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A Taxonomic Revision of the *Myrmica* Species of Europe, Asia Minor, and Caucasia (Hymenoptera, Formicidae)

Eine taxonomische Revision der *Myrmica*-Arten Europas,

Kleinasiens und Kaukasiens

by BERNHARD SEIFERT

with 6 tables and 190 figures

Zusammenfassung

Insgesamt 26 Taxa der Gattung *Myrmica*, darunter 3 sozialparasitische Arten, werden für das Territorium Europas, Kleinasien und der Kaukasusländer als Morphospezies bestätigt, wobei Morphospezies als Hypothese über eine Biospezies zu verstehen ist. 64 Taxa werden als jüngere Synonyme gewertet. Abweichend von bisher üblichen Systemen werden *Myrmica hellenica* FOREL und *M. wesmaeli* BONDROIT wiedereingeführt. Zweifelhaft ist der Status von *M. aloba* FOREL, *turcica* SANTSCHI und *caucasica* ARNOLDI, die in der vorliegenden Revision aus praktischen Gründen als Morphospezies bzw. parapatriische Arten betrachtet werden, in der Realität aber vielleicht nur distinkte Subspezies oder Semispezies sind. Es gibt keine Anhaltspunkte dafür, daß *jacobsoni* KUTTER, *limanica* ARNOLDI, *myrmecophila* WASMANN, *ahngeri* KARAWAJEW, *slovaca* SADIL und *rugulosoides* FOREL eigene Arten sein könnten. Es wurde angestrebt, durch weitgehend objektive Untersuchungsmethoden zu einer taxonomischen Entscheidung zu gelangen, wofür insgesamt etwa 18 000 morphologische Primärdaten ausgewertet wurden. Die Artbeschreibungen werden durch z. T. ausführliche Angaben zur Biologie ergänzt. Es ist nicht möglich, ein dichotomes Entscheidungsschema, das einzelne Merkmale abfragt, zur Bestimmung aller Arten zu benutzen. Die hier vorgelegten Bestimmungsschlüssel fragen deshalb häufig nach Merkmalskombinationen, wodurch die Sicherheit der Determination stark erhöht wird, dem Benutzer aber die unbequeme sorgfältige Untersuchung des Materiales abverlangt wird.

Abstract

26 taxa of the genus *Myrmica*, among them 3 social parasites, are confirmed as morphospecies for the territory of Europe, Asia Minor, and Caucasia, with morphospecies understood as hypothesis on a biospecies. 64 taxa are regarded as younger synonyms. Deviating from systems used up to the present, *M. hellenica* FOREL and *M. wesmaeli* BONDROIT are reintroduced. A doubtful taxonomic status have *M. aloba* FOREL, *turcica* SANTSCHI, and *caucasica* ARNOLDI which are regarded in this revision, for practical reasons, as morphospecies or parapatric species, but could be in reality distinct subspecies or semispecies only. There are no suggestions for *jacobsoni* KUTTER, *limanica* ARNOLDI, *myrmecophila* WASMANN, *ahngeri* KARAWAJEW, *slovaca* SADIL, and *rugulosoides* FOREL to be valid species. The author tried to find taxonomic decisions by application of largely objective investigation methods, evaluating 18 000 primary data on morphology. The species descriptions are supplemented by informations on biology. A simple dichotomous decision schedule asking for single characters can not be applied for the determination of all species. For this reason, the presented keys frequently ask for character combinations which increases the reliability of determinations but demands a time-consuming, careful examination of the material.

Introduction

Including infrasubspecific names, 90 taxa of the genus *Myrmica* have been described so far from the territory of Europe, Asia Minor and Caucasia. More than two thirds of these

taxa are obviously younger synonyms. In the course of this revision, it was possible to examine the types or reliably type-compared material of 31 taxa. In the majority of the remaining 59 taxa where types were not requested or not available, their real status could be concluded with a high probability from descriptions, type locality, and year of description. For instance, I have synonymised *M. puerilis* STÄRCKE, 1942 with *specioides* BONDROIT, 1918 and there is almost no danger that this statement could be erroneous although I have never seen any *puerilis* type. From all the really problematic taxa where direct examination of type material is necessary, I have got type specimens in each case – with exceptions of *striata* FINZI, 1926 which is probably held in MCZ Cambridge/Massachusetts.

In order to keep the size of this paper in reasonable limits, a complete account and discussion of synonymy is not given. Thus a lot of infraspecific or infrasubspecific names are kept out of discussion. However, all these forgotten taxa were considered and even two of them are reintroduced here as species.

As far as informations were available, I have tried to take into consideration ecological and biological properties but it should be emphasized that many of the 26 taxa I have accepted here as species are nothing but morphospecies which identity as real biospecies has to be tested by detailed futural investigations on reproductive isolation. In doubtful cases, I have decided in favour of a taxon which is, for the moment, a better solution than a rash synonymisation; e. g. the taxa *caucasica*, *turcica*, and *aloba* regarded here as good species could be in reality distinct subspecies or semispecies only. I have tried to present numeric evidence for most of my statements and about 18000 primary data on morphology are incorporated in this treatise. Further, I have found it reasonable to give often a few comments in order to avoid a dogmatic presentation and to direct the attention to uncertain decisions.

In contrast to genera as *Tetramorium* or *Tapinoma*, males are frequently of restricted use for detailed separation of morphospecies in *Myrmica* and this paper gives many examples of morphospecies which are distinct in the female castes (with non-overlapping characters) but hardly or not separable in the males. However, males are certainly useful to establish groups of related species; e. g. *rugulosa*, *hellenica*, *specioides*, and *turcica* have very similar males.

Acknowledgements

Among the many friendly persons which have provided me with *Myrmica* material, I wish to thank at first Cedric COLLINGWOOD from Skipton, Yorkshire, Graham ELMES from Wareham Dorset, and Xavier ESPADALER from Barcelona/Spain, who have sent me a lot of specimens from many parts of Europe and have given a lot of well-aimed suggestions on *Myrmica* taxonomy. Further, I wish to express my grateful thanks to Paul DESSART from the Institut Royal des Sciences Naturelles de Belgique (R. I. Sc. N. B.) in Brussels who arranged quick and generous loans of the very important types of BONDROIT which are held there in a very well-curated collection. Very much I am indebted to Genady DLUSSKY from the Zoological Museum of the Moscow Lomonosov University (ZMMU) for the loan of types of ARNOLDI, KARAWAJEW, and RUZSKY and to Jan MACEK from the National Museum in Prague who gave me the opportunity to examine specimens of SADIL. I wish to thank further Claude BESUCHE from Museum of Natural History Geneva (MNHG) for loan of FOREL types, Michel BRANCUCCI from the Museum of Natural History Basel (MNHB) for loan of SANTSCHI types, and Daniel CHERIX from the Lausanne Zoological Museum for loan of the KUTTER types. Considerable material was additionally provided by Donat AGOSTI and Wille SAUTER from ETH Zurich or Petr WERNER, Prague. Other persons who sent useful material were Wolfgang MÜNCH from Tübingen, Volker ASSIG from Hannover and many others sending single specimens could be named. I am indebted further to the colleagues from the Zoological Museum Berlin and from the Department of Insect Taxonomy Eberswalde (formerly Deutsches Entomologisches Institut) for kind arrangement of working visits in their collections.

Investigation Methods and Terminology

All measurements have been taken on mounted dry preparations under use of the Carl Zeiss Jena stereomicroscopes SM XX and TECHNIVAL 2 at magnifications between 50x and 250x. A measuring accuracy of $\pm 1 \mu\text{m}$ is achieved for small structures as funiculus segments or hairs but not for the largest measures where the principal visual error is $\pm 5 \mu\text{m}$. To this visual error have to be added positional errors and errors caused by different humidity – e. g. a queen head width may decrease under the influence of a hot focused light spot within 60 seconds after beginning of exposure from 1300 μm to 1295 μm . To have a uniform re-

ording and because the accuracy is for the majority of measurements better than 0.01 mm, all data are given in μm even for those measurements where such precision is not possible.

Essential for the examination of scape characters is to define standardized visual positions (see Fig. 1). The dorsal view (**d**) is exactly parallel to the axis of the hinge joint between scape and first funiculus segment or, in other words, perpendicular to the plane of movement of the first segment. In this visual position, the basal curvature of scape is almost invisible. The caudal (**c**) and frontal (**f**) visual positions are defined for the scape directed laterad and both positions are perpendicular to dorsal position. In position **c** and **f** the basal curvature of scape is almost fully seen in female castes, but frequently not in males where the frontal view needs often a certain tilt to dorsal position to visualize the bend perfectly. In many species, the plane of basal scape lobe (or of the plane between dorsal and caudal carinae) slopes caudad in a sometimes very diagnostic angle α and is consequently not fully seen in dorsal view. Often, a depiction of scape is necessary in three visual planes (**d**, **cd**, **c**) because the visibility of characteristic edges or carinae is not equally given in each position and since an imagination of the real spatial positions is facilitated.

The characters measured are:

- HL --- maximum head length measured from midpoint of occipital border to midpoint of anterior clypeal border; the head has to be tilted until maximum length comes to lie in measuring plane. If there is a protrusion of sculpture exactly at midpoint of anterior clypeal border, it is included in HL.
- HW · maximum head width including eyes. I clearly prefer this mode of measuring because HW can be taken with equal accuracy in frontad or caudad tilted heads or in the normal dorsal position. This is important if the scape conceals the outer margin of eyes in dorsal position.
- FR ·· minimum distance between frontal carinae
- FL · maximum distance of frontal lobes
- SL · maximum scape length excluding the neck of articular bulb measured in dorsal or frontodorsal positions (see Figs. 3-5).
- SW · maximum scape width in male; the scape has to be turned carefully until maximum width is visible.
- PE ·· maximum width of petiole
- PP · maximum width of postpetiole
- PA --- the angle at which the frontal and dorsal faces of petiole meet in lateral view.
- SP ·· length of propodeal spines as mean of both spines measured in dorsal view but with a slight frontad tilt to have measured full spine length (see Fig. 2).
- PEH ·· length of longest hair on dorsal part of petiole
- PPH · length of longest hair on dorsal part of postpetiole
- AL ·· alitrunk length of queen and male measured as maximum distance from posterior margin of lateral propodeal lobe to anterior border of promesonotum (i. e. not to anterior border of neck shield!). AL is most quickly taken in lateral view (see Fig. 6).
- F 2 · median line length of second funiculus segment in dorsal visual position of scape (d).
- F 3 --- the same for the third funiculus segment
- IF 2 ·· ratio $F 2 /$ maximum width of second funiculus segment in dorsal view
- F 2 H ·· length of longest hair on second funiculus segment
- MEH --- length of longest hair on extensor profile of hind metatarsus except the most distal hairs

Notes on the Use of Characters

In each morphometric description of characters, possible allometric functions should be considered. I have preferentially used here simple ratios to avoid a more complicated presentation and because the majority of these ratios is almost independent from body size; in workers, this can be stated for SL/HL , PE/HW , PP/HW , FL/FR , and HW/FR .

The ratio HL/HW proved to be isometric or to show a negligible decrease with growing body size for most of the worker samples. Apparently notable deviations from HL/HW isometry as calculated for *M. sancta*, *caucasica*, or *lobicornis* need not necessarily be real properties of the species *per se* but may have been produced by chance through computation of genetically different populations' data into one and the same calculation.

Normally very strong and to consider in any case is the positive allometry of SP against HL. Spine length often finds its correlate in strength of sculpture or, in other words, the largest specimens will not only have an absolutely but also relatively coarser sculpture than smaller individuals.

The hair length PEH and PPH shows generally a negative allometry to body size. As an approximate rule of thumb, an HL increase of 10% above the mean head length HL will result in an average increase of 3.8% in hair length above the mean hair length PEH or PPH according to equation

$$\frac{PPH}{PPH} = \frac{PEH}{PEH} = \left(\frac{HL}{HL} \right)^{0.3953}$$

As general rule for many ant genera, scape length indices should be computed as SL/HL better than SL/HW, as normally done by other myrmecologists, to reduce the variability coefficients.

Queens are always similar to workers in diagnostic characters but queen-attributed changes of body ratios should be considered. Apart from the well-known caste-specific deviations, queens have often somewhat stronger and more massive scapes as well as relatively wider and higher petioles or postpetioles than workers.

Much care is needed in those androgynomorph examples with only a minute portion of female structures. These can be regarded by unskilled observers as "pure" males but will often have striking deviations from normal male body ratios which could facilitate mis-identifications.

Body colour is highly variable in the majority of species and of almost no taxonomic significance. It is obviously mostly genetically determined. Even in species which are said to have a constant and characteristic colour, we observe now and then striking colour deviations in adult workers between nests of the same habitat spot or within the same nest.

The Genus *Myrmica* LATREILLE, 1804

Characterization of the genus

Type species: *Formica rubra* LINNÉ, 1758 (YARROW 1955)

Worker: Antennal club 3-4 segmented. Mandibles with 7-10 teeth which gradually increase to apex. Head more or less oval, clypeus rounded, frontal lobes often very prominent. Anterolateral parts of pronotum rounded; promesonotal suture absent, mesopropodeal furrow weakly developed to very distinct; propodeal spines frequently conspicuous. Petiole and postpetiole, which collectively form the waist, with large node; petiole with distinct anteroventral tooth. Rubbing of the posterior postpetiolar edge against fine transverse striae on the base of first gaster tergite produces stridulation signals.

Except few parasitic species, the tibial spurs are clearly pectinate in all castes. Female castes armed with well-developed stinger. Cubital cell of fore-wing in males and queens partially divided by an incomplete vein. Maxillary palps with 6 and labial palps with 4 segments. Antennae 12 segmented in female castes and 13 segmented in males.

Myrmica species are largely predaceous but in several species a certain degree of trophobiosis with aphids, including subterranean forms, was observed and blossoms or other nectar producing plant organs are visited. The main fields of action are the ground surface and the top of litter layer but a number of species will forage additionally in the field and lower bush layers. The colonies are not populous in most of the species, containing few hundred to 1000 (rarely 10000) workers.

List of taxa accepted here as species

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5. <i>Myrmica bergi</i> RUSZKY, 1902	page 11
6. <i>Myrmica rugulosa</i> NYLANDER, 1849	page 11
7. <i>Myrmica hellenica</i> FOREL, 1913	page 13
8. <i>Myrmica specioides</i> BONDROIT, 1918	page 16
9. <i>Myrmica turcica</i> SANTSCHI, 1931	page 18
10. <i>Myrmica caucasica</i> ARNOLDI, 1934	page 19
11. <i>Myrmica sancta</i> KARAWAJEW, 1926	page 21
12. <i>Myrmica bakurianica</i> ARNOLDI, 1970	page 22
13. <i>Myrmica stangeana</i> RUSZKY, 1902	page 23
14. <i>Myrmica salina</i> RUSZKY, 1905	page 25
15. <i>Myrmica scabrinodis</i> NYLANDER, 1846	page 27
16. <i>Myrmica aloha</i> FOREL, 1909	page 29
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22. <i>Myrmica lobicornis</i> NYLANDER, 1846	page 38
23. <i>Myrmica wesmaeli</i> BONDROIT, 1918	page 39
24. <i>Myrmica bibikofti</i> KUTTER, 1963	page 41
25. <i>Myrmica myrmicoxena</i> FOREL, 1874	page 41
26. <i>Myrmica hirsuta</i> ELMES, 1978	page 42

***Myrmica rubra* (LINNÉ, 1758), Figs. 15–17, 19**

Formica rubra LINNÉ, 1758; worker

Myrmica rubra (L., 1758) sensu YARROW 1955, ARNOLDI 1970, COLLINGWOOD 1979

Myrmica laevinodis NYLANDER, 1846; sensu SANTSCHI 1931, WEBER 1947, SADIL 1952, BERNARD 1969, BARONI URBANI 1971, PISARSKI 1975, KUTTER 1977

Myrmica rubra laevinodis NYLANDER, 1846; sensu EMERY 1922

Note: I have followed YARROW's conception who fixed with good reasons one worker specimen in the two species containing type collection of LINNÉ as lectotype and thus as the type of the genus *Myrmica*. This specimen belongs clearly to that species later described by NYLANDER as *laevinodis*.

Material

The material investigated is from whole Europe, but mainly from Central Europe.

Diagnostic characters

Worker (Fig. 15): Head relatively long. Scape long and slender, gently curved near the base. Petiole in lateral view with dorsal surface as small rounded dome sloping caudad continuously (i. e. without definite step) to its junction with postpetiole. Area between spines smooth and brilliantly shining; petiolar and postpetiolar nodes smooth, without rugose sculpture. Sculpture on whole body weak. Propodeal spines shorter than 0.28 HL and with broad base

HL 1205.5 ± 61.8 ($n = 31$, largest 1314), HW 1090.5 ± 51.3 ($n = 31$, largest 1185), HW/FR 2.300 ± 0.071 ($n = 31$, 2.15–2.45), FL/FR 1.070 ± 0.022 (31, 1.03–1.12), SL/HL 0.822 ± 0.0191 (31, 0.769–0.854), HL/HW 1.105 ± 0.169 (29, 1.070–1.134), SP/HL 0.235 ± 0.0239 (31, 0.179–0.274), PE/HW 0.273 ± 0.0114 (29, 0.256–0.307).

Allometry:

$$SP = 0.0007865 \text{ HL } 1.80296 \quad (r = 0.8237, n = 31)$$

Queen (Fig. 16): Scape long and slender, gently curved near the base. Frontal triangle entirely smooth and shining. Propodeal spines shorter than 0.25 HW. Infra-spinal area and waist smooth. Petiole shape similar to worker.

Macrogyne HW 1326.2 ± 48.6 ($n = 18$, 1221–1418), microgyne HW 1038.9 ± 59.5 (9, 980–1165), macrogyne SP/HW 0.189 ± 0.0199 (39, 0.156–0.228), microgyne SP/HW 0.194 ± 0.0346 (8, 0.157–0.250), HW/FR 2.26 ± 0.068 (28, 2.15–2.37), FL/FR 1.06 ± 0.0180 (28, 1.03–1.12).

Male (Figs. 17, 19): Scape long, with gentle curvature near base. Frontal triangle and petiolar node smooth. Tibiae and metatarsi with long suberect to subdecumbent hairs, the longest project 70–100 μm from cuticular surface of hind tibia's extensor profile line. Scape shorter than in *ruginodis*, body colour on average darker.

HL 942.1 ± 55.9 ($n = 21$, 833–1018), HW 1003.8 ± 59.8 (21, 879–1088), HL/HW 0.939 ± 0.0167 (19, 0.908–0.971), SL/HL 0.806 ± 0.0351 (21, 0.742–0.896), SL/HW 0.757 ± 0.0303 (21, 0.710–0.825).

Comments

PEARSON and CHILD (1980) gave electrophoretic evidence that macrogynes and microgynes were most probably separate species whose relationship may be that of host (macrogyne) and social parasite (microgyne). However, their data seem to indicate that a small frequency of interbreeding still occurs, meaning the speciation process is not finished. ELMES (1976) showed that microgynes were isometric reductions of macrogynes.

Biology

M. rubra is a very aggressive species which stings freely. As very euryptent ant, it shows the largest niche width of the Central European *Myrmica* species (SEIFERT 1986). It is more a lowland species which typically occurs in mesophilic to very moist meadows and tolerates a very high growth of grasses and field layer plants much better than other ants. Frequent in gardens and agricultural regions, *rubra* is comparably rare inside of larger forests where it is displaced by its sibling species *ruginodis*. Both species have a high ecological similarity or overlap of their fundamental niches (63%) but their real habitat overlap is 12.9% only (SEIFERT 1986, 1987 a) which indicates a strong competitive displacement. In contact zones, I could observe aggressive interspecific behaviour. Occasionally *M. rubra* develops polycalic or exceptionally large monocalic colonies; the largest nest I found covered an area of 1 m² and contained 10000 workers or more as well as several hundred queens. Densities up to 105 nests/100 m² were recorded in open habitats on alluvial soil with very high growth of field layer where *rubra* was the only ant species. It tends aphids more frequently than other members of the genus and often climbs in the field or lower bush layers; even trees are visited in search for aphids or coccids and nectaries, floral and extrafloral, are exploited. It is the only *Myrmica* where I have repeatedly observed severe intraspecific fightings between neighboured colonies, with high numbers of killed ants and subsequent raiding of the weaker colony for broods and imagines. Such fightings between macrogyne nests need particular conditions to develop and are obviously a mode of density regulation in overcrowded habitat spots. Nuptial flight takes place mainly in August.

Distribution

Portugal to E Siberia, Italy to N Scandinavia. In the Mediterraneans only in moist places.

***Myrmica ruginodis* NYLANDER, 1846**, Figs. 12–14, 18, 20

Myrmica ruginodis NYLANDER, 1846; worker, queen, male; N Europe

Myrmica ruginodis NYLANDER, 1846; sensu YARROW 1955, ARNOLDI 1970, BERNARD 1968, BARONI URBANI 1971, KUTTER 1977, COLLINGWOOD 1979

Myrmica rubra (L.), sensu SANTSCI 1931, WEBER 1947, SADIL 1952, PISARSKI 1975

Myrmica rubra ruginodis NYL., sensu EMERY 1922

Myrmica rubra var. *mutata* SADIL, 1952.

Material

The investigated material is from western, central and eastern parts of Europe but mainly from GDR.

Diagnostic characters

Worker (Figs. 12, 13): Scape long and slender, gently curved near base. Petiole in lateral view massive with truncate dorsal area and abrupt step in caudal slope of node down to junction with postpetiole. Infraspinal area transversely striate; petiolar and post-

petiolar nodes normally rugose. Head and alitrunk with well-developed longitudinal rugosity. Propodeal spines longer than 0.28 HL. Frontal triangle entirely smooth and shining.

HL 1257.6 ± 64.6 ($n = 28$, largest 1365), HW 1148.0 ± 63.2 (28, largest 1237), HW/FR 2.368 ± 0.0584 (252, 2.20–2.52), FL/FR 1.100 ± 0.0250 (28, 1.06–1.16), SL/HL 0.839 ± 0.0184 (28, 0.803–0.880), HL/HW 1.096 ± 0.0181 (28, 1.054–1.127), SP/HL 0.344 ± 0.0277 (31, 0.280–0.419), PE/HW 0.289 ± 0.0119 (28, 0.270–0.312).

Allometry:

$$SP = 0.001126 HL^{1.80155} \quad (r = 0.8413, n = 31)$$

Queen (Fig. 14): Scape long and slender, gently curved near base. Frontal triangle smooth and shining on whole surface. Propodeal spines longer than 0.25 HW. Infraspinal area transversely striate. Petiolar and postpetiolar nodes rugose.

Macrogyne HW 1232.1 ± 37.5 (18, 1170–1280), one microgyne HW 1105, SP/HW 0.310 ± 0.0220 (39, 0.263–0.357).

Male (Figs. 18, 20): Scape very long, with gentle curvature near base. Frontal triangle smooth and shining. Hind tibia and metatarsi with subdecumbent hairs of moderate length, the longest project 20–60 μm from cuticular surface of hind tibia's extensor profile line. Body colour paler, scape longer than in *rubra*. Dorsal plane of petiolar node smooth.

HL 1070.8 ± 85.8 ($n = 12$, 908–1178), HW 1098.8 ± 73.5 (12, 982–1217), HL/HW 0.974 ± 0.241 (12, 0.907–1.002), SL/HL 0.915 ± 0.0349 (12, 0.863–0.962), SL/HW 0.894 ± 0.0444 (12, 0.794–0.955).

Comments

Myrmica rubra var. *mutata* SADIL, 1952 is a teratologic specimen but clearly to recognize as *ruginodis*. The workers of *ruginodis* are easily distinguished from those of *rubra* by petiolar shape and much longer spines. Individuals with spines longer than

$$0.0009467 HL^{1.801}$$

are *ruginodis* and such with shorter spines *rubra*. Males of *ruginodis* are separated from *rubra* by their less projecting, shorter appendage pilosity and longer scape. The difference between microgyne and macrogyne is much less clear-cut than in *rubra* and the taxonomic significance of the varieties *microgyna* and *macrogyna* sensu BRIAN and BRIAN (1949) is very doubtful. According to a morphometric study by ELMES and CLARKE (1981), the species is very constant throughout its range from W Europe to Japan.

Biology

In Central and N Europe *ruginodis* is very abundant in woodlands and high moorlands. As the least thermophilic of all European *Myrmica* species (SEIFERT 1986), it effectively displaces *M. rubra* in grasslands and boggy moorlands above 1000 m. Typical densities in Central European woodland habitats are 5–15 nests/100 m². The macrogyne morph has large queens that live monogyneously, has large, aggressive workers, reproduces by single queen colony initiation after dispersing nuptial flight, and tends to occur in more transient habitats. The microgyne morph has polygyneous colonies with small queens and less aggressive workers, reproduces by colony division after the recruitment of queens that mate in, or close to, the nest, and tends to prefer more stable habitats (ELMES and CLARKE 1981). *M. ruginodis* was seen to visit blossoms and aphids in higher vegetation.

Distribution

Throughout the Northern Palaearctics from W Europe to Japan, Italy to North Cape. Goes to higher latitudes and higher altitudes than *rubra*.

***Myrmica sulcinodis* NYLANDER, 1846**, Figs. 21, 23, 24

Myrmica sulcinodis NYLANDER, 1846; worker, queen; Helsingfors/Finland

Myrmica myrmecophila WASMANN 1910

Myrmica sulcinodis var. *nigripes* RUZSKY, 1896, sensu SADIL 1952

Material

The investigated material is from Norway, England, FRG, GDR, Austria, Switzerland, Italy, Czechoslovakia, Bulgaria, and Central and East Caucasus.

Diagnostic characters

Worker (Figs. 23, 24): Scape sharply curved at base but not really angled, with sharp edge running along the outside of bend down to base and without any posterior lamellar outgrowth or edge. Alitrunk and petiole with very coarse, regularly longitudinal rugosity that lacks transverse connections or reticular structures; distance between sulci 60–80 μm and their depth 20–30 μm . Frontal triangle entirely or at least in part with well-developed longitudinal striae. Propodeal spines strong and normally rather blunt, frequently subparallel and incurved in dorsal view. Petiole massive, relatively high, with anterior cylindrical part shorter than in other species. Big, robust ant with rather constant colouration throughout its range: head and gaster except its basal part normally blackish brown, alitrunk and waist rusty red.

HL 1292.6 ± 61.7 ($n = 25$, 1181–1403), HW 1262.5 ± 58.5 (25, 1172–1371), HW/FR 2.703 ± 0.0949 (30, 2.46–2.95), FL/FR 1.079 ± 0.0283 (26, 1.036–1.160), SL/HL 0.786 ± 0.0199 (25, 0.749–0.823), HL/HW 1.024 ± 0.0182 (25, 0.999–1.068), SP/HL 0.348 ± 0.0277 (25, 0.294–0.397), PE/HW 0.287 ± 0.0155 (13, 0.254–0.314), PP/HW 0.428 ± 0.0172 (13, 0.402–0.460).

Queen: Similar to worker.

HL 1394.6 ± 52.6 ($n = 7$, 1304–1453), HW 1397.7 ± 47.1 (7, 1315–1453), SL/HL 0.762 ± 0.0131 (7, 0.736–0.778), HW/FR 2.784 ± 0.144 (7, 2.58–2.99), FL/FR 1.078 ± 0.0171 (7, 1.05–1.101), SP/HW 0.339 ± 0.0346 (7, 0.292–0.398).

Male (Fig. 21): Scape long, with a clear 45° curvature near base. Frontal triangle with longitudinal striae. Petiolar node always with well-developed longitudinal rugosity. Second funiculus segment at least twice as long as wide.

HL 1018.3 ± 35.0 ($n = 25$, 911–1076), AL 2000.1 ± 91.7 (25, 1801–2198), SL/HL 0.880 ± 0.0290 (25, 0.821–0.944), SL/SW 7.68 ± 0.561 (25, 6.56–9.05), F2 189.7 ± 13.9 (25, 164–221), IF2 2.295 ± 0.203 (25, 1.99–2.71), F2/F3 1.511 ± 0.0938 (25, 1.35–1.70).

Comments

M. sulcinodis is hardly to be confused with any other European species in all three castes. I have synonymized *M. myrmecophila* WASMANN, 1910 which is known in the single type specimen only, found in a *sulcinodis* colony. This intercaste-like specimen is most probably either the result of a particular type of an ephemeral mutation or of a failure during larval development caused by environmental factors. Similar examples that appear to be intercastes between workers and queens I observed in the *Myrmica* species *gallienii*, *aloba*, *salina*, *sabuleti*, *specioides*, and *scabrinodis* in one sample each. All these aberrant examples have in common an abnormally wide postpetiole, broad gaster, and a wider frons; regularly at least one ocellus is present and sometimes the scape is abnormal or the pilosity is more profuse and longer. All these aberrant examples have certainly no taxonomic significance but, provided they are a characteristic type of mutation that rarely occurs in many *Myrmica* species in a similar way, they could be of interest to indicate the initial step that could have led to the evolution of true socialparasitic species as e. g. *M. hirsuta* (see also discussion in ELMES 1981). It should be mentioned that I observed in nematode infested, worker-like examples of *scabrinodis* and *sabuleti* similar abnormalities (lower FL/FR, much larger PP/HW, thickset appearance of all body parts).

Biology

M. sulcinodis is a orcal/subalpine and boreo-nemoral/boreal species of sunexposed habitats. While in S Europe and Caucasus (42° N) characteristic for subalpine meadows between 1400 and 2600 m and in Central Europe (50° N) characteristic for the altitudinal range between 800 and 1800 m, it is already in N Germany and Denmark a lowland species that typically occurs in well-drained moorland heath. In contrast to the statements of BERNARD (1968), I have found it frequently on continuously grazed subalpine pastures in Bulgaria and Caucasus. The colonies are small, normally less than 1000 workers, and contain single or very few queens. Alates occur in the nests from the beginning of July and fly from late July to early September.

Distribution

In Europe and Caucasus it goes south to 41° N at least and in Fennoscandia north to 70° N (North Cape). Throughout the Palaearctics from Portugal to E Siberia.

Myrmica gallienii BONDROIT, 1920, Figs. 8–11, 25, 26, 104, 122

Myrmica gallienii BONDROIT, 1920; worker; Latrecy (Haute Marne/France)

Myrmica rugulosa subsp. *limanica* ARNOLDI, 1934

Myrmica rolandi BONDROIT, sensu JACOBSON 1940

Myrmica bergi RUZSKY, sensu SADIL 1952

Myrmica jacobsoni KUTTER 1963

Myrmica limanica ARNOLDI, ARNOLDI 1970

Myrmica jacobsoni KUTTER, sensu PISARSKI 1975

Material

The examined material is from France (the *gallienii* types of BONDROIT), the Netherlands, Luxembourg, Switzerland, FRG, GDR, Poland, Lettland (the *jacobsoni* types of KUTTER), Svenigorod/Moscow, S Ukraine (the *limanica* types of ARNOLDI plus other examples of *limanica*, det. ARNOLDI), Czechoslovakia, Hungary, and Austria. It consists of about 150 workers, 40 queens, and 35 males and originates from more than 40 different nests.

Diagnostic characters

Worker (Figs. 25, 26): Scape very characteristic; in caudal or frontal view, its basal part is very evenly bent in an ideal curve and the smallest diameter is immediately distal of the bend and amounts 6.2–7.3% of SL. Sharp edges are entirely absent from basal part of scape. Sculpture on all body parts much less coarse than in *sulcinodis*; depth of sulci on alitrunk $\leq 15 \mu\text{m}$, their distance 30–40 μm . Frontal area either striate in caudal portion or entirely smooth and shining. Petiolar node with irregular, rather weak rugosity; postpetiole finely arcuately rugose, at the top often nearly smooth. Propodeal spines relatively long but finer and with sharper tips than in *sulcinodis*. Petiole in lateral view somewhat variable but regularly with slightly concave anterior slope and a short truncate dorsal area which width is distinctly larger than its length.

HL 1148.2 ± 69.4 ($n = 57$, 1014–1311), HW 1123 ± 70.7 (57, 990–1290), HL/HW 1.022 ± 0.0146 (57, 0.985–1.059), SL/HL 0.805 ± 0.0152 (57, 0.770–0.841), HW/FR 2.616 ± 0.0873 (53, 2.44–2.77), FL/FR 1.089 ± 0.0205 (27, 1.057–1.147), SP/HL 0.325 ± 0.0252 (45, 0.265–0.369), PE/HW 0.254 ± 0.0111 (19, 0.239–0.286), PP/HW 0.407 ± 0.0179 (19, 0.373–0.440).

Allometry

$$SP = 0.02152 \text{ HL } 1.38474 \quad (r = 0.7472, n = 45).$$

Queen (Figs. 8–11): Scape as in worker, sculpture similar to worker. Petiole similarly truncate as in worker but relatively higher and wider.

HL 1297.2 ± 38.0 ($n = 35$, 1243–1374), HW 1322.1 ± 43.7 ($n = 35$, 1200–1425), HL/HW 0.982 ± 0.0225 (35, 0.932–1.038), HW/FR 2.545 ± 0.0833 (35, 2.38–2.77), FL/FR 1.0685 ± 0.0201 (14, 1.033–1.097), SL/HL 0.773 ± 0.0150 (35, 0.741–0.806), SP/HW 0.279 ± 0.0210 (27, 0.238–0.316), AL/HL 1.560 ± 0.0221 ($n = 6$), AW/HW 0.821 ± 0.0139 ($n = 6$), PE/HW 0.286 ± 0.0103 (6, 0.278–0.303), PP/HW 0.463 ± 0.0103 (6, 0.454–0.481).

Male (Figs. 104, 122): Scape nearly straight and short, about equal to first 3 funiculus segments. Second funiculus segment 2.01–2.41 as long as wide. Petiole about as high as long, postpetiole in lateral view distinctly higher than long. Mesonotum in front of notauli with fine longitudinal striae. Hairs on extensor profile of hind metatarsus distinctly longer than those on flexor profile.

HL 944.3 ± 58.3 (18, 810–1052), AL 2150.9 ± 142.6 (24, 1746–2472), SL/HL 0.392 ± 0.0167 (18, 0.365–0.427), SL/SW 3.244 ± 0.264 (19, 2.71–3.73), IF2 2.210 ± 0.123 (25, 2.01–2.41), AL/HL 2.262 ± 0.0612 (18, 2.156–2.346), PE/HL 0.386 ± 0.0230 (4, 0.366–0.419), PP/HL 0.549 ± 0.0260 (4, 0.528–0.587).

