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The ant genus *Cardiocondyla* (Insecta: Hymenoptera: Formicidae) – a taxonomic revision of the *C. elegans*, *C. bulgarica*, *C. batesii*, *C. nuda*, *C. shuckardi*, *C. stambuloffii*, *C. wroughtonii*, *C. emeryi*, and *C. minutior* species groups

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Abstract

A taxonomic revision of all holarctic species groups of the ant genus *Cardiocondyla* is given, including all worldwide species groups, with at least one tramp species. General aspects of *Cardiocondyla* biology such as habitat selection, nest construction, behaviour, the ergatoid male syndrome, and gyne polymorphism are treated. 48 species are recognized, 20 of which are described as new: *Cardiocondyla bicoronata* sp.n. (Israel, Jordan, United Arab Emirates, Yemen, Turkestan), *C. brachyceps* sp.n. (E Turkey, Iran, Afghanistan), *C. breviscapus* sp.n. (India), *C. gallilaeica* sp.n. (Israel), *C. goa* sp.n. (India), *C. israelica* sp.n. (Egypt, Israel), *C. littoralis* sp.n. (S Kazakhstan), *C. longiceps* sp.n. (Yemen), *C. melana* sp.n. (Yemen), *C. nana* sp.n. (Brunei), *C. opaca* sp.n. (India), *C. opistopsis* sp.n. (Kuwait), *C. paranuda* sp.n. (Tunisia), *C. persiana* sp.n. (Iran, Israel), *C. rugulosa* sp.n. (Yemen), *C. semirubra* sp.n. (Asia Minor), *C. shagrinata* sp.n. (India), *C. tenuifrons* sp.n. (Jordan), *C. tibetana* sp.n. (Tibet, Tarim Basin) and *C. unicalis* sp.n. (Iran). Sixteen taxa are newly synonymized: *Cardiocondyla bulgarica* FOREL, 1892 (= *C. elegans* var. *eleonorae* FOREL, 1911, syn.n.), *C. elegans* EMERY, 1869 (= *C. dalmatica* SOUDEK, 1925, syn.n., = *C. provincialis* BERNARD, 1956, syn.n.), *C. fajumensis* FOREL, 1913, stat.n. (= *C. schatzmayri* FINZI, 1936, syn.n., = C. *nilotica* WEBER, 1952, syn.n.), *C. mauritanica* FOREL, 1890 (= *C. ectopia* SNELLING, 1974, syn.n.), *C. minutior* FOREL 1899, stat.rev. (= *C. tsukuyomi* TERAYAMA, 1999, syn.n.), *C. nigra* FOREL, 1905 (= *C. elegans* var. *torretassoi* FINZI, 1936, syn.n.), *C. obscurior* WHEELER, 1929, stat. n. (= *C. bicolor* DONISTHORPE, 1930, syn.n.), *C. shuckardi* FOREL, 1891 (= *C. shuckardoides* FOREL, 1895, syn.), *C. stambuloffii* FOREL, 1892 (= *C. bogdanovi* RUZSKY, 1905; syn.n.), *C. venustula* WHEELER, 1908 (= *C. globinodis* STITZ, 1923, syn.n., = *C. badonei* ARNOLD, 1926, syn.n.), C. *wroughtonii* (FOREL, 1890) (= *C. wroughtonii* ssp. *quadraticeps* FOREL, 1912, syn., = *C. longispina* KARAVAJEV, 1935, syn.n., = *C. yamauchii* TERAYAMA, 1999, syn.n.). Five taxa are elevated to species rank, and the status of two controversial taxa is revised. Nine names are listed under "Incertae Sedis". Each species is described based upon workers and gynes, as far as either caste is known, and a detailed morphometry by high-resolution steromicroscopy is provided. Each species is depicted in three or four standard viewing positions preferentially on the basis of type material.

Key words: *Cardiocondyla*, taxonomic revision, Holarctic, tramp species, ergatoid males, gyne polymorphism, new species, new synonymy, new status, behaviour, nest, habitat.

Zusammenfassung

Eine taxonomische Revision der holarktischen Vertreter der Ameisengattung *Cardiocondyla* sowie aller kosmopolitischen Artengruppen, in denen mindestens eine Tramp-Spezies vorkommt, wird präsentiert. Allgemeine Aspekte der *Cardiocondyla*-Biologie wie Habitatwahl, Nistweise, Verhalten, das Syndrom der ergatoiden Männchen und Gynenpolymorphismus werden behandelt. Es werden 48 Arten unterschieden, von denen 20 als neu beschrieben werden: *Cardiocondyla bicoronata* sp.n. (Israel, Jordan, United Arab Emirates, Yemen, Turkestan), *C. brachyceps* sp.n. (E Turkey, Iran, Afghanistan), *C. breviscapus* sp.n. (India), *C. gallilaeica* sp.n. (Israel), *C. goa* sp.n. (India), *C. israelica* sp.n. (Egypt, Israel), *C. littoralis* sp.n.

