

Ant species composition in relation to forest associations in Szczecin Landscape Park

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ABSTRACT. In this study, eight forest associations in Szczecin Landscape Park and in the vicinity were examined for the presence of ant species. The only species present in all the associations was *Myrmica ruginodis*. Habitat conditions in the beech forest (*Galio odorati-Fagetum*), which grows on post-glacial hills, was diversified enough to enable occurrence of as many as 16 ant species. There was no substantial difference in ant species composition between beech and mixed forests. Alder swamps and riparian forests seemed to provide unfavourable living conditions for ants and only 3 ant species were recorded in these environments. Results show that indicating the type of plant association alone may be insufficient to characterize the environmental conditions that affect ant occurrence.

KEY WORDS: ants, habitat preferences, plant associations, Szczecin Landscape Park, *Galio odorati-Fagetum*.

INTRODUCTION

Myrmecological literature provides few papers addressing the correlation between ant species composition and plant association. Authors often tend to describe environment using most abundant plant species. This approach is reasonable as there is no solid evidence that distinction between the lowest taxonomical ranks is reflected by differences in the ant fauna. Although criteria used to distinguish plant associations are often irrelevant in terms of ant occurrence, the role of plants as a factor influencing survival of ants is crucial: plants constitute an indirect (honeydew secreted by aphids) or direct (nectar) food source for ants, they are foraged upon by invertebrates which in turn are preyed on by ants, they influence environmental conditions such as temperature and humidity, they deliver materials for nest

building. All these characteristics should be similar among patches of a particular plant association. Thus, phytosociological classification can be used to define precisely those components of ants' environment which are formed by or correlated with plant association.

Existing data on ant occurrence in relation to the type of vegetation seems to be sufficient to put forward some generalizations. Firstly, ants reach higher densities (as estimated by nest density) in open areas. This rule is exemplified by deforested areas in Karkonosze Mts., where succession of degenerated forest toward meadow plant associations has been accompanied by an increase in both ant nest density (from 8.5 to 17.5 per 100 m²) and sizes of societies. An even more profound difference can be observed in the natural spruce forest growing in this area, where only one ant species has been recorded, with nest density as low as 1 per 100 m², as compared to the meadow within the forest, with five ant species and 33 nests per 100 m² (PĘTAL 1994). Nonetheless, open areas do not always provide ants with so favourable living conditions. WOYCIECHOWSKI (1990), in his study carried out on glades in the Tatra Mts., found that low nest density occurred on non-grazed glades (1.73/100 m²) and was only slightly higher on grazed ones (5.64/100 m²). A possible reason for this was harsh climatic conditions. Grazing, which seemingly causes an increase in the nest density and species diversity, according to the author's explanation "enlarges the surface of the habitats which can be occupied by ants". It seems that full understanding of the environmental mechanism involved requires further study. The influence of climate on results obtained by WOYCIECHOWSKI becomes obvious when taking into account the data in PARAPURA & PISARSKI (1971), who carried out their investigations on pastures and meadows on the level of highland and lower subalpine forest in Bieszczady Mts. They recorded ant nest density amounting to 40 per 100 m². Similar results from an open habitat were obtained by KRZYSZTOFIK (1985). He investigated various habitats in Augustów Forest and recorded 47 ant nests per 100 m² in the wet meadow *Cirsio-Polygonetum*. This number was high but not the highest; the top density was recorded in the uliginose pine forest *Vaccinio uliginosi-Pinetum* and amounted to 61 nests per 100 m². A similar value for the same plant association is given by WENGRIS (1962: 60 nests per 100 m²); thus it can be concluded that uliginose pine forest provides particularly favourable conditions for the development of ant populations. It seems that this rule can be extended to all wet habitats overgrown by peat and only partly overshadowed or fully open. In an association of *Caricetum rostratae*, which was overgrown primarily by sedges, mosses and peats, WENGRIS (1962) recorded high nest density – 60 per 100 m². In the strongly shaded nearby spruce forest on peat (*Sphagno girgensohnii-Piceetum*) the density was lower (36 per 100 m²). Some ant species such as *Formica picea* and *Myrmica scabrinodis* distinctly prefer sunned associations on peats, which provide facile microclimatic conditions and a multitude of nest sites.

