

Kurze Originalmitteilungen

Formica lusatica n. sp. - a sympatric sibling species of Formica cunicularia and Formica rufibarbis (Hymenoptera, Formicidae)

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With 3 tables and 7 figures

Zusammenfassung

Formica lusatica n. sp. - eine neue Schwesternart von *Formica cunicularia* und *Formica rufibarbis* (Hymenoptera, Formicidae).

Formica lusatica n. sp., eine neue Schwesternart von *Formica cunicularia* Fabr. und *Formica rufibarbis* Latr., wird aus Europa beschrieben. *F. lusatica* unterscheidet sich von *cunicularia* und *rufibarbis* signifikant durch die Körperbehaarung, durch einen größeren Scapuslängen-Index und durch eine größere absolute Körpergröße. Die Pigmentierung von Mesosoma und Kopf ist bei *lusatica* insgesamt deutlich heller als bei *cunicularia* und die Pigmentverteilung folgt einem anderen Muster. Morphometrische und chorologische Befunde widerlegen die Hypothese, daß *lusatica* ein Hybrid zwischen *cunicularia* und *rufibarbis* sei. Sowohl das Makroklima der Fundorte als auch das Mikroklima der Neststandorte weisen *Formica lusatica* als deutlich xerothermophiler als *cunicularia* und *rufibarbis* aus. Die absolute Dominanz von *lusatica* über ihre Schwesternarten in den offenen Sandheiden von Truppenübungsplätzen in N Sachsen wird durch adaptive Vorteile erklärt. Es gibt keine westpalaäarktischen Taxa, die sich als ältere Synonyme von *F. lusatica* erwiesen haben. Das offensichtliche Fehlen bzw. der Verlust von Typenmaterial aus *rufibarbis*-Gruppe in den Sammlungen von St. Petersburg, Moskau und Tucuman (Argentinien) und das Fehlen diagnostischer Merkmalsangaben in den Originalbeschreibungen macht eine artliche Zuordnung der Taxa von Ruzsky und Kuznetsov-Ugamsky unmöglich. Annahmen über eine Synonymie von *Formica lusatica* n. sp. mit *Formica fusca* subsp. *rufibarbis* var. *glauca* Ruzsky, 1895, *Formica rufibarbis clara* var. *caucasica* Ruzsky, 1905, *Formica rufibarbis montana* Kuznetsov-Ugamsky, 1923, *Formica rufibarbis montana* var. *minor* Kuznetsov-Ugamsky, 1926, *Formica rufibarbis volgensis* Ruzsky, 1914 sind daher wissenschaftlich kaum zu begründen. Die Synonymliste von DLUSSKY (1967), der nie einen Typus der fraglichen Taxa gesehen hat (briefl. Mitteilung vom Mai 1996), muß als reine Spekulation betrachtet werden. *Formica lusatica* n. sp. ist der korrekte Name für die vom Autor vorher als Hybrid von *rufibarbis* x *cunicularia* (SEIFERT 1994 a), als *Formica rubescens* Forel (SEIFERT 1994 b) bzw. als *Formica glauca* Ruzsky (SEIFERT 1996) bezeichneten Ameisen.

Abstract

Formica lusatica n. sp., a new sibling species of *Formica cunicularia* Fabr. and *Formica rufibarbis* Latr., is described from Europe. *F. lusatica* significantly differs from both *cunicularia* and *rufibarbis* in setae numbers and in having a larger scape length index and bigger absolute body size. The overall mesosomal and head pigmentation of *lusatica* is distinctly lighter than in *cunicularia* and the distribution of dark pigments follows a different pattern. Morphometric and chorological findings strongly contradict the hypothesis of *lusatica* being a hybrid between *cunicularia* and *rufibarbis*. Both the macroclimate of the distribution area as well as the microclimate of the investigated nest spots prove *Formica lusatica* to be distinctly more xerothermophilic than its sibling species. Adaptive advantages of *lusatica* are made responsible for its absolute dominance in open, sandy heathland of military training areas in N Sachsen. There are no taxa in the W Palaearctic region which have proved as senior synonyms of *F. lusatica*. The obvious absence or loss of *rufibarbis* group type material in the collections of St. Petersburg, Moscow and Tucuman (Argentina) and the lack of statements on diagnostic characters in the original descriptions prevents a reliable identification of Ruzsky's and Kuznetzov-Ugamsky's taxa. Suggestions on a synonymy of *Formica lusatica* n. sp. with *Formica fusca* subsp. *rufibarbis* var. *glauca* Ruzsky, 1895, *Formica rufibarbis clara* var. *caucasica* Ruzsky, 1905, *Formica rufibarbis montana* Kuznetzov-Ugamsky, 1923, *Formica rufibarbis montana* var. *minor* Kuznetzov-Ugamsky, 1923, *Formica rufibarbis volgensis* Ruzsky, 1914 have thus no scientific base. The synonymic list of DLUSSKY (1967), who has never seen any type of the taxa in question (letter of May 1996), must be considered as pure guesswork. *Formica lusatica* n. sp. is the correct name for the ant species earlier cited as hybrid of *rufibarbis* x *cunicularia* (SEIFERT 1994 a), as *Formica rubescens* Forel (SEIFERT 1994 b), and as *Formica glauca* Ruzsky (SEIFERT 1996).

