PREDATION ON DORMICE IN ITALY

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ABSTRACT – The authors analyse available data on the impact of predators on Dormouse populations in Italy. Dormice are found in the diet of 2 snakes *(Vipera berus* and *V. aspis*), 2 diurnal birds of prey (*Buteo buteo* and *Aquila chrysaetos),* 6 owls *(Tyto alba, Strix aluco, Asio otus, Athene noctua, Bubo bubo* and *Glaucidium passerinum*) and 9 mammals *(Rattus rattus, Ursus arctos, Canis lupus, Vulpes vulpes, Martes martes, M. foina, Meles meles, Felis silvestris* and *Sus scrofa*) in a variable percentage of the prey taken. Only *Dryomys nitedula* was never encountered as a prey item. The most common prey is *Muscardinus avellanarius.* There are significative regional differences in predation between bioclimatic areas of the Italian peninsula. The contribution of studies on predation to knowledge of Myoxid distribution is discussed.

Key words: Myoxidae, Predation, Italy.

RIASSUNTO – *Predazione di Mioxidi in Italia* – Sono analizzati i dati pubblicati sull'impatto dei predatori sulle popolazioni di Myoxidae in Italia. Myoxidae sono stati riscontrati nelle diete di 2 serpenti (*Vipera berus* e *V. aspis*), 2 rapaci diurni (*Buteo buteo* e *Aquila chrysuetos),* 6 notturni *(Tyto alba, Strix aluco, Asio otus, Athene noctua, Bubo bubo* e *Glaucidium passerinum)* e 9 mammiferi *(Rattus rattus, Ursus arctos, Canis lupus, Vulpes vulpes, Martes martes, M. foina, Meles meles, Felis silvestris* e *Sus scrofa*) in percentuale variabile nella comunita di prede. Solo *Dryomys nitedula* non *e* mai stato incontrato come preda. La specie piu coinunemente predata risulta *Muscardinus avellanarius.* Sono discusse le significative differenze di predazione per aree bioclimaticamente diverse e I'apporto dello studio delle predazioni alle conoscenze sulla distribuzione dei Myoxidae in Italia.

Parole chiave: Myoxidae, Predazione, Italia.

INTRODUCTION

Dormice are known to be preyed upon by a variety of predators, but the level of predation appears to be low, especially when compared with that of other micromammals of similar size (Muridae, Arvicolidae) (Morris, 1991).

The aim of the present work is to investigate the recorded predation on dormice in Italy, the potential impacts on the rodent population and the possibility of using this data for biogeographical studies. We have analysed the literature published this century in order to identify possible predators, their consumption of mammals and the proportion of dormice in their diets.

Literature is scarce on this subject and only in the last few years, with the use of owl pellet analysis and a newly found interest in the ecology and behaviour of

the Carnivora, was it possible to collect sufficient data. Problems arose from lack of uniformity among the papers examined, the insufficient data for some predators and the large degree of stochasticity in the presence of these rodents in the diets of many possible predator species, with consequent difficulties of their detection, Finally, some areas of Italy still do not have any faunistic data that might be used to study prey-predator relationships.

MATERIALS AND METHODS

Our work is based only on data drawn from the literature, taking advantage of unpublished information only with regard to occasional or still unstudied "predators" (e.g. *Rattus rattus*, *Sus scrofa* and *Vipera berus*).

We have studied 96 works on birds of prey, mainly owls, but also diurnal predators. For terrestrial predators we have checked 48 papers.

The best-known predators among the birds are *Tyto alba* (67% of the papers on birds) and *Strix aluco* (15%). Among the terrestrial predators, only *Vulpes vulpes* receives much attention, because of its significance to hunting (Prigioni, 1991). Very few papers are currently available covering the Mustelidae, other Carnivora and snakes.

The data published by various authors referring to terrestrial predators is organised in a far less uniform style than for birds of prey. In fact, material is classified on species level in only a few cases, with the majority of instances showing supra-species groupings, such as food categories. This stems from obvious difficulties, particularly in the analysis of faeces. Moreover, figures sometimes refer to the frequency of occurrence in the total number of samples, instead of the prey total; while other studies express the frequency of various food categories in the total amount. **All** this has often resulted in a failure to quantify the data itself, thus reducing an already limited amount of quantitative information and necessitating only a very general level of analysis here.

We have collected data on 373 diets of birds and **48** of terrestrial predators, but for some species only a few stomach analyses are available. So far, about 92000 prey items have been identified from bird pellets in Italy. About 2000 stomachs of terrestrial predators and 12000 scats have been investigated.

