The two largest known aggregations of mound-building wood ants *Formica rufa* (Hymenoptera: Formicidae)

Dvě největší známé agregace hnízd lesních mravenců *Formica rufa* (Hymenoptera: Formicidae)

KLÁRA BEZDĚČKOVÁ, PAVEL BEZDĚČKA

Metodické centrum pro myrmekologii, Muzeum Vysočiny Jihlava, Masarykovo náměstí 55, Jihlava, CZ – 586 01

Abstract: Ants of the species *Formica rufa* Linnaeus, 1758 typically live in monogynous and monodomous colonies and only locally form aggregations of nests, comprising at most about 100 mounds according to the present knowledge. We describe here the two largest nest aggregations of *F. rufa*, containing 1752 and 573 nests, respectively, found to date. Both these aggregations are situated in non-native forest stands in the southern part of the Bohemian-Moravian Highlands, Czech Republic.

Key words: Hymenoptera, Formicidae, *Formica rufa*, nest aggregations, Czech Republic

INTRODUCTION

Mound-building wood ants of the *Formica rufa* group are dominant organisms having a potential to greatly influence the functions of their ecosystems. They may affect the structure of invertebrate communities by predation, competition or tending Homoptera, spreading plant seeds as well as by changing physical, chemical and biological soil properties (e. g. Dlussky 1967, Holldöbler et Willson 1990, Lach et al. 2010). The size, density and allocation of their mounds reflect and simultaneously influence the magnitude and spatial distribution of their activities. Therefore, wood ants have been the subject of intensive research since the early history of myrmecology (Cotti 1963, 1995, 1996). Despite this interest, the taxonomy and in many aspects also the ecology of wood ants have remained under-explored.

Certain species of the *Formica rufa* group may form large aggregations of nests, some of which are extremely huge polygynous and polydomous colonies, so-called supercolonies (for first use of the term ”supercolony”, see Gris et Cherix 1977, further e.g. Bourke et Franks 1995, Lach et al. 2010). In Europe supercolonies containing several hundred nests are known in *F. aquilonia* Yarrow, 1955, *F. paralugubris* Seifert, 1996 and *F. polyctena* Förster, 1850 (see Seifert 2007).

Formica rufa Linnaeus, 1758 builds polycalic colonies only locally (Seifert 1996). The highest number of mounds in aggregations of this species recorded to date is about 100 (cf. Marikovsky 1962, Miles 2006, Seifert, pers. comm.). In this paper we describe the two hitherto largest known aggregations of *F. rufa* nests, containing 1752 and 573 nest mounds, respectively. These aggregations are located in the southern part of the Bohemian-Moravian Highlands in the Czech Republic.

STUDY AREAS

The study areas are situated on the border of two regions in the south of the Czech Republic.

Site I. Vojtův vrch (co-ordinates of the centre 49°7’14.61” N, 15°25’35.60” E). Forest complex isolated in an agricultural landscape, located 4.5 km north of the centre of the town of Dačice. The occupied area is about 50 ha in size and situated at an altitude of 500–530 m (summit of Vojtův vrch hill 533 m). The terrain is moderately rugged with several small outcrops. Most of the locality is situated on a slightly inclined slope with eastern exposure, extending from the top of the hill to the floodplain of the Vyderský stream. The forest stands consist of smaller units, predominantly Norway Spruce (*Picea abies*) monocultures with scattered European Larch (*Larix decidua)*, Durmast Oak *(Quercus petraea)* and Scots Pine (*Pinus sylvestris)*. *A*pproximately half of the acreage of forests is a 90–100 year old stand, in the other half all age categories are represented. In several places pine monocultures (*Pinus sylvestris)* are present. Stands are interwoven with a relatively dense network of paths and local roads and contain several small clearings after logging.