Comments

This species has often been confused with *rugulosa*, *sulcinodis*, *rubra*, *ruginodis* and others but is comparably easy to determine in all three castes. From *rubra* and *ruginodis*, the female castes are easily distinguished by the very different scape alone (compare Figs. 11, 12, 25, 26). From *sulcinodis*, it is clearly different by its much weaker sculpture, other scape form, less massive petiole, and other characters. The female castes of *rugulosa* differ from *gallienii* in having lower HW/FR, SL/HL, shorter spines, and by the different scape

base which is in *rugulosa* not ideally curved, being a little bit angular. Furthermore, the petiole of *rugulosa* shows in dorsal view nearly straight sides (in *gallienii* convex) and, in lateral view, a rather straight anterior profile (in *gallienii* concave) and a rather straight dorsal profile (in *gallienii* convex or bluntly angled). The *gallienii* male is well-characterized by its higher IF 2, not angled scape, and high and broad waist.

There does not exist a single suggestion that *jacobsoni* KUTTER, *limanica* ARNOLDI, and *gallienii* BONDROIT could be separate species. The morphological coincidence of the very characteristic workers from the examined type series of all three taxa is perfect. Further, the morphological variation of *gallienii* throughout its range from the Netherlands to W Siberia is very low in all three castes and the ecological position of this species shows that we have a continuum with a gradual change of some habitat parameters from W to E. The many records of *gallienii* suggest a continuous distribution from 5° E to 70° E; the populations of the countries are most probably genetically connected, although it seems likely that a certain degree of isolation could be produced by the recent man-made destruction of habitats in Central Europe.

Biology

The species is facultatively halophilous, moderately thermophilous, and rather hygrophilous. Personally, I know it only from habitats where the water table reaches constantly, or at least for short periods in spring, near to the surface and where the height of field layer vegetation is rather limited. Typical habitats are thus meadows and swamps with comparably low vegetation at the margin of flat waters or flat lakes. These are frequently salt marshes in the hot climates of S Ukraine, S Russia, and the Hungarian Plane but these are, in the cooler inland of the GDR, Poland, and Belorussia, in the vast majority of sites meadows and swamps without any salinity. Along the S Baltic Sea, *gallienii* typically inhabits short-grassy coastal meadows that are situated at margins of flat water areas and which are often salty (see also JACOBSON 1940). Deviating from this scheme, occurrence in coastal sand dunes of the Netherlands and Denmark is reported by KRAMER and COLLINGWOOD, but here, I expect the nesting only for those parts of the dunes that are not to high above the water table. Apparently more rarely, *gallienii* nests in the wet and warm Sphagnetalia of open peat bogs, as I have seen near Moskow. In such peat bogs, the humidity and temperature requirements of *gallienii* are in principle well satisfied but a strong competitive pressure of *scabrinodis* or *rubra* will probably displace *gallienii* from most of such places. Of considerable interest is the colonization of the margin of a brown coal mine residual lake in the district of Leipzig, indicating a certain dispersal and colonizing potency even in landscapes which underwent drastic man-made destructions and alterations.

As other members of its genus, *gallienii* is obviously resistant against intensive trampling, indicated by its nesting on a densely peopled beach meadow. It is comparably aggressive, stings freely, and I observed it to climb in the field layer vegetation, visiting blossoms of *Caltha palustris*. In solid ground, the nests have simple entrance holes. Swarming period in Central Europe 5. viii-2. x (n = 15), bulk 17. viii-21. ix (n = 13).

Distribution

25 records alone from the small territory of the GDR indicate that it should be well-distributed in Northern Central Europe. The border lines of *gallienii*'s distributional range are 5° E (Netherlands, France), 70° E (Borovoje/Kokčeta), 60° N (S Finland), with known southern border at 46° N. Hitherto unpublished records from outside of the GDR: Amsterdam/Rotterdam, leg. GRIEP 1940; Trier/Luxembourg, leg. GRIEP 4. v 1940; Wiesbaden, coll. OLDENBERG; Kosovo (Poland), leg. HAHNE 14. ix 1915; Bellinchen/Oder River, leg. GRIEP 6. ix 1937; Svenigorod/Moskow, leg. SEIFERT 24. viii 1985; Bugac Puszta (Hungary), leg. GALLÉ 6. ix 1976; Zemplinska Sirava (E Slovakia), leg SEIFERT 30. viii 1983; Greifensee/Zurich, leg. BORSHAVE 1986; Katzenssee/Zurich, leg. WOLF 3. viii 1941. That gives, together with 25 records from the GDR and published, reliable records of other workers, a total of 60 sites of which I have knowledge for Europe and W Siberia. In Europe, *gallienii* is still not confirmed for Norway, Belgium, the British Isles, the Iberian Peninsula, Italy, and the Balkans. Known vertical distribution in Europe: 0-440 m - an essentially lowland species.

Myrmica bergi RUZSKY, 1902, Figs. 27, 28

Myrmica bergi RUZSKY, 1902; worker; western and northern coast of the Aral Sea

Myrmica bergi var. *kirgisica* RUZSKY, 1903; sensu ARNOLDI 1970; Astrachan

Myrmica bergi var. *barchanica* RUZSKY, 1905; Chauskaja Stavka/Astrachan; according to ARNOLDI (1970) a synonym of *M. bergi kirgisica*

Myrmica bergi kamyschiensis ARNOLDI, 1934; Slavjansk, Sivaš, Kertš

Material

I have not seen types or other material of the European populations (*kamyschiensis* and *kirgisica*) but only three workers from Tunka/Baikal, coll. VIEHMEYER. For that reason, it is impossible for me discuss the validity of these taxa. The descriptions given below are based on those statements of RUZSKY, WEBER, ARNOLDI, and TARBINSKI which are not contradictory.

Description

Worker (Figs. 27, 28): Large species with a broad, rather rounded head. Scape very similar to *gallienii*; in caudal view, the basal part is evenly bent in an ideal curve; the Baikal examples show a rather sharp edge running along the outside of bend down to base. Spines shorter than in *gallienii*, normally shorter than the declivity ventral to them and projecting upwards at about 45°. Whole sculpture much weaker than in *sulcinodis* but on pronotum rather coarse, compared to *gallienii*, and irregular. Upper surface of head predominately with clearly longitudinal rugosity, only near the eyes occurs reticulate rugosity. Frontal area clearly demarcated and deep, smooth or longitudinally striate. Mesopropodeal furrow always present, but variably deep. The European populations differ from the nominal form in being darker brown and larger (*kamyschiensis*) or much larger (up to 6.3 mm) with coarser pronotal sculpture (*kirgisica*). Petiole in lateral view similar to *gallienii*.

HL/HW 1.025 (Kirgisica, TARBINSKI 1976), 1.022 (Europe, ARNOLDI 1970), 1.021 (Baikal); mean HL 1350 (TARBINSKI); HW/FR 2.68 (ARNOLDI), 2.63 (TARBINSKI), 2.55 (Baikal); FL/FR 1.104 (ARNOLDI), 1.14 (TARBINSKI), 1.103 (Baikal); SP/HL 0.190–0.274 (Baikal).

Queen: Similar to worker. Spines broad at base, pointed. 5.5–6.5 mm over-all length.

Male: Clypeus and frontal area shining. Head and alitrunk dorsally wrinkled. Nodes of petiole and postpetiole shining. Scape a little shorter or equal to the first 4 funiculus segments. SL/HL 0.47–0.56, SL/SW 3.95–4.55. Tibial pilosity about as in *sulcinodis*.

Comments

Concluded from descriptions, the female castes should be easily to recognize.

Biology

M. bergi is probably the most thermophilic of all European species, occurring in the southern steppe zone, and it is the *Myrmica* which typically seddles deserts of Kazakhstan and Middle Asia at margins of riversides, creeks or other waters with alluvial sands. According to TARBINSKI (1976), the workers forage on the ground surface in the morning and evening but will climb in higher vegetation (e. g. *Salix* bushes or *Phragmites*) throughout the day. Although predominately zoophagous, it collects seeds or visits flowers of labiates. The nests have simple entrance holes, sometimes with chimney-like collars (TARBINSKI 1976).

Distribution

Central and S Kazakhstan, Middle Asia, S Siberia, Mongolia. Subspecies *kamyschiensis*: southern steppes and northern coast of the Assow Sea northwards to 48° N (Slavjansk, Sivaš, Kertš). Subspecies *kirgisica*: lower Wolga (Astrachan). In Kirgisica up to 1600 m.

Myrmica rugulosa NYLANDER, 1849, Figs. 29, 30, 40, 103, 106, 124, 138

Myrmica rugulosa NYLANDER, 1849; worker, queen; Helsingfors/Finland

Material

The examined material is conspicuous and originates from the GDR, FRG, Denmark, Switzerland, Belgium, Poland, Czechoslovakia, Yugoslavia, Greece, and W Russia.

Diagnostic characters

Worker (Figs. 29, 30, 40, 103): Very constant throughout its European range. Scape sharply and a little bit angularly curved at base, without any trace of sharp edges or projections. Head distinctly longer than wide. Frons broader than in all other European species. Sculpture weak. Petiolar node smooth but not shining. Petiole in lateral view without truncation and with nearly straight frontal and dorsal profile lines that meet at a nearly right angle. Petiole in dorsal view narrow, much less wide than long, and with straight, almost parallel sides.

HL 1007.2 ± 63.9 ($n = 92$, 881–1146), HW 952.2 ± 65.2 (92, 825–1133), HL/HW 1.058 ± 0.0161 (92, 1.011–1.103), SL/HL 0.788 ± 0.0159 (45, 0.754–0.822), HW/FR 2.286 ± 0.0881 (109, 2.07–2.49), FL/FR 1.043 ± 0.0202 (65, 1.000–1.076), SP/HL 0.286 ± 0.0275 (54, 0.202–0.338), PE/HW 0.240 ± 0.0068 (45, 0.228–0.261), PP/HW 0.380 ± 0.0125 (52, 0.352–0.401).

Allometry:

$$\text{HW} = 0.75629 \text{ HL } 1.03231 \quad (r = 0.9651, n = 85)$$

$$\text{SP} = 0.0002383 \text{ HL } 2.02411 \quad (r = 0.8494, n = 56)$$

Queen: Similar to worker.

HL 1156.8 ± 24.6 ($n = 33$, 1100–1203), HW 1147.6 ± 32.6 (33, 1085–1208), HL/HW 1.008 ± 0.0179 (33, 0.964–1.043), HW/FR 2.253 ± 0.070 (33, 2.13–2.395), FL/FR 1.031 ± 0.0153 (25, 1.008–1.066), SL/HL 0.753 ± 0.0165 (33, 0.713–0.787), SP/HW 0.261 ± 0.0219 (25, 0.224–0.305), AL/HL 1.528 ± 0.0216 (15, 1.486–1.560), AW/HW 0.803 ± 0.0123 ($n = 15$, 0.776–0.820), PE/HW 0.268 ± 0.0078 (13, 0.250–0.277), PP/HW 0.428 ± 0.0186 (15, 0.403–0.458).

Male (Figs. 106, 124, 138): Scape short and not angled. In lateral view, the anterior and dorsal faces of petiole meet at a nearly right angle without dorsal dome or truncation. Second funiculus segment distinctly longer than the first. Mesonotum between the notauli smooth and shining without trace of sculpture.

HL 811.1 ± 45.2 ($n = 23$, 731–889), AL 1786.5 ± 122.1 (23, 1562–2028), SL/HL 0.377 ± 0.0155 (23, 0.339–0.409), SL/SW 3.02 ± 0.188 (23, 2.56–3.35), IF2 1.738 ± 0.111 (23, 1.52–1.95), F2 115.5 ± 8.4 (23, 104–133), F2H 91.1 ± 9.2 (19, 75–109), PE/HL 0.329 ± 0.0179 (19, 0.292–0.355), PP/HL 0.491 ± 0.0275 (19, 0.448–0.543).

Comments

The female castes have very distinct and constant characters throughout the species range but the males are difficult to separate from those of *hellenica*, *specioides*, or *salina*. If there is a distinct character at all, then it is the lateral profile of petiole of *rugulosa* males which is frequently typically formed but the variability in all four species is high (for further discussion see *M. hellenica*).

Biology

M. rugulosa differs in many aspects of its biology from other members of the genus. It is a rather thermophilous species (see SEIFERT 1986) seddling all habitats with reduced growth of field layer vegetation. Many of its sites have a high proportion of bare ground where it may be observed to forage in files. In Central Europe, *rugulosa* is frequently an urban species, penetrating into the centres of large cities where it is found along pavements, in court yards, and gardens. Outside urban regions it occurs preferentially in open sandy heath, sunny, intensively grazed pastures, and on rather xerothermous habitats on bare acid rock. I want to stress that I have found it very rarely on the many investigated xerothermous grasslands on limestone which should be, in principle, very suitable for *rugulosa*. Very probably the strong competitive pressure of other *Myrmica* species as *specioides*, *sabuleti*, and *schencki* which are dominating these grasslands will effectively exclude *rugulosa*. As remarkable scavenger, it excessively exploits the numerous dead or disabled insects and other animals which are gathered at the margins of motor highways or which are washed ashore at the S Baltic Sea coast; it may develop very productive populations along these margin lines. The colonies contain often higher queen numbers, are sometimes poly-calic, and may consist of many thousands of workers and cover several square meters. Up to 36 nests/100 m² have been recorded. On sandy soil, the nest openings are surrounded by circular sand ejections. It is an opportunistic, inaggressive species that avoids fightings and frequently coexists in the protected territories of superior, aggressive species as e. g. *Lasius niger* or *L. emarginatus*. Swarming period recorded 15. viii–16. x, mainly ix.

Distribution

It goes to 59° N in Sweden and to 61° N in Finland, but is absent from the British Isles and probably also from Norway. The southern border in the Balkans is at 41° N and in Italy at 44° N. The distribution in E Europe is poorly known: mainly in the forest-steppe and temperate forest zones. In general more a lowland species but in the French and Swiss Alps sometimes up to 1200 m.

Myrmica hellenica FOREL, 1913, Figs. 31–33, 37–39, 42–45, 50–53, 100–103, 107, 109, 125, 127, 139, 142

Myrmica scabrinodis rugulosa v. *hellenica* FOREL, 1913; worker and queen; Patras and Corfu (Greece)

Material

Southern population: 3 type workers (one without head) from Patras/Greece, leg. U. SAHLBERG 1913, MHN Geneva; 1 male, 1 queen, and 2 workers from Maritsa River near Khaskovo/S Bulgaria, leg. COLLINGWOOD vii 1985; 4 queens and 6 workers, same nest, from Melnik/SE Bulgaria, leg. SEIFERT 30. viii 1982; 5 workers from Melnik, leg. BEZDEČKA vi 1984; 2 workers from Sandanski/SE Bulgaria, leg. BEZDEČKA vi 1984.

Northern population: 3 queens from Feldkirch in Vorarlberg/W Austria, leg. MOOSBRUGGER; 2 workers from "Wallis"/Switzerland, coll. REICHERT; 8 workers, 1 queen, and 3 males from Rothenbrunnen and Cazis in Rhine River valley of Domleschg/ Switzerland, leg. WOLF 15. vii 1938, 6. xi 1938, 3. x 1939, 5. x 1939; 5 workers and 1 queen from Zizers in Rhine River valley/Switzerland, leg. WOLF 6. x 1939; 1 worker from Halbendorf at Spree River, distr. Bautzen/GDR, leg. JORDAN 29. v 1964; 1 worker from Lömischau, distr. Bautzen/GDR, leg. JORDAN 9. v 1964; 4 workers from "Revier 55" near Lauchhammer/GDR, leg. BLASCHKE 1981; 342 workers, 68 queens, and 95 males (five nest samples) from Wischgrund near Kostebrau, distr. Lauchhammer, leg. SEIFERT 7./8. viii 1986; 131 workers, 9 queens, and 37 males (5 nest samples) from Litschen, dist. Hoyerswerda/GDR, leg. SEIFERT 13. viii 1982, 10. viii 1986.

Description

Worker (Figs. 31–33, 37–39, 50–53, 103): Scape at base angularly curved and with weak but normally well-visible caudal carina (weaker than in *specioides*), giving an impression intermediate between *specioides* and *rugulosa*. Frontal carinae weakly curved, intermediate between the conditions in *rugulosa* and *specioides*. Head distinctly longer than wide. Petiole in lateral view on average with slightly concave frontal profile and convex dorsal profile, comparable to *specioides*. Petiole in the northern population on average wider than in *rugulosa* but narrower than in *specioides* and, in dorsal view, with very slightly convex or nearly straight sides. In the southern populations, the petiole is often (but not always) notably wider with more convex sides. Relative width of postpetiole intermediate between *rugulosa* and *specioides*. Sculpture of head and alitrunk comparable to *rugulosa* and *specioides*, but on head more reticulate; in *specioides* and *rugulosa*, clearly reticular rugosity is observed only at occipital corners whereas, in *hellenica*, reticulation begins more frontally and covers at least the caudal third of head. Sculpture on dorsum of petiole irregular and notably stronger than in *rugulosa*, comparable to *specioides*. Propodeal spines in the northern population slightly and in the southern population much longer than in *rugulosa*. Colour of head and alitrunk often light yellowish red which is notably lighter than usually seen in *specioides*. Body size as small as in *rugulosa*.

HL 996.4 ± 46.1 ($n = 92$, 858–1134), HW 944.2 ± 46.1 (92 , 801–1085), HL/HW 1.056 ± 0.0145 (92 , 1.010–1.089), SL/HL 0.796 ± 0.0137 (73 , 0.762–0.825), HW/FR 2.515 ± 0.0823 (85 , 2.28–2.71), FL/FR 1.155 ± 0.0319 (85 , 1.076–1.238), SP/HL 0.315 ± 0.0209 (73 , 0.275–0.369), PE/HW 0.247 ± 0.0126 (73 , 0.224–0.277), PP/HW 0.389 ± 0.0164 (85 , 0.353–0.428).

Allometry:

HW = 0.8737 HL 1.0117 ($n = 92$, $r = 0.9589$)

SP = 0.007388 HL 1.54307 ($n = 78$, $r = 0.7951$)

Comparison of northern and southern *hellenica* workers:

	northern <i>hellenica</i>			southern <i>hellenica</i>		
	mean	SD	(n, range)	mean	SD	(n, range)
HL	989.5	44.3	(75, 858-1092)	1025.8	43.8	(17, 956-1134)
HW	937.8	43.6	(75, 801-1051)	972.5	47.4	(17, 897-1085)
HL/HW	1.056	0.0146	(75, 1.010-1.089)	1.055	0.0144	(17, 1.027-1.076)
SL/HL	0.792	0.0116	(56, 0.762-0.815)	0.808	0.0136	(17, 0.780-0.825)
HW/FR	2.511	0.0858	(68, 2.28-2.71)	2.532	0.0655	(17, 2.43-2.641)
FL/FR	1.154	0.0338	(68, 1.076-1.238)	1.157	0.0237	(17, 1.113-1.201)
SP/HL	0.308	0.0155	(56, 0.275-0.340)	0.337	0.0210	(17, 0.304-0.369)
PE/HW	0.244	0.0115	(56, 0.224-0.265)	0.255	0.0129	(17, 0.234-0.277)
PP/HW	0.387	0.0160	(68, 0.353-0.428)	0.399	0.0158	(17, 0.370-0.425)

Queen (Figs. 42-45): Scape similar to worker but slightly thicker and with a little stronger caudal and dorsal edges at base. The plane bordered by these edges slopes caudad at 35-40°. Petiole as in worker but wider and a little higher. Head longer than wide. Alitrunk narrower than in *rugulosa* or *specioides*. Average HL, HW, AL, and AW significantly smaller than in *rugulosa* ($p < 0.001$)! 23 queens of the northern population have no significant differences from 5 southern queens in all characters listed below except the longer scape of the southern examples ($p < 0.01$).

Data of 28 queens: HL 1118.1 ± 29.0 (1070-1169), HW 1093.1 ± 31.5 (1028-1152), HL/HW 1.023 ± 0.0111 (0.999-1.041), HW/FR 2.458 ± 0.0655 (2.35-2.629), FL/FR 1.118 ± 0.0146 (1.098-1.151), SL/HL 0.759 ± 0.0180 (0.727-0.788), SP/HW 0.296 ± 0.0201 (0.251-0.333), AL/HL 1.506 ± 0.0268 (1.460-1.554), AW/HW 0.779 ± 0.0189 (0.748-0.832), PE/HW 0.269 ± 0.0125 (0.248-0.310), PP/HW 0.432 ± 0.0145 (0.405-0.474).

Male (Figs. 100-102, 107, 109, 125, 127, 139, 142):

Northern population: Very similar to *specioides* and *rugulosa* but average body size significantly smaller, second funiculus segment often more slender, petiole and postpetiole often narrower, and cuspis of volsella shorter. Frontal triangle not clearly demarcated and finely punctate-striate. Dorsolateral surface of petiole normally with very fine longitudinal rugosity. Mesonotum in front of notauli nearly smooth but most frontolateral parts of mesonotum with fine striae. Petiole in lateral view normally clearly lower than long, with frontal and dorsal faces meeting at an obtuse angle. Scape nearly straight and about as long as the first four funiculus segments.

Data of 20 males: HL 759.4 ± 26.6 (710-808), AL 1613.7 ± 70.7 (1460-1735), SL/HL 0.399 ± 0.0282 (0.359-0.450), SL/SW 3.296 ± 0.257 (2.83-3.63), IF2 1.883 ± 0.151 (1.49-2.15), F2 115.1 ± 7.77 (102-130), F2H 81.7 ± 10.28 (68-107), PE/HL 0.315 ± 0.0098 (0.294-0.328), PP/HL 0.480 ± 0.0206 (0.438-0.526).

The single male I have from the southern population differs in having longer appendage pilosity, wider and higher petiole and postpetiole, and larger body size, but is otherwise similar. His data: HL 815, AL 1752, SL/HL 0.413, SL/SW 3.03, IF2 1.80, F2 128, F2H 110, PE/HL 0.356, PP/HL 0.532.

Comments

Previously, I intended to describe members of the northern *hellenica* population under the name "*speciolosa*" as new species (see SEIFERT 1986, pp. 22, 93) but, after examination of more southern material, I find it now much more reasonable to regard both populations as conspecific. The workers of the southern population are slightly larger ($p < 0.01$) and have larger SL/HL ($p < 0.001$), PE/HW ($p < 0.002$), and SP/HL ($p < 0.001$), but the coincidence in the characteristic head indices (HL/HW, HW/FR, FL/FR) and in the diagnostic scape base is almost perfect; the queens are nearly equal in all characters except the longer scape of southern examples. Furthermore, a disjunctive distribution of the northern and southern population is certainly not given: we have literature records from N Italy, Yugoslavia, and Albania (FINZI 1926, BARONI URBANI 1971) which are not suspected to be misidentifications. Another argument for conspecificity of both populations is the characteristic and very similar habitat selection (see below).

The most similar sympatric relatives of *hellenica* are *rugulosa* and *specioides*. In the northern population, where I have enough comparison material of the three species, the

workers are easily to separate using a simple product index

$$I = HW/FR \times FL/FR \times PP/HL$$

which amounts 0.8479 ± 0.0390 ($n = 52$, 0.762–0.924) in *rugulosa*, 1.0637 ± 0.0614 ($n = 68$, 0.939–1.288) in *hellenica*, and 1.4482 ± 0.1017 ($n = 77$, 1.250–1.838) in *specioides* (see Fig. 103). For southern *hellenica* workers, this index is 1.168 ± 0.0790 ($n = 17$, 1.047–1.284) but I have only few *rugulosa* and *specioides* to compare. In any case, a save distinction of the three species workers should be given if small nest series are evaluated and whole character combination are considered. The queens are savely separable by the ratio FL/FR alone which is 1.008–1.066 in *rugulosa*, 1.098–1.151 in *hellenica*, and 1.160–1.404 in *specioides*; many other characters for distinction may be derived from the data.

Very difficult and frequently impossible is the separation of the males. I have examined the genitalia of 9 *specioides* males (3 nests/3 sites), of 12 *hellenica* males (4 nests, 2 sites), and of 11 *rugulosa* males (4 nests, 4 sites) and found no detectable difference in structures and weighted measurements of subgenital plate, sagitta, and volsella. The only significant difference is that the absolute length of volsella's cuspis is significantly longer in *specioides* (124.9 ± 6.6 , $n = 9$, 117–136) compared to *hellenica* (100.9 ± 8.10 , $n = 12$, 90–116), but in *rugulosa* we have extreme variability of this measure even in the same nest (108.0 ± 12.7 , $n = 11$, 79–125). Better, but still very difficult, is the situation in external "somatic" morphology; a number of significant differences can be shown (see data) but the overlap of characters is considerable. The *hellenica* male has, compared to *specioides*, smaller HL, AL and PE/HL (all $p < 0.001$), longer IF2 ($p < 0.01$), and smaller PP/HL and F2H ($p < 0.01$). The best differences to *rugulosa* are the smaller HL, AL, petiole height/petiole length, SL/SW (all $p < 0.001$), and larger IF2 ($p < 0.002$). The *hellenica* male gives a slimmer overall appearance and the low lateral profile of petiole is characteristic to a certain degree (see Fig. 107). The hind tibial, hind metatarsal, and scape pilosity shows no notable difference between the three species which all have pilosity on inner side of hind metatarsus much shorter than on extensor side. Further, the lateral aspect of petiole approaches sometimes in *rugulosa* and more frequently in *specioides* to the average *hellenica* condition. A multiple analysis combining seven characters with some separating power (IF2, SL/HL, F2H, PE/HL, PP/HL, and relative height of petiole) resulted in a discrimination of 70% of all specimens only which reflects the very difficult determination.

Concluded from the female castes, *hellenica* is a very distinct morphospecies that has a characteristic habitat selection. However, it should be tested, with other tools of taxonomy (e. g. isoenzyme analysis or crossbreeding experiments), the theory that *hellenica* could be a natural hybrid of *rugulosa* and *specioides* for which I see certain morphological and chorological suggestions.

Biolog y

All the notes I have on habitat from throughout the species range coincide remarkably in certain aspects. In all 10 sites, the soil has a major portion of sand and is more or less sun-exposed. The vegetation cover is incomplete, patches of bare ground are always present. All habitats can be considered as xerothermous, but they are only superficially dry and their vicinity to waters (in Switzerland, Italy, and Bulgaria sandy river banks) will make water constantly available in deeper soil layers. All habitats have an unstable, somewhat transient character: the sites along rivers are endangered by floodings which cause shifts of soil material and frequent alterations of plant cover, while the sites near the margins of residual waters in former brown coal mines in the Lausitz undergo a very slow but continuous increase of plant cover. Thus it seems not inadequate to regard *hellenica* as species with pionier characters.

More intensively studied were three sites in the Lausitz (Wischgrund, Litschen, Lauchhammer). These are xerothermous areas regenerating in slow natural succession (or with very little human interference) on not ameliorated heaps of former brown coal mines for more than 30 years after the shutdown. The ground consists of tertiary sands or mixed materials with major proportion of sands. The desiccation of top soil may be sometimes extreme but in deeper layers humidity is kept at a rather sufficient level because of the influence of neighboured residual lakes or the existence of tight substrata. A humus horizon is not or only patchily developed and 30–50% of surface are free of vegetation. The sites are in general very sunny but the nests are often found at spots where single *Pinus* and *Betula* trees provide partial shade and where a turf layer with thin humus horizon is present. The

obvious disappearance of *hellenica* from "Revier 55" at Lauchhammer with the closure of the tree canopy indicates that much shade and a temperature decrease are not tolerated. Among the 10 examined nests, 8 were constructed within the root layer of grasses (*Avenella flexuosa*, *Festuca ovina* group members, *Corynephorus canescens*), one under a moss crust, and the last in bare ground consisting of a sand-muck mixture. The nests are not small; populations of 400, 700, 1000, and 1600 workers were estimated. The largest nest contained at least 3 dealate queens, 60 males, and 65 alate gynes. Large nests have several entrance holes. The species is apparently largely zoophagous. Recorded nest densities were 7 nests/100 m² at Wischgrund and 8 nests/100 m² at Litschen. Close nesting to *Manica rubida* was frequently observed without any interference or aggressive encounters. One nest contained the myrmecophilous staphylinid beetle *Atemeles emarginatus*. The swarming was only once observed and took place in late afternoon (30. viii 82, sandy river bank near Melnik). Alates were found in the nests from 7. viii to 6. x.

Distribution

Probably widely distributed in the S and W Balkans and N Italy along sandy river valleys, *hellenica* is known in the Alps from river valleys between 500 and 600 m (Rhine, Ill, and Rhone). The population in the southern GDR (five sites in a rather restricted territory of 2000 km² at 51° 30' N) seems to be very isolated, but a special search will probably demonstrate the species' presence also for S Germany and Czechoslovakia. The distribution in the east is perfectly unknown. The short description ARNOLDI (1970) gives for *Myrmica rugulosa* var. *slobodensis* KARAWAJEW 1936 from the Ukraine suggests it could be *hellenica*. I wrote to Kiev, where many of the KARAWAJEW types should be present, but never got an answer.

***Myrmica specioides* BONDROIT, 1918**, Figs. 34–36, 41, 64, 65, 103, 108, 126, 140

Myrmica specioides BONDROIT, 1918; worker, queen, male; S France

Myrmica scabrinodis v. *ahngeri* KARAWAJEW, 1926

Myrmica puerilis STÄRCKE, 1942

Myrmica balcanica SADIL, 1952

Material

Altogether several hundreds of workers, about 60 queens, and 40 males from GDR, Czechoslovakia, FRG, the Netherlands, Luxembourg, France, Spain, Switzerland, Yugoslavia, Bulgaria, the Ukraine, and S Russia. Among this material the whole type series of BONDROIT from S France: lectotype (det. PISARSKI) from St. Affrique, paratypes from St. Affrique, Banyuls, Prades, Harfleur, Maissons-Laff., Le Hève, Mt. Valerien. Also studied: the lectotype (det. ARNOLDI) and a paratype of *M. scabrinodis ahngeri* KARAWAJEW from Taganrog, leg. C. AHNGER 31. v and 8. vi 1926; type-compared material of *Myrmica balcanica* SADIL from Czechoslovakia (SADIL has never labelled any type).

Description

Worker (Figs. 34–36, 41, 103): Scape at base angled and with a caudal carina which is more prominent than in *hellenica* and shows a clear clinal trend to increase its size from Central Europe to the east, becoming finally (in *ahngeri*) a lobe nearly as large as the European *sabuleti* average (see Figs. 64, 65, queen). The plane bordered by the caudal carina slopes caudad at $20^\circ \pm 5^\circ$. The curvature of the frontal carinae is on average correlated with the carina/lobe size and will become stronger from W to E (mean FL/FR 1.273 in France, 1.318 in Czechoslovakia, 1.401 in S Russia; mean HW/FR 2.841 in France, 2.901 in Czechoslovakia, 2.932 S Russia). Petiole in lateral profile variable in height, in concavity of anterior profile, and in steepness of dorsal surface's caudal slope. However, a character rather constant in all European populations is that the frontal and dorsal profiles do not meet in any angle (there is always a rounding) and that the dorsal profile shows no abrupt step in its caudal slope to postpetiolar junction. Petiole in dorsal aspect variable, but on average distinctly narrower than in *sabuleti*; the sides are normally slightly convex. Sculpture of head, alitrunk, and waist clearly finer than in *sabuleti* but stronger than in *rugulosa*, particularly on petiole node. Sculpture on frons regularly longitudinal and almost parallel. Propodeal spines well developed but much shorter than in *sabuleti*. 12 measured types do not

differ significantly from the whole material's data given below, except in their lower PP/HW (0.387) which is different for $p < 0.01$.

HL 1043.7 ± 59.3 ($n = 101, 929-1196$), HL/HW 1.037 ± 0.0148 (99, 1.009-1.070), SL/HL 0.802 ± 0.0182 (72, 0.761-0.848), HW/FR 2.862 ± 0.1075 (2.670-3.209, 99), FL/FR 1.297 ± 0.0537 (99, 1.180-1.460), SP/HL 0.322 ± 0.0229 (76, 0.281-0.371), PE/HW 0.256 ± 0.0148 (80, 0.225-0.294), PP/HW 0.405 ± 0.0170 (99, 0.361-0.442), PEH 193.1 ± 14.6 ($n = 37$), PPH 182.5 ± 12.34 (37, 157-200), PEH/HL 0.185 ± 0.0156 ($n = 37$), PPH/HL 0.175 ± 0.0131 ($n = 37$).

Allometry:

$$HW = 0.79513 HL^{1.02795} \quad (r = 0.9737, n = 89)$$

$$SP = 0.01681 HL^{1.42463} \quad (r = 0.8030, n = 65).$$

Queen (Figs. 64, 65): Characters similar to worker, but scape, petiole and postpetiole more massive and sometimes a distinct step in the caudodorsal profile of petiole is present (Figs. 185-187). In BONDROIT's type series is, besides 5 normal gynes, one microgyne from "Maissons-Laff." which has the size of a *hellenica* queen but the scape characters and FL/FR are completely outside the known range of the latter species. It is the only *specioides* microgyne I have ever seen.

HL 1197.5 ± 33.7 (33, 1117-1253), HW 1197.4 ± 34.3 (33, 1135-1250), HW/FR 2.836 ± 0.111 (33, 2.610-3.040), FL/FR 1.273 ± 0.0521 (33, 1.160-1.404), SL/HL 0.763 ± 0.0145 (33, 0.739-0.797), HL/HW 1.000 ± 0.0155 (0.974-1.035, 33), PE/HW 0.281 ± 0.0148 (33, 0.255-0.325), PP/HW 0.448 ± 0.0193 (0.399-0.485, 33), SP/HW 0.313 ± 0.0171 (33, 0.287-0.347), AL/HL 1.538 ± 0.0252 (26, 1.485-1.597), AW/HW 0.794 ± 0.0247 (0.747-0.851, 26). The microgyne: HL 1089, HW 1066, HW/FR 2.786, FL/FR 1.296, SL/HL 0.758, HL/HW 1.022, PE/HW 0.256, PP/HW 0.434, SP/HW 0.331, AL/HL 1.481, AW/HW 0.775.

Male (Figs. 108, 126, 140): Very similar to male of *rugulosa*. On average (but not always!) the petiole is lower than in *rugulosa*, with a shallow dorsal curvature, the postpetiole is often relatively longer, and the scape is frequently longer and slender. The sculpture is variable but often a little stronger compared to *rugulosa*.