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(S Kazakhstan), *C. longiceps* sp.n. (Yemen), *C. melana* sp.n. (Yemen), *C. nana* sp.n. (Brunei), *C. opaca* sp.n. (India), *C. opistopsis* sp.n. (Kuwait), *C. paranuda* sp.n. (Tunisia), *C. persiana* sp.n. (Iran, Israel), *C. rugulosa* sp.n. (Yemen), *C. semirubra* sp.n. (Asia Minor), *C. shagrinata* sp.n. (India), *C. tenuifrons* sp.n. (Jordan), *C. tibetana* sp.n. (Tibet, Tarim Basin) und *Cardiocondyla unicalis* sp.n. (Iran). Sechzehn Taxa erscheinen als neue Synonyme: *Cardiocondyla bulgarica* FOREL, 1892 (= *C. elegans* var. *eleonorae* FOREL, 1911, syn.n.), *C. elegans* EMERY, 1869 (= *C. dalmatica* SOUDEK, 1925, syn.n., = *C. provincialis* BERNARD, 1956, syn.n.), *C. fajumensis* FOREL, 1913, stat.n. (= *C. schatzmayri* FINZI, 1936, syn.n., = C. *nilotica* WEBER, 1952, syn.n.), *C. mauritanica* FOREL, 1890 (= *C. ectopia* SNELLING, 1974, syn.n.), *C. minutior* FOREL 1899, stat.rev. (= *C. tsukuyomi* TERAYAMA, 1999, syn.n.), *C. nigra* FOREL, 1905 (= *C. elegans* var. *torretassoi* FINZI, 1936, syn.n.), *C. obscurior* WHEELER, 1929, stat. n. (= *C. bicolor* DONISTHORPE, 1930, syn.n.), *C. shuckardi* FOREL, 1891 (= *C. shuckardoides* FOREL, 1895, syn.n.), *C. stambuloffii* FOREL, 1892 (= *C. bogdanovi* RUZSKY, 1905; syn.n.), *C. venustula* WHEELER, 1908 (= *C. globinodis* STITZ, 1923, syn.n., = *C. badonei* ARNOLD, 1926, syn.n.), C. *wroughtonii* (FOREL, 1890) (= *C. wroughtonii* ssp. *quadraticeps* FOREL, 1912, syn.n., = *C. longispina* KARAVAJEV, 1935, syn.n., = *C. yamauchii* TERAYAMA, 1999, syn.n.). Fünf Taxa erfuhren eine Rangerhöhung und der Status zweier umstrittener Taxa wird revidiert. Neun Namen werden unter 'Incertae Sedis' aufgelistet. Jede Art wird anhand von Arbeitern und Gynen, soweit diese bekannt sind, beschrieben, durch eine detailierte Morphometrie mittels Hochleistungsstereomikroskopie vorgestellt und in drei oder vier Standardansichten abgebildet, wobei Typenmaterial bevorzugt dargestellt ist.

Content

1. Introduction

This taxonomic revision considers the complete Holarctic fauna of the ant genus *Cardiocondyla* EMERY, 1869 and extends its view to all members of any tropical species group in which at least one tramp species is known. *Cardiocondyla* ants are minute to small. Natural nests have small populations and are difficult to discover because of the single and tiny entrance holes, which are usually unmarked by ejections of nesting substrate. When nesting in soil, trials to excavate complete nest populations may have a very frustrating outcome and need a very special skill. As a consequence, *Cardiocondyla* ants are neglected or overlooked by many field entomologists and are underrepresented in scientific collections. A recent world-wide catalogue recognized 49 taxa as valid species (BOLTON 1995). This figure is undoubtedly far from conceiving the real species-richness as the following examples suggest: 371 samples from the Palaearctic, which is much less rich in *Cardiocondyla* species than the Palaeotropics, contained 31 species of which 14 are described here as new. Within only 67 samples from the tropical rain forests of Indonesia, Malaysia, and Papua New Guinea were 18 species with 8 of them new (Seifert in prep.). Including the Afrotropical, Oriental, and Australasian regions clearly more than 100 species of *Cardiocondyla* should occur on the globe.

Sociobiologists have paid much attention to *Cardiocondyla* during the last two decades because of some biological traits, which are rare among ants and provide good models to test several kinship theories. *Cardiocondyla* species have unusually long-lived ergatoid males performing a constant spermiogenesis throughout their whole imaginal life. These males usually stay within the mother nest, mate intranidally, and try to monopolize all matings by killing other ergatoid males, preferentially when these still are in the pupal stage. As a consequence, such heavily-armed ergatoids do occur within a nest in singularity or in lower numbers (STUART & al. 1987, KINOMURA & YAMAUCHI 1987, HEINZE & HÖLLDOBLER 1993, HEINZE & al. 1993).