Site II. Dobrohošťský vrch (co-ordinates of the centre 49°4’18.40” N, 15°29’18.48” E). Small part of a large forest complex with the occupied area located 4.2 km east of the centre of the town of Dačice. It is about 16 ha in size and situated at an altitude of 525–550 m on a slightly inclined slope with eastern exposure. Approximately half of the area is covered by a homogenous, approx. 100 year old monoculture of Norway Spruce (*Picea abies*) with scattered European Larch (*Larix decidua)* and Scots Pine (*Pinus sylvestris),* the other half consists of approx. 60 year old Norway Spruce stands with a high proportion of European Larch.

METHODS

The research was conducted from February to May 2008. We counted all the nest mounds and measured their height and the longest axis of the basis. To avoid double counting, the mounds were marked with small coloured signs. Status of the morfospecies *F. rufa* was assessed using the publications by Seifert (1991, 1996, 2007) and Seifert et al. (2010). For statistic evaluation results we used Statistica for Windows 8.

RESULTS

We recorded a total of 1752 nests at the locality of Vojtův vrch and 573 nests at the locality of Dobrohošťský vrch (for details, see Tab. 1, Figs 1, 2). Mounds on Vojtův vrch were significantly higher (Mann-Whitney U-test: $Z = 3.800388$, $p = 0.000144$) and steeper (rate H/LA, Mann-Whitney U-test: $Z = 10.08886$, $p << 0,05$) than mounds at the locality of Dobrohošťský vrch. Some nest mounds at both localities were built around the trunks of living trees.

In both aggregations we observed free moving and mutual mixing of workers from individual nests. We also recorded the transport of individuals between the nests at both localities. All ants observed in both aggregations phenotypically clearly belonged to *F. rufa*. No signs of hybridisation were recorded in the phenotypes. We found *Formicoxenus nitidulus* (Nylander, 1846) in several nests in both aggregations.

Tab. 1. Characterisation of *Formica rufa* nest aggregations at the localities of Vojtův vrch and Dobrohošťský vrch.
Tab. 1. Charakteristiky hnízd *Formica rufa* v agregacích na lokalitách Vojtův vrch a Dobrohošťský vrch.

	Vojtův vrch	Dobrohošťský vrch
Number of nests	1752	573
Average nest abundance	35 nests/ha	36 nests/ha
Range of nest distances	0–1300 m	0–600 m
Range of mound heights	10–130 cm	10–130 cm
Range of lengths of the longest mound basis axis	20–700 cm	10–450 cm
Mean mound heights (± SD)	48.00 ± 21.03 cm	45.08 ± 24.58 cm
Mean length of the longest mound basis axis (± SD)	88.79 ± 45.72 cm	92.07 ± 51.15 cm

DISCUSSION

Wood ants display a high degree of plasticity in their social organisation. Presently we know at least 13 species of this group living in both single and multiple nest colonies (e.g. McIver et al. 1997, Debout et al. 2007). There is a large range of colony structures and sizes. *F. aquilonia* and *F. polyctena* are highly polygynous and polydomous, but *F. lugubris* Zetterstedt, 1838 is monogynous and monodomous in Finland and Ireland, although highly polygynous and polydomous in Central Europe (Bezděčka 1982, Bourke et Franks 1995, Bezděčka et Bezděčková, unpubl. inf.). *F. rufa* and *F. pratensis* Retzius, 1783 are often monogynous and monodomous, although multiple nest colonies of these species are also known (Seifert 2007).

The largest aggregations of *F. rufa* reported until now counted just over a hundred nests. In Russia an aggregation of 111 nests of this species was found by Marikovsky (1962), in the Czech Republic an aggregation containing 112 nests was observed (Miles 2006).

Aggregations of *F. rufa* with 1752 and 573 nests described here are the largest ones that have been recorded to date. In both of them we observed traits typical for supercoloniality – reduced inter-nest aggression, free movement and mixing of workers from different nests as well as exchange of individuals. In addition, during preliminary research we conducted experimental transfers of workers between nests (distant up to 500 m) within individual aggregations and between both aggregations. Intra-aggregations transfers never resulted in the rejection of intruders. The aggression towards them, if it ever occurred, was always weak and often at the level of ritualisation. On the contrary, the inter-aggregations transfers always resulted in execution of intruders. These observations may imply that the described aggregations have a supercolonial status.

