OPOLE SCIENTIFIC SOCIETY
NATURE JOURNAL
No 44 – 2011: 185-191

COLONY SIZE, DENSITY AND TYPE OF NESTING SITES OF THE ANT *TEMNOTHORAX CRASSISPINUS* (HYMENOPTERA: FORMICIDAE)

BIAŁAS BEATA[1], GRANIECZNY PAULINA[1], PĘDZISZ ANNA[1], MITRUS SŁAWOMIR[2]

[1]graduate of Biology, Department of Biosystematics, Laboratory of Evolution and Animal Ecology, Opole University

[2]Department of Biosystematics, Laboratory of Evolution and Animal Ecology, Opole University, Oleska 22, 45-052 Opole, Poland, e-mail: smitrus@uni.opole.pl

[2] – corresponding author

ABSTRACT: The ant *Temnothorax crassispinus* is a wood-dwelling species, widely distributed throughout Poland. In June 2010 in a beech-pine forest in the Opole district (southern Poland), we found an average of 2.5 ant nest sites per m^2, and in August an average of 1.6 nest/m^2. Colonies were discovered in fallen acorns, shells of beech nuts, pinecones, and – most commonly – in fallen sticks. In June the ants inhabited sticks more frequently than other types of nest sites ($\chi^2 = 4.64$; $df = 1$; $P = 0.031$). In June, 30 out of 61 discovered colonies were queenless, and in August only 8 out of 26 colonies. The average number of workers in queenright colonies in June (42.7) was lower than in August (126.5; Mann–Whitney test: $U = 58.5$, $P < 0.001$, $n_1 = 31$, $n_2 = 18$). For laboratory experiments we collected ants from two areas: in the first area we collected colonies only from pine sticks, whilst in the other just from beech sticks. We offered them two artificial nest chambers: one filled with fresh pine shavings, and one with fresh beech shavings. The colonies chose the artificial nest chambers randomly.

KEY WORDS: wood-dwelling ants, Opole district, Poland

Introduction

Ants are typically highly abundant animals in almost all terrestrial ecosystems, and in many areas they dominate ecosystems in respect of abundance and biomass. Most ant species are rather general predators and are therefore able to modify their diet according to the available resources (e.g. Radchenko et. al. 2004, Wilson and Hölldobler 2005). Ants also have a great impact on the processes of soil formation (Wiken et al. 1976,

Frouz et al. 2003). Thus, they have a considerable and multiple impact on local ecosystems (Czechowski et al. 2002, Wilson and Hölldobler 2005).

Thirteen species of ants of the genera *Temnothorax* are known to occur in Poland (Czechowski et al. 2002). They belong to the myrmicine tribe Formicoxenini and are among the most widely distributed and most common, but also most frequently overlooked ants in Central European habitats. Colonies of the species are very small, ranging from a few dozen to hundreds of workers and they nest in preformed cavities in wood, hollow acorns, hazelnuts, pieces of bark, or rotting branches on the ground, but also under moss, stones and in litter (Czechowski et al. 2002, Seifert 2007). Colonies of the ant *Temnothorax* are usually monogynous (have one queen) (Heinze and Buschinger 1988, Seifert 2007, Radchenko et al. 2004). The workers forage individually, typically for small invertebrates (Czechowski et al. 2002, Radchenko et al. 2004).

The cavity-dwelling ant *Temnothorax crassispinus* can be found throughout Western and Central Europe (Czechowski et al. 2002, Seifert 2007) and it is a species widely distributed in Poland, known mostly from sites in coniferous forests (Czechowski et al. 2002, Radchenko et al. 2004, Borowiec 2009). However, even for the species that is known from many areas, data on ecology is limited. In this study we investigated nest-site selection by this ant species. We also gathered data on colony size and density of the nesting sites, as they are important for life history parameters. For example, they could affect the sex ratio (Strätz and Heinze 2004) and direct conflicts over reproduction (Bourke 1999), as well having an influence on discovering new nest sites (Dornhaus and Franks 2006).

Materials and methods

Density and size of colonies

We investigated nest density, colony size and type of nesting site of the ant *Temnothorax crassispinus* in beech-pine forest close to Opole (50°37′ N 18°8′ E). Nest density was studied by opening all potential nest sites in six 4 m^2 plots on 11th and 16th June, and in four 4 m^2 plots on 18th August 2010. All discovered nests of the ant were collected, and types of nesting sites were noted (categorized into types: sticks, acorns, shells of beech nuts and pinecones). We investigated the colony size of these colonies in the laboratory. First the located nests were transported there, then carefully opened and all individuals were collected with an aspirator and counted. As "nest" we arbitrary defined a collected nesting site, containing more than five ant workers.