The very small space needed for nest construction, the expressed polygyny in several species, a sufficient survival rate after shortage of water, and in particular the fact that, in some species, a dozen of detached workers with brood can establish a fully reproductive new colony containing all castes explains the higher number of cosmopolitan tramp species in *Cardiocondyla* such as *C. mauritanica*, *C. obscurior*, *C. wroughtonii*, *C. emeryi*, and *C. minutior*, which all seem to be abundant around the globe. These species probably have reached many areas of their actual range by passive transport via human trade routes. Others, as the Pacific island-hopping *C. nuda*, seem to have a more restricted range.

Wing reduction or inability to fly is apparently abundant in sexuals of *Cardiocondyla*. Within the studied material, macropterous gynes were observed in 13 and brachypterous gynes in 11 species, with five species showing both forms. 14 species with ergatoid males are known. Only five species are reported to produce alate males but this is probably an underrecording because of their temporary occurrence. Isolated occurrence on small habitat patches within large desert systems, the tendency to dominate these habitat patches and to reduce the risk of flight dispersal could have selected for female brachyptery, male aptery, and intranidal mating. The resulting isolation and high inbreeding coefficients could have created an unknown number of rare, locally distributed species. Some of the species described here as new might belong to this category.

In work with these minute ants, tiny surface structures may be diagnostic and interspecific metric differences may be expressed in a few microns. Hence, the use of high-performance stereomicroscopes (numeric aperture > 0.20) with precise measuring systems and adequate illumation is inevitable. Otherwise, a reasonable taxonomic research in these ants is impossible. Secondly, *Cardiocondyla* samples often contain only single specimens. Fortunately, the female castes of *Cardiocondyla* show very low coefficients of variation in most of the numeric characters investigated. This advantage partially compensates for sample size limitations. To get resonably clear determinations of single specimens, the number of investigated numeric standard characters was increased in this study up to 19. This means an average measuring time of 40 minutes per specimen for an experienced observer using a time-sparing pin-holding stage. However, it is a matter of fact that many species can be identified without very expensive equipment or high-precision measurements simply by comparing the drawings and descriptions.

2. Material studied

An estimated total of 2200 worker and gyne specimens of *Cardiocondyla* was examined. 1530 specimens belonging to 680 different samples were subject to a numeric investigation in which 47000 measurements or countings have been taken within 880 working hours. 54 % of the measured specimens were Palaearctic, 19.0 % Indomalayan, 12.9 % Neotropic and S Nearctic, 6.9 % Afrotropical, 5.6 % Australasian, and 1.6 % came from the Malagasy region and islands in the Indian Ocean. Workers are known in 98 % but gynes in only 58 % of the considered species. Hence, the taxonomic decisions are mainly based upon comparison of workers. The institutions or private collections from which material was studied have the following acronyms:

BMNH London	British Museum of Natural History London, U.K.
coll. Heinze	collection of Jürgen Heinze, Regensburg, Germany
coll. Schulz	collection of Andreas Schulz, Leichlingen, Germany
DZU Tel Aviv	Department of Zoology of the University of Tel Aviv, Israel
IZ Kiev	Institute of Zoology of the Ukrainian Academy of Sciences Kiev, Ukraine
MCSN Genova	Museo Civico di Storia Naturale Genova, Italy
MCZ Cambridge	Museum of Comparative Zoology, Harvard University Cambridge, U.S.A.
MHN Genève	Muséum d'Histoire Naturelle Genève, Switzerland
MNHN Paris	Muséum National d'Histoire Naturelle Paris, France
MZ Lausanne	Musée de Zoologie Lausanne, Switzerland
MZ Lund	Museum of Zoology Lund, Sweden
NHM Basel	Naturhistorisches Museum Basel, Switzerland
NHM Los Angeles	Natural History Museum of Los Angeles County, Los Angeles, U.S.A.
NHM Wien	Naturhistorisches Museum Wien, Austria
SMN Görlitz	Staatliches Museum für Naturkunde Görlitz, Germany
UM Oxford	University Museum Oxford: Hope Entomological Collections, U.K.
ZIPAS Warszawa	Zoological Institute of the Polish Academy of Sciences Warszawa, Poland
ZM Berlin	Zoologisches Museum der Humboldt Universität Berlin, Germany