HL 815.3 ± 31.6 (28, 749-872), AL 1801.9 ± 132.4 (1542-2039, 28), SL/HL 0.419 ± 0.0221 (28, 0.372-0.465), SL/SW 3.264 ± 0.213 (28, 2.80-3.75), IF2 1.761 ± 0.078 (25, 1.63-1.92), F2 124.2 ± 9.14 (25, 111-139), F2H 92.3 ± 9.27 (17, 72-108), PE/HL 0.337 ± 0.0212 (17, 0.312-0.382), PP/HL 0.509 ± 0.0310 (17, 0.452-0.606).

Comments

This widely distributed species has been frequently misidentified in the female castes as *scabrinodis* or even *rugulosa*. A very reliable character for distinction from *scabrinodis* all over Europe is the spatial position of the carinae at scape base (see Figs. and descriptions). *M. specioides* specimens abnormal in this respect and approaching the *sancta* or *scabrinodis* condition are real exceptions (2 out of 2000 examined *specioides* workers). The only European species which could be confused more easily with *specioides* are *M. sabuleti* populations with reduced scape lobe and *aloba* populations with enlarged caudal carina at scape base. However, the coarser and differently structured sculpture, the longer spines, and the massive petiole of *sabuleti* should enable a safe determination in such doubtful cases (For differences to *aloba*, *caucasica*, *turcica*, and *bakurianica* see these species).

The "ahngeri population" of *specioides* does not differ from the Central European specimens except the larger scape lobe and larger FL/FR in the female castes as already stated in description. I have not got the types of *M. striata* FINZI 1926 but, concluded from FINZI's description, it is probably a synonym of *specioides*.

Biology

In Central Europe, *specioides* is frequently found on all types of xerothermous grasslands independently of the geological outcrop. Among the 9 most abundant Central European species, it is the most xerothermophilic (SEIFERT 1986) and I suspect in Europe only *deplanata*, *turcica*, *ravasinii*, *bergi*, and *stangeana* to exceed its xerotolerance. However, as typical for the genus, extremely dry places are avoided and a certain degree of plant cover is an essential prerequisite for its ecological success. In Central European xerothermous grasslands of a certain structure (rather short-grassy, but nearly closed field layer), *specioides* is

often the absolutely dominating *Myrmica*, reaching top densities of 48 nests/100 m². For smaller habitat spots, up to 13 nests/100 m² were found and the average density for 23 test plots was 11.6 nests/100 m² (SEIFERT 1986). *M. specioides* is known from the centres of large cities (Leipzig, Halle) and I found it once on a very salty meadow with moderate humidity and one nest inside a very shady SW-sloped oak forest in a region with comparably warm macroclimate (Meißen). *M. specioides* constructs easily overlooked soil nests with one or several simple entrance holes. Often it nests in the periphery of large *Lasius flavus* hills which provides microclimatic advantages in meadows with higher grasses and ensures a stable and nearby protein supply since *M. specioides* is a strong predator of *L. flavus*' broods and adults. One nest I found was an earth mound of 18 cm diameter and 10 cm height, obviously built by the *specioides* themselves. *M. specioides* climbs in the field layer, but to a lesser extent as e.g. *M. schencki*, blossoms are sometimes visited, and tending for aphids of the root and field layer was observed. Once, an epigaecic aphid colony was sheltered by the *specioides* with walls of soil particles. The major part of food input results doubtless from the very strong epigaecic predation on arthropods. *M. specioides* is aggressive and stings freely. The largest nest I found contained approximately 2500 workers, but average nest populations are surely below 1000. The nests contain normally single or few queens, but one nest contained as much as 60 dealate gynes. The alatae were found in the nests from 24. vii to 17. ix and three flights were recorded between 25. viii and 7. ix.

Distribution

Alone from the small territory of the GDR, I have recorded 67 localities with *specioides* which shows its abundance in Central Europe; a major part of these sites is situated in geographic regions with annual precipitations below 600 mm and altitudes of 400 m are not passed over. The known distribution in the W and N is demarcated by Harfleur/Le Havre (France), E Kent (England), Amsterdam, the North Sea islands Norderney (leg. VIEHMEYER, leg. HEYMONS) and Sylt (leg. ZIMMERMANN), Rødby/Lolland (Denmark), Hällevik/Blekinge (Sweden), Täktom and Rymätüllä (S Finland). In S Russia, the easternmost examples are from the lower Denez River (40° E), Taganrog, and Krasnodar but very likely it goes farther. The southern distribution is poorly known: I have seen examples from Trnovo (42° N) and Sozopol in S Bulgaria and the Burgos Region/N Spain. If correctly determined by KUTTER, *specioides* goes up to 1500 m in Switzerland (Col de Pillon).

Myrmica turcica SANTSCHE, 1931, Figs. 60–63, 116, 134, 149, 172

Myrmica scabrinodis var. *turcica* SANTSCHE, 1931; worker, queen; Ankora/Turkey

Myrmica georgica SEIFERT, 1987

Material

The types of *M. scabrinodis* v. *turcica*: 5 workers and 1 queen from Ankora/Turkey, leg. KERVILLE, stored in NHM Basel. The types of *M. georgica*: 97 workers and two males from Tiflis/Georgian SSR, Mzcheta/Georgian SSR, and Sčučinsk/Kokčetavskaia Oblast' N Kazakhstan), 69° 45' E, 53° 5' N.

Description

Worker (Figs. 61, 62, 172): Sculpture of head, alitrunk, petiole, and postpetiole much less pronounced than in *sabuleti* and comparable to *specioides* or *caucasica*. In contrast to *salina*, the longitudinal rugosity between the frontal carinae is less fine, less dense, and less linear and the posterior half of clypeus is more sculptured and not shining. Scape similar to *sabuleti*, with a broad lobe at base which plane slopes caudad very weakly (11–15°). Petiole in dorsal aspect much narrower than in *sabuleti* and with slightly convex, rarely straight sides. Petiole shape in lateral view as in *caucasica* or *specioides*, with no sharp angles, frontal profile concave, dorsal surface convex and sloping posteriorly without distinct step to its junction with the postpetiole. Spines clearly shorter than in *sabuleti*, head on average longer. Colour of all body parts uniformly reddish brown. Data of 25 workers:

HL 1160.4 ± 70.9 (913–1231), HL/HW 1.056 ± 0.0200 (1.018–1.107), HW/FR 3.055 ± 0.114 (2.86–3.25), FL/FR 1.519 ± 0.0516 (1.400–1.600), SL/HL 0.803 ± 0.0150 (0.778–0.835), SP/HL 0.321 ± 0.0230 (0.257–0.369), PE/HW 0.251 ± 0.0112 (0.230–0.272), PP/HW 0.410 ± 0.0158 (0.382–0.447).

Allometry:

$$HW = 0.78377 \text{ HL } 1.02682 \quad (r = 0.9622, n = 25)$$

$$SP = 0.0004281 \text{ HL } 1.93818 \quad (r = 0.9472, n = 25)$$

Queen (Figs. 60, 63): Similar to worker. The one type queen differs from *sabuleti* in having much weaker sculpture, distinctly narrower petiole, shorter spines, and longer post-petiolar hairs. Between the frontal carinae are about 18 fine, longitudinal rugae. The lateral petiole shape differs from *sabuleti* in being less massive (compare Figs. 63 and 184).

HL 1254, HW 1283, HL/HW 0.977, HW/FR 2.912, FL/FR 1.376, SL/HL 0.766, PE/HW 0.284, PP/HW 0.462, SP/HW 0.319, PEH 235, PPH 240, AL/HL 1.588, AW/HW 0.788.

Male (Figs. 116, 134, 149): The two males from N Kazakhstan are similar to *specioides* and *salina*. Occipital corners with subdecumbent hairs of 95 μm maximum length. Lateral parts of petiole and postpetiole with very weak and fine longitudinal striae which may be more pronounced on dorsolateral petiole node. Scape with very weak curvature at base and as long as in *specioides*. Flexor parts of all femora with long semierect hairs. Measurements of two males:

HL 801, 826; HW 900, 943; SL/HL 0.428, 0.424; SL/SW 2.99, 3.19; AL 1838, 1903; F2 134, 129; IF2 1.91, 1.84; PE/HL 0.370, 0.348; PP/HW 0.609 (deformed), 0.538; F2H 98, 100; MEH 120, 130.

Comments

The type workers of *turcica* show a slightly smaller FL/FR and somewhat larger PE/HW and PP/HW than the *georgica* types but the coincidence of character combinations, including sculpture and scape characters, is so clear that *georgica* has to be regarded as younger synonym.

The female castes of *M. turcica* show character combinations which separate them well from *sabuleti*, *salina* or *caucasica*. However, there is much similarity to the members of E European *M. specioides ahngeri* population with enlarged caudal scape carina in most of the characters and even the FL/FR data overlap a little (*specioides ahngeri* 1.347–1.420, *turcica* 1.400–1.600). As already stated above (see also SEIFERT 1987 b), there is a clear clinal trend in *specioides* to enlarge FL/FR and to enlarge the caudal carina into a lobe from France across Central Europe to E Europe and *turcica* could be the Asiatic continuation of this trend, thus being a subspecies only. The high similarity or equality of the males of *turcica* and *specioides* should be noted in this context as well as the comparable habitat selection. To bring more clarity into this issue, futural revisors will have to sample sufficient female material in the steppe regions on both sides of the lower Wolga River where we might expect intermediate phenotypes, if the subspecies theory should be true.

Biology and distribution

M. turcica seems to be an essentially lowland species of Asia Minor, Transcaucasia, and N Kazakhstan (Ankora: 870 m, Tiflis: 500 m, Mzcheta: 620 m, Sčučinsk: below 350 m) which makes its Transcaucasian populations well isolated by the Great Caucasus from the Ciscaucasian *specioides* populations. The two known habitats in Transcaucasia were steppes with closed field layer and the fact that a particularly dense population was found on a 20° north-exposed steppe slope near Tiflis suggests that most xerothermous places are avoided at lower latitudes. The two males from the Sčučinsk series were collected in 18. viii 1966.

***Myrmica caucasica* ARNOLDI, 1934, Figs. 57–59, 110, 128, 143**

Myrmica rugulosa caucasica ARNOLDI, 1934; worker, queen, male; Caucasus

Material

A total of 18 series with 100 workers, 25 queens, and 20 males; mainly from Great Caucasus (12 series), Armenia (3 series, all type-compared material, labelled by the late ARNOLDI as *sancta caucasica* and collected by himself in Sevan 15. vii 1930, Delizan 8. viii 1930, and "Armenia" 1. ix 1930), Turkey (2 series) and Iran (1 series).

Description

Worker (Figs. 57–59): Very similar to *Myrmica specioides*. Scape at base angled and with strong caudal carina which may frequently enlarge to a lobe nearly as large as in European sabuleti average. The full range of scape variability is observed between nests of the same locality and even within same nests a conspicuous variability may exist. The plane bordered by the dorsal and caudal carina at scape base slopes caudad at $26^\circ \pm 6^\circ$. The lateral petiole shape is as in *specioides* and varies in a similar way. Sculpture similar to *specioides*, but clypeus in *caucasica* finely longitudinally sculptured throughout its surface (in *specioides*, a small area of clypeus immediately before the frontal triangle is more shining, with reduced sculpture). The ratios SL/HL, HW/FR, SP/HL, PE/HW, and PP/HW are significantly smaller and the ratio HL/HW significantly larger in *caucasica* compared to *specioides* (all ratios for $p < 0.001$), but the overlap is considerable. Data of 52 workers:

HL 1127.1 ± 57.7 (979–1254), HL/HW 1.050 ± 0.0186 (1.000–1.097), SL/HL 0.786 ± 0.0164 (0.753–0.823), HW/FR 2.769 ± 0.0967 (2.64–3.05), FL/FR 1.318 ± 0.0485 (1.213–1.423), SP/HL 0.295 ± 0.0335 (0.209–0.336), PE/HW 0.241 ± 0.0143 (0.215–0.269), PP/HW 0.387 ± 0.0179 (0.359–0.433), PEH 189.4 ± 13.8 ($n = 37$), PPH 174.7 ± 11.2 ($n = 37$).

Allometry:

$$\text{HW} = 0.43013 \text{ HL } 1.11327 \quad (r = 0.9499, n = 52)$$

$$\text{SP} = 0.15031 \text{ HL } 1.09381 \quad (r = 0.4570, n = 51)$$

Queen: Similar to worker but petiole, postpetiole, and scape more massive and sometimes a distinct step in the caudal slope of petiole is present. Compared to *specioides*, the ratios SP/HW, PE/HW are significantly smaller and AW/HW significantly larger (all for $p < 0.01$), but the overlap is conspicuous. Data of 16 queens:

HL 1229.6 ± 23.9 (1185–1265), HW 1227.9 ± 24.4 (1192–1267), HW/FR 2.778 ± 0.1381 (2.53–3.00), FL/FR 1.273 ± 0.0496 (1.202–1.356), SL/HL 0.759 ± 0.0105 (0.740–0.779), HL/HW 1.002 ± 0.0193 (0.977–1.042), PE/HW 0.270 ± 0.0121 (0.250–0.294), PP/HW 0.438 ± 0.0234 (0.414–0.485), SP/HW 0.283 ± 0.0321 (0.244–0.350), AL/HL 1.562 ± 0.0519 (1.474–1.661), AW/HW 0.816 ± 0.0167 (0.791–0.849).

Male (Figs. 110, 128, 143): Scape very slightly curved and about as long as first four funiculus segments. Occipital hairs always present. Mesonotum in front of notauli frequently smooth and shining. Compared to the similar *specioides* males, the postpetiole is higher, the appendage pilosity is frequently a little stronger, and F2H is on average longer. Data of 15 males:

HL 861.7 ± 29.9 (820–917), AL 1890.1 ± 101.5 (1726–2069), SL/HL 0.428 ± 0.0250 (0.382–0.474), SL/SW 3.078 ± 0.196 (2.82–3.48), IF2 1.833 ± 0.105 (1.55–1.99), F2 133.3 ± 10.1 (122–156), F2H 113.9 ± 18.3 (92–151), PE/HL 0.333 ± 0.0184 (0.315–0.377, $n = 14$), PP/HL 0.516 ± 0.0164 (0.472–0.540, $n = 14$), MEH 142.9 ± 13.2 (128–173, $n = 13$).

The hairs on extensor profile of hind metatarsus are semierect ($45^\circ \pm 11.5^\circ$, $n = 13$).

Comments

The most similar of all species dealt with here is *M. specioides* and there is no morphological character with a really clear difference in all three castes. In this context, it should be noted that the *specioides* population of the Ciscaucasian lowland steppes (0–700 m) is effectively isolated from the *caucasica* population, which is found in the Great Caucasus between 1200 and 2000 m, by the segregating population of *sancta* which is distributed from 0 to 1500 m. Thus we have a clear altitudinal separation with very different habitat parameters, particularly in precipitations and temperatures, and it seems more adequate to avoid a rash synonymisation and to regard *caucasica*, for the present, as species different from *specioides*. A similarly doubtful problem is *M. caucasica*'s relatedness to *M. sancta*. The morphological differences are comparatively clear in the female castes; examination of nest series and consideration of character combinations will normally result in satisfactorily save determinations and the altitudinal distribution is really different. These are arguments enough to regard *sancta* and *caucasica* as different species but this decision is not free of doubts because the relations in the overlap region (1200–1500 m) are not sufficiently studied. I have collected only 4 nest series of *caucasica* and 3 of *sancta* from these altitudes and one sample of *caucasica* from 1400 m shows morphological characters approximating a

little to *sancta*. Furthermore, the very high mountain barriers in Great Caucasus have obviously generated a very effective isolation of *caucasica* populations in neighbored valleys and produced a morphological divergence which complicated the picture additionally. The worker samples of *caucasica* ($n = 52$) and *sancta* ($n = 49$) differ in following characters for $p < 0.001$: FL/FR, HW/FR, SP/HL, PE/HW, HL, SL/HL, and PP/HW. The differences between the queens are similar but, because of low sample size, $p < 0.001$ is given for FL/FR, HW/FR, and SP/HW only. The *caucasica* male differs significantly from *sancta* in having smaller SL/HL, SW/SL, and shorter appendage hairs which are less erected.

I have never got any response from Leningrad to my question for *caucasica* types. From ARNOLDI's morphological descriptions it seems that he could not really distinguish *sancta* and *caucasica*, and his type series, if still existing, will possibly include both taxa. My decision what *caucasica* is was derived from examination of type-compared material from Armenia and from ARNOLDI's statements on distribution: "very abundant in Caucasus in the woodland as well as in the subalpine zones" (ARNOLDI 1970).

Biology

In Great Caucasus, characteristic habitats are short-grassy and sunny meadows (frequently sheep pastures) and open grassland spots on river banks between 1200 and 2000 m. The humidity conditions will change extremely throughout the year. After snowmelt there is excess of water and some of the river bank nests are endangered by floodings. In summer, however, many of the *caucasica* nest sites will have really xerothermous conditions, particularly in eastern regions with limited summer rain. Consequently, the ant fauna accompanied to *caucasica* consists of mesophilic and xerothermophilic elements: *Lasius niger* and *L. flavus* as well as *Tetramorium* and *Lasius alienus*. In coincidence with ARNOLDI, I found *caucasica* to be the absolutely dominating *Myrmica* species in many places. The alpine zone, where we have *M. sulcinodis* and *lobicornis*, is not reached. Alates were found in the nests from 29. vii to 13. ix. The queen number is obviously low; I found only nests with one queen. One case of mound construction was observed.

Distribution

In Great Caucasus at 1200–2000 m. In Armenia, Turkey and N Iran, as far as known, in similar altitudes (two labels give 1860 m and 1900 m).

***Myrmica sancta* KARAWAJEW, 1926, Figs. 54–56, 111, 129, 144**

Myrmica scabrinodis v. *sancta* KARAWAJEW, 1926; worker; Krim.

Material

A total of 16 series with 49 workers, 9 queens, and 9 males. Origin: Krim (3 series) the Caucasian Black Sea coast (7 series), lower altitudes of Great Caucasus (5 series), and a single worker from Camlidere in Isik valley/Turkey.

Description

Worker (Figs. 54–56): Scape at base angled and with a well-developed dorsal and caudal carina. The plane bordered by these carinae slopes caudad at $48^\circ \pm 8^\circ$ which is much steeper than in *specioides* and *caucasica*. Petiole in lateral and dorsal view similar to *specioides*. Sculpture as in *specioides* or a little coarser, spines longer, frons wider, frontal carinae less diverging, and head longer. Data of 49 workers:

HL 1062.7 ± 53.3 (963–1193), HL/HW 1.057 ± 0.0177 (1.009–1.101), SL/HL 0.804 ± 0.0184 (0.769–0.851), HW/FR 2.561 ± 0.105 (2.35–2.76), FL/FR 1.184 ± 0.0432 (1.094–1.290), SP/HL 0.345 ± 0.0211 (0.294–0.391), PE/HW 0.257 ± 0.0106 (0.235–0.279), PP/HW 0.401 ± 0.0132 (0.373–0.430).

Allometry:

$$\text{HW} = 0.5075 \text{ HL } 1.089435 \quad (r = 0.9557, n = 49)$$

$$\text{SP} = 0.007559 \text{ HL } 1.54806 \quad (r = 0.8132, n = 49).$$

Queen: Similar to worker but with usual queen-attributed change of certain morphometric ratios and sometimes a distinct step in the caudal slope of petiole is present. Data of 9 queens:

HL 1209 \pm 22.2 (1182-1247), HW 1198.7 \pm 17.2 (1178-1222), HW/FR 2.573 \pm 0.1062 (2.31-2.65), FL/FR 1.159 \pm 0.0316 (1.102-1.202), SL/HL 0.759 \pm 0.0138 (0.734-0.774), HL/HW 1.009 \pm 0.0135 (0.991-1.033), PE/HW 0.278 \pm 0.0116 (0.259-0.293), PP/HW 0.449 \pm 0.0106 (0.434-0.465), SP/HW 0.352 \pm 0.0257 (0.317-0.401), AL/HL 1.517 \pm 0.0124 (1.498-1.536), AW/HW 0.798 \pm 0.0185 (0.771-0.825).

Male (Figs. 111, 129, 144): It differs from males of related species as *specioides* through rather distinct characters: The appendage pilosity is more profuse, longer, and erect, approaching something to the conditions in *aloba* or *scabrinodis*. The scape is significantly longer and slender than in *caucasica* or *specioides* and a little more bent. The hairs on extensor profile of hind metatarsus are long and erect ($59^\circ \pm 11^\circ$). Data of 9 males:

HL 850.0 \pm 24.3 (808-875), AL 1786.8 \pm 65.9 (1695-1864), SL/HL 0.475 \pm 0.0209 (0.434-0.506), SL/SW 3.546 \pm 0.227 (3.04-3.87), IF2 1.791 \pm 0.067 (1.68-1.86), F2 138.8 \pm 6.7 (131-146), F2H 125.9 \pm 17.4 (103-150), PE/HL 0.341 \pm 0.0168 (0.315-0.367), PP/HW 0.507 \pm 0.0313 (0.451-0.556).

Comments

The differences to *specioides* are clear in all three castes. The best characters for separation of female castes are the much lower FL/FR and HW/FR as well as the very different spatial position and shape of carinae at scape base. Further, the ratios HL/HW and SP/HL are significantly ($p < 0.001$) larger in *sancta* workers. The next relative of *sancta* within the considered territory is most probably *caucasica* (see this species).

Habitats and distribution

The distribution of *sancta* is characteristic. It seems to be the dominating *Myrmica* species on the Krim and the adjacent eastern Black Sea coast from Novorossiysk down to Soviet-Turkish border (Batumi) where it reaches a region with subtropical climate. In the gardens of Sochi it was very abundant and the only *Myrmica* I found. Along valleys, it penetrates the northern and southern slope of Great Caucasus and the Transcaucasian lowland (Kutaisi, Tiflis). In southern river valleys of Great Caucasus which have a warm climate *sancta* may reach altitudes of 1500 m, but a really abundant species it is in altitudes between 0 and 700 m. In the north, it goes to the Kuban River and, in the south, to Anatolia. It may be predicted for lower altitudes in Armenia. In localities with hot macroclimate (Sochi, Tiflis), it prefers shady habitats, e. g. parks and gardens with high trees, but the highest Caucasus site at 1500 m (Passanauri) was very sunny. According to my rather limited experience, steppe-like habitats as typical for *specioides* are avoided. Three nuptial flights were recorded for 18.-25. ix.

***Myrmica bakurianica* ARNOLDI, 1970**, Figs. 66-68, 112, 130, 145

Myrmica pilosiscapus bakurianica ARNOLDI, 1970; worker, queen, male; Bakuriani (Transcaucasus/SW Georgia)

Material

6 workers, 3 queens, and 3 males from Borzomi Mountains (1700 m) near Bakuriani, taken by ARNOLDI 20. viii 1927 (coll. No 5012) and labelled by himself as *M. pilosiscapus*. ARNOLDI writes in his original description: "in the surroundings of Bakuriani at 1500-1700 m; described after 5 workers, among them the holotype - 4. ix 1927 (Arnoldi), and on 4 males and 2 queens." Since ARNOLDI used to label his types and because the sampling dates do not coincide, these examples are surely no types but reliably type-compared material.

Description

Worker (Figs. 66-68): Scape similar as in those *specioides* examples with well-developed lobe. The plane of lobe slopes caudad at $20^\circ \pm 5^\circ$. Scape with very numerous and long suberect hairs which have twice the density as usually seen in other *Myrmica* species. Very long and numerous hairs are present on dorsal surfaces of head, promesonotum, waist, and gaster. Sculpture on average coarser than in *specioides*, particularly on waist and promesonotum. Epinotal spines longer than in *specioides* and relatively slender, diverging more than in *specioides*. Lateral petiole shape similar to *specioides* but with clearly larger width in dorsal view; postpetiole relatively higher and wider. Body colour dark brown. Data of 6 workers:

HL 1151.5 ± 42.4 (1097–1222), HL/HW 1.023 ± 0.0057 (1.013–1.030), SL/HL 0.818 ± 0.0110 (0.803–0.832), HW/FR 2.858 ± 0.0691 (2.76–2.93), FL/FR 1.333 ± 0.0464 (1.248–1.377), SP/HL 0.358 ± 0.0275 (0.328–0.397), PE/HW 0.271 ± 0.0115 (0.257–0.283), PP/HW 0.433 ± 0.0224 (0.405–0.457), PEH 226.5 ± 7.87 (216–235), PPH 203.4 ± 5.03 (198–208).

Allometry:

$$\text{HW} = 0.80137 \text{ HL } 1.0281 \quad (r = 0.9896, n = 6)$$

$$\text{SP} = 0.00521 \text{ HL } 1.600 \quad (r = 0.9113, n = 6)$$

Queen: Diagnostic characters similar to worker. Data of 3 queens:

HL 1160.0 ± 53.8 (1125–1222), HW 1182.0 ± 48.5 (1142–1236), HW/FR 2.79 ± 0.036 (2.75–2.82), FL/FR 1.301 ± 0.033 (1.267–1.333), SL/HL 0.786 ± 0.0071 (0.780–0.794), HL/HW 0.981 ± 0.016 (0.963–0.992), PE/HW 0.276 ± 0.019 (0.258–0.296), PP/HW 0.443 ± 0.0115 (0.431–0.454), SP/HW 0.326 ± 0.024 (0.300–0.347), AL/HL 1.536 ± 0.025 (1.515–1.564), AW/HW 0.788 ± 0.0116 (0.775–0.796), PEH 223 ± 13.9 (214–239), PPH 218.0 ± 2.0 (216–220).

Male (112, 130, 145): Scape similar to *sancta* but a little thicker. Appendage pilosity nearly as long as in *sancta* but less erect. Second funiculus segment notably more elongated than in *sancta*, *caucasica*, and *specioides*. Postpetiole with many hairs of which the longest measure 203–221 μm . Data of 3 males:

HL 882.3 ± 22.7 (858–903), AL 1897.3 ± 94.6 (1789–1964), SL/HL 0.460 ± 0.0114 (0.452–0.473), SL/SW 3.223 ± 0.193 (3.07–3.44), IF2 2.01 ± 0.026 (1.98–2.03), F2 145.7 ± 9.61 (137–156), F2H 142.7 ± 22.7 (122–167), PE/HL 0.354 ± 0.0132 (0.344–0.369), PP/HW 0.534 ± 0.0172 (0.516–0.551), PEH 201.5 ± 23.0 (182–228), PPH 210.2 ± 9.6 (203–221), MEH 159.3 ± 15.6 (143–174).

Comments

M. bakurianica is so far known from the type locality only. ARNOLDI's type series was apparently still darker in colour than the material I have seen; he writes for worker: „head and gaster black, body dark reddish brown“. Concluded from morphology alone, *bakurianica* should be a good species and has nothing to do with *scabrinodis* (= *pilosiscapus*). The next relatives are probably *caucasica* and *specioides*. From *caucasica*, the female castes are different by the longer spines, much longer and more profuse pilosity, coarser sculpture, broader head, and longer scape. In the workers, *bakurianica* differs for $p < 0.001$ from *caucasica* in HL/HW, SL/HL, PEH, and PPH. The morphometric deviations from *specioides* are less clear but the pilosity is much longer and more numerous in all three castes and the combined picture of all characters is sufficiently different. ARNOLDI said nothing about habitat or biology. The very interesting region of Boržomi Mountains near Bakuriani has much limestone with karst areas (here *M. ravasimii*) but also rich coniferous forests.

Myrmica stangeana RUZSKY, 1902, Figs. 69–74

Myrmica stangeana RUZSKY, 1902; worker; Kirghiz Steppes of Turgai

Myrmica stangeana medvedevi ARNOLDI, 1970

Material

1 worker labelled by RUZSKY himself as follows: “Kirghizk. step', Gora Mal. Bogdo, 5. vi 1902, M. Ruzsky; *Myrmica scabrinodis stangeana* Ruzsk.” This specimen was designated by ARNOLDI in 1970 as lectotype. 1 worker with equal label (surely a paratype) but taken on 2. vi 1902. 4 workers from Naurzum, Kustanai Oblast', leg. KAMENSKY 24. vi 1940. 7 workers, the holotype and paratypes, of *Myrmica stangeana medvedevi* ARNOLDI from Askania Nova, leg. MEDVEDEV May 1927, No. 6496. 2 workers from the Krim, 8. vi 1947. 2 queens from Naurzum, Kustanai Oblast', leg. KAMENSKY 7. viii 1939. 1 queen from Tockoje, Machovka/Sorochinsk, west of Ural River.

Description

Worker (Figs. 69, 71–74): Scape strongly compressed at base, in a way that the smallest diameter is visible in caudodorsal view and the largest in frontodorsal view. Caudal carina always distinct, about as in average Central European *specioides*. A dorsal carina is often very distinct and sharp and runs along three quarters of dorsal scape length, but may be

almost imperceptible in the *medvedevi* types which have further a slightly more prominent caudal carina. Head short. Sculpture in general about as strong as in *specioides*, on front of head very regularly longitudinal. Alitrunk with regular longitudinal rugae which are somewhat reminiscent of *sulcinodis* but are much less coarse. Spines shorter than in *specioides* and slender (often nearly awl-shaped), with thin base and projecting upwards at about 45°. Petiole in lateral aspect similar to *specioides*, but sometimes the frontal and dorsal profiles meet in an angle. Alitrunk profile convex, with more or less shallow mesopropodeal impression. Pilosity on dorsal surface of petiole and postpetiole rather long. Data of 15 workers:

HL 1156.9 ± 70.7 (1043–1292), HL/HW 1.007 ± 0.0103 (0.983–1.020), HW/FR 3.067 ± 0.131 (2.78–3.25), FL/FR 1.320 ± 0.033 (1.244–1.375), SL/HL 0.807 ± 0.0088 (0.790–0.828), PE/HW 0.252 ± 0.0110 (0.234–0.270), PP/HW 0.403 ± 0.0163 (0.378–0.431), SP/HL 0.282 ± 0.0164 (0.253–0.310), PEH 215.3 ± 13.4 (192–240), PPH 203.1 ± 18.0 (174–242).

Allometry:

HW = 0.8269 HL 1.02598 (r = 0.9869, n = 15)

SP = 0.08529 HL 1.1695 (r = 0.7869, n = 14)

Queen (Fig. 70): Similar to worker but with the usual queen-attributed changes of body ratios; base of spines thicker. Caudal slope of petiole with distinct step in all three queens. Data of 3 queens:

HL 1281.6 ± 21.5 (1257–1296), HW 1315.7 ± 16.2 (1301–1333), HL/HW 0.974 ± 0.0113 (0.966–0.987), HW/FR 2.987 ± 0.0252 (2.96–3.01), FL/FR 1.255 ± 0.0122 (1.247–1.269), SL/HL 0.752 ± 0.0194 (0.730–0.765), PE/HW 0.273 ± 0.0105 (0.262–0.283), PP/HW 0.431 ± 0.0045 (0.427–0.436), SP/HW 0.272 ± 0.0163 (0.254–0.284), PEH 222.0 ± 28.2 (196–252), PPH 208.0 ± 12.5 (195–220).

Male: Unknown to me. We have only a brief description of ARNOLDI who has taken an isolated male outside a nest which he believed to be *M. stangeana*: Scape short, about 2.5 the length of first funiculus segment, SL/HL 0.345, SL/SW 2.75, F2/F1 1.17, F2/F3 1.67, head width behind eyes/HL 1.0; head broad and very rounded behind the eyes; frontal triangle deep; hairs on scape about as long as its diameter, those on tibiae shorter than diameter.

Comments

The character combination of *stangeana* should make its separation from sympatric species relatively easy. In general, the worker is similar to Central European *specioides* but the sympatric *specioides* populations differ clearly.

The coincidence of mean values between the two *medvedevi* worker series (n = 9) and the two series of the nominal form (n = 6) is almost perfect for each of the ten numeric characters given in description and there can be shown no statistically significant difference in each character even for the very weak level $p < 0.05$. The series share also the typically compressed scape base with very narrow and tapering dorsal plane, and the delicate differences in the expression of dorsal and caudal carinae are much smaller than the variability we usually have in other species. Thus it is difficult to understand why ARNOLDI could make up a subspecies which distribution is a consistent part of the geographical range of the nominal form.

Biology and Distribution

The poor literature statements describe it as halophilic species of steppes and semideserts from the lower Dnepr River to E Kazakhstan (about 33° E to 70° E). The known geographical range seems to be inhabited through a coherent population; it is known from the lower Dnepr River, Askania Nova, the Krim, the northern coast of the Assow Sea, the Ciscaucasian steppes, the N Caspian and lower Wolga River steppes, the Turgai, Kustanai and Kokçetav regions. There are suggestions that it could go farther west.

Myrmica salina RUZSKY, 1905, Figs. 115, 133, 148, 168-171

Myrmica scabrinodis var. *salina* RUZSKY, 1905; worker, queen, male; Tobolsk/Gouv. Orenburg.

Myrmica slovacica SADIL, 1952

Myrmica slovacica SADIL, sensu ARNOLDI 1970

Myrmica slovacica SADIL, sensu KUTTER 1977

Material

A total of 29 series from 21 localities with 80 workers, 25 queens, and 12 males: GDR (10 series, 4 localities), Czechoslovakia (6/6, including SADIL's specimens of *slovaca*), Hungary (1/1), Bulgaria (1/1), the Ukraine and S Russia (4/4), Kazakhstan (2/2), Novosibirskij Oblast' and Altai (3/3).

Description

Worker (Figs. 168-171): Scape at base clearly angled, without dorsal carina (!), and with an almost *sabuleti*-like lobe of somewhat differing size. The plane of lobe slopes caudad very weakly (15° or less). Posterior and middle part of clypeus remarkably smooth and shining. A very narrow frons diverges strongly into broad frontal lobes. Head short. Sculpture very much weaker and finer than in *sabuleti*. Between frontal carinae very fine, rather indistinct longitudinal striae. Petiole in dorsal view much narrower than in most of the other species and with more or less straight, frontad converging sides. Lateral aspect of petiole variable, but with always concave anterior face and a rounded dorsocaudal surface which gradually slopes down to its junction with postpetiole. Colour of head dark brown, gaster blackish brown, alitrunk lighter. Data of 68 workers:

HL 1092.1 ± 69.3 (948-1253), HL/HW 1.005 ± 0.0141 (0.969-1.038), HW/FR 3.914 ± 0.212 (3.39-4.49), FL/FR 1.811 ± 0.109 (1.551-2.095), SL/HL 0.791 ± 0.0149 (0.756-0.817), SP/HL 0.328 ± 0.0239 (0.284-0.372), PE/HW 0.242 ± 0.0094 (0.223-0.268), PP/HW 0.386 ± 0.0160 (0.348-0.426), PEH/HL 0.188 ± 0.0146 (n = 52, 0.158-0.217), PPH/HL 0.174 ± 0.0138 (n = 52, 0.146-0.202).

