GORTANIA - Atti Museo Friul. di Storia Nat.	20 (1998)	253-262	Udine, 31.X.1998	ISSN: 0391-5859

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ANALYSIS OF SMALL MAMMAL COMMUNITIES IN SOUTH-EASTERN PO VALLEY (NORTHERN ITALY)

ANALISI DELLE COMUNITÀ A MICROMAMMIFERI DELLA PIANURA PADANA SUD-ORIENTALE (ITALIA SETTENTRIONALE)

Abstract - A total of 2,147 small mammals was found in 621 barn owl (*Tyto alba*) pellets collected in 14 different sites in the Po Valley, northern Italy. We identified remains belong to five species of Insectivora and eight of Rodentia. On the total *Microtus savii* (29.6%) and *Apodemus sylvaticus* (20.1%) among Rodentia, and *Crocidura suaveolens* (17.6%) among Insectivora, were the prey occurring most frequently in the pellets. The structure of the communities has been analysed using ecological indices and comparing the habitat of the sites. Wetlands and rice fields are those with the highest occurrence of *Micromys minutus* and the sites with high percentage of agricultural fields present high frequencies of Microtidae, in particular *Microtus arvalis* is present almost only in sites characterised by sowable/ agricultural fields. The cluster analysis obtained through the Bray and Curtis similarity index identified two groups of sites with a partial correspondence to different habitats identifiable in "wetlands" and "agricultural field". The multi-dimensional scaling ordination partly reflects the cluster classification distinguishing the same group of six sites characterised by wetlands and rice fields. The two groups also showed a difference in diversity and evenness. The sites with wetlands present higher diversity and evenness while the sites with agricultural fields are characterised by lower values.

Key words: Small mammal communities, Rodentia, Insectivora, Po valley.

Riassunto breve - *Sono stati analizzati 621 boli di Barbagianni (*Tyto alba*) raccolti in 14 siti distribuiti nella pianura padana orientale. Da questi sono risultati 2.147 esemplari di micromammiferi identificabili in 5 specie di Insettivori e 8 di Roditori. In totale* Microtus savii *(29,6%) e* Apodemus sylvaticus *(20,1%) per i Roditori e* Crocidura suaveolens *(17,6%) per gli Insettivori, sono risultate le specie più predate. La biomassa totale è risultata di 41.521 g. La struttura delle comunità microteriologiche è stata analizzata attraverso la comparazione di alcuni indici ecologici e degli habitat dei diversi siti. Le aree caratterizzate da zone umide e risaie sono risultate quelle con le abbondanze più elevate di* Micromys minutus, *mentre i siti con predominanza a seminativi hanno presentato alte frequenze di Microtidi, in particolare* Microtus arvalis. *L'analisi dei cluster, ottenuta attraverso l'indice di similarità di Bray & Curtis, ha mostrato la ripartizione in due gruppi di siti con una parziale corrispondenza alle differenze delle caratteristiche ambientali identificabili con le aree umide e con i seminativi. Ciò si riflette nella ordinazione della MDS dove si distingue un gruppo, composto da sei siti, caratterizzato da zone umide e risaie. Questi due raggruppamenti mostrano anche una differenza degli indici di diversità e di equiripartizione; il gruppo con aree umide presenta valori più elevati rispetto a quello dominato da coltivi.*

Parole chiave: *Comunità microteriologiche, Rodentia, Insectivora, Pianura Padana.*

Introduction

The barn owl (*Tyto alba*) is not a selective predator, consequently the species recognizable from its pellets are representative samples of the small mammal fauna inhabiting its hunting area.

This makes possible to analyse the small mammal communities and the species distributions in relation to the habitats of the sampling sites where the pellets of the barn owl are collected (Lovari et al., 1976; Contoli & Di Russo, 1985). A number of papers have analysed the barn owl's diet and in some cases investigated the relationship among the prey items and the environment (Bertazzini & Sala, 1978; Boldreghini et al., 1982; Boldreghini & Matteucci, 1983; Boldreghini et al., 1986; Boldreghini et al., 1988; Vicini & Malaguzzi, 1988; Contoli et al., 1989; Bertazzini et al., 1990 Bon et al., 1997). The aim of present paper is to investigate the small mammal communities exclusively, and is a first attempt to a better definition of the communities structural differences in relation to the habitats. The analysis of the potential differences was performed through classical ecological indices and multivariate methods.