1. Introduction

Formica rufibarbis Fabricius 1793 and *Formica cunicularia* Latreille, 1798 are widely distributed ants of open xerothermous habitats, where they frequently occur syntopically. The contemporary keys (DLUSSKY 1967, KUTTER 1977, COLLINGWOOD 1979) distinguished *cunicularia* from *rufibarbis* by its lower setae numbers and darker mesosomal pigmentation. Subjectively, there seemed to exist no substantial determination problems. However, in field studies performed by the author during the last 16 years evidence for the existence of a morph with intermediate setae conditions arose (fig. 1). This morph can not be allocated to either *cunicularia* or *rufibarbis* and was initially suspected to represent a hybrid of these species (SEIFERT 1994 a). Meanwhile, a detailed morphometric analysis of the species complex forced the author to give up the hybrid theory. This new interpretation is confirmed by the distribution pattern of the three species in question, which is not compatible with a hybrid theory. The arguments for a separate species status of the morph and for its taxonomic description as *Formica lusatica* n. sp. are presented in this paper. *Formica lusatica* is identical with the ants earlier named as *Formica rubescens* Forel (SEIFERT 1994 b) and *Formica glauca* Ruzsky (SEIFERT 1996).

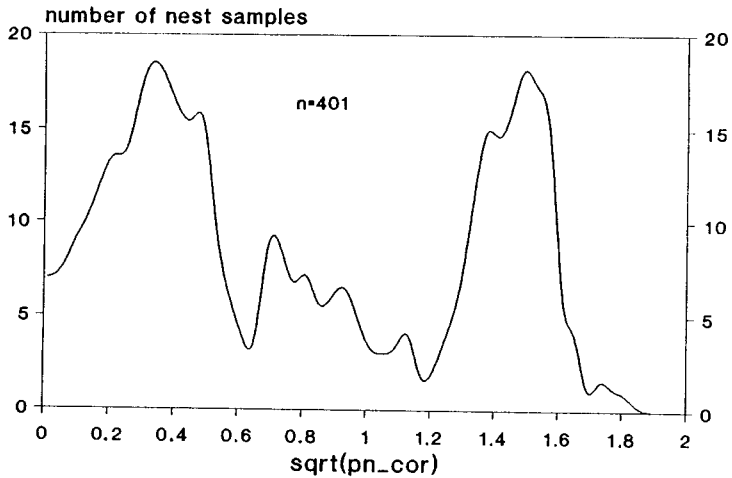


fig. 1 Distribution of square-root-transformed and size-corrected pronotal setae numbers of 401 worker nest samples of *Formica cunicularia*, *lusatica*, and *rufibarbis*

2. Materials and Methods

2.1. Material

The morphometric study was performed on the basis of 401 nest samples consisting of 2200 workers. 238 samples were investigated in the first phase of the study for seta numbers, head width, and pigmentation pattern. Later, after it became apparent that the linear measures of scape, head, and setae were important discriminators, further 163 samples were investigated for an extended set of characters. The regions where the samples were collected and the number of samples are:

Danmark and Sweden:	27	Slovakia and Poland:	2	Germany and Czechia:	320
England and France:	2	Caucasus:	7		
Austria and Switzerland:	41	Bulgaria and Turkey:	2		

2.2. Terminology and methods of morphological investigation

All linear measurements were taken in mounted and dried specimens using a pin-holding device freely turnable into each spatial position. A Wild M10 stereomicroscope equipped with a 1.6x planapochromatic objective was used at magnifications of 80-320x. The maximum possible magnification to keep a structure within the range of the ocular micrometer was used. A mean measuring error of $\pm 1 \mu\text{m}$ is given for small and well-defined structures such as hair length, but may reach $5 \mu\text{m}$ for large measures with difficult positioning and high dependency from air humidity such as CW. To avoid rounding errors, all measurements have been recorded in μm even for characters where a precision of $\pm 1 \mu\text{m}$ is impossible. In order to reduce irritating reflexions of the cuticular surfaces and to obtain an improved visualization of the microsculpture, a plastic diffusor was positioned as close as possible to the specimen.

If not otherwise stated, statistic tests testing the equality of mean values are: a **t** test when an **F** test proved the equality of the variances; otherwise a modified **t** test with corrected degrees of freedom according to WELCH (1947).

Setae are differentiated from pubescence hairs in having a much larger basal diameter (4-8 μm in setae and 1-2 μm in pubescence).

Seta counts are restricted to standing setae projecting $>10 \mu\text{m}$ from cuticular surface.