Allometry:

HW = 0.68276 HL 1.05384 (n = 68, r = 0.9798)

SP = 0.011066 HL 1.48446 (n = 67, r = 0.8387)

Queen: Similar to worker. Data of 21 queens:

HL 1197.7 ± 31.5 (1129-1247), HW 1240 ± 31.3 (1164-1284), FL/FR 1.752 ± 0.0862 (1.584-1.911), HW/FR 3.946 ± 0.174 (3.60-4.39), HL/HW 0.966 ± 0.0181 (0.942-1.017), SL/HL 0.742 ± 0.0147 (0.722-0.777), PE/HW 0.267 ± 0.0088 (0.252-0.280), PP/HW 0.429 ± 0.0149 (0.403-0.461), SP/HW 0.323 ± 0.0134 (0.298-0.346), PEH 224.8 ± 15.0 (197-261), PPH 217.4 ± 10.8 (201-236), AW/HW 0.786 ± 0.0248 (0.750-0.833), AL/HL 1.568 ± 0.0325 (1.513-1.649).

Male (Figs. 115, 133, 148): Very similar to males of *hellenica*, *specioides*, and *turcica*. Occipital corners of head with many subdecumbent to suberect hairs of 98-127 μm maximum length. Petiole and postpetiole perfectly smooth. Petiole shape variable, but on average very narrow and low, with anterior and dorsal profiles meeting at a very blunt angle. Scape weakly curved at base. Hairs on extensor profile of hind metatarsus much longer than those on flexor profile. Data of 12 males:

HL 816.6 ± 26.3 (769-856), AL 1796.8 ± 73.9 (1667-1908), SL/HL 0.404 ± 0.0195 (0.369-0.429), SL/SW 2.970 ± 0.149 (2.77-3.26), F2 133.3 ± 9.7 (118-147), IF2 1.881 ± 0.131 (1.65-2.06), F2H 116.9 ± 15.8 (99-162), PE/HL 0.346 ± 0.0292 (0.299-0.406), PP/HW 0.508 ± 0.0375 (0.453-0.584), MEH 124.9 ± 12.9 (105-146).

Comments

In the female castes, *M. salina* is not to be confused with any other European species except perhaps *turcica*, but *salina* has a very much larger HW/FR (non-overlapping data!), clearly larger FL/FR, much shorter head, narrower postpetiole, different sculpture, much more prominent frontal lobes in lateral view, and a different structure of scape base (see Figs. 171, 172).

I have never got an answer from Leningrad regarding the types of *salina*, but in such a clearly characterized ant it seems to be no risk to identify it from description alone. AR-

NOLDI (1970), who had worked for many years in Leningrad, did not say a word whether the types are lost or not and fixed a lectotype (!) in a series from Kulundinskaja Step', Blagodarnoje, leg. PAVLOVA 19. vii 1969, which is in fact *salina* but, according to the international laws of nomenclature, never a lectotype. Further, the alleged morphological differences between *slovaca* and *salina* as stated by ARNOLDI (1970) are not existing. ARNOLDI's error is in part explained by a misidentification: he determined *M. turcica* from Kazakhstan as *slovaca* and found consequently clear differences between "*slovaca*" and *salina*.

M. salina has a notably constant morphology and characteristic habitat selection throughout its huge range from 7° E to 85° E. In fact, I could not see a notable difference between the *slovaca* specimens of SADIL (who did not designate types for all the taxa he introduced) from Bohemia, Slovakia, and Moravia and specimens from *salina*'s terra typica in SW Siberia. The mean values of 11 characters listed up in the table below, taken on 51 workers from Europe (west of the Ural River) and on 17 workers from Siberia (east of the Ural River), are equal for $p < 0.02$ in 10 characters. In FL/FR only, we have a small difference which is significant for $p < 0.001$ but insufficient as argument to maintain *slovaca* as European subspecies of *salina*. Sculpture and colour of European and Siberian female castes do not differ and the single Siberian male is not different from 16 European males.

Data of *Myrmica salina* workers

	Europe mean	(n = 51) SD	Siberia mean	(n = 17) SD	significancy level
HL	1094.1	76.2	1086.0	43.8	n. s.
HW/FR	3.891	0.189	3.981	0.267	n. s.
FL/FR	1.786	0.094	1.887	0.118	0.001
HL/HW	1.003	0.0139	1.012	0.0123	0.05
SL/HL	0.789	0.0139	0.795	0.0171	n. s.
SP/HL	0.330	0.0220	0.326	0.0295	n. s.
PE/HW	0.244	0.0095	0.238	0.0076	0.05
PP/HW	0.387	0.0156	0.384	0.0175	n. s.
PEH/HL	0.188	0.0145	0.188	0.0153	n. s.
PPH/HL	0.175	0.0150	0.174	0.0139	n. s.
FLW/HL	0.148	0.0081	0.153	0.0085	0.05

FLW = maximum width of one frontal lobe measured perpendicularly to border line with frontal triangle

Biology and distribution

In Siberia as well as in Europe, *salina* is characteristic for habitats with a particularly high salinity which are frequently margins of salt lakes. RUZSKY's brief statements on habitat and mode of nesting coincide with my own findings from the salinas at Hecklingen and Sülldorf/district Magdeburg. In both these sites, there are, around bare central areas with extreme salinity where no vascular plants can exist, narrow zones with declining salinity (0.5–0.1 ‰) and beginning growth of *Salicornia*, *Puccinellia distans*, *Halimione pedunculata*, and other salt vegetation, giving a cover percentage of 20–40 ‰. In these "struggle zones", *M. salina* was the absolutely dominating ant, having nest densities of 20 (Hecklingen) and 25 nests/100 m² (Sülldorf) and a dominance of 59 ‰ and 64 ‰ respectively; the remainder was shared by the subordinated ant species *Lasius niger*, *L. flavus*, *Myrmica gallienii*, *scabrinodis*, *specioides*, *rugulosa*, and *rubra*. The more the vegetation closed and surface salinity declined the more *salina* lost its dominance and was finally competed out by *scabrinodis*, *gallienii*, and *rubra* – a drastic change sometimes to be observed within a distance of 2 meters. In its dominance zone, *salina* was observed to behave aggressive against other *Myrmica* species: I saw it repeatedly killing *rubra* and fighting with *specioides*. Although surely thermophilic, it still foraged at surface temperatures of 13 °, on ground and in lower vegetation. At Hecklingen, *salina* was frequently observed to live in trophobiosis with the subterranean aphid *Geoica utricularia* (Mordv.), det. GOTTSCHALK; the aphid galleries were within the nests, but frequently additionally spaced outside the nest in small *Puccinellia* spots 0.5–1 m away. The same nest could dominate several external root aphid spots as detected by tracking of above-ground traffic movements. The nests have few, larger nests up to 8, small entrance holes which are sometimes surrounded by small soil ejections. They are normally constructed at spots with a little vegetation as *Salicornia* (11 obser-

vations), *Puccinellia* (5), *Salicornia* + *Puccinellia* (4), *Aster tripolium* (4), *Halimione pedunculata* (2), *Odontites rubra* (2), and *Lotus tenuitoliis*; one nest was found in bare ground. Larger, older nests may sometimes show a suggestion of a flat mound. The inner nest structure showed galleries and chambers mainly 4–13 cm below surface, but a vertical duct went to much deeper chambers. Six nests dug out contained 200, 250, 300, 600 and 800 workers and never more than one queen which coincides with the findings of ASSING (1987) who reported monogyny for all the nests he controlled in the Neusiedlersee region in E Austria. Although high resistance against increased soil salinity is surely its most outstanding property, *salina* is not restricted to salty habitats; as recedent or subrecedent ant it can be found in several types of steppe-like habitats, e. g. xerothermous limestone grasslands (Krahnberge near Gotha) or xerothermous margin lines in agricultural regions (Trebbichau near Köthen). Alates were observed in the nests from 1. viii to 30. viii.

Together with several reliable literature records, I have knowledge of 33 *salina* sites from 7° E (Genfer See) to 85° E (Altai, Kysyl Ozek). The species is known from Switzerland (1 locality), GDR (4), Czechoslovakia (9), Austria (2), Hungary (1), Bulgaria (2), the Ukraine and European Russia (6), and SW Siberia (8). The northern border is in Central Europe at 52° N, in S Russia at 54° N (south of Rjasanskaja Oblast'), and in Siberia at 54° N (Kokčetaev). The southernmost site in the Balkans in Bačkovó/S Bulgaria (42° N).

Myrmica scabrinodis NYLANDER, 1846, Figs. 113, 131, 146, 159–163, 165, 167

Myrmica scabrinodis NYLANDER, 1846; worker, queen, male; Vadstena/Sweden

Myrmica scabrinodis var. *rugulosoides* FOREL, 1915

Myrmica pilosiscapus BONDROIT, 1920

Myrmica scabrinodis rolandi var. *reticulata* SANTSCHI, 1931.

Material

Many thousands of workers, more than 200 queens, and about 60 males, mainly from GDR, the Caucasus, and near Moskow; smaller samples from Sweden, England, Wales, France, Spain, Switzerland, Czechoslovakia, Poland, Bulgaria, and Yugoslavia. 2 workers of *M. scabrinodis rugulosoides* from the type locality Marais sur Roche/Switzerland. Type specimens of *M. scabrinodis rolandi* var. *reticulata* SANTSCHI (1 male, 2 queen, 13 workers) from Oð, Val d'Astos, Central Pyrenees, leg. G. DE KERVILLE 22.viii 1929.

Description

Worker (Figs. 159–163, 165, 167): Scape at base sharply angled; its dorsal and caudal carinae are always strong and form together the frequently horseshoe-shaped border of a plane sloping caudad at an angle of $47.0^\circ \pm 4.3^\circ$ ($n = 21$). This angle is very constant throughout the species' geographic range and offers the most reliable means for distinction from *specioides* and *sabuleti*. In contrast to its constant slope and the always strong bordering carinae, the area and shape of this plane is highly variable even within one nest; it may form a relatively narrow, proximally tapering plane or, as opposite extreme, a broad plane circumscribed by a three-quarter circle and produced more caudad (see Figs. 159–163). The more or less concave anterior petiolar face and the straight dorsal petiolar profile meet always in a distinct angle of $85.9^\circ \pm 5.3^\circ$ ($n = 178$, 70° – 95° , nearly the full range is possible within same nest). Dorsocaudal slope of petiole always with distinct step before its junction with postpetiole. Relative petiole width on average much larger than in *specioides*, propodeal spines longer.

HL 1067.3 ± 63.0 ($n = 230$, 896–1239) HL/HW 1.036 ± 0.0161 (198, 1.000–1.073), SL/HL 0.780 ± 0.0162 (198, 0.740–0.822), HW/FR 3.060 ± 0.120 (198, 2.70–3.44), FL/FR 1.384 ± 0.0571 (198, 1.227–1.570), SP/HL 0.353 ± 0.0246 ($n = 211$, 0.297–0.405), PE/HW 0.283 ± 0.0134 (198, 0.251–0.337), PP/HW 0.407 ± 0.0150 (198, 0.376–0.439), PEH 185.5 ± 17.0 ($n = 50$), PPH 166.0 ± 16.3 ($n = 50$), PEH/HL 0.173 ± 0.0151 ($n = 67$), PPH/HL 0.158 , 0.0155 ($n = 67$).

Allometry:

HW = 1.0320 HL 0.9903 ($r = 0.9544$, $n = 195$)

SP = 0.05905 HL 1.2556 ($r = 0.7129$, $n = 193$)

Queen: Similar to worker:

HL 1224.4 ± 38.0 ($n = 41$, macrogynes 1122–1295, microgyne 1098), HW 1229.0 ± 38.1 ($n = 41$, macrogynes 1158–1286, microgyne 1095), HL/HW 0.996 ± 0.0148 (41, 0.957–1.032), HW/FR 2.955 ± 0.0945 (41, 2.746–3.185), FL/FR 1.323 ± 0.0555 (41, 1.186–1.484), SP/HW 0.342 ± 0.0327 (41, 0.267–0.404), SL/HL 0.742 ± 0.0179 (41, 0.702–0.783), PE/HW 0.307 ± 0.0154 (41, 0.275–0.346), PP/HW 0.465 ± 0.0172 (41, 0.437–0.510), AW/HW 0.804 ± 0.0184 (23, 0.776–0.836), AL/HL 1.529 ± 0.0312 (23, 1.486–1.625), PEH 200.8 ± 17.9 (18, 172–223), PPH 196.9 ± 14.8 (18, 175–218).

Male (Figs. 113, 131, 146): Scape very short and thick, a little curved at base. Pilosity on scape, proximal funiculus, femora, tibiae, and tarsae very long and suberect to erect. The longest hairs on hind metatarsus except the most apical hairs are 210–273 μm long and suberect to erect; hairs on occipital corners of head 85–155 μm long. Petiole and post-petiole relatively high and wide; petiole in lateral view with almost straight frontal profile and a straight or moderately rounded dorsocaudal surface.

HL 893.4 ± 42.1 (782–979, $n = 45$), AL 1931.4 ± 116.0 (44, 1637–2123), SL/HL 0.387 ± 0.0170 (41, 0.343–0.420), SL/SW 2.565 ± 0.142 (2.33–2.95, 41), F2 135.8 ± 11.0 (41, 118–158), IF2 1.670 ± 0.145 (28, 1.43–2.03), F2H 170.5 ± 16.9 (30, 136–201), MEH 234.8 ± 19.4 (18, 211–273), PE/HL 0.407 ± 0.0274 (0.356–0.451, 21), PP/HL 0.563 ± 0.0378 (0.478–0.634, 20).

Comments

I can not see a suggestion to maintain *M. rugulosoides* FOREL. In a previous study (SEIFERT 1984), I have shown for Central Europe that *scabrinodis* populations from dry habitats do not differ morphologically from those populations which inhabit the wettest parts of peat bogs and are said to be an own species *M. rugulosoides*. Two workers from the type locality Marais sur Roche, Switzerland, leg. VIEHMEYER 24.viii 1919, apparently labelled by FOREL himself as paratypes (first description 1915!) were normal *scabrinodis*. Further there is no suggestion for me that *pilosiscapus* BONDROIT could be a species different from *scabrinodis*. BONDROIT had erroneously determined *sabuleti* as *scabrinodis* and gave his *scabrinodis* material the name *pilosiscapus*.

The geographic variability of *scabrinodis* seems to be relatively low compared to *sabuleti*; *scabrinodis* from Central Europe, Moscow, and Caucasus are almost equal in morphology and the habitat selection is almost the same. However, attention should be paid to certain *scabrinodis* populations from S France (Alpes Maritimes), the Pyrenees, and N Spain. Here, we find samples which seem to approximate morphologically a little to *aloba*; they show subaverage FL/FR and PE/HW and larger SP/HL and body size than the *scabrinodis* population from outside this region. Their scape shape is in general much more similar to *scabrinodis* than to *aloba*, but there is a trend visible to lose the sharp angle and to be more "angularly curved". These somewhat intermediate populations and the nearly equal males of *scabrinodis* and *aloba* suggest both taxa to be conspecific. However, there are no samples with clearly transitional characters among the 8 *scabrinodis* nest samples from the critical region, including the type series of *reticulata* SANTSCH; they are much more *scabrinodis* than *aloba*. Further, the 28 series of *aloba* workers I have examined show no clear trends towards *scabrinodis* and it seems to me there is a region of overlap of *aloba*'s and *scabrinodis*' distributional ranges in the Pyrenees and N Spain with no obvious destruction of morphological differences. Thus, I think *aloba* and *scabrinodis* to be parapatric species rather than distinct subspecies and a rash synonymisation should be avoided.

Outside this problematic region, the only species the *scabrinodis* worker is easily confused with is *vandeli* (see this species) and the separation from *sabuleti* and *specioides* is quickly possible by the scape characters alone.

I have not seen the NYLANDER types. According to KUTTER (1977) who knew the species' characters sufficiently, the sexuales were typical *scabrinodis* while the workers belonged to *sabuleti*. Here, a lectotype fixation in one of the sexuales is indicated to save a stable nomenclature.

Biology

The nest populations of *scabrinodis* were very well studied by ELMES and WARDLAW (1982 a, b) in S England. They reported for 7 different grassland sites a mean nest density of 0.21 nests/100 m^2 whereas the top density was 1.0 nests/ m^2 with 900 workers/ m^2 and 4.6

queens per nest. My own data (SEIFERT 1986) are very similar; I found for 15 test plots in the southern GDR a mean nest density of 19.1 nests/100 m² and a maximum density of 109 nests/100 m² which is probably the upper limit of carrying capacity a habitat can hold spaciouly. The largest nest ever found I estimated to contain 2500 workers. Among 8 widely distributed Central European *Myrmica* species, *scabrinodis* occupies an intermediate position in the preferred habitat temperatures; it is less thermophilic than *rugulosa* or *sabuleti*, but more than *rubra*, *ruginodis*, and *lobicornis* (for details see SEIFERT 1986). An outstanding ecological property of *scabrinodis* is the high tolerance for soil humidity; it can develop very dense populations in fresh-dry as well as in extremely wet habitats but avoids the driest parts of xerothermous grasslands. The latter must be emphasized for we have many false reports of *scabrinodis*' occurrence in very dry habitats which refer in reality to *specioides* or *sabuleti*. I recorded the highest densities for the wettest, floating Sphagnalia of peat bogs where the heating up by insolation is large enough for *scabrinodis* to compete out the oligothermo-hygrophilic species *ruginodis* and *rubra*. The habitat selection in Caucasus is similar as in Europe. It is no woodland species but may occur even in centres of large forests if there are small spots of ground with direct exposure to sunlight. In meadows, *scabrinodis* frequently lives in close neighbourhood of *Lasius flavus* nests which broods are exploited as constantly available protein source. The zoophagous activity is large. Trophobiosis with aphids on roots or lower herbs was observed. If attacked and seized by other ants, as observed in encounters with *Lasius niger* and *Formica rufa*, the *scabrinodis* worker feigns death so that she will be released after few seconds and escapes quickly. Once recorded as host of *Microdon*. The first alates were observed in the nests in late July and 4 flights were recorded from 24. viii to 16. ix.

Distribution

The southern border of distribution in the Mediterraneans is unknown to me and, because of possible misidentifications, I can not rely on literature records. In the Balkans, it goes south to 41° N at least and seems to be, at these latitudes, an exclusively mountain species, occurring between 1400 and 2000 m. In Scandinavia it is widely distributed up to 68° N.

***Myrmica aloba* FOREL, 1909, Figs. 46-49, 105, 123, 140**

Myrmica scabrinodis var. *aloba* FOREL, 1909; worker; Ronda/Andalusia

Myrmica rolandi BONDROIT, 1918

Myrmica albuterensis LOMNICKI, 1923

Material

A total of 28 series with 62 workers, 10 queens, and 7 males from entire Spain, SW France (2 series), Mallorca (4 series), and Formentera (1 series). Among them 4 worker types of FOREL labeled as "Andalusia (Vogt), Typus" (2 workers) and "Ronda, Andalusia (Vogt), Cotypus" (2 workers) from the Geneva museum. Furthermore 8 types of *M. rolandi* BONDROIT from the Brussels museum with labels "Pyrénées Orientales 1917, Type" (2 workers); "Pozuela/Espagne, Type" (3 workers); "Cartagena, Type" (1 queen); "Madrid, Type (1 queen); "Espagne, Type" (1 queen).

Description

Worker (Figs. 46-49): Scape very characteristic; in caudal view its base is normally evenly bent in an ideal curve (as in *gallienii*) and a weak but clearly visible caudal carina as well as a weak edge running along the outside of bend are present. In few examples, the caudal carina is not detectable. Series from NE Spain or Mallorca have sometimes a more developed caudal carina (about as strong as in average W European *specioides*) and the scape base is not ideally curved, with the suggestion of an angle, but less angular than in *specioides*. Sculpture normally strong and somewhat similar to *sulcinodis*, but on average much less coarse, on petiole and postpetiole in few series weak. Frontal triangle normally weakly demarcated and entirely longitudinally striate. In few examples, the striae are restricted to caudal half of a better demarcated frontal triangle, but even this reduced sculpture is stronger than in *specioides*. Longitudinal sculpture on clypeus coarser than in *specioides*. Spines long and acute. Petiole in lateral view somewhat similar to *sabuleti*, but less high and in dorsal view narrower. Large robust species. Data of 62 workers:

HL 1181.4 ± 72.8 (948–1283), HL/HW 1.023 ± 0.0151 (0.990–1.056), HW/FR 2.804 ± 0.116 (2.550–3.07) FL/FR 1.197 ± 0.0359 (1.107–1.287), SL/HL 0.784 ± 0.0157 (0.758–0.819), PE/HW 0.262 ± 0.0132 (0.236–0.292), PP/HW 0.390 ± 0.0167 (0.343–0.424), SP/HL 0.365 ± 0.0184 (0.323–0.419), PEH/HL 0.175 ± 0.0132 (n = 42), PPH/HL 0.165 ± 0.0090 (n = 44). 15 workers from Mallorca and Formentera do not differ significantly from 47 continental workers except their larger body size (HL 1244.1 ± 28.8 against 1161.4 ± 71.3), lower PE/HW (0.250 ± 0.0097 against 0.266 ± 0.0117), and lower PP/HW (0.376 ± 0.0180 against 0.394 ± 0.0139).

Allometry:

HW = 0.7864 HL 1.0307 (r = 0.9761, n = 62)

SP = 0.1596 HL 1.1167 (n = 0.8166, n = 62)

Queen: Similar to worker. Data of 10 queens:

HL 1316.3 ± 33.1 (1276–1387), HW 1329.3 ± 25.7 (1300–1385), HL/HW 0.990 ± 0.0085 (0.982 bis 1.003), HW/FR 2.626 ± 0.083 (2.483–2.723), FL/FR 1.144 ± 0.0270 (1.099–1.185), SL/HL 0.745 ± 0.0168 (0.715–0.766), PE/HW 0.296 ± 0.0152 (0.270–0.316), PP/HW 0.450 ± 0.0203 (0.427–0.485), SP/HW 0.355 ± 0.0162 ((0.329–0.382), AW/HW 0.816 ± 0.0352 (0.770–0.871), AL/HL 1.560 ± 0.0347 (1.524–1.632), PEH 212.3 ± 16.5 (196–250), PPH 204.6 ± 14.5 (185–226).

Male (Figs. 105, 123, 140): Nearly equal to *scabrinodis*. Scape very short and thick, a little curved at base. Pilosity on scape, basal funiculus, femora, tibiae, and tarsae very long and suberect to erect. The longest hairs on hind metatarsus (except the most apical hairs) are between 200 and 250 μ m long. Genae and occipital corners with long hairs. Petiole and postpetiole less wide than in *scabrinodis*. Petiole in lateral view with straight frontal profile and a moderately rounded dorsocaudal profile. Data of 7 males:

HL 921.4 ± 24.3 (892–953), HW 1012.0 ± 28.4 (965–1043), AL 1939.7 ± 85.1 (1838–2084), IF2 1.663 ± 0.086 (1.56–1.81), SL/HL 0.385 ± 0.0181 (0.364–0.411), SL/SW 2.604 ± 0.222 (2.37–2.91), PE/HL 0.378 ± 0.0258 (0.355–0.428), PP/HL 0.520 ± 0.0247 (0.488–0.561), F2H 173.7 ± 28.9 (150–234), F2 150.0 ± 9.5 (133–163), F3 102.1 ± 7.8 (91–114).

Comments

All the 8 types of BONDROIT's *M. rolandi* I have examined are clearly *M. aloba*. This proves true also for those two type workers labelled "Pyrenées Orientales, 1917" for which ESPADALER (pers. comm.) assumed they should be "the very and unique types of *M. rolandi*" because they should have head indices differing from *aloba* types. The mean values of 4 *aloba* types, these 2 *rolandi* types, and all 5 *rolandi* worker types are as follows: HW/FR 2.737, 2.724, 2.766; FL/FR 1.213, 1.199, 1.196; HL/HW 1.024, 1.038, 1.033; SL/HL 0.771, 0.776, 0.784; SP/HL 0.364, 0.363, 0.357. These values are very similar and each of these 15 means differs less than one standard deviation from the mean of the total *aloba* material (see description). Furthermore all *rolandi* types have the diagnostic *aloba* scape and are also in additional characters normal *aloba*. Thus, I can not see a single suggestion for separate species identity of *rolandi*.

On the Balearic Isles, we have apparently only one *Myrmica* species, described from Mallorca as *M. albuterensis* by LOMNICKI in 1923. I can state that the *Myrmica* samples from Mallorca and Formentera I have examined are almost equal to *aloba* from the Iberian mainland in the diagnostic morphometric and structural characters as scape base and head sculpture. *Myrmica* from Mallorca have a more angularly curved scape base with a more developed caudal carina, but exactly such examples as well as different degrees of intermediates are found on the continent too. Compared to the intraspecific variability we usually have in *Myrmica* species, the only clear differences of *albuterensis* from the mainland populations (larger size and narrower waist) are insufficient arguments to justify it as own morphospecies.

Biology and distribution

The species is reported by several authors as typical ant of salt marshes with high water table along the whole Spanish Mediterranean Sea coast as well as on the islands Mallorca, Menorca, Ibiza and Formentera. The records from Banyuls, St. Laurent du Var, and the Carmarque suggest that *aloba* can be expected for corresponding habitats along the coast of the Golfe du Lion. According to my site records, *M. aloba* is obviously widely distributed

throughout the Iberian inland between sea level and 1400 m and TINAUT and ESPADALER (1987) write the species is "widely distributed in zones with a certain degree of humidity." The upper limit of altitudinal distribution in Spain is unknown to me. Alates are found in viii. ix.

Myrmica sabuleti MEINERT, 1861, Figs. 89, 90, 93–96, 120, 137, 153, 173, 184

Myrmica sabuleti MEINERT, 1861; worker, male; Buurkrat ved Norse-Vosborg (Danmark)

Myrmica scabrinodis NYLANDER, sensu BONDROIT 1920

Myrmica scabrinodis ssp. *lonae* FINZI, 1926

Myrmica sabuleti var. *spinosior* SANTSCHI, 1931

Material

Altogether several hundred workers, 50 queens, and 50 males from Norway (1 locality, 1 series), Finland (1/1), Scotland (3/3), England and Wales (2/2), GDR (24/30), Czechoslovakia (1/1) Hungary (2/2), Switzerland (5/7), S France (4/5), the Pyrenees (2/2, among them a worker type of *spinosior* SANTSCHI, labelled "Pyren. occ., Irun, 25.–26. 3. 1926, Lindberg, type", stored in NHMB), North and Central Spain (10/12), S Bulgaria (4/7), Elba (1/1), Corsica (1/1), N Italy (1/1), Greece (2/2), Anatolia (1/1), Yugoslavia (1/1), and S. Russia (1/1).

Diagnostic characters

Worker (Figs. 89, 90, 93–96, 173): Scape base rectangularly angled and with a caudal carina or lobe of extremely variable size but invariable spatial position. The plane bordered by the more or less diagonal dorsal carina and by the caudal carina slopes caudad at only $19^\circ \pm 6.8^\circ$ ($n = 25$) which is a very clear difference to *scabrinodis* throughout both species' sympatric range. In the W Mediterranean population we have frequently the lobe reduced to a caudal carina in size comparable to that of Central European *specioides*, but outside this region, from Finland to Bulgaria, this carina may expand, in many local populations, into an extremely large, semicircular lobe as described for the var. *lonae* FINZI (compare Figs. 89, 90, 93–96). Petiole relatively massive and wide and, in contrast to *scabrinodis*, with a more rounded dorsal dome and no truncate node. Spines on average longer than in all other species dealt with here. Sculpture relatively coarse. Members of the W Mediterranean population (Spain, Pyrenees, Corsica, Elba, N Italy) have significantly smaller FL/FR, HW/FR, and SP/HL and significantly larger SL/HL than populations from other territories and could be confused, at first glance, with *specioides* (see there). The following table gives the data of 47 W Mediterranean and of 98 workers from outside this region.

	W Mediterraneans (n = 47)			Whole territory except W Mediterraneans (n = 98)			Signi- ficancy level
	mean	SD	(range)	mean	SD	(range)	
HL	1204.4	57.8	(1018–1322)	1187.4	72.5	(1001–1330)	n. s.
HL/HW	1.029	0.0167	(0.991–1.062)	1.026	0.0194	(0.975–1.061)	n. s.
HW/FR	3.020	0.142	(2.795–3.343)	3.275	0.165	(2.968–3.674)	0.0001
FL/FR	1.353	0.0742	(1.234–1.532)	1.545	0.0957	(1.366–1.826)	0.0001
SL/HL	0.810	0.0218	(0.777–0.847)	0.787	0.0177	(0.743–0.827)	0.0001
PE/HW	0.279	0.0139	(0.254–0.322)	0.285	0.0140	(0.256–0.333)	0.01
PP/HW	0.401	0.0148	(0.350–0.428)	0.407	0.0157	(0.381–0.468)	0.02
SP/HL	0.376	0.0228	(0.329–0.429)	0.396	0.0241	(0.340–0.457)	0.0001
PEH/HL	0.174	0.0097	(n = 34)	0.185	0.0136	(n = 34)	0.001
PPH/HL	0.166	0.0133	(n = 34)	0.171	0.0120	(n = 34)	n. s.

Allometry:

$$HW = 0.89995 HL^{1.01113} \quad (n = 145, r = 0.9545)$$

$$SP = 0.43064 HL^{0.9853} \quad (n = 145, r = 0.6517)$$

Queen (Fig. 184): Similar to worker. Data of 33 queens from the whole territory except the W Mediterraneans and of 3 queens from Spain are listed up in the following table.

	Spain (n = 3)			Whole territory except W Mediterraneans (n = 33)		
				mean	SD	(range)
HL	1325, 1365, 1414			1313.1	33.8	(1236-1384)
HW	1377, 1389, 1402			1334.2	31.6	(1276-1403)
HL/HW	0.963, 0.983, 1.009			0.984	0.0150	(0.947-1.020)
HW/FR	2.883, 2.922, 3.014			3.211	0.156	(2.954-3.67)
FL/FR	1.237, 1.240, 1.307			1.434	0.0712	(1.320-1.600)
PE/HW	0.306, 0.313, 0.318			0.306	0.0123	(0.282-0.332)
PP/HW	0.460, 0.465, 0.468			0.457	0.0181	(0.427-0.500)
SP/HW	0.319, 0.332, 0.359			0.356	0.0213	(0.306-0.391)
SL/HL	0.762, 0.780, 0.793			0.757	0.0171	(0.723-0.792)
PPH	214, 228, 244			203.4	16.1	(n = 31, 166-242)

Male (Figs. 120, 137, 153): Scape in dorsal view with unequal diameter, a convex frontal profile line, and a nearly straight caudal profile line. Scape base in anterior view a little angled at 30-45°. Characteristic scape ratio (SL/HL 0.596) is not approached by other species except *vandeli* and *hirsuta*. Occipital head roundings behind the eyes with no or very short subdecumbent hairs which are never longer than 75 µm. Pilosity on hind metatarsus varying from subdecumbent to suberect and longer than in most other species, but on average shorter than in *scabrinodis*. Petiole and postpetiole in lateral view relatively short and high, massive. Large body size. Data of 30 males:

HL 945.7 ± 35.1 (877-991), AL 1951.7 ± 103.6 (1744-2103), SL/HL 0.596 ± 0.0360 (0.494-0.674), SL/SW 3.816 ± 0.359 (3.24-4.63), F2 151.0 ± 11.65 (133-170), IF2 1.762 ± 0.123 (1.51-2.02), F2H 103.5 ± 9.85 (85-117), MEH 193.3 ± 16.7 (164-228), PPH 165.0 ± 38.2 (64-226).

Comments

There is no clear indication for the variety *lonae* to be a valid taxon. We find such specimens with extremely large and massive scape lobes and correspondingly large FL/FR. From S Finland to S Bulgaria (here samples with FL/FR up to 1.826!), but we observe all kinds of intermediates to average samples and the males as well as the habitat selection seem to be equal. On the other hand, the opposite extreme with reduced scape lobe which is typical for the W Mediterraneans is connected with the average through enough transitions and is probably no distinct species. However, this W Mediterranean population is significantly different in a number of characters and could be regarded as subspecies (see above).

Biology and distribution

Among the Central European *Myrmica*, it is a rather xerothermophilic species that will select on average dryer and warmer habitats than *scabrinodis* (see SEIFERT 1986). In Central Europe, *sabuleti* is found on all types of semidry grasslands and at sunny margins of woodland, rather independent from the geological outcrop. However, I observed rarely a dense population in sandy xerothermous grasslands where it seems to be competed out especially by *specioides* and *schrencki*. In contrast, dense populations, up to 39 nests/100 m², are locally found on semidry grasslands on limestone, with a top density of 18 nests on a small habitat spot of 11.5 m² (= 1.56 nests/m²) in a special situation. The most extreme parts of xerothermous grasslands are almost avoided and, on the other hand, I never found *sabuleti* in very wet habitats as bogs or fens. In geographic regions with warm macroclimate, e. g. S Bulgaria, it can develop dense populations in very shady woodland habitats. In the GDR, I recorded, for 37 tests plots with *sabuleti*, a mean density of 14.4 nests/100 m² and ELMES and WARDLAW (1982 a, b) found a mean density of 20 nests/100 m² on grassland sites in S England, with a top density of 1.0 nests/m² for a small patch. Nest density as well as colony size vary considerably depending on habitat quality. A rough count of the largest nest I found resulted in an approximate number of 2100 workers and 9 dealate queens and ELMES and WARDLAW (1982 b) found a mean of 700 workers and 2.2 queens in an extensive study.

Alates were found in the nests in 8.vii-14.ix. Although the main extranidal activity is restricted to ground surface and moss or litter layers, *M. sabuleti* also forages in the field layer to visit floral and extrafloral nectaries, but to a lesser extent than *M. schrencki* or *rubra*.

Honeydew producers are visited in the field and lower bush layers, sometimes with dozens of workers tending an aphid colony. *M. sabuleti* seems to be not aggressive and tends to avoid fightings with other species. If attacked by *Formica fusca* in an artificially provoked battle, it will defend by stinging and biting for 5–20 seconds but then behave motionless and is released without injury. After poison attack by *Tapinoma erraticum*, *M. sabuleti* was disabled for a short time only and recovered very well. Intraspecific fightings were observed under extreme conditions (1.55 nests/m² and heavy disturbance by turning of nest stones).