Study area and methods

In the study area the intense anthropization and the geomorphologic characteristics have determined a poor differentiation of the habitat with a consequent environmental homogeneity. As a matter of fact the natural vegetation cover of the north-eastern alluvial plain of the Po river has almost completely been replaced by agricultural fields (sowable lands, orchards and vineyards, poplar groves and rice fields); only a small portion is still covered by plain forest and woods, mostly coastal ilex groves and pine woods. Wetlands too have been drastically reduced due to soil reclamation, and today they are limited to the Po river delta or scattered in small parcels. The fourteen sampling sites well represent the territory pattern.

The sampling was carried out examining *Tyto alba* pellets according to a well established methodology (Chaline et al., 1974; Contoli, 1980). The pellets of barn owl were collected from 1988 to 1994 in 14 sampling sites in the Po Valley (fig. 1) according to roosts availability in the different environmental categories. At each site the pellets were found in isolated farm houses, barns or ruins. The pellets were broken apart in laboratory and diagnostic remains of small mammals (skulls, mandibles and girdles) were determined according to Toschi & Lanza (1959), Toschi (1965), Chaline et al. (1974), Contoli (1980), Di Palma & Massa (1981).

The biomasses of the single species were computed using the average of the values reported by Toschi & Lanza (1959) and Toschi (1965), while for *Suncus etruscus* Boldreghini

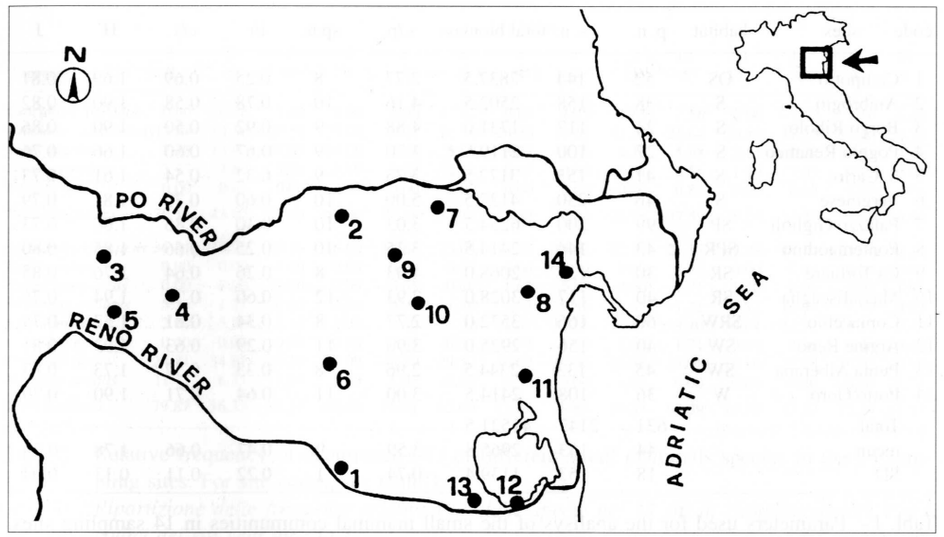

Fig. 1 - Location of the study area and distribution of 14 sampling sites in the Po Valley, northern Italy. For site codes, see table 1.
- *Localizzazione dell'area di studio e distribuzione dei 14 siti di campionamento. Per i codici dei siti vedi tabella 1.*

& Matteucci (1983) was followed. In the case of *Rattus norvegicus* the biomass was arbitrary considered of 300 g since the preyed specimens were all juveniles.

In order to analyse the small mammal community, the following indices were used: the thermoxerophily index (Crocidurinae/Soricidae) (Contoli, 1980), the environmental assessment index (Insectivora/Rodentia) (Contoli, 1980), the diversity index (H') according to Shannon & Weaver (1963), and the evenness index (J) (Pielou, 1969).

Similarity among sampling sites was investigated by cluster analysis using the Bray and Curtis similarity index (Southwood, 1978), after double square root transformation of data, UPGMA (unweighted pair group method averages) was the linkage method used (Sneath & Sokal, 1973). The ordination of sampling sites was performed according to multi-dimensional scaling (MDS) (Kruskal, 1964).