CL	maximum head (caput) length in median line; the head must be carefully tilted to the position with real maximum
CW	maximum head (caput) width which may be across or behind the eyes
GHL	length of longest seta on dorsal plane of first gaster tergite excluding the longer setae at the hind margin
nHFE	number of standing setae on the flexor profile of both hind femora
nMN	number of standing setae on mesonotum
nPE	number of standing setae on the edge of petiolar scale above the opening of the spiracle
nPN	number of standing setae on pronotum
nPP	number of standing setae on propodeum
PIGM	the per cent ratio of the blackish or dark brown pigmented surface of the mesosoma excluding the coxae as perceptible in lateral view. A value of 0 means that the whole mesosoma is uniformly reddish or yellowish red
SCL	maximum straight line scape length excluding the articular condyle

In *F. lusatica* and *F. rufibarbis* the most distinctive seta numbers showed a within-species correlation of 0.34-0.78. This led to the decision to reduce the number of positions for seta counts to the single (but most discriminative) character nPN and instead to increase the number of specimens investigated. In order to obtain a better discrimination of certain morphometric characters, the variation produced by allometries was removed by calculating size-corrected indices.

In the first step, indices of the numeric characters were calculated: CL/CW, SCL/CL, SCL/CW, nPN/CW, GHL/CW. In the second step, linear regression functions of these indices against CL or CW were calculated for each species separately. This two-step procedure empirically results in a good approximation of allometries by linear functions in all ant groups showing no extreme worker polymorphism (SEIFERT 1992 a, 1992 b, own unpublished results).

The size-corrected indices CL/CW_{cor} , SCL/CL_{cor} , SCL/CW_{cor} , nPN_{cor} , and GHL_{cor} were then computed by division with the values of cumulative regression functions. Compared to the unprocessed primary indices, the coefficients of variation are reduced in the size-corrected indices to 75 % if there is a strong dependency from body size as in SCL/CW (fig. 2).

The procedure to obtain the size-corrected pigmentation value $PIGM_{\text{cor}}$ was somewhat different - i. e. the primary data of PIGM were divided by the values of a triphasic linear function. This triphasic correction function is a description of the arithmetic mean of the values of the species-specific functions of *cunicularia* and *lusatica* with

$$PIGM = - 0.1282 CW + 201 \quad \text{for } CW < 1240$$

$$PIGM = - 0.0746 CW + 135 \quad \text{for } 1240 \leq CW < 1520$$

$$PIGM = - 0.0476 CW + 94 \quad \text{for } CW \geq 1520$$

The situation in *rufibarbis* was not considered since the pigmentation does not help to separate *lusatica* and *rufibarbis* and is not necessary as a further discriminating character in the well-separable *rufibarbis/cunicularia* pair. In principle the reduction of dark pigmentation with increasing body size in *rufibarbis* followed the same rule as in *lusatica*.

2.3. The recording of ecological data

The environmental variables temperature, plant density, and soil substrate were recorded for the habitat spots where nests were found. The temperature and plant density data refer to a 1 m² soil spot with the nest in the centre, excluding that surface area which is structurally changed by the nest construction. The temperature conditions were estimated by the maximum soil temperature 'T'. T is the maximum soil temperature at a depth of 4 cm as it is achieved in Central Europe at a cloudless 'standard' summer day. This maximum soil temperature method was developed to enable a direct comparison of temperature measurements taken at different times and different localities. It aims to record just that point of temperature fluctuation which contributes most to between-habitat differences (for details see SEIFERT 1986). PD was recorded as the plant density in the moss and field layer as the product of cover percentage and mean height in cm - e. g. a cover percentage of 95 % and a mean height of 10 cm results in a PD value of 950.

3. Results

3.1. The numeric separation of *F. lusatica* n. sp. from its sibling species and the morphometric arguments against a hybrid identity.

Fig. 1 gives the distribution of square-root-transformed and size-corrected pronotal seta numbers for all 401 nest samples studied. Three clear peaks are visible which are interpreted to represent three different species. Tables 1 and 2 compare 12 numeric characters of *cunicularia*, *lusatica*, and *rufibarbis* on the individual level and on the basis of nest sample means. *F. lusatica* is intermediate between *cunicularia* and *rufibarbis* in almost all investigated seta number characters. This led to the initial hypothesis that it could be a hybrid.

This interpretation is, however, strongly contradicted by the morphometrics. *F. cunicularia* and *rufibarbis* are very similar in absolute size (CL and CW) and in the head and scape length indices (CL/CW_{cor} , SCL/CL_{cor} , SCL/CW_{cor}). In contrast *F. lusatica* differs from both putative parent species in being definitely larger and having larger indices of head and scape length. This is most clearly expressed in SCL/CW_{cor} , where the mean of *lusatica* is significantly larger than the means of *cunicularia* ($t=9.40$, $p<0.0001$) and of *rufibarbis* ($t=7.42$, $p<0.0001$). Exactly in this most discriminative character the means of *cunicularia* and *rufibarbis* are statistically equal ($t=0.99$). This important fact is elucidated in fig. 2, which shows the size-dependency of the scape length index. If *lusatica* would be a hybrid of *cunicularia* and *rufibarbis*, it should express phenotypic characters which are more or less intermediate or, at worst, equal to one of the putative parents. The means of CW in *lusatica* are much larger than those of *cunicularia* ($t=15.5$, $p<0.0001$) and those of *rufibarbis* ($t=11.9$, $p<0.0001$). In contrast, the means of CW in *cunicularia* and *rufibarbis* differ only slightly. This difference is significant ($t=0.99$) if the samples of nest means (tab. 2) are compared and is weakly significant ($t=2.55$, $p<0.02$) if the samples of the individuals (tab. 1) are compared. These morphometric results and the chorological and ecological arguments presented below give evidence that *lusatica* should be a species different from *cunicularia* and *rufibarbis*.

