

Food Habits of the Otter in the Central Sierra Morena (Cordoba, Spain)¹

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The food habits of the otter *Lutra lutra* (Linnaeus, 1758) have been studied by the analysis of their faeces in both: Guadalmazán and Cuzna rivers, in Sierra Boyera Reservoir, and a stream called Garcia, all situated in the Central Sierra Morena. The diet varies little, being composed of six main categories of prey listed here in order of importance in the diet: fish, amphibians, reptiles, insects, birds and mammals. In four zones studied, the existence of seasonal variations in the diet has been observed. During the wet season, fish constitute the principal nutritional source but then lose importance when contrasted with the rest of the prey found in the low period. The changing of the season, as made clear by the Principal Components Analysis (PCA), is shown to be marked in the rivers than in the reservoir. In the same way local variation which existed chiefly between the food in the two rivers and in the reservoir and corroborated by the PCA and Stepwise Discriminant Analysis (SDA) were observed. The composition of the diet is principally influenced by the availability of the resources and the preference which the otter has towards certain species.

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1. INTRODUCTION

The study in Europe of the otter's food, *Lutra lutra* (Linnaeus, 1758) by the examination of the food remains found in their excrements has been carried out in several habitats: in Sweden (Erlinge, 1967, 1968, 1969), in Ireland (Fairley, 1972; Fairley & Wilson, 1972) and in Great Britain (Stephens, 1957; Hewson, 1973; Webb, 1975; Jenkins *et al.*, 1979; Jenkins & Harper, 1980; Mason & Mac Donald, 1980 and Wise *et al.*, 1981) amongst others.

The bibliography about the otter's diet on the Iberian Peninsula is very limited. At the present time the only work which contributes quantitative and qualitative data based on the analysis of digestive tracts and excrements is that carried out in Galicia (the NW of the Peninsula) by Callejo *et al.* (1979).

In view of such a limited bibliography the prime objective of the

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present study, was to determine the otter's diet, in a zone where its existence could apparently be endangered due to the irregular water flow in the water courses to which it is tightly bound. It has been used multivariate analysis techniques, to study the food of this species with the aim of determining in a more objective and reliable way the local, monthly and seasonal variations as well as the factors which provoke them.

2. METHODS

Study area. In order to determine the otter's diet in the Central Sierra Morena, two rivers: Guadalmez and Cuzna, belonging to different hydrographic basins; a stream: Garcia, which is a tributary of the river Cuzna, and the Sierra Boyera Reservoir, situated at the headwaters of River Guadiato (Fig. 1) were chosen. The climate of this zone, classified as Mediterranean sub-humid, provides a limited and highly irregular water flow, leaving the water concentrated, throughout the lengthy dry season (from the middle of May to the middle of September) in pools isolated one from the other.

Apart from the Sierra Boyera Reservoir, the three remaining sampling zones are situated in areas scarcely influenced by the human population, and where the Mediterranean type termophyle vegetation belonging to the *Querceta ilicis* (C.E.B.A.C., 1971) class predominates, whilst the riverbed of the waterways is protected by a thick maquia.

Analysis of spraints and data processing. The excrements were collected fortnightly in the four indicated zones, following a fixed course, from April, 1979 to March, 1980.

The cleaning of the scats was carried out following the method described by Webb (1976). The identification of the remains was carried out with use of guides, keys and by type collection created for this purpose, and which we based on the following structures: vertebrae, pharyngeal teeth, bone radii, jaw bones, preopercula and opercula bones, and on the extremities, scales, skins, feathers and exoskeletons of insects.

In order to present the data we have followed the method employed by Erlinge (1967, 1968 and 1969) and other authors (Stephens, 1967; Rowe-Rowe, 1977 c; Mason & MacDonald, 1980; among others) in which the data are expressed as a percentage of the relative frequency of appearance. The remains of a prey found in an excrement are considered as belonging to a single captured specimen. The total captured prey of a certain species is given by the sum total of all scats containing the remains of the species.

The variation of the fish population in the area where the scats were collected in the Sierra Boyera Reservoir was carried out by means of sampling with nets — two trammel nets and two gill nets — which were checked every 12 hours in order to avoid saturation. The data obtained were converted by means of fishing effort index (Ricker, 1975), with two nets being used to avoid his selectivity. In order to measure the diet preference index of Ivlev (1961), in according to Cock (1978), was used:

