Biodiversity Journal, 2017, 8 (2): 697–718

Relationships between macroarthropods assemblages and soil characteristics: data from forest habitats of Central Italy

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ABSTRACT With this work we wanted to study qualitatively and quantitatively epigeal soil fauna in some forest areas in the Regional Natural Reserve of Monte Rufeno, Lazio (Italy). In addition to the meso- and macroarthropods (quality and quantity) we also examined some chemical parameters of the soil (pH, organic carbon, nitrogen, exchangeable cations, cation exchange capacity, limestone) and physical ones (particle size, apparent density), in order to demonstrate possible relationships between the texture of the soil fauna and the soil itself. The sampled stations consist of mixed oak and were chosen to represent the diversity of these forest formations in the area concerned. The results are structured in a scheme that identifies the soils groups, an analysis of the fauna, and fauna-soil correlations. By the different approaches of statistical analysis conducted to assess the interlinkages between soil characteristics and density of activities of centipedes and of all arthropods, the values of the number of species detected confirm those found in other forest areas of central Italy. As regards the correlations between soil characteristics and density of activity of the Arthropods, it was observed that the latter is positively correlated with the amount of organic substance and, secondarily, with the quantity of clay + silt present in the first layers of the profiles. It was also deepened the study of one taxonomic group (Chilopoda) and, with respect to the results, the number of species that constitutes the taxocenose within the Reserve (19 species), confirmed results found in other forest areas of central Italy. The small skeleton and surface horizon of the soil, do not seem to favor the presence of centipedes.

KEY WORDS analysis of biodiversity; multivariate analysis; centipedes; macroarthropods soil.

Received 30.03.2017; accepted 19.05.2017; printed 30.06.2017

INTRODUCTION

With a view to safeguarding the Earth's ecosystems, biodiversity and the promotion of sustainable development strategies, soil conservation has certainly a major role since it is home to many forms of animals, plants, fungi and microorganisms which perform essential functions (production, consumption, mineralization) for terrestrial ecosystems.

In this sense it is meant not only the physical maintenance of the substrate for forest and agricultural productions, but also the maintenance of a high level of "quality".

In this work we considered arthropods and the centipedes in order to demonstrate possible relationships between the texture/quantitative of the soil fauna and the soil itself.

We decided to study the centipedes as one of the Authors of this work is a scholar of this group of arthropods.

The Chilopoda constitute a class of terrestrial arthropods small in number, represented in the world by about 3300 species (Minelli, 2006), of which 486 in Europe (Stoev & Enghoff, 2011) and 162 in Italy (Foddai et al., 1995; Zapparoli & Minelli, 2005, Zapparoli & Peroni, 2007). It is a taxonomic group of particular biogeographical and ecological interest, since the species are relatively small, generally with narrow geographic area, often with discrete levels of endemic, predators (in particular of small invertebrates), mostly related to the first layers of the soil. They live especially in forest ecosystems, where in many cases are affluent communities, often numerically well represented, of edaphobic, subcorticicolous, and sublapidicolous species, widespread from litorals to over 4000 m above sea level (see also Lewis, 1981; Minelli & Iovane, 1987; Zapparoli, 2006).

Despite the still fragmentary knowledge of taxonomy, geographic distribution and habitat preferences of some species, they may be considered useful ecological and biogeographic indicators.

The Regional Nature Reserve of Mount Rufeno, given its geographical location, within easy to reach mountain ranges rich of preappennines floristic and particular elements (such as as Amiata and Cetona Mountain and eroded forms of the Paglia Valley) suggests a singular interest also in terms of wildlife.

In this area, in fact, coexist northern European mesophilic elements, at the southern limit of their distribution area, next to southern or Mediterranean thermophilic elements, at the northern limit of their range (Papi, 1997; Vigna Taglianti & Cobolli, 1992).

MATERIAL AND METHODS

Study area and sampling sites

Monte Rufeno Regional Nature Reserve covers approximately 2,892 hectares and falls within the territory of the municipality of Acquapendente, province of Viterbo, Lazio northeastern. The morphology is typically hilly (average altitude 500 m above sea level; Greppe of the Maddalena, 774 m above sea level, Mount Rufeno 734 m, river Paglia 240 m), the substrate consists of turbidite sediments facies Ligure, represented by layers of limestone marl alternating with clays; the stay part consists of flysch sediments of autochthonous whole, as well as small patches of the volcanic Vulsino district, found only in the southern sector of the Reserve (Buonasorte et al., 1988). The whole area is affected by landslides, both ancient and recent; in the landslide, which presents counterslopes, there are small reservoirs that hold water (locally "Trosce"), creating wetlands of natural interest. The surface hydrography is represented mainly by the Paglia River, dividing into two parts the Reserve, which flows into tributaries with torrential regime. The vegetation is strongly shaped by man (Scoppola & Avena, 1992; Blasi, 1994; Scoppola, 1997).

The most relevant vegetational surface by extension and articulation is the oak-dominated *Quercus cerris* L., which occupies approximately 49% of the surface area. This formation, sometimes represented by old coppices, is found mainly in the areas east and west of the Paglia river, from base of the valley to the highest altitudes. This wood assumes different aspects, mesophilic or thermo-Mediterranean, depending on the exposure, the altitude and the substrate. Connected to the facies more mesic of turkey oaks, it is *Castanea sativa* Mill. coppice. Although in the past it was favored by the man, this species is now only in the summit of Monte Rufeno, resulting in formation of a limited extension in which there are also other broadleaf trees *Carpinus betulus* L., *Ostrya carpinifolia* Scop., *Quercus cerris*, *Acer obtusatum* (Waldst & Kit. ex Wild.) Gams., *Fraxinus ornus* L. In connection with the freshest aspects of the Turkey oak is also the mesophilic mixed forest, which develops in suitable slopes, in the valleys or along ditches and streams (Monte Croscione, Troscia of Porcino, Tigna, Fossatello, Tirolle), including *Quercus petraeae* (Mattuschka) Liebl., *Carpinus betulus*, *Ulmus glabra* Huds., *Acer* sp., and *Castanea sativa*. On southern slopes and in the more xeric areas develop irregularly

Quercus pubescens woods, with many open areas where *Spartium junceum* L. and other heat-loving species live frequently. These are secondary formations, kind of replacement of the Turkey oak. In some areas of non-high altitude (Bandita, Africheto) develops a stain in sclerophyllous vegetation, also of secondary origin, presumably replacing a deciduous oak forest, dominated by *Arbutus unedo* L., *Pistacia lentiscus* L., *Viburnum tinus* L., *Smilax asper* L., *Phyllirea latifolia* L. and *Quercus ilex* L.

There is also a extensive reforestation (25% of the surface area), represented by groups of conifers (*Pinus* sp.) planted in the 1950 and 1970 on abandoned agricultural land. On the right bank of the Paglia river are located open formations, represented by abandoned cultivations of little natural interest or grass-pasture attributable to brome grasses. Along the banks of the Paglia there are examples of riparian vegetation, although limited in range, dominated by *Salix* spp., *Alnus glutinosa* (L.) Gaertn., *Populus* spp., *Fraxinus oxycarpa* Bieb ex Willd. and *Quercus robur* L.

The nomenclature of the plant associations to which they refer the woods of the stations follows Scoppola (1997) and Scoppola & Filesi (1997).

Sampling sites. Samplings were found in 11 locations to represent the phytosociological and pedological characteristics of the Monte Rufeno Regional Nature Reserve.

Station 1. Greppe Maddalena, 665 m, exposure WNW, gradient 43%, clay and limestone soil, shallow soil (46 cm), rugged terrain (roots emerging, medium-high erosion: micro ditches), outcropping of rocks virtually absent (1%); high forest transient. *Cerreta xerophile Quercus cerris* and *Quercus pubescens* Willd. The oak woods of this sector of the reserve, although belonging to the floristic structure to *Quercion-pubescent petraeae*, have not been further typed.

Station 2. Field Baglioni, 755 m, exposure NNE, 10% slope, substrate flyschoid sandstone soil with low depth (39 cm),not rugged terrain, rocks outcropping little (2–3%); coppice with reserve trees; oak woods mesophilic attributable to association *Cephalantero longifoliae-Quercetum cerridis*.

