

Some characteristic features of predation in the Iberian Mediterranean ecosystem

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Introduction

The aim of this report is to present some examples serving as introduction to the peculiarities in food habits of Mediterranean Iberian predators in relation with their conspecifics in other latitudes, especially temperate Europe. In this study we consider the limit of Mediterranean Iberia as shown by Emberger *et al.* (1963). The characteristic features of the Mediterranean climate (mild winters and hot and dry summers) are known to increase from North to South in the Iberian Peninsula.

Various theoretical models applied to predation in terms of energy economy allow to deduce that the trophic diversity of a predator is linked very much to the abundance and diversity of its potential preys (MacArthur & Pianka 1966, Schoener 1971). This permits Herrera (1974) to state that «on theoretical grounds one may predict contractions or enlargements of the food-niche depending on changes in prey availability».

In this respect, the community of Iberian Mediterranean vertebrates, compared with this of Central Europe, is characterized among other things for:

a) The relative scarcity of small mammals, when the number of individuals and species are considered. The Microtinae are missing completely, except for one species of *Pitymys*, some *Microtus*, restricted to high and middle altitude mountains, and *Arvicola sapidus*, always found near water.

Even though *Apodemus sylvaticus* and *Eliomys* are very abundant locally, their numbers do not seem to reach the high density of small mammals

populations found in Central Europe. Besides, we must note in connection with predation that *Apodemus* and *Eliomys* are more difficult to capture, because of their greater agility and their habits of living in burrows (Lockie 1964).

b) The extraordinary abundance of the rabbit (*Oryctolagus cuniculus*), that in certain Andalusian localities in spite of myxomatosis permits professional hunters to obtain up to 1000 animals per square kilometer every year, (Amores, unpublished).

As a consequence of a) and b), it is expected that the small Central European predators specialized in the capture of small mammals, will amplify their trophic niche in the Mediterranean or, without altering the niche's breadth, change their usual prey for more abundant ones. On the other hand, middle sized predators (feeding mainly on Hares — *Lepus* ssp. —, Galliformes, young Ungulates, carcasses and small mammals, in Central Europe) should in Southern Spain and Portugal centre their predation on rabbits, thus probably reducing the breadth of their niche.

Let us then analyse the cases of two «small predators» (a bird, *Tyto alba*, and a mammal, *Genetta genetta*) and three middle sized ones (a bird, *Aquila chrysaetos*, and two mammals, the European species of *Lynx*) with the intention of verifying the predictions stated before.

We must point that the food habits of *Tyto alba* and *Aquila chrysaetos* have been analysed in detail in original publications (Herrera 1974, Delibes *et al*

1975b), therefore we shall limit ourselves to present the results of their studies and our own ones on *Genetta* and *Lynx*, with a complete evaluation of the situation.

Results

1. *Tyto alba*

Herrera (1974), precursor of many of the ideas presented here, compares carefully the trophic diversity of the Barn Owl in 48 localities of Western Europe, of which 22 are considered Mediterranean and the rest are of the temperate areas (perhaps an exceedingly simple but very useful classification for the purpose of comparisons).

His results show a strong negative correlation between the latitude and the trophic diversity, (Fig. 1), the latter considered in relation to the number of individuals taken from each taxonomic group and to the biomass obtained from the different groups. This is to say that in Mediterranean areas *Tyto alba* captures a greater variety of prey than in the rest of Europe. In fact, as also shown by Herrera (1973), the Barn Owl feeds in a greater proportion on birds (4.3 % of 14 801 preys), reptiles and amphibians (4.4 %) and invertebrates (4.3 %)

