

Rank elevation in two European ant species: *Myrmica lobulicornis* NYLANDER, 1857, stat.n. and *Myrmica spinosior* SANTSCHI, 1931, stat.n. (Hymenoptera: Formicidae)

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Abstract

Elevation to species level is performed for *Myrmica lobulicornis* var. *lobulicornis* NYLANDER, 1857 and *Myrmica sabuleti* var. *spinosior* SANTSCHI, 1931. *Myrmica lobulicornis* is established as senior synonym of *M. arduennae* var. *pyrenaea* BONDROIT, 1918, *M. lobicornis* ssp. *alpina* STÄRCKE, 1927, and *M. lobicornis* ssp. *apennina* STÄRCKE, 1927; and *M. lobicornis* NYLANDER, 1846, as senior synonym of *M. lobicornis* ssp. *arduennae* BONDROIT, 1911, *M. lobicornis lobicornis* var. *lissahorensis* STÄRCKE, 1927, *M. lobicornis* ssp. *angustifrons* STÄRCKE, 1927, and *M. lobicornis* st. *foreli* SANTSCHI, 1931. The use of standardized morphometrics and discriminant functions enabled a safe allocation of any nest sample including the type samples to *M. lobulicornis*, *M. lobicornis* and *M. wesmaeli* BONDROIT, 1918 with an error probability of $p < 0.0007$. The discrimination between *M. sabuleti* and *M. spinosior* was possible in 99 % of 133 nest samples with $p < 0.007$. The type sample of *M. spinosior* was allocated with an error probability of $p = 0.006$. Comparative morphometric and zoogeographical data of the six European species of the *M. lobicornis* and *M. sabuleti* complex are given.

Key words: *Myrmica lobicornis* complex, *Myrmica sabuleti* complex, lectotype fixation, discriminant analysis

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Introduction

Myrmica lobicornis var. *lobulicornis* NYLANDER, 1857 was described from Mont-Dore in the Massif Central, France, and has been considered conspecific with *M. lobicornis* NYLANDER, 1846 by all contemporary and past authors except BONDROIT (1920). This paper presents evidence for a surprisingly distinct external morphology and a characteristic geographic distribution of *M. lobulicornis*, providing a sound basis for considering it a valid species. *Myrmica lobulicornis* can be termed a montane to subalpine sibling species of *M. lobicornis*, distributed in the Pyrenees, the Massif Central, the Alps, and the high northern Apennine. Together with *M. wesmaeli* BONDROIT, 1918, there are three species of the *M. lobicornis* complex in Europe. The taxonomic structure of the *M. lobicornis* complex from Asia Minor across the Caucasus, the Central Asian Mountains to W Siberia is more complicated than in Europe (RADCHENKO 1994, ELMES & al. 2002) and needs an extended investigation with an objective numeric character evaluation and assistance by genetic methods. The purpose of this paper is to clear up, in a first step, the situation in Europe.

Myrmica sabuleti var. *spinosior* SANTSCHI, 1931, described from the French part of the northwestern Pyrenees, has never been considered a valid species by any author. SEIFERT (1988), however, presented a table with significant morphological differences between *M. sabuleti* and an entity called "W Mediterranean population of *M. sabuleti*" but he did not risk giving the latter a valid taxonomic status. A recent reinvestigation of this issue, showing morphological differences stronger than between well-established species and detecting *M. spinosior* as the valid name for this sister species, is presented here.

Material and Methods

Measurements were made on mounted and dried specimens using a goniometer-type pin-holding device, permitting endless rotations around X, Y, and Z axes. A Zeiss Jena Technival 2 stereomicroscope (numeric aperture < 0.12) was used until the year 1992 and a Wild M10 stereomicroscope (numeric aperture 0.25) after 1992 – both systems mainly at magnifications of 100 - 225 x. The improvement of microscopic equipment and better knowledge of measuring errors after 1992 reduced measuring error from 3 μm to 1 μm for smaller structures such as FR and from 5 μm to 3 μm for larger structures such as cephalic length. The lower quality data taken before 1993 (termed here "old data") were not always replaced by reinvestigation with the new system (termed here "new data"). To avoid rounding errors, all measurements were recorded in μm even for characters for which a precision of $\pm 1 \mu\text{m}$ is impossible.

Nineteen standard morphometric characters were investigated:

- CL maximum cephalic length in median line; the head must be carefully tilted to the position with the true maximum. Excavations of occiput and/or clypeus reduce CL. Longitudinal carinae or rugae on anterior clypeus are included in the measurement – if exactly median, in their full height and, if of doubtful position, in their half height.
- CS cephalic size; the arithmetic mean of CL and CW, used as a less variable indicator of body size.
- CW maximum cephalic width; this is in *Myrmica* always across the protruding compound eyes.

EYE eye-size index: the arithmetic mean of the large (EL) and small diameter (EW) of the elliptic compound eye is divided by CS, i.e. $EYE = (EL + EW) / (CL + CW)$.

FL maximum anterior divergence of frontal carinae (= maximum distance of frontal lobes; Fig. 5).

FR minimum distance between frontal carinae (Fig. 5).

MetL height of metapleuron including the propodeal lobe measured in lateral view perpendicular to the straight section of metapleuro-coxal border (heavy dashed line in Fig. 1). The lower endpoint of measuring line is the metapleuro-coxal border and the upper one the upper margin of propodeal lobe. The level of the measuring line is positioned in the middle between the anteriormost point of subspinal excavation and the posteriormost point of propodeal lobe (fine dashed lines in Fig. 1).

MetSp height of subspinal excavation from upper margin of propodeal lobe to lower spine margin measured along the dorsal continuation of the measuring line for MetL (Fig. 1).