To determine the environmental characteristics of each sampling site the mean hunting territory of the barn owl was taken into consideration; we referred to a mean hunting territory as an area of 12.56 km² having a radius of 2 km and the centre at the sampling site. Since several estimates of the minimum radius are reported in the literature, from a minimum radius of 460 m (Evans & Emlen, 1947) to a maximum radius of 5,000 m (Petretti, 1977), we chose the same value (2 km) used by Lovari et al. (1976) in their study area in Tuscany.

code	sites	habitat	p. n.	s. n.	total biomass	s./p.	sp.n.	i/r	c/s	H'	J
1	Campotto	OS	52	144	2837.5	2.77	8	0.25	0.69	1.69	0.81
2	Ambrogio	S	38	158	2502.5	4.16	10	0.78	0.58	1.90	0.82
3	Borgo Ribolo	S	24	117	1731.0	4.88	9	0.92	0.50	1.90	0.86
4	Poggio Renatico	S	27	100	2119.5	3.70	9	0.67	0.60	1.66	0.76
5	S. Carlo	S	41	153	3172.5	3.73	9	0.32	0.54	1.61	0.73
6	Verginese	S	46	230	4137.5	5.00	10	0.60	0.79	1.81	0.79
7	Palazzo Giglioli	SP	99	300	6254.5	3.03	10	0.40	0.86	1.68	0.73
8	Pontemaodino	SPR	43	144	2414.5	3.35	10	0.25	0.66	1.85	0.80
9	Ca Torbiere	SR	30	121	2068.0	4.03	8	0.26	0.64	1.76	0.85
10	Massafiscaglia	SR	40	117	3028.0	2.93	12	0.60	0.75	1.94	0.78
11	Comacchio	SRW	60	166	3572.0	2.77	8	0.34	0.81	1.57	0.75
12	Argine Reno	SW	40	156	2925.0	3.90	11	0.29	0.63	1.93	0.81
13	Punta Alberana	SW	45	133	2344.5	2.96	8	0.33	0.52	1.73	0.83
14	Porto Goro	W	36	108	2414.5	3.00	11	0.64	0.71	1.90	0.79
	Total		621	2147	41521.5						
	mean		44	153	2965.8	3.59	9	0.47	0.66	1.78	0.79
	SD		18	53	1139.4	0.74	1	0.22	0.11	0.13	0.04

Tabl. 1 - Parameters used for the analisys of the small mammal communities in 14 sampling sites. Habitats: O, orchard and vineyard; P, poplar-plantation; R, rice-field; S, sowable; W, wetland. p.n., pellets number; s.n., specimens number; s./p., number of specimens per pellet; sp.n., species number. Biomass expressed in grams. i/r, environmental assessment index; c/s, thermoxerophily index; H', diversity index; J, evenness index.
- *Parametri usati per l'analisi delle comunità microteriologiche nei 14 siti di campionamento. Habitat: O, frutteti e vigneti; P, pioppeti; R, risaie; S, seminativi; W, zone umide; p.n., numero borre; s.n., numero esemplari; s./p., numero di esemplari per borra; sp. N., numero specie. La biomassa è espressa in grammi. i/r, indice di valutazione ambientale; c/s, indice di termoxerofilia; H', indice di diversità; J, indice di uniformità.*

The environmental categories of each sampling site were identified with reference to the maps of soil use published by the Emilia-Romagna region (scale 1 : 25,000), at each site was then attribute an abbreviation describing the main habitats present (table 1).

Results

The sampling yielded a total of 621 pellets from which 2,147 specimens of small mammals were obtained (table 1), 5 species of Insectivora and 8 of Rodentia, were identified.

In all the fourteen sampling sites Rodentia present a relative abundance frequency always higher than Insectivora (table 2). Among Rodents does not exist a single dominant species, but *Microtus savii* has the highest relative abundance frequency in 10 sites (fig. 2a). On the contrary among Insectivores a single species, *Crocidura suaveolens*, is always dominant according to Bon et al. (1997); nevertheless there are some remarkable variations in the