Station 3. Macchione, 595 m, exposure SW, slope 33%, sandstone substrate, soil with low depth (36 cm), rugged terrain (erosion, micro-ditches), outcropping of rocks absent; coppice with reserve trees. oak woods mesophilic attributable association *Maples obtusati-Quercetum cerridis*.

Station 4. Morto del Loto, 645 m, exposure NE, 10% slope, clay and limestone soil, soil with average depth (> 42 cm), rugged terrain (widespread erosion and channeled), outcropping of rocks virtually absent (1%); coppice with reserve trees, oak woods xerophile attributable to association *Serratulo-Quercetum petreae* var.

Station 5. Troscia dell'Erba scopina, 560 m, exposure NE, slope 6%, flyschoid-sandstone substrate, soil with low depth (37 cm), not rugged terrain; rocks outcropping virtually absent (1%); coppice with reserve trees, oak woods thermophilic attributable to association *Asparagus tenuifolii-Quercetum cerridis*. A permanent water collection (Troscia) originated from the counter slope of a landslide.

Station 6. Macchia Bruciata, 660 m, exposure W, 2–3% slope, clay and limestone soil, soil with low depth (36 cm), not rugged terrain, rocks outcropping absent; coppice with reserve trees. Oak wood xerophilous, with a prevalence of *Quercus ilex* L. attirbutable to the association *Orno-Quercetum ilicis* var.

Station 7. Monte Rufeno, 660 m, exposure E, slope 2–45%, flyschoid-sandstone soil, soil with low depth (34 cm), moderately rugged terrain (erosion: widespread) and outcropping of rocks virtually absent (1%); coppice under conversion to high forest. Wood mesophilic with prevalence of *Castanea sativa* with affinity for the association *Digital-Castanetum*.

Station 8. Monte Rufeno, 650 m, exposure NE, slope 44%, flyschoid-sandstone soil, soil with low depth (32 cm), moderately rugged terrain (erosion: widespread) and outcropping of rocks virtually absent (1%); high forest transient. Wood mesophilic including *Castanea sativa* and other hardwoods with affinity for the association *Digital-Castanetum*.

Station 9. Lame, 500 m, exposure E, slope 25–38%, limestone substrate, soil with low depth (25 cm), rugged terrain (presence of stones, strong and widespread erosion) rocks outcropping common (3–15%); coppice with reserve trees. Oak wood thermophilic attributable to association *Asparagus tenuifolii-Quercetum cerridis*.

Station 10. Bandita, 300 m, exposure S, gradient 8–23%, sandstone substrate, soil with low depth (27 cm), moderately rugged terrain, rocks outcropping absent; coppice with reserve trees. Oak wood xerophilous with a prevalence of *Quercus ilex* attrib-utable to association *Orno-Quercetum ilicis* var.

Station 11. Fosso del Molino-Paglia River, 240 m, exposure NW, slope <2%, alluvial soil, soil with low depth (>30 cm), not rugged terrain, rocks outcropping absent; coppice with reserve trees. Hydric riparian forest with a prevalence of *Alnus glutinosa* and *Quercus cerris* with *Salix* and *Populus* spp., attributable to association *Aro italici-Alnetum glutinosae.*

Sampling method for Arthropods assemblages

The material examined was achieved by sampling with pitfall traps (see Wytwer, 1995, 2000; Baini et al., 2016).

Samplings (11 stations) with pitfall traps were performed each month during the period February 2001–February 2002. In each station were placed six traps 10–20 m away from each other, according to the morphology of the terrain and the penetrability of the forest; each trap was constituted by a glass of plastic of 9 cm in diameter and of 50 cc capacity, to which a drainage hole has been practiced about 1 cm from the edge; the traps were baited with a solution of vinegar and formalin 4%.

For each species it was calculated the density of activities (DA) in accordance with Mazzei et al. (2015): DA = [n ° individuals / (trap x days)] x 10. For the calculation were used only adults. In order to obtain a picture of the trend of seasonal activity, for each species, the values obtained in the individual stations were summed and plotted on the graph.

Diversity Analysis

For each station the following diversity indices were calculated (Magurran, 1991):

- Diversity Index Shannon- Weaver (H') (Magurran, 1991; Bugio, 1999):
  $H' = -\Sigma p_i \ln p_i$
  Where:
  $p_i = (n_i / N)$ is the frequency or proportion of individuals of each species on the total, ni being the number of individuals of a certain species, and N is the total of sampled individuals.
  ln = natural logarithm

- Uniformity Index or equipartition (Evennes, E) (Magurran, 1991; Bugio, 1999):
  $E = H' / \ln S$
  Where:
  S = number of species
  H'= Shannon-Weaver Index

- Jaccard similarity index (J) (Magurran, 1991; Bugio, 1999):
  $J = j / (a + b - j)$
  Where:
  a = number of species at site at site a
  b = number of species at the site b
  j = number of species in common.

Soil sampling and analysis

Compilation of country cards. For detection of the soils the following field card has been used, in which the main elements were listed and described (see below). These cards allow to make a detailed and macroscopic description of the station, and the soil.

Topography - altitude, slope and site exposure.

Morphology - provides a short description of the landscape, its basic forms and dynamics.

Lithology - information on the type of pedogenetic substrate (bedrock).

Structure - spatial organization of soil aggregates; With an indication of the "type", "degree" and "class." Type: granular, sub-angular polyhedral, multifaceted angular, prismatic, laminated. Grade: weak, moderate, strong. Class: fine, medium, large, very large.

Porosity - percentage of visible voids present in a unit surface area of the layer, mixture of macropores (> 60 μ) and slits (> 0.1 mm).

Rockiness - the presence or absence of rock outcrops on the soil surface. It is estimated as a percentage (not rocky <2%, poor 2–10%, rockiness 10–25%, high 25–50%, highest 50–90%)

Stoniness - Indicates the presence on the soil of stones divided in 3 size classes: small diameter >7.5 cm, average 7.5 to 25 cm and large >25 cm; while the presence of 5 classes are expressed in percent-