Distribution: In Fennoscandia north to 62° N, in Spain south to 39° N at least, and in S Bulgaria up to 1600 m; Portugal to Urals, Anatolia. I have not seen material from Sicilia and W Siberia where *sabuleti* is said to be distributed according to other authors.

***Myrmica vandeli* BONDROIT, 1919**, Figs. 114, 132, 147, 156–158, 164, 166

Myrmica vandeli BONDROIT, 1919; queen, male; Pontarlier (French Jura)

Material

A total of 17 series, mainly nest samples, with 25 males, 35 queens, and 70 workers. Origin: Federsee/Baden-Württemberg, leg. MÜNCH 1981 (1 series); Les Granges, Pontarlier/French Jura (the type series of BONDROIT with 2 males and 5 queens); Massignieu-de-Rives, Rhone Valley, Savoie, leg. ELMES 1982 (1 series); Ambert, Dptm. Puy-de-Dome, leg. ELMES 1984 (1 series); Creux du Van, Neuchatel/Switzerland, leg. KUTTER 1935; Davos, Switzerland, leg. WOLF 1939 (1 series); Freiburg, Switzerland, leg. WOLF 1939 (2 series); Soumarsky Most, S Bohemia, leg. WERNER 1982 (2 series); Kvilda, S. Bohemia, leg. WERNER 1977 (1 series); Horazdovice, W Bohemia, leg. WERNER 1981 (1 series); Beneckenstein, Harz Mountains, GDR, leg. KÖLLER 1953 (1 series); Bad Brambach, W Erzgebirge, GDR, leg. SEIFERT 1986/1987 (3 series).

Description

Worker (Figs. 156–158, 164, 166): Sometimes difficult to separate from *scabrinodis*, but in *vandeli* the ratios FL/FR, HW/FR, HL/HW, SL/HL, PE/HW, PP/HW are significantly lower ($p < 0.0001$) while PEH, PPH as well as the hairs on gaster tergites are much longer ($p < 0.0001$). Scape base similar to those *scabrinodis* scapes which have a relatively narrow plane between dorsal and caudal carinae; semicircular extensions as frequently seen in *scabrinodis*, I have never observed in *vandeli*. Dorsal profile of scape in caudal view frequently curved, in *scabrinodis* more straight; the whole *vandeli* scape appears thicker. The sculpture differences between *vandeli* and *scabrinodis* are on average clear, but not always reliable because we have sometimes *scabrinodis* workers with reduced sculpture. Pronotum in *vandeli* with fine, rather regular, longitudinal sculpture, without cross-linkings or reticular structures (in *scabrinodis* coarser, more irregular, and with cross-linkings). A transverse line across maximum pronotal width crosses in *vandeli* 17 ± 2.3 ($n = 19$, 14–22) rugae of 12–14 μm height and in *scabrinodis* 12 ± 1.2 ($n = 32$, 9–14) rugae of 16–25 μm height. Median parts of postpetiolar node in *vandeli* frequently (but not always!) without sculpture and shining; if sculpture present then fine. Petiolar node normally with finer, circularly oriented rugae (in *scabrinodis* on average much coarser, more longitudinal rugae, often with cross-linkings). Spines and lateral aspect of petiole and postpetiole as in *scabrinodis*. Posterior part of clypeus shining. Data of 43 workers:

HL 1128.5 ± 50.2 (1026–1203), HL/HW 1.010 ± 0.0149 (0.982–1.042), SL/HL 0.748 ± 0.0175 (0.699–0.785), HW/FR 2.799 ± 0.0913 (2.53–2.99), FL/FR 1.273 ± 0.0309 (1.195–1.345), PE/HW 0.266 ± 0.0106 (0.248–0.294), PP/HW 0.390 ± 0.0155 (0.355–0.419), PEH 222.0 ± 12.9 (195–246), PPH 209.6 ± 11.7 (184–232), PEH/HL 0.197 ± 0.0106 , PPH/HL 0.186 ± 0.0108 , SP/HL 0.362 ± 0.0258 (0.308–0.403).

Allometry:

HW = 1.07915 HL 0.98775 ($r = 0.9492$, $n = 43$)
SP = 0.03243 HL 1.34207 ($r = 0.6986$, $n = 43$)

Queen: Very different from *scabrinodis*; there is no overlap in absolute data of HW (*vandeli* ≥ 1343 , *scabrinodis* ≤ 1286) and PP (*vandeli* ≥ 639 , *scabrinodis* ≤ 625), and almost no overlap in PEH and PPH data. Highly significant ($p < 0.0001$) are further the smaller FL/FR, HW/FR, HL/HW, SL/HL, and the larger PP/HW of *vandeli*. Scape similar to

worker. Longitudinal rugosity on mesonotum much finer than in *scabrinodis*; at least a small median spot at anterior border of mesonotum is completely without rugosity and shining, but such smooth and shining surfaces may cover, in the opposite extreme, most of mesonotal surface, confining clear rugosity to a small area at posterior border. Petiolar and postpetiolar sculpture similar to worker. As in worker, the long hairs on waist and gaster are characteristic. One of the largest European *Myrmica* queens and not to confuse. Data of 28 queens:

HL 1350.3 ± 37.7 (1245–1412), HW 1413.5 ± 36.6 (1343–1485), HL/HW 0.955 ± 0.0107 (0.927–0.981), HW/FR 2.760 ± 0.0648 (2.61–2.89), FL/FR 1.215 ± 0.0258 (1.166–1.253), SL/HL 0.703 ± 0.165 (0.674–0.737), SP/HW 0.336 ± 0.0240 (0.285–0.393), PE/HW 0.312 ± 0.0150 (0.286–0.339), PP/HW 0.492 ± 0.0154 (0.457–0.516), AW/HW 0.797 ± 0.0196 (0.773–0.842), AL/HL 1.553 ± 0.0206 (1.498–1.602), PEH 256.6 ± 15.9 (226–278), PPH 248.0 ± 14.0 (209–268).

Male (Figs. 114, 132, 147): Only to confuse with *hirsuta*. Scape in dorsal view with more or less straight sides and almost equal width from base to apex; scape base in anterior view slightly curved or a little angled at 25–35°. Characteristic scape ratios (SL/HL 0.622 and SL/SW 4.54) are not approached by other species except *sabuleti* and *hirsuta*. In dorsal view, numerous and very long, subdecumbent hairs protrude over the occipital head roundings behind eyes; the longest of these hairs measure 120–190 μm (in *sabuleti*, there are in this position no or very few, short, decumbent hairs which are always shorter than 75 μm). Pilosity of hind tibiae and metatarsae variable; sometimes a little longer and sometimes a little shorter than in Fig. 147. Data of 19 males:

HL 896.2 ± 26.4 (833–942), AL 1831.6 ± 64.5 (1724–1926), SL/HL 0.622 ± 0.0384 (0.534–0.677), SL/SW 4.528 ± 0.326 (3.83–5.15), F2 145.4 ± 10.2 (119–157), IF2 1.783 ± 0.112 (1.51–1.96), F2H 112.2 ± 11.8 (89–133), PE/HL 0.380 ± 0.0258 (0.338–0.439), PP/HW 0.533 ± 0.0427 (0.477–0.646).

Comments

Single, isolated *vandeli* workers are sometimes hardly to distinguish from *scabrinodis*, but nest samples of 5 workers and combined consideration of the discriminating characters given in description are sufficient for a clear separation.

Biology and distribution

All the 8 habitat records I have indicate a rather special habitat selection and suggest to a narrow niche width; *M. vandeli* is characteristic for particular types of sunny boggy land with low vegetation and a high cover percentage of mosses in the colline, submontane, and montane altitudinal belts in Central Europe and along the Alps. These sites are peat bogs as well as fens, with a tendency to prefer the latter. The altitudes of 12 sites range from 230 to 1650 m, with 10 sites at 400–1000 m. There is no clear lowland record and the northernmost site so far known is situated at 51° 40' N, 10° 43' E, and 530 m.

M. vandeli frequently coexists with *scabrinodis*, having a large habitat overlap with this species. According to Petr WERNER (pers. commun.) and own observations, the nests are preferentially constructed in moss pads of *Sphagnum* and *Polytrichum*, but the series of KÜTTER was taken from under a stone. The largest nest I found near Bad Brambach (620 m) contained about 1500 workers, 65 males, and 40 alate gynes, was constructed in a big *Polytrichum* mound, and had a south-sloped "sun collector" of moss particles cutted up by the ants. The *vandeli* workers were not aggressive to the investigator who dismembered their nests and they ran across the human skin without stinging whereas the handling of neighbouring *scabrinodis* nests was a much more unpleasant occupation under equal conditions (+ 23° C, air humidity near saturation point).

The density of *vandeli* on one fen near Bad Brambach was 2.7 nests/100 m², accompanied by *scabrinodis* (25.5 nests/100 m²), *Formica lemniai* (10.7), *M. rubra* (9.4), *M. ruginodis* (5.4), *Leptothorax acervorum* (1.3). Alates were found in the nests from 3. viii to 15. ix.

Myrmica schencki EMERY, 1894, Figs. 87, 88, 119, 136, 152

Myrmica rubra scabrinodis var. *schencki* EMERY, 1894; worker, male; Maine and New Jersey/USA, Europe

Material

The investigated material of several hundred workers, 30 queens, and 30 males is from a total of 41 localities and divides up to the countries: GDR (20 localities), Czechoslovakia (9), Switzerland (4), Caucasus (3), Danmark (2), Norway (1), France (1), Bulgaria (1).

Diagnostic characters

Worker (Figs. 87, 88): Scape sharply angled at base, with a broad upright flange at the bend. Frons very narrow, less than 1/4 HW. Mesopropodeal furrow shallow or almost imperceptible. Spines long. Petiole relatively lower than in *lobicornis* and somewhat cubical in profile, with nearly straight or weakly concave anterior face which meets the dorsal surface at a blunt angle. Petiole in dorsal aspect relatively narrower and longer than in *lobicornis* and with convex sides. Height of concavity below the spines in lateral view larger than height of lateral propodeal lobe. Head broad and rounded. Sculpture less coarse and more longitudinal compared to *lobicornis*. Data of 46 workers:

HL 1192.6 ± 55.9 (1072–1287), HW 1187.8 ± 62.2 (1053–1295), HL/HW 1.004 ± 0.0180 (0.968–1.037), HW/FR 4.626 ± 0.213 (4.20–5.16), FL/FR 1.634 ± 0.0796 (1.454–1.816), SP/HL 0.323 ± 0.0235 (0.284–0.377), PA $102.4^\circ \pm 5.94^\circ$ (91° – 112°), SL/HL 0.777 ± 0.0158 (0.742–0.813), PE/HW 0.257 ± 0.0117 (n = 42, 0.232–0.286), PP/HW 0.404 ± 0.0148 (42, 0.353–0.433), PEH/HL 0.199 ± 0.0115 (42, 0.183–0.231), PPH/HL 0.189 ± 0.0103 (45, 0.168–0.212).

Allometry:

HW = 0.6803 HL 1.05378 (r = 0.9417, n = 46)

SP = 0.001761 HL 1.73565 (r = 0.7906, n = 46)

Queen: Similar to worker. Data of 23 queens:

HL 1294.5 ± 30.7 (1242–1354), HW 1353.2 ± 32.1 (1295–1439), HL/HW 0.957 ± 0.0150 (0.915–0.981), HW/FR 4.691 ± 0.194 (4.34–5.29), FL/FR 1.572 ± 0.0617 (1.441–1.707), SP/HW 0.274 ± 0.0171 (0.246–0.311), SL/HL 0.747 ± 0.0153 (0.722–0.777), PA $97.83^\circ \pm 6.79^\circ$ (n = 18, 88° – 117°), PE/HW 0.277 ± 0.0108 (n = 22, 0.255–0.292), PP/HW 0.445 ± 0.0190 (n = 20, 0.409–0.476), PEH 243.8 ± 17.4 (n = 22, 201–279), PPH 247.2 ± 21.8 (n = 22, 211–312), AL/HL 1.569 ± 0.0225 (n = 22, 1.536–1.604), AW/HW 0.773 ± 0.0223 (n = 22, 0.744–0.828).

Male (Figs. 119, 136, 152): Scape short and, in contrast to similar species, clearly angled at base which is best visible in frontodorsal view. Second funiculus segment elongated. Petiole rather long and low, in lateral aspect with a rounded and never angular dorsal profile. Appendage hairs short. Anterior half of frontal petiolar face with dense, erect pubescence.

HL 887.5 ± 37.0 (n = 19, 804–947), AL 1964.9 ± 72.6 (n = 20, 1815–2088), F2 168.8 ± 8.40 (n = 20, 153–185), IF2 2.346 ± 0.134 (n = 20, 2.14–2.59), F2H 94.3 ± 6.95 (n = 15, 81–104), SL/HL 0.469 ± 0.0309 (n = 19, 0.430–0.531), SL/SW 3.692 ± 0.253 (n = 20, 3.39–4.12), SL/F2 2.468 ± 0.165 (n = 20, 2.23–2.71), PE/HL 0.340 ± 0.0168 (n = 14, 0.309–0.365), PP/HL 0.515 ± 0.0222 (n = 14, 0.480–0.567), MEH 114.5 ± 9.9 (n = 15, 104–137).

Comments

I have not seen any type of EMERY and it remains obscure whether the ants he described in 1894 from the United States were conspecific with the European ants he simultaneously mentioned in his original description. Provided we should have two different species in N America and Europe and types should exist from N American material only, the name for our well-characterized W Palaearctic ant which has been designated up to the present as *schencki* would change. *M. schencki* is very constant in morphology throughout the studied geographical range which enables to separate it from the highly variable *lobicornis* that may approach in several characters to *schencki*, but never in the combination of all characters.

Biology

According to ELMES and ABBOTT (1981), the worker population of *schencki* nests will

not exceed 1000, with an arithmetic mean of 354, and there may be up to 5 fertilised queens, with an arithmetic mean of 0.97. Freshly fertilized young queens may be accepted by mature queen-right colonies. I found the low mean nest density of 3.35 nests/100 m² and an absolute maximum of 13.0 nests/100 m² on 25 test plots in the GDR which shows the rather wide spacing of nests. To a larger extent than most of the other species, *M. schencki* exploits the nectaries of field layer blossoms as *Euphorbia cyparissias*, *Potentilla verna* group, *Hieracium pilosella*, and *Hypochoeris radicata*. The predatory activity is conspicuous and prey items up to 90 mg were moved by single workers. Although not notably aggressive, it may sting the human skin painfully and it is probably very fit in fightings with other ant species. In one case, I found about 50% of dry weight of all prey items to consist of alien ants, mainly *Lasius* and *Formica* species, among them *Formica pratensis*. *M. schencki* was seen to exploit the same blossom simultaneously with *Lasius alienus* without any interference. The nests have often 1-4 entrances with a small funnel- or chimney-like vertical extension, made of fine plant material and having an inner diameter of 3-5 mm. Such constructions I have not seen in all localities, but they are typical for sandy grasslands without surface stones and high percentage of moss layer. As in many other *Myrmica* species, dealate queens are frequently observed to move on ground throughout the whole season prior the swarming time. According to SKØTT (COLLINGWOOD 1979, in lit.) *schencki* has no winter brood and mainly nocturnal activity. Alates were found in the nests 29. vii-25. viii. Among the Central European *Myrmica* species, it is one of the most thermophilic species (SEIFERT 1986), but its habitat temperature tolerance is considerable. *M. schencki* is found on all kinds of xerothermous grasslands, open heath, and xerothermous border lines of woodland or along ways, but I found single nests in more mesophilic habitat spots with much shade. It is no stenopotent species, probably present in all non-urban localities in Central Europe which are sufficiently xerothermous. However, *schencki* does not tolerate the effects caused by strong eutrophication of soil and it is rarely found in cities.

Distribution

Probably distributed throughout the Palaearctics. In Europe found in the south of British Isles, in Norway up to 60° N, in Finland up to 62° N, and in the Balkans or Caucasus it goes south to 41° N or farther. In the Alps, it is reported to elevate to the subalpine zone (2300 m).

***Myrmica deplanata* RUZSKY, 1905**, Figs. 83-86, 118, 135, 151

Myrmica lobicornis var. *deplanata* RUZSKY, 1905; worker; Caucasus, Krim, steppe near Orenburg

Myrmica moravica SOUDEK, 1922

Myrmica lobicornis var. *plana* KARAWAJEW, 1926 b

Material

Altogether 22 workers, 3 queens, and 6 males. 3 nest series with 16 workers, 1 queen, and 4 males from the Prokop Valley near Prague, leg. TKALCU 1958, WERNER 1980, and SEIFERT 1983. 1 queen from Durbach near the Neusiedlersee/Austria, leg. ASSING 1985. 3 workers, 1 queen, and 1 male from Kopet Dagh, leg. ARNOLDI 1935. 3 workers and 1 male from near the village Buran at the lower course of the river Čornyj Irtyš / E Kazakhstan, leg. REZNIKOVA 1976.

Diagnostic characters

Worker (Figs. 83-86): Big species. Scape long and almost rectangularly bent and with a small, dorsad directed tooth-like process at base which is absent in the examples from the Kopet Dagh. Frontomedial margin of clypeus with clear indentation. Mesopropodeal impression lacking or almost imperceptible. Spines much shorter than in similar species and projecting dorsad at 45°. Petiole rather low and somewhat elongated, with anterior cylindrical part a little longer than in many other species; in lateral aspect with a clearly concave frontal profile, a convex dorsocaudal surface, and no angular structures. Head broad. Sculpture on alitrunk and waist more longitudinal than in *lobicornis*, without anastomosae. Dorsum of postpetiole with reduced sculpture. Nodes of petiole and postpetiole with long hairs. Data of 22 workers:

HL 1297.8 ± 54.9 (1150–1389), HW 1307.6 ± 58.2 (1169–1429), HL/HW 0.992 ± 0.0198 (0.951–1.045), HW/FR 3.533 ± 0.130 (3.30–3.78), FL/FR 1.414 ± 0.0320 (1.340–1.466), SL/HL 0.818 ± 0.0129 (0.789–0.841), PE/HW 0.264 ± 0.0151 (0.239–0.291), PP/HW 0.406 ± 0.0198 (0.375–0.447), SP/HL 0.239 ± 0.0160 (0.214–0.264), PEH/HL 0.197 ± 0.0065 ($n = 14$, 0.183–0.209), PPH/HL 0.177 ± 0.0080 (14, 0.166–0.192), PEH 255.9 ± 12.0 (236–273, 14), PPH 228.6 ± 12.1 (216–257, 14).

Allometry:

HW = 1.4659 HL 0.94768 ($r = 0.9062$, $n = 22$)

SP = 0.2026 HL 1.02302 ($r = 0.5451$, $n = 22$)

Queen: Similar to worker. The Kopet Dagh queen has a reduced dorsal tooth at scape base as the workers and the Prague queen has no standing hairs on dorsum of waist and gaster. Such abnormal lack of pilosity was already stated by RUZSKY (1905) for the worker. Data of 3 queens (Durbach, Prague, Kopet Dagh):

HL 1429, 1454, 1416; HW 1478, 1548, 1441; HW/FR 3.340, 3.330, 3.291; FL/FR 1.264, 1.312, 1.339; HL/HW 0.967, 0.939, 0.983; PE/HW 0.267, 0.280, 0.268; PP/HW 0.439, 0.440, 0.441; SL/HL 0.765, 0.757, 0.785; SP/HW 0.211, 0.214, 0.239; AW/HW 0.784, 0.785, 0.818; AL/HL 1.613, 1.665, 1.646; AL/AW 1.989, 1.993, 1.978; PEH 265, –, 291; PPH 241, –, 249.

Male (Figs. 118, 135, 151): Scape very short and nearly straight. Second funiculus segment elongated. Ratio SL/F2 lower than in all other species dealt with here. Petiole and postpetiole lower and more elongated than in other species and with very long standing hairs. Petiole in dorsal view nearly twice as long as wide, in lateral view with frontal and dorsal profiles meeting at a very blunt angle. Anterior half of frontal petiolar face with dense erect pubescence. Data of 6 males:

HL 854 ± 49.7 (792–941), AL 1916.7 ± 202.8 (1704–2293), F2 151.2 ± 13.4 (132–171), IF2 2.250 ± 0.198 (1.89–2.44), F2H 86.5 ± 27.7 (66–136), SL/HL 0.330 ± 0.0124 (0.316–0.351), SL/SW 2.798 ± 0.091 (2.74–2.97), SL/F2 1.873 ± 0.148 (1.68–2.13), PE/HL 0.321 ± 0.0147 (0.302–0.335), PP/HL 0.512 ± 0.0253 (0.481–0.543), MEH 106.2 ± 12.4 (91–127).

Comments

M. deplanata is not to be confused in all three castes. The next relative is probably *M. schencki* concluded from the rather similar males and synapomorphies of female castes.

Biology and distribution

M. deplanata exclusively occurs in very xerothermous steppe-like habitats which often have a high proportion of bare rock or a plenty of stones on soil surface. In the Tianshan, it is found in the *Artemisia* and *Festuca ovina* steppes (TARBINSKI 1976) at 1500–3000 m and the Kopet Dagh sample was taken at 1800 m. The biology is nearly unknown. Alates where found in the nests from 30. vii to 18. ix. A colony excavated near Prague contained one gyne. The border of the known range can be circumscribed with Bohemia (50° N, 14° E) – Moravia – Slovakia – Charkov – Kujbysev (53° N) – Orenburg – Central Kazakhstan – E Kazakhstan (85° 14' E, 48° 5' N) – Tianshan – Kopet Dagh (37° N) – Terek River – Crim – the Turkish part of the Balkans – Split/Yugoslavia – E Austria.

***Myrmica ravasini* FINZI, 1923**, Figs. 91, 92

Myrmica ravasini FINZI, 1923, Boll. Soc. Ent. Ital. 55: 2; worker; Tomor/Albania

Material

3 workers from „Turkey“, leg. COLLINGWOOD 23. vi 1986; 4 workers from Kure/Turkey, leg. COLLINGWOOD vi 1985; 1 worker from Cagveri near Borzomi/SW Georgia, leg. ZILASVILI.

Diagnostic characters

Worker (Figs. 91, 92): Not to confuse. Frons extremely narrow, less than 1/6 HW. The process at scape base is an extremely large, plate-shaped flange. Petiole without anterior cylindrical part and very coarse sculpture, reminiscent of *sulcinodis*. Big species. Data of 8 workers:

HL 1286.5 ± 75.2 (1210-1454), HW 1283.1 ± 73.7 (1208-1450), HL/HW 1.003 ± 0.0142 (0.983-1.019), HW/FR 7.579 ± 0.454 (6.905-8.331), FL/FR 2.755 ± 0.199 (2.462-3.147), SL/HL 0.798 ± 0.0126 (0.780-0.812), PE/HW 0.267 ± 0.0087 (0.249-0.275), PP/HW 0.397 ± 0.0121 (0.370-0.404), SP/HL 0.361 ± 0.0160 (0.340-0.385), PEH/HL 0.214 ± 0.0136 (0.192-0.231), PPH/HL 0.191 ± 0.0063 (0.182-0.198).

Comments

The queen and male are unknown to me. All three sites with more exact geographic records (Tomor/Albania, Kure/Turkey, and Cagveri/SW Georgia) are situated at 41° N. The elevation of the Tomor site is 1600 m and that of the Cagveri site, which is situated in a limestone karst region, 1200 m. In addition to the localities given above, COLLINGWOOD (pers. comm.) found it in S Yugoslavia. Biology unknown.

Myrmica lobicornis NYLANDER, 1846, Figs. 22, 78-82, 117, 150

Myrmica lobicornis NYLANDER, 1846; worker, queen; Uleaborg (= Oulu)/Finland

Myrmica denticornis SMITH, 1855

Myrmica lobulicornis NYLANDER, 1856

Myrmica lobicornis var. *ardennuae* BONDROIT, 1911

Myrmica ardennuae var. *pyrenaee* BONDROIT, 1918

Myrmica schencki var. *obscura* FINZI, 1926, partim

Myrmica lobicornis alpina STÄRCKE, 1927

Myrmica lobicornis angustifrons STÄRCKE, 1927

Myrmica lobicornis apennina STÄRCKE, 1927

Myrmica lobicornis lissahorensis STÄRCKE, 1927

Myrmica schencki var. *starki* KARAWAJEW, 1929

Myrmica lobicornis foreli SANTSCHI, 1931

Myrmica lobicornis alpestris ARNOLDI, 1934

Material

Altogether several hundred workers, 35 queens, and 35 males from entire Europe (excluding Italy and Greece) and Great Caucasus. Type material examined: *M. l. ardennuae* BONDROIT, Hockai/Prov. de Liège, 6 workers and 1 queen; *M. a. pyrenaee* BONDROIT, Mt. Canigou x-1917, 8 workers; *M. l. foreli* SANTSCHI, Schluderbach/Switzerland, leg. FOREL, 2 workers; *M. schencki* var. *obscura* FNZI, 1 worker (Cotype), Kelbra/Kyffhäuser, leg. KRAUSE ix-1928.

Description

Extremely polymorphic throughout its range. A tooth-like to spoon-shaped transverse process at scape base is directed dorsad and has a highly variable size, from very small as in *pyrenaee* to very large as more frequently found in many of the northern variants. Petiole typically high and wide, with anterior and dorsal profiles meeting at a right angle. Spines normally short. Sculpture normally coarse and with anastomose. Concavity below spines in lateral view often smaller than the lateral propodeal lobe. Head relatively short. Mesopropodeal impression normally well-developed. Colour highly variable, from entirely blackish brown to bicoloured with light brown alitrunk. Size relatively small. Data of 101 workers from whole geographic range:

HL 1060.1 ± 58.2 (922-1152), HL/HW 1.014 ± 0.0214 (0.969-1.057), HW/FR 3.648 ± 0.326 (2.983-4.627), FL/FR 1.456 ± 0.106 (1.214-1.728), SP/HL 0.293 ± 0.0378 (0.212-0.400), PA $89.0^\circ \pm 5.28^\circ$ (73° - 103°), PE/HW 0.275 ± 0.0133 (0.237-0.317), PP/HW 0.419 ± 0.0137 (0.391-0.447), SL/HL 0.786 ± 0.0194 (0.727-0.831), PPH/HL 0.174 ± 0.0152 (0.144-0.211).

Allometry:

HW = 1.4050 HL 0.9492 (r = 0.9312, n = 101)

SP = 0.0002483 HL 2.01425 (r = 0.6864, n = 101)

Queen: Similar to worker. Data of 26 queens:

HL 1167.3 ± 31.2 (1108-1216), HW 1191.3 ± 29.9 (1144-1252), HL/HW 0.980 ± 0.0131 (0.955-1.011), HW/FR 3.715 ± 0.309 (3.06- 4.14), FL/FR 1.442 ± 0.0943 (1.288-1.633), HW/FL

2.568 ± 0.111 (2.328–2.789), PE/HW 0.294 ± 0.0123 (0.264–0.318), PP/HW 0.468 ± 0.0232 (0.422–0.516), SL/HL 0.756 ± 0.0124 (0.737–0.782), AL/AW 1.911 ± 0.0500 (1.812–1.992), PA 87.4° ± 4.8° (75°–94°, n = 18), AL/HL 1.554 ± 0.0222 (1.505–1.593), AW/HW 0.797 ± 0.0213 (0.757–0.861), SP/HW 0.294 ± 0.0329 (0.210–0.341), PEH 215.2 ± 15.5 (194–254, n = 23), PPH 208.7 ± 15.1 (189–249, n = 23).

Male (Figs. 22, 117, 150): Scape long and angled at base at 45°, sometimes more curved. Second funiculus segment less than twice as long as wide. Frontal triangle in part smooth and in part finely sculptured. Mesonotum in front of notauli frequently smooth. Petiole with longitudinal sculpture which is normally weaker than in *sulcinodis*.

HL 924.3 ± 58.4 (n = 24, 827–1042), AL 1758.9 ± 109.5 (24, 1542–1976), SL/HL 0.790 ± 0.0476 (24, 0.702–0.888), SL/SW 6.597 ± 0.404 (24, 5.99–7.39), IF2 1.777 ± 0.121 (24, 1.48–2.00), F2 133.9 ± 11.8 (24, 110–154), F2H 81.9 ± 8.33 (n = 7, 75–99), MEH 97.2 ± 19.8 (n = 7, 81–136).

Comments

The heading account of synonymy is incomplete; I have counted 15 taxa for the territory considered here, belonging to *lobicornis*, and it is surprising how many variants have been named which do not deviate from the average *lobicornis* morphology. Among the many infraspecific taxa so far described, the populations from the Pyrenees (*pyrenaica* BONDROIT), the Apennines (*apennina* STÄRCKE), and the Caucasus (*alpestris* ARNOLDI) could possibly have a subspecies rank, but this is a matter of opinion. At least one morphological character may deviate extremely from the *lobicornis* average as given in description, but even those variants approaching to *schencki* in one or more characters are not to misidentify for they have always kept few morphological structures diagnostic for *lobicornis* and never found in *schencki*; e. g. *lobicornis* with *schencki*-like frons ratios and scapes will have the diagnostic *lobicornis* petiole, spines, and/or alitrunk and those *lobicornis* with *schencki*-like petiole, spines, and/or alitrunk will have a very broad frons and a small scape process. Despite of the much lower average FL/FR and HW/FR data of the southern populations compared to the northern populations, it is difficult to speak of a clear clinal trend because the Central European populations do not follow such a schedule.

Biology and distribution

M. lobicornis is a widely distributed species but nowhere abundant. I recorded, for 5 test plots in the GDR, a mean nest density of 2.5 nests/100 m² only, with a top value of 4.0 nests/100 m². A subjective estimate of nest densities on certain subalpine meadows in Europe and Caucasus where I observed the highest abundance does not exceed 10 nests/100 m². The nests are under stones, in dry peat, moss, or litter and once I found an earth mound in a high-grassy meadow. As far as known, the colonies are monogyneous and have rather small worker populations (below 500). The workers are not aggressive and are normally seen to forage alone. After *M. ruginodis* and *rubra* and comparable to *sulcinodis*, it is one of the least thermophilic species (SEIFERT 1986) and avoids very wet and very dry habitats. The vertical and horizontal distribution is similar to *sulcinodis*; in Caucasus and S Europe (42° N) *lobicornis* is typical for subalpine and oreol meadows or sunny woodland between 1400 m (north slope) and 2700 m (south slope), but already in Central Europe (52° N) it goes down to sea level. The habitat selection is directed mainly by its narrow temperature and moisture tolerance and it is found in habitats of very different vegetation structure, in woodland, heath, and grasslands. According to ARNOLDI (1970) it is entirely absent from the steppes of S Russia south of the line Kijev – Kursk – Voronež – Kujbyšev. The niche width of *lobicornis* was computed to be lower than in other *Myrmica* species (see SEIFERT 1986). The geographic range goes from Portugal to W Siberia and 40° N (at these latitudes an essentially mountain species) to North Cape (70° N). Alates were observed in the nests from 14.vii to 9.ix.

Myrmica wesmaeli BONDROIT, 1918, Figs. 75, 76, 77

Myrmica wesmaeli BONDROIT, 1918; worker; Mont Canigou/E Pyrenees

Myrmica lobicornis (group 2), sensu ESPADALER 1981

Material studied

8 worker types of BONDROIT labelled "France, Pyr. Ori. Mont Canigou, type *Myrmica*

wesmaeli Bondr., coll. R. I. Sc. N. B. (one I have designated as lectotype); 3 workers from La Llebre/Lleida (Central Pyrenees); 1 worker and 2 queens from Arco/Lleida; 4 workers from Baricauba/Lleida; 4 workers from Bohavi /Lleida, all Lleida series leg. ESPADALER; 1 worker from Teruel/Javalambre, 1 worker from Pt. de Navacerrada, and 1 worker from Cuenca, all leg. COLLINGWOOD.

Diagnostic characters

Worker (Figs. 75-77): Scape with a very small dorsal tooth at base, as small or smaller than in the lower extreme of *lobicornis*. Sculpture similar to *schencki* and finer than in sympatric *lobicornis*, especially on petiole and postpetiole. Petiole less wide than in *lobicornis*, in dorsal aspect clearly longer than wide. Spines longer than in sympatric *lobicornis*. Petiolar shape similar to *schencki*, with frontal and dorsal faces meeting at a blunt angle, frontal face concave, dorsal surface always truncate and falling down without step to junction with postpetiole. Subpetiolar process often larger, frontal lobes less diverging, head shorter, and body size on average larger than in sympatric *lobicornis*. Data of 23 Iberian *wesmaeli* workers and 25 sympatric *lobicornis* workers:

	<i>wesmaeli</i> (n = 23)		<i>lobicornis</i> (n = 25)	
HL	1113.0 ± 42.0	(1040-1231)	1052.4 ± 56.2	(961-1129)
HW	1106.1 ± 47.5	(1016-1206)	1025.7 ± 59.7	(911-1121)
HL/HW	1.007 ± 0.0208	(0.959-1.052)	1.026 ± 0.0165	(0.990-1.056)
HW/FR	3.125 ± 0.140	(2.959-3.481)	3.350 ± 0.171	(3.002-3.608)
FL/FR	1.219 ± 0.0461	(1.158-1.334)	1.377 ± 0.0759	(1.214-1.512)
SP/HL	0.324 ± 0.0189	(0.268-0.350)	0.259 ± 0.0249	(0.212-0.301)
PA	100.0° ± 3.62°	(90°-107°)	88.9° ± 4.12°	(79°-96°)
SL/HL	0.768 ± 0.0186	(0.747-0.814)	0.772 ± 0.0197	(0.727-0.803)
PE/HW	0.260 ± 0.0112	(0.244-0.286)	0.277 ± 0.0063	(0.265-0.289)
PP/HW	0.414 ± 0.0123	(0.393-0.433)	0.420 ± 0.0115	(0.400-0.451)
PPH/HL	0.165 ± 0.0098	(0.149-0.193)	0.176 ± 0.0107	(0.146-0.192)

Allometry:

<i>M. wesmaeli</i>	HW = 0.9293 HL 1.0095	(r = 0.8764, n = 23)
Iberian <i>lobicornis</i>	HW = 0.6876 HL 1.0501	(r = 0.9620, n = 25)
<i>M. wesmaeli</i>	SP = 0.02276 HL 1.3785	(r = 0.6646, n = 23)
Iberian <i>lobicornis</i>	SP = 8.44 · 10 ⁻⁵ HL 2.153	(r = 0.8351, n = 25)

The mean values of SP/HL, PA, FL/FR, PE/HW, HW/FR, and HW are significantly different for p < 0.0001, those of HL and PPH/HL for p < 0.001, and HL/HW for p < 0.002.