PEA angle formed by the anterior half of the dorsal petiolar surface and the dorsal third of petiolar face. If the dorsal profile of petiolar dome is convex, the cord from the centre of petiolar dome to the corner between dome and anterior profile is taken as reference.

PEH maximum petiole height measured perpendicular to a reference line defined as follows: the frontal endpoint of the reference line is marked by the centre of the petiole-propodeal junction and the caudal endpoint by the centre of petiole-postpetiolar junction (dark spots in Fig. 2).

PEL maximum measurable diagonal petiole length from the tip of subpetiolar process to the posterodorsal corner of the posterior peduncle (Fig. 2).

PEW maximum width of petiole.

PoOc postocular distance. Use a cross-scaled ocular micrometer and adjust the head to the measuring position of CL. Caudal measuring point: median occipital margin; frontal measuring point: median head at the level of the posterior eye margin. Note that many heads are asymmetric and average the left and right measurement (Fig. 3).

PPHL length of longest hair on dorsal postpetiole.

PPW maximum width of postpetiole.

ScLH scape lobe height measured perpendicular to a reference line at SVPS *f* or *c*. Maximum height at which cuticular projections such as lobes or carinae protrude above the upper profile of scape base. The reference line is the cord of the curved dorsal scape profile stretching from midpoint of scape length to the point just before the projections at scape bend begin to rise.

SL maximum straight line scape length excluding the articular condyle and lobes at the scape bent. Preferred measuring position: SVPS *df*.

SP maximum length of propodeal spines. Arithmetic mean of both spines measured in anterodorsal view from spine tip to the bottom of the meniscus formed between the spines. This mode of measuring is less ambiguous than other methods but results in some spine length in species with reduced spines (Fig. 4).

SVPS standard viewing positions of scape defined by their position relative to the moving plane of the hinge joint between scape and first funiculus segment (Fig. 6). Dorsal view *d* is directed perpendicular to this moving plane (in this position the anterior margins of upper and lower lobe of the distal scape end are congruent and the basal curvature of scape is not or only weakly visible). Frontal view *f* and caudal view *c* are within the moving plane and perpendicular to the longitudinal scape axis – i.e. when the scape is imagined to be directed strictly laterad from head, viewing position *f* is the frontal and viewing position *c* the caudal aspect of scape. SVPS's such as *cd* and *df* describe intermediate viewing positions.

The process of discriminating sister species included the removal of allometric variance by species-specific functions valid for species pairs (SEIFERT 2002) and a canonical discriminant analysis with a SPSS 10.0 program. Extended tests have shown that allometric corrections improve discriminative power when single or very few characters are considered. However, when more characters are computed in discriminant functions calculating a covariance matrix and when allometries are moderate such as in *Myrmica*, allometries will no longer affect discriminative power. Apparently the covariance calculations compensate for allometric variance. As a consequence, allometric corrections are only recommended for genera with extreme allometries such as *Messor* or *Camponotus* or when single or few characters are considered. Here, I continue to use allometric corrections because the calculation system is already established and because the Eigen values are slightly improved.

Size-dependent variance of body ratios (= allometry) was removed by correction functions describing the average situation in 28 West Palaearctic species of *Myrmica*. The size-corrected characters $CL / CW_{1.15}$ to $SP / CS_{1.15}$ describe ratios for the assumption of each specimen having the same size (CS = 1.15 mm). Factors with negative / positive signs refer to negative / positive allometries.