	sites													
species	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %
Crocidura leucodon	0.00	10.76	3.42	1.00	0.00	10.87	0.00	1.39	1.65	2.56	0.00	1.92	1.50	6.48
Crocidura suaveolens	13.89	14.56	20.51	23.00	13.07	18.70	24.33	11.81	11.57	25.64	20.48	12.18	11.28	21.30
Sorex araneus	2.78	13.92	17.95	10.00	7.84	5.65	3.33	6.25	4.13	5.98	3.61	0.64	4.51	7.41
Suncus etruscus	3.47	3.80	5.98	6.00	3.27	2.17	0.67	0.69	3.31	2.56	1.20	7.05	7.52	0.93
Neomys sp.	0.00	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85	0.00	0.64	0.00	2.78
Total Insectivora	20.14	43.67	47.86	40.00	24.18	37.39	28.33	20.14	20.66	37.59	25.29	22.43	24.81	38.90
Apodemus sylvaticus	36.81	10.76	10.26	18.00	17.65	23.04	13.67	15.97	22.31	21.37	43.98	11.54	24.06	11.11
Rattus rattus	0.00	0.00	0.00	0.00	0.00	0.43	0.00	0.69	0.00	2.56	0.00	0.64	0.00	0.00
Rattus norvegicus	0.00	0.00	0.00	2.00	0.65	0.00	1.67	0.00	0.00	1.71	1.20	0.00	0.00	1.85
Micromys minutus	5.56	1.27	0.85	0.00	0.00	1.30	7.33	29.86	11.57	1.71	4.82	16.67	1.50	0.93
Mus domesticus	2.08	3.16	5.13	2.00	9.80	7.39	11.67	14.58	11.57	9.40	9.04	23.72	19.55	0.93
Arvicola terrestris	0.00	0.00	0.00	0.00	0.65	0.87	0.33	1.39	0.00	1.71	0.00	2.56	0.00	0.00
Microtus savii	24.31	34.81	28.21	37.00	45.10	29.57	36.67	17.36	33.88	23.93	15.66	22.44	30.08	30.56
Microtus arvalis	11.11	6.33	7.69	1.00	1.96	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	15.74
Total Rodentia	79.87	56.33	52.14	60.00	75.81	62.60	71.67	79.85	79.33	62.39	74.70	77.57	75.19	61.12

Tabl. 2 - Relative frequency of occurrence (%) of different small mammals species in the 14 sampling sites. For site codes, see table 1.
- *Ripartizione delle frequenze relative (%) delle specie nei 14 siti di campionamento. Per i codici dei siti vedi tabella 1.*

		sites												
species	average biomass	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %
Crocidura leucodon	10.5	0.00	7.13	2.43	0.50	0.00	6.34	0.00	0.87	1.02	1.04	0.00	1.08	0.90	3.04
Crocidura suaveolens	3.5	2.47	3.22	4.85	3.80	2.21	3.64	4.09	2.46	2.37	3.47	3.33	2.27	2.24	3.33
Sorex araneus	8.5	1.20	7.47	10.31	4.01	3.22	2.67	1.36	3.17	2.06	1.96	1.43	0.29	2.18	2.82
Suncus etruscus	2.0	0.35	0.48	0.81	0.57	0.32	0.24	0.06	0.08	0.39	0.20	0.11	0.75	0.85	0.08
Neomys sp.	11.0	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.00	0.38	0.00	1.37
Total Insectivora		4.02	18.74	18.40	8.87	5.74	12.89	5.51	6.59	5.83	7.03	4.87	4.77	6.16	10.64
Apodemus sylvaticus	26.0	48.56	17.66	18.02	22.08	22.13	33.31	17.04	24.77	33.95	21.47	53.14	16.00	35.49	12.92
Rattus rattus	160.0	0.00	0.00	0.00	0.00	0.00	3.87	0.00	6.63	0.00	15.85	0.00	5.47	0.00	0.00
Rattus norvegicus	300.0	0.00	0.00	0.00	28.31	9.46	0.00	23.98	0.00	0.00	19.82	16.80	0.00	0.00	24.85
Micromys minutus	7.0	1.97	0.56	0.40	0.00	0.00	0.51	2.46	12.47	4.74	0.46	1.57	6.22	0.60	0.29
Mus domesticus	19.0	2.01	3.80	6.59	1.79	8.98	7.81	10.63	16.53	12.86	6.90	7.98	24.03	21.07	0.79
Arvicola terrestris	130.0	0.00	0.00	0.00	0.00	4.10	6.28	2.08	10.77	0.00	8.59	0.00	17.78	0.00	0.00
Microtus savii	21.5	26.52	47.25	40.99	37.53	46.76	35.34	37.81	22.26	42.63	19.88	15.65	25.73	36.68	29.38
Microtus arvalis	30.0	16.92	11.99	15.60	1.42	2.84	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00	21.12
Total Rodentia		95.98	81.26	81.60	91.13	94.26	87.11	94.49	93.41	94.17	92.97	95.13	95.23	93.84	89.36