The same plant association may vary in respect of ant species composition, which reflects age (succession stage) differences. Investigations conducted in fresh coniferous forests (*Peucedano-Pinetum* and *Serratulo-Pinetum*) have shown quite large differences in the ant fauna among sites of increasing age of the planted forests (CZECHOWSKI 1998, CZECHOWSKI & CZECHOWSKA 2006). In plantations and young coppices the dominants

were *Tetramorium caespitum* and *L. platythorax* (mean percentage of nests belonging to these species were 64 and 20, respectively). However, in the 15-year-old coppice and mature tree stand the dominance had been assumed by *Myrmica ruginodis* (59% of nests belonged to this species) and *Leptothorax acervorum* (24%). The retreat of *Tetramorium caespitum* and *Lasius niger* (or *Lasius platythorax*, a species described in 1991; SEIFERT 1991), replaced by *Leptothorax acervorum*, was also demonstrated in a comparison of transitional dry pine forest *Cladonio-Pinetum* (canopy cover 60-70%, short trees, no undergrowth) and typical *Cladonio-Pinetum* forest (canopy cover - 70-80%; PAWLIKOWSKI & SOBIESZCZYK 1980).

The purpose of this study was to examine ant species occurrence in a variety of forest associations, which may increase our understanding of how environmental differences affect the occurrence of ants.

STUDY AREA, METHODS AND MATERIAL

The investigations were carried out in August and September 2004 and at the end of July and beginning of August 2005 in Gryfino Forest District, with special attention being paid to the area protected as Szczecin Landscape Park (53°19'N 14°42'E). The study takes into account the earlier records of 1999, when *Ponera coarctata* and *Myrmecina gramini-cola* were recorded. Gryfino Forest District covers 17.640 ha of forest areas south of Szczecin. The predominant forest types are pine, mixed and beech forests (information from the administration of Gryfino Forest District).

Selected sites representing 8 forest associations were investigated by means of seeking out ants wandering on the surface, exploring potential ant nests, like soil mounds, patches of mosses, twigs, and setting bait with diluted honey. Regardless of the way they were found, ant records were pooled together according to species for each of the associations. One or more specimens of the same species caught at particular site, was considered as one record. Sites were far from each other enough to rule out possibility of sampling ants from the same colony at more than one site. Following their collection, ant specimens were preserved in ethanol and identified in a laboratory.

Szczecin Landscape Park is situated on Buk Hills, which are glacial geological structures. Within the Park there are adjacent plains and valleys. On Buk Hills there are great differences in relative altitude and steep area slant (over 20°). Another geological feature of this area are small valleys radiating from the tops of hills down to their feet, in which erosion and earth slide processes are still present (MUSIELAK 1993). Developed landscape of Buk Hills creates diversity of microhabitats available to plants and animals. Dominant soil types, which cover most of the area, are true and acid brown soils formed on sands and boulder clay.

Forest associations

It is well known that vegetation may vary within the range of a given plant association, which makes it necessary to provide a more detailed description of some of the study sites. Identification of an association was carried out with the use of documents obtained from the forest administration. In two cases (i.e. *Luzulo pilosae-Fagetum* and *Fago-Quercetum*) they were based on habitat features rather than on plant species composition, hence actual vegetation might differ from that considered as typical for a given association (for details see MATUSZKIEWICZ 2005). Some additional data on studied habitats are presented below.

Galio odorati-Fagetum (fertile beech forest)

Post-glacial hills and valleys present on the area covered by this forest produced many microhabitats differing in degree of shade and humidity. The tree layer was monopolized by beech *Fagus sylvatica*. The forest floor was covered by a thick layer of litter made of decomposing leaves.

Luzulo pilosae-Fagetum (acidophilic beech forest of lowlands¹)

It differed from the typical form described in literature because of the presence of numerous pine trees which had appeared here as a result of forest management. In some places, e.g. in forest division 243, they dominated in the tree layer, whereas the shrub layer consisted of oaks and beeches. In this place the main component of the herb layer was *Vaccinium myrtillus*. The canopy cover was looser than that in a pure beech forest.

Leucobryo-Pinetum (subatlantic fresh pine forest)

The forest was from 40 to 50 years old, with its tree layer composed of pines with accessory presence of birches. *Deschampsia flexuosa*, a grass species characteristic for this association, occurred in abundance, as did *Vaccinium myrtillus*. Each species overgrew the forest floor in mosaic patches. Beside the forest interior, also the edges near the paths separating different forest divisions were investigated and the results were processed separately.

Fago-Quercetum (beech-oak forest)

The natural vegetation of this association had been disturbed by the introduction of pines by foresters. This led to the podzolization of the surface soil layer and the appearance of acidophilous plant species. An interesting case was subdivision 277 1 where about 50 years ago pedunculate oaks and pines had been planted on a habitat of xerothermic grassland on a slope with southern exposure. This subdivision is the habitat of a rare thermophilous plant species – *Anthericum liliago*.