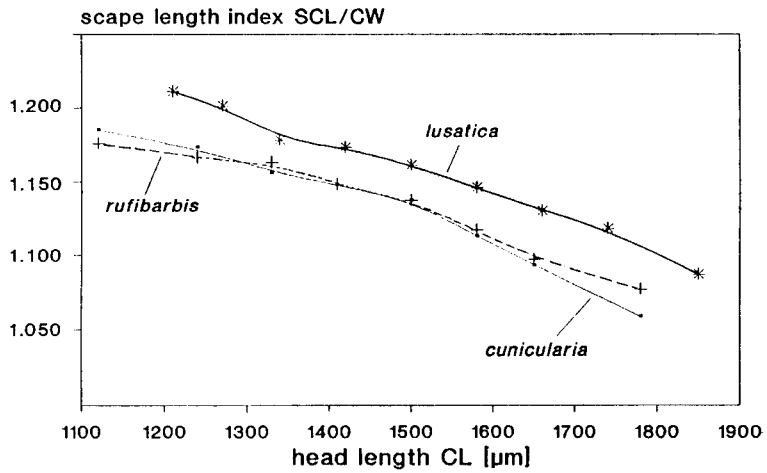


fig. 2 Scape length index SCL/CW plotted against head length CL. The points represent arithmetic means of 10 head length intervals and were calculated from a sample of 200 *cunicularia*, 221 *lusatica*, and 151 *rufibarbis* workers

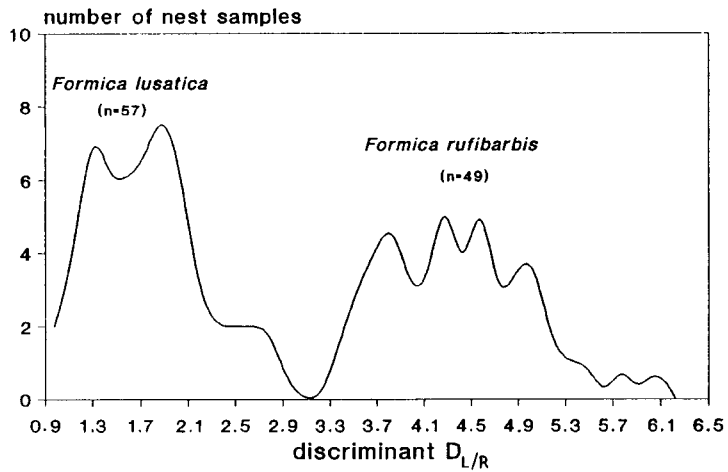


fig. 3 Distribution of the discriminant $D_{L/R}$ of nest sample means of *Formica lusatica* and *Formica rufibarbis* workers
 $D_{L/R} = 2.3 \text{ nPN}_{\text{cor}} + 1.2 \text{ GH}_{\text{cor}} - 0.5 \text{ SCL/CW}_{\text{cor}}$

A good distinction of *lusatica* from *rufibarbis* is given by nest sample means of nPN_{cor} (tab. 2). This separation is improved by considering two further characters in a discriminant $D_{L/R}$ (tab. 2, fig. 3). $D_{L/R}$ is calculated as

$$D_{L/R} = 2.3 nPN_{cor} + 1.2 GH_{L_{cor}} - 0.5 SCL/CW_{cor}$$

As a simplification for applied determination purposes a simple regression with

$$nPN = 0.0328 CW - 27.8$$

may be used. *F. rufibarbis* has larger and *lusatica* smaller pronotal setae numbers than defined by this function.

Less clear is the separation of *lusatica* from *cunicularia*. Seven characters presented in tab. 1 and 2 differ between the species for $p < 0.0001$ but there is always a considerable overlap. The most discriminative characters are nPN_{cor} and $PIGM_{cor}$. SCL/CW_{cor} is a less powerful accessory discriminator. The mesosomal pigmentation is, in the majority of the nest samples, bright reddish in *lusatica* and much darker in *cunicularia*. The average differences are striking. However, a small fraction of nests in both species show an inversion of the average pigmentation pattern (fig. 4).