Deeper research of these unique aggregations might significantly contribute to the understanding of certain issues relating to social organisation in wood ants.

ACKNOWLEDGMENTS

We thank the Ministry of Culture of the Czech Republic for the financial support of this research project (DE-07PO4O MG009 MK ČR). We are very grateful to B. Seifert for valuable information and J. W. Jongepier for language correction.

REFERENCES

BEZDĚČKA P. (1982): [Biology of wood ants and inventory their nests. Action Formica. A Handbook of Methods No. 1.] – Czech Union for Nature Conservation, Prachatice. 31 pp. [in Czech]

BOURKE A. F. G. et FRANKS N. R. (1995): Social evolution in ants. – Princeton Univ. Press, Princeton, NJ. 529 pp.

COTTI G. (1963): Bibliografia ragionata 1930–1961 del gruppo *Formica rufa* in Italiano, Deutsch, English. – Ministero dell'Agricoltura e delle Foreste, Rome.

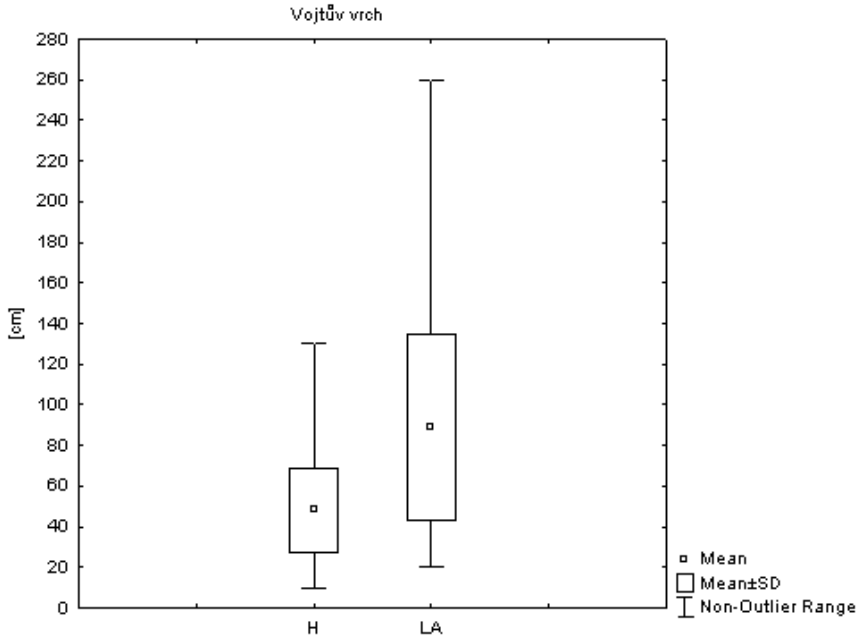

Fig. 1. Mound height (H) and length of the longest mound basis axis (LA) in locality of Vojtův vrch.
Obr. 1. Výška kupy (H) a délka nejdelší osy její základny (LA) na lokalitě Vojtův vrch.

