INSECTIVORA, CHIROPTERA, LAGOMORPHA, RODENTIA AND CARNIVORA OF THE GRAN PARADISO NATIONAL PARK: CHECKLIST AND PRELIMINARY ECOLOGICAL CHARACTERIZATION

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Abstract - Between 1992 and 1996 a survey was carried out in the Gran Paradiso National Park (Western Italian Alps) in order to draw up a species list and collect ecological information on the different taxa of the orders of Insectivora, Chiroptera, Lagomorpha, Rodentia and Carnivora, excluding marmot and fox. Data were obtained from different sources, among which: sighting, trapping, inspection of discarded bottles, pellet analysis and visit to potential bat roost sites. With the exception of data from pellets, records are reported with regard to seven habitat types: human settlements, deciduous woods, mixed woods, coniferous woods, ecotones (stream edges and grassland close to woods), green alder shrubwoods and alpine open habitats far from woodland. At a more detailed level the composition of communities of woodland Insectivores and Rodents is described. In deciduous forests the most frequently trapped taxa were *Clethrionomys glareolus*, *Apodemus* sp. and *Sorex araneus*; in coniferous woods the dominant species were *Clethrionomys glareolus* and *Eliomys quercinus*.

Key-words - Western Italian Alps. Gran Paradiso National Park. Mammals. Checklist. Habitats.

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1. Introduction

Finalized studies were conducted in the Gran Paradiso National Park in the years 1992, 93, 95 and 96, the aim of which being:

- to draw up a species list of mammals belonging to the orders of Insectivora, Chiroptera, Lagomorpha, Rodentia and Carnivora;
- to collect preliminary ecological information about the different species, with the exception of marmot and fox as these have already been covered in specific studies or are being studied at present.

Previous works only made sporadic mention of the presence of some species in the Park, mainly referring to generic territories and not described ecologically (for a review see: Baratti *et al*. 1994a). It must be added that in the theriological literature there is no work about the composition and structure of mammal communities of the Western Italian Alps.

2. Study Area

The Gran Paradiso National Park has an area of about 72,000 ha, varying in altitude from about 750 to 4,061 metres a.s.l. Almost half the territory, including 6,600 ha of glaciers, is characterized by an absence or by a very limited development of plant life, 39% by low bushes and grasslands of natural or artificial origin (pastures and hay meadows on land that was once forest) and 12% by forest (mainly coniferous woods).

The area features sublittoral rainfall (Mennella 1967). Precipitation is scanty (in the period 1938-1970 mean annual values were between 662 and 1,189 mm), particularly on the Aosta Valley sector, where annual precipitation was around 1.6 times less than that in the Piedmontese sector. However, there are never drought conditions as temperatures are never too high for the altitude and melting ice and snow ensure a water supply. Harsh winters with abundant snowfalls are frequent (Perosino & Scarpinato 1981).

3. Materials and methods

Data were collected using the following techniques:

Insectivores and rodents

i - Trapping. Sherman SFAL (cm 5.2x6.5x23.4), Sherman LNA (cm 7.8x7.8x23.4), Longworth and pitfall (30 cm deep and 8 cm in diameter) live-traps were used. Bait consisted of a mixture of cheese, nuts, carrots and *Tenebrio molitor* larvae. No pre-baiting was done.

The traps were positioned in stations each one showing homogeneous main features of vegetation. In 1992 and '93 the traps were placed in lines, with a trap spacing of about 3 m. With the exception of some trap lines, set only during the night and checked in the morning, the traps were kept active day and night and examined evening and morning. Captured animals were individually marked by fur-clipping (Gurnell & Flowerdew 1982), weighed, sexed, classified according to breeding condition and released. The capture effort varied from site to site (Tab. II and appendix). The collected data must be considered qualitative.

In 1995 and '96, in three different sites representative of forest habitat types, traps were arranged in grids consisting of 100 traps (half Longworth and half Sherman) set in a 10-by-10 array, with a 10 m spacing between traps (grid size = 0.81 ha). In two of these sites only one session of trapping was carried out. In the other site trapping was repeated twice in consecutive years and in one of the trapping sessions 25 pitfall live-traps, at 20 m intervals from one another, were added inside the grid area. This did not produce any substantial difference in the results, either in the species captured or in the numbers of individuals caught. Concerning the latter aspect, it must be observed that in the whole trapping activity bias resulting from competition for traps could be excluded since the number of traps found empty always exceeded 49% and usually was higher than 80% of the total set.

Tab. I. Species recorded and altitudinal range of records.

