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Considerations on the structure of the diet of the barn owl (*Tyto alba*) in Sicily (Italy)

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ABSTRACT

About 40% of the pellets of the barn owl (*Tyto alba*), collected throughout the year in open and rural environments in Sicily, contained remains of *Microtus savii*. This percentage is an exception to the low proportions of Microtidae generally present in the barn owl's diet in the Mediterranean region. The biometrical study of 666 mandibles of *M. savii* taken from 1500 pellets allowed us to determine the monthly trend of the four different size classes, corresponding to age classes of this rodent. Adults and subadults were the most frequent prey; the peaks of juvenile and old adult voles were found respectively in May and September, which suggests an average life of 16 months for the voles. *M. savii* was the main component of the diet of the barn owl for eight months of the year, whereas *Apodemus sylvaticus* was the main component for only two months. This distribution of abundance of the few species preyed on by the barn owl agrees with the Motomura model. The regression of logarithm of occurrence of preys on abundance rank is more sloped if *M. savii* is at rank 1 than if *A. sylvaticus* is at the same rank. We found a significant difference between the two slopes. It seems that in Sicily there is a local specialization of the barn owl to prey on *M. savii*. The daily food intake of this owl was estimated at about 80-85 grams, a value lower than that obtained in North-Europe.

KEY WORDS: Barn owl, Diet structure, Daily food intake, Savi's pine vole, Age classes.

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INTRODUCTION

In Northern Europe the Microtidae usually constitute more than 70% of the diet of owls (Strigiformes), whereas in the Mediterranean region these rodents only amount to about 14% of the diet (Mikkola, 1983). In Northern Europe the diet of the barn owl, *Tyto alba* (Scopoli), consists of 22-68% of Microtidae (Mikkola 1983), whereas in the Mediterranean these rodents constitute 12-20% of the diet (Cheylan 1976; Herrera & Hiraldo 1976). Contoli (1981) gives values just above 20% in central and southern Italy. Nevertheless Lovari *et al.* (1976) found a high percentage (about 50%) of Savi's pine voles (*Microtus savii*) in cultivated areas of Central Italy; Massa & Sarà (1982) found about 40% of this rodent in woody areas and about 50% in rural areas of Sicily. These values are an exception to the low proportions of Microtidae in the diet of the Mediterranean barn owls. Since in Sicily no significant correlation has been found between the occurrence of *M. savii* in the diet of barn owls and the vegetation cover (Massa & Sarà 1982), its proportion should probably be correlated to the great abundance of pine voles on the whole island and to the fact that few other species of small mammals are present in Sicily. The aims of this paper were the following: 1) to know the age trend of pine voles preyed on by the barn owl; 2) to describe the structure of the barn owl's diet; 3) to attempt an interpretation of the importance of the barn owl's predation on Savi's pine vole throughout the year.

MATERIALS AND METHODS

We used some material which had previously been examined (Massa, 1981; Di Palma & Massa, 1981; Massa & Sarà, 1982; Sarà & Massa, 1985). This material consisted of 1500 pellets collected monthly at diurnal roosts in open and rural environments in Sicily during the period 1980-84. All the mandibles of voles taken from the pellets were preserved in small envelopes. Drawings of the mandibles were made in order to have a sample of mandibles which are representative of all the months and sizes of voles. We took two measurements of 666 right mandibles: total length and diastema length (Fig. 1). In August and November mandibles were not measured because of the small size of the sample. We subdivided all the values into four different size classes corresponding to age classes: 1) diastema from 2.40 to 3.00 mm: juveniles; 2) from 3.01 to 3.40: subadults; 3) from 3.41 to 3.80: adults; 4) from 3.81 to 4.20: old adults. From these data we established the seasonal trend of the size of the barn owl's prey. Biomass of the pine voles obtained from the pellets was estimated by a regression of body weight (y) to mandible length (x) as calculated from twelve trapped specimens ($y = 5.49x - 43.23$; $r = 0.93$; $P < 0.001$). Biomass of other small mammals was estimated and taken as 21 grams for the wood mouse (*Apodemus sylvaticus*), 12 grams for the house mouse (*Mus domesticus*), 7 grams for the greater white-toothed shrew (*Crocidura russula*) and 2 grams for the pygmy white-toothed shrew (*Suncus etruscus*) (Di Palma & Massa, 1981).