$$CL / CW_{1.15} = 1.0339 * CL / CW / (-0.0592 * CS + 1.1020)$$

$$SL / CS_{1.15} = 0.8074 * SL / CS / (-0.0814 * CS + 0.9010)$$

$$ScLH / CS_{1.15} = 0.0275 * ScLH / CS / (-0.0166 * CS + 0.0466)$$

$$FL / CS_{1.15} = 0.4290 * FL / CS / (0.0200 * CS + 0.4060)$$

$$FR / CS_{1.15} = 0.3278 * FR / CS / (0.0080 * CS + 0.3186)$$

$$MetL / CS_{1.15} = 0.2018 * MetL / CS / (0.0028 * CS + 0.1986)$$

$$MetSp / CS_{1.15} = 0.1825 * MetSp / CS / (0.0082 * CS + 0.1731)$$

$$SP / CS_{1.15} = 0.3323 * SP / CS / (0.1038 * CS + 0.2129)$$

$$PEH / CS_{1.15} = 0.3280 * PEH / CS / (-0.0149 * CS + 0.3451)$$

$$PEL / CS_{1.15} = 0.4650 * PEL / CS / (-0.0291 * CS + 0.4985)$$

$$PEW / CS_{1.15} = 0.2572 * PEW / CS / (-0.0229 * CS + 0.2835)$$

$$PPW / CS_{1.15} = 0.3991 * PPW / CS / (0.0596 * CS + 0.3306)$$

$$PPHL / CS_{1.15} = 0.1737 * PPHL / CS / (-0.0596 * CS + 0.2422)$$

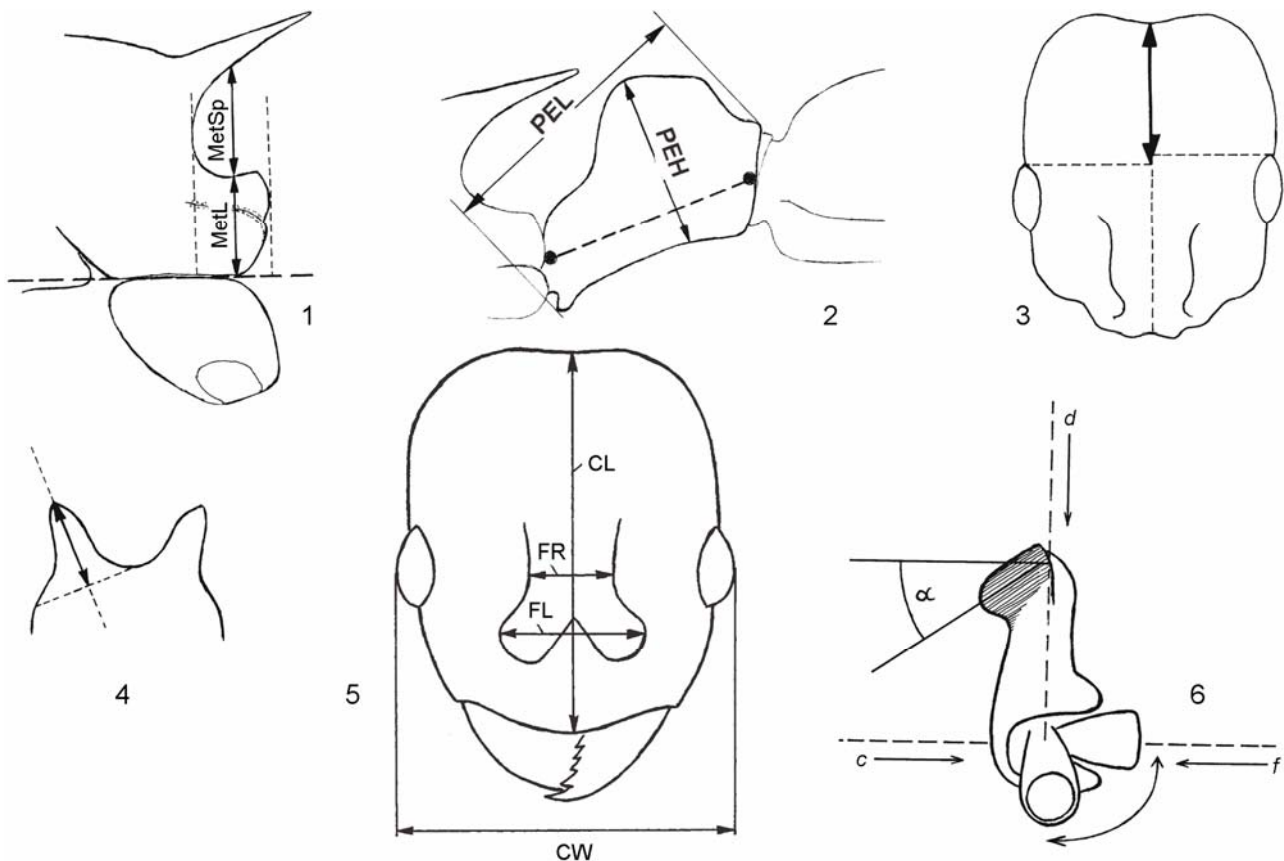
$$EYE / CS_{1.15} = 0.1969 * EYE / CS / (0.0166 * CS + 0.1778)$$

$$PoOc / CS_{1.15} = 0.4248 * PoOc / CS / (0.0107 * CS + 0.4125)$$

$$SW / SL_{1.15} = 0.2010 * SW / SL / (0.0134 * CS + 0.1856)$$

Source collections of the investigated material have the following acronyms:

FMNH Helsinki – Finnish Museum of Natural History, University of Helsinki, Finland



Figs. 1 - 6: (1) Mode of measuring MetSp and MetL. (2) Mode of measuring petiolar height and length. (3) Mode of measuring the postocular distance PoOc. (4) Mode of measuring spine length in anterodorsal view. (5) Mode of measuring cephalic length, cephalic width, minimum frons width, and maximum frontal lobe width. (6) Standard viewing positions *c*, *d*, and *f* of scape relative to the plane of movement of the hinge joint formed by distal scape and pedicellus. The angle α describes the caudal slope of scape lobe.

IRSN Bruxelles – Institut Royal des Sciences Naturelles de Belgique, Bruxelles

MCZ Cambridge – Museum of Comparative Zoology of the Harvard University, Cambridge, Massachusetts, USA

MZ Lausanne – Musée de Zoologie Lausanne, Switzerland

NHM Basel – Naturhistorisches Museum Basel, Switzerland

SMN Görlitz – Staatliches Museum für Naturkunde Görlitz, Germany

Type material investigated

Note: According to an agreement with A. Radchenko (January 2005), his lectotype / paralectotype labels were not removed and are published here for the first time.

***Myrmica arduennae* var. *pyrenaea* BONDROIT, 1918:** lectotype worker labelled "Canigou 10-1917", "Myrmica pyrenaea type! Bondr.", "LECTOTYPE (upper specimen) desig. Radchenko & Elmes 2000", CS 1.1080 mm, FL 0.394, FR 0.297; 3 paralectotype workers from the same pin, IRSNB Bruxelles.

***Myrmica lobicornis* NYLANDER, 1846:** lectotype worker and 1 paralectotype male on the same pin labelled "Uleaborg \ W.Nyland. \ Mus. Zool. H:fors Spec.typ. No 5053 Myrmica lobicornis Nyl \ LECTOTYPE Myrmica Σ lobicornis Nyl. des. Radchenko", FMNH Helsinki; 1 paralectotype worker and 1 paralectotype male on the same pin labelled "Uleaborg \ W.Nyland. \ Mus.fenn. \

Mus. Zool. H:fors Spec.typ. No 5050 Myrmica lobicornis Nyl \ PARALECTOTYPE desig. Radchenko & Elmes 2002 Σ \ LECTOTYPE desig. Radchenko & Elmes 2002 Σ ", FMNH Helsinki; 1 paralectotype worker and 1 paralectotype male together on another pin labelled "Uleaborg \ W.Nyland. \ Coll.Nyland. \ Mus. Zool. H:fors Spec.typ. No 5051 Myrmica lobicornis Nyl \ PARALECTOTYPE desig. Radchenko 2002", FMNH Helsinki. Note: the lectotype fixation in the specimen with CS = 1122 μ m and labelled "... Spec.typ. No 5053..." is published herewith, while the erroneous lectotype labelling of the worker with CS = 1051 μ m labelled "...Spec.typ. No 5050..." is declared herewith as lapsus calami and transformed into a paralectotype status.