Species		Altitude range
Western hedgehog	*Erinaceus europaeus*	*742-1600*
Alpine shrew	*Sorex alpinus*	*1050*
Common shrew	*Sorex araneus*	*1000-2350*
Pygmy shrew	*Sorex minutus*	*1000-1955*
Water shrew	*Neomys fodiens*	*1450*
Blind mole	*Talpa caeca*	*950-1230 **
Whiskered bat	*Myotis mystacinus*	*1700-1960*
Common pipistrelle	*Pipistrellus pipistrellus*	*742-1630*
Savi's pipistrelle	*Hypsugo savii*	*1150*
Brown long-eared bat	*Plecotus auritus*	*1540-1840*
Brown hare	*Lepus europaeus*	*1000-2412*
Mountain hare	*Lepus timidus*	*1050-3000*
Red squirrel	*Sciurus vulgaris*	*1000-2300*
Alpine marmot	*Marmota marmota*	*not considered in this study*
Garden dormouse	*Eliomys quercinus*	*1000-2194*
Fat dormouse	*Myoxus glis*	*1050-1770*
Common dormouse	*Muscardinus avellanarius*	*1120-1780 ***
Bank vole	*Clethrionomys glareolus*	*1340-1950*
Common vole	*Microtus arvalis*	*1820*
Alpine/Common pine vole	*Microtus multiplex/subterraneus*	*1780-1830*
Savi's pine vole	*Microtus savii*	*1620-1830*
Snow vole	*Chionomys nivalis*	*1820-2959*
Alpine mouse	*Apodemus alpicola*	*1860-1955*
Wood/Yellow necked mouse	*Apodemus sylvaticus/flavicollis*	*1000-1640 ****
Brown rat	*Rattus norvegicus*	*742-1023*
House mouse	*Mus domesticus*	*1000-1234*
Fox	*Vulpes vulpes*	*not considered in this study*
Badger	*Meles meles*	*950-1960*
Stoat	*Mustela erminea*	*1000-2750*
Weasel	*Mustela nivalis*	*1000-1650*
Beech marten	*Martes foina*	*1000-2205*
Pine marten	*Martes martes*	*1540 *****

* Molehills, considered as signs of presence of the genus *Talpa*, were observed up to 1,750m.
** Cantini *et al.* (1988) recorded the presence of the species at 1,950 metres.
*** Other specimens, classified as *Apodemus* sp., were collected between the range of *Apodemus sylvaticus/flavicollis* and *Apodemus alpicola*.
**** Species not encountered directly, but whose presence is testified by De Marinis and Lapini (1994) that report a record for the cited altitude.

Tab. II. Trapping effort and numbers of discarded bottles found containing mammals for each habitat type.
Trap nights = number of traps per numbers of nights or 24-hours periods of trapping. In cases of recording limited to the night period the corresponding percentage of traps nights is reported in parentheses (ex.: in coniferous woods 6.3% of the total 2,547 trap nights refer to night trapping and the remaining 93.7% to night and day trapping).

	HUMAN SETTLEMENTS	DECIDUOUS WOODS	CONIFEROUS WOODS	ECOTONES	GREEN ALDER SHRUBWOODS	ALPINE OPEN HABITATS
N. trapping sites	3	2	7	7	2	7
Trap nights (Sherman + Longworh)	not quantified	791	2547 (6.3%)	301 (68%)	310	891 (43%)
Trap nights (Pitfall)	0	0	369	91	140	191
N. discarded bottles/tins	0	5	7	15	3	6

Each grid-trapping session lasted six days and six nights (12 trap runs). Captured animals were examined and marked as above mentioned, so that minimun sure numbers of individuals using the grid area were determined. The same numbers can be considered as indexes of relative abundance of trappable species, but they are inadequate to estimate real population densities in the absence of important complementary information, for example on the incidence of trap-shyness phenomenon.
In order to allow the comparison with other studies the average distance moved between successive captures for each species and Lincoln Petersen estimates are reported too. The former parameter is often used to "correct" the grid area value in order to avoid population density overestimates due to the edge-effect (Brant, 1962; Spitz 1969). Lincoln Petersen estimates were computed using Chapman's modification (unbiassed estimate and its associated variance in: Seber 1982) and the technique for condensing data of multiple capture-recaptures described by Menkens and Anderson (1988).
ii- Further data on shrews and small rodents were obtained by inspection of discarded bottles and tins and by analysis of Tengmalm's owl (*Aegolius funereus*) pellets, collected in a nestbox and, marginally, below natural roosts.

Bats
i - Captures by mist nets of flying individuals previously detected by a bat detector (Petterson Elektronik D940) were realized. Individuals were determined according to external morphology and immediately released.
ii- Visit to potential roost sites were also carried out.

All species
The presence of the different species was moreover monitored by:
i - collection of specimens found dead on the ground;
ii - sight recording and observation of diagnostic tracks and other signs of presence.

Animals were identified according to Chaline *et al.* (1974), Erome & Aulagnier (1982), Amori *et al.* (1984), Niethammer & Krapp (1978, 1982, 1990), Maurizio & Hausser (1990), Schober & Grimmberger (1991).
From *Apodemus* skeletal remains the identification was carried only to the genus level, since morphological criteria in literature have never been tested on material from the study area. Living adult individuals with a proportionally longer tail (at least 120% the head and body lenght) were recorded as possible *Apodemus alpicola* (Vogel *et al.*, 1991), otherwise as possible *A. flavicollis/sylvaticus*. If the tail length criterion proves to be wrong, data presented should be considered as generically referred to *Apodemus* spp. From *Microtus (Terricola)* skeletal remains, on the basis of dental morphology and craniometric measures, specimens seemingly closer to the *Microtus multiplex/subterraneus* group have been distinguished from specimens closer to *M. savii*, but in the absence of sure evidence (*i.e.* DNA, electrophoresis, cariotype) these taxo-

nomic attributions too should be considered carefully.