RESULTS AND DISCUSSION

1. PREDATORS

For the four Moxyid species found in Italy (*Myoxus glis, Dryomys nitedula, Eliomys quercinus, Muscardinus avellanarius*), the recorded predators are 2 snakes (*Vipera berus* and *V. aspis*), 2 diurnal birds of prey (*Buteo buteo* and *Aquila chrysaetos*), **6** owls (*Tyto alba, **Strix** aluco, Asio otus, Athene noctuu, Bubo bubo* and *Glaucidium passerinum*) and 9 mammals (*Rattus rattus, Ursus arctos, Canis lupus, Vulpes vulpes, Martes martes, M. foina, Meles meles, Felis silvestris* and *Sus scrofa*) (Table 1). For some of them, there is evidence of the presence of dormice in their diets, but no quantitative data.

Only *Dryomys nitedula* has still not been recorded as a prey item, while the

most common prey is *Muscardinus avellanarius*, found in the diet of 14 species. *M. glis* and *E. quercinus* were often present in diets of carnivores, but they appear to be limited to the diet of larger species of owls, such as *Tyto alba*, *Strix aluco* and *Bubo bubo*. These birds have the highest dependence on mammals, in both Mediterranean and temperate environments (Contoli et al., 1989). There may also be some negative selection by small species of owls on account of the size. aggressive behaviour and habitat selection of *Myoxus* and *Eliomys*.

Tab. 1 – Predation on Myoxidae in Italy. (*) Knows predation out of Italy.

	E. quercinus	*D. nitedula*	*M. glis*	*M. avellanarius*
REPTILIA				
Vipera berus			*	*
Vipera aspis				*
AVES				
Tyto alba	*		*	*
Strix aluco	*		*	*
Asio otus	(*)		(*)	*
Athene noctua	(*)		*	*
Bubo bubo	*			(*)
Glaucidium passerinum	(*)			*
Buteo buteo	(*)			*
Aquila chrysaetos	*		*	
MAMMALIA				
Rattus rattus			*	*
Canis lupis	*		*	*
Vulpes vulpes			*	
Ursus arctos	*		*	
Martes martes	*		*	*
Martes foina	*		*	*
Meles meles				*
Felis silvestris	(*)	(*)	*	*
Sirs scrofa			*	
N. OF PREDATORS	8	0	13	14

Analysis of the various categories of recorded predators highlights the disparity in the knowledge of terrestrial predators (Table 2) and birds (Table 3), which have so far received much greater attention.

As regards snakes, there are few studies carried out on the diets of these animals in their environment (e.g. Capula & Luiselli, 1990), with frequent recourse to be had to casual or museum data (Stergulch, 1986; Lapini, 1984). Predation on *M. avellanarius* in particular seems possible for several other species of snakes, such as those of the genus *Elaphe*, but the scarce data available does not include Myoxids among the prey of these snakes (Cattaneo, 1979). Vague information on predation on *M. glis* by *Coluber viridiflavus*, and on *M. glis and M. avellanarius* by *Elaphe longissima* and *E. quatuorlineata* is reported by Bruno (1984): on *M. avellanarius* by *Vipera ammodytes* again by Bruno (1985), but it is not known whether this specifically refers to Italian territory.

R. rattus is known to have been a predator of the young of *M. glis* inhabiting the same den (Lapini, *in verbis*), but while this was undoubtedly an occasional

behaviour, it may indicate potential competition between these species in cases of close cohabitation.

Among the mammals (Table 2), the highest percentage of dormice in diet composition appears in medium-sized Carnivora, such as *Martes* or *Felis*, that are commonly found in environments inhabited by dormice, although the relevant data is still decidedly scanty. **As** regards other small woodland carnivores, we suffer from severe lack of information, and practically nothing is known about individuals of the genus *Mustela* that may be considered potential predators of this group. **A** comparison of available information on other potential terrestrial predators for Italy and the rest of Europe (e.g. Amores, 1980; Debrot, 1981; Delibes, 1978; Kozena, 1990; Tapper, 1976; Weber, 1989) shows generally low predation rates that seem to increase in the Mediterranean area.

Tab. 2 – Predations rate of terrestrial predator. Notes: no Myoxidae found in *M. foina* stomach analyses (n=59). *= only presence recorded.