Tabl. 3 - Relative frequency of biomass (%) of different small mammals species in 14 sampling sites. Average biomass expressed in grams. For site codes see table 1.
- *Ripartizione delle frequenze relative (%) delle biomasse delle specie nei 14 siti di campionamento. La media delle biomasse è espressa in grammi. Per i codici dei siti vedi tabella 1.*

frequency of *C. leucodon*, *Sorex araneus* and *Suncus etruscus* (fig. 2b). The most abundant species in all the 14 sampling sites are *M. savii* with 29.6%, *Apodemus sylvaticus* with 20.1% and *C. suaveolens* with 17.6% (fig. 3).

Rodentia present a relative biomass frequency always higher than Insectivora (table 3),

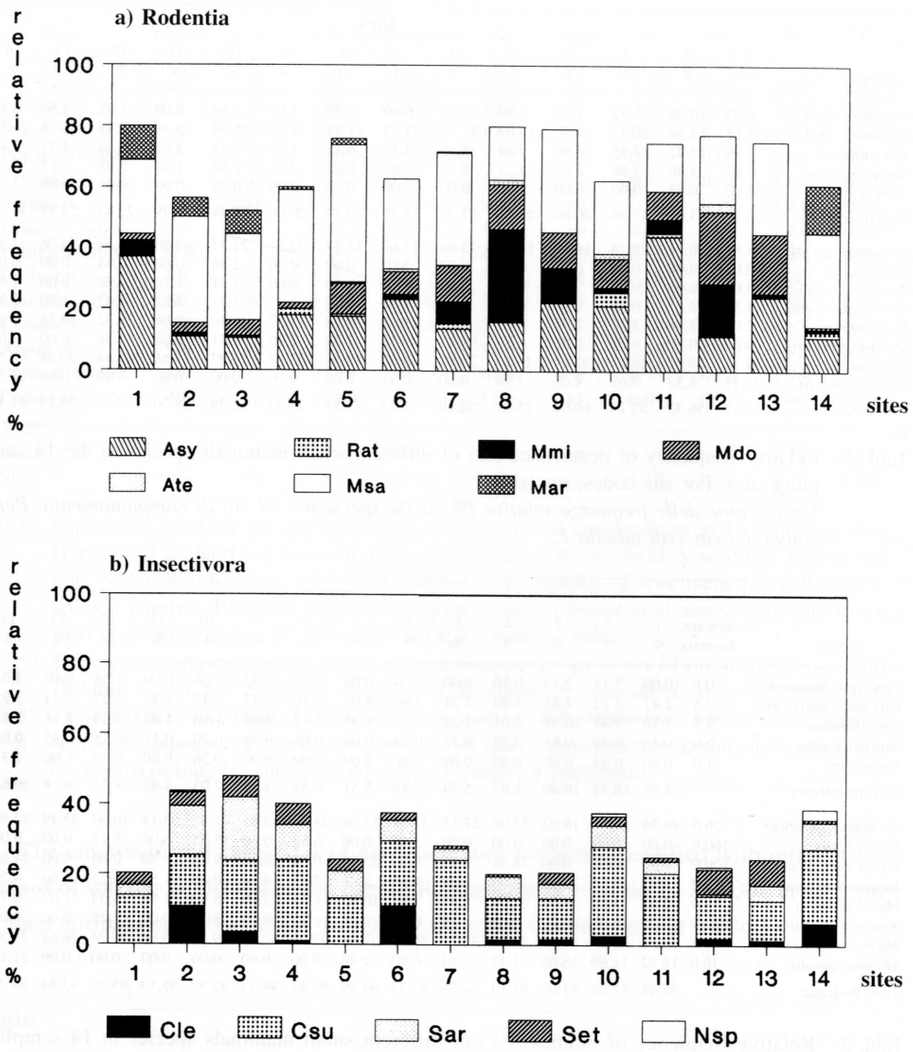

Fig. 2 - Relative frequency (%) of occurrence of Rodentia (a) and Insectivora (b). a): Asy, *Apodemus sylvaticus*; Ate, *Arvicola terrestris*; Mar, *Microtus arvalis*; Mmi, *Micromys minutus*; Mdo, *Mus domesticus*; Msa, *Microtus savii*; Rat, *Rattus norvegicus* + *R. rattus*; b): Cle, *Crocidura leucodon*; Csu, *Crocidura suaveolens*; Nsp, *Neomys* sp.; Sar, *Sorex araneus*; Set, *Suncus etruscus*. For site codes, see table 1.
- *Ripartizione delle frequenze relative (%) dei Roditori (a) e degli Insettivori (b). a): Asy,* Apodemus sylvaticus*; Ate,* Arvicola terrestris*; Mar,* Microtus arvalis*; Mmi*, Micromys minutus*; Mdo,* Mus domesticus*; Msa,* Microtus savii*; Rat,* Rattus norvegicus + R. rattus*; b): Cle,* Crocidura leucodon*; Csu,* Crocidura suaveolens*; Nsp,* Neomys *sp.; Sar,* Sorex araneus*; Set,* Suncus etruscus*. Per i codici dei siti vedi tabella 1.*