Laboratory experiments on nest choice

In the research area close to Daniec the ant inhabits mostly beech sticks. However, close to Kup (Opole district), in mixed forest with a dominance of pine (50°48′ N, 17°53′ E) – mostly pine sticks (unpublished data). On 21st September 2010, in the forest close to Daniec, we collected colonies of the ant dwelling in beech sticks only, and on 18th October 2010 in the forest close to Kup – colonies dwelling only in pine sticks. In the laboratory we carefully opened the nest sites and from each colony we captured the queen and 50 workers with an aspirator. We gathered 24 such standardized colonies from the forest close to Daniec, and 23 from the forest close to Kup.

We put two artificial nests in plastic, square Petri dishes (10,2 cm × 10,2 cm × 1,9 cm) (Fig. 1). Such an artificial nest has a cavity between a

piece of cardboard and ½ microscope slide, kept apart by a plexiglass frame. In each Petri dish we put two nests – one with 2 mm^3 of fresh beech shavings and one with 2 mm^3 of fresh pine shavings. Each ant colony was placed into a separate Petri dish. The Petri dishes with ant colonies were kept in a thermostatic cabinet Pol-Eko ST 1. A daily cycle: 10 h of dark ("night") in a temperature of 10°C and 14 h of light ("day") in 20°C was maintained throughout the experiments. Subsequently, we recorded which nest was inhabited by ants at ca. 24 h intervals. The experiments lasted 14 and 11 days respectively. Ants were fed three times a week with dead fruit flies *Drosophila hydei* and honey.

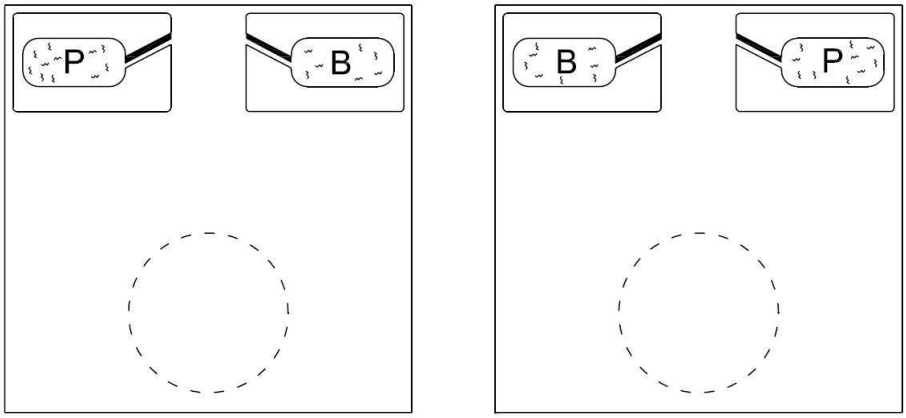

Fig. 1. Scheme of laboratory experiment. In square Petri dishes (10.2 cm × 10.2 cm × 1.9 cm) two artificial nest chambers were placed – one filled with fresh pine shavings (P), and one with fresh beech shavings (B). Ants were released close to the opposite edge of the Petri dish (an area marked with a dotted line)

Statistical analysis

Statistical analyses were carried out using the software package Statistica, ver. 6.1. (StatSoft Inc. 2004).

Results

Density and size of colonies

We collected data on size and type of nesting sites from 61 colonies of this ant species in June (31 queenright and 30 queenless), and from 26 colonies in August (18 queenright and 8 queenless). In June all queenright colonies contained one queen, but in August we found one colony with two and one with three queens. The percentage of queenless colonies in the two different periods was similar (chi square test: $\chi^2 = 2.51$, $df = 1$, $P = 0.11$), but the size of queenright colonies were higher in August (Mann–Whitney test: $U = 58.5$, $P < 0.001$, $n_1 = 31$, $n_2 = 18$): the average number of workers in such colonies were 42.7 and 126.5, in June and August respectively (Tab. 1). In June the average number of nest sites was 2.5 nests/m^2, and in August the average was 1.6 nest/m^2. In June we also found two sites containing only queens, and five sites with 1–5 workers. In August we found two sites containing only queens, two sites with one and

four workers respectively, as well as a small stick inhabited by five queens and three workers.