PREDATOR	N° SAMPLES F: SCATS S: STOMACHS	N° POSITIVE SAMPLES	MAMMALS IN POSITIVE SAMPLES	SPECIMENS N.	%	MAXIMUM REPORTED VALUE (%)
MUSCARDINUS AVELLANARIUS						
Martes foina	F 1546	**6**	390	24	6.15	**12.05**
Felis silvestris	S 93	1	228	21	9	7,4
Canis lupus	F 654	**1**	93	*		
Vulpes vulpes	F 10209	4	710	**14**	1.97	6.58
Vulpes vulpes	S 2014	2	329	2	0.6	0.93
Vipera aspis	S 62	**1**	**165**	*		
Also present in the diet of *Meles meles* and *Vipera berus*						
ELIOMYS QUERCINUS						
Martes foina	F 718	2	290	4	1.38	2.63
Canis lupus	F 654	1	93	*		
Vulpes vulpes	F 10209	2	4585	3+*		0.6
Also recordered in the diet of *Martes martes* and *Meles meles*						
MYOXUS GLIS						
Martes foina	F 828	3	**512**	40	7.18	14
Felis silvestris	S 93	**1**	22	4	**18**	**18**
Vulpes vulpes	F **10209**	2	284	6	2.1	2.56
Vulpes vulpes	*S* **2014**	1	**89**	2	2.25	2.25
Also recordered in the diet of *Rattus rattus, Meles meles, Martes martes, Ursus arctos, Sus scrofa, Vipera berus*						

Among the Canidae, *Vulpes vulpes* is a predator of three species with especially high predation rates on *M. avellanarius*. Cases of predation by *Canis lupus* have been reported, but under conditions in nothern Italy where game or domestic prey are not so easily found (Meriggi et al., 1991). Predation by *Ursus arctos* (Osti, 1979) appears to be a very occasional fact but, as shown by *Sus scrofa* (Santini, ined.), there is a possibility that wild boars in particular actively search for

dormice (especially *M. glis)* in their hibernacula, as happens for other micromammals (Massei & Toso, 1993).

Tab. 3 – Predations rate of avian predators. Notes: No Myoxidae found in birds of prey stomach analyses (n=567).

PREDATOR	N° OF DIETS	TOTAL MAMMALS	N° POSITIVE SAMPLES	%	SPECIMENS N.	%	MAX REPORTED VALUE (%)
MUSCARDINUS AVELLANARIUS							
Tyto alba	250	78967	111	44.4	1288	1.56	36.84
Strix aluco	35	4150	9	25.11	57	1.70	16.07
Asio otus	9	4200	1	1.11	2	0.04	0.30
Athene noctua	10	315	1	10.00	2	0.61	2.67
Glaucidium passerinum	1		1		*		
Buteo buteo	3	37	1		1	0.61	16.67
ELIOMYS QUERCINUS							
Tyto alba	263	81432	14	5.32	39	0.05	2.78
Strix aluco	35	4150	4	\	14	0.42	6.25
Bubo bubo	6	520	1	16.67	1	0.19	0.74
Aquila chrysaetos	2	168	1		1	0.52	0.96
MYOXUS GLIS							
Tyto alba	267	81919	10	4.12	10	0.01	2.56
Strix aluco	35	4150	4	11.43	50	1.49	12.50
Bubo bubo	6	520	2	33.33	11	2.05	5.15
Aquila chrysaetos	3	168	1		1	0.52	1.56

Far more data is available for birds of prey (Table 3). Owls are the group that has been studied most, with greatest attention being devoted to *T. alba, S. aluco* and *A. otus* in this order. Data concerning other species is still sparse or totally non-existent. We have poor data for *Bubo bubo* in Italian territory and only one extensive work is available (Rigacci & Scaravelli, 1992). Some data, recording predation of *M. glis,* came from the neighbouring areas of Istria and Dalmatia (Benussi et al., 1986).

Overall, as regards *T. alba, S. aluco* and *B. bubo,* average predation rates recorded in Italy are usually higher than those found elsewhere in continental Europe (Bitz, 1990), though cases of "food specialisation", are noticeable.

In the classification of predators as "occasional" and "habitual" with reference to their prey (Speakman, 1991), only predation by *T. alba* and *S. aluco* on *M avellanarius* can be deemed to be frequent (with 42.11% and 25.71% of dormice presence in their respective diets in Italy). **All** other predators are clearly occasional, with data missing for some species which are considered highly theriophagous and which share the same forest habitat and could thus theoretically be predators of the group.