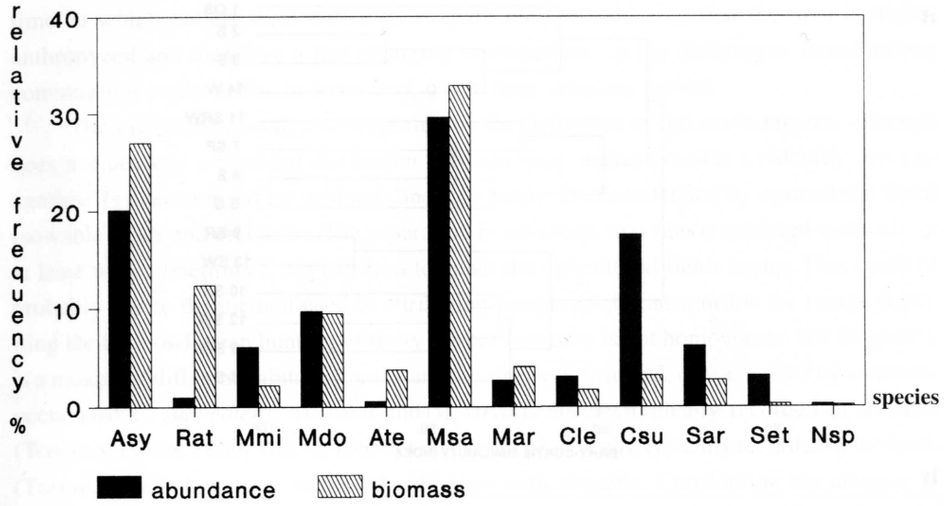

Fig. 3 - Relative frequency (%) of occurrence and biomass of small mammals species in all the 14 sampling sites. For species codes, see figure 2.
- *Ripartizione delle frequenze (%) delle biomasse delle specie nei 14 siti di campionamento. Per i codici dei siti vedi figura 2.*

but in this case this is due to the Insectivores low average biomass, that accounts as low as 4 % (site n. 1). Among Rodentia, regardless the single site, the two species with the highest biomass are, as for the relative abundance, still *Apodemus sylvaticus* and *M. savii* (fig. 3).

The sites characterised by wetlands and rice fields are those with the highest occurrence of *Micromys minutus* (sites n. 8, 9, 12) (fig. 2a), and the sites with high percentage of agricultural fields present high frequencies of Microtidae, in particular *Microtus arvalis* is present almost only in the sites with this characteristics. The environmental assessment index (table 1) has a mean value of 0.47 that, despite some variations, attests an highly anthropized area (Contoli, 1980), the values of the thermoxerophily index (table 1) are fairly homogenous and the mean is 0.66 that Contoli et al. (1989) indicated as typical of communities of temperate zones.