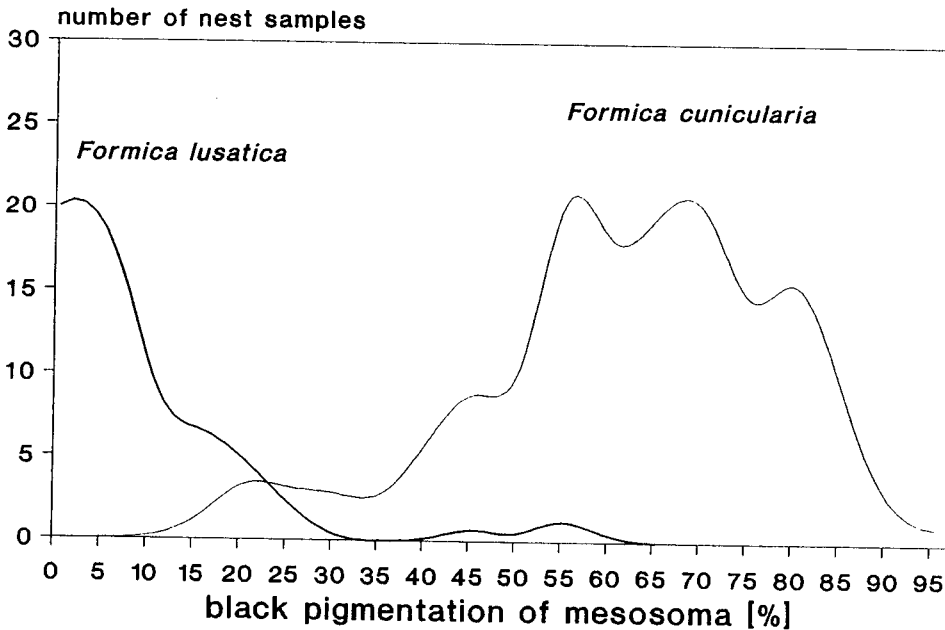


fig. 4 Percentage of dark pigmented mesosomal surface as seen in lateral view. Distribution of nest sample means of *Formica lusatica* and *Formica cunicularia* workers

A similar situation exists in *rufibarbis* where nests with dark workers are sometimes found. From these phenotypic observations, it seems that the pigmentation in these species is mainly inherited by a dominant/recessive system. This either/or decision reduces the reliability of this character for determination purposes. As a consequence, the weighting of $PIGM_{cur}$ was reduced in a discriminant $D_{L/C}$ that separates *lusatica* and *cunicularia*:

$$D_{L/C} = 4.8 \log(1 + nPN_{cur}) - 1.9 PIGM_{cur} + 0.3 SCL/CW_{cur} + 5.5$$

$D_{L/C}$ offered a rather clear separation of both species (fig. 5) but about 4 % of unclear samples with a conflicting character combination are found within the range of [4.5-5.5]. These nests were determined subjectively, using accessory informations.

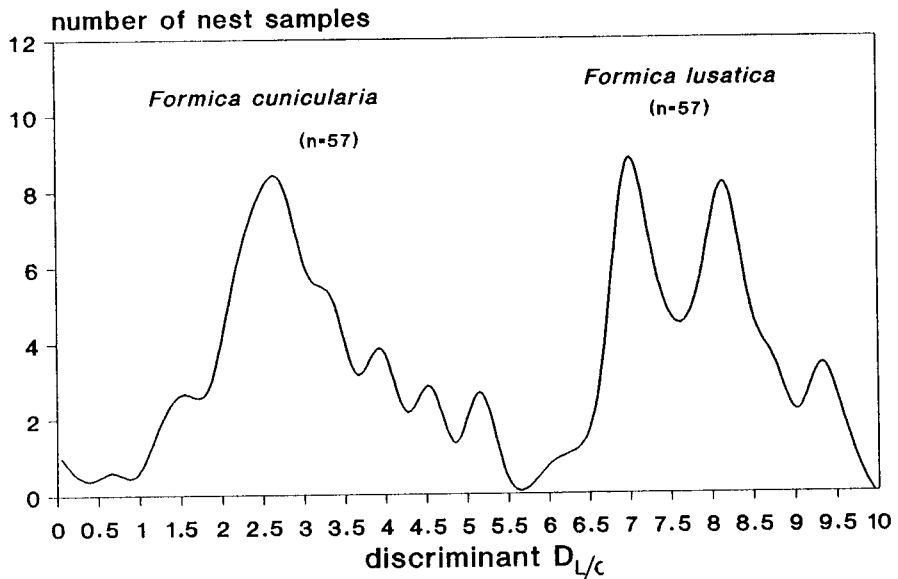


fig. 5 Distribution of the discriminant $D_{L/C}$ of nest sample means of *Formica lusatica* and *cunicularia* workers

$$D_{L/C} = 4.8 \log(1 + nPN_{cur}) - 1.9 PIGM_{cur} + 0.3 SCL/CW_{cur} + 5.5$$

table 1 Morphometric data of individual workers of *F. cunicularia*, *lusatica* n. sp., and *rufibarbis*. Given are the arithmetic mean, the standard deviation and the extreme values. Note that the sample size for the data of CL/CW, SCL/CL, SCL/CW and GHL/CW is only 200 in *cunicularia*, 221 in *lusatica*, and 152 specimens in *rufibarbis*

