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Ground-dwelling true bugs (Heteroptera) in afforested fields

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Former agricultural lands may host peculiar biota, because agriculture activities have changed the physical, chemical and biological features of the soil; however, biodiversity in afforested fields is poorly known. The aim of this study was to investigate the diversity of ground-dwelling true bugs (Heteroptera) in early successional afforested fields in central Finland. We used a large-scale field experiment, in which agricultural land had been afforested 25 years ago by planting monocultures of birch, pine and spruce trees. Pitfall traps caught a total of 224 heteropteran individuals representing 20 species. The community was numerically dominated by Lygaeidae, *Drymus brunneus* being the most abundant species. Birch plots hosted about the double the number of individuals and species in spruce and pine plots. The near-threatened *Teloleuca pellucens* (Saldidae) was recorded from a birch plot. Although *T. pellucens* is suggested to require old-growth forests, our observation indicates that the species can occur also in other types of forests. In conclusion, more studies on Heteroptera in different environments are needed to better understand their distribution, abundance and habitat affinities.

Introduction

Agricultural lands are afforested for varying purposes, such as to produce timber, fight erosion, improve water quality, sequester carbon or support biodiversity (Navarro & Pereira 2012). In Finland, almost 300,000 hectares have been afforested since 1970 (Finnish…2014). Given the large area of afforested fields in many regions, they can contribute to local and regional biodiversity. However, little is known about biodiversity in afforested fields in the boreal zone (but see Wall 1998, Lindgren 2000, Komonen et al. 2015, 2016). Biological features of afforested fields depend on the agricultural history, time since cultivation ceased, physical and chemical qualities of the soil, climate, regional species pools, as well as restoration and management measures (Cramer & Hobbs 2007). Agricultural activities, such as fertilization, have long lasting effects on soil and vegetation, because they increase the amount of organic matter, pH and nutrients (Wall & Hytönen 2005).

Heterotrophic species follow changes in vegetation. Vegetation composition and structure affect insects via changes in microclimate, light, litter quality and litter quantity, which in turn are influenced by the identity of the dominant tree species, age structure of trees and canopy cover (Niemelä et al. 1996, Antvogel & Bonn 2001, Jukes et al. 2001). Many of the heteropterans are dependent on specific plant species (Rintala & Rinne 2010), so it can be expected that differences in vegetation composition and structure affect their occurrence and abundance (Frank & Künzle 2006, Zurbrügg & Frank 2006, Sobek et al.

2009). Ground-dwelling heteropterans, however, are mostly seed-eaters, fungivores, detrivores, predators, or they suck juices from mosses and lichens (Rintala & Rinne 2010); thus, their responses to changes in higher vegetation are harder to predict. The objective of this study was to document diversity patterns of ground-dwelling true bugs (Heteroptera) in 25-year-old afforested fields.

Materials and methods

Eight afforested fields were studied in western Tavastia borealis and eastern Ostrobottnia in the summer of 2013 (Table 1). Fields had been afforested during the year 1990, by planting monocultures of Silver birch (*Betula pendula*), Norway spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*) (Ferm et al. 1993). The sites were mostly organic agricultural soils having a high organic matter content in the top soil classified as peat. Most sites had dense understory vegetation dominated by *Deschampsia cespitosa*, *Calamagrostis arundinacea*, *C. phragmitoides*, *Filipendula ulmaria*, *Cirsium palustre*, *Urtica dioica* and *Rubus idaeus*. In some of the sites, tree stands had been thinned.

Each study site had been originally divided in rectangular plots, the average plot size being roughly 1000 m^2 (min = 225, max = 2000 m^2). After soil preparation, one to three-year-old seedlings (2000–3000 ha^{-1}) had been planted. At each site, we chose 2 plots of each of the 3 tree species, if these were available, totaling 16 birch plots (8 sites), 15 spruce plots (8 sites) and 10 pine plots (5 sites).

Arthropods were sampled using pitfall traps (200 ml, 6.5 cm diameter), which were covered by elevated plywood roofs (10 cm × 10 cm). Traps were filled with 100 ml of salt water and a few drops of dishwashing liquid. In each plot, 4 pitfall traps were placed in a line (running through the centre of the plot). Traps were always > 1 m from the edge of another plot, usually more. Altogether there were 164 pitfall traps. The traps were set up from the 14^{th} to 16^{th} of May 2013, and emptied 4 times: 4.6., 25.6., 16.7. and 6.8. Nomenclature follows Rintala & Rinne (2010) and red-list status (Rassi et al. 2010).

