

***Formica lusatica* SEIFERT, 1997 (Hymenoptera: Formicidae), an ant species new to Finland, with notes on its biology and the description of males**

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Abstract

A taxonomically problematic ant species from southernmost Finland, so far determined as *Formica rufibarbis* FABRICIUS, 1793 or / and *F. cunicularia* LATREILLE, 1798, is identified as *Formica lusatica* SEIFERT, 1997. This is the first report of this species from Finland. Aspects of the biology of *F. lusatica* under the local conditions, and especially its relations with *Formica sanguinea* LATREILLE, 1798, are presented and the description of its males is given.

Key words: Ants, *Formica lusatica*, *Formica sanguinea*, fauna, taxonomy, description of male, ecology, social parasitism, Finland.

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Introduction

Until recently, two species of the *Formica rufibarbis* complex were recorded in Finland: *F. rufibarbis* FABRICIUS, 1793 (COLLINGWOOD 1979) and *F. cunicularia* LATREILLE, 1798 (ALBRECHT 1993), both reported only from the southern part of the country (approximately to latitude 62° N). The main morphological differences between *F. rufibarbis* and *F. cunicularia*, two sympatric sibling species, are the characters of standing pilosity on the alitrunk and petiole, and the colouration of the workers. *Formica rufibarbis* is generally more hairy: setae on the alitrunk are more abundant and long, and those on the petiolar scale (seen in profile) are directed backward and forward; the alitrunk is usually totally reddish, sometimes with variable amounts of dark. The alitrunk of *F. cunicularia*, usually with vast dark patches on the sides, has at most a few setae and very often is completely hairless; there are usually no setae on the petiolar scale or, if some setae are present, they are directed upward or slightly forward (for details see DLUSKY 1967, BERNARD 1968, KUTTER 1977, COLLINGWOOD 1979, SEIFERT 1996, CZECHOWSKI & al. 2002, RADCHENKO & al. 2004).

ALBRECHT (1993), in his short report on the occurrence of *F. cunicularia* in Finland, insisted that all previous records of *F. rufibarbis* for this country need to be re-examined, as some of them might pertain to *F. cunicularia*. This unclear situation of these two species already reported from Finland is in fact even more complicated with our observation of a third sibling species there, the rather recently described *F. lusatica* SEIFERT, 1997. It differs from both, *F. rufibarbis* and *F. cunicularia*, in the character of pilosity, in having a relatively longer antennal scape, and a generally bigger, more robust body. From *F. cunicularia* it additionally differs in having a lighter alitrunk and in head colouration; for details see SEIFERT (1997).

SEIFERT (1997) did not include *F. lusatica* sexual forms in his description of the species and comparison of sexuals of *F. lusatica* with those of so far known sibling species. Only a brief morphological characterization of gynes of *F. lusatica* (under the name *F. glauca* RUZSKY, 1896) was

given by SEIFERT (1996) in the key. Together with this report, we describe the males of *F. lusatica* and briefly compare them with the males of *F. cunicularia* and *F. rufibarbis*. The aim of the study was also to describe elements of biology of *F. lusatica*, especially the nature of its relationships with *Formica sanguinea* LATREILLE, 1798, as the ants of the *F. rufibarbis* complex are potential slave species for the latter.

Material and methods

Formica lusatica was found in Tvärminne village and its vicinity on Hango Peninsula, the southernmost part of Finland (59° 50' N, 23° 15' E). A few nests of this species, originally recognized as (atypical) *F. rufibarbis*, were seen every year from 1996 till 2005 in a local complex of sand dunes when myrmecological studies, mainly on interspecific social-parasitic and competitive relations, were carried out there (see, e.g., CZECHOWSKI & ROTKIEWICZ 1997, CZECHOWSKI 1999, 2000, 2001, CZECHOWSKI & VEPSÄLÄINEN 2001). Earlier, the same ant species, also recognized as *F. rufibarbis*, was reported from the Tvärminne dunes by GALLÉ (1991). Earlier still (in the late seventies), these Tvärminne ants were determined both as *F. rufibarbis* and *F. cunicularia* (B. Pisarski & K. Vepsäläinen unpubl.).