As far as ecological characterization of the considered species is concerned, the habitat types have been classified into the following categories:
- *Human settlements*. Villages, with buildings and their gardens and kitchen gardens. This category does not include uninhabited mountain dwellings.
- *Deciduous woods*. Mainly mixed deciduous woods deriving from artificial transformation of beech (*Fagus sylvatica*) woods. The presence of this category in the Park is only marginal due to the high altitudes of its borders.
- *Mixed woods*. Forest land with deciduous and coniferous trees.
- *Coniferous woods*. The dominant type of forest in the Park, the main tree species being larch (*Larix decidua*) and Norway spruce (*Picea abies*).
- *Ecotones: stream edges and grassland close to woods*. Ecotonal category, with vegetation structurally dominated by herbs and shrubs and characterized by the proximity to woods. The respective data contained in this study mainly refer to areas above an altitude of 1,500 m.
- *Green alder shrubwoods*. High shrubs dominated by green alder (*Alnus viridis*). For this category records refer to areas above 1,500 m.
- *Alpine open habitats far from woodland.* Characterized by screes, alpine meadows and pastures far from the treeline.

4. Results and discussion

4.1. Species list

The collected data and a record from literature allow of drawing up a list of 32-34 taxa (Tab. I) whose presence is certain in the Park.
It must be stated that the unrecorded species Miller's water shrew (*Neomys anomalus*), common mole (*Talpa europaea*) and black rat (*Rattus rattus*) are biogeographically and ecologically compatible with the Park's area.
As far as bats are concerned, the very limited information available for Piedmont and the Aosta Valley does not allow of making any hypothesis on the possible presence of taxa that are not included in the list. The reported record for *Hypsugo savii* represents the first sure evidence of the occurrence of the species in Aosta Valley (see: Baratti et al. 1994b).
The list of carnivores could see in the near future the inclusion of the lynx (*Lynx lynx*), which is recolonizing the geographical area in which the Park is located and of the wolf (*Canis lupus*), which has recently reappeared in the Western Alps.
The brown bear (*Ursus arctos*) has been extinct since the middle of the last century (Geroudet 1972), whilst the last sightings of the otter (*Lutra lutra*) were reported in the 1950s (Holloway & Jungius 1975).
A record of the wild cat (*Felis silvestris*) in the Val di Rhemes in 1972, considered as reliable by Ragni (1988), would lead one to consider its possible presence in the area. However, it should be pointed out that there has been no other proved recording of this species, either before and after the above-mentioned one.
Similarly does not exist any evidence of the presence of the polecat (*Mustela putorius*), which Festa (1925) cited as being present in the Park.

4.2. Ecological distribution

The altimetric data (Tab. II) attest the presence of certain species (*Sorex araneus*, *Myotis mystacinus*, *Plecotus auritus*, *Lepus europaeus*, *Eliomys quercinus*, *Myoxus glis*, *Muscardinus avellanarius*, *Chionomys nivalis*) at the highest altitudes so far recorded in Italian Alps (for previous data see: Cantini, 1991; Sindaco *et al.*, 1992; S.TE.P., in press) and the wide overlap range of certain allied taxa (*Lepus europaeus* and *L. timidus*; *Mustela nivalis* and *M. erminea*; *Martes foina* and *M. martes*), some of which have an exclusively alpine distribution in Italy (*Lepus timidus*, *Mustela erminea*).
Tab. III presents the data collected in each habitat type with the exception of those obtained by pellet analysis (Tab. IV). Pellets were collected in coniferous woods, but predation could have occurred in other habitat types.
The four species of bats recorded were mainly observed in roosts in buildings or near them. No breeding or hibernation sites have been recorded in the Park that are significant for the number of species and/or individuals present. Not far from the Park, at Pompiod (Aymavilles, Aosta), an important bat hibernation site has been discovered inside an abandoned mine. Seven species of bats hibernate here: *Rhinolophus ferrumequinum*, *Myotis myotis*, *Pipistrellus pipistrellus*, *Pipistrellus kuhli*, *Eptesicus serotinus*, *Barbastella barbastellus* and *Plecotus auritus*. The presence of a large breeding colony of *Myotis myotis* is known in Aymavilles castle (Baratti *et al.* 1994b).
For insectivores and rodents it may be attempted a characterization of the communities present in the different habitat types and particu-

Tab. III. Data collected in each habitat type. Numbers represent observed individuals/specimens **(C =** captured; B = found in discarded bottles/tins; D = found dead on the ground; S = recorded by sight or sign of presence considered due to a single animal).