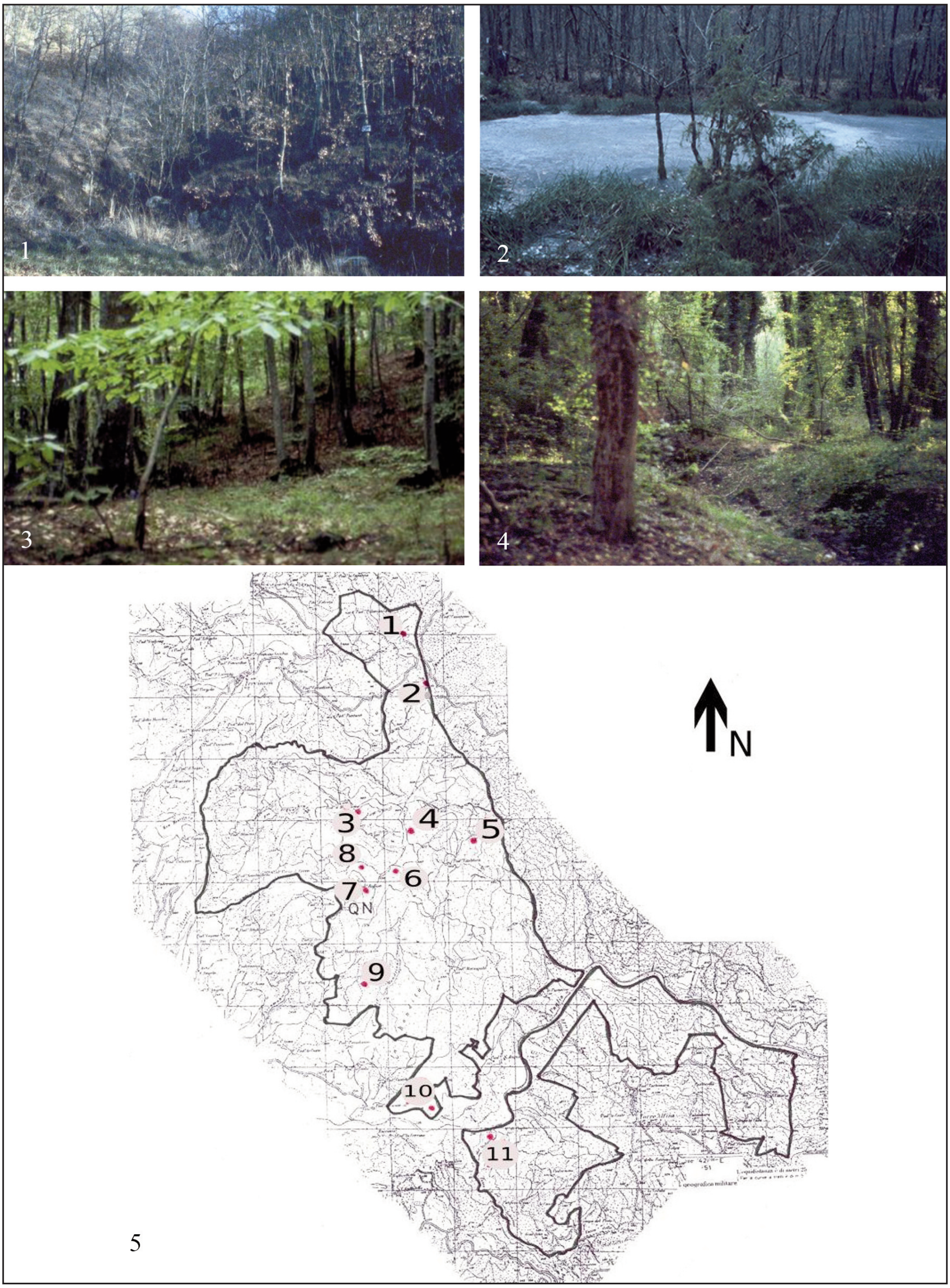

Figure 1. Station 1, Greppe Maddalena. Figure 2: Station 5, Troscia dell'Erba scopina. Figure 3: Station 8, Monte Rufeno; Figure 4: Station 11, Fosso del Molino-Paglia River. Figure 5. Map of the distribution of the sampling sites within the Regional Natural Reserve of Monte Rufeno, Lazio (Italy).

age (absent <0.01%, poor 0.01–0.1%, common 0.1–3%, high 3–15%, highest 15–90%).

Weaving - Represents the percentage between the size classes: sand-silt-clay. Textural classes are established by the triangle of Muller (Soil Taxonomy, USDA).

Color - is determined with tables Munsell Soil Color Chart. The three variables that characterize a given color are given by “Hue”, “Value” and “Chroma”.

Chemical-physical analysis of the soil: analytical procedures. Chemical properties of the soil used primarily for its characterization are as follows using the “Methods of Analysis of Soil Chemistry” National Observatory MIPAF pedological and soil quality (Violante, 2000):

soil reaction (pH): with the potentiometric method and water/land ratio equal to 2:5;

carbonate content: gas-volumetric method by the determination of the CO_2 released using the calcimeter Dietrich-Fruhling;

the cation exchange capacity (CEC): the sum of the cations that in minerals and organic colloids of a soil can be exchanged by means of an ammonium acetate solution.

bulk density: determined through the use of a known volume sampler, thus making the ratio of the weight of the dry ground and the volume of the sampler;

organic carbon (C): the method used is Walkley-Black (Walkley & Black, 1934),

total nitrogen: method Kjeldahl (see Kjeldahl, 1883)

C/N ratio: the ratio between the percentages of organic carbon and nitrogen;

soil texture: particle size determination of mineral soil particles (diameter <2mm) grain size classes according to USDA. Eliminated the organic component, the determination of the clay fraction was derived by densimetric analysis, with the method of Bouyoucos hydrometer (see also Bouyoucos, 1935); the sand was obtained by sieving, while silt by difference.

Skeleton: ‘was obtained by sieving (Ø> 2 mm) a known amount of land and is expressed as a percentage ratio.

For the classification of soils was used the Soil Map of the Monte Rufeno Nature Reserve (Biondi et al., 2000), it is based on the Soil Taxonomy method that was developed by the Soil Survey Staff of the Department of Agriculture US ((USDA, 1972, 1975, 1998,1999).

Climatic parameters

In order to characterize this work from a point of view of soil and climate, and in particular define availability of soil water, was used the Thornthwaite method (Thornthwaite & Mather, 1957).

This method allows to do the “soil water budget” and then calculate indices defining the climatic characteristics of the territory. The climate classification according to Thornthwaite method, has as its central point the determination of two indices: “Ih = humidity index”, and “Ia = aridity index” which are derived from the “soil water budget”. This assessment is done by calculating the temperature (T), precipitation (P), the potential (Etp) and real (ETR) evapotranspiration for each month and then year for a given territory.

Thornthwaite poses that the potential monthly evapotranspiration of an area is a function of temperature (T); the average air is calculated to the following exponential relationship: Etp = 1.6 (10 T/Ic) α, where “Ic” is the annual index heat obtained from the sum of the 12 monthly indices of the heat, and “α” is represented from the index annual calorie “Ic”. Taken precipitation “P”, the temperature “T” and the water supply useful soil “Ru” (calculated using the “Salter-Wiliams” formula, Persicani, 1989), it possible to calculate, by Thornthwaite formula, the “soil water budget”. From this budget there are two important parameters in mm of water: the water deficit of the soil “D” and the soil water surplus “S”; with these values the two climate indices (“Ih = humidity index”, and “Ia = aridity index”) were calculated.

By the term evapotranspiration it means the total water that is transferred into the atmosphere by evaporation from the soil and from liquid mirrors, and for transpiration from plants. For the practical purposes little matters to know the quantity of water passing in one way or another since the global phenomenon is the result of overlap of both phenomena. Other things being in equal conditions, with increasing water availability in the soil will increase the value of evapotranspiration, but not indefinitely. There will be an evapotranspiration limit which will not be exceeded even for more availability of water; this limit is called the potential evapotranspiration Etp.

We define:

ETR-real Evapotranspiration: sometimes also called evapotranspiration current. It is the result of the interaction vegetation-atmosphere- soil that really happens.

1. power evaporating atmosphere;
2. vegetation (type, development and vegetative stage);
3. soil water content

ETP-Potential evapotranspiration: this evapotranspiration depends on the same factors of the "real", however, when the soil water content does not constitute a limiting factor for it. The availability of water in the soil should be equal to or greater than the amount of water that the "soil-vegetation-atmosphere" system is able to evaporate.

Ru-useful reserve: this value (expressed in mm) will normally be achieved by making the difference between the humidity of the soil at field capacity and moisture at the wilting point multiplied by the apparent density of the soil (g/cm^3); in this study we have used the empirical formula of Salter et al., (1966) which takes into account the percentages of sand, silt and organic carbon in the soil, which gave accettable results.

The following climatic indices were calculated: Ia (aridity Index), Ih (humidity Index), Ig (global humidity Index). Soil water balance values are expressed in the Table 1.

The set of temperature and precipitation data are referred to the thermo-pluviometric stations of Monaldesca (altitude above sea level 700 m) and Acquapendente (altitude above sea level 390 m), considered for a 10-year time interval. The rainfall values were averaged; while for the values of temperature, being the survey sites distributed at different heights, they have been adjusted according to the thermal gradient, and then averaged. Therefore each station study differs from the other.

Data analysis

The two sets of data, wildlife and soil, have been studied by relating them to each other by means of multivariate statistics (Figure 6).

The choice of the soil variables to be used in the model, can be made in a logical manner, on the basis of what has been observed in the analysis of the main components, by entering only some variables strongly correlated with the first components of the model through the analysis of statistical indices such as r-squared, standard error of the estimate, standardized coefficients etc. Or you can resort to some of the proposed variable selection by the software techniques that provide for the inclusion or exclusion of independent variables, on the basis of statistical criteria that anyway tend to maximize the fit of the model. The most used methods are: Stepwise selection, selection Forward, Backward elimination.

The dependent variable of the model that has been used is the density of activities (DA), while, among independent variables, pedological ones are those that best correlate with the model.