RESULTS

Table I shows the average values of the barn owl's predation on small mammals based on the contents of the pellets. Table II gives values of mandible length

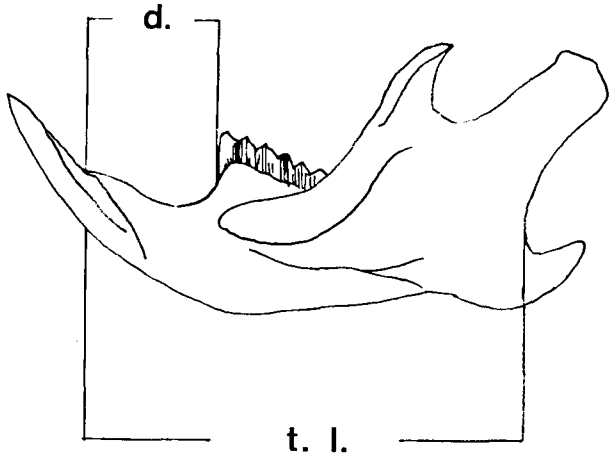

Fig. 1 - Measurements taken from the mandibles of Savi's pine voles. d = diastema length; t. l. = total length of the mandible.

TABLE I - *Small mammals present in Sicily and their percentage in the barn owl's diet. Since all the prey of the barn owl is not reported, the total percentage does not reach 100. Other prey (birds, reptiles, insects, etc.) does not exceed 12%.*

	%	% biomass
Microtus savii	38.5	44.7
Apodemus sylvaticus	17.83	25.8
Crocidura rassula	12.4	5
Mus domesticus	12.13	8
Rattus spp.	2.6	15
Suncus estruscus	2	0.2
Eliomys quercinus	< 0.1	0.1
Chiroptera	< 0.1	0.01
*Muscardinus avellanarius**	–	
Glis glis	–	

* M. avellanarius *was found only once.*

TABLE II - *Average montly length of 666 right mandibles of Savi's pine vole which were obtained from Sicilian pellets of barn owls.*

	X	s.d.	n
J	11.92	0.42	73
F	11.67	0.52	58
M	11.52	0.53	48
A	11.44	0.51	60
M	11.43	0.67	50
J	11.53	0.50	125
J	11.61	0.49	81
A	–	–	–
S	11.35	0.46	77
O	11.82	0.64	40
N	–	–	–
D	11.28	0.42	54

throughout the year. A correlation was found between the lengths of the diastema and the mandible ($r = 0.89$; $P < 0.001$). Since the pellets were collected in different localities throughout the year, we also calculated the mean values for mandible and diastema lengths in each locality, but we found no statistically significant difference among samples from different localities in the same month. Therefore the trend of values of the diastema of the vole is that shown in Figure 2. Adults and subadults are the age classes of voles most preyed upon by the barn owl throughout the year.

The monthly average weight of preyed voles was estimated by quoted regression (Table III column B) to be about 20 grams, a value more similar to that estimated by Contoli *et al.* (1978) than by Massa & Sarà (1982). The mean weight trend decreases regularly from January to May and afterwards it fluctuates until December. Table III column A shows the mean number of preyed voles per pellet. We observe that the mean number of voles per pellet does not increase as its mean weight decreases ($r = 0.1$; $P = N. S.$), whereas it is inversely correlated to the mean number of the other small mammals per pellet (Table III column C) ($r = -0.65$; $P < 0.05$). In the months of May and July we found the highest values of the mean weight and number of preyed voles.