***Myrmica lobicornis alpina* STÄRCKE, 1927:** 1 syn-type worker labelled "Val Aosta 1915 La Thuile", "Myrm. lobicornis alpina STÄRCKE paratype", MZ Lausanne.

***Myrmica lobicornis arduennae* BONDROIT, 1911:** lectotype worker labelled "Hockay Locaille", "Type", "LECTOTYPE desig. Radchenko & Elmes 2000", IRSNB Bruxelles. CS 1.008 mm, FL 0.357, FR 0.241. 3 paralectotype workers on two pins "Hockay Locaille", "PARALECTOTYPE desig. Radchenko & Elmes 2000", IRSNB Bruxelles.

***Myrmica lobicornis* st. *foreli* SANTSCHI, 1931:** lectotype worker (des. Radchenko & Elmes) labelled "Type

\ *Myrmica foreli* Sant \ Schluderbach - Forel \ *lobicornis* var. *foreli* Finzi \ LECTOTYPE desig. Radchenko & Elmes 2000", NHM Basel. The specimen has CS 1.043 mm, the right spine broken at half length and the left spine without the tip. 2 paralectotype workers (des. Radchenko & Elmes) labelled "Type", "*Myrmica foreli* Sant type", "Suisse Schluderbach Forel", "*M. lobicornis* Nyl. Σ Schluderbach" (handwritten by Forel), "PARALECTOTYPE desig. Radchenko & Elmes 2000", NHM Basel.

***Myrmica lobicornis lobulicornis* NYLANDER, 1857:** lectotype worker (des. Radchenko & Elmes 2002) "M.Dore \ W.Nyland. \ *F. lobicornis* var. *lobulicornis* Nyl. \ Mus. Zool. H:fors Spec.typ. No 5118 *Myrmica lobulicornis* Nyl. \ LECTOTYPE desig. Radchenko & Elmes 2002", FMNH Helsinki. 1 paralectotype worker labelled "M.Dore \ W. Nyland. \ Mus. Zool. H:fors Spec.typ. No 5119 *Myrmica lobulicornis* Nyl. \ Paralectotype *Myrmica lobulicornis* Nyl. des. Radchenko", FMNH Helsinki. Lectotype with CS = 1056.0 μ m.

***Myrmica sabuleti* ssp. *lonae* FINZI, 1926:** Lectotype worker (published in SEIFERT 2000) from Karislojo (Finland), leg. Forsius; 3 worker paratypes from Monte Baldo (Trentino/ Italy), 1923.07; 3 worker paratypes from Monte Manos (NE of Trieste, now in Slovenia), leg. Finzi May 1923; 1 worker and 1 gyne paratype from Razes/Tirol [= Razes / Trentino]. All material stored in MCZ Cambridge.

***Myrmica sabuleti* var. *spinosior* SANTSCHI, 1931:** Lectotype worker labelled "Typus", "*M. sabuleti* v. *spinosior* Sant", "Pyren. occ. Irun 25-26 3. 1926 Lindberg", "LECTOTYPE desig. Radchenko & Elmes 2002", NHM Basel. CS 1198 μ m. 2 paralectotype workers on one pin, labelled "Pyren. occ. Irun 25-26 3. 1926 Lindberg", "*M. sabuleti* v. *spinosior* Sant", "Paralectotype *M. spinosior* Santschi det. Seifert 2004", NHM Basel.

***Myrmica wesmaeli* BONDROIT, 1918:** lectotype worker labelled "Canigou", "*Myrmica wesmaeli* Type Bondr.", "Lectotype det. Seifert 1987", CS = 1.157 mm, FL 0.399, FR 0.330; 6 paralectotype workers labelled "Canigou", "*Myrmica wesmaeli* Type Bondr.", "PARALECTOTYPE desig. Radchenko & Elmes 2002", IRSNB Bruxelles.

Geographic origin of investigated material

Detailed collecting data of the 345 investigated samples are not given here but are available on request from the author. Here is only given a summary account.

Myrmica lobicornis and synonymized taxa: 63 nest samples with 130 individuals from England (4 nests), Sweden (5), Finland (3), Belgium (1), Germany (35), Switzerland (10), Slovakia (1), Italy (1), Russia (2), and Czech Republic (1).

Myrmica lobulicornis and synonymized taxa: 41 nest samples with 65 individuals from France (2 nests), Switzerland (23), Austria (1), Spain (7), and Italy (8).

Myrmica lonae: 94 nest samples with 315 individuals from Scotland (1 nest), Norway (1), Sweden (11), Finland (9), Netherlands (1), Germany (37), Switzerland (5), Austria (18), Italy (4), Bulgaria (2), and Turkey (5).

Myrmica sabuleti: 105 nest samples with 309 individuals from England (6 nests), Sweden (3), Germany (71), Czech Republic (5), Slovakia (1), France (1), Switzerland (1), Hungary (1), Spain (1), Italy (1), Serbia and Montenegro (2), Bulgaria (5), Greece (5), and Turkey (2).

Myrmica spinosior: 29 nest samples with 113 individuals from Spain (20 nests), S France (5), Italy (2), and

Turkey (2).