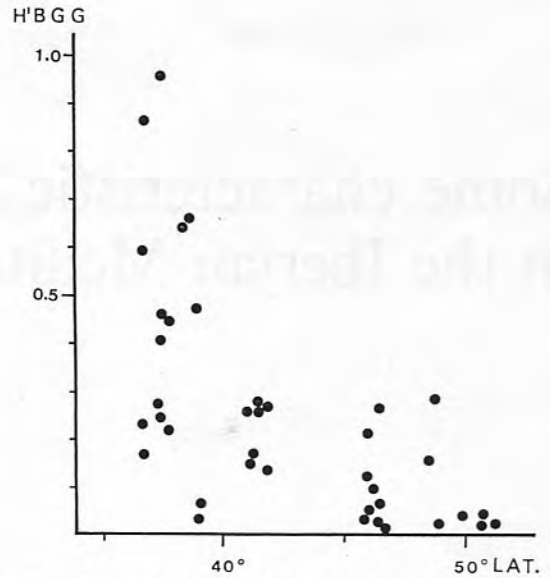
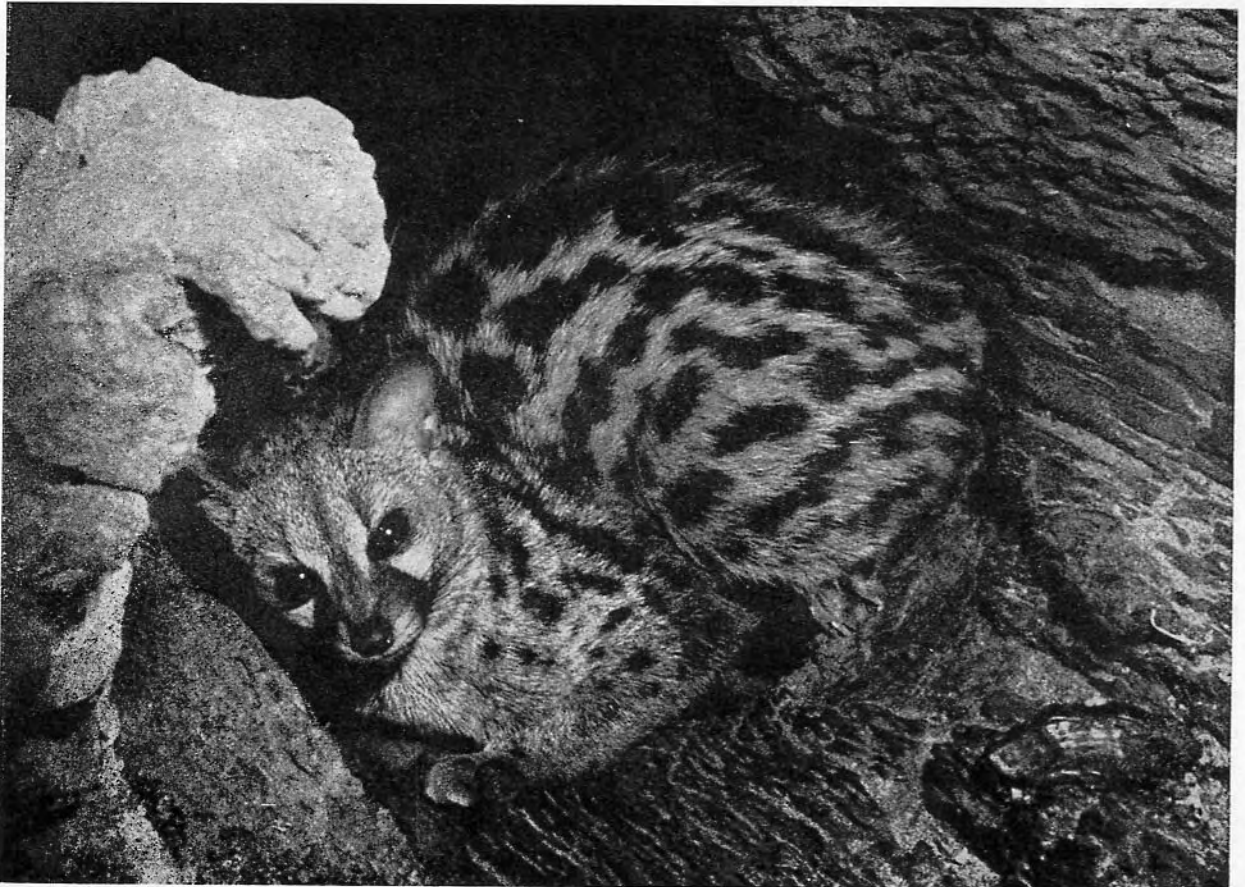


Fig. 1 — Changes of H'BGG (trophic diversity in relation to the biomass supplied by the diverse taxonomic groups to the Barn Owl's diet) with latitude. As seen, «Mediterranean» Barn Owls show a greater trophic diversity than «temperate» ones, feeding more often upon prey other than mammals (from Herrera, 1974)

in Southern Spain than in Central Europe, where as is well known, almost all the captures are small mammals (95.7 % of mammals in 77 602 preys, according to Uttendoerfer, in Geroudet, 1965).



