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Ecological Engineering 24 (2005) 135–147
ECOLOGICAL ENGINEERING
www.elsevier.com/locate/ecoleng

Soil zoology II: Colonization, distribution, and abundance of terrestrial Heteroptera in open landscapes of former brown coal mining areas

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Accepted 1 November 2004

Abstract

In the post-mining landscape of Lower Lusatia (eastern Germany), four mining areas were studied with respect to distribution and abundance of terrestrial Heteroptera. Colonization dynamics and formation of species communities in devasted open areas with different environmental conditions were investigated. In total, 127 species were found in 30 sampling sites, representing about 30% of all species of the state of Brandenburg. The ratio between purely phytophagous and mainly zoophagous species in younger (<20 years) and older sites (>20 years) did not differ much; the ratio between purely macropterous and partly brachypterous species was higher in younger sites. Macropterous species are able to colonize the sites more rapidly. Correspondence and cluster analyses revealed that community patterns are mainly determined by the architecture of the vegetation. Herb cover, grass cover, vegetation density and height, relation of grass versus herb dominance explained most of the community variances, while soil parameters and age of sites were of minor importance. Species number of Heteroptera is also strongly influenced by the plant species composition of sites. Except of young pioneer stages no significant differences in species number between undisturbed and disturbed sites were detected. Younger and older sites differed only slightly in species number of Heteroptera. Colonization by numerous species takes place rather rapidly, depending on the formation of special features of the vegetation and on the species pool of the surrounding area.

Keywords: Colonization; Distribution; Abundance; Heteroptera; Lower Lusatia; Germany; Coal mining area; Community patterns

1. Introduction

The formation of spatial patterns of animal communities in the course of habitat colonization has been studied in the framework of numerous ecological theories. An overview is given in Bröring et al. (this issue).

The following questions have been addressed in our study:

1. What is the present state of colonization of Heteroptera of open sites in the post-mining landscape?
2. What are the main environmental parameters determining colonization process and community patterns of open sites after recolonization?

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doi:10.1016/j.ecoleng.2004.12.015

3. Which mechanisms determine the colonization, is there any evidence for time dependence of the formation of spatial community pattern, and are there any assembly rules to be detected?

Terrestrial Heteroptera (True Bugs) of the ground layer and the herb–grass layer are included into the present study. This group of hemimetabolic insects comprises zoophagous as well as phytophagous, and more or less eurytopic species with very different ecological characteristics and habitat requirements. Some species prefer ground layer habitats (e.g. most of the Lygaeidae), some others upper layers, respectively. In the area of Central Europe approximately 1100 species occur.

2. Study area and study sites

The mining region of Lower Lusatia comprises the area of southern Brandenburg and north-eastern Saxonia. A more detailed description of the region and a map are presented in Bröring et al. (this issue).

In total, 30 sites have been included in this study (Table 1). Except for four sites on undisturbed land, which have been included for comparative purpose, all

Table 1
Dominant vegetation, age of the sample sites, number of Heteropteran species and sampling

No.	Mining site	Vegetation resp. habitat type	Age	Species	Sampling
Young mining sites					
S111* ■	Schlabendorf-Nord	*Calamagrostis epigejos* stand	Undist.	20	SW, PT
S112* ▲	Schlabendorf-Nord	Dwarf shrub heath	Undist.	33	SW, PT
S113 ●	Schlabendorf-Nord	Psammophytic grassland	20 years	11	SW, PT
S121 ●	Schlabendorf-Nord	Dense sown grassland	20 years	6	SW, PT
S122 ●	Schlabendorf-Nord	Dense sown grassland	20 years	35	SW, PT
S131 ▽	Schlabendorf-Nord	Sparse vegetation on bare sand	20 years	23	SW, PT
S132 ●	Schlabendorf-Nord	Species-rich psammophytic grassland	20 years	47	SW, PT
S133 ■	Schlabendorf-Nord	*Calamagrostis epigejos* stand	20 years	24	SW, PT
S134 ◯	Schlabendorf-Nord	Moss-rich psammophytic grassland	20 years	26	SW, PT
S211* ■	Schlabendorf-Süd	*Calamagrostis epigejos* stand	Undist.	41	SW, PT
S221* ■	Schlabendorf-Süd	*Calamagrostis epigejos* stand	Undist.	34	SW, PT
S212 ▽	Schlabendorf-Süd	Sparse vegetation on bare sand	6 years	25	SW, PT
S222 ◯	Schlabendorf-Süd	Sparse sown grassland	7 years	21	SW, PT
S223 ◊	Schlabendorf-Süd	Failed pine afforestation	7 years	10	SW, PT
S224 □	Schlabendorf-Süd	Dense sown grassland	5 years	31	SW, PT
S225 ▽	Schlabendorf-Süd	Free of vegetation	15 years	4	PT
S231 ◯	Schlabendorf-Süd	Scarce Corynephorus canescens stand	10 years	22	SW, PT
Old" mining sites					
K311 ◯	Koyne	Bare sand with bulk ripples, surrounded by psammophytic grassland	45 years	10	SW, PT
K312 ■	Koyne	*Calamagrostis epigejos* stand	45 years	21	SW, PT
K314 ●	Koyne	Psammophytic grassland	45 years	33	SW, PT
K316 ■	Koyne	Sparse *Calamagrostis epigejos* stand	45 years	10	SW, PT
K322 ▽	Grünewalde	Lake shore free of vegetation	35 years	7	SW, PT
K324 □	Grünewalde	Dense, sown grassland	35 years	39	SW, PT
K325 ♦	Grünewalde	Mature psammophytic grassland	35 years	24	SW, PT
K326 ▲	Grünewalde	Dwarf shrub heath	35 years	26	SW,
K411 ▽	Plessa	Free of vegetation	50 years	23	SW, PT
K412 ●	Plessa	Psammophytic grassland	50 years	49	SW, PT
K413 ■	Plessa	*Calamagrostis epigejos* stand	50 years	34	SW, PT
K425 ▽	Plessa	Free of vegetation	70 years	2	PT
K426 ▽	Plessa	Free of vegetation	70 years	8	PT

Asterisk (*) denotes undisturbed land, classification of habitats according to Felinks (2000); SW, sweepnet sampling; PT, pitfall trapping; sampling sites: S, young sites near Schlabendorf, K, old sites near Koyne.