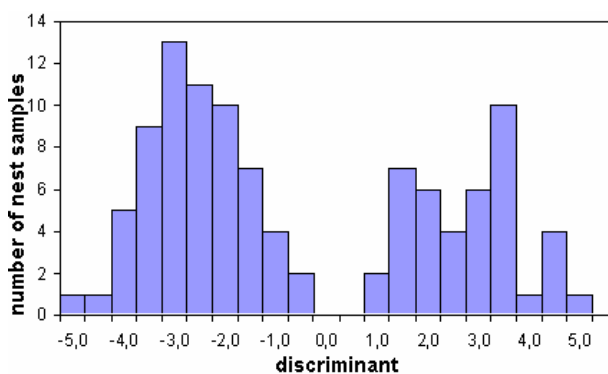


Fig. 7: Canonical discriminant values of 63 and 41 worker nest samples of *Myrmica lobicornis* and *M. lobulicornis* based upon 6 morphometric characters. Old and new investigations with differing accuracy are given into the data pool.

Myrmica wesmaeli: 13 nest samples with 35 individuals from France (1 nest) and Spain (12).

Results

1. The separation of *M. lobulicornis*, *M. lobicornis*, and *M. wesmaeli*

The first European species for which a separate species identity has to be demonstrated is *M. wesmaeli*. Concluded from morphology, *M. lobulicornis* appears less closely related to *M. wesmaeli* than it is to *M. lobicornis*. *Myrmica lobulicornis* differs from *M. wesmaeli* by shorter spines, longer postpetiolar setae, the relatively higher petiole with its frontal and dorsal profile meeting in a distinct angle of $\pm 90^\circ$, by the petiole appearing in dorsal view not clearly longer than wide, by the less approached spine base and by the usually coarser sculpture on petiole and postpetiole (Tab. 1). A discriminant $46.439 * FL / CS_{1.15} + 8.534 * FR / CS_{1.15} - 2.885 * CS + 31.239 * CL / CW_{1.15} - 7.734 * SL / CS_{1.15} - 45.755 * SP / CS_{1.15} + 91.655 * PPHL / CS_{1.15} - 67.820 * PEW / CS_{1.15} + 48.129 * PPW / CS_{1.15} - 0.466 * PEA - 4.008$ allocated any of the 54 nest samples to either cluster with $p < 0.00008$:

M. wesmaeli -3.369 ± 1.040 [-4.90, -1.73], n = 13,

M. lobulicornis 4.389 ± 0.988 [1.73, 6.72], n = 41.

This discriminant was minus 4.90 in the type series of *M. wesmaeli*, 3.37 in the syntype of *M. alpina*, 3.53 in the type series of *M. pyrenaica* and 4.71 in the type series of *M. lobulicornis*. 100 % of correct identifications are also possible on the individual level, with 99 % of specimens with $p < 0.05$ (data not given here).

Though characters such as shape and measurements of petiole, sculpture characters or height of propodeal lobe and subspinal excavation do not differ, the discrimination of *M. lobulicornis* from *M. lobicornis* is also very obvious (Tab. 1). Already under use of a reduced character set and including old investigations with lower data quality, the separation of *M. lobicornis* and *M. lobulicornis* is sufficiently clear (Fig. 7). A discriminant $43.308 * FL / CS_{1.15} + 45.367 * FR / CS_{1.15} - 3.133 * CS + 20.741 * CL / CW_{1.15} - 19.680 * SL / CS_{1.15} - 28.115 * SP / CS_{1.15} - 23.368$

Tab. 1: Worker nest sample means of morphometric data of the European sister species of *M. lobicornis* and *M. sabuleti*. Arrangement of data: arithmetic mean \pm standard deviation [minimum, maximum], n = number of nest sample means, i = total of individuals to calculate nest sample means. Old and new investigations with differing accuracy are given into the data pool.