Results and Discussion

A total of 224 heteropteran individuals representing 20 species were recorded (Table 2). These fig-

Table 1. Summary of the study sites. All sites were afforested the year 1990. Bulk density, pH and total nutrient amounts were measured in the 0-10 cm soil layer at the afforestation year.

		Thinnings*						
Site	Soil**	Birch	Spruce	Pine	pH	Ca, kg ha^{-1}	N, kg ha^{-1}	Bulk density, g dm^{-3}
Alajärvi	P+M	Yes	No	Yes	5.0	1640	2444	600
Alavus	P+M	Yes	No	Yes	4.9	884	3247	469
Kuortane	P+M	Yes	No	NA	5.0	1941	5986	357
Lappajärvi	P	Yes	Yes	NA	4.2	1196	6805	252
Petäjävesi	P+M	No	No	No	5.4	4138	7006	579
Sarkala***	P	Yes	Yes	NA	4.9	1425	4044	185
Suosaari***	P+M	Yes	Yes	Yes	4.8	1155	3029	262
Töysä	P	Yes	Yes	Yes	4.6	1656	3657	462

* Yes = forest stand had been thinned, No = not thinned, NA = not applicable, i.e. plots of the given tree species were not studied in the site in question;
** P = peat soils, P+M = originally peat soil, but during cultivation mineral soil added in the top soil layer;
*** These sites are situated in Kyyjärvi.

Table 2. Heteropteran species recorded with pitfalls from afforested fields in central Finland.

Taxa	Individuals
Ceratocombidae	
Ceratocombus spp.	5
Saldidae	
Chartoscirta elegantula	2
Saldula saltatoria	1
Teloleuca pellucens	1
Tingidae	
Acalypta carinata	9
Derephysia foliacea	1
Miridae	
Monalocoris filicis	1
Stenodema holsatum	2
Stenodema calcaratum	1
Capsus wagneri	1
Mecomma ambulans	6
Lygaeidae	
Kleidocerys resedae	1
Drymus brunneus	114
Drymus ryei	8
Drymus sylvaticus	1
Eremocoris abietis	4
Lamproplax picea	3
Scolopostethus thomsoni	60
Stygnocoris sabulosus	2
Acanthosomatidae	
Elasmucha fieberi	1

ures are about a half of the ones recorded with pitfall trapping in different types of grasslands in the same region, but with twice the number of pitfall traps. Thus, preliminarily it seems that the numbers of individuals and species of ground-dwelling heteropterans in afforested fields are comparable to other environments in central Finland. The community was numerically dominated by Lygaeidae, which included 86% of all individuals. *Drymus brunneus* (51% of all individuals) was the most abundant species. Lygaeidae are ground-dwelling seed-eaters and typically the most abundant heteropteran family in pitfall material.

There were some differences between the tree species. 53% of the individuals and 85% of the species were recorded from birch plots, whereas the share of spruce and pine plots was 25% of the individuals and 45% of the species each. The most abundant species, *Drymus brunneus* and *Scolopostethus thomsoni*, were recorded from plots of all tree species. Because birch plots had the highest diversity of vascular plants, it is not surprising that the heteropteran community had the highest number of species and individuals there (Frank & Kützle 2006; Zurbrügg & Frank 2006). Spruce plots, in turn, were almost devoid of vascular plants, particularly if they had not been thinned. Pine plots were roughly halfway birch and spruce plots in terms of the vascular plant richness. It is also known that tree species identity can affect species composition of heteroptera communities (Sobek et al. 2009).

One individual of the near-threatened *Teloleuca pellucens* (Saldidae) was recorded from a birch plot in Sarkala, Kyyjärvi. The species has a scattered distribution in southern and central Finland. According to Rintala & Rinne (2010) the species requires old-growth forests with moist microclimate and plenty of dead wood. Our observation indicates that the species can occur also in other types of forests. In conclusion, more studies on Heteroptera in different environments are needed to better understand their distribution, abundance and habitat affinities. More studies are also needed in afforested fields, which may host surprising biodiversity values.

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