The dune colonies of *F. lusatica* were observed particularly with the aim of studying their relations with *F. sanguinea*, a facultative slave-maker, which was a very common ant species in that habitat. Every year these observations were carried out during 2 - 3 weeks, starting in late June or early July, i.e., in the period of raiding activity of *F. sanguinea* (each time including its very beginning). Besides observations of natural situations, an experimental colony of *F. sanguinea* was artificially founded in the vicinity of two *F. lusatica* nests in 2003 to provoke a conflict between the species.

In the years 2003 - 2005, the investigation of *F. lusatica* was expanded to include other neighbouring habitats. In total, nearly 20 *F. lusatica* nests were localized. Nest

samples, including sexuals if present, were taken from most of them. The species was identified based on SEIFERT's (1997) description of workers and, in the case of gynes, on SEIFERT's (1996) key (where *F. lusatica* is referred to as *F. glauca*). In the latter case, the most useful discriminating features of *F. lusatica*, *F. cunicularia* and *F. rufibarbis* appeared to be the number of standing setae on the alitrunk and pigmentation of the alitrunk.

Thirty males taken as pupae from three nests on the meadow and reared in the laboratory in 2004 were subjected to morphological examination, using the following morphometrics and indices:

- HL maximum length of head in dorsal view, measured in a straight line from the anteriormost point of clypeus to the mid-point of the occipital margin.
- HW maximum width of head in dorsal view behind eyes.
- SL maximum straight-line length of antennal scape from its articulation with condylar bulb to the proximal edge of scape.
- AL diagonal length of alitrunk in profile, measured from anterodorsal point of alitrunk to posterior margin of metapleural lobe.
- CI cephalic index: HL / HW .
- SI scape index: SL / HL .
- AI alitrunk index: AL / AH .

Results

1. Habitats and mode of nesting

In the study area, *F. lusatica* was most abundant on a dry, sporadically mowed country meadow (Fig. 1), where c. 10 nests were found in an area of approximately 0.5 ha. Apart from the ubiquitous *F. fusca* LINNAEUS, 1758, and *F. polycтена* FÖRSTER, 1850, a visitor from a nearby forest, *F. lusatica* was the main representative of the genus *Formica* L. there. There were also sporadic small colonies of *F. exsecta* NYLANDER, 1846, and *F. sanguinea*. Most *F. lusatica* nests were found in the driest part of the meadow with *Calamagrostis epigeios* (L.) ROTH as the prevalent grass species. The largest colonies were found along a sandy road cutting across the meadow, in a thin marginal band of herbaceous vegetation (Fig. 2). The nests had a number of nest holes and were 40 - 50 cm in diameter. The earth mounds were irregular, rather flat (at most several centimeters in height) (Fig. 3). The *F. lusatica* colonies were all seen only in that one meadow (in two parts separated by a gravelly road; to be seen on the right in Fig. 1) with no nests found in the surrounding meadows despite apparently similar habitat conditions.

Five other colonies of *F. lusatica* (including one incipient colony) were found in the habitat of the sand dunes with some early stands of pine (for a habitat description see GALLÉ 1991 and CZECHOWSKI & al. 2005). These colonies nested in two complexes (I and II; Figs. 6, 7), about 300 m apart, in open localities near the southern slope of the dunes and along the northern edge of a pine forest below the dune, several metres away from the forest edge. The sand there was partly covered with a layer of lichens and low moss, somewhere else with sparse coverage of *Carex arenaria* L., *Festuca ovina* L. or *Calamagrostis epigeios* (Fig. 4). The *F. lusatica* nests in this habitat generally resembled nests of *F. cinerea* MAYR, 1853, the dominant *Formica* species on the Tvärminne dunes, with single nest holes or groups of nest holes, surrounded



Fig. 1: Meadow at Tvärminne populated by *F. lusatica* (photo: W. Czechowski).



Fig. 2: Part of the meadow at Tvärminne with biggest colonies of *F. lusatica* along the right side of the sandy route (photo: W. Czechowski).



Fig. 3: Nest of *F. lusatica* in the meadow at Tvärminne (photo: W. Czechowski).

by flat embankments of elevated sand (Fig. 5). The nest area of the largest colony, including two groups of nest holes, was approximately 60 cm in diameter.

A third habitat where *F. lusatica* occurred was the gravelly side of an asphalt road. One nest was found there in the village of Tvärminne (on the same side as the dune complex), with more nests occurring farther on (K. Vepsäläinen, pers. comm.).