Table 1. Colony size of the ant *Temnothorax crassispinus* collected in 2010 in the Opole district

Month	Mean	Median	Min–Max	Quartiles
11–16 June				
– queenright colonies [n = 31]	42.7	39.0	6–136	16, 54
– queenless colonies [n = 30]	26.4	25.5	6–49	15, 38
18 August				
– queenright colonies [n = 18]	126.5	111.5	34–252	95, 145
– queenless colonies [n = 8]	47.5	30.0	13–164	16, 55

Most nest sites were found in sticks (mostly beech ones). Nests were found also in acorns, the shells of beech nuts and – in June – in pinecones (Fig. 2). In June the ants more frequently inhabited sticks than other types of nesting sites (chi square test: χ^2 = 4.64; *df* = 1; *P* = 0.031).

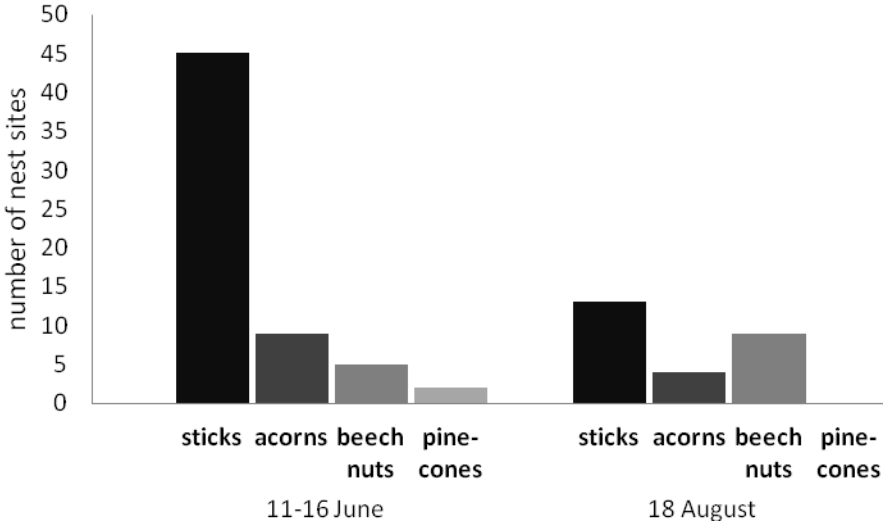

Fig. 2. Composition of nest site types for the ant *Temnothorax crassispinus* collected in the Opole district

Laboratory experiments on nest choice

Most colonies (22/24 from Daniec and 10/23 from Kup) inhabited artificial nests in the first 24 hours of the experiments. In the third day of the experiments 23 out of 24 and 19 from 23 colonies had chosen nest cavities. In both experiments colonies of the ant were located randomly in the nests with both kinds of shavings (chi square tests: χ^2 = 0.39; *df* = 1; *P* = 0.53, and χ^2 = 2.57; *df* = 1; *P* = 0.11; for ants from the Daniec region and the Kup region, respectively). During the experiments two colonies collected

near Daniec and one near Kup changed nest: in all cases they had initially chosen a nest with pine shavings, and later changed it to the one containing beech shavings.

Discussion

The size of colony of the ant *Temnothorax crassispinus* found in the research generally correspond with data from different publications (e.g. Seifert 2007, Foitzik et al 2007, Czechowski et al. 2002). However, the size of colonies differ with the time of the year, thus it is difficult to compare available data, as many of them are presented without information about the term of the research. A large part of the queenless colonies found in June, as well as in August, could be the result of seasonal polydomy. It is known that ants of this genus can inhabit more than one nesting site (Strätz and Heinze 2004, Debout at el. 2007). In Poland, nuptial flights of the ant take place in July and early August (Czechowski et al. 2002), and the presence of multi-queen colonies in August could be a result of the presence of young queens in the nests.

The high percentage of queenless colonies in late spring could be the effect of large colonies splitting into several subunits, when nest sites are more available (cf. Foitzik and Heinze 1998). Nest site limitation has an influence on the population structure of cavity-dwelling ants (Foitzik and Heinze 1998). As presented in earlier research (e.g. Seifert 2007, Czechowski et al. 2002), the ant inhabits mostly temporary sites like sticks and acorns, although in the research we also found nest sites in the shells of beech nuts and pinecones. Further sites were probably used because of the lack of good nesting sites, and the presence of lots of such shells and cones in the area. Shells of beech nuts could be used by the ant when they almost closed, and when opened are not suitable for nesting (ants of the genus *Temnothorax* prefer nest cavities with a smaller entrance; Franks et al. 2008, Pratt 2010). The presence of colonies in the shells of beech nuts and pinecones suggests that nest sites are limited in the research area. The ant could also inhabit cavities in the soil (Czechowski et al. 2002, Lorinczi 2011). Although we didn't find any such sites, in the study such potential nests could have been overlooked. In the Daniec and Kup regions the ant inhabits mostly beech sticks and pine sticks, respectively. However, laboratory experiments showed that for the ant the type of wood has no appreciable influence on the selection of the nest site, and therefore they probably inhabited cavities in such sticks because of their availability.

