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FACTORS AFFECTING THE ABUNDANCE OF WILD RABBIT *(ORYCTOLAGUS CUNICULUS)* IN AGRO-ECOSYSTEMS OF THE MOUNT ETNA PARK

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ABSTRACT - A study on the abundance of Wild rabbit *Oryctolagus cuniculus* and environmental factors which may affect its occurrence in agro-ecosystems of Mount Etna was carried out in 1998. Density data, collected monthly by pellet counts in 7 sample areas, show a mean value of 9.16 individuals per hectare; in two samples high density values were recorded and the difference compared to other areas was significant. Two peaks of abundance were recorded during the year. No significant correlation was found between rabbit density and the factors considered but altitude and percentage of abandoned cultivation seem to have a certain influence on the occurrence of the species. The main natural predators, *Vulpes vulpes* and *Buteo buteo,* do not have any negative effect on rabbit abundance.

Key words: Mount Etna Park, agro-ecosystems, *Oryctolagus cuniculus*, abundance, habitat.

INTRODUCTION

The Wild rabbit *(Oryctolagus cuniculus)* is a very important species in the vertebrate predator/prey system in the Mediterranean region. However, information about this species in southern European countries is scarce, particularly in Italy. Moreover, the more frequently dealt with aspects of its biology in Europe are pathology, ethology and diet while studies on ecology, habitat selection and population dynamics are rare (Meriggi, 1988).
An ongoing study on the Wild rabbit began in 1997 on some cultivated lands of the Regional Natural Park of Mount Etna where this species is very common and causes damage to crops. The aim was to estimate the current abundance of the wild rabbit population and the possibility of its management.
The present paper deals with habitat factors which affect the abundance of some samples of the Etnean population.

STUDY AREA AND METHODS

Data were collected in 1998 from January to December. Seven sample areas were chosen around Mount Etna's piedmont belt, located between 750 and 1150m a.s.l; 6 samples within the protected area and 1 was outside its perimeter (sample area n. 5). These areas, each 1 km^2 in diameter, were within agro-ecosystems characterized by a patchy landscape of natural areas and small farm lands. In the natural areas oak, chestnut, broom scrub-land and abandoned cultivation with spontaneous vegetation, were dominant. Instead, the agricultural areas consisted of orchards, vineyards and associated vineyards (mixed cultivation of grape vines and fruit trees, typical of the traditional Etnean agriculture; Table 1). The climate is meso-Mediterranean (Bagnouls and Gaussen, 1957).
The pellet count method proposed by Taylor and Williams (1956) was used to estimate the rabbit population size. This procedure is widely used as an index of rabbit abundance (AA.VV. in Wood, 1988). The number of pellets within fixed stations, made of circular plots of 1.54 m^2, was recorded monthly. The 361 plots (on average 52 per sample area) were randomly distributed both in the natural vegetation areas and in the cultivated lands.

Table 1 - Habitat characteristics of the sample areas.

Habitat characteristics	Sample areas						
	1	2	3	4	5	6	7
Altitude (m a. s. l.)	750	750	950	950	750	1150	800
Diversity (Shannon index)	1.24	0.93	1.11	1.25	1.04	0.55	0.82
Cultivated land (%)	45.7	62.5	28.7	50.6	58.3	16.1	69.4
Woodland (%)	27.7	18.6	53.2	11.2	13.5	81.6	0.0
Scrub-land (%)	0.8	0.1	0.0	16.4	0.0	0.0	2.3
Woodland/scrub-land (%)	0.0	0.0	0.0	6.7	0.0	0.0	0.0
Abandoned cultivation (%)	19.4	18.7	4.7	15.2	2.1	2.3	17.1
Abandoned cultivation/ scrub-land (%)	0.0	0.0	0.0	0.0	0.0	0.0	5.7
Abandoned cultivation/ sciara (%)	0.0	0.0	0.0	0.0	0.0	0.0	5.5
Built up areas (%)	6.3	0.1	13.4	0.0	26.1	0.0	0.0

Table 2 -Abundance of Wild rabbit in the sample areas.

Sample areas	mean number of pellets per plot (SD)	mean number of rabbits per hectare (SD)
1	18.21 (7.99)	12.03 (5.96)
2	57.35 (17.49)	38.38 (17.70)
3	5.74 (5.87)	4.15 (5.63)
4	1.87 (1.24)	1.24 (0.82)
5	4.75 (3.35)	3.03 (1.86)
6	2.01 (2.12)	1.46 (1.36)
7	6.09 (2.98)	3.84 (1.98)
mean (SD)	13.72 (20.02)	9.16 (13.39)

The density estimate in the different sample areas (D) was obtained by applying Eberhardt and Van Etten's (1956) formula: $D = d/rt$ where (d) is the average number of pellets per plot, (r) is the number of pellets produced daily by a single animal and (t) is the period of time (expressed as the number of days from the last count) in which the pellets (d) were deposited. Due to the lack of data for our region, (r) was considered to be equal to 350, the value given by Moreno and Villafuerte (1992) for a Mediterranean environment (Dotiana, Spain). This rate is similar also to those found in other countries (Wood, 1988).

The density data of the Wild rabbit were correlated with some habitat variables of the sample areas. In particular the altitude, the different environmental typologies (expressed as percent coverage; Table 1), the environmental diversity (calculated by the Shannon Index), as well as the number of natural predator species, were taken into consideration. Correlation was also calculated for the Buzzard *(Buteo buteo)* and the Red fox *(Vulpes vulpes)* abundance data which were recorded monthly in the sample areas. For the foxes the excrements were counted along linear transects (one transect per sample area, mean

length: 1.19±0.18 km) while for the buzzards the abundance assessment was carried out according to the index of frequency (n. of individuals/n. of surveys). For the correlation the Spearman rank test was used.