	<i>Formica cunicularia</i> (n=944)		<i>Formica lusatica</i> (n=523)		<i>Formica rufibarbis</i> (n=624)	
	mean \pm SD	[min-max]	mean \pm SD	[min-max]	mean \pm SD	[min-max]
CL	1478 \pm 142	[1080-1848]	1622 \pm 141	[1220-1918]	1513 \pm 143	[1094-1882]
CW	1314 \pm 145	[930-1724]	1434 \pm 143	[1028-1803]	1333 \pm 144	[952-1752]
CL/CW	1.127 \pm 0.025	[1.069-1.183]	1.132 \pm 0.026	[1.049-1.193]	1.136 \pm 0.025	[1.070-1.207]
CL/CW _{cov}	0.991 \pm 0.019	[0.921-1.042]	1.008 \pm 0.020	[0.923-1.063]	1.001 \pm 0.018	[0.943-1.044]
SCL/CL	1.005 \pm 0.026	[0.896-1.080]	1.002 \pm 0.025	[0.918-1.069]	0.995 \pm 0.025	[0.930-1.051]
SCL/CL _{cov}	0.998 \pm 0.022	[0.901-1.062]	1.009 \pm 0.021	[0.931-1.063]	0.992 \pm 0.022	[0.921-1.064]
SCL/CW	1.132 \pm 0.042	[0.976-1.231]	1.134 \pm 0.044	[0.987-1.242]	1.131 \pm 0.043	[1.021-1.224]
SCL/CW _{cov}	0.990 \pm 0.027	[0.872-1.056]	1.009 \pm 0.030	[0.896-1.086]	0.993 \pm 0.030	[0.920-1.076]
PIGM	58.0 \pm 22.5	[0-98]	10.5 \pm 16.1	[0-80]	24.2 \pm 23.5	[0-90]
nPN	1.63 \pm 1.90	[0-12]	10.8 \pm 6.0	[0-35]	25.0 \pm 8.8	[5-60]
nMN	1.10 \pm 1.38	[0,8]	5.7 \pm 4.5	[0-21]	13.3 \pm 7.9	[1-36]
nPP	0.02 \pm 0.13	[0-1]	0.09 \pm 0.40	[0-4]	2.12 \pm 2.37	[0-16]
nHFE	0.41 \pm 0.77	[0-6]	1.39 \pm 1.44	[0-6]	4.35 \pm 2.69	[0-12]
nPE	0.67 \pm 1.07	[0-7]	2.29 \pm 2.04	[0-10]	5.92 \pm 2.72	[0-13]
GHL/CW [%]	--	-	7.34 \pm 0.79	[4.3-10.3]	8.91 \pm 0.84	[6.6-11.6]

table 2 Nest sample means of numeric characters of workers of *F. cunicularia*, *lusatica* n. sp., and *rufibarbis* given as arithmetic mean, standard deviation and extreme values. Note that the sample size for the data of SCL/CW_{cov}, GHL, GHL/CW_{cov}, D_{LC} and D_{LVR} is only 57 in *cunicularia*, 57 in *lusatica*, and 49 in *rufibarbis*

	<i>Formica cunicularia</i> (n=181)		<i>Formica lusatica</i> (n=74)		<i>Formica rufibarbis</i> (n=135)	
	mean \pm SD	[min-max]	mean \pm SD	[min-max]	mean \pm SD	[min-max]
CW	1312 \pm 111	[997-1590]	1421 \pm 113	[1079-1613]	1329 \pm 117	[1068-1612]
SCL/CW _{cov}	0.990 \pm 0.022	[0.937-1.031]	1.017 \pm 0.025	[0.943-1.066]	0.992 \pm 0.025	[0.944-1.071]
PIGM	62.3 \pm 16.0	[18-93]	9.7 \pm 11.8	[0-58]	23.2 \pm 18.3	[0-80]
PIGM _{cov}	1.683 \pm 0.463	[0.564-3.422]	0.268 \pm 0.281	[0-1.457]	0.551 \pm 0.386	[0-1.573]
nPN	1.47 \pm 1.31	[0-6.6]	10.6 \pm 4.1	[2.6-20.2]	25.7 \pm 6.5	[12.1-46.0]
nPN _{cov}	0.150 \pm 0.122	[0-0.700]	0.989 \pm 0.354	[0.345-1.765]	2.880 \pm 0.461	[1.992-4.291]
GHL/CW _{cov}	--	-	0.897 \pm 0.075	[0.703-1.048]	1.093 \pm 0.085	[0.944-1.071]
D _{LC}	2.877 \pm 1.059	[0.14-5.10]	7.744 \pm 0.985	[5.18-9.67]	--	-
D _{LVR}	--	-	1.755 \pm 0.457	[0.953-2.838]	4.372 \pm 0.618	[3.358-6.110]

3.3. Distribution and ecology of *F. lusatica* n. sp. and chorological arguments against a hybrid identity

The vertical distribution of *Formica lusatica* is restricted to planar and colline regions with a more xerothermous local climate. This proves true for the more northern German state Sachsen, where it does not surpass 250 m, and for the more southern states Rheinland-Pfalz and Baden-Württemberg, where its upper limit is probably at 550 m. This basic pattern is confirmed by the samples taken in the Alps and the Caucasus where it is restricted to xerothermous river valleys below 750 m. In contrast, *Formica cunicularia* and *rufibarbis* have an extended range including the planar, colline, submontane, and even montane altitudinal belts. In the southern slopes of the Alps and of the Caucasus their upper range ends on semidry grasslands at 1800 - 2000 m. The northernmost known site of *Formica lusatica* is at 53°15'N near Gartz in Brandenburg. It seems to be absent in Danmark and S Sweden, where both *cunicularia* and *rufibarbis* occur.