Fot. 1 — The Genet is a «generalist» Mediterranean predator whose diet varies locally. In France and temperate Spain it mainly feeds upon rodents and in Mediterranean Spain mostly upon insects and fruits. (Fot. by I. Boroviczén)

2. *Genetta genetta*

The case of the Genet is somewhat different, since being of North African origin and having settled in the Iberian Peninsula and Southern France, its diet must in all probability have been adapted as an answer to the different density of small mammals in the areas invaded.

The data relative to the Genet's food habits in three different areas in Europe (France and temperate Iberia, Central Spain and Southern Spain — Andalusia and Murcia) are presented in Table I, where our own results of gut contents analysis and

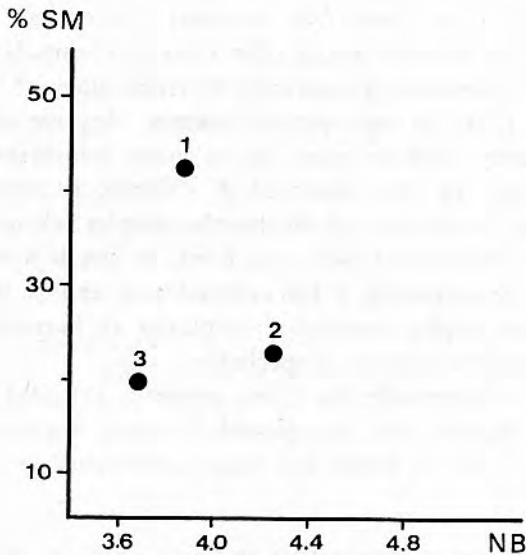


Fig. 2 — Variation of the trophic niche breadth (NB) of the Genet in three regions according to the importance of the number of Small Mammals (SM) in the diet. The Genet does not change substantially trophic diversity with latitude, but its diet. The numbers correspond to: 1 — France and temperate Spain; 2 — Central Spain; 3 — Southern Spain

those found in the literature (Chanudet *et al.* 1967, Valverde 1967, Vericad 1970 and Delibes 1974) are summarized.

As a measure of trophic niche breadth the following expression is used

$$B = \exp \left(-\sum_i p_i \log_e p_i \right)^{(1)}$$

where p_i represents the frequency of each type of prey in the sample.

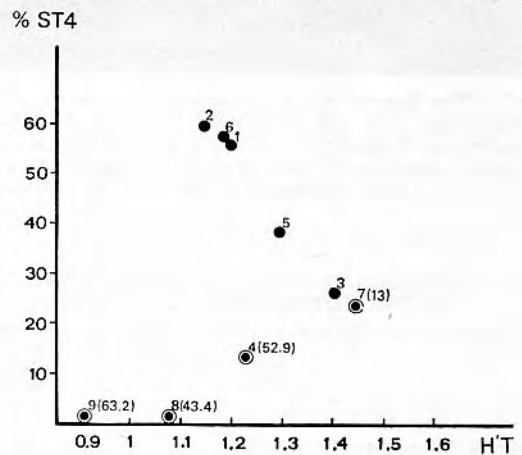
As can be seen in this Table there are not substantial alterations in the trophic niche breadth between the different areas (Fig. 2). There are, however, obvious differences in the representation of the various types of prey in the diet, affecting principally mammals invertebrates and fruits. Although the number of gut contents analysed is not very high, there appears to be a gradual decrease

to the importance of fruits, invertebrates and reptiles (although the latter are not frequently captured by the Genet) as the latitude increases, at the same time there is a higher significance of small mammals in the diet. Birds appear also as important buffer preys.

3. *Aquila chrysaetos*

Delibes *et al.* (1975b) have studied the food habits of the Golden Eagle in three Spanish regions and have compared it with the diet of the same species in other six areas of Europe.

In Spain, there is a noticeable decrease of the trophic diversity in relation to the number of prey items of each species taken (H'S) as well as an increase in the importance of the Rabbit as prey (H'S=2.086 with 13% of Rabbits as prey represented in the North; H'S=1.355 with 43.4% of Rabbits represented in Central Spain; H'S=0.984 with 63.2% of Rabbits represented in the South).