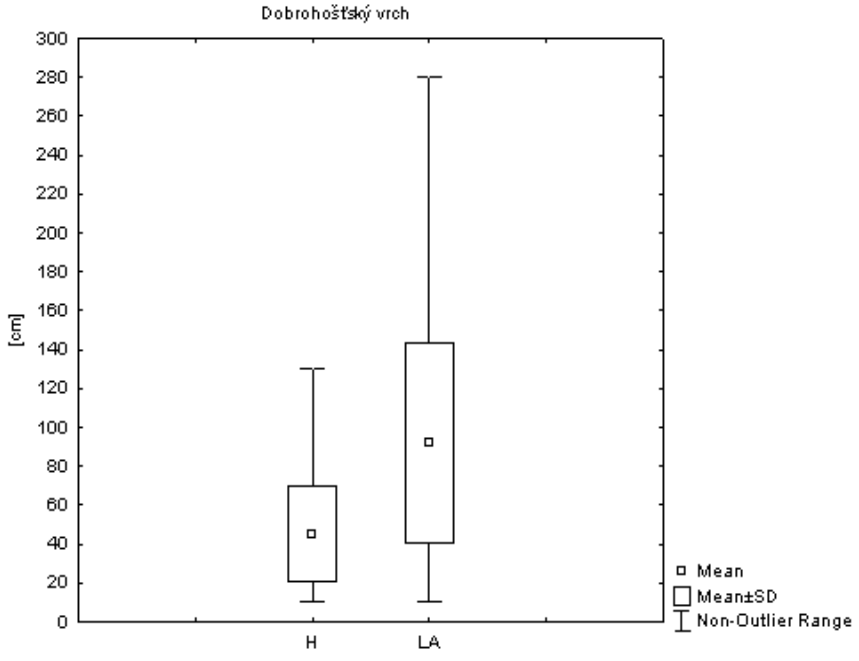

Fig. 2. Mound height (H) and length of the longest mound basis axis (LA) in locality of Dobrohošťský vrch.
Obr. 2. Výška kupy (H) a délka nejdelší osy její základny (LA) na lokalitě Dobrohošťský vrch.

COTTI G. (1995): Bibliografia ragionata 1962–1981 del gruppo *Formica rufa* in Italiano, Fran¸cais, Deutsch. – Istituto di Entomologia dell'Universit`a di Pavia, Centro Interdisciplinare di Bioacustica e di Ricerche Ambientali, Rome.

COTTI G. (1996): A bibliography of the *Formica rufa* group (Hymenoptera, Formicidae). – Insect Social Life, 1, 133–136.

DEBOUT G., SCHATZ B., ELIAS M. et 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.

DLUSSKY G. M. (1967): [The ants of the genus *Formica*, (Hymenoptera, Formicidae, g. *Formica*).] – Nauka, Moskva, 236 pp. [in Russian]

HÖLLDOBLER B. et WILSON E. O. (1990): The Ants. – Cambridge, Mass.: Harvard University Press, 732 pp.

GRIS G. et CHERIX D. (1977): Les grandes colonies de fourmis des bois du Jura (groupe *Formica rufa*). – Bulletin de la Société Entomologique Suisse, 50: 249–250.

LACH L., PARR C. L. et ABBOT K. L. (2010): Ant Ecology. – Oxford University Press. New York, United States, 402 pp.

MARIKOVSKY P. I. (1962): On intraspecific relations of *Formica rufa* L. (Hymenoptera, Formicidae). – Entomol. Rev., Silver Spring, 41: 47–51.

MCIVER J. D., TORGERSEN T. R. et CIMON N. J. (1997): A supercolony of the thatch ant *Formica obscuripes* Forel (Hymenoptera: Formicidae) from the Blue Mountains of Oregon. – Northwest Science, 71: 18–29.

MILES P. (2006): Inventarizace, výzkum a ochrana mravenců v oblasti Krkonoš. Der Schutz und die Forschung uber Ameisen im Gebiet des Riesengebirges (Krkonoše). – Formica, 9: 7–10. [in Czech, German summary]

SEIFERT B. (1991): The phenotypes of the *Formica rufa* complex in East Germany. – Abh. Ber Naturkundemus, Görlitz, 65 (1):1–27.

SEIFERT B. (1996): Ameisen beobachten, bestimmen. – Naturbuch Verlag, Augsburg, 352 pp.

SEIFERT B. (2007): Die Ameisen Mittel- und Nordeuropas. – Lutra Verlags- und Vertriebsgesellschaft., 368 pp.

SEIFERT B., KULMUNI J. et PAMILO P. (2010): Independent hybrid populations of *Formica polyctena* x *rufa* wood ants (Hymenoptera: Formicidae) abound under conditions of forest fragmentation. Evol. Ecol., 24: 1219–1237.