In suitable environmental conditions the density of nest sites of the ant *Temnothorax crassispinus* could be high (e.g. we found a density of 2.5 nests/m^2 in June). It is high density; for example in Hungary Lorinczi (2011) found an average of 0.11 nest of the species/m^2. However, in Germany near Regensburg, nest density of a closely related species *Temnothorax nylanderi* was much higher (mean 8.69 nest/m^2; Strätz and Heinze 2004). Colonies of the species can reach high densities, given the correct environmental conditions and the ant can therefore play an important role in the ecosystem.

Acknowledgements

The data presented in the paper were gathered as part of the master thesis written in the Laboratory of Evolution and Animal Ecology (Department of Biosystematics, Opole University). Supervisor of the thesis was prof. dr hab. T. Zatwarnicki. The work was supported financially by grant number 8/KBi/10-W from Opole University

Bibliography

Bourke, A.F.G. 1999. Colony size, social complexity and reproductive conflict in social insects. Journal of Evolutionary Biology, 12(2): 245-257.

Borowiec M.L. 2009. Nowe dane o rozmieszczeniu mrówek (Hymenoptera: Formicidae) z plemienia Formicoxenini w Polsce. Wiadomości Entomologiczne, 28(4): 237-246.

Czechowski W., Radchenko A., Czechowska W. 2002. The ants (Hymenoptera, Formicidae) of Poland. Wydawnictwo Muzeum i Instytut Zoologii Polskiej Akademii Nauk, 200 pp.

Debout G., Schatz B., Elias M., Mckey D. 2007. Polydomy in ants: what we know, what we think we know, and what remains to be done. Biological Journal of the Linnean Society, 90: 319-348.

Dornhaus A., Franks N. 2006. Colony size affects collective decision-making in the ant Temnothorax albipennis. Insectes Sociaux, 53: 420-427.

Franks N.R., Hardcastle K.A., Collins S., Smith F.D., Sullivan K.M.E., Robinson E.J.H., Sendova-Franks A.B. 2008. Can ant colonies choose a far-and-away better nest over an in-the-way poor one? Animal Behaviour, 76(2): 323-334.

Foitzik S., Heinze J. 1998. Nest site limitation and colony takeover in the ant Leptothorax nylanderi. Behavioral Ecology, 9: 367-375.

Foitzik S., Strätz M., Heinze J. 2003. Ecology, life history and resource allocation in the ant, Leptothorax nylanderi. Journal of Evolutionary Biology, 16: 670-680.

Heinze J., Buschinger A. 1988. Polygyny and functional monogyny in Leptothorax ants (Hymenoptera: Formicidae). Psyche, 95: 309-325.

Lorinczi G. 2011. Density and spatial pattern of nests in sub-Mediterranean ground-dwelling ant communities (Hymenoptera: Formicidae). Community Ecology, 12(1): 51-57.

Pratt S.C. 2010. Nest Site Choice in Social Insects. In: M.D. Breed, J. Moore (eds.), Encyclopedia of Animal Behavior, volume 2: 534-540. Academic Press, Oxford.

Radchenko A., Czechowska W., Czechowski W. 2004. Część ogólna. In: Klucze do oznaczania owadów Polski. Część XXIV. Błonkówki – Hymenoptera. Zeszyt 63. Mrówki – Formicidae: 3-17. Polskie Towarzystwo Entomologiczne, Toruń.

Seifert B. 2007. Die Ameisen Mittel- und Nordeuropas. Lutra, Görlitz. 368 pp.

Strätz M., Heinze J. 2004: Colony structure and sex allocation ratios in the ant Temnothorax crassispinus. Insectes Sociaux, 51: 372–377.

Wiken F.B., Broersma L., Lavkulich L.M., Farstad L. 1976. Biosynthetic Alteration in a British Columbia Soil by Ants (Formica fusca Linné). Soil Science Society of America Journal, 40: 422-426.

Wilson E.O., Hölldobler B. 2005. The rise of the ants: A phylogenetic and ecological explanation. Proceedings of the National Academy of Sciences of the United States of America, 102(21): 7411-7414.