● With *Oryctolagus* in the diet
○ % of *Oryctolagus* in the diet

Fig. 3 — Variation of H'T (trophic diversity in relation to the number of individuals taken from each type of size by the Golden Eagle) with respect to the percentage of the frequencies of captured specimens of size type 4 (*Lepus*, *Tetrao...*; weight between 1800-5400 grs.). The localities in which the Rabbit (size type 3; weight between 600-1800 grs.) is a staple prey are clearly differentiated from the general tendency, showing that ST4 is selected by the Golden Eagle where there is a scarcity the trophic diversity more than any other. The numbers correspond to: 1 — Northern Finland; 2 — Southern Finland; 3 — Estland (U.R.S.S.); 4 — Isl. of Lewis (United Kingdom); 5 — Slovakia (C.S.S.R.); 6 — Alps Mets; 7 — Northern Spain; 8 — Central Spain; 9 — Southern Spain (from Delibes *et al.* 1975b)

This effect stands out even better when comparing the diet of the Golden Eagle in the nine areas considered (from North Finland to Southern Spain), after classifying the preys in groups of different size. It is then noted that where the Rabbit is very abundant (mainly but not only in Mediterranean countries), it becomes the basic prey substitut-

(¹) Levin, 1968.



Fot. 2— The Spanish Lynx is one of the predators of the Mediterranean area whose existence is most threatened. Its staple prey is the Rabbit. The photograph has captured this young specimen in the Doñana Biological Reserve. (Fot. by Ortali; «Animali e Natura», 10, 1974)

ing others of bigger size (*Lepus*, *Tetrao*, *Marmota*...) that play this role in other latitudes. In consequence, the two Mediterranean populations are the ones presenting the least diversity in diet (in relation to the number of prey items of each size class) and therefore smallest niche breadth (Fig. 3).

It is also worth noting that the reptiles, hardly ever captured by the Golden Eagle in the rest of Europe, reach in Spain 12.6 % of preys in the North, 21.7 % in the Centre and 7.6 % in the South.

4. *Lynx lynx* and *Lynx pardinus*

The Iberian Lynx (*Lynx pardinus*) is recognized as being a different species from *Lynx lynx*, since both have coexisted sympatrically in recent times (Kur-tén 1968). In our opinion, however, they are sufficiently close to allow us to make comparisons among the diets observed in different European areas, irrespective of whether the samples belong to the Spanish or Continental *Lynx*. In fact it would not be surprising if the adaptation to exploit different trophic resources had played an important part in the process of speciation.

Unfortunately, the *Lynx*, originally extended in all Europe, has disappeared in many countries, being scarce where still found (Kratochvil *et al.*

Table 1 | GENET'S FOOD HABITS. PERCENTAGES OF NUMBER OF SPECIMENS OF EACH TYPE OF PREY IN THE TOTAL SAMPLE ANALYSED

Localities	No. of gut analysed	No. of preys found	Mammals (Small mammals)	Wild birds	Reptiles	Amphibians	Invertebrates	Fruits	Poultry & Carcass	Niche breadth
France & temp. Spain	47	132	43.2 (43.2)	9.1	0.0	2.3	34.9	3.8	6.8	3.83
Central Spain	125	587	24 (22.8)	11.7	0.9	1.4	42.8	17.9	1.9	4.23
Southern Spain	50	270	25.6 (20.0)	5.6	1.5	0.4	47.0	18.9	0.7	3.67

Table 2 | LYNXES' FOOD HABITS. PERCENTAGES OF NUMBER OF SPECIMENS OF EACH TYPE OF PREY IN THE TOTAL SAMPLES ANALYSED

Localities	Species	Total number of preys	Author	Ungulates	Lagomorpha (Rabbits)	Other Mammals	Birds	Carcass and other types of prey	Niche breadth
Finland	<i>L. lynx</i>	123	Pulliainen & Hyppiä 1975	—	86 (—)	9	5	—	1.64
Sweden	<i>L. lynx</i>	158	Haglund, 1966	54	25 (—)	5	14	1	3.16
Al'ai Mt. (URSS)	<i>L. lynx</i>	56	Dul'keit in Stroganov, 1969	86	7 (—)	—	5	—	1.72
Poland	<i>L. lynx</i>	?	Lindemann in Suminski, 1973	15	42 (—)	18	23	2	3.95
Carpathian Mt. (Rumanin)	<i>L. lynx</i>	46	Hell, 1971	72	2 (—)	24	2	—	2.09
Carpathian Mt. (CSSR)	<i>L. lynx</i>	24	Vasiliu & Decei, 1964	83	— (—)	4	13	—	1.73
Central Spain	<i>L. pardinus</i>	85	Delibes <i>et al.</i> (1975a)	—	60 (56)	27	12	1	2.61
Doñana (S. Spain)	<i>L. pardinus</i>	126	Delibes (unpubl.)	2	87 (87)	4	7	—	1.67

1968a and 1968b). Today it is restricted mainly to mountainous regions, where its diet appears as very much influenced by the peculiarities of mountain ecosystems, such as seasonal fluctuations (Stroganov, 1969). This and a lack of data makes comparisons very difficult, and therefore our results must be interpreted very cautiously, although we think them valid as first approximation to the problem.