RESULTS

The mean density of rabbits was 9.16 individuals per hectare with a minimum value of 1.24 for area n. 4 and a maximum value of 38.38 for area n. 2 (Table 2; Fig. 1). Differences among all sample areas were significant (F= 38.55; *df*= 77; P= 0.000; Table 3). The annual patterns of abundance of the different samples show two peaks, one for winter and one for late summer except for areas n. 6 and 7 where the second peak is localized in early summer (Fig. 2).

Environmental typologies considered (cultivated land, woodland, abandoned cultivation, built up areas) were positively correlated with density while altitude and diversity were negatively correlated but values for both groups were not significant. The highest values of correlation were found for abandoned cultivation (r_s= 0.643; P= 0.110) and altitude (r_s= – 0.563; P= 0.163).

The correlation between the number of predator species (Table 4) and the density of the rabbits in the single areas was positive but not significant (r_s= 0.643; P= 0.110). The abundance of rabbits does not seem to depend on the frequency of the Red fox nor on that of the Buzzard as correlation in both cases was not significant (r_s= –0.107, P= 0.781; r_s= 0.670; P= 0.089).

DISCUSSION

Except for areas 1 and 2 which showed high density values, the other population samples have values comparable to those found in Sweden (min.: 1.2 ind./ha, max.: 8.2 ind./ha; von Schantz, 1980) and in another protected Mediterranean area (Doñana National Park: min.: 1.0 ind./ha, max.: 5.2 ind./ha; Moreno and Villafuerte, 1992). Density values recorded in area n. 1 are more similar to those found

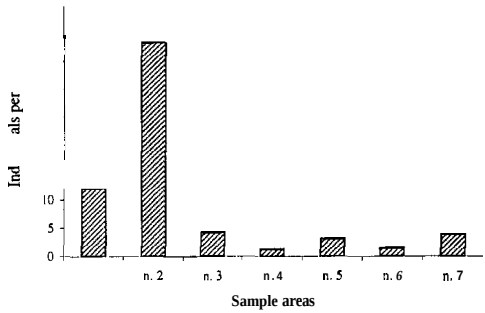

Figure 1 - Average density of *Oryctolaguscuniculus* in sample areas.

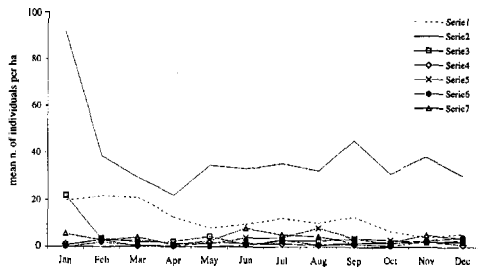

Figure 2 - Variations of density of *Oryctolagus cuniculus* (mean number of individuals) in sample areas during the year.

in Northern France by Arthur (1980; min.: 4 ind./ha, max.: 19 ind./ha). Other comparisons with Mediterranean populations were not possible due to the lack of available data on abundance.

Statistical analysis showed no correlation between rabbit density and the environmental factors considered in the study which confirms that this species has no particular ecological needs. Nevertheless, some of the parameters analyzed seem to have a certain influence on the abundance of the population samples. As far as altitude is concerned, it should be noted that, among the areas within the Park boundaries, those where the highest density values (n. 1 and 2) have been reported are at the lowest altitudes while the lowest density level is found at 1150 m a.s.l. where, during the winter, the ground remained covered in snow for a few weeks.

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Table 3 - Comparison of rabbit abundance in the sample areas.

Sample areas	Variance analisys
1, 3, 4, 5, 6, 7	F= 14.76; *df*= 66; P= 0.000
2, 3, 4, 5, 6, 7	F= 43.23; *df*= 66; P= 0.000
3, 5, 7	F= *0.31*; *df*= 33; P= 0.737
4, 6	F= 0.23; *df*= 22; P= 0.636
1, 2	F= 23.89; *df*= 22; P= 0.000

Table **4** - Occurrence of the main potential predator species of the Wild rabbit in the sample areas.

Predator species	Sample areas						
	1	2	3	4	5	6	7
Buteo buteo	•	•	•	•		•	•
Aquila chrysaetos							
Canis familiaris	•	•	•	•	•	•	•
Vulpes vulpes	•	•	•	•	•	•	•
Mustela nivalis	•	•	•	•	•	•	•
Martes martes							
Felis silvestris		•	•			•	•
Felis catus	•	•	•	•	•		•
N	5	6	6	5	4	5	6

the cultivated and natural vegetation areas, there is evidence that rabbit density depends on the kind of natural vegetation. The rabbit preferred cultivation in areas 3 (F= 19.27; P<0.05) and 6 (F= 6.35; *df*= 22; P= 0.02). The natural parts of these areas are predominantly chestnut woods, while in areas 1 (F= 32.79; *df*= 22; P= 0.000) and 7 (F= 4.45; *df*= 22; P= 0.044) rabbits chose natural areas which consisted mostly of abandoned cultivation.

The extension of built up areas alone does not explain the numerical differences of the studied populations but, in the case of sample n. **5**, which among those at the same altitude (750 m a.s.l.) has the lowest Wild rabbit density, it should be noted that the study area is outside the park boundaries and with an inhabited center inside and human activity in general is much more intense.

Results show that predation by the Red fox has no negative influence on rabbit populations neither in the case of high density levels nor in the case of low density of the prey. In other habitats, when rabbit density is limited, the predator affects its abundance and population dynamics (Moreno and Villafuerte, 1992; Trout and Tittensor, 1989).

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