¹ Name given according to the phytosociological classification, but actually it was mixed forest.

Stellario holostae-Carpinetum betuli (mid-European oak-hornbeam forest)

The habitat of this community was more fertile and moist than that of the beech forest. This type of vegetation had been formed in some distance from streams and small rivers bordered by the riparian forest. It was restricted to narrow bands of land along the rivers as its distal parts had been cut down by foresters (except in the reserves where it was preserved).

Carici remotae-Fraxinetum (riparian forest)

The tree layer was composed of beech (*Fagus sylvatica*), common ash (*Fraxinus excelsior*) and black alder (*Alnus glutinosa*). The forest floor was humid, partially in the form of mud, and strongly shaded. This association had been formed along small forest stream.

Ribesto nigri-Alnetum (alder swamp)

The association was situated in a depression. It had a typical hummocks-and-hollows structure. The tree layer consisted of ashes and alders. The soil was marsh but without stagnant water.

Calamagrosito arundinaceae-Quercetum (mid-European acidophilic oak forest)

The site selected to sample ant fauna was slightly slanting. The tree layer consisted of Scots pines and sessile oak. About 30% of the forest floor was covered in by grasses and *Vaccinium myrtillus*. The tree canopy was sparse, enabling sunshine to reach lower vegetation and ground.

RESULTS

A total of 22 ant species were found during the study (Table 1). The highest number of species (16) were collected from the beech forest *Galio odorati-Fagetum*, but only six of them were collected from more than one site. *Myrmica ruginodis* was the only species present in each of the associations studied. The species' dominance was also clear in the total number of records – 44 that is 31.9% of the total number for all species. This species in general inhabits forests as well as open areas. In forests it prefers sunny places, but it is able to colonize completely shaded areas (KOEHLER 1951).

The second most commonly found species was *Leptothorax crassispinus*, which was collected from 23 sites. According to literature data it prefers moderately dry coniferous forests (especially pine), but also enters deciduous forests (CZECHOWSKI et al. 2002). It utilizes twigs on the ground branches of dead trees, underneath of tree bark, soil and acorns as nest sites. In the beech forest I found nests in fallen hollow beech nut cases and this may be regarded as a special form of nesting in this type of forest.

The ant fauna of the pine forest was characterized by the occurrence of *Lasius flavus* (Table 1). It typically occurs in meadows and pastures but avoids humid habitats. More rarely it is found in deciduous and coniferous forests.

Occurrence of *Myrmica sabuleti*, *M. schencki* and *Tetramorium caespitum* in *Fago-Quercetum* was recorded only in a patch of sunny forest in subdivision 277 I (see Forest associations). All these species prefer sunny and dry places.

Table 1. Occurrence of ant species in different forest associations: G o-F - Galio odorati-Fagetum, L p-F - Luzulo pilosae-Fagetum, L-P - Leucobryo-Pinetum, F-Q - Fago-Quercetum, S h-C - Stellario holostea-Carpinetum betuli, C r-F - Carici remotae-Fraxinetum, R A - Ribesto nigri-Alnetum, C Q - Calamagrosito arundinaceae-Quercetum (numbers denote records of a given species; + - species recorded in 1998, prior to regular study).

Species/ forest association	G o-F	L p-F	L-P		F-Q	S h-C	C r-F	R A	C Q
			interior	edge					
<i>Ponera coarctata</i> (LATR.)	+								
<i>Myrmica rubra</i> (L.)			1						
<i>Myrmica ruginodis</i> NYL.	16	7	3	1	7	4	2	3	1
<i>Myrmica lobicornis</i> NYL.			1						
<i>Myrmica sabuleti</i> MEIN.	1			1	1				
<i>Myrmica schencki</i> EM	1			1	2				
<i>Stenamma debile</i> (FÖRST.)							1		
<i>Leptothorax acervorum</i> (F.)	1								
<i>Leptothorax nylanderi</i> (FÖRST.)	1								
<i>Leptothorax crassispinus</i> KARAV.	12	6	2		2				1
<i>Myrmecina graminicola</i> (LATR.)	+								
<i>Tetramorium caespitum</i> (L.)	1			1	1				
<i>Formica rufa</i> L.	1								
<i>Formica polycтена</i> (FÖRST.)					1				
<i>Formica pratensis</i> RETZ.			1						
<i>Formica fusca</i> L.	3	2		1					
<i>Formica sanguinea</i> LATR.	1	2	1	1					
<i>Lasius niger</i> (L.)	11	1	2	2	1				
<i>Lasius platythorax</i> SEIFERT	8	3	2					1	
<i>Lasius brunneus</i> (LATR.)	2					1	1		
<i>Lasius flavus</i> (F.)			4						
<i>Lasius fuliginosus</i> (LATR.)	1	2							