$$P = \frac{Ne/Se - N/S}{Ne/Se + N/S} \quad \text{where}$$

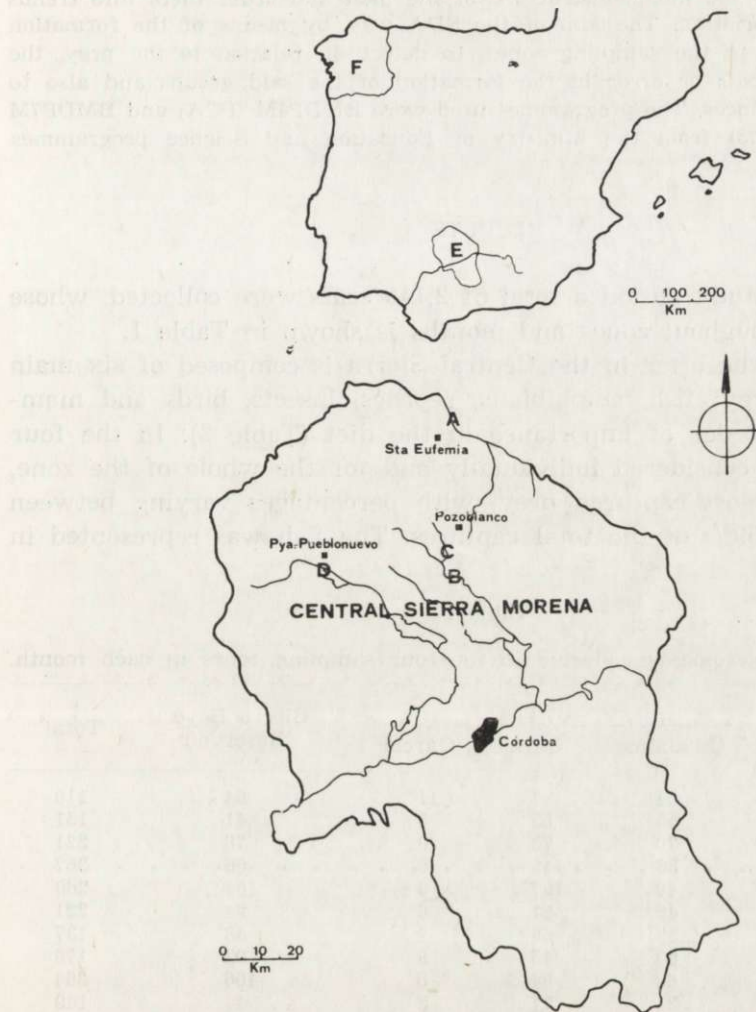


Fig. 1. Position of the province of Córdoba and of the four zones sampled. A: River Guadalmez, B: River Cuzna, C: García Stream, D: Sierra Boyera Reservoir. The letters E (Córdoba) and F (Galicia) indicate the places where, at the present time, the diet of the otter has been studied on the Iberian Peninsula.

N_e — is the number of prey type I eaten; N — is the number of prey initially present; S_e — the total number of prey eaten and S — is the the total number of prey initially present.

As for the multivariant methods, the Principal Components Analysis (PCA) and the Stepwise Discriminant Analysis (SDA) were used to study the specimens collected in the four zones considered monthly and seasonally. The aim of PCA was to attain the ordering of the seasons and months, using the percentages of appearance of each category of prey in the different sampling areas as variables,

in order to detect the internal structure of the data and order them into trends of independent variation. The aim of the SDA was, by means of the formation of a priori groups in the sampling zones, to detect, in relation to the prey, the percentage of success or error in the formation of the said groups and also to detect their differences. The programmes used were BMDP4M (PCA) and BMDP7M (SDA) (Dixon, 1975) from the Ministry of Education and Science programmes library.

RESULTS

During the study period a total of 2,145 scats were collected, whose distribution throughout zones and months is shown in Table 1.

The diet of the otter in the Central Sierra is composed of six main categories of prey: fish, amphibians, reptiles, insects, birds and mammals, listed in order of importance in the diet (Table 2). In the four sampling areas, considered individually and for the whole of the zone, fish were the most captured prey, with percentages varying between 70.56‰ and 82.69‰ of the total captures. The fish was represented in

Table 1

The number of excrements collected in the four sampling zones in each month.

Month	Rivers			Sierra Boyera Reservoir	Total
	Guadalmez	Cuzna	García		
April	34	1	11	64	110
May	55	55	5	41	151
June	70	73	0	78	221
July	86	115	0	66	267
Aug.	49	107	0	104	260
Sept.	46	81	0	94	221
Oct.	12	65	2	58	137
Nov.	60	15	9	92	176
Dec.	68	84	6	106	264
Jan.	31	71	3	44	149
Feb.	39	29	0	41	109
March	47	18	0	15	80
Total	597	709	36	803	2145

the diet by three families: *Cyprinidae*, *Centrarchidae* and *Cobitidae* (in the García stream and the River Cuzna the *Centrarchidae* family did not appear). The first of these families provided the majority of the fish captures. Amphibians — all of the captures referring to *Rana ridibunda* — constituted the second important capture in the diet, except in the reservoir, where the birds took this place. Reptiles, especially *Natrix maura*, and insects too formed an important part in the diet. On the other hand, only few mammals were captured.

Table 2

The composition of the otter's diet in the four zones sampled and for the whole of the Sierra Morena. F=No. of excrements which contain the remain prey. FR%=The percentage of the relative frequency of appearance.