	<i>lobicornis</i> (n = 63; i = 139)	<i>lobulicornis</i> (n = 41; i = 79)	<i>wesmaeli</i> (n = 13; i = 37)	<i>spinosior</i> (n = 29; i = 106)	<i>sabuleti</i> (n = 105; i = 340)	<i>lonae</i> (n = 94; i = 304)
CS [μ m]	1065 \pm 56 [960, 1192]	1073 \pm 60 [918, 1174]	1122 \pm 45 [1065, 1202]	1201 \pm 63 [1096, 1333]	1162 \pm 52 [1028, 1290]	1189 \pm 51 [1065, 1332]
CL / CW	1.009 \pm 0.017 [0.973, 1.054]	1.022 \pm 0.019 [0.980, 1.059]	1.016 \pm 0.016 [0.998, 1.052]	1.030 \pm 0.017 [0.994, 1.070]	1.030 \pm 0.011 [1.010, 1.055]	1.021 \pm 0.013 [0.987, 1.054]
SL / CS	0.796 \pm 0.016 [0.754, 0.830]	0.779 \pm 0.019 [0.735, 0.806]	0.779 \pm 0.024 [0.754, 0.827]	0.826 \pm 0.019 [0.796, 0.865]	0.801 \pm 0.015 [0.767, 0.837]	0.805 \pm 0.014 [0.769, 0.844]
PoOc / CL	0.437 \pm 0.006 [0.424, 0.448]	0.439 \pm 0.011 [0.418, 0.463]	0.443 \pm 0.012 [0.416, 0.460]	0.434 \pm 0.008 [0.419, 0.448]	0.432 \pm 0.008 [0.416, 0.450]	0.431 \pm 0.007 [0.417, 0.447]
EYE / CS	0.194 \pm 0.005 [0.184, 0.205]	0.192 \pm 0.006 [0.178, 0.205]	0.195 \pm 0.004 [0.189, 0.203]	0.193 \pm 0.006 [0.186, 0.208]	0.196 \pm 0.005 [0.185, 0.212]	0.195 \pm 0.004 [0.185, 0.210]
FL / CS	0.388 \pm 0.009 [0.366, 0.417]	0.414 \pm 0.012 [0.386, 0.442]	0.390 \pm 0.010 [0.368, 0.404]	0.438 \pm 0.012 [0.413, 0.460]	0.458 \pm 0.010 [0.434, 0.487]	0.486 \pm 0.013 [0.458, 0.515]
FR / CS	0.257 \pm 0.011 [0.224, 0.278]	0.312 \pm 0.020 [0.275, 0.355]	0.314 \pm 0.016 [0.281, 0.334]	0.329 \pm 0.013 [0.308, 0.354]	0.299 \pm 0.012 [0.268, 0.329]	0.294 \pm 0.012 [0.264, 0.330]
PEW / CS	0.274 \pm 0.013 [0.247, 0.305]	0.268 \pm 0.011 [0.246, 0.294]	0.260 \pm 0.010 [0.248, 0.282]	0.275 \pm 0.012 [0.249, 0.312]	0.281 \pm 0.010 [0.259, 0.307]	0.279 \pm 0.011 [0.248, 0.309]
PPW / CS	0.417 \pm 0.012 [0.392, 0.450]	0.415 \pm 0.016 [0.394, 0.461]	0.410 \pm 0.009 [0.396, 0.429]	0.396 \pm 0.011 [0.370, 0.416]	0.400 \pm 0.013 [0.374, 0.430]	0.400 \pm 0.013 [0.369, 0.436]
PEH / CS	0.354 \pm 0.009 [0.330, 0.380]	0.345 \pm 0.009 [0.326, 0.370]	0.327 \pm 0.007 [0.317, 0.340]	0.327 \pm 0.009 [0.314, 0.345]	0.336 \pm 0.010 [0.318, 0.368]	0.336 \pm 0.009 [0.315, 0.361]
PEL / CS	0.462 \pm 0.009 [0.443, 0.481]	0.459 \pm 0.015 [0.426, 0.486]	0.465 \pm 0.013 [0.449, 0.490]	0.487 \pm 0.013 [0.451, 0.522]	0.479 \pm 0.011 [0.451, 0.508]	0.479 \pm 0.011 [0.445, 0.505]
PPHL / CS	0.173 \pm 0.012 [0.153, 0.200]	0.182 \pm 0.008 [0.161, 0.200]	0.165 \pm 0.010 [0.154, 0.181]	0.169 \pm 0.012 [0.154, 0.194]	0.179 \pm 0.010 [0.160, 0.198]	no data
SP / CS	0.322 \pm 0.022 [0.223, 0.358]	0.280 \pm 0.023 [0.229, 0.330]	0.324 \pm 0.015 [0.299, 0.343]	0.379 \pm 0.023 [0.327, 0.433]	0.399 \pm 0.019 [0.349, 0.451]	0.396 \pm 0.016 [0.358, 0.455]
MetL / CS	0.248 \pm 0.012 [0.226, 0.281]	0.244 \pm 0.009 [0.227, 0.261]	0.229 \pm 0.012 [0.210, 0.246]	no data	no data	no data
MetSp / CS	0.157 \pm 0.012 [0.135, 0.190]	0.172 \pm 0.016 [0.151, 0.222]	0.171 \pm 0.011 [0.150, 0.188]	no data	no data	no data
PEA [$^{\circ}$]	89.4 \pm 3.7 [82.0, 96.5]	89.7 \pm 1.8 [84.3, 92.0]	96.2 \pm 1.6 [93.0, 99.0]	no data	no data	no data
ScLH / CS	0.061 \pm 0.016 [0.018, 0.095]	0.023 \pm 0.011 [0.007, 0.050]	0.011 \pm 0.005 [0.003, 0.018]	no data	no data	no data
SW / SL	no data	no data	no data	0.153 \pm 0.010 [0.137, 0.172]	0.199 \pm 0.014 [0.167, 0.231]	0.265 \pm 0.021 [0.227, 0.316]

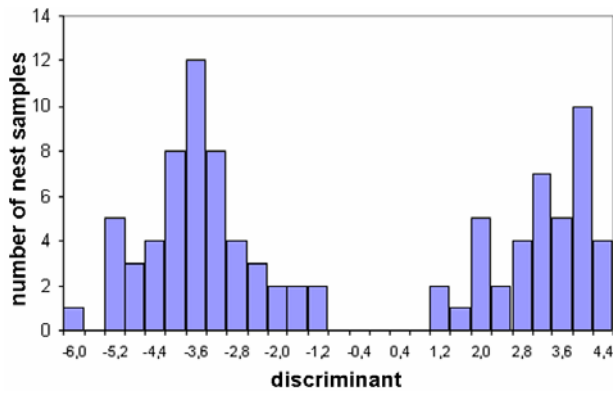


Fig. 8: Canonical discriminant values of 54 and 41 worker nest samples of *Myrmica lobicornis* and *M. lobulicornis* based upon 13 morphometric characters. Only new investigations with higher accuracy are given into the data pool.

allocated any of the 104 investigated nest samples to either cluster with $p < 0.042$. The values were

M. lobicornis -2.600 ± 0.981 [-5.25, -0.46], $n = 63$,
M. lobulicornis 2.823 ± 1.030 [0.85, 4.90], $n = 41$.

The allocation of any type series to either cluster was highly significant – in the worst case, in the single syntype worker of *M. alpina*, error probability was $p = 0.002$. The discriminants were minus 3.50 for the type series of *M. foreli*, minus 3.39 for the type series of *M. arduennae*, minus 1.72 for the type series of *M. lobicornis*, 1.26 for the type of *M. alpina*, 1.69 for the type series of *M. pyrenaea* and 2.26 for the type series of *M. lobulicornis*. Excluding all samples with old data a discriminant