DISCUSSION

The following reservations have to be made while interpreting the data obtained:

- (1) Sample effort was unequal between associations and depended on the relative area. The beech forest, which covered the largest area, was investigated more thoroughly than other forests. Moreover, a larger area may consist in more microhabitats available for ants, resulting in higher species diversity.
- (2) Not all species occurring in the study area were found, which can be concluded from the high number (8) of species represented by only one record.
- (3) Species abundances within a given association should be compared with caution. It cannot be assumed that all of the species were equally vulnerable to the collection methods applied.

Bearing in mind the limitations that follow from the simplicity of the methods, it can be assumed that the results obtained here give an approximate insight into environmental preferences of the species and their relative abundances. They can be treated as a framework for building a more detailed hypothesis, which require quantitative studies and standardized methods. The following suggestions may be useful for future studies:

- (1) *Myrmica ruginodis* seems to have the widest ecological tolerance among the species studied. It successfully colonized all types of forests.
- (2) There is no visible difference between deciduous and mixed forest ant fauna when one compares the results from *Galio odorati-Fagetum* and *Luzulo pilosae-Fagetum*. These two associations are similar in respect of climatic and geomorphological conditions (MATUSZKIEWICZ 2005). Thus, the differences in plant species composition play a smaller role here and do not clearly influence the occurrence of ants.
- (3) The previous conclusion is also supported by the results from the beech forest alone where species inhabited preferable microhabitats. For example, in shaded dense forests no ants were present except *Myrmica ruginodis*. Ants occurred almost exclusively in patches with loose canopy cover. Moreover, the occurrence of *Tetramorium caespitum* or *Myrmica sabuleti* was limited to places with unusual habitat conditions, i.e. sites which were warmer, drier and less shaded than the rest of the forest. Thus, it seems that plant association alone may not characterize ant environment completely enough; the existence of microhabitats is no less important. This was particularly the case in the beech forest on postglacial hills where valleys, peaks and slopes diversified habitat conditions.
- (4) Unlike deciduous forests, the pine forest *Leucobryo-Pinetum* was inhabited by *Lasius flavus*. This species is commonly found in meadows and pastures. This species feeds on honeydew secreted by homopterans living on the roots of herbaceous plants. Consequently, insolation needed to maintain herb layer in forest may act as a limiting factor for the presence of this species.
- (5) Alder swamps and riparian forests are hardly inhabited by ants because of the strong shade and shortage of suitable nest sites which cannot be dug in marsh ground. This conclusion is also supported by the results of a study by WENGRIS (1962), who found very low ant nest density in the periodically flooded association of slender tufted-sedge *Caricetum*

gracilis (1,6/100 m²) as well as in the alder bog forest, *Ribeso nigri-Alnetum* (1,6/100 m²), with marsh floor. The sensibility of ants to flooding is confirmed by PARAPURA & PISARSKI (1971), who studied wet, overflowed meadows in Bieszczady and recorded no ants except sporadically found *Myrmica sabuleti*.

(6) Detection of *Leptothorax nylanderi* supports hypothesis that there is a narrow area of co-occurrence of *Leptothorax nylanderi* and *L. crassispinus* along Odra river and further towards Southern Europe (SEIFERT 1996, RADCHENKO 2000). These two sibling species have been distinguished from within one former taxon known as *Leptothorax nylanderi* (SEIFERT 1995, 1996) and their distribution ranges still need to be confirmed.

(7) The path edge in *Leucobryo-Pinetum* was characterized by the presence of three ant species which are typical for open areas and which were absent in the forest interior. Close vicinity of the gaps in dense tree stands produces habitats different enough to be reflected in ant species composition. Thus, beside forest association, microhabitats should also be considered in describing ants' environment.

Studies on the occurrence of invertebrates in different plant communities can uncover some correlations. For example, in spiders many studies have revealed that quality of litter affects species diversity and abundance. However, many causes can be involved here, such as amelioration of moisture and temperature conditions, which maintain prey populations, availability of refuges from predators or sites appropriate for affixing webs. Determination of casual factors that explain correlative patterns needs experimental studies (WISE 1993, Chapter 7). Thus, investigations of dependence of ant species composition on vegetation can be treated as an introduction to more detailed studies.

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