	Guadalmaz River F	597 excr. FR%	Cuzna River F	709 excr. FR%	García stream F	36 excr. FR%	S. Boyera Reser. F	803 excr. FR%	Sierra Morena F	2,145 excr. FR%
INSECTS										
<i>Coleoptera</i>	51	5.04	65	4.78	2	3.85	66	5.75	184	5.15
<i>Orthoptera</i>	39	3.85	39	3.87	2	3.85	41	3.57	184	3.39
Unidentified insects	—	—	1	0.07	—	—	1	0.08	2	0.05
FISHES	12	1.19	25	1.84	—	—	24	2.10	61	1.71
<i>Cyprinidae</i>	510	70.56	617	71.55	33	82.69	711	73.85	1,871	72.17
<i>Rutilus alburnoides</i>	488	61.87	603	63.31	33	80.77	436	40.02	1,560	55.67
<i>Cyprinus carpio</i>	—	—	—	—	—	—	5	0.44	5	0.14
<i>Barbus sclateri</i>	125	12.35	371	27.28	7	13.46	244	21.27	244	6.83
<i>Chondrostoma polylepis</i>	121	11.96	183	13.46	27	51.93	90	7.85	593	16.61
<i>Leuciscus cephalus</i>	351	34.69	281	20.66	7	13.46	107	9.33	438	12.27
Uniden. cyprinids	29	2.87	26	1.91	1	1.92	13	1.13	639	17.89
Centrarchidae									69	1.93
<i>Micropterus salomoides</i>	8	0.79	—	—	—	—	349	30.43	357	10.00
Cobitidae										
<i>Cobitis paludicola</i>	74	7.31	110	8.09	1	1.92	12	1.05	197	5.32
Uniden. fishes	6	0.59	2	0.15	—	—	27	2.35	35	0.98
AMPHIBIANS										
<i>Rana ridibunda</i>	103	10.18	206	15.15	4	7.69	42	7.69	355	9.94
REPTILES	82	8.10	100	7.35	2	3.85	58	5.06	242	6.77
<i>Natrix maura</i>	78	7.71	89	6.54	2	3.85	50	4.36	219	6.13
Uniden. sauria	4	0.39	11	0.81	—	—	8	0.70	23	0.64
BIRDS	57	5.63	9	0.66	—	—	112	9.76	178	4.99
MAMMALS	1	0.10	3	0.22	—	—	7	0.61	11	0.31
<i>Mus musculus</i>	—	—	—	—	—	—	1	0.09	1	0.03
<i>Arvicola sapidus</i>	1	0.10	2	0.15	—	—	2	0.17	5	0.14
<i>Rattus sp.</i>	—	—	—	—	—	—	4	0.35	4	0.11
<i>Orctolagus cuniculus</i>	—	—	1	0.07	—	—	—	—	1	0.03
Uniden. remains	4	0.39	4	0.29	1	1.92	15	1.31	24	0.67

It was in the reservoir where the greatest variety and quantity of prey was recorded, whereas the last recorded was in the García stream, where almost all the captures centred on fish, above all on *Chondrostoma polylepis willkommi*.

1. The Monthly and Seasonal Variation of the Diet in the Different Habitats

The monthly and seasonal variation of the diet was studied in all zones except the García stream, in view of the limited number of scats collected there and irregularity of their distribution throughout the year.

(a) The River Guadalmez. The monthly variation of the different categories of prey can be proved that from May to July fish captures decreased drastically whereas there was an increase in *N. maura*, *R. ridibunda* and above all in birds captures, which displayed a clear seasonality in being captured (Fig. 2). The basis of the diet was constituted by *leuciscus cephalus* which maintained its relative frequency of appearance above those of the remainder of the prey, except in June, when they coincided with the maximum displayed by *N. maura*. During

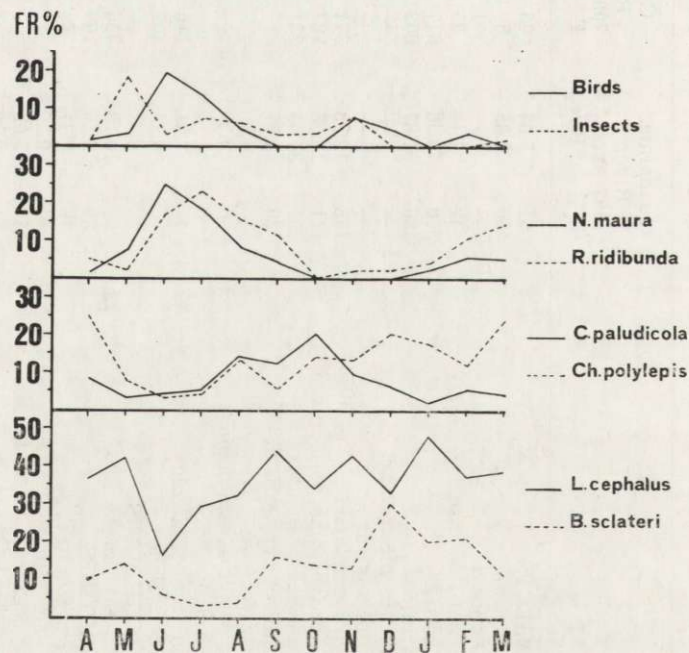


Fig. 2. The monthly distribution of the relative frequencies (FR%) of the prey captured in the River Guadalmez. *A. sapidus*, *M. salmoides* and Sauria are excluded due to their limited percentage.