In the multivariate statistical analysis, the matrix of correlaction coefficients was observed, which did not reveal strong relationships, and later the study was dealt with in more detail using Factor analysis, used to identify a small number of factors that representing synthetically the relationships between a group of related variables.

The factor extraction was carried out by resorting to PCA (Principal Components Analysis). The study of the relationships between variables that describe a series of cases or objects may be faced with the principal component analysis which consists of a particular linear combinations of the observed variables, extracted for subsequent steps.

The first principal component (PC) is a linear combination that collects itself the highest share of common variance between the variables studied. The second PC is a linear combination that collects the maximum amount of residual variance not controlled by the first PC and is not correlated with this. Subsequent PCs explain portions gradually decreasing residual variance and are not related to each other. The number of the extracted components is equal to the number of variables in the study, but the attempt is to minimize the components, trying to make maximum the total variance explained by these.

RESULTS

In addition to the multivariate statistical analysis described in the “Material and Methods” section, numerous other multivariate correlations have been made to correlate faunistic, pedological and climatic data, all possible combinations have been made but none statistically significant results were yielded, probably because of a limited set of consistent data available in a single year of sampling.

Therefore, only the results with statistical significance will be presented here.

Soils groups

The variables considered in the clustering process are: the pH, the CEC, the bulk density, the sum as a percentage of the granulometric classes of clay and silt, the organic substance, the C/N ratio.

The result of the cluster analysis is shown in figure 6 which represents dendrogram of sampling stations as a function of the soil characteristics, using the grouping techniques of the average link between groups.

The dendrogram shows four groupings: group A consists of five stations (2, 5, 7, 8 and 10); group B by two stations (1 and 9); group C by three stations (4, 6 or 3); group D by one (11).

Table 2 shows the average values of the soil characteristics of the four groups. The characteristics that diversify the station 11 from the others are the low values of the organic substance and the amount of clay and silt, while the pH and the apparent density take on higher values.

Group A is characterized by a low pH value; Group B presents high pH, clay + silt and organic matter; group C is characterized by high values of CEC, clay + silt.

Fauna analysis: Arthropoda

Table 4 shows the overall data of the annual activity density and total taxa sampled for each of the eleven examined taken station.

Stations with larger number of sampled taxa (44) are 10 and 3.

The taxa with the highest density of annual activities (DAa) found in the natural reserve, are as follows:

	Stat. 1	Stat. 2	Stat. 3	Stat. 4	Stat. 5	Stat. 6	Stat. 7	Stat. 8	Stat. 9	Stat. 10	Stat. 11
Ru - useful reserve (mm)	105.0	58.00	105.0	140.0	87.08	87.04	87.06	89.09	78.03	56.00	51.02
Etp - potential evapotraspiration (mm)	669.0	684.0	709.0	702.0	714.0	700.0	700.0	701.0	724.0	758.0	769.0
Etr - real evapotraspiration (mm)	553.0	508.0	558.0	575.0	548.0	538.0	540.0	543.0	545.0	540.0	533.0
D - soil water deficit (mm)	146.0	176.0	161.0	127.0	166.0	191.0	159.0	158.0	178.0	217.0	236.0
S - soil water surplus (mm)	503.0	548.0	498.0	482.0	508.0	518.0	516.0	513.0	511.0	515.0	523.0
Ia - aridity index	22	26	23	18	23	27	23	23	25	29	31
Ih - humidity index	75	80	70	69	71	74	74	73	71	68	68
Ig - global humidity index	53	54	48	51	48	47	51	51	46	39	37

Table 1. Results of the calculation of climate indices.

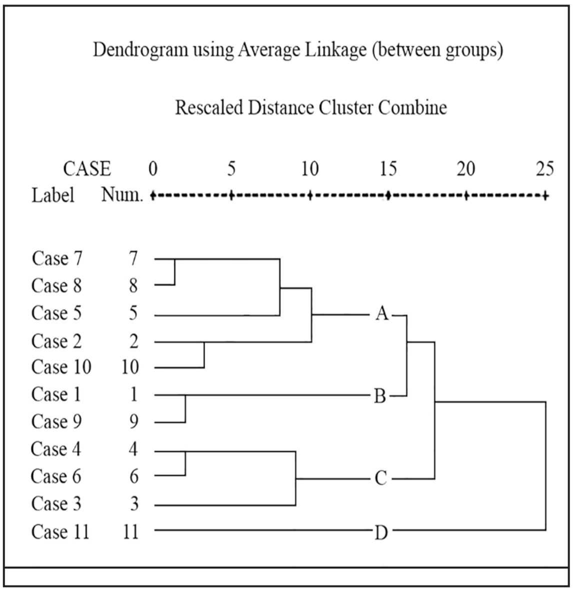

Figure 6. Dendrogram of soil data of sampling stations, using the linkage between groups.

Soil characteristics/ groups of stations	Group A (7-8-5-2-10)	Group B (1-9)	Group C (3-4-6)	Group D (11)
pH	5.98	7.50	6.47	7.80
CEC	25.88	21.90	34.60	28.20
C/N	18.20	22.00	17.00	16.00
Clay+ Silt	52.20	72.50	77.00	40.00
Bulk density	1.20	1.23	1.37	1.52
Organic substance	5.40	6.05	4.37	1.30

Table 2. Soil characteristics (mean values) of the stations groups identified through cluster analysis.

Diptera...2,289.43
Coleoptera Staphylinidae......................1,860.58
Hymenoptera Formicidae.....................1,804.28

Other taxa with densities of greater activity of 500.00 are:

Coleoptera Geotrupidae.......................... 829,07
Araneae.. 599,03
Collembola.. 539,78
Coleoptera Carabidae.............................. 240,46

The density of monthly activity (DAm) follows the seasonal pattern of temperature. The spring-summer months, from April to September, generally have higher values. It has a peak of DAm values in January–February, most likely due to the sum of the DAm of some stations (Stations 1, 3, 7 and 9, have DAm greater than 100, mainly due to the activities of Diptera).

DAm's minimum values are in October-November, probably due to a sudden drop in temperature during the study period and the beginning of autumn precipitation. In this regard it should be noted that the year 2001 had an extraordinary season because until October, there have been relatively high temperature values (Table 4).

The stations with the density of higher activity are the two chestnut: station 7 Rufeno Muntain (with DAa = 1416.93) and 8 Rufeno Muntain (with DAa = 1350.44). In both, the main contribution is given by the activity of staphylinid beetles, Diptera, ants and beetles Geotrupidae.

The station with lower density of activity is the station 5 Troscia dell'Erba Scopina (with DAa = 678.81).

The density of monthly activity has irregular trend for most of the stations, only some have a Gaussian (normal) trend, although with some "anomalies":

Station 1, regularity is interrupted by a positive peak in January/February; Station 4, it was found the max in June and the minimum in December/January; Station 8, there was a decrease in density of activity in the months from July to September; Station 11 has a positive peak from August to September. The positive peaks are due:

Station 1 (January/February) to Diptera (DAa = 144.64); Station 4 (in June), Hymenoptera Formicidae (DAa = 103.64); Station 11 (August/September), the rove beetles (DAa = 38.48) and Diptera (DAa = 29.79); Station 3 presents values of DA monthly rather low throughout the year except for February/April period when the greatest contribution of DA comes from Hymenoptera Formicidae (DAa = 144.88) and Diptera (DAa = 58.54). In this station sampling was not carried out from April to May.