The cluster analysis (fig. 4a) shows a partial separation of the sampling sites characterised by wetlands and rice fields and those with a different soil use, as a matter of fact six of the wetlands sites (n. 9, 13, 10, 12, 8, 6) are gathered in a single group. This reflects the community composition differences among sites referred previously, supporting the consideration that wetlands are probably able to sustains a different small mammals community, both for species composition and relative abundance. Furthermore sites characterised by wetlands and rice fields have high H' and J values (table 1) while all the sites characterised mainly by sowable present the lowest values. The MDS ordination (fig. 4b) partly reflects the

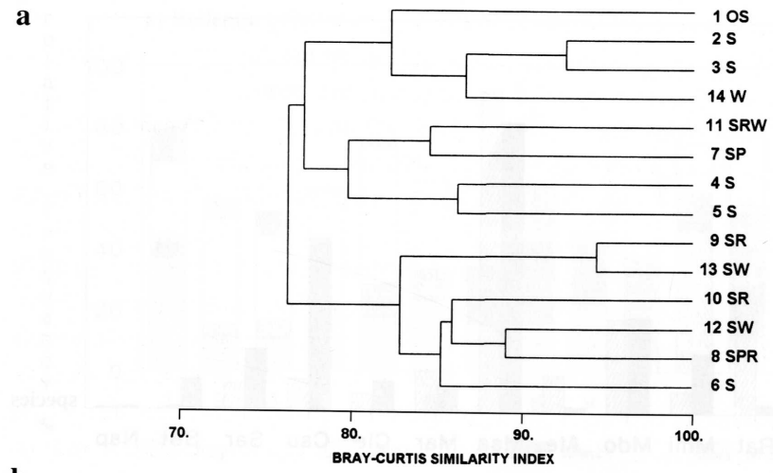

Fig. 4 - Dendrogram obtained by classifying the 14 (a); ordination of the 14 sites by multi-dimensional scaling (MDS), stress of configuration = 0.15 (b). For site codes, see table 1.
- *Dendrogramma ottenuto dalla classificazione dei 14 siti di campionamento (a); ordinamento attraverso multi-dimensional-scaling (MDS), stress di configurazione = 0.15 (b). Per i codici dei siti vedi tabella 1.*

cluster classification distinguishing the same group of six sites characterised by wetlands and rice fields, but also points out a difference of site n. 7 and 11 that are confined separately.

Discussion

For the analysis of the present paper we took in consideration the minimum number of specimens per site suggested by CONTOLI (1981) that is 100 specimens, as a matter of fact the mean number in the present work is 153 (table 1), hence seasonal fluctuations of the small mammals community should not have influenced the general results. On the other hand the

time in which pellets were collected is quite long, considering that the area is highly anthropyzed and therefore a fast changing environment, so the differences found among communities could suffer, in some way, of the long sampling period.

The multivariate analyses, supported by the definition of the environments, although does not produce a clear-cut distinction between sites, makes possible to identify two categories: 1) characterised by wetlands and rice fields; 2) characterised by agricultural fields (sowable fields and orchards). The separation is not sharp, two sites considered wetlands, or at least with a fraction of, are gathered together the agricultural fields group. This could be probably due to the method used in attributing categories, because inside the radius delimiting the barn owl mean hunting territory the environment is not homogenous but frequently is a mosaic of different habitats. For instance in sites n. 8, 9 and 12, characterised by wetlands, occur also *C. suaveolens*, *M. savii* and *M. arvalis* species typically recorded in sowable (TOSCHI & LANZA, 1959; TOSCHI, 1965) or vice versa *M. minutus*, typically recorded in wetlands (TOSCHI, 1965) sometimes occurs also in sites with sowable. Considering the absence of forests in the study area, *Apodemus sylvaticus* probably occurs in those sites where the habitat is rich of hedges and bushes as already suggested by LOVARI et al. (1976), CONTOLI (1981) and BOLDREGHINI & MATTEUCCI (1983).

In order to make a more detailed analysis of the small mammal communities and of the relation existing with the habitats, would be necessary to dispel the doubts and the approximation which are still entailed in the method used to define the surface of the predator's hunting area. Furthermore different sampling methodologies, such for instance trapping methods, associated to local measurements of environmental characteristics of more homogeneous habitats could contribute to a better definition of the knowledge of the ecology of the species.

Manoscritto pervenuto il 27.IV.1998.

Acknowledgements

Sincere thanks are due to Prof. Benedetto Sala for his indispensable advice provided during the identification of species and Prof. Anna Elisa Fano for her advice and critical revision of the manuscript. For the field work and for the preparation of pellets and bone materials in laboratory we heartily thank Dr. Roberta Marchesini, Beatrice Ballanti, Dr. Stefano Volponi, Marco Bertazzini, Lorenzo Borghi and Dr. Chiara Bortolotti.

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