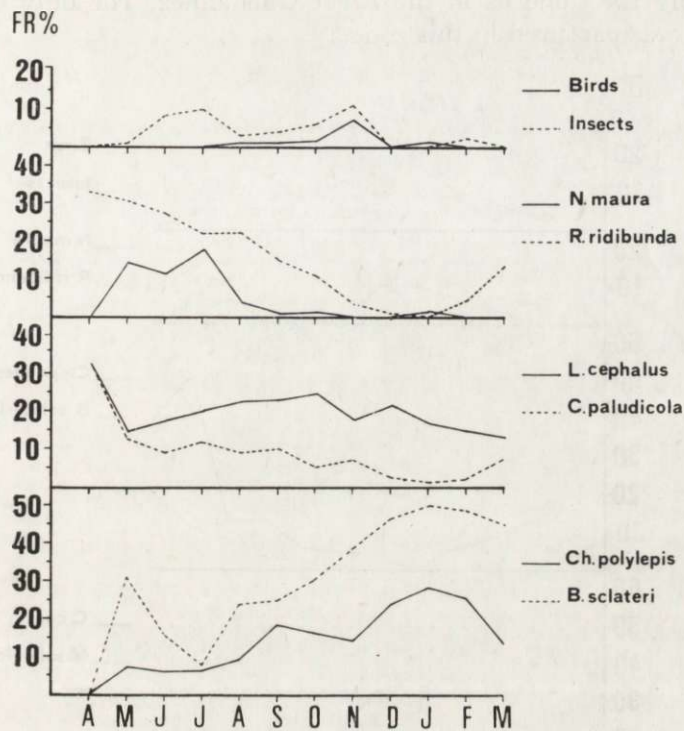


Fig. 3. The monthly distribution of FR%, of the prey captured in the River Cuzna. *A. sapidus*, *O. cuniculus* and Sauria are excluded because of their low FR%.

a very definite period of time — from September to November — a limited quantity of *Micropterus salmoides* was captured. The greater part of *N. maura*, *R. ridibunda*, birds and insects captures took place at a time when the river levels were low.

(b) The River Cuzna. Just as the monthly variation occurred in the River Guadalmez, so too did it occur in the River Cuzna, and in this zone it took place in a more marked form (Fig. 3). As in the previous zone, *L. cephalus* maintained its relative frequencies of appearance fairly constant throughout the year. In general, the most important fish captures took place from August to March, although from April to June more *Cobitis paludicola* were captured. The dominant prey, with regard to fish, was *Barbus sclateri*, amounting to 50% of the total captured prey in January. In this zone birds were infrequent prey of the otter, appearing in a small proportion in the diet from August to January. *N. maura* and *R. ridibunda* were distributed throughout the year ap-

proximately the same as in the River Guadalmez. The only *Oryctolagus cuniculus* was captured in this zone.

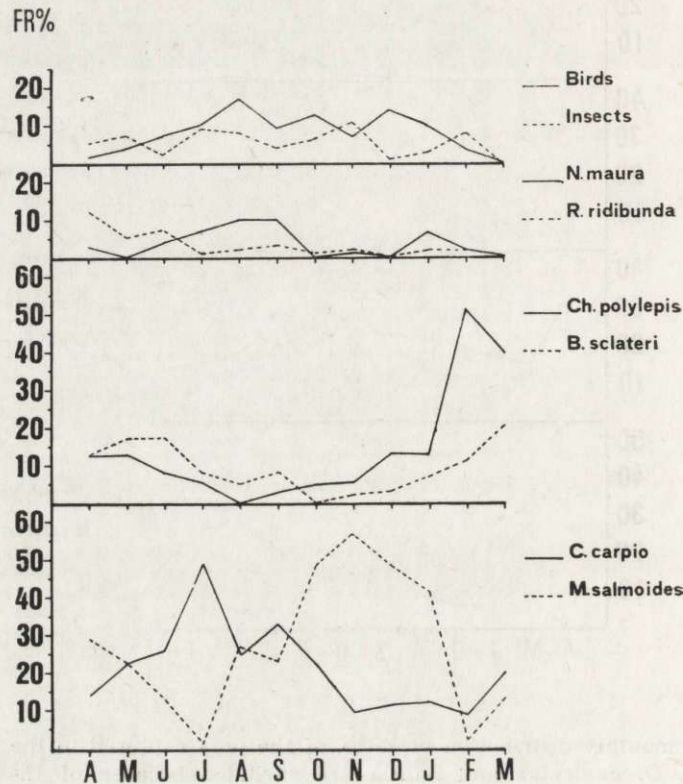


Fig. 4. The monthly distribution of FR% of the prey captured in the Sierra Boyera Reservoir. *R. alburnoides*, *C. paludicola*, Sauria and mammals are excluded because of their low FR%.

(c) The Sierra Boyera Reservoir. In the monthly variation of the relative frequencies of appearance of the different prey it has been observed that fish constituted the basis of the diet during the whole year (Fig. 4). When the frequency of appearance (FR%) of a species decreased there was a corresponding increase in another, allowing the year to be divided up into three periods, in which dominated alternitavely *Cyprinus carpio*, *M. salmoides* and *Ch. polylepis willkommi*. The rest of the fish species were captured in a smaller quantity. The rest of the vertebrates and insects which completed the diet were distributed with different frequencies throughout the year, without standing out particularly at any time, as occurred in the two zones dealt with previously. Birds were an exception, displaying higher frequencies in Summer and

Autumn. It was in this zone that the highest capture percentages of birds and mammals was found, representing at the same time the greatest specific diversity.

