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Soil zoology I: arthropod communities in open landscapes of former brown coal mining areas

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Abstract

In different habitat types of the former coal mining area of Lower Lusatia, distribution and abundance of species of various arthropod groups was studied as to the colonization dynamics and the formation of community patterns. Heteroptera, Auchenorrhyncha, different groups of Coleoptera, Araneida, and Orthoptera were included in the study. In total, about 850 species were captured by pitfall trapping and sweepnet sampling. A detailed analysis of species–environment-relations was performed by means of gradient and eigenvector analysis (DCA, CCA). It is shown that colonization of bare sand habitats, pioneer vegetation with ruderal herbs, short grass prairie with *Corynephorus* and xerophytic herbs, tall grass prairie with *Calamagrostis*, and shrubs takes place rather quickly. In all the analysed habitats an adequate degree of the colonization was attained by the studied groups. Both the formation of patterns of species assemblages and population dynamics in upper layers of vegetation mainly depend on the patterns of plant communities and vegetation architecture. In lower layers micro-climatic conditions as well as abiotic soil parameters were shown to be of special importance. Differences of community patterns between predators and mainly phytophagous arthropod groups were discussed.

Keywords: Arthropoda; Araneida; Carabidae; Heteroptera; Auchenorryncha; Staphylinidae; Scarabaeidae; Orthoptera; Lower Lusatia; Germany; Community patterns

1. Introduction

Animal colonization and the formation of spatial patterns of animal communities have been studied in the framework of numerous ecological theories, the most important one being the general theory of island biogeography (MacArthur and Wilson, 1963; Connor and McCoy, 1979; Coleman, 1981). Time and size dependency as well as habitat features and different properties of sites like heterogeneity have been stressed to explain both species–area-relations (Whittaker, 1972; Williamson, 1981; Nielsson et al., 1988; Seagle and Shugart, 1985) and species-abundance relations (Williams, 1964; May, 1975). Assembly rules have been proposed to explain patterns of

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species distribution in animal communities (Diamond, 1975; Connor and Simberloff, 1979; Wilson, 1994; Palmer and White, 1994) and the importance of environmental filters have been stressed (Keddy, 1992; Niemelä, 1993). The role of interspecific competition is often considered as weak (Connor and Simberloff, 1979; Connell, 1980; Strong et al., 1979; Simberloff, 1983).

In order to analyse both patterns of colonization and community formation under different environmental conditions and their variation in time, we investigated open landscapes of former opencast brown coal mining areas. Open mining leaves great areas of devasted land after dumping requiring all species to invade into the area again and recolonize it. The following questions will be adressed in what follows:

1. What are the main environmental factors which determine colonization processes of invertebrate animals and community pattern formation of open sites?
2. Which mechanisms determine the colonization, and is there any evidence for time dependence of the formation of spatial community pattern?
3. Are there any differences among certain taxocoenoses and functional animal groups?

Compared to biogeographic investigations carried out in order to analyse colonization mechanisms on islands the former mining area is less isolated from the colonization source. Former investigations have often been restricted to certain taxocoenoses (see references in Connor and McCoy, 1979), while we tried to include different groups of animals, at least predatory and non-predatory as well as groups restricted to vertical different layers. In the framework of the present study, the following procedure is applied:

- Selection of study sites in former opencast mining areas including different habitats in open landscapes, inventarisation of arthropods of different groups with different collecting methods and data sampling including different biotic and abiotic environmental factors.
- A priori classification of the landscape according to the general vegetation architecture, selecting study sites.
- Application of different gradient analyses (Detrended Correspondence and Canonical Correspondence Analysis) to different animal groups in order to classify habitats in relation to environmental parameters, occurrence of species and the effect of time.
- Detection of environmental parameters as to their relative importance for the formation of animal communities and comparison of effects for different groups of arthropods.

2. Study area and study sites

Investigations on the distribution and abundance of terrestrial organisms in former coal mining areas of Lower Lusatia were carried out since 1995 in the framework of different research projects. The mining region of Lusatia comprises the area of Southern Brandenburg and Northeastern Saxonia, approximately 130 km southeast of Berlin and 100 km north of Dresden, respectively (Fig. 1). It is situated at the southeastern edge of the north German lowlands area. Mining sites were situated both in glacial valleys and ground moraine areas which results in a different hydrological situations. Most glacial deposits resulted in sandy soils except in the north western part of the region. Predominant land use in the non-mining areas is forestry which covers approximately 70% of the total area. Agriculture is traditionally weak in Lusatia as the soils are generally nutrient poor and infertile.

For detailed account on the ecological and socioeconomical problems of the area see Wiegleb (1996), Blumrich et al. (1998), and Wiegleb and Felinks (2001a,b). The opencast lignite mining-activities leaves destroyed large areas with bare substratum and without any vegetation, so that all organisms have to recolonize the area anew. Subsequently, anthropogenous activities are addressed to reclamation and restoration in order to use the landscape for farming, forestry or nature conservation. Reclamation techniques as amelioration, pine afforestation, or sowing of commercial grass mixtures are used. Several methods for compaction of substratum and solification are applied.

In total, 24 sites from which 20 sites are located on mined land and four sites on undisturbed land have been included into the present study (Table 1). The time of the natural development, partly after reclamation activities, is indicated as “age” here. The sites can be regarded as representative for the habitat and vegetation