzione, definiti come rapporto tra il peso di pesce ingerito dalle lontra e il peso dei resti rinvenuti nelle feci, sono stati determinati, attraverso un totale di 21 test, per *Anguilla*, Scardola *Scardinius erythrophthalmus* e Alborella *Alburnus alburnus alborella*. Essi differivano ampiamente tra le specie e quello più elevato è stato riscontrato per l'*Anguilla*.

Parole chiave: *Lutra lutra*, Cattività, Successo di predazione, Tempi di immersione, Coefficienti alimentari di correzione.

INTRODUCTION

The otter *Lutra lutra* is notoriously difficult to study in the wild because of its secretive and prevalently nocturnal habits. On the other hand the research in captivity offers the opportunity to investigate several biological aspects of this species combining both direct observation and recording of its signs of presence.

Diet, feeding ecology and foraging behaviour of the otter have been intensively studied in the wild (for a review see Carss, in this volume) but

results are often questionable. For example, there are various limitations about the assessment of diet by spraint analysis method: results expressed as "percent frequency" or "relative frequency" (see Mason & Macdonald, 1986) can give a misleading picture of otter diet.

In this context, we continued the research on captive otters by Prigioni et al. (1991) undertaking some feeding experiments in order to determine correction factors evaluating the fish intake by remains in spraints (e.g. see Goszczynski, 1974 for the red fox *Vulpes vulpes*), and to test the foraging success of otters in relation to different fish prey.

STUDY AREA AND METHODS

The study was carried out during 1990-91 in "La Torbiera" Faunistic Park (Piemonte region, northern Italy). Feeding experiments were conducted on otters housed in enclosures of 210-360 m² in size with ponds of 20-33 m² and about 1 m in depth; the substrate of ponds consisted of stones and mud. Scrubs, trees and otter sleeping boxes were present.

Three foraging tests were done on a pair of otters (7 years old) using separately eels *Anguilla anguilla*, rainbow trout *Salmo gairdneri* and roach *Rutilus erythrophthalmus*. In each test a quantity of 1.5-2.8 kg of fish of different size (Tab. I) was given to otters which were fasting from 12 hours. About 2 months passed from a test to another and the general conditions of the experiments did not vary. The fish was released into the pools when otters were in the sleeping box or their attention was attracted by other food used as bait by an operator. During the effective time of active hunting (about 40 minutes), the duration in seconds of successful dives (a prey was caught) and unsuccessful dives were timed. Foraging success (FS) was defined as percent ratio between the number of successful dives and the total number of dives.

To determine feeding correction factors for estimating the weight of fish intake by remains in spraints, 21 experiments were done on three pairs of otters of 2-6 years old using a quantity of 0.5-2 kg of *A. anguilla* (9 tests), rudd *Scardinius erythrophthalmus* (6) and bleak *Alburnus alburnus alborella* (6); for each test only a single fish species was offered to the animals. Each experiment lasted 5 days: on the 1st and 2nd day otters were fed on meat, on the 3rd day a weighed quantity of fish was given after removing all spraints from the enclosure, on the 4th and 5th day otters were fed again on meat and all faeces were collected.

Spraints were washed on sieves of 0.05-0.5 mm in mesh and all fish remains were separated. Remains were placed inside an oven at 105 °C per 12 hours and the dry weight was determined using an electronic balance (± 0.001 g)

For each fish species considered a feeding correction factor (FCF) was determined as follows:

$$FCF = \frac{FFW}{DRW}$$

where FFW is the fresh fish weight offered to otters and DRW is the dry weight of undigested remains of fish.

The duration of unsuccessful and successful hunting dives was compared using Wilcoxon test. The foraging success related to different fish species was tested by Chi-square. The Mann-Whitney U test was used to compare the feeding correction factors recorded for each fish prey.

Tab. 1 – Mean weight in g of fish species used for foraging tests (S.D. = Standard Deviation).