	Human Settlements				Deciduous Wood				Mixed Wood	Coniferous Wood				Ecotones				Green Alder Shrubwoods				Alpine Open Habitats				
	C	B	D	S	C	B	D	S	S	C	B	D	S	C	B	D	S	C	B	D	S	C	B	D	S	TOT
E. europaeus	–	–	2	1	–	–	–	1	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	**6**
S. alpinus	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**
S. araneus	–	–	1	–	40	46	2	1	–	3	24	3	–	–	37	8	–	1	7	2	–	–	39	2	–	**216**
S. minutus	–	–	1	–	–	3	3	–	–	–	–	1	–	1	7	–	–	1	–	–	–	–	2	–	–	**19**
N. fodiens	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	**1**
T. caeca	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**
Talpa sp.	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2	–	–	–	–	–	–	–	–	**3**
M. mystacinus	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	**2**
P. pipistrellus	3	–	4	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	**8**
H. savii	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**1**
P. auritus	2	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1*	**4**
L. europaeus	–	–	–	–	–	–	–	3	–	–	–	–	3	–	–	–	7	–	–	–	–	–	–	–	–	**13**
L. timidus	–	–	–	–	–	–	–	1	–	–	–	–	6	–	–	–	34	–	–	–	–	–	–	–	27	**68**
Lepus sp.	–	–	–	–	–	–	–	1	2	–	–	–	10	–	–	–	21	–	–	–	1	–	–	–	28	**61**
S. vulgaris	–	–	–	–	–	–	–	53	38	–	–	–	285	–	–	–	36	–	–	–	–	–	–	–	–	**412**
E. quercinus	–	–	–	–	–	–	1	–	–	58	–	3	7	–	–	2	1	3	–	–	1	1	–	–	–	**77**
M. glis	–	–	–	1	1	–	1	7	3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**13**
M. avellanarius	–	–	–	–	–	–	–	–	2	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–	–	**6**
C. glareolus	–	–	–	–	50	7	3	–	–	135	30	–	–	3	6	–	1	1	12	–	–	–	–	–	–	**248**
M. arvalis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	**1**
M. multiplex/subterraneus	–	–	–	–	–	–	–	–	–	–	2	–	–	–	1	–	–	–	–	–	–	–	–	–	–	**3**
M. savii	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	**2**
M. (Terricola) sp.	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**
C. nivalis	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	1	8	–	–	–	–	2	2	2	6	**24**
A. alpicola	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	3	–	–	–	**4**
A. sylvaticus/flavicollis	20	–	2	–	25	–	1	–	–	–	1	–	–	–	–	–	–	3	–	–	–	–	–	–	–	**52**
Apodemus sp.	–	–	–	–	–	–	1	–	–	4	–	–	–	–	6	–	–	7	–	–	–	–	–	–	–	**18**
M. domesticus	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**
R. norvegicus	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	**2**
M. meles	–	–	–	–	–	–	–	20	2	–	–	–	5	–	–	2	14	–	–	–	–	–	–	–	–	**43**
M. erminea	–	–	–	8	–	–	–	2	–	–	–	–	2	–	–	–	30	–	–	–	–	–	–	–	32	**74**
M. nivalis	–	–	–	4	–	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	**6**
M. foina	–	–	–	–	–	–	2	1	–	–	–	1	–	–	–	2	4	–	–	–	–	–	–	–	–	**10**
Martes sp.	–	–	–	11	–	–	–	11	1	–	–	–	3	–	–	–	37	–	–	–	–	–	–	–	–	**63**

*Individual roosting in an abandoned mine.

Tab. IV. Data from Tengmalm's owl pellets collected on 2 grid trapping sites (6 - Lillaz and 10 - Eau Rousses), in coniferous woods.
The abundance of *Chionomys nivalis*, never caught by traps, shows that the predation mainly occurred outside the trapping areas.

LOCALITY	PREDATION	ROOST	PREY SPECIES (Specimen number)
Eau Rousses	Ago. 95	Tree	*Sorex araneus* (1), *Clethrionomys glareolus* (5)
Eau Rousses	Jul. 96	Tree	*Sorex araneus* (1), *Clethrionomys glareolus* (1), *Chionomys nivalis* (1)
Lillaz	May.-Jun. 96	Nest-box	*Sorex araneus* (1), *Clethrionomys glareolus* (5), *Microtus arvalis* (1), *Microtus (Terricola)* sp. (3), *Chionomys nivalis* (52), *Apodemus* sp. (1)
Lillaz	Sep. 96	Tree	*Clethrionomys glareolus* (5), *Chionomys nivalis* (1).

larly in woods, as better trapping data are available for these (appendix).

Insectivores
Among shrews, *Sorex araneus* and *S. minutus* are the most common species in the Park. They are present in all the habitat types examined, denoting ecological adaptability.
Both the overall data and those regarding the individual stations show a greater abundance of *Sorex araneus* compared to *S. minutus* (91.9% as against 8.1% of the total data for the two species). Due to its smaller size, *S. minutus* could be more difficult to trap by Sherman and Longworth traps than *S. araneus* is, but, on the other hand, a small body size facilitates entering discarded bottles and these represented the major source of data for the two species in the present work (Tab. III). Moreover *S. araneus'* more subterranean habits (Ellenbroek 1985) would lead one to suppose greater difficulty in sampling this species. Probably due to its greater abundance, *S. araneus* is the shrew that was encountered most frequently, being found in 33 different localities, against 11 localities for *S. minutus* (in 8 of which *S. araneus* was found too).
S. araneus was particularly abundant on grid trapping station 1, in a deciduous wood, where the species represented 37.7% of the total number of mammals caught (Fig. 1). On the contrary, in coniferous woods, trapping results demonstrate that the species and the whole genus *Sorex* occur at low demographic densities. Data obtained from discarded bottles do not disagree with such observations, being 9.2 the mean number of *Sorex araneus* specimens per bottle in deciduous woods against 3.4 in coniferous woods (Tab. II and Tab. III).
Among the other species of shrews *Neomys fodiens* and *Sorex alpinus* are rare and localized. The rarity of the former species can be explained by its ecological requirements and its tie to aquatic habitats. For *Sorex alpinus* its rarity is probably attributable, at least partially, to biogeographical causes (the study area is at the species range limits); this hypothesis would in fact explain the rarity of this species in the more general context of the Piedmontese-Aostan Alps (S.TE.P. unpublished). In the Park *S. alpinus* was observed only at trapping site 1, in a deciduous wood characterized by high moisture on the ground and exceptionally abundant litter. The presence of the species was also reported by Niethammer and Krapp (1990) with a generic reference to the Park and by Rinetti (1987) at two sites in coniferous woods. However, the latter report is doubtful as it comes from hair identification in badger faeces, namely using a technique that has very little possibility of distinguishing at species level samples that refer to the genus *Sorex* (Keller 1978).
The absence of the *Crocidura* genus may be attributable to the Park's cool climate: the Park has high altitude valley bottoms and there are no xerothermic areas on the slopes. In other valleys of the Western Alps the genus *Crocidura* reaches record distribution heights (2000 m for *C. suaveolens* in Val Chisone, Turin province, Debernardi *et al.*, in press).
Erinaceus europaeus occurres only below the treeline.
The collected data are insufficient to characterize the ecological distribution of the genus *Talpa*.