Fig. 4: Habitat of *F. lusatica* in the sandy dunes at Tvärminne; situation of the *F. lusatica* (FL-IV) and *F. sanguinea* (FS-V) nests is marked (see also Fig. 7) (photo: W. Czechowski).



Fig. 5: Nest of *F. lusatica* (FL-III) in the sandy dune habitat (photo: W. Czechowski).

2. Relations with other ant species

About 30 ant species live on the Tvärminne dunes (GALLÉ 1991 plus later addenda in CZECHOWSKI & ROTKIEWICZ 1997, CZECHOWSKI 1999, CZECHOWSKI & al. 2005). Nests found in the vicinity of *F. lusatica* colonies included *Myrmica ruginodis* NYLANDER, 1846, *M. schencki* VIREECK, 1903, *Leptothorax acervorum* (FABRICIUS, 1793), *Temnothorax* spp., *Harpagoxenus sublaevis* (NYLANDER, 1849), *Tetramorium caespitum* (LINNAEUS, 1758) (the latter even almost plesiobiotically), *Lasius niger* (LINNAEUS, 1758), *L. psammophilus* SEIFERT, 1992, *Formica fusca*, and *F. sanguinea*. *Formica lusatica* could encounter individuals of these species within its range of searching. *Formica cinerea* was another species found abundantly in the same dune successional stages, but it was never seen in direct contact with *F. lusatica*.

All *F. lusatica* colonies found on the dunes were within the raiding range of *F. sanguinea*, or even very close to nests of this slave-maker. FL-I, an incipient colony, was only observed during two years (2001, 2002) and subsequently disappeared. Colony FL-V was first noticed in 2004, but it might actually have been there previously. The other three colonies: FL-II, FL-III and FL-IV, were seen in permanent locations throughout the study period. The distance between individual *F. lusatica* nests and the *F. sanguinea* nests closest to them ranged between 6 and

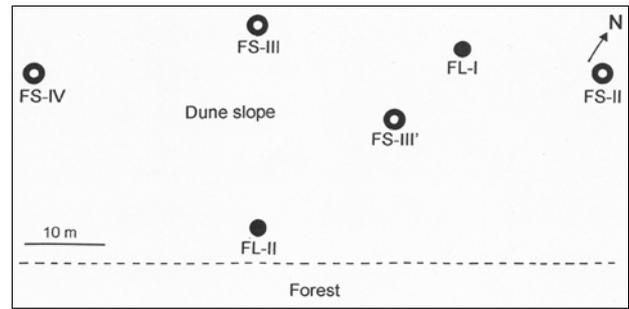


Fig. 6: Map of the observed complex I of nests of *F. lusatica* (colonies FL-I and FL-II) and *F. sanguinea* (FS) in the sandy dune habitat (see the text and also Fig. 2 in CZECHOWSKI & VEPSÄLÄINEN 2001).

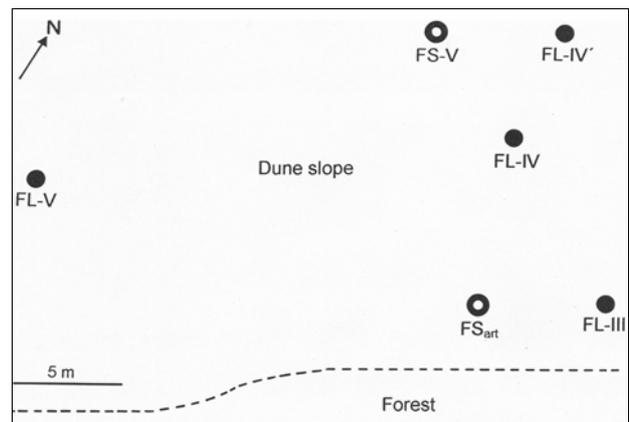


Fig. 7: Map of the observed complex II of *F. lusatica* (colonies FL-III, FL-IV and FL-V) and *F. sanguinea* (FS) (FS_{art.} – nest artificially founded) in the sandy dune habitat (see the text).