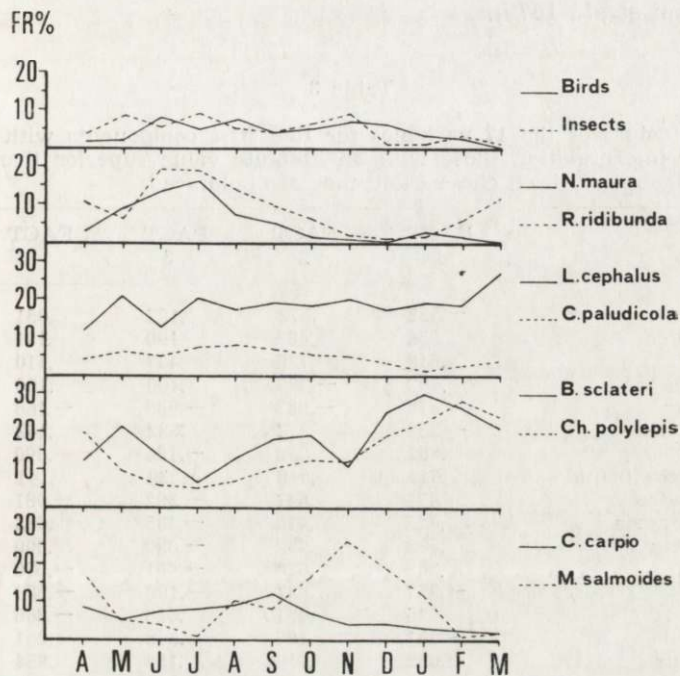


Fig. 5. The monthly distribution of FR% of the prey captured during the study in the Central Sierra Morena. *R. alburnoides*, Sauria and mammals are excluded because of their low FR%.

(d) The Central Sierra Morena. For the whole of the Central Sierra Morena the monthly variation of the different species was subject to the distribution patterns which were displayed individually in the different areas considered (Fig. 5). For example, the frequency of appearance of fish as a whole, decreased at the time understood, between May and July, when the captures of *N. maura* and *R. ridibunda* increased. As occurred in the two rivers, the captures of *L. cephalus* were produced in a fairly stable way during the whole year. The limited captures of mammals occurred from April to September.

2. Comparison of the Diet in the Different Sampling Zones

(a) Monthly variation. For the samples of the diet considered monthly — with the exception of the Garcia stream which produced a limited amount of excrements — the PCA acquired in the first five

axes 75.9% of the total accumulated variance (Table 3), with 28.0%, 18.1% and 12.7% corresponding respectively to the first three axes. The adequacy mean of the samples gathered was 0.57 (Dziuban & Shirkey, 1974; Dziuban *et al.*, 1979).

Table 3

Non rotated factors of the 17 variables for five first components with considered monthly. For interpretation those with an absolute value superior than 0.50 have been chosen, and they are boldfaced.

Variables	FACT 1	FACT 2	FACT 3	FACT 4	FACT 5
1 <i>C. carpio</i>	-.552	.672	.127	.051	.184
2 <i>M. salmoides</i>	.553	.433	.190	.171	.526
3 <i>B. sclateri</i>	.618	-.126	.477	.110	.370
4 <i>C. polylepis</i>	.462	-.306	.400	.150	.480
5 <i>L. cephalus</i>	.873	-.083	-.085	-.166	.024
6 <i>R. alburnoides</i>	-.288	.477	.682	.142	-.345
7 <i>C. paludicola</i>	.861	.232	-.134	-.090	.035
8 Unidentified ciprinids	.644	.010	.230	.141	-.330
9 <i>Natrix maura</i>	.471	.647	-.392	-.081	-.252
10 Unident. Sauria	.325	.410	-.135	.683	.006
11 <i>R. ridibunda</i>	.802	.452	-.090	.000	-.038
12 Insects	.365	.620	-.401	-.070	.036
13 Birds	-.357	.637	-.180	-.286	.303
14 <i>A. sapidus</i>	.225	.421	.618	-.366	.030
15 <i>Rattus</i> sp.	-.251	.487	.568	-.251	-.215
16 <i>M. musculus</i>	-.652	.210	.152	.854	-.064
17 <i>O. cuniculus</i>	-.451	-.147	-.263	.084	-.465
Variance, %	28.0	18.1	12.7	9.6	7.5
Cummulative variance, %	28.0	46.1	58.8	68.4	75.9

After rotation, the existence of three groups was shown on the graph defined axes I and II (Fig. 6A). One group characterized by its strong positive polarity around axis I and which is composed of the species which displayed a greater frequency in the dry seasons of the rivers, formed by: *R. ridibunda*, *N. maura*, *C. paludicola* and insects. A second group composed of the variables which gather together with high values on axis II and are prey were more abundantly present in the excrements gathered in the reservoir, formed by: *C. carpio*, *M. salmoides* and birds. Finally a third group formed of the variables with cluster together around the coordinates centre and in which appear prey which were found together and with greater regularity in the rivers and reservoir.

The months are separated into three groups by PCA (Fig. 6B): one group (G. 1), separated from the rest by axis I, is constituted of the months in which the rivers offered less water and is dominated by the prey with high values on axis I (*R. ridibunda*, *N. maura*, *C. paludicola*