3. Methods and terminology

The number of investigated standard numeric characters was increased in this study up to 19 within the female castes. Each worker specimen was evaluated for a minimum of 16 numeric characters, meaning 32 different measurements or countings at magnifications of 200 - 320x and an average measuring time of 40 minutes. All measurements were made on mounted and dried specimens using a pin-holding stage, permitting endless rotations around X, Y, and Z axes. A Wild M10 high-performance stereomicroscope equipped with a 1.6x planapochromatic objective was used at magnifications of 200 - 320x. The maximum possible magnification to keep a structure within the range of the ocular micrometer was used. A Leica cross-scaled ocular micrometer with 120 graduation marks ranging over 65 % of the visual field was used. A cross-scale is inevitable for exact measurements of characters such PoOc, MGr, or SP. A mean measuring error of ± 0.6 µm was calculated for small and well-defined structures such as petiole width, but one of ± 1.5 µm for larger structures with difficult positioning such as gyne mesosoma length. To avoid rounding errors, all measurements were recorded in µm even for characters for which a precision of ± 1 µm is impossible. In order to reduce irritating reflections of the cuticular surfaces, a plastic diffuser was positioned as close as possible to the specimen. This method considerably improved the resolution of microsculpture and the measuring accuracy for tiny structures such as pubescence hairs.

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

3.1 Definition of descriptive terms:

Bicoronate foveola: a foveola showing an inner and outer corona; the outer corona is the margin of the foveola, the inner corona is the margin of an inner structure (usually a flat central tubercle) surrounding the base of a pubescence hair.

Carina: a larger elevated ridge on the body surface (adv.: carinate); compare with costa and ruga.

Carinula: a finer elevated ridge on the body surface (adv.: carinulate); compare with striate.

Corrugated: referring to a body surface that is wrinkled in appearance; compare with shagreened.

Costa: an elevated ridge rounded at the crest (adv.: costate); compare with carina.

Decumbent: referring to a hair standing 10 - 40 degrees from the body surface.

Fovea: a large pit in the body surface (adv.: foveate).

Foveola: a small pit in the body surface (adv.: foveolate); compare with punctate.

Frontal carinae: the sharp lateral edges of frontal laminae which may continue on vertex posterior of the frontal laminae.

Frontal laminae (= lobes): the raised surface delimited medially by the frontal triangle and the posterior clypeus and laterally by the frontal carinae.

Gyne: a strictly morphological term for a female ant that differs from the workers by a much larger mesosoma showing additional sclerites and wing insertions, by clearly developed ocellae, and by more massive waist segments. The term queen, in contrast, is functional by considering the reproductive status and applicable to female specimens with both gyne and worker morphology.

Glabrous: referring to a perfectly smooth and brilliantly shining body surface

Microreticulum: a very delicate reticulum whose sculptural elements are not thicker than 1 µm. Such structures are visible only at magnifications > 100x (adv.: microreticulate).

Punctate: referring to a surface bearing fine punctures like pinpricks; compare with foveolate.

Reticulum: a regular network of carinae, rugae, or carinulae (adv.: reticulate).

Ruga: a large elevated wrinkle on the body surface (adv.: rugose).

Rugoreticulate: rugae forming a less regular network or grid.

Shagreened: referring to a surface covered with a fine but close-set and irregular roughness; compare with corrugated.

Stria: a fine impressed line on the body surface (adv.: striate).

Suberect: referring to a hair standing at an angle of about 45 degrees.

Tuberculate: covered with tubercles (small thick spines or pimple-like structures).

Vertex: the dorsal plane of the head between eyes, frons, and occiput.

Waist: the structure collectively formed by petiole and postpetiole.

3.2 Definition of numeric characters:

CL: maximum cephalic length in median line; the head must be carefully tilted to the position with the true maximum; excavations of occiput and/or clypeus reduce CL.

CS: cephalic size; the arithmetic mean of CL and CW, used as a less variable indicator of body size.

CW: maximum cephalic width; the maximum is found in *Cardiocondyla* usually across and including the eyes, exceptionally posterior of the eyes.

dFOV: mean diameter of foveolae or mesh-like surface structures on vertex at about half way between the median line of head and the inner eye margin. These structures are either real foveolae or meshes of a reticulum and have usually the base of a decumbent pubescence hair in their centre. In species with reduced foveolae or mesh-like structures (e.g. in the *C. stambuloffii* group) the mean diameter of the small punctures or tubercles at hair bases is measured as dFOV. At least six measurements are averaged. Use magnifications ≥ 250x and light diffusers to suppress irritating reflexions.

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

EyeHL: length of the longest hair on eye.

FL: maximum anterior distance of frontal carinae.

FRS: distance of the frontal carinae immediately caudal of the posterior intersection points between frontal carinae and the lamellae dorsal of the torulus. If these dorsal lamellae do not laterally surpass the frontal carinae, the deepest point of scape corner pits may be taken as reference line. These pits take up the inner corner of scape base when the scape is fully switched caudad and produce a dark triangular shadow in the lateral frontal lobes immediately posterior of the dorsal lamellae of scape joint capsule (Fig. 1).