28.5 m (18.9 m on average) (Figs. 4, 6, 7). Still, only two *F. sanguinea* raids on *F. lusatica*, including one unsuccessful attempt, were observed during the 10 years of study, alongside tens of raids against colonies of the other host species, *F. cinerea* and *F. fusca*, though the distance to cover was usually well above 30 m (for examples see CZECHOWSKI 1999, 2000, 2001, CZECHOWSKI & VEPSÄLÄINEN 2001); the route of the longest raid observed exceeded 90 m. During these raids columns of *F. sanguinea* were often seen to pass close by *F. lusatica* nests, paying no attention whatsoever to the latter.

A particularly spectacular finding was that of colony FL-II of *F. lusatica*, located within the raiding range of, initially, at least two (FS-III, FS-IV), and later, at least three (FS-III, FS-III', FS-IV) colonies of *F. sanguinea* (Fig. 6). FL-II nested in the dune-forest ecotone zone, amongst locally numerous colonies of *F. fusca*, which were raided every year by *F. sanguinea* from the upper edge of the dune (see Fig. 2 in CZECHOWSKI & VEPSÄLÄINEN 2001). Raiding routes often almost ran across the *F. lusatica* nest. Colony FL-II was attacked only once (in 2001), unsuccessfully, by *F. sanguinea* of colony FS-III. *Formica lusatica* workers guarded all nest holes head-to-head, forcing the raiders to retreat following a few hours' siege.

The only colony of *F. lusatica* which was successfully raided by *F. sanguinea* was FL-IV, situated merely 6 m away from colony FS-V (Fig. 7). On 21 July 2005, af-

ter nine years of conflict-free co-existence, during which *F. sanguinea* raided only far more detached colonies of *F. fusca*, the slave-maker attacked nest FL-IV. The reason why that attack was successful was probably that the nest was situated under a patch of dry moss. The raiders managed to sneak under it simultaneously from different directions, causing *F. lusatica* workers to flee in panic with larvae and pupae. The *F. lusatica* scattered on an area of several square metres. Some took shelter among grasses and herbs, which are rather scarce in that habitat. A few reached as far as another *F. lusatica* nest (FL-III) 9 metres away, facing an aggressive welcome from their foreign conspecifics. *Formica sanguinea* gained about 200 worker pupae in that raid. Over a few days, the scattered workers of *F. lusatica* got organized and established a new nest, situated less than 6 m away from the previous one (now completely deserted), at the same distance from *F. sanguinea* as before (Fig. 7).

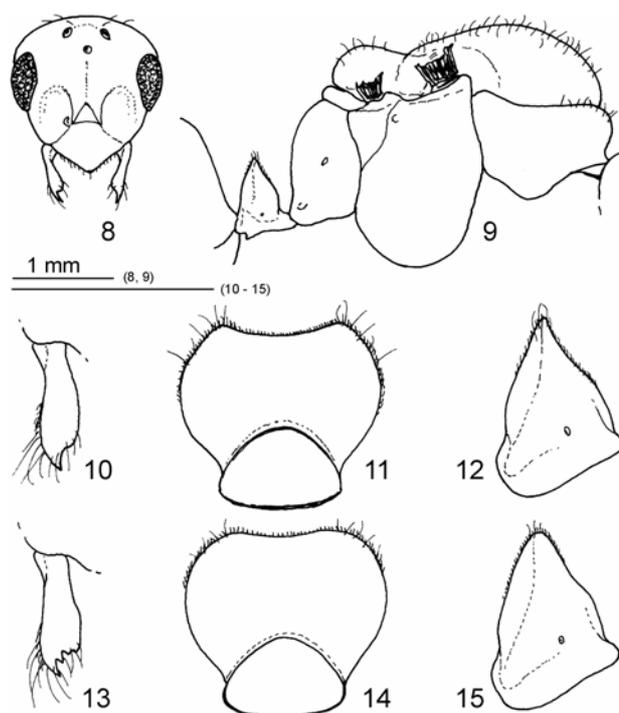
An artificial nest of *F. sanguinea* was established earlier on, in 2003, in the vicinity of nests FL-III and FL-IV, 7.8 m and 6 m away from them respectively (Fig. 7). *Formica sanguinea* was known to invade immediately nearby colonies of the host species *F. cinerea* and *F. fusca* in such cases (CZECHOWSKI & ROTKIEWICZ 1997, W. Czechowski, unpubl.). However, in this study, no nest of *F. lusatica* was raided during the two weeks of observation. No colony of *F. sanguinea* was found in that location in the next year of study.