The increased temperature requirements of *lusatica*, which are indicated by the geographic distribution, are confirmed by the local habitat temperatures. Table 3 shows the temperature T, plant density PD, and main soil substrates of 361 nest spots of the 3 species considered. The nest spots of *Formica lusatica* have a 3.8 K higher maximum soil temperature and only half the plant density than the nest spots of *cunicularia* (both differences significant for $p < 0.0001$). Despite almost equal plant densities recorded for the nest spots of *lusatica* and *rufibarbis*, the temperatures of the *lusatica* spots are 1.5 K higher than in *rufibarbis* ($p < 0.01$). The *rufibarbis* nest spots have 2.3 K higher T values and only 60 % of the plant density than the *cunicularia* spots (both differences significant for $p < 0.0001$). These results clearly indicate that *lusatica* and *rufibarbis* prefer a more open vegetation structure than *cunicularia*. Both species further differ from *cunicularia* in being more frequent on well-drained, sandy soils (tab. 3). This tendency is most clearly expressed in *lusatica*, which is, on the other hand, rarely found on soils with more tight substrates.

table 3 Maximum soil temperature T, plant density PD, and soil substrates of the nest spots of *F. cunicularia*, *lusatica* n. sp., and *rufibarbis*. The soil substrates are given as within-species per cent ratio of all nests found.

	<i>Formica cunicularia</i> (n=153)		<i>Formica lusatica</i> (n=66)		<i>Formica rufibarbis</i> (n=114)	
	mean ±SD	[min-max]	mean ±SD	[min-max]	mean ±SD	[min-max]
T [°C]	26.5 ±4.0	[20-37]	30.3 ±3.0	[22-37]	28.8 ±3.5	[21-36]
PD	1161 ±756	[50-3500]	602 ±371	[100-1500]	698 ±521	[100-3000]
Sand	22.6 %		67.6 %		45.9 %	
Loam	22.0 %		7.7 %		14.8 %	
Limestone	19.5 %		20.0 %		21.5 %	
Loess	8.5 %		4.6 %		5.2 %	
Others	27.4 %		0.0 %		12.6 %	

Formica lusatica is notably larger and stronger than *cunicularia* and *rufibarbis*. In particular big nests with large workers represent an important defence force and are very aggressive against competitors. The observations in the sandy heathlands of the Oberlausitz indicate that *lusatica* is obviously more effective in defending its nests against the raids of *Formica sanguinea*. *F. lusatica* has thus far not been confirmed to serve as host for a social parasitic colony foundation by *Formica pratensis* queens which, in contrast, successfully found in *Formica cunicularia*. The larger average body size of *lusatica* implicates a better adaptation for foraging in more open habitats with a less dense field layer. These special defensive and foraging abilities may lead to a clear adaptive advantage over *rufibarbis* and *cunicularia* in open heathland habitats with reduced plant cover if the local climate is sufficiently warm. This is obviously the case in 4 open heathland sites in N Sachsen which are former military training areas. 43 nest samples were collected in these 4 sites which had a comparable habitat structure. 83 % of these nests belonged to *lusatica*, 10 % to *cunicularia*, and only 7 % to *rufibarbis*. Since *rufibarbis* is similar to *lusatica* in its response to certain environmental variables (tab. 3) and since these 4 localities are fully within the geographic range of *rufibarbis*, the most plausible explanation is a displacement of *rufibarbis* by the superior competitor *lusatica*.

In other regions of Sachsen, where the local climate is cooler and more rainy (hill country in SW Sachsen near Zwickau), not a single *lusatica* nest was found and *cunicularia* and *rufibarbis* occurred syntopically in almost equal frequencies with an observed overall ratio of 25 : 22 nests. These findings are a further strong argument against a hybrid identity of *lusatica*. Such a hypothesis would demand *lusatica* to be a fully fertile hybrid with extreme selective advantages over its parent species for the sites in N Sachsen but simultaneously must demand extreme selective disadvantages leading to its immediate eradication for sites in SW Sachsen. This is hardly intelligible and the most reasonable explanation of these chorological findings is a separate species identity of *lusatica*.

3.4. Description of *F. lusatica* n. sp. and discussion of synonymies

Type material:

A type series was fixed in 6 nest samples taken at the same place in a former military training area in NE Sachsen/Germany. It consists of 36 workers and carries the label »Kr. Niesky, Förstgen-1.5 W, 1994.06.19«. The nest sample No. is appended to the date with a hyphen. The holotype and 6 paratypes have the nest sample No. »-88«. The remaining 5 nest samples are designated »-A1«, »12«, »-59«, »-94« and »-127«. The holotype and the paratypes are kept in the collection of the Staatliches Museum für Naturkunde Görlitz.