$-1.460 \text{ CS} + 24.937 * \text{CL} / \text{CW}_{1.15} - 12.327 * \text{SL} / \text{CS}_{1.15} - 29.872 * \text{SeLH} / \text{CS}_{1.15} + 43.626 * \text{FL} / \text{CS}_{1.15} + 35.252 * \text{FR} / \text{CS}_{1.15} - 11.042 * \text{PEW} / \text{CS}_{1.15} + 22.752 * \text{PPW} / \text{CS}_{1.15} + 9.462 * \text{MetL} / \text{CS}_{1.15} + 19.869 * \text{MetSp} / \text{CS}_{1.15} - 30.857 * \text{SP} / \text{CS}_{1.15} - 39.998 * \text{PEH} / \text{CS}_{1.15} - 15.377 * \text{PEL} / \text{CS}_{1.15} - 21.622$

separates any of the remaining 95 samples with $p < 0.0007$ (Fig. 8):

M. lobicornis -3.599 ± 1.054 [-6.13, -1.20], $n = 54$,
M. lobulicornis 3.223 ± 0.923 [1.20, 4.76], $n = 41$.

FR / CS is the most powerful discriminator with only minimal overlap of nest sample means: it ranged 0.224 - 0.278 in *M. lobicornis* and 0.275 - 0.355 in *M. lobulicornis* (Tab. 1). The morphometric data given in the original descriptions of STÄRCKE (1927) allow a reasonable allocation of his taxa to either the *M. lobicornis* or *M. lobulicornis* cluster: FR / CS was 0.293 for 7 worker syntypes of *M. alpina* from Val Aosta, 0.331 for 5 worker syntypes of *M. apennina* from Monte Cimone, 0.247 for 6 worker syntypes of *M. lissahorensis* from Lissa Hora / Beskid Mountains, 0.237 for 6 worker syntypes of *M. angustifrons* from Weybridge / Surrey. Furthermore the drawings of Stärcke show that these taxa do not belong to a member of the *M. schencki* group or to *M. wesmaeli*.

As a consequence from all the data presented here, the following synonymies are well supported:

***Myrmica lobulicornis* NYLANDER, 1857, stat.n.**

Myrmica lobicornis lobulicornis NYLANDER, 1857 [type investigated]

Myrmica arduennae var. *pyrenaea* BONDROIT, 1918 [type investigated]

Myrmica lobicornis ssp. *alpina* STÄRCKE, 1927 [type investigated]

Myrmica lobicornis ssp. *apennina* STÄRCKE, 1927 [description]

***Myrmica lobicornis* NYLANDER, 1846**

Myrmica lobicornis NYLANDER, 1846 [types investigated]

Myrmica lobicornis ssp. *arduennae* BONDROIT, 1911 [types investigated]

Myrmica lobicornis lobicornis var. *lissahorensis* STÄRCKE, 1927 [description]

Myrmica lobicornis ssp. *angustifrons* STÄRCKE, 1927 [description]

Myrmica lobicornis st. *foreli* SANTSCHI, 1931 [type investigated]

2. The distribution of *M. lobulicornis*, *M. lobicornis*, and *M. wesmaeli*

The recent distribution suggests that the *M. lobulicornis* populations had their glacial refuges in colline or planar zones of southwestern France, northern Spain and Italy from which they moved up into the montane and subalpine zones of the Pyrenees, the Massif Central, the Alpes, and the northern Apennine by the end of the pleistocene. From Italy *M. lobulicornis* is only reported for the northern Apennine (Lombardia, Emilia) – further south no members of the whole *M. lobicornis* complex are known (BARONI URBANI 1971). *M. lobulicornis* is a typical species of open montane to subalpine grassland or light forest in the Pyrenees, the Massif Central, the Alpes and the high northern Apennine. It is sympatric with *M. lobicornis* at least all over the Alpes but vertical distribution differs. In Switzerland, where its distribution is best studied, it occurs between 1000 and 2700 m, while sympatric *M. lobicornis* is known from the lowland up to 1900 m.

In Iberia, *M. wesmaeli* seems to occupy more or less the altitudinal position of *M. lobicornis* that is apparently absent from Spain. *Myrmica wesmaeli* is distributed over the mountain ranges of North and Central Spain and is sympatric with *M. lobulicornis* in the Pyrenees where the former occurs between 1200 and 1900 m and the latter between 1500 and 2600 m. Syntopic occurrence of both taxa is so far not reported (ESPADALER 1981, SEIFERT 1988).

Myrmica lobicornis has the widest distribution among the three European members of the *M. lobicornis* complex. It is found from France to the Urals, on the British Isles and extends north to 71° N in Fennoscandia. The southern limit of distribution is not clearly known – in Russia and the Ukraine it is apparently formed by the southern border of the nemoral woodland zone. The type locality of *M. l. foreli*, Schluderbach (= Carbonin, situated at 1437 m and 12 km S of Toblach in S Tyrol), indicates a distribution of *M. lobicornis* also in the southern part of the Alpes. In the Balkans, where *M. lobulicornis* seems to be absent, *M. lobicornis* is found at least in high mountain ranges (Pirin, Rhodopes, Mt. Olympus). Morphometric data of this southern Balkan population are not given here. It clearly clusters with *M. lobicornis* but shows already some morphological deviations indicating relations to the Asian populations.