Queens: Similar to worker. Differs from sympatric *lobicornis* in having much less diverging frontal lobes, much lower AL/AW, shorter head, much longer spines, narrower petiole, weaker sculpture on petiole and postpetiole, larger body size, and differing lateral aspect of petiole (the dorsal and frontal faces meet at a blunt angle). Data of 2 queens:

HL 1181, 1157; HW 1232, 1211; HW/FR 3.033, 2.911; FL/FR 1.128, 1.113; PE/HW 0.277, 0.265; PP/HW 0.472, 0.467; SL/HL 0.731, 0.750; AL 1858, 1777, AL/AW 1.694, 1.719; SP/HW 0.330, 0.309; PEH 199, 201; PPH 215, 209; HL/HW 0.959, 0.956; PA 99°, 101°.

Male: I have not more carefully examined four males sent by ESPADALER, but on the first look they are similar to the *lobicornis* males.

Comments

The female castes of *wesmaeli* clearly differ from sympatric *lobicornis* which is a sufficient justification to regard it as morphospecies. A perfect separation of all studied *wesmaeli* workers (8 samples, n = 23) and sympatric Iberian *lobicornis* workers (7 samples, n = 25) is given through a simple product index $I = PA \times SP/HL \times FR/FL \times HW/PE$, with $I = 102.6 \pm 9.48$ (81.3-119.1) in *wesmaeli* and $I = 60.3 \pm 5.39$ (52.7-69.5) in *lobicornis*. As similarly noted by ESPADALER (1981), we have a different but partially overlapping vertical distribution of both species in the Pyrenees, with *wesmaeli* occurring at 1200-1900 m and *lobicornis* pyrenaea at 1550-2600 m (which is the same vertical range we find *lobicornis* at

equal geographical latitudes from Italy to Caucasus). Farther in the south of Spain where we have a hotter and dryer climate, *wesmaeli* will go higher; COLLINGWOOD recorded 2000 m for both the Javalambre region and Pt. de Navacerrada. *M. wesmaeli* is surely a more xerothermophilic species than *lobicornis*. Its biology is unknown.

Myrmica bibikoffi KUTTER, 1963

Myrmica bibikoffi KUTTER, 1963; worker, queen, male; Vaulion, Kanton Waadt Switzerland

Material

I have seen the holotype, a worker. The following descriptions of queens and males are based solely on KUTTER's statements and figures.

Diagnostic characters

Worker: Postpetiole very wide and whole body appearing thickset. Head, particularly posterior surface, with coarse and clearly reticulate sculpture. Waist and alitrunk with reticulate sculpture. Spines strongly diverging, distance between their tips 683 μm . Scape shape intermediate between the *scabrinodis* and *sabuleti* condition. Mid and hind tibiae with very reduced, non-pectinate spurs, their length 30 μm on mid tibia and 40–70 μm on hind tibia. Data of the holotype:

HL 1274, HW 1218, HL/HW 1.046, HW/FR 3.15, FL/FR 1.395, PE/HW 0.344, PP/HW 0.511, SP/HL 0.367, SL/HL 0.774.

Queen: Sculpture similar to worker, but with a higher portion of longitudinal rugosity on head, alitrunk and pedicel. Scape similar to worker. Spurs of mid and hind tibia non-pectinate and 0.10–0.12 mm long.

HL 1.28 mm, HW 1.37 mm, HL/HW 0.934, HW/FR 2.915, FL/FR 1.319, SL/HL 0.727, AW/HW 0.876 (very large in any case, but it is not defined by KUTTER where AW was taken), distance between tips of spines 0.67 mm, PE/HW 0.358, PP/HW 0.540.

Male: Scape as long as first 5 funiculus segments and clearly curved at base. Petiole in lateral view reminiscent of *hirsuta*, with rather straight dorsal profile that abruptly slopes down to junction with postpetiole. Pilosity long and profuse.

HL 800–900, HW 900–1000, SL/HL appr. 0.79, SL/SW appr. 6.0, IF2 1.7, PE/HL 0.40, PP/HL 0.55.

Comments

This form is only known in the type series taken in Switzerland on 5. viii 1949 by M. BIBIKOFF.

Myrmica myrmicoxena FOREL, 1874

Myrmica lobicornis var. *myrmicoxena* FOREL, 1874; queen, male; Switzerland: Alp Anzeindaz/Vaud.

Description

I have not seen the types and give here a description after KUTTER (1973, 1977).

Queen: Postpetiole nearly twice as wide as petiole and with conspicuous ventral bulge. Petiole with large ventral lobe and rather straight frontal and dorsal faces which meet at an angle of less than 90°. Upper carinae of spines almost reaching to metanotum. Scape short, hardly reaching to occipital margin; scape base bent in a blunt angle and not thickened. Spines rather short and somewhat erect. Overall length 4.13–4.3 mm. Longest hairs on petiole and postpetiole less than 180 μm long. HL 1.07, AL 1.6 mm, AW 0.82 mm, PE 0.31 mm, PP 0.55 mm, SP appr. 0.27 mm.

Male: Alitrunk and petiole very short and thickset. In lateral view, the length of the straight slope line made by the caudal face of scutellum and metanotum is about 0.35 of the

total alitrunk height (in other species less than 0.3). Petiole with clearly convex sides and a rather well-developed ventral process. Scape shorter than the first 4 funiculus segments. SL/SW 3.3, SL/HL 0.371. Overall length 4.4 mm.

Comments

This probably workerless form was only once found on 20.viii 1869 in a colony of *M. lobicornis* and has been never rediscovered at the type locality despite of repeated search.

***Myrmica hirsuta* ELMES, 1978, Figs. 97–99, 121, 154, 155**

Myrmica hirsuta ELMES, 1978; queen, male; Dorset, S England

Material

1 male and 1 queen from Durlleston Country Park, Purbeck Dorset, leg. ELMES 1973, both paratypes; 14 queens and 8 males from Zscheiplitz near Freyburg GDR, leg. SEIFERT 20. viii 1980 and 31. viii/1. ix 1981; 3 dealate queens from Leutra near Jena, GDR, 23. v 1972, 3. x 1972, and 24. viii 1986; 2 queens from Sonnenberge near Jena, leg. SANDER 23. iii 1973; 6 queens and 3 males from Landeskrone near Görlitz/GDR, leg. SEIFERT vi–viii 1982; 1 queen from Kapela/Yugoslavia, leg. COLLINGWOOD viii 1984.

Diagnostic characters

Queen (Figs. 97–99): Scape base almost rectangularly angled, with a plane bordered by the dorsal and caudal carina sloping caudad at $33^\circ \pm 5^\circ$ ($n = 20$). Postpetiole wider than 0.5 HW. Whole body covered by very long standing hairs, the longest on postpetiole measure 248–298 μm . Spines rather short. Frontal carinae weakly diverging. Alitrunk in lateral view with a steep and long slope line formed by the posterior faces of scutellum and metanotum (in other species this slope is relatively lower and less steep). Data of 26 queens:

HL 1113.8 ± 46.0 (989–1204), HW 1139.0 ± 58.3 (1011–1237), HL/HW 0.979 ± 0.0165 (0.949 bis 1.006), SL/HL 0.757 ± 0.0126 (0.727–0.782), HW/FR 2.702 ± 0.0844 (2.57–2.94), FL/FR 1.214 ± 0.0289 (1.180–1.280), PE/HW 0.344 ± 0.0230 (0.306–0.424), PP/HW 0.544 ± 0.0314 (0.502–0.667), SP/HW 0.274 ± 0.0241 (0.231–0.321), PPH 268.3 ± 13.6 (248–298). According to data of ELMES (1978), queens from England have a still wider postpetiole than continental queens but a less extreme pilosity.

Male (Figs. 121, 154, 155): Scape similar to *sabuleti* or *vandeli*, weakly bent at base. Whole body from head to gaster with long standing pilosity. The longest hairs on occipital head roundings measure 85–180 μm in British examples, but are still much longer in continental males: 221.2 ± 35.9 ($n = 10$, 177–278). Petiole in lateral view relatively high and short, massive and, in contrast to other species except *bibikoffi*, the rather straight or weakly curved dorsal surface slopes abruptly down before the posterior margin. Mesonotum not as smooth as in *vandeli*; always with fine longitudinal sculpture, at least behind the notauli. Although body hairs are not much longer than in *vandeli*, the general appearance is more hirsute. Data of 12 males:

HL 892.4 ± 39.4 (826–944), AL 1744.2 ± 62.4 (1675–1855), SL/HL 0.567 ± 0.0254 (0.528–0.608), SL/SW 3.952 ± 0.365 (2.99–4.25), F2 127.6 ± 6.30 (116–136), IF2 1.740 ± 0.089 (1.59–1.92), F2H 98.1 ± 5.7 , PE/HL 0.421 ± 0.0211 (0.383–0.443), PP/HL 0.586 ± 0.0248 (0.533–0.620), MEH 162.2 ± 15.9 (144–195), PPH 218.9 ± 10.4 (197–231). British males have much larger mean PE/HL (0.453) and PP/HL (0.640).

Comments

The male could be confused with *vandeli* but consideration of character combinations should enable a determination. The queen could be misidentified by unskilled determinators as *scabrinodis* or *specioides*, but the much longer pilosity, the wider postpetiole, and the lateral alitrunk profile are diagnostic.

Biology and distribution

This workerless social parasite is obviously widely distributed and can be expected for all sites in Europe with sufficiently dense populations of its host *M. sabuleti*. The habitat

patches with *hirsuta* have sometimes the highest densities of host nests ever reported: I found, on a small area of 11.5 m² near Freyburg, 1.57 nests/m² of *sabuleti* and at least 9 (= 50%) nests were parasitized by *hirsuta*; ELMES reported for one *hirsuta* site in Dorset 1.0 host nests/m². The question whether intranidal mating occurs or a real nuptial flight is not clear. Single dealate queens may be observed in search of a host colony throughout the whole season. ELMES (1978) found a bimodal size distribution in queens of which the smallest gynes had no queen effect on *sabuleti* workers in contrast to the macrogynes. Known distribution: England, Sweden, S Finland, FRG, GDR, Austria, Yugoslavia, and Czechoslovakia.

Key to workers

This dichotomous key is not adequate to each problem. In doubtful cases, character combinations, nest samples, and the geographic range have to be considered and descriptions, comments, and figures have to be studied carefully. See also Tables 1-2.

- 1 Frons extremely narrow, HW/FR > 5.8 **M. ravasinii**
 -- HW/FR < 5.8 **2**
- 2 Scape long and slender; scape base weakly curved, without any trace of carinae and continuously reducing its ideally cylindrical diameter towards proximal end (Fig. 12). Head long, HL/HW 1.054-1.134. **3**
 -- Scape base clearly angled or more or less strongly curved and with no ideally cylindrical cross section. Scape diameter in caudal view not continuously and conspicuously reducing from the point distal to the point proximal of curvature **4**
- 3 Propodeal spines short, SP/HL < 0.277, SP < 0.0009467 HL^{1.801}. Petiole profile as in Fig. 15. **M. rubra**
 -- Propodeal spines longer, SP/HL > 0.277, SP > 0.0009467 HL^{1.801}. Petiole profile as in Fig. 13. **M. ruginodis**
- 4 Scape base without any trace of a caudal carina (use large magnifications and suitable illumination); a dorsal carina or edge running along the outside of the bend down to base may be present **5**
 -- Scape base with a suggestion of a caudal carina at least or with a large lobe or transverse, upright, tooth-like process which size differs from very small to very large **8**
- 5 Scape sharply curved at base and with sharp dorsal edge running along the outside of bend down to base (Figs. 23, 24). Alitrunk and petiole with very coarse, regular, longitudinal rugosity; depth of sulci on alitrunk 20-30 μm, their distance 60-80 μm. Petiole massive, relatively high and with an anterior cylindrical part shorter than in other species (Fig. 179) **M. sulcinodis**
 -- Scape with a less sharp or without dorsal carina along outside of bend. Alitrunk and petiole with much less coarse rugosity. Petiole much less massive, relatively lower and narrower, and with less short anterior cylindrical part **6**
- 6 Frons very broad, nest sample means of HW/FR < 2.46. Scape base angularly curved (Figs 29, 30). Petiole in lateral view with nearly straight frontal and dorsal surfaces that meet at a nearly right angle (Fig. 40); in dorsal view narrow and with straight, almost parallel sides. Head rather long, nest means of HL/HW > 1.040. Compare to *hellenica*. **M. rugulosa**
 -- Frons narrower, nest means of HW/FR > 2.46. Scape base very evenly bent in an ideal curve (Figs. 25-28). Petiole in lateral view with concave frontal profile and short, truncate dorsal area which width is larger than its length (Fig. 178). Head shorter, nest means of HL/HW < 1.040. **7**
- 7 Propodeal spines relatively long, SP > 0.000453 HL^{1.9067}, SP/HL 0.265-0.369. **M. gallienii**
 -- Propodeal spines short, SP < 0.000453 HL^{1.9067}, SP/HL 0.190-0.274. **M. bergi**
- 8 Postpetiole very broad (PP/HW > 0.475). Whole body thickset. Mid and hind tibiae with very reduced non-pectinate spurs of 30 μm (mid tibia) and 40-70 μm (hind tibia) length. **M. bibikoffi**

- Postpetiole narrower, whole body slender. Mid and hind tibiae with longer, at least partially pectinate spurs. 9
- 9 Scape base angularly curved and with weak, but normally well visible caudal carina (Figs. 31–33, 50–52). Frontal carinae weakly diverging (Fig. 37), frons rather broad, head rather long, petiole and postpetiole narrow (Fig. 38), small body size. Nest means: FL/FR < 1.21, HW/FR < 2.65, SP/HL < 0.345. Southern Central Europe, N Italy, Balkans. **M. hellenica**
Character combination in at least one character and/or distribution clearly different 10
- 10 Scape base in caudal view evenly bent in an ideal curve or curved with suggestion of an angle, caudal carina weak (Figs. 46–49) Frontal triangle weakly demarcated and entirely longitudinally striate, sometimes the striae are restricted to caudal half of a better demarcated frontal triangle. Nest means: HW/FR < 2.95, FL/FR < 1.25, SP/HL > 0.340. Relatively large size. Iberian Peninsula, coast of Golfe du Lion, Balearic Islands. Compare to *hellenica* and *specioides*. **M. aloba**
Character combination in at least one character and/or distribution clearly different 11
- 11 Scape strongly compressed at base in a way that the smallest diameter is visible in caudodorsal view and the largest in frontodorsal view (Figs. 71–74). Caudal carina always distinct, a dorsal carina may be very distinct and run along three quarters of dorsal scape length but is sometimes reduced. Head short, HL/HW < 1.030. Spines rather short (SP/HL \leq 0.310) but slender, often nearly awl-shaped. Alitrunk profile convex with shallow mesopropodeal impression (Fig. 69). Steppes and semideserts from lower Dnepr River to E Kazakhstan. Compare to *specioides*. **M. stangeana**
Character combination in at least one character clearly different 12
- 12 Scape at base without a dorsal carina and with conspicuous caudal lobe (Figs. 168–171). Posterior and middle part of clypeus smooth and shining. Frons very narrow (HW/FR 3.91), diverging strongly into broad frontal lobes (FL/FR 1.81). Petiole in dorsal view very narrow (PE/HW 0.242), in lateral view with clearly concave anterior face (Fig. 180). Sculpture weak and fine. Head short (HL/HW 1.005). **M. salina**
Character combination different 13
- 13 Scape base with a small to large, transverse, upright tooth or flange 14
--- Scape base with a caudal carina or lobe and frequently with a dorsal carina 17
- 14 Frons very narrow (HW/FR 4.63), frontal lobes conspicuously diverging (FL/FR 1.63), spines rather long (SP/HL 0.323), height of concavity below spines larger than height of lateral propodeal lobe. Dorsal and anterior face of petiole meeting at a blunt angle (Fig. 181). Scape base always with large, upright flange (Figs. 87, 88). Mesopropodeal furrow weak to almost imperceptible. **M. schencki**
Character combination different 15
- 15 Large body size; broad head (HW 1169–1429); HW/FR 3.30–3.78; FL/FR 1.34–1.47; scape long (Figs. 83–86); petiole with anterior cylindrical part a little longer than in other species, in lateral view with clearly concave frontal profile, convex dorsocaudal profile, and no angular structures (Fig. 183). Spines short and projecting dorsocaudad at 45°, SP/HL 0.214–0.264. Hairs on dorsum of petiole long, PEH 230–280. **M. deplanata**
Character combination different 16
- 16 Pyrenees and Iberian Peninsula only. Dorsal and frontal face of petiole meet at a blunt angle (Fig. 77). Petiole in dorsal aspect clearly longer than wide. Spines rather long, SP/HL 0.27–0.35; FL/FR 1.16–1.33, PE/HW 0.25–0.28. Upright, transverse, tooth-like process at scape base very small. **M. wesmaeli**
Pyrenees and Iberian Peninsula: Dorsal and frontal face meet at a right angle (Fig. 82). Petiole in dorsal aspect not clearly longer than wide. Spines short, SP/HL 0.21–0.30; FL/FR 1.21–1.51, PE/HW 0.27–0.29. Outside the Pyrenees and Iberian Peninsula we may have *lobicornis* populations approaching to the *wesmaeli* morphology in several characters, but not in the whole character combination (Figs. 78–82). **M. lobicornis**
- 17 The plane between dorsal carina and caudal carina or caudal edge of lobe at scape base slopes caudad at less than 32°. 20
— The plane between dorsal and caudal carina slopes caudad at 32–64°. 18

- 18 Petiole in lateral view with slightly concave frontal face which meets the convex dorsocaudal face in no angle (there is a rounding). The dorsocaudal face shows no abrupt step in its caudal slope to junction with postpetiole. NE, E, and S coast of Black Sea, Cis- and Transcaucasus from sea level to 1500 m. Fig. 176. *M. sancta*
The frontal and dorsal faces of petiole meet at a distinct angle, dorsal surface truncate and showing an abrupt step before its junction with postpetiole (Fig. 175). 19
- 19 Sculpture coarser and more reticulate (Figs. 165, 167). FL/FR 1.26–1.50, HW/FR 2.85–3.30, HL/HW 1.020–1.052, SL/HL 0.760–0.800, PE/HW 0.265–0.296, PEH 168–204, PPH 150–183 (all data refer to nest sample means). *M. scabrinodis*
Sculpture finer, less reticulate, and on petiole node more circular (Figs. 164, 166). Nest sample means: FL/FR 1.23–1.31, HW/FR 2.65–2.90, HL/HW 0.995–1.029, SL/HL 0.728–0.766, PE/HW 0.256–0.276, PEH 205–235, PPH 193–223. *M. vandeli*
- 20 Petiole relatively massive and wide, in lateral view (see Fig. 173) with a high, more rounded than truncate node which falls steeply down to postpetiolar junction. Spines long and acute, SP/HL 0.353–0.420. Scape base extremely variable in size of lobe but not in basic structure (Figs. 89, 90, 93–96). *M. sabuleti*
Lateral petiole profile as in Fig. 176, spines shorter 21
- 21 Pilosity on whole body long and rather dense, PEH 216–235, PPH 198–208. Scape with very numerous and long suberect hairs which have twice the density as usually seen in *Myrmica* (Figs. 66–68). Sculpture on waist and promesonotum very coarse. Postpetiole wide, PP/HW 0.433. Transcaucasia: Boržomi Mountains only. *M. bakurianica*
Pilosity less dense and shorter, PEH < 210, PPH < 198. Sculpture weaker. Postpetiole much narrower. 22
- 22 Caucasus, Armenia, Asia Minor, and N Iran between 1200 and 2000 m. For distinction from following species see descriptions and Table 2. *M. caucasica*
Xerothermous habitats, particularly steppes of Europe, Asia Minor, Transcaucasia and Kazakhstan below 1200 m. 23
- 23 Europe east to Wolga River. FL/FR < 1.43. *M. specioides*
Steppes ~~west~~ ^{east} of the Wolga River, Asia Minor, Transcaucasia. FL/FR > 1.43. *M. turcica*

Key to Queens

The queen of *M. ravasini* is unknown but should be well-characterized by extremely large HW/FR. The scapes of queens are as in workers but frequently a little more stronger. A bimodal size distribution (macrogynea–microgynea) is known for *M. rubra*, *ruginodis*, and *hirsuta*. Occurrence of microgynea with normal queen morphology can be expected, as rare exception, for further species.

- 1 Scape long and slender; its base weakly curved, without any trace of carinae and continuously reducing its ideally cylindrical diameter towards proximal end (Fig. 12). 2
Scape base clearly angled or more or less strongly curved and with no ideally cylindrical cross section near base. Scape diameter in caudal view not continuously and conspicuously reducing from the point distal to the point proximal of curvature. 3
- 2 Propodeal spines short, SP/HW < 0.255. Macrogynea HW > 1200, microgynea HW < 1200. Petiole profile as in Fig. 16. *M. rubra*
Propodeal spines long, SP/HW > 0.255. Petiole profile see Fig. 14. *M. ruginodis*
- 3 Scape hardly reaching to occipital margin of head. Scape base bent in a blunt angle and not thickened. Postpetiole nearly twice as wide as petiole and with conspicuous ventral bulge. Petiole with large ventral lobe. PP/HW \geq 0.500. PEH and PPH < 180. *M. myrmicoxena*
- Character combination in at least one character different. 4
- 4 Postpetiole very wide, PP/HW > 0.501. Whole body with numerous, long hairs, PPH > 244. HW < 1250. *M. hirsuta*
Character combination in at least one character different. 5
- 5 Whole body of very thickset appearance. Petiole and postpetiole very wide, PP/HW 0.54, PE/HW 0.344, HW 1370. Spurs of mid and hind tibia non-pectinate and 0.1–0.12 mm long. *M. bibikoffi*

- Whole body appearing more slender, $AW/HW < 0.865$, $PP/HW < 0.520$. Spurs of mid and hind tibia at least in part pectinate and longer. **6**
- 6 Scape base without any trace of a caudal carina (use large magnifications and suitable illumination), a dorsal carina or edge running along the outside of the bend down to base may be present. **7**
- 7 Scape base with a suggestion of a caudal carina at least or with large lobe or with transverse, upright, tooth-like process or flange. **10**
- 7 Scape base sharply curved and with sharp dorsal keel running along the outside of bend down to base. Alitrunk and petiole with very coarse, regularly longitudinal rugosity; depth of sulci 20–30 μm , their distance 60–80 μm . Petiole massive and high. Spines strong, SP/HW 0.292–0.398. Large size, HL 1304–1453. HW/FR 2.58–2.99. **M. sulcinodis**
- 8 Scape with less sharp or no dorsal carina along outside of bend. Alitrunk and petiole with much less coarse rugosity. Petiole less massive, relatively lower and with anterior cylindrical part. Spines shorter. **8**
- 8 Frons very broad, HW/FR 2.13–2.395. Scape base angularly curved. Waist narrow (PE/HW 0.268, PP/HW 0.428) and with weak sculpture. Small size, HW 1085–1208. **M. rugulosa**
- 9 Frons narrower, $HW/FR > 2.37$. Scape base evenly bent in an ideal curve. Petiole wider. Body size larger, $HW > 1200$. **9**
- 9 Propodeal spines longer, $SP/HW > 0.237$. **M. gallienii**
- 9 Propodeal spines shorter, broad at base, $SP/HW < 0.237$. **M. bergii**
- 10 Scape at base angularly curved and with weak, but normally well-visible caudal carina (Figs. 42–44). Frontal carinae weakly diverging (Fig. 45), FL/FR 1.098–1.151. Frons broad, HW/FR 2.35–2.63. Very small size, head narrow, HW 1028–1152, HL/HW 0.999–1.041. Southern Central Europe, N Italy, Balkans. **M. hellenica**
- 10 Character combination in at least one character clearly different. HW frequently larger. **11**
- 11 Scape base in caudal view evenly bent in an ideal curve or curved with suggestion of an angle, caudal carina weak. Frontal triangle weakly demarcated and longitudinally striate. HW/FR 2.48–2.72, FL/FR 1.099–1.185, SP/HW 0.329–0.382. Rather large size, HW 1300–1385. Iberian Peninsula, coast of Golfe du Lion, Balearic and Pityusic Islands. **M. aloba**
- 11 Character combination in at least one character different. **12**
- 12 Scape strongly compressed at base in a way that the smallest diameter is visible in caudodorsal view and the largest in frontodorsal view (Figs. 70–74). Caudal carina always distinct; a dorsal carina may be very distinct and run along three quarters of dorsal scape length, but is sometimes reduced. Head rather short, HL/HW 0.966–0.987, HW 1301–1333. Steppes and semideserts from lower Dnepr River to E Kazakhstan. **M. stangeana**
- 12 Character combination in at least one character different. **13**
- 13 Scape base without a dorsal carina and with conspicuous caudal lobe (Figs. 168–171). Posterior and middle parts of clypeus smooth and shining. Frons narrow (HW/FR 3.946) and diverging into broad frontal lobes, FL/FR 1.584–1.911. Petiole in dorsal view very narrow, PE/HW 0.252–0.280. Sculpture weak and fine. Head short, HL/HW 0.942–1.017, HW 1164–1284. **M. salina**
- 13 Character combination different **14**
- 14 Scape base with small to large, transverse, upright tooth-like process or flange. **15**
- 14 Scape base with a caudal carina or lobe and frequently with a dorsal carina. **18**
- 15 Frons very narrow, $HW/FR > 4.24$. $HW > 1275$. Scape base with a large upright flange (Figs. 87, 88). **M. schencki**
- 15 Character combination different.
- 16 Large size, $HW > 1350$, $HW/FR < 3.50$ **M. deplanata**
- 16 Smaller, $HW < 1350$ **17**

- 17 FL/FR < 1.21, AL/AW < 1.77. Upright, transverse, tooth-like process at scape base very small. Pyrenees and Iberian Peninsula only. **M. wesmaeli**
 FL/FR > 1.21, AL/AW > 1.77. Tooth-like process at scape base of extremely variable size. **M. lobicornis**
- 18 The plane between dorsal and caudal carina at scape base slopes caudad at 40–60°. HW/FR 2.31–2.65, FL/FR 1.10–1.20, HW 1178–1222. NE, E, and S coast of Black Sea, Cis- and Transcaucasus from sea level to 1500 m. **M. sancta**
 --- Character combination different. 19
- 19 The plane between dorsal and caudal carina at scape base slopes caudad at 38–55°. Large size, HW 1343–1485; broad postpetiole, PP > 630. Long hairs on dorsum of waist, PEH 226–278, PPH 209–268. Sculpture on whole body fine. At least a small median spot at anterior border up to large parts of mesonotum completely without rugosity and shining. Scape short, SL/HL 0.674–0.737, HW/FR 2.61–2.89, FL/FR 1.166–1.253. **M. vandeli**
 --- Character combination in at least one character clearly different. 20
- 20 The plane between dorsal and caudal carina at scape base slopes caudad at 38–55°. HW 1158–1286, PP < 630. Shorter hairs on dorsum of waist, PEH 172–223, PPH 175–218. Sculpture coarser. Mesonotum on whole surface with strong sculpture. **M. scabrinodis**
 --- The plane between dorsal and caudal carina at scape base slopes caudad at less than 38°. 21
- 21 Petiole in lateral view with very high and massive node which falls down to junction with postpetiole with an abrupt step of 100 µm height at least (see Fig. 184). Spines long, SP/HW 0.306–0.391. Size rather large, HW 1276–1403. **M. sabuleti**
 Petiole in lateral view with less high and massive node (see Figs. 185–187) which more gradually falls down to junction with postpetiole; if a distinct step is present, then its height is less than 90 µm. Spines shorter, SP/HW 0.244–0.350. Smaller size, HW 1135–1300. 22
- 22 Pilosity on whole body, but particularly on scape, long and dense. Sculpture on petiole and postpetiole coarser. Scape long, SL/HL 0.780–0.794. Uniformly dark brown. Transcaucasia: Boržomi Mountains only. **M. bakurianica**
 --- Pilosity less dense, sculpture on waist finer, scape shorter. 23
- 23 Caucasus, Armenia, Asia Minor, and N Iran between 1200 and 2000 m. For distinction form following species see descriptions and Table 4. **M. caucasica**
 --- Xerothermous habitats, particularly steppes of Europe, Asia Minor. Transcaucasia, and Kazakhstan below 1200 m. 24
- 24 Europe east to Wolga River. FL/FR frequently < 1.37. HW 1135–1250. **M. specioides**
 --- Asia Minor, Transcaucasia, steppes east of the Wolga River. FL/FR 1.376. HW 1283. **M. turcica**

Key to Males of Central Europe

- 1 Alitrunk and petiole very short and thickset. Head narrower than alitrunk. Length of straight slope line made up by caudal face of scutellum and metanotum is more than 0.30 of total alitrunk height seen in lateral view. Petiole with clearly convex sides and a rather well-developed ventral process. Scape shorter than first four funiculus segments, SL/HL 0.371, SL/SW 3.3. **M. myrmicoxena**
 --- Character combination in at least one character clearly different. 2
- 2 Scape long and slender, SL/HL > 0.691, SL/SW > 5.30. 3
 --- Scape shorter and thicker, SL/HL < 0.691, SL/SW < 5.30. 7
- 3 Petiole in lateral view with rather straight dorsal profile that abruptly slopes down to junction with postpetiole (reminiscent of *hirsuta*, Fig. 121). Scape clearly curved at base, SL/HL 0.79, SL/SW 6.0. Pilosity long and profuse. **M. bibikoffi**
 --- Dorsal surface of petiole gradually sloping down to junction with postpetiole, SL/SW > 6.0. 4

- 4 Scape with gentle curvature at base (Figs. 12, 20). Frontal triangle smooth and shining. 5
 Scape strongly curved or angled (Figs. 21, 22). Frontal triangle at least in part with fine sculpture. 6
- 5 Hind tibia and metatarsus with subdecumbent hairs of moderate length, the longest project 20–60 μm from hind tibia extensor profile line (Fig. 18). Scape longer, SL/HL 0.863–0.962, SL/HW 0.794–0.955. Size larger, HL 908–1178. Body colour paler. **M. ruginodis**
 Hind tibia and metatarsus with long suberect to subdecumbent hairs, the longest project 70–100 μm from hind tibia extensor profile line (Fig. 17). Scape shorter, SL/HL 0.742–0.896, SL/HW 0.710–0.825. Size smaller, HL 833–1018. Body colour darker. **M. rubra**
- 6 IF2 1.99–2.71, SL/HL 0.821–0.944. Frontal triangle with longitudinal striae. Larger, AL 1801–2198. Scape with clear 45° curvature, but never angled (Fig. 21). Petiole in lateral view lower, with frontal and dorsal profiles making a broad rounding. **M. sulcinodis**
 IF2 1.48–2.00, SL/HL 0.702–0.888. Frontal triangle with weaker, less longitudinal, more reticulate sculpture and often in part smooth. Smaller, AL 1542–1976. Scape frequently clearly angled (Fig. 22), but sometimes curved in a similar way as in *sulcinodis*. Petiole in lateral view higher, with frontal and dorsal faces meeting in a weakly rounded angle (Fig. 117). **M. lobicornis**
- 7 Scape very short and nearly straight. Second funiculus segment elongated. SL/F2 1.68–2.13, SL/HL 0.316–0.351. Petiole and postpetiole very low and elongated (Fig. 118) and with very long standing hairs, anterior part of frontal face with very dense erect pubescence. Petiole in dorsal view nearly twice as long as wide. **M. deplanata**
 SL/F2 always > 2.00, character combination different. 8
- 8 Scape rather short and clearly angled in frontodorsal view (Fig. 136). SL/HL 0.430–0.531. Second funiculus segment clearly elongated, IF2 2.14–2.59. Petiole rather long and low, in lateral aspect with a rounded and never angular dorsal profile (Fig. 119). Anterior half of frontal petiolar face with dense erect pubescence. **M. schencki**
 Character combination different. 9
- 9 SL/HL > 0.480 10
 SL/HL < 0.480 12
- 10 Occipital head roundings behind the eyes with no or very short subdecumbent hairs which are not longer than 75 μm . **M. sabuleti**
 Occipital head roundings behind the eyes with long hairs of which the longest measure 90 μm at least. 11
- 11 Petiole in lateral view with rather straight or weakly convex dorsal surface that abruptly slopes down before the junction with postpetiole (Fig. 121). Mesonotum always with fine longitudinal sculpture, at least behind the notauli. General appearance of whole body more hirsute. Longest hairs on occipital head roundings behind the eyes 90–278 μm long. SL/SW 2.99–4.25. **M. hirsuta**
 Dorsal surface of petiole in lateral view gradually sloping down to posterior margin (Fig. 114). Mesonotum often on whole surface smooth and shining. General appearance somewhat less hirsute. Length of longest hairs on occipital corners behind eyes 120–190 μm . SL/SW 3.83–5.15. **M. vandeli**
- 12 Second funiculus segment clearly elongated. Scape short and nearly straight, SL/HL 0.365–0.427, IF2 2.01–2.41. Petiole in lateral view high and massive (Fig. 104). PE/HL 0.366–0.419, PP/HL 0.528–0.587. Size large, AL 1746–2472. **M. gallienii**
 Character combination different. 13
- 13 Appendages with very long erect to suberect hairs, MEH 211–273. Petiole and postpetiole high and wide. **M. scabrinodis**
 Appendages with much shorter hairs, MEH < 160. 4 species difficult to separate (see descriptions, figures, and Table 6): **M. rugulosa, hellenica, specioides, salina**

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Table 1. Data of *Myrmica* workers with no trace of a caudal carina at scape base (*rugulosa* to *sulcinodis*) and of such with upright, transverse tooth-like process or flange at scape base (*vesmaeli* to *ravasini*): upper line arithmetic mean, lower line standard deviation.

For extreme values see descriptions.