Table III also shows the monthly average weight of the other small mammals (D), their weight per pellet (F), the weight of pine voles per pellet (E), the food intake in grams (G), and the biomass percentage of pine voles to other small mammals (H). The biomass of pine voles preyed on by the barn owl peaks in the summer. The monthly trend of food intake ranges from 36.9 to 55.7 grams (average: 46.9).

DISCUSSION AND CONCLUSIONS

Age of preyed Savi's pine voles. The age trend of preyed voles should show a breeding cycle between February and October with a halt during the winter. The trend of values of the old adults peaks in September whereas that of the juveniles peaks in May, that is four months earlier. Therefore an average life of 16 months can be estimated for Savi's pine vole, just two months less than the average life estimated for the genus *Microtus* (18 months) by Chaline *et al.* (1974). The increase of voles in the diet of the barn owl (April-July) occurs two months after the appearance of the first juvenile voles (February) and may depend on the higher occurrence of old adults (more easily preyed upon) in the same months. The lower percentage of pine voles preyed upon between February and April may depend on the fact that they breed and spend more time in their burrows, or that the high grass makes predation by owls difficult.

Structure of the diet. Only four species of Sicilian small mammals are preyed upon in a percentage higher than 10%, the other species are insignificant, one rodent (*Glis glis*) has not been found till now in the barn owl's pellets; another one (*Muscardinus avellanarius*) was found only once (Siracusa & Ciaccio, 1985) (Table I).

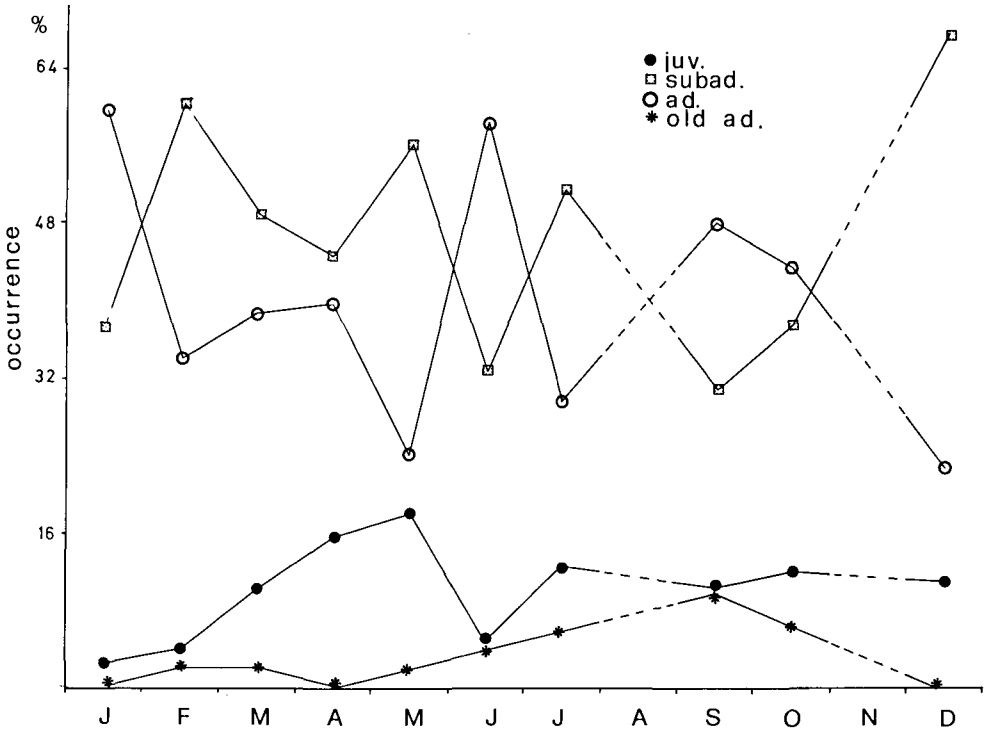

Fig. 2 - Monthly trend of the occurrence of the four age classes of Savi's pine vole according to diastema length.