FR: minimum distance between frontal carinae if such a point is defined by anterior divergence of the frontal carinae (usual measuring mode in *Myrmica*).

MGr: Depth of metanotal groove or depression, measured from the tangent connecting the dorsalmost points of promesonotum and propodeum; here given as per cent ratio of CS.

ML: mesosoma length in the alates; measured in lateral view from the caudalmost portion of propodeum to the frontalmost point of the anterior pronotal slope (i.e. not to the frontalmost point of the whole pronotum that is usually concealed by the occiput !).

MW: maximum mesosoma width of alates anterior to the tegulae.

PEH: maximum petiole height. The straight section of ventral petiolar profile at node level is the reference line perpendicular to which the maximum height of petiole node is measured at node level (Fig. 2).

PEL: diagonal maximum length of petiole in lateral view, measured from anterior corner of subpetiolar process to dorsocaudal corner of caudal cylinder.

PEW: maximum width of petiole.

PigCap and **PigMes:** Pigmentation score of dorsal head (PigCap) and lateral mesosoma (PigMes) considering only the degree of dark pigment (not the involved colour components yellow, red, or brown). Two standard colour tables were manufactured, each distinguishing 12 degrees of darkening, beginning with light-yellow or light-red (score 1) and ending with blackish brown (score 12). Pigmentation scaling was performed by simultaneous subjective comparison of the microscopic picture with these colour tables. The specimen was observed with the right eye under use of a Schott KL 1500e cold-light source in position 3 (colour temperature 2200 K) at a magnification of 128x. The standard colour table was illuminated by 60 W desk lamp and was simultaneously observed with the left eye in a distance equal to the microscopic picture distance. Callows were excluded from evalution but there was no way to exclude adult specimens suspected of strong post mortal fading.

PigG1: Covering percentage of dark pigmentation on the first gaster segment expressed as arithmetic mean of covering percentage on tergite (PigT1) and sternite (PigS1). In light specimens, an area is considered as dark if it is notably darker than the postpetiole or the lighter gaster parts.

PLG: mean length of pubescence hairs on dorsum of first gaster tergite as arithmetic mean of 6 measurements; here given as per cent ratio of CS. Use magnifications > 250 and light diffusers to suppress irritating reflexions.

PPH: maximum postpetiole height; the lateral suture of dorsal and ventral sclerites is the reference line perpendicular to which the maximum height of postpetiole is measured (Fig. 2).

PPL: maximum median length of postpetiolar node in dorsal view

PPW: maximum width of postpetiole.

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

SL: maximum straight line scape length excluding the articular condyle as arithmetic mean of both scapes.

Smax: The maximum scape diameter at middle of its length; to measure the real cuticular surface and not the pubescence surface use transmitted- or reflexion-reduced light.

SPBA: the smallest distance of the outer margins of the spines at their base. This should be measured in dorsofrontal view, since the wider parts of the ventral propodeum do not interfere the measurement in this position. If the lateral margins of spines diverge continuously from the tip to the base, a smallest distance at base is not defined. In this case, SPBA is measured at the level of the bottom of the interspinal meniscus.

SP: maximum length of propodeal spines; measured in dorsofrontal view along the long axis of the spine, from spine tip to a line, orthogonal to the long axis, that touches the bottom of the interspinal meniscus (Fig. 4). Left and right SP are averaged. This mode of measuring less ambiguous than other methods but results in some spine length in species with reduced spines.

sqrtPDG: square root of pubescence distance on dorsum of first gaster tergite. The number of pubescence hairs **n** crossing a transverse measuring line of length **L** is counted, hairs just touching the line are counted as 0.5. The pubescence distance PDG is then given by **L/n**. In order to normalise the positively skewed distributions, the square root of PDG is calculated. Exact counting is promoted by clean surfaces and flat, reflexion-reduced illumination directed slightly skew to the axis of pubescence hairs. The counting was performed at magnifications of 320x. Tergite pubescence is easily torn-off in *Cardiocondyla*. Keep care to evaluate undamaged surface spots. In specimens with almost removed pubescence, PDG can be calculated from the mean distance of hair base pits (BD) and PLG using the formula PDG = BD^2 /PLG.

3.3 Drawings:

The drawings have been made under use of a Leica projection system at magnifications of 320x (workers), 250x (gyne head), and 200x (gyne mesosoma) and show preferentially type material in four standard positions. They correctly depict curvatures, size ratios, and the basal shape of the specimens. However, it is a matter of subjective decision when to depict and when to omit visible sculpture elements. A body part depicted to have no sculpture may really have it. As a consequence, figures should always be checked by reading the verbal statements on surface structures. In the detailed drawings of the paramedian vertex sculpture it was tried to omit nothing though weak disagreements to the text statements are possible due to individual variation.