stational features	1	2	3	4	5	6	7	8	9	10	11
Vegetation cover	f.C.R.	cm.C.Cn. R	cm.C.R. O	cm.C.Ro. O	cm.C.F. O	cm.C.R. O	f.Ca. m	f.Ca. p.	cm.C. O	cm. L	cm.C.Cb. Fa
pedogen-etic substrate	CM	A	A	Fac	A	Fac	A	A	C	A	al
type of soil	Xop.coll	Xop.d	Xop.t	Xop.coll	Xop.d	Alf.oll	Xop.d	Xop.d	Xop. coll	Xop.t	Fluv.oll
exposure	WNW	NNE	SW	NE	E	W	E	NE	E	S	NE
elevation	665	755	595	645	560	660	660	650	500	300	240
First layer											
pH	7.4	5.6	6.3	6.3	5.6	6.8	6.3	6.1	7.6	6.3	7.8
S.O.	7.5	8.7	14.1	7.7	6.8	4.9	19.3	23.6	16	8.9	2.5
DA	0.77	0.95	0.85	0.78	0.75	1.05	0.74	0.86	0.94	0.77	1.13
clay	28	20.5	34.1	26.8	6.8	16.4	8.8	7.9	26.2	10.8	11.4
CEC	21.2	26.2	35	38.4	28.3	30.4	23.6	30.7	22.6	20.6	23.2
C/N	24	14	14	18	21	19	20	18	20	18	16
First two layers (average weight)											
pH	**7.55**	5.43	6.3	6.21	5.52	5.86	6	5.87	7.8	6.25	8.04
SO	6.34	3.75	5.91	3.14	3.59	2.61	7.49	7.56	6.65	3.54	1.32
DA	1.22	1,25	1.29	1.48	0.96	1.33	1.15	1.2	1.18	1.24	1.32
clay	31.9	16.64	35.74	23.28	4.6	33.2	8.06	8.12	27.42	5.25	7.8

Table 3. Lithology, soil and vegetation cover of the sampling stations.Abbreviations: Lithology: A: sandstone; to: the recent floods; C: limestones; CM: marl limestone; Fac: flysch clay and limestone. Soils: Alf. oll.: haploxeralf mollic; Fluv. oll.: udifluvent mollic; Xop. coll.: xerochrept calcixerollico; Xop. d: xerochrepts district; Xop. t: typical xerochrept. Vegetation cover: C: *Quercus cerris*; Cam: chestnut mixed; Cap: pure chestnut; Cb: *Carpinus betulus*; cm: coppice with reserve trees; Cn: *Ostrya carpinifolia*; f: high forest; F: *Fraxinus oxyphylla*; Fa: *Quercus robur*; L: *Quercus ilex*; O: *Fraxinus ornus*; A: *Quercus pubescens*; Ro: *Quercus petraea*.

Stations Taxa	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Σ**
Arachnida Scorpiones	0.52	0	2.46	0	0.36	0	0	0	0	1.19	0	4.52
Arachnida Pseudoscorpionida	1.71	1.49	2.51	2.51	1.21	3.38	3.47	4.65	2.21	7.37	2.88	32.77
Arachnida Opiliones	1.46	5.56	1.33	7.58	2.24	4.16	2.51	4.87	4.76	5.1	4.12	43.69
Arachnida Araneae	56.93	63.54	52.58	55.76	48.3	70.56	46.13	40.57	68.94	46.76	48.95	599.03
Arachnida Acari	6.32	6.75	6.94	1.88	3.46	7.11	6.9	1.02	24.99	8.71	4.65	78.73
Crustacea Isopoda	15.52	2.86	24.38	6.41	6.14	7.68	7.46	15.37	13.73	9.53	28.2	137.27
Crustacea Amphipoda	0	113.79	0.18	15.73	11.83	0	0	0	0	0.12	0	141.65
Chilopoda	6.22	2.78	6.3	5.16	5.48	4.29	5.09	3.65	4.62	8.9	6.19	58.68
Diplopoda	23.14	2.76	0.73	2.69	3.07	3.35	1.27	1.81	1	4.86	2.71	47.37
Collembola	51.12	33.14	37.58	50.33	37.2	45.28	36.73	55.02	40.28	55.47	97.62	539.78
Protura	0	0.67	0	0	0	0	0	0.17	0	0	0	0.83
Diplura	0.72	0.13	0	0	0	0	0	0	0	0.52	0.51	1.89
Exapoda (larvae different orders, pupae)	62.67	33.05	29.81	26.61	32.09	64.46	20.47	30.36	31.1	25.11	32.29	388.03
Zygentoma	5.75	0.16	6.35	4.49	1.48	4.2	3.22	3.41	6.4	11.83	8.39	55.68
Blattaria	3.6	3.71	1.67	8.36	3.27	4.2	4.26	26.29	1.37	0.43	1.74	58.9
Mantodea	0	0	0	0	0	0	0	0	0	0.24	0	0.24
Isoptera	0	0	0	0	0	0	0	0	0	0.17	0	0.17
Orthoptera Celifera	0.52	0	1.17	1.13	0.71	1.61	0.49	0	0.65	0.24	0	6.52
Orthoptera Ensifera Grillidae	34.15	2.45	73.83	32.24	18.84	32	57.93	15.57	0	24.56	0.74	292.31
Orthoptera Ensifera indet.	0.69	0.42	0	0.2	0	0	0.56	5.83	0.17	0	0.15	8.02
Orthoptera indet. (juvenile stages)	0	2.5	0	0.45	0	0	0	0	0	0	0.21	3.15
Phasmatodea	0	0	0	0	0	0	0	0	0	0.24	0	0.24
Dermaptera	0	0	0.13	0	0	0.6	0	0	0	0	0	0.73
Psocoptera	0	0	0	0	0.18	0	0	0	0	0	0	0.18
Heteroptera	0.52	0.99	1.42	0.34	0.63	0.84	0.15	0.13	0.98	0.82	0.86	7.69
Homoptera	1.84	0	3.16	1.17	0.44	1.82	0.41	0	1.4	2.34	0.6	13.18
Hemiptera (juvenile stages)	0.17	0.89	0.31	0.3	0	0.68	0.48	0.27	0.64	1.25	0.2	5.2
Coleoptera (larvae)	4.09	1.02	2.49	1.61	2.71	4.21	4.18	1.45	9.12	2.41	1.31	34.6
Coleoptera Carabidae	12.05	6.51	3.57	19.34	8.57	28.15	46.77	18.11	3.92	50.86	42.6	240.46
Coleoptera Carabidae (larvae)	0.19	0.19	0	0	0.54	0	0	0.37	0.47	0.18	0.36	2.3
Coleoptera Silphidae	0	0	0.17	0	0	0	0.16	0	0	2.41	0	2.74
Coleoptera Silphidae (larvae)	0	0.17	0	0	0	1.94	0	0	0.39	0	0.17	2.66
Coleoptera Staphylinidae	120.29	217.38	113.47	87.06	58.83	97.08	316.26	365.99	152.85	178.83	152.52	1860.58

Table 4/1. Density and total annual activity of taxa and lithology, soil and vegetation cover of the sampling stations.