Rodents
Among arboreal rodents, the collected data

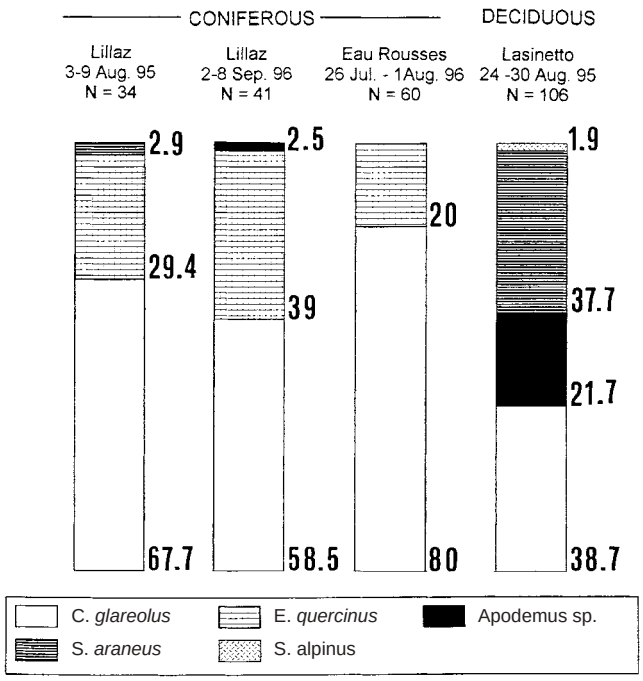

Fig. 1 - Percentage of individuals of each species caught by grid trapping in woodland. N= total number caught.

show that *Sciurus vulgaris* is a common species in all the Park's woodlands.

The most common dormouse in the Park is *Eliomys quercinus*. Although it has been found in various habitat types, the species' main habitat within the Park is certainly coniferous woods. The species was found in 5 out of the 7 trapping stations in coniferous woods, representing on grid trappings from 20% to 39% of the mammals caught (Fig. 1). On the contrary, it was absent in both trapping stations in deciduous woods (appendix) and, if general data are considered (Tab. III), only one record is referred to deciduous woodland. This picture fits in with the one that has so far emerged from surveys made for the Mammal Atlas of Piedmont and Aosta Valley: throughout the Alps the distribution of *E. quercinus* concerns coniferous woods, in deciduous woods the species is mainly rare or absent and so far there has been no proof of its presence in the remaining woods in the plains or in the woods of the region's internal hills. At the same time this picture differs from the ecological distribution of the species shown for other geographical areas, Apennine and Mediterranean ones or on the other side of the Alps, where the garden dormouse is frequent in deciduous woods too.

Considering the characteristics of the two stations in coniferous woods where the species has not been recorded, some of the elements that were considered unfavourable to its presence in the French Hautes Alpes (Le Louarn & Spitz 1974; Baudoin *et al.* 1986) emerge: the rocky cover of less than 10% and the tree cover of more than 50% at station 4; the presence of a low ligneous layer covering over 25% and the absolute dominance of larch at station 7; the presence in both stations of a herbaceous layer covering over 25%. Nevertheless, conditions considered to be unfavourable for the presence of the species are also found in the stations where its presence was found, such as the rocky cover of less than 2% at station 5, herbaceous cover of more than 25% at station 9, the presence of dense low ligneous vegetation at stations 8 and 9 and the dominance of larch at station 9. From the data collected any fixed relationships with environmental variables of vegetation structure or concerning rocky cover do not emerge.

Myoxus glis was recorded in deciduous or mixed woods, as well as in farmhouses located near such woods, but its favourite habitat in the Park is surely represented by deciduous woods (Tab. III). Five out of the six records of *Muscardinus avellanarius* coincide with nests and individuals observed inside nest-boxes for Tengmalm's owl placed in mixed and coniferous woods. It must be pointed out the difficulty in recording this species, which is rarely captured in ground traps and whose most commonly used signs for detecting its presence (hazelnut shells) are not available in most of the Park's woodlands. The presence of the species in the Park has been further documented in coniferous woods by Rinetti (1987) and Cantini *et al.* (1988).

Among ground rodents, within forest habitats by far the most common species is *Clethrionomys glareolus*, which is found constantly in all habitats characterized by good woodland or shrubbery cover. In the Park's coniferous woods the abundance of this species (representing from