3. The separation of *M. sabuleti* and *M. spinosior*

Myrmica spinosior differs from *M. sabuleti* in particular by narrower scape lobe, narrower frons, more approached frontal lobes and longer scape (Tab.1). A discriminant $-39.8 \text{ FL} / \text{CS}_{1.15} + 49.452 \text{ FR} / \text{CS}_{1.15} + 11.722 \text{ CS} + 20.397 \text{ CL} / \text{CW}_{1.15} + 25.861 \text{ SL} / \text{CS}_{1.15} - 1.95 \text{ SP} / \text{CS}_{1.15} - 0.541 \text{ PEW} / \text{CS}_{1.15} - 23.323 \text{ PPW} / \text{CS}_{1.15} - 40.356 \text{ SW} / \text{SL}_{1.15} - 22.292 \text{ PoOc} / \text{CS} - 5.609 \text{ EYE} / \text{CS} - 15.586 \text{ PEH} / \text{CS} + 32.491 \text{ PEL} / \text{CS} - 35.832$ allocated 99.2 % of the 133 investigated nest samples with $p < 0.007$ (Fig. 9). The values were

M. sabuleti $-2.604 \pm 0.853 [-4.57, -0.69]$, $n = 105$,
M. spinosior $3.161 \pm 1.414 [0.59, 5.88]$, $n = 29$.

Only one *M. spinosior* sample from Briançon / Haute Alpes showed a doubtful value of 0.59 ($p = 0.132$) while the type series of *M. spinosior* was clearly allocated (1.17, $p = 0.006$). As a consequence, the morphological separation between *M. sabuleti* and *M. spinosior* is sufficient to consider them as different species. This morphological indication is also supported by a finding in mitochondrial DNA: Schlick-Steiner and Steiner (pers. comm.) found 1.85 % difference in a 840 bp fragment of cytochrome oxidase subunit I between a Iberian sample of *M. spinosior* and an Austrian *M. sabuleti* sample, whereas the latter sample differed from its social parasite *M. hirsuta* by only 1.35 % (GenBank accession numbers: AY956325, AY956326).

Myrmica spinosior is a mainly West Mediterranean species, being most abundant on the Iberian peninsula and southernmost France, and becomes significantly rarer towards the east. Out of 22 samples from Iberia 21 belonged to *spinosior* and only one sample from Logrono (leg. Collingwood 1982.07) to *sabuleti*. When considering the whole Mediterranean faunal range, 96 % of 27 samples west of 8° E belonged to *spinosior* but only 22 % of 18 samples from east of this line. The easternmost samples known are from Turkey: Bafra (leg. Collingwood, pre 1990) and "Golocok" (probably Gölecik, leg. Collingwood, May 1985). Within the used 13-character system, these two samples are clearly allocated to the *M. spinosior* cluster and not to any other known species including *M. turcica* SANTSCHI, 1931, *M. georgica* SEIFERT, 1987, or *M. tulinae* ELMES, & al. 2002. However, these samples from Asia Minor are worth of being checked with other systems for a separate species identity because their geographic origin seems quite isolated from the main range of *M. spinosior*.

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Zusammenfassung

Myrmica lobulicornis NYLANDER, 1857, und *Myrmica spinosior* SANTSCHI, 1931, zwei ursprünglich als infraspezifisch beschriebene Taxa, werden zu Art erhoben. *Myrmica lobulicornis* wird als älteres Synonym von *M. arduennae* var. *pyrenaea* BONDROIT, 1918, *M. lobicornis* ssp. *alpina* STÄRCKE, 1927, und *M. lobicornis* ssp. *apennina* STÄRCKE, 1927, aufgezeigt und *M. lobicornis* NYLANDER, 1846 als älteres Synonym von *M. lobicornis* ssp. *arduennae* BONDROIT, 1911, *M. lobicornis lobicornis* var. *lissahorensis* STÄRCKE, 1927, *M. lobicornis* ssp. *angustifrons* STÄRCKE,

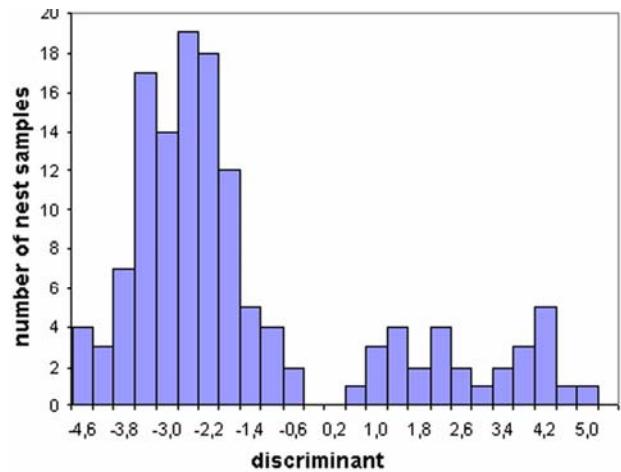


Fig. 9: Canonical discriminant values of 104 and 29 worker nest samples of *Myrmica sabuleti* and *M. spinosior* based upon 13 morphometric characters. Only new investigations with higher accuracy are given into the data pool.

1927, und *M. lobicornis* st. *foreli* SANTSCHI, 1931. Mittels standardisierter Morphometrie und Anwendung von Diskriminanzfunktionen konnte jede Nestprobe einschließlich der Typenserien den Arten *M. lobulicornis*, *M. lobicornis* und *M. wesmaeli* BONDROIT, 1918 mit einer Irrtumswahrscheinlichkeit von $p < 0.0007$ zugewiesen werden. Die Unterscheidung von *M. sabuleti* und *spinosior* war in 99 % von 133 Nestproben mit einer Irrtumswahrscheinlichkeit von $p < 0.007$ möglich. Dabei wurde die Typenserie von *M. spinosior* mit $p = 0.006$ zugewiesen. Vergleichende morphometrische Daten und Angaben zur Zoogeographie der sechs europäischen Arten des *M. lobicornis*- und des *M. sabuleti*-Komplexes werden präsentiert.

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