3. Description of males

Head broadly rounded above eyes, anterior clypeal margin prominent and very narrowly rounded. Eyes without hairs. Occipital margin of head bare or with at most 2 - 4 short straight standing hairs, ventral surface of head without standing hairs (Fig. 8). Masticatory margin of mandibles rounded, with only one apical tooth (Fig. 10). Alitrunk relatively short and high, with strongly convex scutum. Pronotum, scutum and scutellum with numerous standing hairs (Fig. 9). Petiolar scale (seen in profile) strongly tapering to top, with very narrowly rounded dorsal crest; when seen in front or from behind, its dorsal margin strongly concave, and anterodorsal corners pointed; anterior and posterior faces, and dorsal margin of scale both with short dense pilosity and much longer straight or slightly curved standing hairs (Figs. 11, 12).

Measurements (in mm) and indices (in order: mean \pm SD, minimum - maximum in parentheses): HL 1.64 ± 0.031 (1.57 - 1.69), HW 1.45 ± 0.025 (1.40 - 1.49), SL 1.34 ± 0.049 (1.22 - 1.44), AL 3.31 ± 0.101 (3.12 - 3.50), AH 2.16 ± 0.089 (2.00 - 2.31), CI 1.13 ± 0.015 (1.09 - 1.16), SI 0.82 ± 0.033 (0.75 - 0.91), AI 1.54 ± 0.035 (1.48 - 1.62) (n = 30).

Males of *F. lusatica* visibly differ from those of *F. cunicularia* first of all in the shape of petiolar scale. In *F. cunicularia* it is much thicker, not tapering to the top, with the dorsal crest quite widely rounded (seen in profile); seen in front or from behind, its dorsal margin is straight or at most slightly concave, and anterodorsal angles are not pointed, but broadly rounded (compare Figs. 11 and 12 vs. 14 and 15). Furthermore, in *F. cunicularia* males the masticatory mandible margin usually has 1 - 3 additional teeth except the apical tooth (compare Figs. 10 and 13). On the



Figs. 8 - 15: Details of morphological structures of males of *F. lusatica* (8 - 12) and *F. cunicularia* (13 - 15): (8) head, frontal view; (9) alitrunk and petiole in profile; (10, 13) mandible; (11, 14) petiolar scale, frontal view; (12, 15) petiolar scale in profile.

other hand, males of *F. lusatica* are virtually indistinguishable from males of *F. rufibarbis*.

4. Phenology of sexuals

In 2002, individual alate and freshly dealated gynes of *F. lusatica* were seen outside nests in the first 10 days of July. In 2003, following a particularly cold spring, only larvae of sexuals could be seen in nests at the same time. In 2004 young (white and soft) pupae of sexuals appeared in *F. lusatica* nests in early July. They were taken out to be reared in laboratory on 19 July, with imagines (both males and gynes) emerging in late July. In 2005 nuptial flights of *F. lusatica* sexuals were observed in early August.

Discussion

Southern Finland (especially the region of Hanko Peninsula) is notorious for taxonomic problems regarding the local ants. The most spectacular example of systematic confusion is that of wood ants of the *Formica rufa* group (see, e.g., VEPSÄLÄINEN & PISARSKI 1981, CZECHOWSKI 1996), but the subgenus *Lasius* s.str. is not any clearer (W. Czechowski & A. Radchenko, unpubl.; see also CZECHOWSKI & al. 2005). The *F. rufibarbis* complex is also problematic. In practically all *F. lusatica* colonies investigated, apart from workers typical of this species, there were individuals which could not be unequivocally determined to species based on their morphology: *F. cunicularia*-like, *F. rufibarbis*-like, hybrid-like. The share of such dubious forms in a colony could be associated with the colony's age. Workers which were more or less typical of *F. lusatica* (large, stout, fair-coloured) predominated in

larger colonies, whereas smaller nests had a distinct share of these indeterminate forms, which were smaller, with more slender and darker bodies with variable, misleading pilosity patterns.

Earlier, ALBRECHT (1993) faced the same difficulties. In his report of *F. cunicularia* in Finland, including the Tvärminne locality, he stated that on the basis of the key diagnostics for *F. cunicularia* and *F. rufibarbis* one might conclude that all the nests he studied contained both species. Further on he wrote that "Morphological analyses [...] show, however, that morphological variation in *F. cunicularia* is wider than previously believed, at least in Finnish populations, which in some instances makes the identification questionable [...]" (loc. cit., p. 13). This was, naturally, written before SEIFERT (1997) described *F. lusatica*, which has intermediary traits (most significantly as regards pilosity) with respect to the two known sibling species (see also BOER 2002).