	HL	HL/HW	HW/FR	FL/FR	SL/HL	PE/HW	PP/HW	SP/HL	PEH	PPH	PEH/HL	PPH/HL
RUGULOSA	1007.2	1.058	2.286	1.043	0.788	0.240	0.380	0.286				
n = 92	63.9	0.0161	0.0881	0.0292	0.0159	0.0068	0.0125	0.0275				
RUBRA	1205.5	1.105	2.300	1.070	0.822	0.273		0.235				
n = 31	61.8	0.0169	0.071	0.022	0.0191	0.0114		0.0239				
RUGINODIS	1237.6	1.096	2.368	1.100	0.839	0.289		0.344				
n = 28	64.6	0.0181	0.0584	0.025	0.0184	0.0119		0.0277				
GALLIENII	1148.2	1.022	2.616	1.089	0.805	0.254	0.407	0.325				
n = 57	69.4	0.0146	0.0873	0.0205	0.0152	0.0111	0.0179	0.0252				
BERGI	1350	1.022	2.62	1.109				0.220				
n = 5												
SULCINODIS	1292.6	1.024	2.703	1.079	0.786	0.287	0.428	0.346				
n = 28	61.7	0.0182	0.0849	0.0283	0.0199	0.0155	0.0172	0.0277				
WESMAELI	1113.0	1.007	3.125	1.219	0.768	0.260	0.414	0.324			0.165	
n = 23	42.0	0.0208	0.140	0.0461	0.0186	0.0112	0.0123	0.0189			0.0098	
DEPLANATA	1297.8	0.992	3.583	1.414	0.818	0.264	0.406	0.289	258.6		0.177	
n = 22	54.9	0.0198	0.130	0.0320	0.0129	0.0151	0.0198	0.0160	12.0	12.1	0.0065	
LOBICORNIS	1060.1	1.014	3.648	1.456	0.786	0.275	0.419	0.293			0.174	
n = 101	58.2	0.0214	0.326	0.106	0.0194	0.0133	0.0137	0.0378			0.0152	
SCHENCKI	1192.6	1.004	4.626	1.634	0.777	0.257	0.404	0.323			0.199	
n = 46	55.9	0.0180	0.213	0.0796	0.0158	0.0117	0.0148	0.0235			0.0115	
RAVASINII	1266.5	1.003	7.579	2.755	0.798	0.267	0.397	0.361				
n = 8	75.2	0.0142	0.454	0.199	0.0126	0.0087	0.0121	0.0160				

Table 3 Data of *Myrmica* queens with no trace of a caudal carina at scape base (*ruginodis* to *sulcinodis*) and of queens with upright, transverse tooth-like process or flange at scape base (*wesmaeli* to *schencki*); upper line the arithmetic mean, lower line standard deviation; for extreme values see descriptions.

	HL	HW	HL HW	HW/FR	FL/FR	SL HL	SP HW	PE HW	PP HW	PEH	PPH
RUGULOSA	1156.8	1147.6	1.008	2.253	1.031	0.753	0.261	0.268	0.426		
n = 33	24.6	32.6	0.0179	0.070	0.0153	0.0165	0.0219	0.0078	0.0186		
RUBRA macrog.		1326.2		2.26	1.06		0.189				
n = 28		48.6		0.068	0.0180		0.0199				
RUBRA microg.		1039.8					0.194				
n = 9		59.5					0.0346				
RUGINODIS		1232.1		2.31	1.09		0.310				
n = 28, macrog.		37.5					0.0220				
RUGINODIS		1105		2.31	1.09		0.320				
n = 1, microg.											
GALLIENII	1297.2	1322.1	0.982	2.545	1.0685	0.773	0.279	0.286	0.463		
n = 35	38.0	43.7	0.0225	0.0833	0.0201	0.0150	0.0210	0.0103	0.0103		
SULCINODIS	1394.6	1397.7	0.998	2.784	1.078	0.762	0.339				
n = 7	52.6	47.1	0.0111	0.144	0.0171	0.0131	0.0346				
WESMAELI	1169.0	1221.5	0.958	2.372	1.120	0.740	0.320	0.271	0.470	200.0	212.0
n = 2	17.0	14.8	0.0021	0.0863	0.0106	0.0135	0.0148	0.0065	0.0035	1.4	4.2
DEPLANATA	1433.0	1489.0	0.963	3.320	1.305	0.769	0.221	0.272	0.440	278.5	245.0
n = 3	19.3	54.3	0.0223	0.0259	0.0380	0.0144	0.0154	0.0072	0.0010	19.1	5.7
LOBICORNIS	1467.3	1191.3	0.930	3.715	1.442	0.756	0.294	0.294	0.468	215.2	208.7
n = 26	31.2	29.9	0.0131	0.309	0.0943	0.0124	0.0229	0.0123	0.0232	15.5	15.1
SCHENCKI	1294.5	1353.2	0.957	4.691	1.572	0.747	0.274	0.277	0.445	243.8	247.2
n = 23	30.7	32.1	0.0150	0.194	0.0617	0.0153	0.0171	0.0108	0.0190	17.4	21.8

Table 4 Data of *Myrmica* queens with at least a trace of caudal carina at scape base; upper line arithmetic mean, lower line standard deviation. For extreme values see description

	HL	HW	HL/HW	HW/FR	FL/FR	SL/HL	SP/HW	PE/HW	PP/HW	PEH	PPH
HELLENICA	1118.1	1093.1	1.023	2.458	1.118	0.759	0.296	0.269	0.432		
n = 28	29.0	31.5	0.0111	0.0655	0.0146	0.0180	0.0201	0.0125	0.0145		
SPECIOIDES	1197.5	1197.4	1.000	2.836	1.273	0.763	0.313	0.281	0.448		
n = 33	33.7	34.3	0.0155	0.111	0.0521	0.0145	0.0171	0.0148	0.0193		
TURCICA	1254	1283	0.977	2.912	1.376	0.766	0.319	0.284	0.462	235	240
n = 1											
CAUCASICA	1229.6	1227.9	1.002	2.778	1.273	0.759	0.283	0.270	0.438		
n = 16	23.9	24.4	0.0193	0.1381	0.0496	0.0105	0.0321	0.0121	0.0234		
SANCTA	1209.0	1198.7	1.009	2.573	1.159	0.759	0.352	0.270	0.449		
n = 9	22.2	17.2	0.0135	0.1062	0.0316	0.0138	0.0257	0.0116	0.0106		
BAKURIANICA	1160.0	1182.0	0.981	2.790	1.301	0.785	0.326	0.276	0.443	223.0	218.0
n = 3	53.8	48.5	0.0160	0.036	0.033	0.0071	0.0240	0.0190	0.0115	13.9	2.0
STANGEANA	1281.6	1315.7	0.974	2.987	1.255	0.752	0.272	0.273	0.431	222.0	206.0
n = 3	21.5	16.2	0.0113	0.0252	0.0122	0.0194	0.0163	0.0105	0.0043	28.2	12.5
ALOBA	1316.3	1329.3	0.990	2.626	1.144	0.745	0.355	0.296	0.450	212.3	204.6
n = 10	33.1	23.7	0.0085	0.083	0.0270	0.0168	0.0162	0.0152	0.0203	16.3	14.5
SCABRINODIS	1224.4	1229.0	0.996	2.955	1.323	0.742	0.342	0.307	0.465	200.8	196.9
n = 41	38.0	38.1	0.0148	0.0945	0.0555	0.0179	0.0327	0.0154	0.0172	17.9	14.8
VANDELI	1350.3	1413.5	0.955	2.760	1.215	0.703	0.336	0.312	0.492	256.6	248.0
n = 28	37.7	36.6	0.0107	0.0648	0.0253	0.0165	0.0240	0.0150	0.0154	15.9	14.0
SABULETI	1363.0	1389.3	0.985	2.940	1.261	0.778	0.337	0.312	0.464	229.7	229.7
W Mediterr.	44.6	12.5	0.0231	0.0673	0.0396	0.0156	0.0204	0.0060	0.0040		15.0
n = 3											
SABULETI	1313.1	1334.2	0.984	3.211	1.434	0.757	0.356	0.306	0.457	203.4	203.4
exc. W Medit.	33.8	31.6	0.0150	0.156	0.0712	0.0171	0.0213	0.0123	0.0181	16.1	16.1
n = 33											
SALINA	1197.7	1240.0	0.966	3.946	1.752	0.742	0.323	0.267	0.429	224.8	217.4
n = 21	31.5	31.3	0.0181	0.174	0.0862	0.0137	0.0134	0.0088	0.0149	15.0	10.8
HRSUTA	1113.8	1139.0	0.979	2.702	1.214	0.757	0.274	0.344	0.544	268.3	268.3
n = 26	46.0	58.3	0.0165	0.0844	0.0289	0.0136	0.0241	0.0230	0.0314		13.6

Table 5 Data of Myrmica males arranged in order of decreasing SL_{HL}; upper line arithmetic mean, lower line standard deviation. Note that we have sometimes skewed distributions and see descriptions for extreme values.

	HL	AL	SL _{HL}	F2	IP2	SL _{SW}	PE _{HL}	PP _{HL}	F2H	MEH	PEH	PPH
RUGINODIS	1070.8		0.915									
n = 12	85.8		0.0349									
SULCINODIS	1018.3	2000.1	0.880	189.7	2.295	7.68						
n = 25	35.0	91.7	0.0290	13.9	0.203	0.561						
RUBRA	942.1		0.806									
n = 21	55.9		0.0351									
LOBICORNIS	924.3	1758.9	0.790	133.9	1.777	6.597			81.9	97.2		
n = 24	58.4	109.5	0.0476	11.8	0.121	0.404			8.33	19.8		
BIBIKOFFI	850		0.79		1.70	6.0	0.40	0.55				
n = 1												
VANDELI	896.2	1831.6	0.622	145.4	1.763	4.528	0.380	0.533	112.2			
n = 19	26.2	64.5	0.0384	10.2	0.112	0.326	0.0258	0.0427	11.8			
SABULETI	945.7	1951.7	0.596	151.0	1.762	3.816			103.5	193.3		165.0
n = 30	35.1	103.6	0.0360	11.65	0.123	0.359			9.85	16.7		38.2
HIRSUTA	892.4	1744.2	0.567	127.6	1.740	3.952	0.421	0.586	98.1	162.2		218.9
n = 12	39.4	62.4	0.0254	6.30	0.089	0.365	0.0211	0.0248	5.7	15.9		10.4
SANCTA	850.0	1796.8	0.475	138.8	1.791	3.546	0.341	0.507	125.9	171.2		
n = 9	24.3	65.9	0.0209	6.7	0.067	0.227	0.0168	0.0313	17.4	21.4		
SCHENCKI	837.5	1964.9	0.469	168.8	2.346	3.692	0.340	0.515	94.3	114.5		
n = 19	37.0	72.6	0.0309	6.4	0.134	0.253	0.0168	0.0222	6.95	9.9		

Table 6 Data of *Myrmica* males arranged in order of decreasing SL HL; upper line arithmetic mean, lower line standard deviation. Note that we have sometimes skewed distributions and see for extreme values the descriptions.

	HL	AL	SL HL	F2	IF2	SL SW	PE HL	PP HL	F2H	MEH	PEH	PPH
BAKURIANICA	882.3	1897.3	0.460	145.7	2.01	3.223	0.354	0.534	142.7	159.3	201.5	210.2
n = 3	22.7	94.6	0.0114	9.61	0.026	0.193	0.0132	0.0172	22.7	15.6	23.0	9.6
CAUCASICA	861.7	1890.1	0.428	133.3	1.833	3.078	0.333	0.516	113.9	142.9		
n = 15	29.9	101.5	0.0250	10.1	0.105	0.196	0.0184	0.0164	13.3	13.2		
TURCICA	813.5	1870.5	0.426	131.5	1.875	3.09	0.359	0.538	94.5	125.0		
n = 2	17.1	46.0	0.003	3.5	0.049	0.141	0.0156	-	7.8	7.1		
SPECIOIDES	815.3	1801.9	0.419	124.2	1.761	3.264	0.337	0.509	92.3			
n = 28	31.6	132.4	0.0221	9.1	0.078	0.213	0.0212	0.0310	9.3			
SALINA	816.6	1796.8	0.404	133.3	1.881	2.970	0.346	0.508	116.8	134.9		
n = 12	26.3	73.9	0.0195	9.7	0.131	0.149	0.0292	0.0375	15.3	12.9		
HELLENICA	759.4	1613.7	0.399	115.1	1.833	3.296	0.315	0.480	81.7			
n = 20	26.6	70.7	0.0282	7.77	0.151	0.257	0.0098	0.0206	10.3			
GALLIENII	944.3	2150.9	0.392		2.210	3.244	0.386	0.549				
n = 19	53.3	142.6	0.0167		0.123	0.264	0.0230	0.0260				
SCABRINODIS	893.4	1931.4	0.387	135.8	1.870	2.565	0.407	0.563	170.5	234.8		
n = 45	42.1	116.0	0.0170	11.04	0.145	0.142	0.0274	0.0378	16.9	19.4		
ALOBA	921.4	1939.7	0.385	150.0	1.863	2.604	0.378	0.520	173.7	235.0		
n = 7	24.3	85.1	0.0181	9.5	0.086	0.222	0.0258	0.0247	23.9	18.0		
RUGULOSA	811.1	1786.5	0.377	115.5	1.738	3.020	0.329	0.491	91.1			
n = 23	45.2	122.1	0.0155	8.4	0.111	0.183	0.0179	0.0275	9.2			
DEPLANATA	854.0	1916.7	0.330	151.2	2.250	2.788	0.321	0.512	86.5	106.2		
n = 6	49.7	202.8	0.0124	13.4	0.198	0.091	0.0147	0.0253	27.7	12.4		

Figures

Fig. 1 Scape in lateral (and slightly dorsal) view. The standard visual positions c, d, and f are defined by the plane of movement of the hinge joint at distal scape end. The angle at which the plane of basal scape lobe (or the plane between dorsal and caudal carina) slopes caudad is measured in lateral view by computation of the arcus tangens function of cathetus data taken with an ocular grid.

Figs 2-7 Measuring of propodeal spine length (SP), scape length (SL) in female castes and male, alitrunk length (AL), and head measures (HL, HW, FL, FR).

Figs. 8-11 Queen of *Myrmica gallienii*. Scale bar = 1 mm.

Figs. 66, 67 Scape of *M. bakurianica* with projecting pilosity (in all other scape figures of female castes of other species the pilosity is omitted!)

Figs. 100-102 Sagitta, volsella, and subgenital plate of *M. hellenica*.

Figs. 164-167 Sculpture on petiolar node and pronotum of *M. vandeli* and *scabrinodis* workers.

Figs. 171, 172 Median (and slightly dorsal) view of scapes of *M. salina* and *turcica*.

Note: In order to avoid a time-consuming reading of explanatory context, the figures are designated, in addition to figure numbers, with abbreviations of the species names as string of first letters, e. g. RUGI = *ruginodis* or RUGU = *rugulosa*.

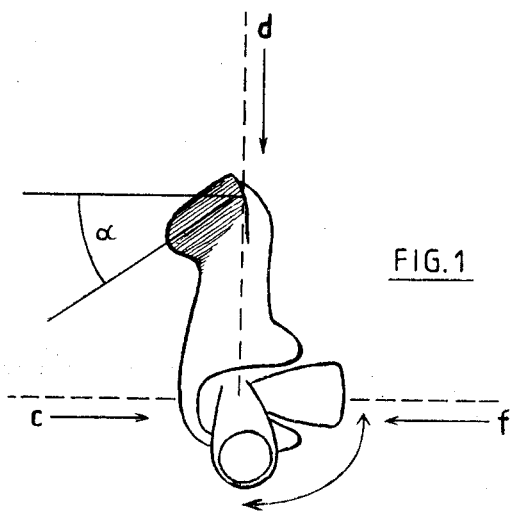


FIG. 1

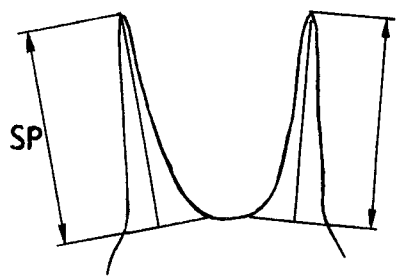
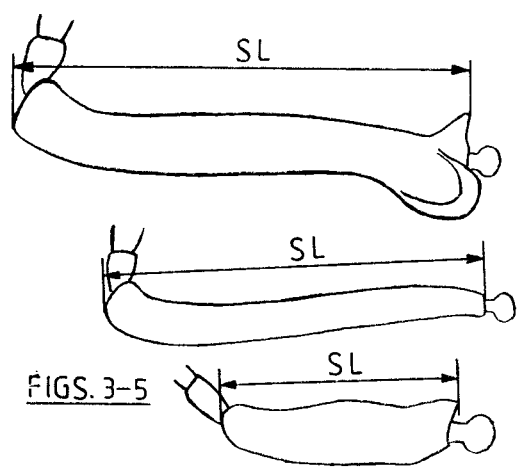


FIG. 2



FIGS. 3-5

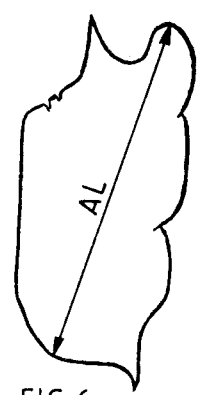


FIG. 6

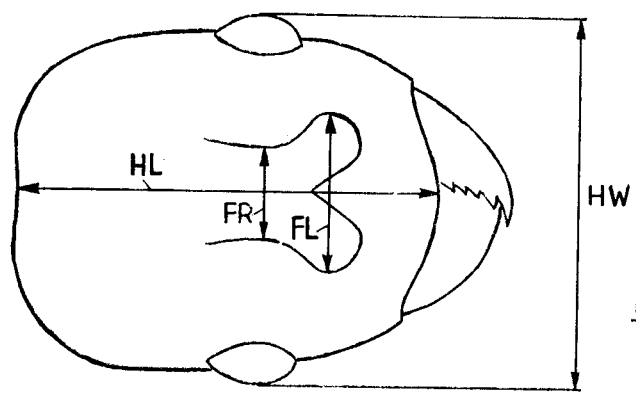
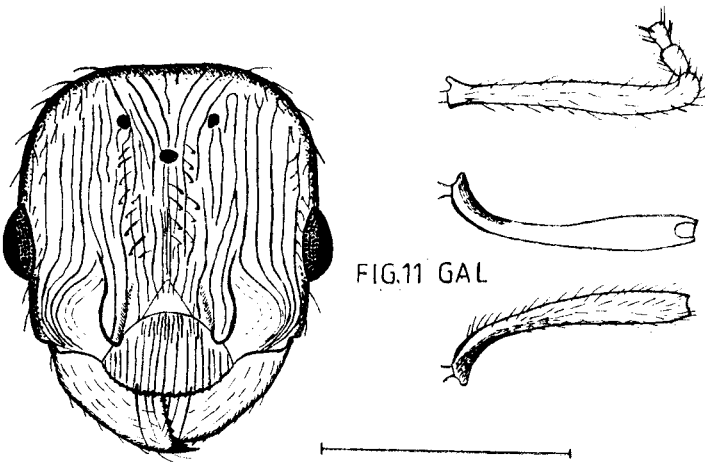
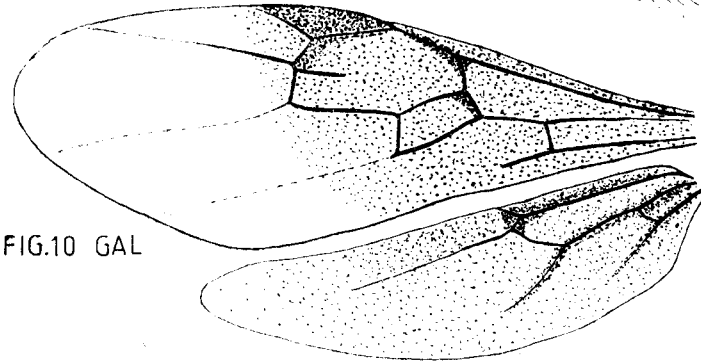
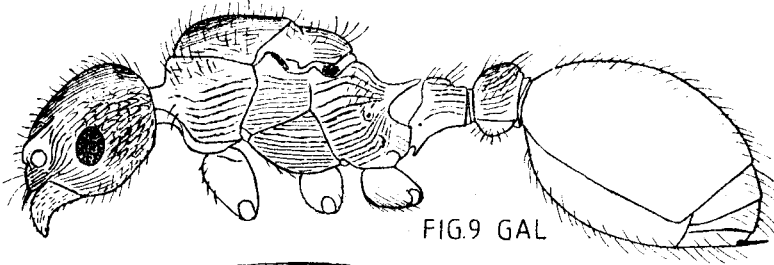
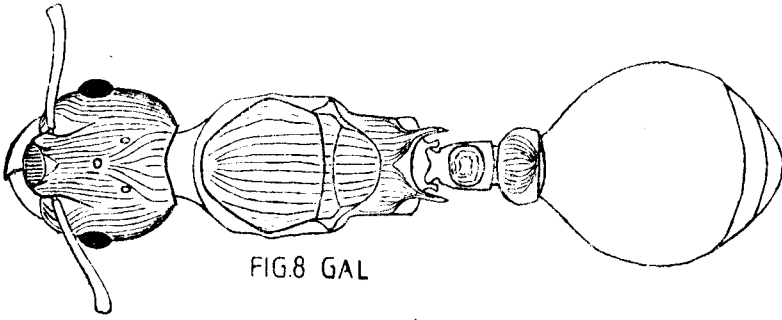


FIG. 7



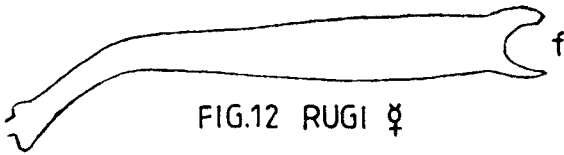


FIG.12 RUGI ♀

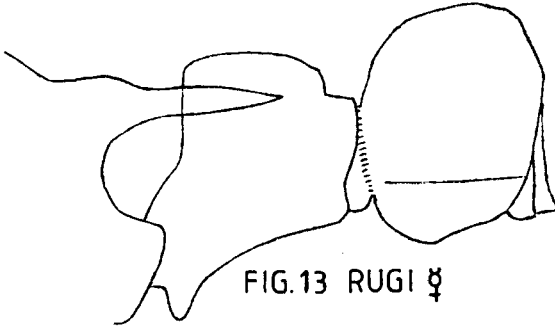


FIG.13 RUGI ♀

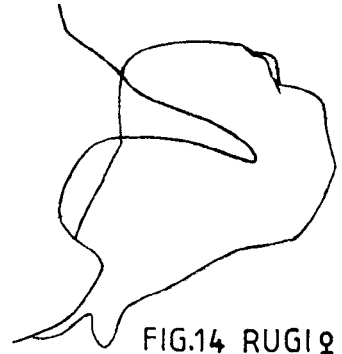


FIG.14 RUGI ♀

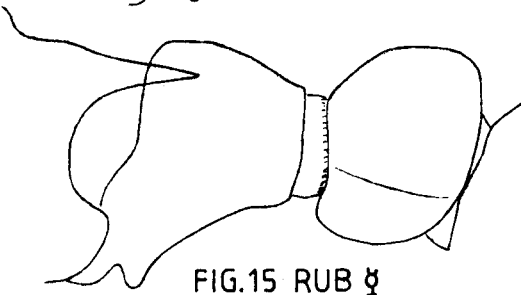


FIG.15 RUB ♀

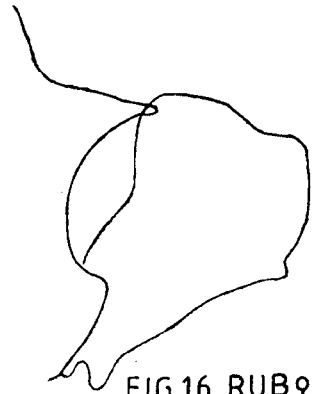


FIG.16 RUB ♀



FIG.17 RUB ♂

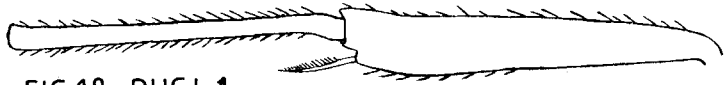


FIG.18 RUGI ♂

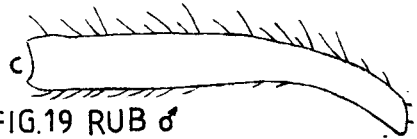


FIG.19 RUB ♂

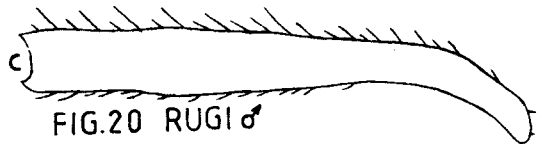


FIG.20 RUGI ♂

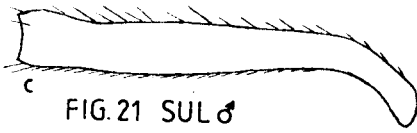


FIG. 21 SUL ♂

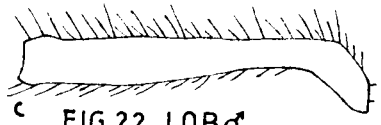


FIG. 22 LOB ♂

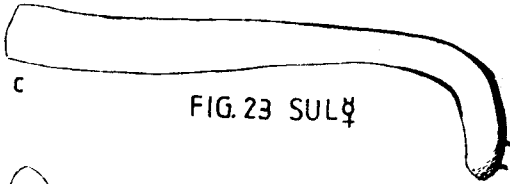


FIG. 23 SUL ♀

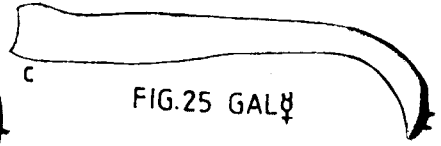


FIG. 25 GAL ♀

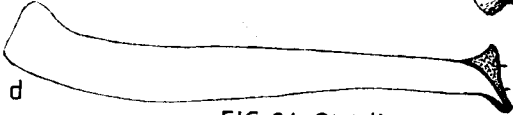


FIG. 24 SUL ♀

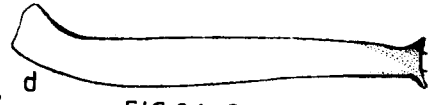


FIG. 26 GAL ♀

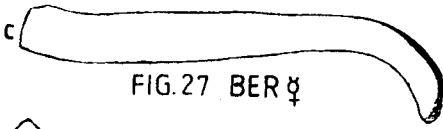


FIG. 27 BER ♀

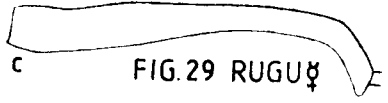


FIG. 29 RUGU ♀

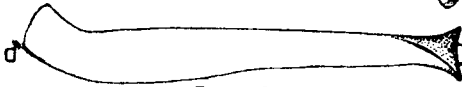


FIG. 28 BER ♀



FIG. 30 RUGU ♀

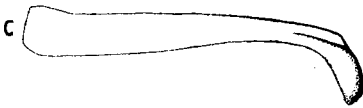


FIG. 31-33 HEL ♀

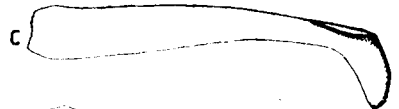
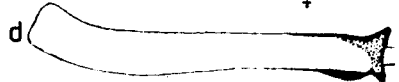
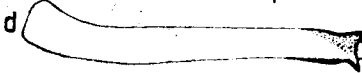
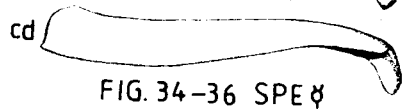
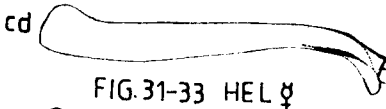
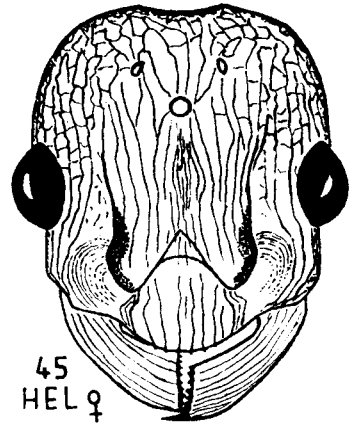
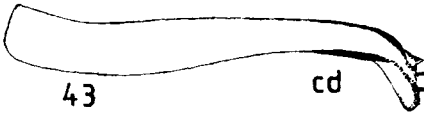
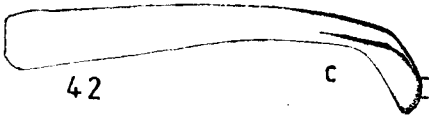
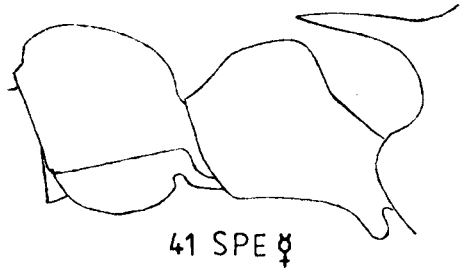
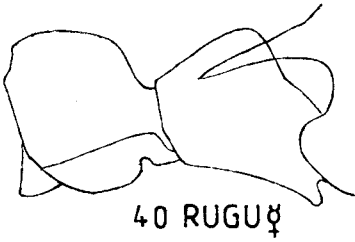
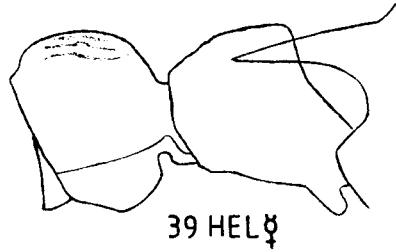
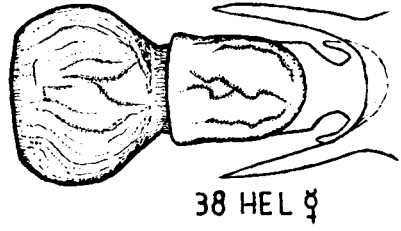
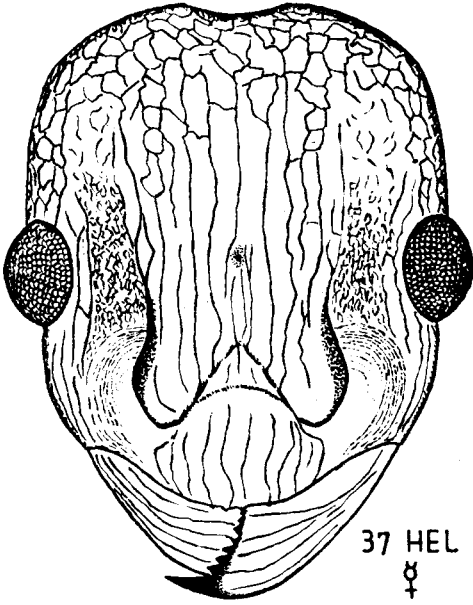
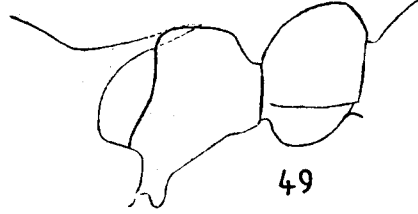
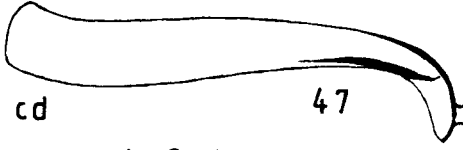
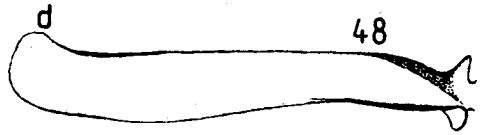


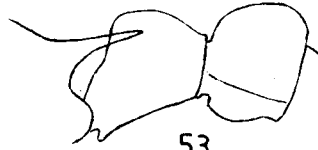
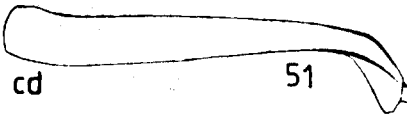
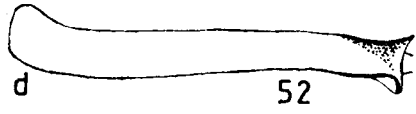
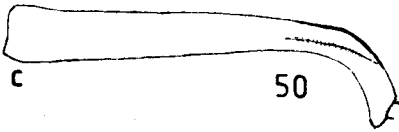
FIG. 34-36 SPE ♀



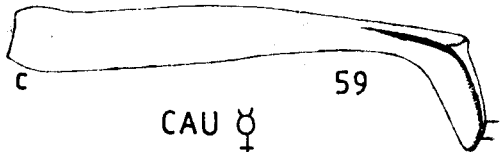
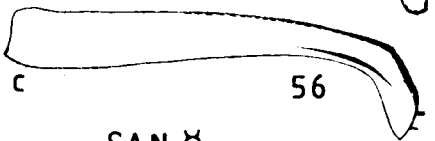
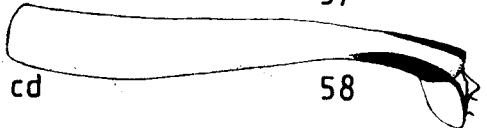
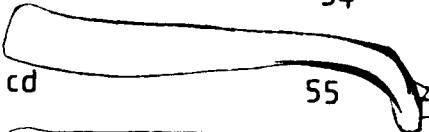
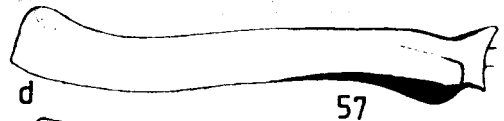
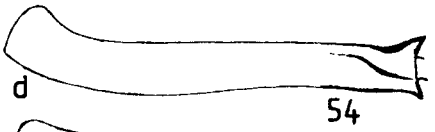




ALO type ♀

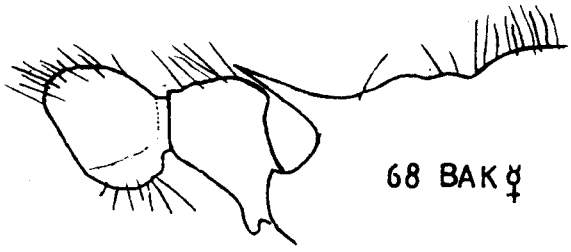
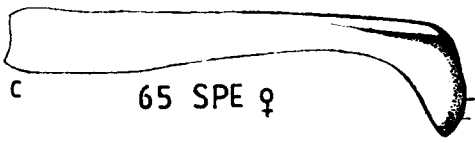
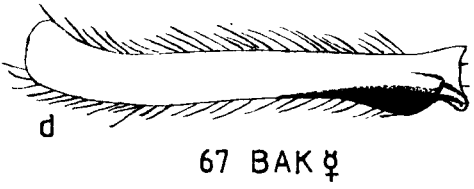
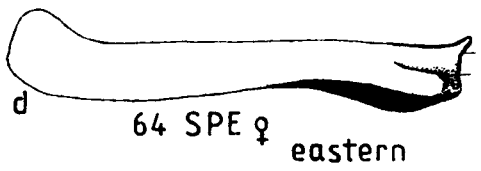
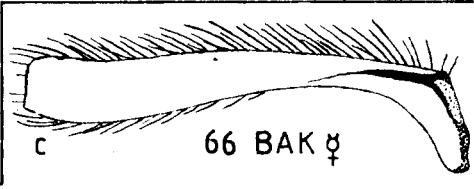
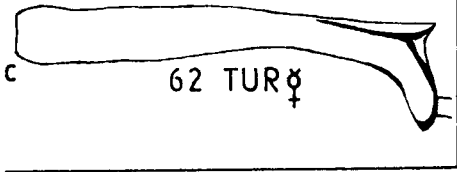
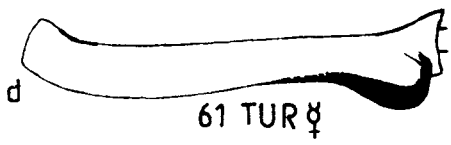
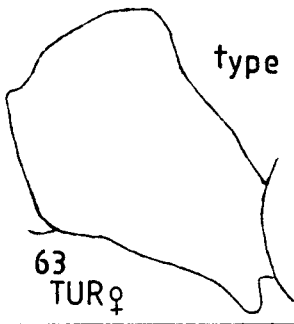
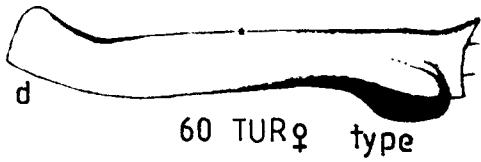