58.5% to 80% of the total number of mammals caught on the grids, fig. 1) contrasts with the contemporary absence or the scarcity of individuals of the genus *Apodemus*.
The taxon *Apodemus* was in fact never captured in the traps in the coniferous woods, except at stations 4 and 6. At station 6, in spite of a trapping activity conducted in three different years, only one individual of *Apodemus* was caught (appendix). This suggests that, even taking into account that populations fluctuate year by year, *C. glareolus* is the dominant ground rodent in the coniferous woods studied.
In the deciduous woods and alder shrubwoods the absolute dominance of *C. glareolus* seems to be more uncertain, the species being largely syntopic with the genus *Apodemus*. On the grid at station 1, *C . glareolus* and *Apodemus* made up 38.7% and 21.7% respectively of the mammals caught (fig. 1). In the line trapping at station 11, in alder shrubwood, more *Apodemus* than *Clethrionomys* were caught.
An increase in the abundance of *C. glareolus* compared to *Apodemus* moving from deciduous to coniferous alpine woods is suggested also by the results obtained by Locatelli & Paolucci (1995) in an area of Eastern Italian Alps and by Praz & Meylan (1973) in lower Engadine (Switzerland).
Microtus (Terricola) taxon can occasionally occurr in the Park's woodlands (tab. 3, appendix).
The few data collected in Alpine open habitats above the treeline only allow very limited discussion. Trapping activity has given scarce results and this may be attributable to various factors:
- low demographic densities of the species present at the stations and/or at the time of observation;
- inadequacy of the traps used for trapping fossorial species;
- trapping effort scarce and limited, at some stations, only at night.
The overall collected data indicate a richer community in open habitats not far from woodlands ("ecotones"), that, among rodents, includes taxa of the open habitat (*Microtus Terricola* spp., *Chionomys nivalis* and, probably, *Microtus arvalis*) and woodland species (*Clethrionomys glareolus* and probably *Eliomys quercinus*). The genus *Apodemus* is part of this community, but for the taxonomic problems mentioned before it is impossible to define its ecological role.
The more typically high alpine habitats, far from woodlands, denote a poorer rodent fauna. The most typical species and the one that reaches the highest altitudes is *Chionomys nivalis*, whilst the importance of the taxa *Apodemus* (the specimens observed at the highest altitudes would seem to be *A. alpicola*), *Eliomys quercinus* and *Microtus arvalis* at relatively lower altitudes, still has to be explained. The latter species, which was recorded only twice (Tab. III, Tab. IV), is the rodent with the highest capture frequency in the study carried out by Douheret (1970) in the neighbouring Vanoise National Park, at heights over 1800 metres. It should be pointed out that the Gran Paradiso National Park and, more generally the Western Italian Alps, are located on the edge of the *Microtus arvalis*'range and the species is actually absent in all the Piedmontese plain (S.TE.P., unpublished).

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APPENDIX

Data concerning the trapping activity in woodland habitat types.

Trapping effort is quantified as number of trap-nights. If not otherwise specified traps were operated night and day.

Main vertical structural layers of vegetation are classified as suggested by Daget and Poissonet (1965): HL high ligneous layer (> 2 m), LL low ligneous layer (< 2m), H herbaceous layer. For the ligneous layers dominant species are listed; in parenthesis less abundant species.

Moss covering and litter depht are expressed according to a five levels scale, ranging from "-" (absence of the component) to "++++" (component very important).

Site / Trapping pattern	**1 / Trap grid**
Locality	*Lasinetto (Forzo) (SoanaValley)*
Trapping period	*24-30 Aug. 95*
Trapping effort, trap nights (type of trap)	*600 (Sherman + Longworth)*
Altitude, metres a.s.l.	*1050-1072*
Ground slope, degrees	*17°-22°*
Exposure	*NE*
HL: cover, %	*75-100*
HL: species	*Corylus avellana, Fagus sylvatica, (Populus tremula, Acer pseudoplatanus, Laburnum alpinum)*
LL: cover, %	*10-25*
LL: species	*Rubus sp., Corylus avellana*
H: cover, %	*10-25*
Moss: degree of covering	+ + + +
Litter: degree of deepth	+ + + +
Stones/rocks: cover, %	*25-50*
Water habitats	*Torrent and small stream near the site*
Captured individuals	*2 Sorex alpinus, 40 Sorex araneus *, 41 Clethrionomys glareolus, 23 Apodemus flavicollis/sylvaticus*
Lincoln -Petersen estimates (variance)	*42.7 Clethrionomys glareolus (2.6)* *22.8 Apodemus flavicollis/sylvaticus (1.2)*
Average distance between successive captures	*Clethrionomys glareolus : 23.8 m (N=77)* *Apodemus flavicollis/sylvaticus: 27.9 m (N=36)*
Specimens found in bottles	*30 Sorex araneus, 1 Sorex minutus, 3 Clethrionomys glareolus*
Further species otherwise recorded	*Sciurus vulgaris, Myoxus glis*

* For this species, due to the mortality of several individuals, it was not possible to compute the Lincoln - Petersen estimate.

Site / Trapping pattern	**2 / Trap line**
Locality	*Ciantel (Ribordone) (Orco Valley)*
Trapping period	*26 Jul. 93 - 5 Aug. 93*
Trapping effort, trap nights (type of trap)	*191 (Longworth)*
Altitude, metres a.s.l.	*1350*
Ground slope, degrees	*45°*
Exposure	*NE*
HL: cover, %	*75-100*
HL: species	*Fagus sylvatica, Acer pseudoplatanus, Fraxinus excelsior (Picea abies)*
LL: cover, %	*1-10*
LL: species	*Fraxinus excelsior*
H: cover, %	*1-10*
Moss: degree of covering	+ + +
Litter: degree of deepth	+ + +
Stones/rocks: cover, %	*10-25*
Water habitats	*Absent*
Captured individuals	*1 Myoxus glis, 9 Clethrionomys glareolus, 2 Apodemus flavicollis/sylvaticus*
Specimens found in bottles	*11 Sorex araneus, 2 Sorex minutus, 1 Clethrionomys glareolus*
Further species otherwise recorded	*Sciurus vulgaris*