3.4 Discriminant functions:

It is rare in *Cardiocondyla* that a single character can separate all specimens of most similar species. As a consequence, linear discriminant functions considering many characters were frequently used. Each discriminant function was always calculated for a concrete species pair and not for a collective of > 2 species. The first step was the removal of variance caused by allometries. In these allometric corrections, a character Y (for instance CL) was always used weighted in an index Y/X where X is either another character (for instance CW to give the index CL/CW) or a size measure (here always CS to give the index Y/CS; e.g. SL/CS, PEW/CS etc.). The allometry of a character Y for a species A was then described as

$$Y_A/X_A = f_A\,(CS) = a_A * CS + b_A$$

Positive or negative allometries are given in case of positive or negative slopes, isometry in case of a = 0. A standard function $f_{A,B}$ collectively estimating the allometries of both considered species A and B is then defined by the parameters $a_{A,B} = (a_A + a_B)/2$ and $b_{A,B} = (b_A + b_B) / 2$. Allometrically corrected sets of index values which have the accessory advantage of being centred (weighted) around 1.0 are then computed by division with the function values of the standard function $f_{A,B}$. If no removal of allometries was considered as necessary (frequent in *Cardiocondyla*), the centering of primary index data around 1.0 was performed by division with the mean of the arithmetic means of both species. As next step, the discriminative power T_i of the centred index data was estimated by

$$T_i = [\,|\,m_{i,A} - m_{i,B}\,|\;/\;(\,\sigma_{i,A} + \sigma_{i,B}\,)\,]^{1.2} - 0.17$$

where $m_{i,A}$, $\sigma_{i,A}$, $m_{i,B}$, and $\sigma_{i,B}$ are the arithmetic means and standard deviations of the compared species A and B for the character i. The exponent 1.2 and the constant -0.17 were empirically found and introduced to prevent an overestimation of weakly discriminating characters. Characters with $T_i > 2.4$ provide a perfect separation of the species while such with $T_i < 0.2$ have almost no discriminative power. If the sign of T_i is defined by $(m_{i,A} - m_{i,B}) / |m_{i,A} - m_{i,B}|$ a simple but most effective discriminant function of the type

$$D(n) = T_1 x_1 + T_2 x_2 + ... + T_n x_n + a$$

is ready (**a** is a constant that may be introduced to prevent negative scores). In order to save space, discriminant functions and the resulting discriminant scores are presented in the text as given by the following example: "A discriminant score D(7) = +0.048 CL/CW +0.176 SL/CS +0.94 EYE +0.126 PEH/CS +0.46 PEW/PPW -3.4 MGr/CS +0.53 sqrt(PigCap/PigMes) separates all worker nest sample means of *C. bulgarica* with D(7) 1.207 ± 0.045 [1.16, 1.29] (n = 12) and *C. sahlbergi* with D(7) 1.057 ± 0.035 [0.97, 1.12) (n = 25)".

3.5 Predicting numeric characters of unknown gynes and workers:

Morphometric characters are closely correlated between workers and gynes as it can be shown for 16 species with both castes present. The specific means of 13 morphometric characters show high correlation coefficients: PoOc/CL 0.99, dFOV 0.96, PPW/CS 0.95, PEW/CS 0.93, sqrtPDG 0.91, CS 0.86, CL/CW 0.83, SP/CS 0.82, PPH/CS 0.81, SL/CS 0.78, PEH/CS 0.77, PEW/PPW 0.75, PLG/CS 0.41. All these correlations are highly significant ($p < 0.001$) except for PLG/CS.

If in a species X the gyne is unknown, realistic predictions of its morphometric data are possible as explained in the following. A number of species i to n (in which both workers and gynes are known and which are closely related to the species X) is selected to estimate the specific change between the worker character expression W and gyne character expression G. The arithmetic mean M of the ratio G /W found in the species i to n, given by

$$M = (G_i/W_i + G_{i+1}/W_{i+1} + ... + G_N/W_N)/N$$

is then used as factor to predict the gyne character expression in species X by multiplicating the worker data W_x with M. Reciprocal calculations are made when the worker caste is unknown.

4. The allometric variance of characters

Allometries were calculated for 15 species in which more than 18 worker specimens were available, with a total of 609 evaluated worker individuals. The body size measure CS and the character values were weighted by division with the arithmetic species-specific means so that all data were centred around 1.0. A linear regression of the weighted character value against the weighted CS was then calculated for all species collectively. In the result, the characters PLG/CS, sqrtPDG, MGr/CS, dFov, SL/CS, EYE, and CL/CW show insignificant allometries. All waist indices (PEW/CS, PPW/CS, PEH/CS, PPH/CS, PEW/PPW) and the spine index (SP/CS) show positive allometries and the postocular index (PoOc/CL) a negative allometry (all regressions significant for $p < 0.001$). To give an overall estimate, if CS grows from the lower to the upper limit of its 95 % confidence interval, PEW/CS grows by 8.4 %, PEH/CS by 5.4 %, PPW/CS by 5.1

%, PPH/CS by 2.8 %, PEW/PPW by 3.4 %, and SP/CS by 10.4 %, while PoOc/CL is reduced by 2.4 %. Thus, allometrically-caused variance is not dramatic in *Cardiocondyla* and was not considered in the comparative tables and descriptions. However, in discriminant functions separating most similar species (e.g. *C. wroughtonii* vs. *C. obscurior*), allometric variance was removed using the procedure as described in "Discriminant functions".