FISH SPECIES	N	MEAN	S.D.	MIN-MAX
<i>Anguilla anguilla</i>	20	140.5	23.5	110-220
<i>Salmo gairdneri</i>	19	148.7	55.4	40-240
<i>Rutilus erythrophthalmus</i>	45	33.3	18.9	10-80

RESULTS AND DISCUSSION

There were highly significant differences in unsuccessful (UD) and successful (SD) dive lengths between the fish species, except for roach vs. rainbow trout, while no difference was found comparing UD and SD lengths of a same species (Tab. 2). Foraging success (FS) for rainbow trout was higher than of eel ($\chi^2 = 4.2$

Tab. 2 – Foraging success (%FS) and mean time (in seconds) of otter's dives related to three fish species.

	UNSUCCESSFUL DIVES (UD)			SUCCESSFUL DIVES (SD)			%FS
	N	$\bar{X} \pm SD$	MIN-MAX	N	$\bar{X} \pm SD$	MIN-MAX	
(1) <i>Anguilla anguilla</i>	36	14.2 \pm 8.1	6-46	9	11.9 \pm 4.7	5-17	20.0
(2) <i>Rutilus erythrophthalmus</i>	30	35.4 \pm 14.5	10-63	10	24.6 \pm 4.7	10-39	25.0
(3) <i>Salmo gairdneri</i>	19	29.8 \pm 16.5	9-63	15	26.8 \pm 9.5	12-46	44.1
STATISTICAL SIGNIFICANCE	UD		SD		UD-SD		
(1) vs. (2)	Z = 4.47***		Z = 2.6**		(1)	Z = 0.6 NS	
(1) vs. (3)	Z = 3.36***		Z = 2.7**		(2)	Z = 1.6 NS	
(2) vs. (3)	Z = 0.41 NS		Z = 0.35 NS		(3)	Z = 1.1 NS	

** P < 0.01; ***P < 0.001

P = 0.04). Pooling all data of the three fish species, FS was 28.6%, and UD and SD lengths were similar (UD: mean = 25.1 \pm 11.0, min-max = 6-63, N = 85; SD: mean = 22.2 \pm 10.4, min-max = 5-46, N = 34). These data fall within the range of values found by Nolet et al. (1993) in the wild. In marine habitats (Shetland, U.K.), these authors recorded that the underwater time of successful and unsuccessful dives and the success rate generally increased with the water depth; at a depth of 1-2 m successful dives varied from 11.8 s to 23.2 s, unsuccessful dives from 10.7 s to 25.1 s, and the success rate from 12.6% to 29.8%

In the present study the dive length and the foraging success of otters were influenced by the behaviour of the fish prey. When eels, slow-moving fishes, were released into the pools, they tried to hide under the stones or mud. For this reason otters made various short dives, in order to locate or force out the prey. On the other hand, for rainbow trout and roach, fast-moving species, FS was higher and associated to longer dives, because these fishes tried to save themselves by otters escaping. This behaviour probably induces a major persistent hunting activity by

otters. In a similar study, Erlinge (1968) found that fishes were caught in inverse relation to their ability to escape. Our results agree in general with this indication, although a correct comparison of the data collected in the two studies is not possible because of different feeding tests used.

High significant differences in feeding correction factors were found between the fish species tested (Tab. 3). This was due to the different quantity of bony remains recorded in spraints. For the eel remains were very scarce and constituted by vertebrae, for cyprinid species they were abundant and mainly represented by scales.

Tab. 3 – Feeding correction factors for three fish species. Statistical significance: (1) vs. (2): $Z = 3.12$, $P = 0.002$; (1) vs. (3): $Z = 3.12$, $P = 0.002$; (2) vs. (3): $Z = 2.64$, $P = 0.008$.

FISH SPECIES	N	MEAN	S.D.	MIN-MAX	MEDIAN
(1) <i>Anguilla anguilla</i>	9	525.0	62.2	419.4-605.7	550.1
(2) <i>Alburnus alburnus alborella</i>	6	75.1	11.7	54.3-87.2	78.7
(3) <i>Scardinius erythrophthalmus</i>	6	52.1	5.2	45.5-61.0	51.6

In order to define quantitatively the otter diet in the wild, much caution needs in the use of the feeding correction factors calculated for the fish species considered, because their digestibility, as suggested by Lockie (1959), Goszczynski (1974) and Stahl (1990) in feeding studies on the red fox, can vary in relation to the prey size, sequence of ingestion of prey and age of the predators.

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