2. BIOCLIMATIC AND ENVIRONMENTAL INFLUENCE

There exist few data for the determination of seasonal differences in predation on the Myoxidae. Only for the numerous analyzed sites of *Tyto alba* and only for *M avellanarius* and *E. quercinus* is it possible to show quantitative data (Tab. 4)

(Aloise et al., 1990; Contoli et al., 1983; Petretti, 1977; Siracusa & Ciacco, 1985; Torre, 1983). Some other studies on seasonal diets (Furlani, 1990; Boldreghini et al., 1988) do not mention Myoxidae, and the autumnal data of Sforzi (1991) include those referring to the first collection, which are therefore not datable. At Saracinesca (Monti della Tolfa, Central Italy), with an intermediate bioclimate between the temperate and Mediterranean type, the monthly samples showed predation by *T. alba* on *M. avellanarius* from September to March with 2-5 captures per month and a peak in January with 9 specimens (Aloise & Contoli, unpublished). Two animals trapped in December have also been reported from the Ionian coast of Calabria (Cagnin & Aloise, 1995). Costa (1859) had already asserted that the species does not hibernate, but another southern author (Lucifero, 1907) reported on some specimens found together in the same hibernacula. It is therefore possible that in central and southern areas and/or with a more decidedly Mediterranean climate hibernation may be erratic, with periods of activity in winter too.

Tab. 4 – Seasonal presence of Myoxidae in the diets of *Tyto alba*. B = Bioclimate **type:** M = Mediterraean: T = temperate.

SITE	B	WINTER		SPRING		SUMMER		AUTUMN		REFERENCES
		n	%	n	%	n	%	n	%	
MUSCARDINUS AVELLANARIUS										
M.te Rufeno (Latium)	M-T	8	4 10	*6*	2.8	30	14.5	90	I I2 2	Aloiseetal.. 1990
Saracinesca (Latium)	M-I	17	10.7	2	1.6	3	2.92	8	7.8	Contoli et al., 1983
M te Lungo (Latium)	M							7	*6.6*	Contoli et al., 1983
Castel di Guido (Latium)	M	2	3.45	2	4					Petretti, 1977
ELIOMYS QUERCINUS										
Tamariglio (Sardinia)	M	5	3.62			7	2.06	3	7.14	Tonc, 1983
Rocca Capraia (Sicily)	M			1	0.5	*6*		2	0.7	Siracusa & Ciacco, 1985

In two of the diets shown in Table 5, *M. avellanarius* was preyed on in all seasons, with peaks in winter and summer, but for the other species predation occurs only in winter and autumn. This suggests that the local vegetation structure can also influence predation success of the owl. In deciduous woodlands especially, the susceptibility of *M. avellanarius* to predation can be higher during autumn and winter when there is less vegetation cover. At that time, the owl can better take advantage of mammals in that environment, as suggested for other species of the same ecosystem, such as *Sorex minutus* and *Clethrionomys glareolus* (Aloise et al., 1990). The scarce data for *E. quercinus* does not allow any comment.

Of all the different predators, only two, *T. alba* and *S. aluco* (e.g. Aloise et al., 1993) provide sufficient data to determine the effect on predator-prey relationships played by the location of sites in the various Italian bioclimates. This made it possible to verify a varying degree of predation by these owls on several prey species in temperate or Mediterranean bioclimates (sensu Tomaselli et al., 1973), or in insular environmeiits (Table 5).

E. quercinus should be considered a rare and occasional prey in the diet of *T. alba* in all tlie environments examined, from the point of view of both the predation frequency on the total of mammals and the number of diets in which it is found. This is probably due to the fact that this rather aggressive animal is not a very typical prey of the Barn Owl (Contoli, 1988), but it may also be due to its "patchy" distribution. The latter hypothesis was suggested for at least one of the areas examined (Cagnin & Aloise, 1995). Only when the focus is shifted from temperate to Mediterranean and insular environments does predation by *T. alba* (number of 'positive' diets) show some increase. A far smaller amount of information is available for *S. aluco* than for *T. alba*, although the predation rate appears to be higher as shown by increased local predation rates (up to 6.25%). This is understandable because of the bigger size of the former, making it better equipped against the prey's aggressiveness,. On the other hand, the small number of positive sites seems to support, though indirectly, tlie hypothesis of a patchy distribution.

Tab. 5 – Differences in Myoxidae predation intake by bioclimate type in Italy. T = temperate; M = Mediterranean; I = islands.