In Table 2 we present the frequency percentages of the various types of food in *Lynxes*' diet. The data from Doñana (Spain) were obtained by analysis of scats. The calculation of niche breadth was done by applying expression (1).

It is apparent in this Table that usually the larger *Lynx lynx* pays more attention to ungulates than the smaller *Lynx pardina*. According to our prediction, the great abundance of Rabbits in the Mediterranean area reduces the breadth of the *Lynxes*' trophic niche, but this is also the case in other communities where there are no Rabbits. Probably the specialization of *Lynx lynx* in the capture of ungulates in some regions represents a secondary adaptation, due to a lack of Hares (Haglund 1966). It is also possible that the *Lynx* plays a rôle intermediate between the part played by the «specialist» *Aquila chrysaetos* and that of the «generalist» *Vulpes vulpes*, whose trophic niche breadth does not vary in the Mediterranean region, although many Rabbits are captured (Amores, 1975).

Conclusions

From the examples analysed, and waiting for the results of more profound studies already under way, we can point out some provisional conclusions.

— Small «specialist» predators, that in temperate regions obtain practically the whole of their food by capturing small mammals (as it is the case of *Tyto alba*) tend, in the Mediterranean region, to amplify their trophic niche, capturing prey of less energetic value. In consequence their density may decrease. In the same context, Herrera & Hiraldo (1975) proved that the low number of small mammals could be the determining factor for the absence of several European species of owls breeding in Southern Spain.

— Small not very selective predators, with an ample potential food niche (as is the case of *Genetta genetta*) do not change their trophic diversity with latitude, changing, however their food habits by capturing many small mammals in the North, substituting them in the South with other types of prey (invertebrates, fruits, reptiles...).

— Middle sized predators, specialised in capturing vertebrates (as is the case of *Aquila chrysaetos*)

tend to reduce their trophic diversity in the Mediterranean, concentrating their predation on *Oryctolagus*. If the medium size predator is a «generalist» in its food habits, as appears to be the case for *Vulpes vulpes*, the breadth of the food niche in the Mediterranean region does not vary, even though many Rabbits are captured (Amores 1975). The *Lynxes*' rôle appears to occupy an intermediate position.

— Finally, as a general conclusion, we would like to emphasize the interest and the necessity of further studies about the population dynamics of small mammals and of the Rabbit in Mediterranean countries. Only this will permit an adequate use of the natural resources and an effective management of species threatened with extinction.

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Resumen

La amplitud del nicho trófico de los predadores está muy relacionada con la abundancia y diversidad de sus presas potenciales. En el ecosistema mediterráneo ibérico, carnívoros y aves de presa encuentran a su disposición menos micromamíferos que en la Europa templada, pero un elevado número de Conejos. Las respuestas a esta disponibilidad de presas característica del sur de la Península Ibérica varían de un predador a otro, dependiendo de su tamaño y especialización.

En este trabajo estudiamos los casos de *Tyto alba* y *Genetta genetta* como pequeños predadores, y de *Aquila chrysaetos* y *Lynx* como predadores medianos. Para cada especie se compara su alimentación en el sur de España con la conocida en otros países europeos.

Los resultados obtenidos permiten las siguientes conclusiones: a) los pequeños predadores especializados en la Europa templada en la captura de micromamíferos amplían en el sur de España su nicho trófico. Tal es el caso de la Lechuza. b) los predadores «generalistas», como la Gineteta, no varían la amplitud de su nicho con la latitud, sino su dieta. En el sur de España invertebrados y frutos tienen gran importancia en el régimen, en tanto en el norte la presa común son los micromamíferos.

c) los predadores de tamaño medio especializados en la caza de vertebrados, como el Aguila Real y el Lince, tienden a reducir su diversidad trófica en la Iberia mediterránea, concentrando su predación sobre el Conejo. El efecto es más claro en el caso del Aguila.

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