Stations Taxa	1	2	3	4	5	6	7	8	9	10	11	Σ
Coleoptera Scarabeoidea	0.51	1.5	0	2.49	3.76	1.36	0.84	0.58	5.96	1.23	2.33	20.57
Coleoptera Lucanidae	0.17	0.76	0.5	0	0	0.33	0.17	0.16	0	0	0	2.09
Coleoptera Geotrupidae	32.48	293.08	3.52	8.02	12.04	2.66	149.93	255.68	56.46	15.19	0	829.07
Coleoptera Cetoniidae	0	0.17	0.31	0	0	0.99	0.16	0.16	1.4	0	0.36	3.56
Coleoptera Elateridae	0	0.47	0.24	0	0.72	0	0	0	0.43	0	0.36	2.23
Coleoptera Buprestidae	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera Lampyridae	1.06	0.15	0.5	0.72	1.27	0.88	0	0.13	0.78	1.47	0.59	7.56
Coleoptera Lampyridae (larvae)	1.23	0	0.37	1.38	0.36	0	0	0.71	0.74	1.29	1.17	7.24
Coleoptera Cantharidae	0	0	0.12	0	0	0	0	0	0	0	0	0.12
Coleoptera Bostrichidae	0	0	0	0	0	0	0	0	0	0	0.2	0.2
Coleoptera Coccinellidae	0	0	0	0.17	0.27	0	0.24	0	0	0	0	0.68
Coleoptera Meloidae	0	0	0	0	0	0	0	0.17	0	0	0	0.17
Coleoptera Tenebrionidae	1.9	8.58	3.19	5.4	5.35	6.74	8.2	7.18	2.96	5.4	3.51	58.41
Coleoptera Cerambycidae	0.5	0.17	0.33	0.26	0.55	0.16	0.47	0.53	0	0.13	0.38	3.49
Coleoptera Chrysomelidae	0	0	0.31	0.17	0	0.21	0	0.29	0	0.34	0	1.34
Coleoptera Brachyceridae	0	0	0	0.13	0	0	0	0	0	0	0.2	0.32
Coleoptera Curculionidae	3.02	1.71	0.17	0.47	3.75	0.25	1.21	5.29	1.18	1.35	2.35	20.74
Coleoptera Scolytidae	0.17	1.73	1.65	0.4	2.63	5.52	0.86	0	0	0.61	0.16	13.74
Coleoptera (different family)	8.58	17.05	9.93	6.12	9.63	6.35	51.61	25.16	11.74	15.42	17.39	178.98
Neuropteroidea	0	0.34	0	0.27	0	0	0	0	0	0	0	0.62
Mecoptera	0	0	0	0	0	0	0	0	0.19	0	0	0.19
Siphonaptera	0.17	0	0	0	0	0	0	0	0	0.17	0	0.34
Diptera	332.26	113.88	234.3	63.27	96.03	186.67	244.96	272.84	387.71	137.29	220.53	2289.73
Trichoptera	0	0	0	0	0	0	0.17	0	0	0	0	0.17
Lepidoptera	38.82	102.1	54.65	53.68	40.34	109.07	61.13	100.34	31.66	19.25	16.8	627.85
Lepidoptera (larvae and chrysalises)	1.22	5.52	2.6	3.91	4.95	10.48	0.56	1.07	1.76	3.89	1.19	37.14
Lepidoptera Lymantriidae (larvae)	0.4	17	0.83	4.8	4.52	3.87	0.32	0.32	0.58	0.31	0	19.73
Hymenoptera Symphyta	0	0.75	0	0	0	0	0	0	0	0	0	0.75
Hymenoptera Apocrita	4.1	4.72	2.77	1.74	4.2	2.63	5.47	1.57	3.79	2.82	4.37	38.17
Hymenoptera Apocrita Formicidae	64.08	70.43	248.85	240.2	238.24	148.95	259.09	148.01	103.46	84.98	198	1804.28
Hymenoptera Apocrita Vespidae	0.17	0.17	0.17	0	0.171	0.33	0.16	1.65	0.5	0.5	4.94	10.29
Hymenoptera (different family)	0	0	0.52	0.34	0.89	0.33	0	0.17	0.65	0	3.54	6.44
Density Activity (DA)	900.61	1130.34	938.39	724.71	678.81	875.41	1350.44	1416.93	981.93	742.13	916.32	
N. taxa sampled	40	43	44	41	40	39	38	39	39	44	41	

Table 4/2. Density and total annual activity of taxa and lithology, soil and vegetation cover of the sampling stations.

One might note that this station is very sensitive to the summer drought since the climate anomaly recorded in the year 2001. It should also be pointed out that this station is located in landslide areas.

Related soil fauna: Arthropods. The matrix of correlation coefficients between soil variables and those of wildlife shows little sharing of their variability, with the exception of the variable annual activity density (DAa) which seems to establish a good correlation with the organic matter (Table 5).

Multiple Regression Model. The choice of the independent variables of the model was made on the basis of some statistical criteria offered by the software (Stepwise selection, selection Forward, Backward elimination). All of them have led to the solution which involves the insertion of organic matter variable and variable clay+silt, thus responding to the logical criterion of choice of the variables among those strongly correlated with the first extracted components. In Table 6 is shown an example of the choice of the variables according to the Backward elimination method that allows to follow, step by step, the elimination of the less representative variables, pending the resolution of the best model possible.

The model chosen is then the number 5: DA= 1126.32 to 8.636 (clay+silt) + 76.86 organic matter.

Discussion: Arthropods. Given the limited number of experimental data used, the model can not be used for predictive purposes but only for a further confirmation that the soil variables that have had a certain influence on the activity densities variable are the organic substance and the content of clay + lime of the observed sites.

Similar studies conducted in two stations of Latium, Circeo National Park (LT) area of Canino (VT), respectively in Mediterranean plant formations and olive groves in an agro-ecosystem (Calvario et al., 1986; Zapparoli & Jona Lasinio, 1993) have shown that beetles, springtails Formicidae and arachnids are the most numerous groups.

In the agro-ecosystem with olive trees there are more numerous beetles, carabids and staphylinids (DAa carabids = 40, DAa staphylinids = 26, DAa ants = 65, other groups less than 30, instead DAa values of the present work are: carabids = 240, staphylinids = 1860, ants = 1804.28) (Zapparoli & Jona Lasinio, 1993).The beetles and araneids have an almost uniform presence throughout the year, but the latters are more abundant in spring. The Collembola are more present in winter–spring. As for centipedes, in the Circeo Park, the highest number of species are collected in plain woods while the poorest stations consist of high and low bush (Minelli & Zapparoli, 1986).

Analysis of fauna: Centipedes

The species of centipedes collected in the Regional Natural Park Rufeno Muntain are 19, distributed (Table 7) in four orders and six families. It is a fauna consisting largely of species with European distribution with some endemics of the Apennines (*Lithobius cassinensis* and *Eupolybothrus fasciatus*).

As a whole, the centipedes community in the reserve has a number of species comparable to that of other forest ecosystems of central Italy; 17–20 species were sampled in Lepine Mountains (southern Lazio) (Zapparoli 2007; Zapparoli & Peroni, 2007); 21 species were collected in the area of Ausoni and Aurunci, Lazio (Zapparoli, 1994) 18 species are known in the forest of the Circeo National Park, Lazio (Minelli & Zapparoli, 1994).

The station with the highest number of species is 11, with eight species, follow the Station 8 and Station 9, both with seven species. The number of species sampled in the other stations oscillates from a minimum of four to a maximum of six (Table 8).

The species common to all stations is *Eupolybothrus fasciatus*, well represented with numerous individuals, especially to forest ecology in the Apennine distribution (Zapparoli, 1992, 1994)

The following stations are characterized by the exclusive presence of:

Station 4: *Stigmatogaster gracilis*
Station 5: *Geophilus carpophagus*
Station 7: *Lithobius tricuspis*
Station 8: *Cryptops anomalans*
Station 8: *Cryptops hortensis*
Station 9: *Himantarium gabrielis*
Station 11: *Strigamia crassipes*

		Sum	pH	CEC	C/N	clay+silt	bulk density	Organic matter (SO)
Sum	Corr. di Pearson							
	Sig. (2-code)							
	N							
pH	Corr. di Pearson	-.100						
	Sig. (2-code)	.770						
	N	11						
CEC	Corr. di Pearson	-.128	-.275					
	Sig. (2-code)	.707	.414					
	N	11	11					
C/N	Corr. di Pearson	-.139	.284	-.457				
	Sig. (2-code)	.683	.398	.157				
	N	11	11	11				
clay+silt	Corr. di Pearson	-.328	.130	.356	.154			
	Sig. (2-code)	.324	.702	.282	.652			
	N	11	11	11	11			
bulk density	Corr. di Pearson	-.259	.422	.350	-.401	-.098		
	Sig. (2-code)	.443	.196	.291	.222	.774		
	N	11	11	11	11	11		
Organic matter (SO)	Corr. di Pearson	.658*	-.117	-.066	.154	.245	-.539	
	Sig. (2-code)	.028	.733	.847	.651	.467	.087	
	N	11	11	11	11	11	11	

Table 5. Relationship. Sum = density of activities; * = The correlation is significant at the 0.05 level (2-tailed).

Model	R	R-square	R-square correct	standard error of estimate
1	.862[a]	.742	.355	194.1540
2	.860[b]	.740	.481	174.2783
3	.859[c]	.737	.562	160.1036
4	.850[d]	.723	.604	152.2338
5	.830[e]	.689	.611	150.8268

Table 6. Choice of variables according to the method of Backward elimination; a = estimators: (Constant), organic matter (SO), CEC, pH, C / N, clay+silt, bulk density; b = estimators: (Constant), organic matter, CEC, pH, C/N, clay + silt; c = estimators: (Constant), organic matter, pH, C / N, clay + silt; d = estimators: (Constant), organic matter, C / N, clay + silt; e = estimators: (Constant), organic matter, clay + silt.