	BIOCLIMATE TYPE	MAMMAL TOTALS	SPECIMENS N.	MEAN	% RANGE	SITES N.	POSITIVE SITES	%
ELIOMYS QUERCINUS								
Tyto alba	T	25626	5	0.02	0.50 - 1.69	73	2	2.74
	M	49564	9	0.02	0.05-0.75	137	6	4.38
	I	9869	31	0.31	0.15-2.78	60	6	10.00
Strix aluco	T	2046	10	0.49	01.86-6.25	16	2	12.5
	M	1400	0	0		8	0	0
	I	781	4	0.51	?-0.91	13	2	15.38
MYOXUS GLIS								
Tyto alba	T	25626	1	0 02	0.79	73	1	1.37
	M	49564	9	<0.01	0.2-0.81	137	7	5.11
	I	10356	3	0.03	0.34-2.08	64	3	4.69
Strix aluco	T	2046	0	0		16	2	12.5
	M	I400	10	0.49	01.86-6 25	8	0	0
	I	781	4	0.51	?-0.91	13	2	15.38
MUSCARDINUS AVELLANARIUS								
Tyto alba	T	25626	273	107	0.01-7.59	73	26	35.62
	M	49364	1094	2.21	0.16-36.84	137	91	66.42
	I	7388	*(1)	?		47		
Strix aluco	T	2046	30	1.46	0.38-3.90	16	5	31.25
	M	1400	24	1.71	0.59-4.99	8	3	37.5
	I	781	3	0.38	(2 78)	13	1	7.69

*(1) A only sighteen for Sicilia, without quantitative data (Siracusa & Ciaccio, 1985)

The data concerning *M. glis* as a prey of *T. alba* are extremely homogeneous and low, as expected on account of tlie rather clearcut ecological separation of the two species, as well as of the conspicuous size of *M. glis*. The size factor declines in importance when it comes to *S. aluco*, which is also a wood-dwelling species, as proved by the fact that in individual sites *M. glis* may make up a signficant proportion of the owl's diet (up to 12.50% of the number of mammals), especially

as biomass preyed upon. In this case, too, as for *E. quercinus*, the number of sites is low where predation is verified independently of the bioclimate.

Matters are different for *M. avellanarius*, undoubtedly a common, though not predominant, prey in the diet of *T. alba* (Aloise et al., 1993), so much so that it often forms **a** significant portion of the diet of this bird. The number of sites where predation has been verified is also high (44.4%). The figures referring to both predation rates and the percentage of sites with evidence of predation appear to be considerably higher in Mediterranean than in temperate environments, which confirms that ***M. avellanarius*** is a species strongly, though not exclusively, connected with Mediterranean environments (Contoli, 1981; Amori et al., 1986). Data concerning tlie islands may underestimate the true situation, for in Sicily the species seems to be restricted to tlie north-eastern corner (Sara & Casamento, 1995), while tlie data refers to the island as a whole.

Tab. 6 – Contribution of predation data to faunistical knowledge. **A:** total IGM 1:25000 plates with prescncc of the species. B: plates fill with data coming from sightings, traps or animals found dead. C: plates with data coming from birds of prey diets. Between brackets in percent on **A.** D: plates with data coming from terrestrial predator diets. Between brackets in percent on **A.** E: percentage contribution of data from predation on the total.

SPECIES	A	B	C (%)	D (%)	E %
E quercinus	88	*12*	13 (14.8)	3 (3.4)	18.2
D nitedula	*9*	**9**			
M. glis	100	77	13 (13)	10 (10)	23
M. avellanarius	108	62	33 (30.5)	13 (12)	42.5

3. FAUNISTIC AND BIOGEOGRAPHICAL CONSIDERATIONS

The use of data drawn from the diets of various predators for the purpose of faunistic and biogeographical assessments lias long been debated, especially with reference to micromammals (Contoli et al., 1989). We have tried to use the diet records as a basis for biogeographical studies and Fig.1 shows the national map with I.G.M. (national military institute) grid.

Amori et al. (1995) have presented an updated picture of dormouse distribution in Italy, complete with data obtained with all the existing methods of research. Such data may also include unpublished information on predation. A comparison with the data **in** our hands shows that the study of tlie diets of various predators, especially birds, is a good tool for this type of research (Table 6). For *M. avellanarius*, in particular, this contribution is as high as 42.5% of the total data, with 30.5% coining from predation by birds. It has thus been possible to draw maps showing the distribution of tlie various species in association with the predation pressure exerted on them (Fig. 1).