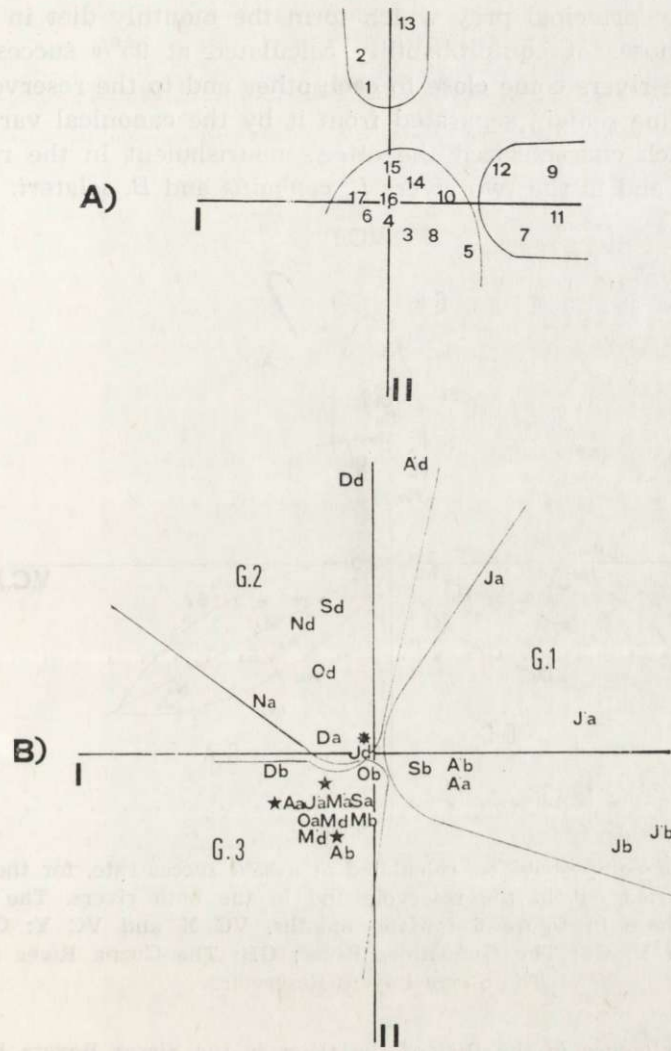


Fig. 6. The ordering of the prey (A) and the months (B) by means of PCA on axes I and II, excluding the Garcia Stream. The prey are expressed as in Table 3. The months are indicated with two letters: the capital corresponding to the month (March, July and August have an apostrophe) and the second letter to the River Guadalmez (a), River Cuzna (b) and Sierra Boyera Reservoir (d).

and insects). Another group is principally formed during autumn and spring of the reservoir, and in which dominated by *C. carpio*, *M. salmoides* and birds. The third group is formed by the rest of the months (G. 3) and is dominated by less characteristic prey for each zone.

(b) Local variation. The SDA (Fig. 7) distinguishes the three functional zones from the principal prey which form the monthly diet in each of them. The ellipses of equiprobability calculated at 95% success rates, reveal that the rivers come close to each other and to the reservoir, and, at the same time remain separated from it by the canonical variable Y. The prey which characterized the otter's nourishment in the reservoir was *C. carpio* and in the two rivers *L. cephalus* and *B. sclateri*.

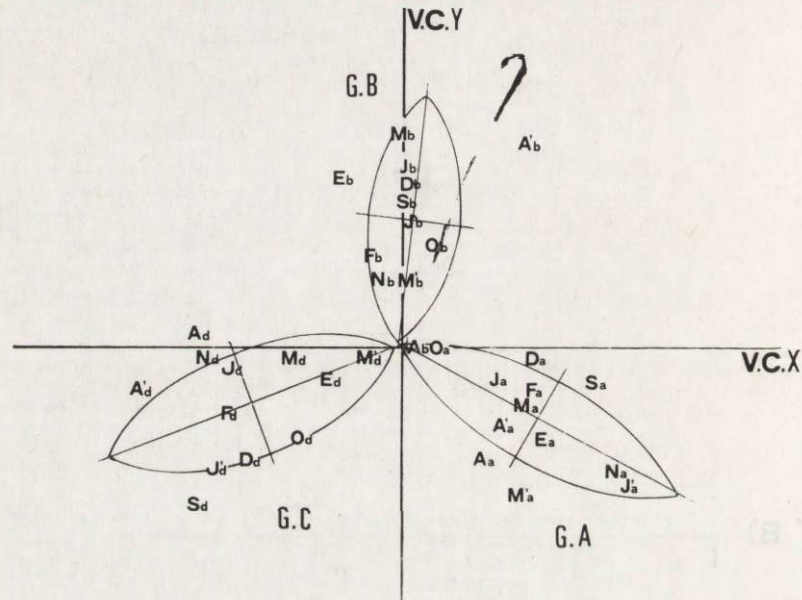


Fig. 7. Ellipses of equiprobability, calculated at a 95% success rate, for the months of sampling carried out in the reservoir and in the both rivers. The symbols correspond to those in figure 6 for the months, VC X and VC Y: Canonical variables X and Y. Ga: The Guadalmez River; GB: The Cuzna River and GC: The Sierra Boyera Reservoir.

3. The Food Preference in the Diet of the Otter in the Sierra Boyera Reservoir

The food preference in the otter's diet, with regard to fish, has been studied in the Sierra Boyera Reservoir, following the evolution of the fish population, by means of sampling with nets, throughout the study year (Table 4) and it has been compared by the otter in this place during the same period of time (Table 4B) (Erlinge, 1967; Wise *et al.*, 1981).

The annual fluctuation in the *C. polylepis* population, the most abundant species in the reservoir, was evident, and there existed a period, June to August and November, when no capture of this species took place with nets. The *M. salmoides* population was maintained regularly

Table 4

The number of specimens present according to the sampling carried out in Sierra Boyera Reservoir, converted, after having been rounded off to complete specimens, by the fishing effort (A). The number of specimens eaten by the otter in the same period and place (B). Ivlev's preference index (C).