		Not standardized coefficients		standardized coefficients		
		B	**Standard error**	**Beta**	**t**	**Sig.**
1	(Constant)	1114.023	1063.377	-	1,048	0,354
	pH	62.916	131.547	0.197	0,478	0,657
	CEC	4.840	17.176	0.114	0,282	0,792
	C/N	-17,439	5.470	-0,215	-0,628	0,564
	clay+ silt	-9,444	5.470	-0.570	-1,727	0.159
	Bulk density	-139.851	825,657	-0,083	-0,169	0,874
	Organic matter (SO)	79.886	31.424	0,817	2,542	0,064
2	(Constant)	1016.979	804.129	-	1,265	0,262
	pH	46.721	81,099	0.146	0,576	0,590
	CEC	3.305	13,096	0,078	0,252	0.811
	C/N	-15.480	22.678	-0.190	-0,683	0,525
	clay+ silt	-9.165	4,681	-0.553	-1,958	0,108
	Organic matter (SO)	82,679	24.010	0,846	3,443	0.018
3	(Constant)	1164.083	508.862	-	2.228	.062
	pH	41,039	71,574	0,128	0.573	0.587
	C/N	-18.290	18.149	-0.225	-1.008	0.352
	clay+ silt	-8.535	3,638	-0.515	-2,346	0,057
	Organic matter (SO)	81,584	21,694	0,834	3,761	0,009
4	(Constant)	1371.418	340.428	-	4,029	0,005
	C/N	-15.233	16.495	-.187	-0,923	0,386
	clay+ silt	-8,252	3,427	-0,498	-2,408	0,047
	Organic matter (SO)	79.147	20.228	0.809	3,913	0,006
5	(Constant)	1126.323	211.222	-	5,332	0,001
	clay+ silt	-8,636	3.370	-0,521	-2.562	0.034
	Organic matter (SO)	76.876	19.893	0,786	3.865	0,005

Table 7. Correlations. Sum=density of activity; * = the correlation is significant at the 0.05 level (2-tailed).

species/station	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Eupolybothrus fasciatus (Newport, 1845)	11	4	16	11	11	10	4	4	8	8	5
Eupolybothrus grossipes (C.L. Koch, 1847)											4
Eupolybothrus nudicornis (Gervais, 1837)	2		1								
Lithobius cassinensis (Verhoeff, 1925)	2	1	3	1	6	3		1	1	7	5
*Lithobius castaneus (*Newport, 1844)	2	2					1		3		2
Lithobius forficatus (Linnaeus, 1758)							2	6			1
Lithobius lapidicola (Meinert, 1872)									1	1	1
Lithobius tricuspis (Meinert, 1872)							1				
Lithobius tylopus (Latzel, 1882)	4						7	1			
Cryptops anomalans (Newport, 1844)								1			
Cryptops hortensis (Donovan, 1810)								1			
Cryptops parisi (Brölemann, 1920)				2	2	1	1	1	1	1	1
Himantarium gabrielis (Linnaeus, 1767)									2		
Stigmatogaster gracilis (Meinert,1870)				1							
Schendyla nemorensis (C.L. Koch, 1837)		2				2					
Clinopodes flavidus (Koch, 1847)					1					1	
Geophilus carpophagus (Leach, 1814)					1						
Geophilus richardi (Brolemann, 1904)	3				2	1			1		
Strigamia crassipes (C.L. Koch, 1835)			1			1					1
tot. n° species	6	4	4	4	6	6	6	7	7	5	8
tot. n° specimens	24	9	20	15	23	18	16	15	17	18	20

Table 8. Natural Reserve of Rufeno Mountain: list of species of centipedes in the stations examinated and number of individuals collected.

Stations	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
H’	1.53	1.27	0.76	0.82	1.40	1.34	1.48	1.61	1.58	1.20	1.97
E	0.9	0.9	0.5	0.6	0.8	0.8	0.8	0.8	0.8	0.7	0.9

Table 9. Value of Shannon & Weaver index (H') and Evennes (E) in centipedes from the examined stations

These are generally forest elements, more or less closely linked to *Quercus* formations in central and central-Northern Italy, except for *Himantarium gabrielis* species of avventism (Zapparoli, 1992).

Diversity index of Shannon & Weawer (H') and Evennes (E). In Table 9 are reported the values of the Index of diversity of Shannon & Weawer (H') and Evennes (E) of the chilopods taxocene of the various sampled stations. The index of Shannon & Weaver (H') has the highest value in the station 11.Fosso del Molino-Paglia (H'=1.97), while the lowest value is observed in Station 3. Macchione (H'= 0.76) and Station 4. Morto del Loto (H'= 0.82). This result is probably linked to the fact that both stations are rather degraded with landslide layers. Only four stations have values of H' greater than 1.53.

The parameter (H') would not seem linked to an altitudinal gradient, mesophilic/xerophilous or with soil characteristics detected for each station.

The Evennes follows the trend of H', except for Station 2. The highest value is in station 11 (0.95).

Jaccard similarity index. Table 10 shows the index values of similarity of Jaccard calculated for eleven sampling stations. From this analysis it can be deducted that the most similar stations are 5 and 10, 9 and 11, 7 and 8, 1 and 2.

Through cluster analysis it was constructed a dendrogram (Fig. 7) in which the hierarchical classification of the stations was carried out using the average bond method (UPGMA). Through this analysis it would appear possible to highlight three groups of stations:

1) stations 7 and 8
2) stations 11, 9, 6, 10, 5, 4
3) stations 1, 2, 3

The groups of stations detected by the dendrograms, are only moderately correlated with some soil characteristics of the same stations.

Related Fauna soil: Centipede. Comparison of faunal and soil data shows an inversely proportional correlation between the number of individuals in each station and the presence of skeleton in the first soil layer.

It has been found that in the stations 1, 3 and 11, where the presence of individuals is greater than 20 (all other stations have fewer than 20 individuals), the skeleton is small and low, the only exception being station 5 which has 23 individuals with a small and common skeleton (Table 11).

Analysis R^2. All weak (Fig. 8).

Increasing the value of the granulometric band is there a direct proportionality, of course. This data is confirmed by inverse proportionality with clay and confirmed by the relationship of sandy + silt.

The organic substance, bulk density and pH, have no influence.

So centipedes prefer a generally porous soil.

The humidity index (Ih, calculated with Thornthwaite formula) is inversely proportional to the density of activity. This is confirmed, albeit weakly, by both the evapotranspiration (ETR), which is directly proportional, and the soil water deficit that it is also directly proportional.

In conclusion it appears that the DA of chilopods increases in porous soils and where there is stagnant humidity.

Discussion: Centipedes. Based on the statistical analysis of most representative soil data (pH, CEC, bulk density, organic matter, granulometric sand clay and silt, C / N), the eleven sampling stations are subdivided into four groups.

In the first group are represented the stations that have a sandstone lithological substrate or Flisch arenaceous characterized by a pH subacid (stations 2, 5, 8, 7, 10).

In the second group are placeable stations with soils formed on Flisch clay substrate, characterized by an increased CEC of 30 meq (stations 1, 9).

The third group consists of the stations with soils in which carbonates are present, in fact, the pH is greater than 7.4 (stations 3, 4, 6).

The fourth is replaced by a single station placed on the recent floods (station 11. Fosso del Molino-Paglia).

An alternative to this is to write a general description of the soils in the Reserve.

From the various statistical analysis approaches to verify any correlation between soil characteristics and the density of activity of the centipedes, the number of species that make up the taxocenose of the Reserve is 19, a value confirming those found in other forest areas in Central Italy.