Site / Trapping pattern	**3 / Trap line**
Locality	*Piamprato (Soana Valley)*
Trapping period	*4-11 Aug. 92*
Trapping effort, trap nights (type of trap)	*86 (Sherman), 107 (Pitfall)*
Altitude, metres a.s.l.	*1550-1560*
Ground slope, degrees	*25°*
Exposure	*E*
HL: cover, %	*25-50*
HL: species	*Larix decidua*
LL: cover, %	*1-10*
LL: species	*Rhododendron ferrugineum, Vaccinium myrtillus*
H: cover, %	*50-75*
Moss: degree of covering	+
Litter: degree of deepth	+
Stones/rocks: cover, %	*50-75*
Water habitats	*Absent*
Captured individuals	*1 Clethrionomys glareolus*
Further species otherwise recorded	*Sciurus vulgaris*

Site / Trapping pattern	**4 / Trap line**
Locality	*Rio Boiretto, Ribordone (Orco Valley)*
Trapping period	*16-19 Aug.93*
Trapping effort, trap nights (type of trap)	*144 (Longworth)*
Altitude, metres a.s.l.	*1555-1570*
Ground slope, degrees	*25°*
Exposure	*E*
HL: cover, %	*50-75*
HL: species	*Picea abies*
LL: cover, %	*1-10*
LL: species	*Rubus idaeus*
H: cover, %	*25-50*
Moss: degree of covering	+ +
Litter: degree of deepth	+
Stones/rocks: cover, %	*1-10*
Water habitats	*Stream near the site*
Captured individuals	*3 Clethrionomys glareolus, 4 Apodemus flavicollis/sylvaticus*
Further species otherwise recorded	*Sciurus vulgaris, Sorex araneus*

Site / Trapping pattern	**5 / Trap line**
Locality	*Lillaz (Cogne Valley)*
Trapping period	*30 Aug. 93- 1 Sep. 93*
Trapping effort, trap nights (type of trap)	*51 (Longworth+Sherman)*
Altitude, metres a.s.l.	*1605*
Ground slope, degrees	*12°*
Exposure	*N*
HL: cover, %	*75-100*
HL: species	*Picea abies*
LL: cover, %	*1-10*
LL: species	*Picea abies, Juniperus communis*
H: cover, %	*1-10*
Moss: degree of covering	+ + +
Litter: degree of deepth	+ +
Stones/rocks: cover, %	*< 2*
Water habitats	*Several small streams inside the station*
Captured individuals	*1 Eliomys quercinus, 1 Clethrionomys glareolus*
Further species otherwise recorded	*Sciurus vulgaris, Sorex araneus*

Site / Trapping pattern	**6 / Trap line**
Locality	*Lillaz (Cogne Valley)*
Trapping period	*1-3 Sep. 93*
Trapping effort, trap nights (type of trap)	*156 (Longworth+Sherman)*
Altitude, metres a.s.l.	*1620-1720*
Ground slope, degrees	*15°-25°*
Exposure	*NE*
HL: cover, %	*50-75*
HL: species	*Picea abies, Larix decidua*
LL: cover, %	*10-25*
LL: species	*(Juniperus communis, Juniperus nana, Arctostaphylos uva-ursi, Vaccinium myrtillus, Lonicera xylostelum, Rhododendron ferrugineum)*
H: cover, %	*1-10*
Moss: degree of covering	+ + +
Litter: degree of deepth	+ +
Stones/rocks: cover, %	*25-50*
Water habitats	*Absent*
Captured individuals	*12 Eliomys quercinus, 6 Clethrionomys glareolus*
Further species otherwise recorded	*Sciurus vulgaris*

Site / Trapping pattern	**6 / Trap grid**
Trapping period	*3-9 Aug. 95*
Trapping effort, trap nights (type of trap)	*600 (Longworth + Sherman), 150 (Pitfall)*
Captured individuals	*1 Sorex araneus, 10 Eliomys quercinus (10 adults), 23 Clethrionomys glareolus*
Lincoln -Petersen estimates (variance)	*11.8 Eliomys quercinus (3.8)* *28.3 Clethrionomys glareolus (20.3)*
Average distance between successive captures	*Eliomys quercinus: 27.0 m (N=9)* *Clethrionomys glareolus : 20.6 m (N=16)*

Site / Trapping pattern	**6 / Trap grid**
Trapping period	*2-8 Sep. 96*
Trapping effort, trap nights (type of trap)	*600 (Sherman + Longworth)*
Captured individuals	*16 Eliomys quercinus (5 adults), 24 Clethrionomys glareolus, 1 Apodemus flavicollis/sylvaticus*
Lincoln -Petersen estimates (variance)	*20 Eliomys quercinus (12)* *35 Clethrionomys glareolus (84)*
Average distance between successive captures	*Eliomys quercinus: 26.4 m (N=33)* *Clethrionomys glareolus : 20.9 m (N=13)*

Site / Trapping pattern	**7 / Trap line**
Locality	*Chiapili (Orco Valley)*
Trapping period	*17-26 Jun. 93*
Trapping effort, trap nights (type of trap)	*150 (Sherman-Longworth), 93 (Pitfall)*
Altitude, metres a.s.l.	*1690-1730*
Ground slope, degrees	*25-32°*
Exposure	*E*
HL: cover, %	*25-50*
HL: species	*Larix decidua*
LL: cover, %	*25-50*
LL: species	*Vaccinium myrtillus*
H: cover, %	*25-50*
Moss: degree of covering	+ + +
Litter: degree of deepth	+ +
Stones/rocks: cover, %	*25-50*
Water habitats	*Small stream inside the station*
Captured individuals	*2 Sorex araneus, 12 Clethrionomys glareolus*
Specimens found in bottles	*18 Sorex araneus, 1 Sorex minutus, 9 Clethrionomys glareolus*
Further species otherwise recorded	*Sciurus vulgaris*