	Total	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>Chondrostroma polylepis</i>	A	1,450	80	130	240	150	270	0	0	340	190	0	50
	B	107	8	24	6	15	7	4	0	4	4	7	19
	C	-.73	-.66	-.15	-.30	-.62	-.68	1	1	0	-.92	-.87	1
<i>Micropterus salmoides</i>	A	204	8	0	38	40	25	41	12	23	3	0	4
	B	349	25	1	2	35	12	15	1	46	34	72	68
	C	.57	.73	1	.006	.34	.55	-.66	-.87	-.26	.69	.95	1
<i>Cyprinus carpio</i>	A	35	1	1	0	1	0	0	0	1	0	6	1
	B	244	7	4	2	17	12	30	37	42	48	17	12
	C	.88	.87	.87	1	.95	1	1	.05	1	.99	1	-.77
<i>Barbus sclateri</i>	A	3	0	0	0	1	0	1	0	0	0	0	1
	B	90	4	5	3	16	9	20	6	9	12	0	4
	C	.97	1	1	1	1	.97	1	.62	1	1	0	.36
<i>Rutilus alburnoides</i>	A	17	0	1	3	5	1	2	0	4	0	0	1
	B	5	0	0	0	1	1	2	1	0	0	0	0
	C	-.22	0	-1	-1	-.05	.77	-.28	-1	-1	0	0	-1
Total	A	1,709	89	132	281	196	297	43	35	364	193	6	57
	B	795	44	34	13	84	41	76	49	97	98	59	107
	C	.03	-.29	-.82	-.04	-.54	-.58	.50	.86	-.27	-.21	.94	.60

in the zone sampled and in terms of numbers it was the second important species in the reservoir. The *R. alburnoides* and *C. carpio* populations appeared in lesser number with almost all of the captures later taking place in July. Only three specimens of *B. sclateri* were captured in the year.

It can be observed a priori that the most captured prey by the otter — *M. salmoides* and *C. carpio* — were not the most abundant in the environment, and that a preference existed towards certain species, as made clear by Ivlev's index (Table 4C). Apart from *C. polylepis* and *R. alburnoides* to which the otter displayed a negative preference, the remains had a positive preference with the maximum corresponding to *B. sclateri*.

DISCUSSION

Despite the limited water flow and the lengthy low water period in the water courses of the zones studied, the number of scats gathered in the study year was fairly high. It was precisely in the months when the rivers' waters were at their lowest, that the greatest quantity of excrements were collected (apart from Garcia stream which dried up completely). When the otters became concentrated in the limited water zones, this led to an increase in their density and so to an increase in the number of excrements deposited (Jenkins & Burroughs, 1980) and collected.

The otter's diet in the Central Sierra shows slight diversity with regard to the species captured — 17 categories of prey counted as opposed to the 33 of Callejo *et al.*, (1979) and 28 of Erlinge (1967) — since it exploits in an almost exclusive way the freshwater environment which is poor in species in our zones. Despite this, the exploitation is carried out in a fairly effective way, as the otter obtains almost all of its food from this environment. The full exploitation of the resources gives place to the differentiation of the diet between the different zones sampled, due to the resources of the environment or to the species towards which the otter has a preference. These factors give place to the existence of characteristic prey for each zone. Thus the most characteristic in the reservoir were *M. salmoides* and *C. carpio* and the two in the river were *L. cephalus* and *B. sclateri*, as the SDA made clear.

A similarity was observed between the diet in the two rivers and a differentiation observed with respect to the diet in the reservoir, which is made clear by the PCA and the SDA.

The seasonal changes were more marked in the river currents than in the reservoir. But despite the fluctuations and the populational dy-

namics which certain animals displayed and which had an influence on the composition of the diet when the number of possible prey varied (Wise *et al.*, 1981), the scarcity of water in the water currents had a decisive influence on the diet. In the Sierra Boyera Reservoir, since the quantity of water is almost constant, it does not have an influence upon the fish populations, nor upon those of other prey, and its density of specimens is due to their dynamics, biology or other factors. When Spring and Summer arrived, the number of amphibians and reptiles increased and the early elements in the birds and mammals populations appeared which lead to potential prey increase for the otter. The diet was enriched by other prey besides fish, but without the quantity of fish captures being diminished in such considerable way as in the rivers, since the density of these new prey was limited when compared with the density of fish and with the great volume of water in the reservoir.

In the rivers, the scarcity of water in the low water period and the formation of isolated pools, compelled the fish to migrate to free zones or, as occurred with the remaining categories of prey, to become concentrated in these pools. The inferior swimming abilities of *R. ridibunda* and *N. maura* compared to those of fish, made them more easily captured by otter (Erlinge, 1968) which found an important source of food in them during this period.

The greatest insects captures were all beetles, with the exception of two *Grillotalpa grillotalpa*. These insect capture together with captures of *R. ridibunda* and *N. maura* were produced precisely in the low water period when advantage was taken, as we have already stated, of the great concentration of the latter in the limited water zones.

Reptiles constituted an important prey in the otter's diet in the Central Sierra Morena, where the highest percentages of reptile captures were found, with those of Callejo *et al.*, (1979) being somewhat smaller in Galicia. This constitute a differentiating feature in the diet on the Iberian Peninsula with respect to the rest of Europe.

The results obtained from the birds present a greater difficulty of interpretation, since the food remains could not be identified in their entirety. Nevertheless the presence of feather belonging to *Anas platyrhynchos*, *Gallinula chloropus* and *Fulica atra* could be detected. The River Cuzna and García Stream, offer limited open zones and few aquatic birds and, because of this, the captures were limited or null. On the other hand they were more plentiful in the River Guadalmez and the Sierra Boyera Reservoir where the captures had greater importance. The movements and migrations of the birds and the appearance of early elements in the populations (Wise *et al.*, 1981) had an influence on the captures which caused their seasonality.