TABLE III - *Parameters of predation on small mammals by the barn owl in Sicily.*

	A Average No. of *M. savii* per pellet	B Calculated weight of *M. savii*	C Average No. of other small mammals per pellet	D Average weight of other small mammals	E Biomass of *M. savii* per pellet (A × B)	F Biomass of other small mammals per pellet (C × D)	G Biomass of all the small mammals per pellet (E + F)	H % Biomass *M. savii* (E/g)
J	1.4	23.2	1.8	10.8	32.5	19.4	51.9	0.6
F	0.7	20.8	2	16.9	14.6	33.8	48.4	0.3
M	0.9	20	1.5	16.3	18	24.5	42.5	0.4
A	0.96	19.6	1.2	15.1	18.8	18.1	36.9	0.5
M	1.8	19.5	0.7	19.0	35.1	13.3	48.4	0.7
J	1.6	20.1	1.3	16	32.2	20.8	53	0.6
J	2.1	20.5	0.9	14.1	43.0	12.7	55.7	0.8
A	0.8	20	1.3	17.6	16	22.9	38.9	0.4
S	1.9	20	1.4	13.8	26	19.3	45.3	0.6
O	1.5	21.7	1.4	12.3	32.5	17.2	49.7	0.6
N	1.4	20	1.5	12.3	28.0	18.4	46.4	0.6
D	1.6	18.7	0.9	18.4	29.9	16.6	46.5	0.6

There appears to be a local specialization of the barn owl to prey upon Savi's pine voles. Curio (1976) believes that specialization may be a factor for optimization of the predation efficiency. In Sicily the barn owl achieves the maximum specialization recorded in the Mediterranean, allowed by variations of the structure of prey populations. The barn owl's prey does not occur randomly in the diet structure, but its occurrence agrees with a log-linear model, the Motomura model (also called geometrical series model). According to this model a small number of species occurs in the barn owl's diet in such a way that a large hierarchy of abundances is achieved (Fig. 3).

Data concerning the barn owl's diet in Central France were recorded by Henry (1982) using this model. He recognizes at least three different structures of the diet, in which three different species of small mammals occupy the rank 1 of abundance. We recognized only two diet structures of which one resulted more important than the other. The most important structure shows the pine vole at rank 1 of abundance and the other five or six prey species range according to the Motomura model of abundances. The wood mouse is the main component of the diet for only two months, and the other species occur according to the Motomura model (Fig. 3). We calculated monthly regressions of