ALBRECHT's (1993) *F. cunicularia* (at least the specimens from Tvärminne) and our *F. lusatica* were almost doubtless the same as no other ants of the *F. cunicularia/rufibarbis/lusatica* complex occurred anywhere near Tvärminne, at least during the recent years. Identification of the problematic ant species from southern Finland as *F. lusatica* does not rule out the possibility that the other two sibling species occur there as well. As K. Vepsäläinen (pers. comm.) maintains, originally (25 - 30 years ago) he met in the Tvärminne area typical *F. rufibarbis* (aggressive, fairly slender and relatively "F. rufa-coloured" ants) and, very rarely, also typical *F. cunicularia* (timid, dark, almost "F. fusca-coloured" ants). Thus it can not be excluded that *F. lusatica*, for which Tvärminne is now the northernmost known site (compare SEIFERT 1997), could be a relatively new colonizer of this area, competitive enough to outcompete locally both *F. rufibarbis* and *F. cunicularia*.

Apart from the morphology of (typical) workers and gynes, the biology of the ants under discussion provides more arguments to support the statement that they were *F. lusatica*, and also against their being *F. cunicularia*. Even before *F. lusatica* was first described, studies pointed out different patterns of behaviour of *F. cunicularia* and *F. rufibarbis* towards *Polyergus rufescens* (LATREILLE, 1798) and *F. sanguinea*. *Formica cunicularia* is practically defenseless against these slave-makers and, just like *F. fusca*, often falls prey to their social parasitism. *Formica rufibarbis*, on the other hand, is very aggressive towards both slave-makers (their scouts, raiding columns, and usurping queens), which generally prevents its colonies from being parasitised. The aggressive attitude of *F. rufibarbis* makes *P. rufescens* and *F. sanguinea* avoid attacking *F. rufibarbis* nests if there is another host species around, such as *F. cunicularia* (GRASSO & al. 1994, LE MOLI & al. 1994, MORI & al. 1994, A. Mori, pers. comm.). As for *F. lusatica*, their colonies have a great defence force against competitors and even outdo *F. rufibarbis* in defending their nests against *F. sanguinea* raids, and against social parasitism in general (SEIFERT 1997, see also *F. glauca* in SEIFERT 1996). Thus, the mutual relations between the Tvärminne ants under discussion and *F. sanguinea* provide enough evidence to rule out the possibility of these ants belonging to *F. cunicularia*. This conclusion is not to be invalidated in view of the conflict between one of the colonies under investigation and *F. sanguinea*, which

ended in the former abandoning their own nest. If raiders break through the defence, though this happens very rarely, this kind of response can be seen even in *F. cinerea*, which are known for their aggressiveness and the ability to defend their nests successfully against *F. sanguinea* (CZECHOWSKI 1977, CZECHOWSKI & ROTKIEWICZ 1997, W. Czechowski, unpubl.).

The separation of *F. lusatica* as a new, third species in the *F. cunicularia / F. rufibarbis* complex, has resulted in a marked reduction (though not complete elimination) of determination problems regarding these ants. The former *F. cunicularia* and *F. rufibarbis* have often been mistaken for each other, due to great variation among them and the presence of transitional forms (DLUSSKY & PISARSKI 1971). The identification problems are well reflected in the humorous name "ruficularia", which actually is quite fitting for some individuals of the *F. lusatica* colonies discussed in this paper.

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Zusammenfassung

Eine taxonomisch problematische Ameisenart aus dem äußersten Süden Finnlands, bisher als *Formica rufibarbis* FABRICIUS, 1793 oder / und *F. cunicularia* LATREILLE, 1798 bestimmt, wird hier als *Formica lusatica* SEIFERT, 1997 identifiziert. Es handelt sich dabei um die erste Meldung der Art aus Finnland. Aspekte der Biologie von *F. lusatica* unter den lokalen Bedingungen, insbesondere ihre Beziehung zu *Formica sanguinea* LATREILLE, 1798 betreffend, werden präsentiert. Die Männchen von *F. lusatica* werden erstmals beschrieben.

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