

Differentiation of Coleoptera (Carabidae and Tenebrionidae) communities in Mediterranean-type ecosystems from mountainous areas in the Peloponnese, Greece

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ABSTRACT: Soil Coleoptera are one of the most abundant and diverse groups of insects in Mediterranean-type ecosystems. Their ecology, especially in mountainous areas of Greece, has been poorly studied although they are considered as being very useful for ecological studies since they correlate well with ecological parameters such as soil type and vegetation cover. In the present study, an analysis of the structure and diversity of soil Coleoptera was carried out in Mediterranean habitats in six mountains of the Peloponnese. Sampling was carried out using pitfall traps in 7 sampling stations. The analysis was carried out at the species level for the families of Carabidae and Tenebrionidae. At the same time, we measured various ecological factors that influence the distribution of soil Coleoptera such as soil composition and vegetation cover. Following that, the effect of these ecological parameters on the composition of the soil coleopteran community was analyzed and the various stations were compared using seasonal phenology, distribution and density activity of soil Coleoptera. The analysis of the structure of the communities revealed a differentiation between stations of the different mountains, especially following a north-south gradient. Vegetation cover and the plant species composition seem to affect the distribution and abundance of the species. Concerning seasonal phenology, the highest values of density/activity were obtained during spring. Movement to the shadow under the vegetation compensated the increase of temperature during summer. This seems to be the reason for an increased summer activity in several stations, which was, however, smaller than the corresponding autumn increase.

1 INTRODUCTION

Carabidae and Tenebrionidae are important study groups in ecological research. They show clear associations with environmental parameters such as soil type and vegetation cover and are thus good indicators of environmental change (Thiele 1977, Gardner 1991).

The Peloponnese is a mountainous area in southern Greece that supports an interesting invertebrate fauna with high diversity and high levels of endemism. Five mountains were chosen for this study covering a large percentage of its area. These were Erymanthos and Chelmos in the north, Mainalo in the center, Paronias in the east and Taygetos in the south. In each mountain, several different habitat types were sampled for Carabidae and Tenebrionidae using pitfall traps. These habitats included the mediterranean-type habitats of maquis and phrygana. The aim of this study was to study the structure and diversity of the edaphic Coleoptera in relation to the different mountains, the seasonality, the different habitats and a number of ecological parameters.

2 MATERIALS AND METHODS

In order to analyze the structure and diversity of the edaphic Coleoptera communities, 5 stations were selected in maquis habitats (one station in each mountain) and 2 in phrygana. In particular, 20 pitfall traps were placed in each station in two transects of 10 traps each. Pitfall traps are the most widely used method for the study of soil arthropods (Lövei and Sunderland 1996). The two transects were separated by at least 10 m. The distance between the traps was 10 m and their contents were emptied each season. The traps that were destroyed during the sampling period were not taken into account. Stations with less than 12 traps in good condition were also not taken into consideration. The results were transformed to individuals per trap per 100 trap-days. In the Chelmos maquis, traps were studied for three years, in the Taygetos maquis for two years and in the remaining mountains for one year. In the phrygana, both stations operated for one year. The contents of the traps were identified in the lab. Coleoptera were identified at the family level while Carabidae and Tenebrionidae were identified to the species level. In parallel with the traps, a number of ecological parameters considered to influence the diversity of Coleoptera were also measured. These included *inter alia* vegetation cover, organic content, soil humidity, pH and water content.

Variation of the measured environmental variables, especially those relating to habitat structure, was analysed by one-way ANOVA. Differences in the Coleoptera communities between habitats were examined by analyzing the differences in both the number of species and in the number of individuals of the species caught in each habitat type by one-way ANOVAs. Repeated measures multivariate ANOVA on the effects of species, habitat, mountain and season on Coleoptera abundance was carried out. Species associations of Coleoptera were analysed by canonical ordination of the data for each species. Canonical ordination was carried out using the CANOCO programme (ter Braak, 1987-1992). Within the programme, the canonical correspondence analysis (CCA) option was used.

3 RESULTS

A total of 72 species (47 Carabidae and 25 Tenebrionidae) were caught in all the habitats and mountains during the sampling period. Thirty-one species were recorded from the maquis of Chelmos, 18 from Erymanthos, 26 from Mainalo, 13 from Parnonas, 14 from Taygetos, 19 from the phrygana of Chelmos and 33 from the phrygana of Taygetos. The ANOVA between species abundances showed a mixture of common and rare species. The analysis of seasonal phenology showed that the season with highest abundances was in most of the station spring. However, in some stations, summer showed the highest abundances. Movement to the shadow under the vegetation compensated the increase of temperature during summer. This seems to be the reason for an increased summer activity in several stations, which was, however, smaller than the corresponding autumn increase. Autumn had generally lower abundances while winter had the lowest. Considering differences between maquis and phrygana habitats, it was not possible to separate them since both had stations with high and low abundances. The same was true for the maquis stations from each mountain.

Cluster analysis of the mountains showed that the northern mountains (Chelmos and Erymanthos) are grouped together. A second cluster included the central-eastern mountains (Mainalo & Parnonas) while Taygetos formed a third group.

Canonical correspondence analysis showed that the factors mostly responsible for the differences in abundances were soil humidity, altitude, presence of low vegetation, east-west gradient and pH at a lesser extent. Altitude was strongly correlated with the north-south gradient. The stations were well grouped according to these variables. The four groups that were formed were the phrygana, the northern maquis, the central-eastern maquis and the maquis of Taygetos.

The ANOVA of the ecological parameters showed differences mainly between the different habitat types.

4 DISCUSSION

The edaphic Coleoptera fauna of the Peloponnese shows significant differences that are due to many factors. These include the north-south and east-west gradients, the differences in habitats, seasonal differentiation, vegetation cover, soil humidity and soil pH. The interrelationship between these factors produces a very variable and diverse fauna, which is also influenced by the geological history of the area. Only few species were common between the various stations. Many species were characteristic of mountains and habitats. However, most of the differences occurred between habitats and not mountains. This reflects to some extent the response of the species to the various environmental parameters that is evident in their differentiation according to habitats.

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