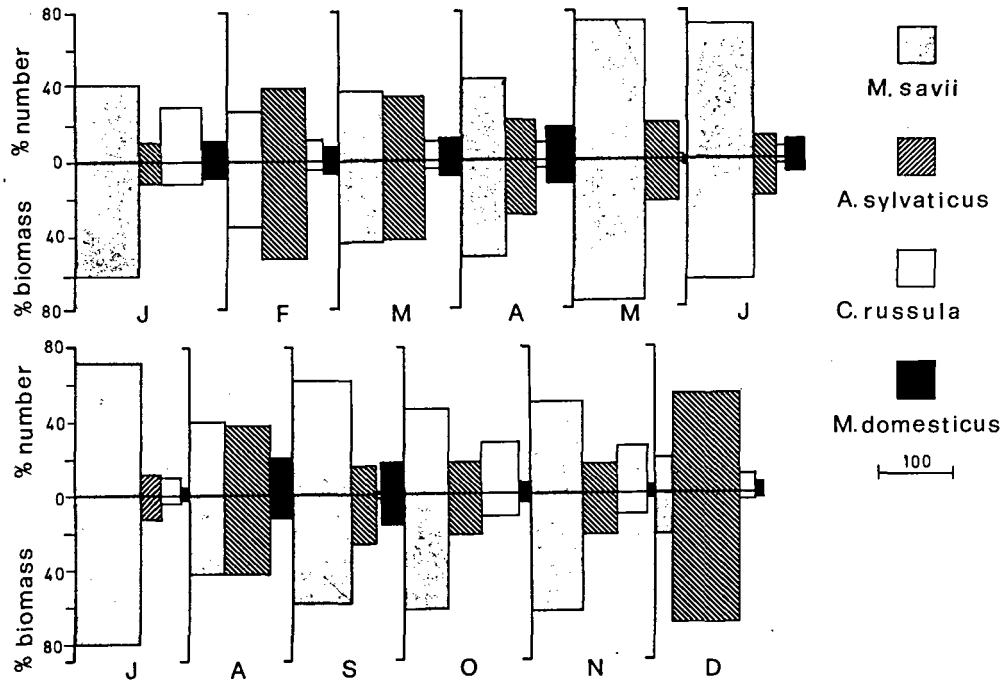

Fig. 3 - Monthly trend of the importance of predation on the four most preyed upon small mammals. Occurrence may exceed 100 because two or more species were often found in a single pellet.

the logarithm of occurrence of prey on the abundance rank (Table IV). As expected, the slope is negative, with values from – 0.186 to – 0.564. The regression is more sloped if Savi's pine vole is at rank 1 than if the wood mouse is at the same rank. We found a significant difference between the two slopes (– 0.360 ± 0.093 and – 0.214 ± 0.028; t of Student = 2.11; $P < 0.05$).

In conclusion, values of the two slopes should suggest that Savi's pine vole is usually not replaced by only one prey, and when it happens, it is only for a very short time, perhaps only one month.

Data of pellets taken in Sicily show that the diet structure of the barn owl did not change and therefore we believe that there were no important fluctuations of small mammals.

Daily food intake. Bunn *et al.* (1982) give 100-150 grams as an average daily food intake for the barn owl, while Mikkola (1983) estimates it as 95 grams. Contoli (personal communication) thinks that the barn owl in Italy, probably for climatic reasons, eats less than in northern Europe and he considers as reliable the value of 80-85 grams per day. The pellets we examined were collected at diurnal roosts and we can consider the prey obtained from them as half the daily food intake. The daily food intake is the sum of the biomass of the preys of one pellet (larger) rejected from a diurnal roost and another (smaller) from a nocturnal one (Bunn *et al.* 1982). The biomass of the contents of the smallest pellets does not correspond to the biomass of the larger ones. The average value that we obtained from the pellets of diurnal roosts was 46.9 grams, therefore 93.8 grams can be calculated as the value for two pellets per day. If we consider that pellets of nocturnal roosts contain a lower number of prey we can consider reliable for Sicily the value of 80-85 grams, suggested by Contoli for Italy.

TABLE IV - *Monthly regression, correlation and significance levels of logarithm of percentage of prey on the abundance rank. The regression resulted more sloped if Savi's pine vole is at rank 1 than if the wood mouse is at same rank ($\bar{x} = -0.360 \pm 0.093$ and -0.214 ± 0.028; t of Student = 2.11; $P < 0.05$). July and September were excluded because of the small size of the samples.*

January	February	March	April	May
y=2.484 -0.336x	y=1.89 -0.186x	y=2.306-0.283x	y=1.926 -0.249x	y=1.951 -0.564x
r = -0.96	r = -0.95	r = -0.95	r = -0.95	r = -0.92
p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01
June	August	October	November	December
y=2.386 -0.368x	y=1.57 -0.43x	y=2.054 -0.353x	y=2.182 -0.297x	y=1.432 -0.242x
r = -0.81	r = -0.91	r = -0.98	r = -0.95	r = -0.86
p < 0.05	p < 0.01	p < 0.001	p < 0.01	p < 0.05

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