The station with greater number of species is the

stations	1	2	3	4	5	6	7	8	9	10	11
1	1										
2	0.43	1									
3	0.43	0.33	1								
4	0.25	0.33	0.33	1							
5	0.33	0.25	0.25	0.42	1						
6	0.33	0.42	0.42	0.42	0.5	1					
7	0.33	0.25	0.11	0.25	0.2	0.2	1				
8	0.3	0.22	0.22	0.37	0.3	0.27	0.44	1			
9	0.44	0.37	0.22	0.37	0.44	0.44	0.3	0.27	1		
10	0.22	0.16	0.28	0.5	0.57	0.37	0.22	0.33	0.5	1	
11	0.25	0.33	0.33	0.33	0.27	0.4	0.4	0.36	0.5	0.44	1

Table 10. Jaccard Index values in the comparison between the examined stations

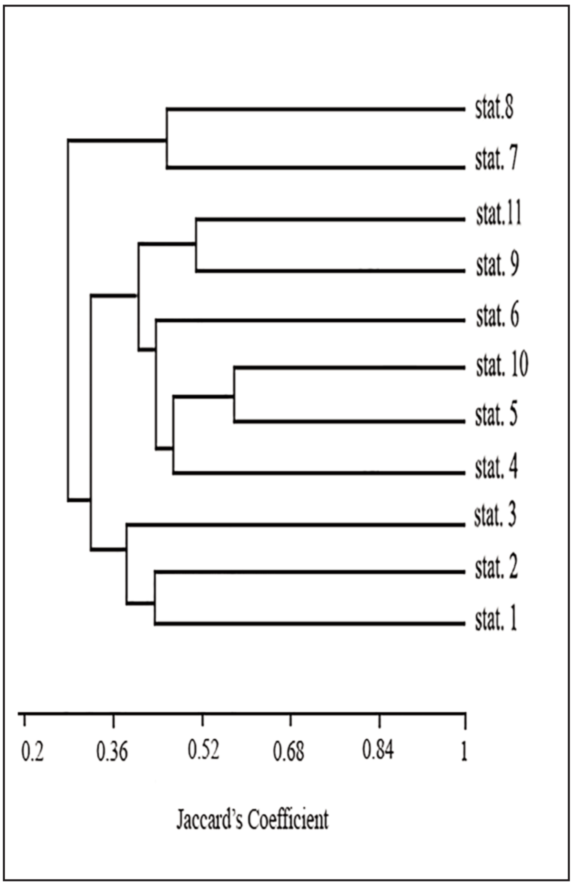

Figure 7. Dendrogram similarity between taxocenoses of centipedes in the Natural Reserve of Rufeno Mountain.

station	n° species	n° individual	skeleton
1	6	24	meager, small
2	4	9	none; then plenty, medium/small
3	4	20	none; then meager, small
4	4	15	none; then common, small
5	6	23	none; then common, small
6	6	18	none; common, small
7	6	16	none; common, small
8	7	15	none; common, small
9	7	17	none; plenty, medium
10	5	18	none, frequent, small; frequent, small and medium
11	8	20	none; meager, small, very abundant:gravel

Table 11. Natural Reserve of Rufeno Mountain: centipedes and soil skeleton (first 30 cm, layers A + B). Legend: none <1%; meager 1–5%; Common 5–15%; frequent 15–35%; plenty of 35-70%; very abundant> 70%.

11, confluence Fosso del Molino-River Paglia (8 species) which is located on an alluvial soil with a high sand content.

The common species at all stations is *Eupolybothrus fasciatus*, species of forest ecology, Apennine endemic, while some species, however showing European chorology, have been found exclusively in some stations.

In conclusion, it appears that the DA chilopods increases in porous soils and where there is no stagnation of humidity, and that the small skeleton, and the horizon of the soil, do not seem to favor their presence.

Regarding the diversity of species of centipedes, this was analyzed by the index of Shannon-Weaver, which shows that it is higher in station 11.

While the lowest values of diversity index were found in stations 3. Macchione and 4. Morto del Loto, which are placed in areas affected by landslides consequence of a considerably degraded vegetation.

CONCLUSIONS

To conclude, this study, although conducted for a whole year and for a large number of stations, is still preliminary and partial oin nature, as has been investigated only a particular portion of the area of the fauna attached to a precise soil layer, and has maintained an identification taxonomic level not lower than that of the family.

However, the huge amount of collected invertebrates, 58,651 specimens, referring to no less than 3 phyla (Arthropoda, Annelida, Mollusca), 5 classes, 34 orders, more than 23 families of beetles and centipedes for 6 families of centipedes, constitute a important potentially usable

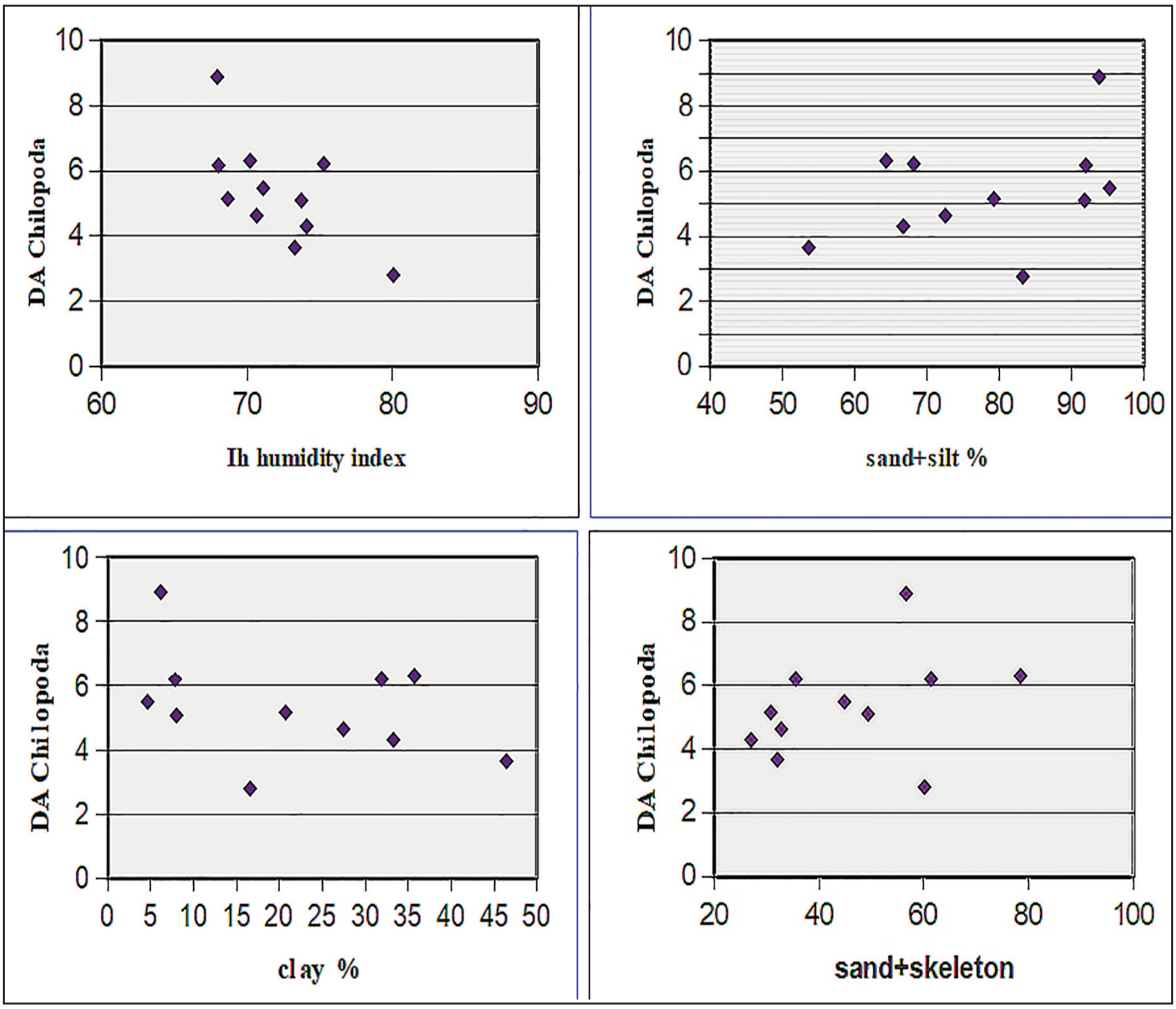

Figure 8. Graphs that relate the activity density of Chilopoda and physical soil parameters: skeleton+sand, clay, sand + silt, and a climate parameter moisture.

material for the continuation of research in the protected area.

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