Mammals are an occasional prey of the otter in the Central Sierra Morena as is demonstrated by the limited percentage in which they appeared in the diet, which contrast with the 13,3% obtained by Cajelló *et al.*, (1979) in Galicia, the highest for the whole *Lutra* genus. As occurs with reptiles and amphibians the preference towards aquatic species is evident, since the majority of the captures were centred upon *A. sapidus* and *Rattus* sp., which prowl near the bank, among the reeds and bulrushes of the reservoir — the place where the capture of the latter originated. The limited number of mammals captured may be due, in part at least, to competition with other mammals, especially *Vulpes vulpes*, which are plentiful in the zone (Erlinge, 1969 and 1972; Jenkins & Harper, 1980; Wise *et al.*, 1981).

Fish, considered both as separate species, and together, represented the most important prey in the otter's diet in any period of the year, although they were subject to monthly and seasonal variation. It was in the rivers where the greatest difference between the quantity of fish captured in the dry season and the wet season was registered, because of the reasons already explained. For the whole of the Central Sierra Morena the same phenomenon was observed.

In the diet of otters in both rivers the regular presence of *L. cephalus* stood out throughout the whole annual cycle. This is due to the fact that this species is a particular exploiter of the river's habitats. The most captured fish in the River Cuzna was *B. sclateri* since the otter takes advantage of the concentrations of this fish in the deep pools on this river's bed (*B. sclateri* feeds from riverbeds), whereas the River Guadalmez does not offer any of these pools. It was noticed in both rivers that *C. carpio* was not present which may be due to the fact that this species is characteristic of still, deep waters (Castello, 1980). The presence of some *M. salmoides* captures in the River Guadalmez was probably due to the fact that they moved up from the nearby Zujar Reservoir, where they had been introduced artificially to exploit the river's food resources.

The remaining species which complete the diet displayed fluctuations which are probably due to the particular biology and dynamics of the fish populations, unknown at this time on the Iberian Peninsula.

Although *C. polylepis* was the most abundant species in the reservoir, *M. salmoides* and *C. carpio* were the most eaten. Moreover, a clear preference existed towards *B. sclateri*, together with the existence of three periods in the year, with each one dominated by one species. This makes it clear that the most captured prey was not always the most abundant in the environment (Erlinge, 1967; Frined, 1978). The causes for the preferred capture of a certain prey and the monthly fluctuations include factors such as the biology and dynamics of the prey (Erlinge, 1967;

Callejo *et al.*, 1979; Wise *et al.*, 1981) the greatest vulnerability and least ability to escape, their activity, the size of the fish (Erlinge, 1967; Rowe-Rowe, 1977a, b; Jenkins *et al.*, 1979), the situation of the prey (Wise *et al.*, 1981) and the clarity and temperature of the water (Rowe-Rowe, 1977a, b).

We can sum up by saying that in the Central Sierra Morena both seasonal and monthly variations were observed which were produced in the same way as those observed in Great Britain (Jenkins *et al.*, 1979; Jenkins & Harper, 1980; Wise *et al.*, 1981) and in Sweden (Erlinge, 1967) but in a contrary way to those which occurred in Galicia (Callejo *et al.*, 1979).

A local variation could be observed too between the otter's food in the rivers and in the reservoir, which was due to the seasonal variation and to the prey caused principally by amphibians and reptiles, and to the existence of dominant or characteristic prey in the diet of each area. The composition of the diet in our zone is influenced by several factors: (1) The availability of the resources, as is shown by the exploitation of the prey which displayed a marked seasonality and the existence of dominant prey in the diet, which coincided with their abundance in the environment. (2) The preference towards certain species — *B. sclateri*, *C. carpio* and *M. salmoides* — as was evident in the case of the reservoir. (3) The seasonality which certain prey displayed and which gave place to a seasonal variation in the diet. (4) The irregular system of the rivers, which creates a concentration of certain species in the zones with water. (5) The dynamics and biology of the prey populations.

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STOSUNKI POKARMOWE WYDRY W CENTRALNEJ SIERRA MORENA
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Streszczenie

Badania nad składem pokarmu wydry, *Lutra lutra* (Linnaeus, 1758) prowadzono na podstawie analizy kału. Materiał zbierano nad brzegami rzek Guadalmez i Cuzna, strumienia Garcia oraz wokół zbiornika wodnego Sierra Boyera, w Centralnej Sierra Morena (Tabela 1; Ryc. 1). Jeżeli chodzi o rodzaj pokarmu, dieta wydry była mało zmienna i składała się z ryb, płazów, gadów, owadów, ptaków i ssaków (Ryc. 2—5). W czterech badanych strefach wystąpiły jednak pewne sezonowe różnice w składzie diety (Tabela 2, 3). W okresie obfitującym w deszcze, główne źródło pokarmu stanowią ryby, których udział znacznie zmniejsza się, gdy wody zaczyna być mało. Zmiany sezonowe diety oceniono przy pomocy analizy komponentów głównych i stwierdzono, że są one znacznie wyraźniejsze w rzekach niż w zbiorniku wodnym (Ryc. 6). Przy pomocy tego samego testu oraz analizy dyskryminacyjnej, oszacowano różnice w pokarmie wydr żyjących w badanych rzekach i na zalewie wodnym (Ryc. 7). Skład żeru uwarunkowany jest głównie jego dostępnością oraz wybiórczością wydry w stosunku do pewnych gatunków (Tabela 4).