A certain type of worker-gyne intercaste was observed in species such as *C. bulgarica*, *sahlbergi*, *C. ulianini*, *C. elegans*, *C. nigra*, *C. brachyceps* sp.n., *C. mauritanica*, *C. wroughtonii*, and *C. stambuloffii*. These specimens, having an overall frequency of about 6 %, deviate from the normal worker habitus mainly by suggestions of tegulae and significantly increased waist ratios.

5. Taxonomic significance of characters

Most important discriminative characters in *Cardiocondyla* are the postocular index, eye-size, scape and head indices, waist indices, and pubescence length. These characters should be generally investigated. Future revisors are also recommended to measure basal spine distance (SPBA) and frontal carinae distance behind scape joint level (FRS). A rather small overall contribution to species discrimination is given by spine length and pubescence distance sqrtPDG, though it is not advisable to generally abandon these characters.

An important structural character is the type of microsculpture; in particular on vertex it is extremely differentiated within the genus. However, high intraspecific variability in species such as *C. emeryi* and *C. yemeni* may serve as a warning not to overestimate this character. Attention should be directed to the shape of mesosoma and waist. The postpetiolar sternite can show a diagnostic shape and prominent structures such as carinae, bulbs, bilateral dents, or lobes (Figs. 5, 6).

Even if callows are excluded from consideration, the ratio of dark and light pigments shows intraspecifically a considerable continuous variation and, still worse, in several species (e.g. *C. ulianini*, *C. emeryi,* and *minutior*) discrete dark and pale colour morphs are expressed. Hence, pigmentation characters are unreliable interspecific discriminators in most of the cases and pigmentation scaling (PigCap, PigMes) is not very promising. However, in one species pair (*C. wroughtonii* vs. *C. obscurior*) the pigmentation pattern of the gaster and in another (*C. bulgarica* vs. *sahlbergi*) a calibrated brightness contrast between head and mesosoma may serve as accessory differential characters.

Foveolar diameter can be dismissed as well; it did not help in most of the difficult determination problems.

6. General aspects of *Cardiocondyla* biology

6.1 Habitats, nesting, and behaviour:

Knowledge on habitat selection and biology is poor or lacking in most of the known species. Many species of the world fauna are typically found in anthropogenically or naturally disturbed, open and xerothermous habitats along rivers, traffic lines, or wood margins and in sand dunes or other badlands. In particular the tramp species, but not only these, show a preference for habitats with a high degree of urbanization and the question arises which are the natural habitats. These should be, first of all, semideserts and steppes as well as open habitats on immature soils at rivers, lakes, and sea shore and to a lesser extent forest margins or burned-down woodland patches. In contrast to this open-land group, the original habitats of many tropical species are primary rain forests.

In the majority of species, nests are constructed in the soil and less frequently under stones. Nests usually have a single entrance hole of only 1 - 1.5 mm diameter which is not marked by soil ejections. A very narrow vertical duct leads down to 2 - 15 cm depth before it changes abruptly to a horizontal direction or ends in a simple chamber of 15 - 20 mm diameter and 3 - 4 mm height. Simple nests without a complex vertical structure are found if moist soil horizons are not very deep and if the local climate does not show extreme temperature amplitudes. The depth of the uppermost chamber depends upon climatic conditions and the cohesiveness of soil particles (CREIGHTON & SNELLING 1974, MEI 1984; J. Heinze, pers. comm.; own observations). In the desert species *C. ulianini*, when ground water is very deep, the nest structure can be much more complex with the vertical duct crossing as much as 40 - 50 of such chambers one after the other down to a depth of 150 cm. This elaborate vertical structuring ensures direct access to ground water, it enables a free choice of narrow temperature optima during the extreme diurnal temperature changes in the desert, and it provides a protected hibernation during the cold Central Asian winter (MARIKOVSKY & YAKUSHKIN 1974).

Nesting in plant structures above soil surface is obviously rare in Holarctic *Cardiocondyla.* This behaviour is typical for *C. obscurior* and *C. wroughtonii* which occur in open areas, in grassland, at forest margins, in urban areas, or plantations.