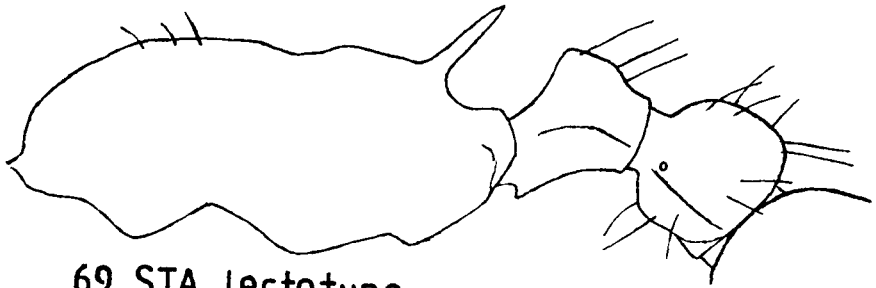
HEL type ♀



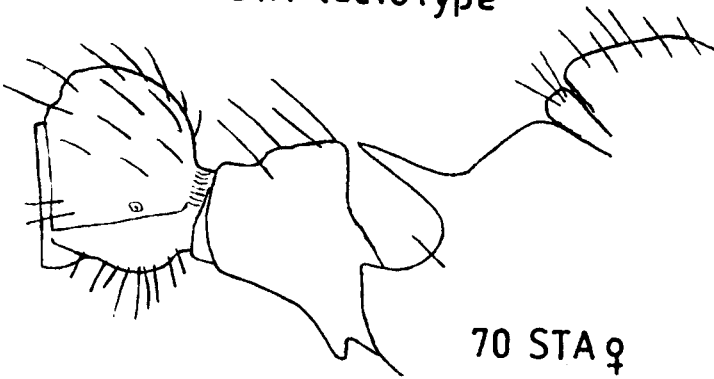
SAN ♀

CAU ♀

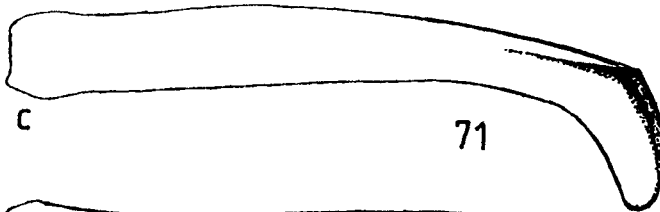




69 STA lectotype

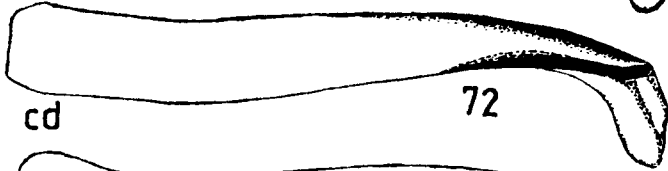


70 STA ♀



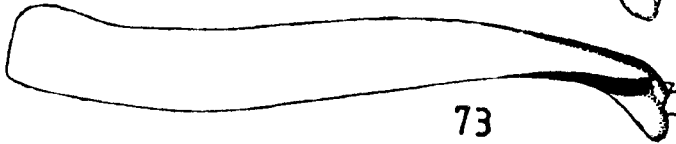
c

71



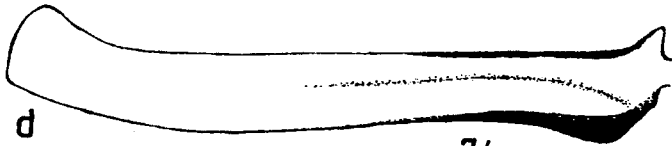
cd

72



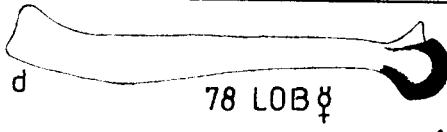
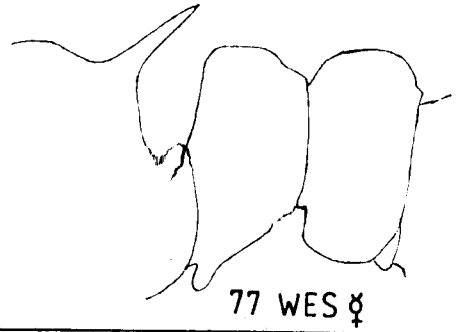
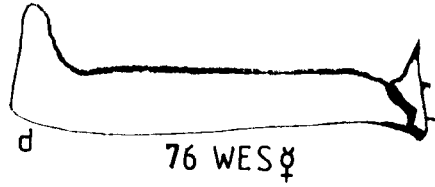
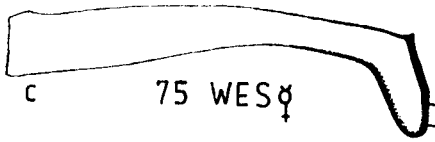
STA ♀

73

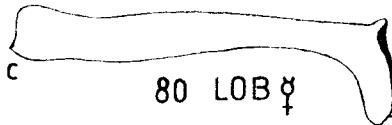
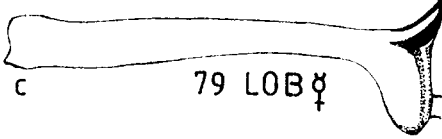


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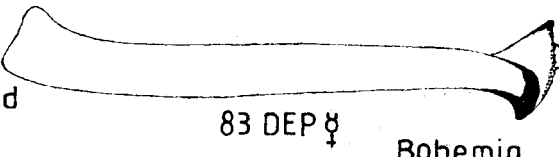
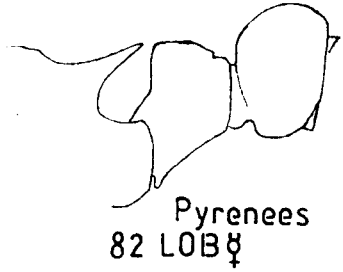
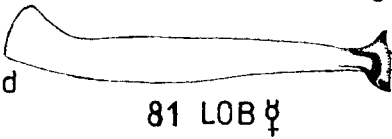
74



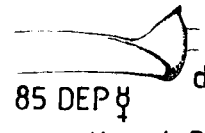
upper
extreme



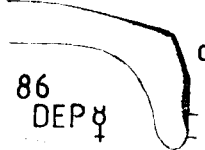
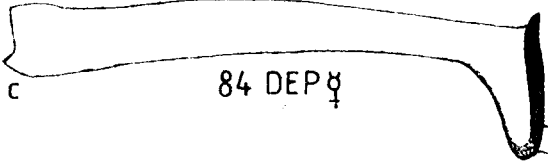
lower
extreme

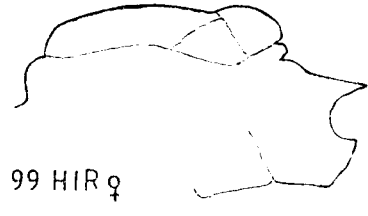
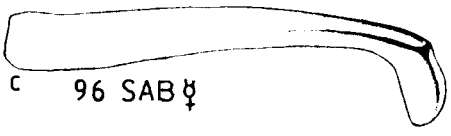
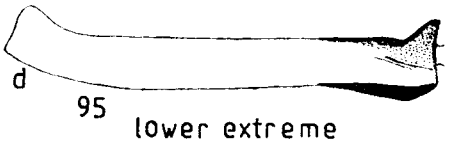
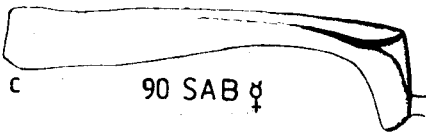
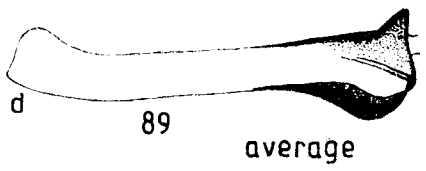
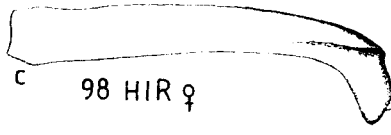
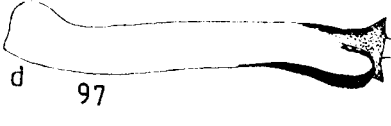
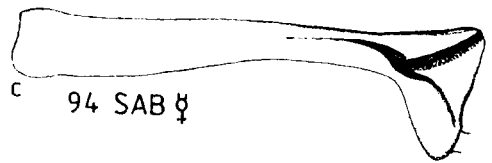
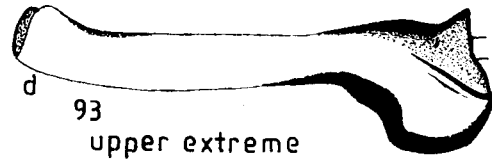
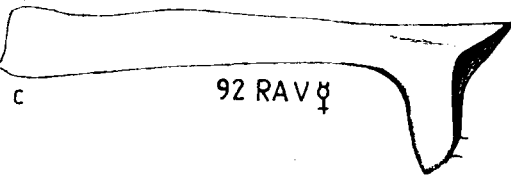
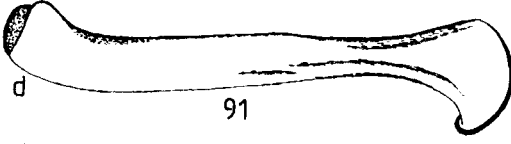
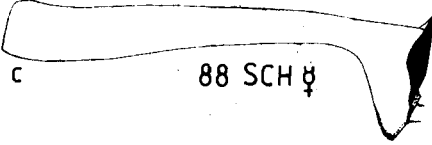
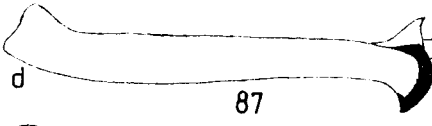


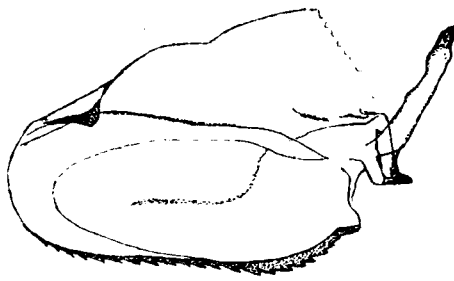
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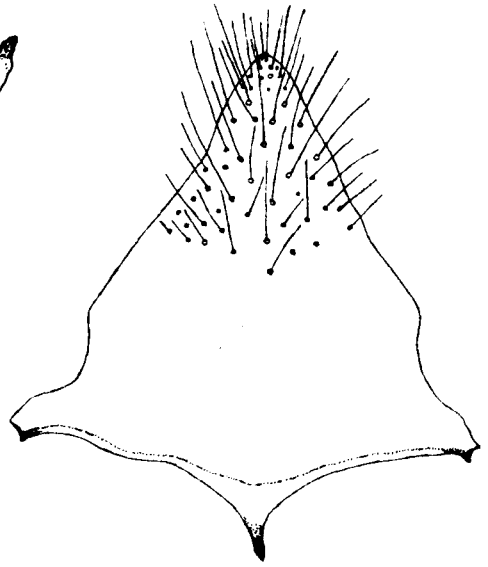
Kopet Dagh







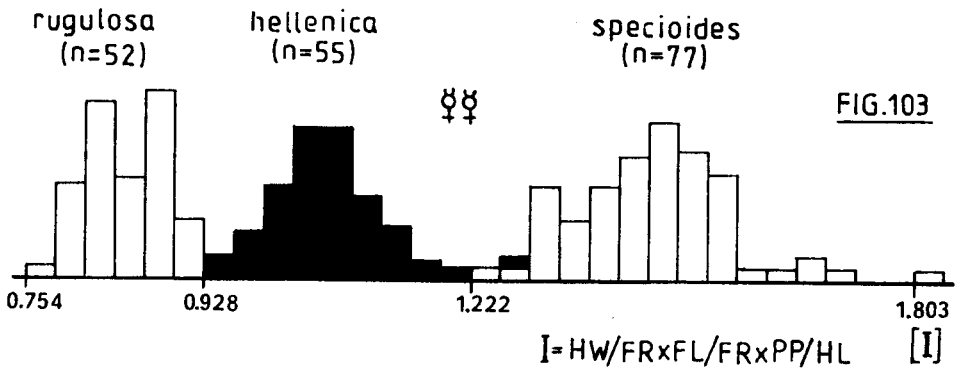
100 HEL ♂

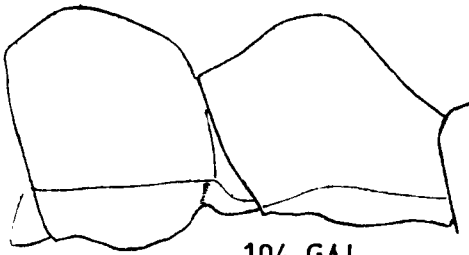


102 HEL ♂



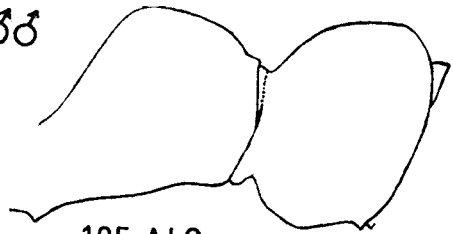
101 HEL ♂



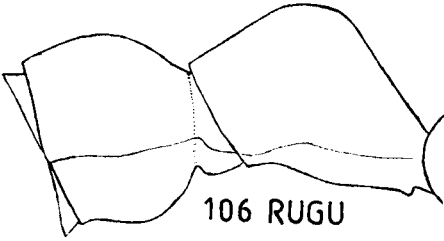


104 GAL

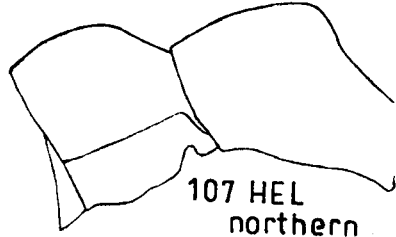
♂♂



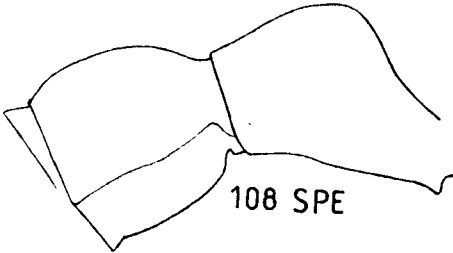
105 ALO



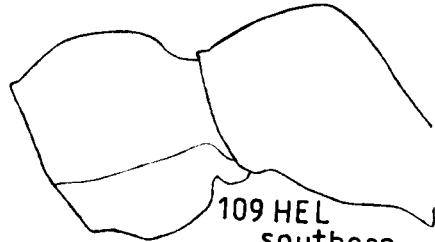
106 RUGU



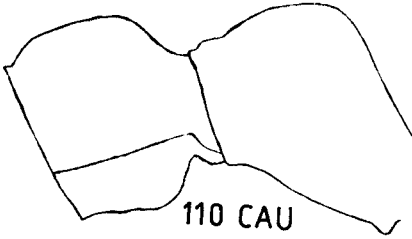
107 HEL
northern



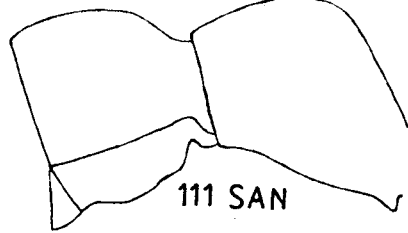
108 SPE



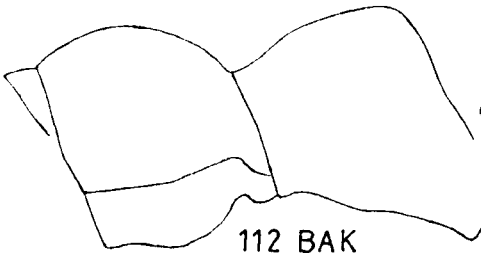
109 HEL
southern



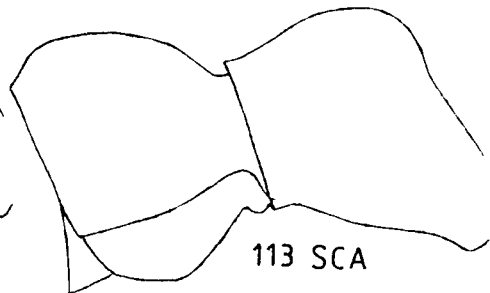
110 CAU



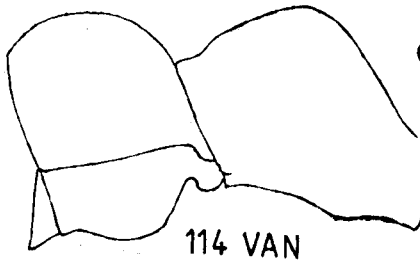
111 SAN



112 BAK

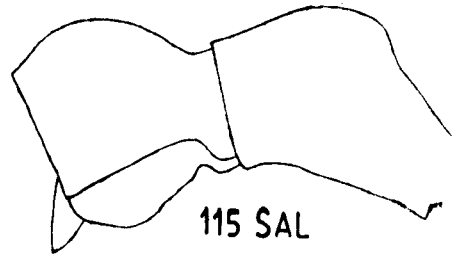


113 SCA

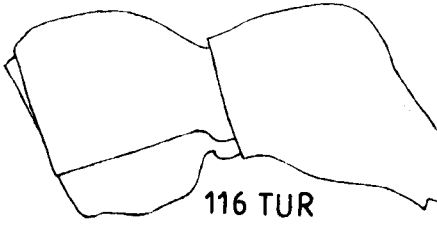


114 VAN

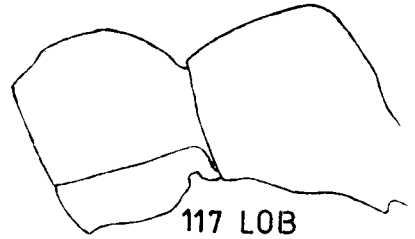
♂♂



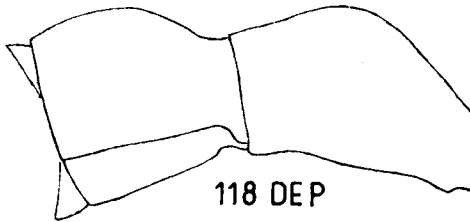
115 SAL



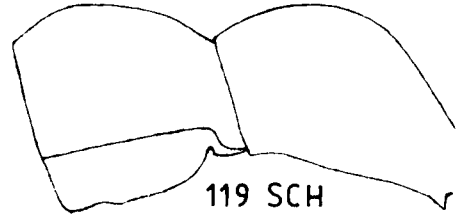
116 TUR



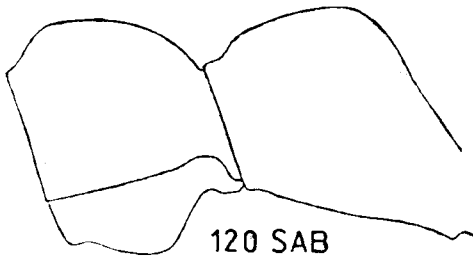
117 LOB



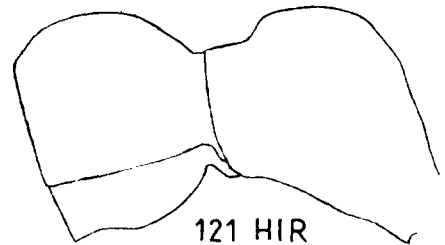
118 DEP



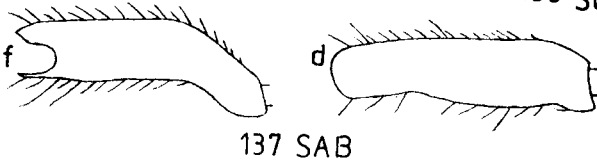
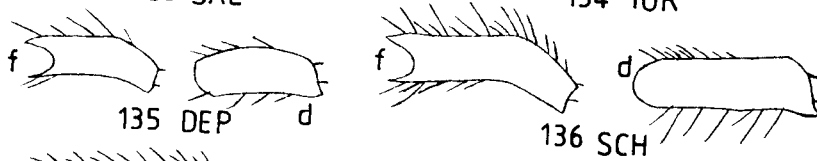
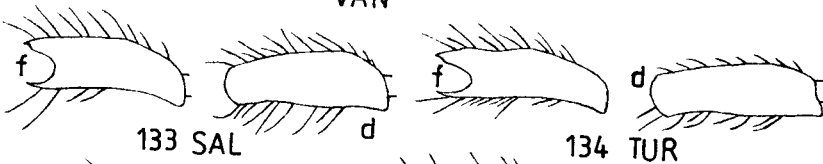
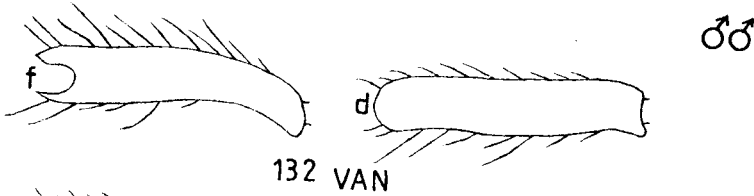
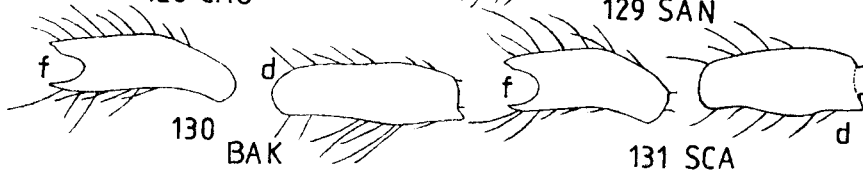
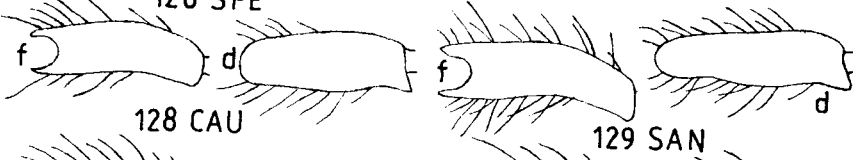
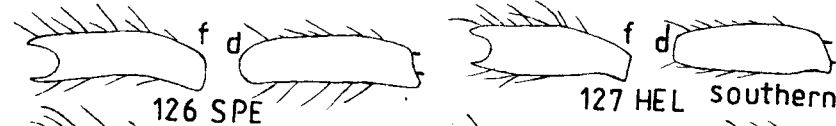
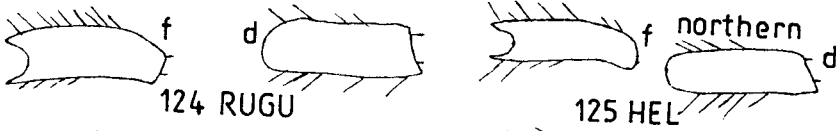
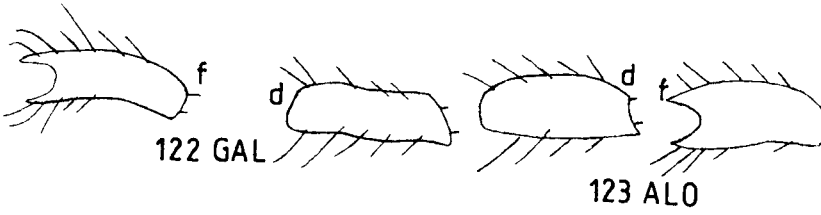
119 SCH

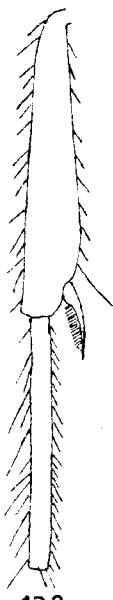


120 SAB



121 HIR

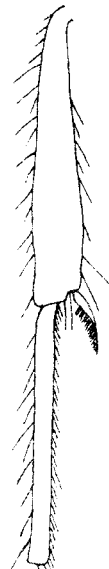




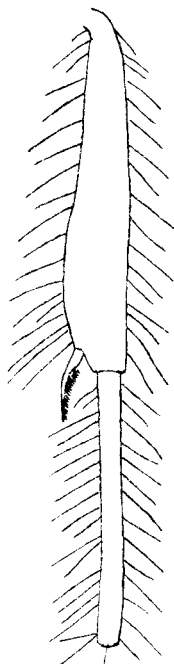
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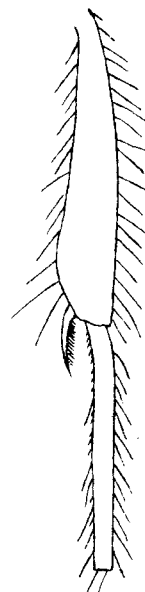
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northern



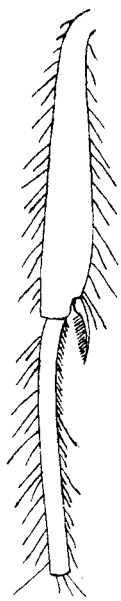
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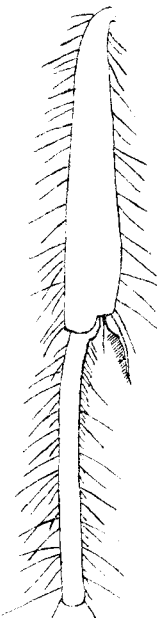
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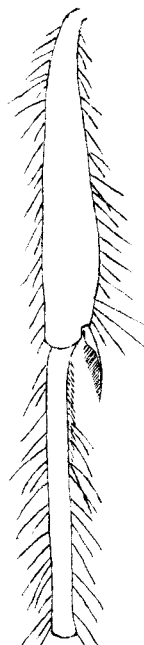
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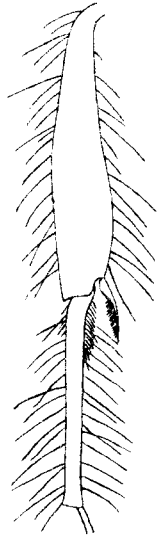
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CAU



144
SAN



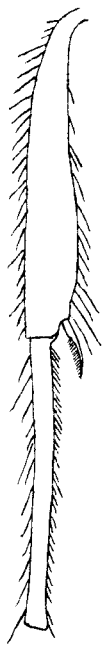
145
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146
SCA

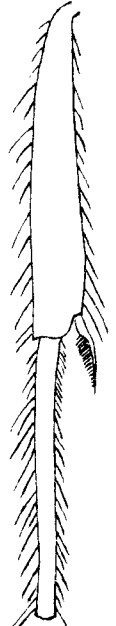


147
VAN



148
SAL

♂♂



149
TUR



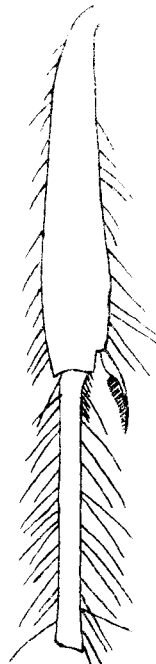
150
LOB



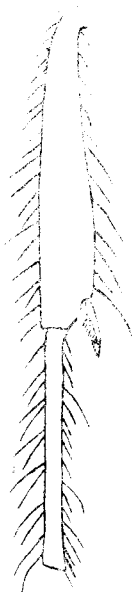
151
DEP



152
SCH



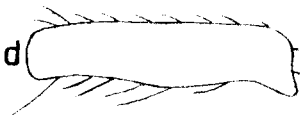
153
SAB



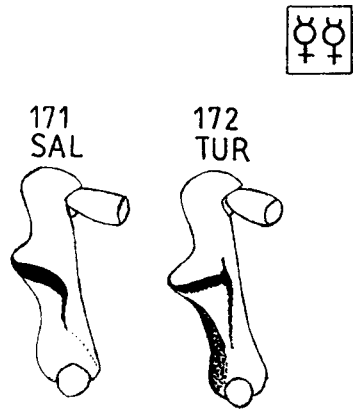
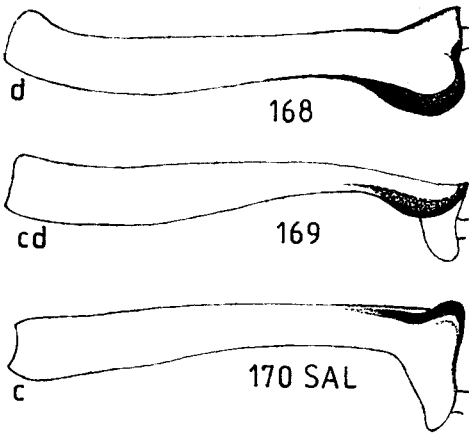
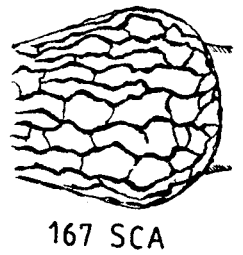
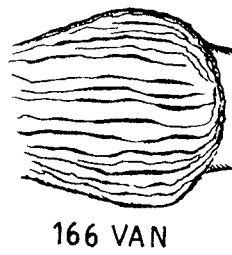
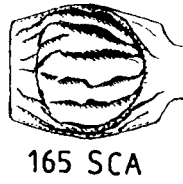
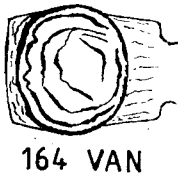
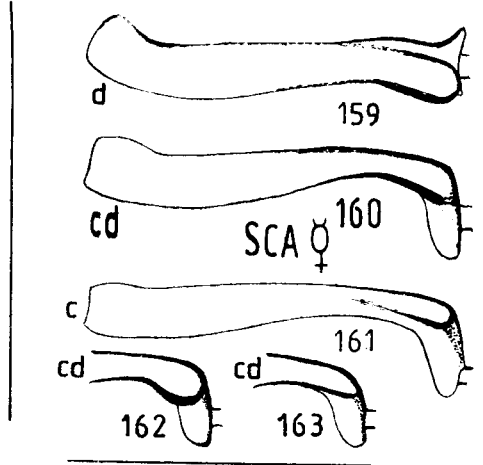
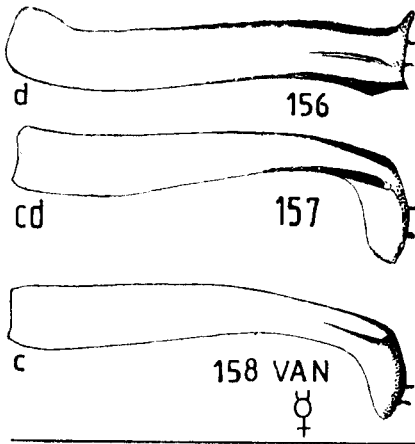
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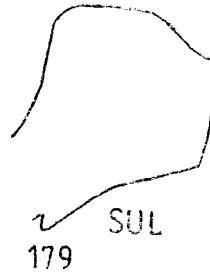
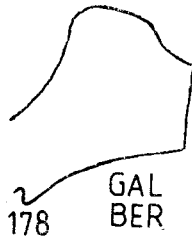
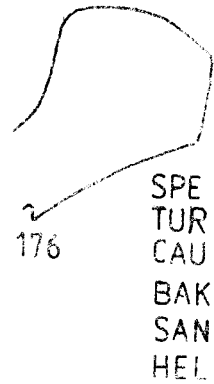
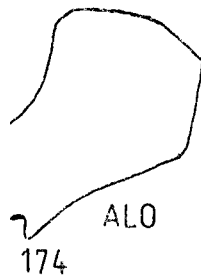


155 HIR

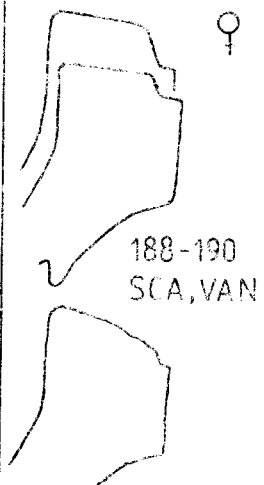
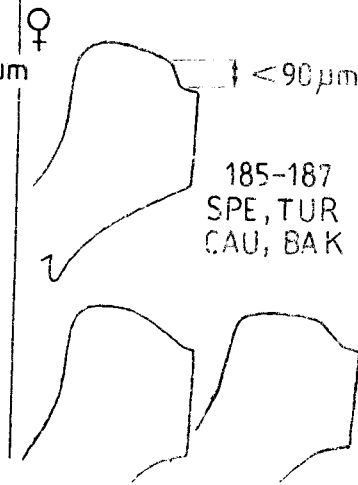
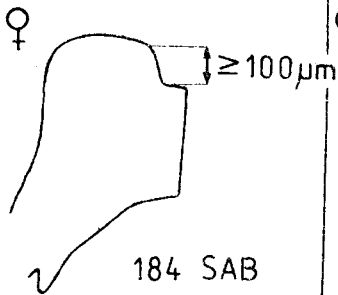
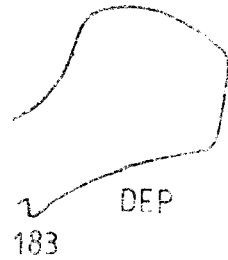
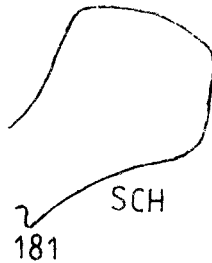
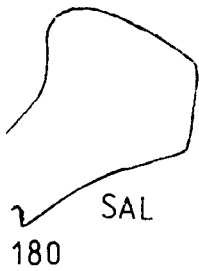


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schematic



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