It is not currently possible to quantify the predation pressure exerted on dormice in Italy, especially in the absence of any estimates of the size and status of populations. Nevertheless, analysis of the diets of predators is not only essential for further insight into the ecology of the prey species, but it can also play a significant role in tlie better knowledge of species distribution.

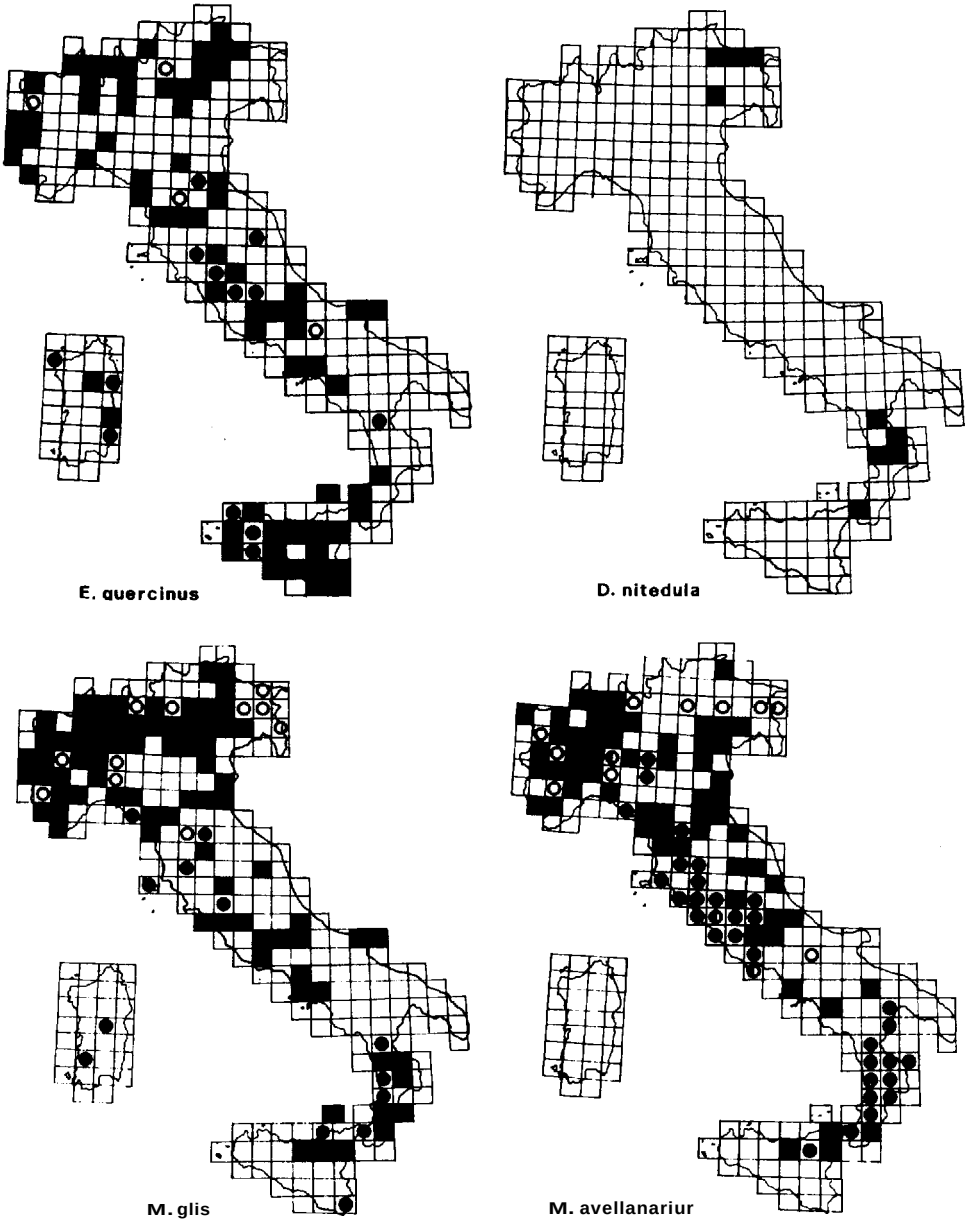

Fig. 1 – Myoxidae distributional data in Italy by origin. ● = from birds of prey. ○ = from others predators. ■ = from others sources.

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