Description of worker (figs. 2 and 6, tabs. 1 and 2):

Anterior half of frontal furrow often more noticeable than in *cunicularia*, forming a narrow shining stripe of 17-21 µm width. Scape relatively longer and average body size larger than in *cunicularia* and *rufibarbis* (fig. 2, for morphometric data see tabs. 1 and 2). Dorsal surface of head, mesosoma, and gaster matt (the surfaces of *cunicularia* appear, in direct comparison, a little more shining). Pubescence on dorsum of head and gaster rather dense and whitish. Occiput, genae, and underside of head without standing setae. Medium-sized workers with a head width of 1300-1600 µm have 5-17 erect to semierect setae on pronotum and 1-10 short setae on mesonotum. Propodeum normally without setae; occasionally a few short setae may be present. Dorsal margin of petiolar scale with 0-6 short setae. Dorsal plane of gaster with scattered erect setae, the length of the longest setae is 6.5-8.2 % of head width. Anterior and posterior margin of coxae and gaster sternites with much longer, more pointed and more numerous standing setae than on dorsal body

parts. Scape and extensor profile of tibiae and femora without setae. Flexor profile of forefemora with a number of erect setae which are frequently reduced in number or fully absent from the flexor profile of hindfemora. Scape, mandibles, clypeus, frontal triangle, genae, underside of head, pronotum, mesonotum, propodeum, and petiole in medium-sized to large individuals bright yellowish-red. Coxae, femora, and tibiae usually darker. The reddish pigmentation on posterior

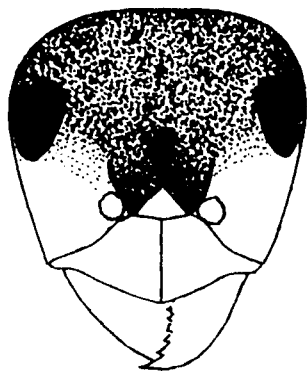


fig. 6 Distribution of blackish pigmentation on the head of a medium-sized *Formica lusatica* worker

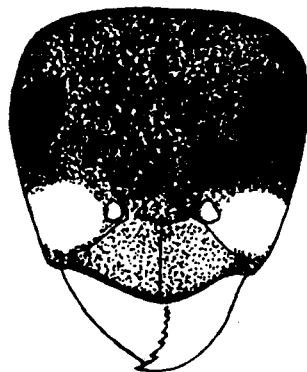


fig. 7 Distribution of blackish pigmentation on the head of a medium-sized *Formica cunicularia* worker

part of genae is not notably darker than on anterior part (fig. 6); if there is a weak darkening trend, the transition is gradual. [In *cunicularia*, the yellowish-red pigmentation on anterior genae forms a rather distinct patch which contrasts to the dark pigmentation of posterior genae (fig. 7).]

There is almost no doubt that *lusatica* represents a species different from *cunicularia* and *rufibarbis*. Among the taxa described from Central Europe, *Formica fusca* var. *rubescens* Forel 1904 had been suspected to represent a synonym of *lusatica*. All specimens in the Forel collection of the Lausanne museum, apparently labelled by Forel himself as cotypes, show the typical pigmentation and setae characters of *cunicularia*. The 4 cotype workers have discriminants D_{LC} of 0.39, 1.46, 2.28, and 2.38, which are completely outside the known variation of *lusatica*.

The species identity of several taxa of the *rufibarbis* group which have been described by Ruzsky and Kuznetsov-Ugamsky remains obscure. This refers to the names *Formica fusca rufibarbis* var. *glauca* Ruzsky 1895, *Formica rufibarbis clara* var. *caucasica* Ruzsky 1905, *Formica rufibarbis volgensis* Ruzsky 1914, *Formica rufibarbis montana* Kuznetsov-Ugamsky 1923, and *Formica rufibarbis montana* var. *minor* Kuznetsov-Ugamsky 1926. According to informations by the keepers of the entomological collections of St. Petersburg (letter of Zinovjev, May 1995), Moscow (letter of Dlussky, May 1996), and Tucuman/Argentina (letter of Willink, February 1992) type material of these taxa is not detectable. Dlussky further stated that he has never seen any type of the questioned taxa. Furthermore all the original descriptions are lacking reliable and concrete statements on morphometrics and seta characters which we urgently need for species identification. As a consequence any suggestion on possible synonymies of these taxa is pure guesswork. To demarkate the range of possible speculations, *F. glauca* could either be conspecific with *cunicularia* or *lusatica*, or even be an own Siberian species. *F. caucasica* could be a synonym of *cunicularia*, *clara* Forel 1886, *glauca*, or *lusatica*. The two workers of *volgensis* taken by Ruzsky could either represent a

large *rufibarbis* or could be *glauca* or *lusatica*. Possible interpretations of the taxa of Kuznetsov-Ugamsky are as ambiguous. It is on the verge of scientific irresponsibility how one could write long synonymic lists on the basis of almost no informations.

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