Site / Trapping pattern	**8 / Trap line**
Locality	*Chavromenti (Rhemes Valley)*
Trapping period	*24-26 Jun. 92*
Trapping effort, trap nights (type of trap)	*100 (Sherman). Set only at night.*
Altitude (metres a s.l.)	*1750*
Ground slope, degrees	*20-30*
Exposure	*NW*
HL: cover, %	*25-50*
HL: species	*Picea abies (Larix decidua)*
LL: cover, %	*1-10*
LL: species	*Picea abies, Larix decidua*
H: cover, %	*25-50*
Moss: degree of covering	+
Litter: degree of deepth	+
Stones/rocks: cover, %	*1-10*
Water habitats	*Absent*
Captured individuals	*2 Eliomys quercinus, 1 Clethrionomys glareolus*
Specimens found in bottles	*9 Sorex araneus, 7 Clethrionomys glareolus, 2 Microtus (Terricola) multiplex/subterraneus, 2 Microtus (Terricola) sp., 1 Microtus (Terricola) savii*
Further species otherwise recorded	*Sciurus vulgaris*

Site / Trapping pattern	**9 / Trap line**
Locality	*Pellaud (Rhemes Valley)*
Trapping period	*26-29 Jun.92*
Trapping effort, trap nights (type of trap)	*60 (Sherman), 19 (Pitfall). Sherman traps set only at night.*
Altitude, metres a.s.l.	*1820*
Ground slope, degrees	*11°*
Exposure	*N*
HL: cover, %	*25-50*
HL: species	*Larix decidua*
LL: cover, %	*25-50*
LL: species	*Vaccinium myrtillus, Juniperus communis (Larix decidua, Vaccinium uliginosum, Lonicera xylostelum, Rhododendron ferrugineum, Rosa sp.,)*
H: cover, %	*25-50*
Moss: degree of covering	*+ +*
Litter: degree of deepth	*+*
Stones/rocks: cover, %	*50-75*
Water habitats	*Torrent near the site*
Captured individuals	*5 Eliomys quercinus, 12 Clethrionomys glareolus*
Further species otherwise recorded	*Sciurus vulgaris*

Site / Trapping pattern	**10 / Trap grid**
Locality	*Eau Rousses (Valsavarenche)*
Trapping period	*27 Jul. 96 - 1 Aug. 96*
Trapping effort, trap nights (type of trap)	*600 (Sherman + Longworth)*
Altitude, metres a.s.l.	*1770-1810*
Ground slope, degrees	*23°*
Exposure	*W*
HL: cover, %	*25-50*
HL: species	*Picea abies, (Larix decidua, Pinus cembra)*
LL: cover, %	*1-10*
LL: species	*(Picea abies, Juniperus communis, Rhododendron ferrugineum, Vaccinium myrtillus, Arctostaphylos uva-ursi, Rubus idaeus)*
H: cover, %	*10-25*
Moss: degree of covering	*+ + +*
Litter: degree of deepth	*+ +*
Stones/rocks: cover, %	*50-75*
Water habitats	*Absent*
Captured individuals	*12 Eliomys quercinus (5 adults), 48 Clethrionomys glareolus*
Lincoln -Petersen estimates (variance)	*14 Eliomys quercinus (4.3)* *50 Clethrionomys glareolus (8.4)*
Average distance between successive captures	*Eliomys quercinus: 46.3 m (N=8)* *Clethrionomys glareolus: 17.7 m (N=31)*
Further species otherwise recorded	*Sorex araneus, Sciurus vulgaris*

Site / Trapping pattern	**11 / Trap line**
Locality	*Piamprato (Soana Valley)*
Trapping period	*3-11 Aug. 92*
Trapping effort, trap nights (type of trap)	*150 (Sherman), 140 (Pitfall)*
Altitude (metres a s.l.)	*1560-1580*
Ground slope, degree	*25°*
Exposure	*NE*
HL: cover, %	*75-100*
HL: species	*Alnus viridis (Larix decidua)*
LL: cover, %	*10-25*
LL: species	*Alnus viridis*
H: cover, %	*25-50*
Moss: degree of covering	+ + +
Litter: degree of deepth	+ +
Stones/rocks: cover, %	*1-10*
Water habitats	*Small stream inside the station*
Captured individuals	*1 Sorex araneus, 1 Sorex minutus, 1 Clethrionomys glareolus, 10 Apodemus flavicollis/sylvaticus*

Site / Trapping pattern	***12* / Trap line**
Locality	*Rio Carro (Orco Valley)*
Trapping period	*26-29 Jun. 93*
Trapping effort, trap nights (type of trap)	*158 (Sherman), 10 (Pitfall)*
Altitude, metres a.s.l.	*1925-1950*
Ground slope, degrees	*22°*
Exposure	*NW*
HL: cover, %	*75-100*
HL: species	*Alnus viridis*
LL: cover, %	*10-25*
LL: species	*Alnus viridis*
H: cover, %	*25-50*
Moss: degree of covering	+ + +
Litter: degree of deepth	+ +
Stones/rocks: cover, %	*25-50*
Water habitats	*Stream inside the station*
Captured individuals	*11 Clethrionomys glareolus, 1 Apodemus alpicola*
Specimens found in bottles	*6 Sorex araneus*