Mature natural nests of monogynous and polygynous species usually contain less than 500 workers as found in *C. wroughtonii*, *C. obscurior*, *C. mauritanica*, *C. ulianini*, *C. koshewnikovi*, and *C. elegans*. The real frequency of monogyny within the genus is unknown; it has been observed so far in *C. elegans*, *C. batesii*, and *C. ulianini*. The cosmopolitan tramp species *C. wroughtonii*, *C. obscurior*, *C. mauritanica*, *C. emeryi*, and *C. minutior* are polygynous and found new colonies preferentially by nest splitting.

Development at room temperature from oviposition to the eclosion of adults lasted approximately 56 days in ergatoid males of *C. mauritanica* (HEINZE & al. 1993) and 55 days in workers of "*C. emeryi*" (CREIGHTON & SNELLING 1974), with the egg, larval, and pupal stages lasting for 12, 27, and 16 days. Most remarkably, the callow stage in workers was as short as 2 days. Development of gynes of *C. ulianini* in the Central Asian deserts seems to need 100 days at least. After oviposition in May, gynes are reported to eclose by the end of August and in September, to hibernate in the nest and to leave it in next spring (MARIKOVSKY & JAKUSHKIN 1974). A similar situation seems to exist in *C. batesii* (J. Heinze, pers. comm.) in which the young gynes are most probably mated intranidally in late summer, hibernate in the nest in an alate condition, and use the moist spring situation for dispersal to have better founding success. Reproductive gynes of *C. mauritanica* produced 2 - 3 eggs per day in well-fed laboratory colonies and their ovaries contained 3+3 ovarioles (HEINZE & al. 1993). No observations or suggestions of worker reproduction are known in *Cardiocondyla.*

Workers of aggressive superior species such as *Pheidole dentata*, *Solenopsis geminata*, and *Linepithema humile* were observed to shrink back when encountering foragers of *Cardiocondyla* "*emeryi*" and *C. mauritanica* (CREIGHTON & SNELLING 1974) which suggests the emission of effective repellents.

Cardiocondyla ants are omnivorous. Zoophagy (zoonecrophagy and killing of small weakly sclerotised arthropods), granivory, and nectarivory are reported (CREIGHTON & SNELLING 1974, MARIKOVSKY & YAKUSHKIN 1974, DLUSSKY 1981). Recruitment to food sources or nest sites can be performed by tandem running as observed in few species (CREIGHTON & SNELLING 1974). The latter authors, the present author, and MARIKOVSKY & JAKUSHKIN (1974) noted a well-developed, almost linear light compass orientation of *C. mauritanica* and *C. ulianini* foragers on open surfaces.

6.2 The ergatoid male syndrome - all ergatoids show a fighter-phenotype:

Males were not subject of a thorough morphometric and structural investigation during this revision. The statements presented below are based upon short visual inspection of material seen during this revision and upon critical revision of literature (BARONI URBANI 1973, MARIKOVSKY & YAKUSHKIN 1974, KUGLER 1983, TERAYAMA 1999). In one case, species identification is doubtful: MARIKOVSKY & YAKUSHKIN (1974) described a "male-like wingless gyne of *Cardiocondyla ulianini*" which in fact is an ergatoid male of another related species. The wider petiole and wider spine base distance compared to the ergatoid male of *C. ulianini* and the locality suggest an allocation to the Central Asian population of *C. sahlbergi*.

With these objections, alate (A) and/or ergatoid (E) males are known so far in the following *Cardiocondyla* species: *C. batesii* (E), *C. elegans* (E), *C. emeryi* (A+E), *C. kagutsuchi* (A+E), *C. koshewnikovi* (E), *C. mauritanica* (E), *C. minutior* (A+E), *C. nigra* (A+E), *C. paranuda* sp.n. (E), *papuana* (E), cf. *sahlbergi* (E), *C. stambuloffii* (E), *C. ulianini* (E), *C. obscurior* (A+E), *C. wroughtonii* (A+E), and an undescribed Indonesian species (E). This suggests ergatoid males to be present in any species while alate males seem to be lost in 60 % of the species.

The morphology of ergatoid males in *Cardiocondyla* shows a number of common traits in the manner of a syndrome which indicate similar life-strategies:

(1) All ergatoid males investigated have mandibles very effective for mutilating or seizing male competitors. One evolutionary way is to develop worker-like mandibles with increased sclerotisation and increased size of apical dentition. Worker-like mandibles have been observed in *C. elegans, C. ulianini, C.* cf. *sahlbergi, C. mauritanica*, *C. paranuda*, *C. kagutsuchi*, *C. batesii*, *C. nigra*, *C. stambuloffii, C. koshewnikovi*, *C. minutior*, and *C. emeryi*. The other way, the development of long, toothless and saber-shaped mandibles, is so far known in *C. wroughtonii, C. obscurior,C. papuana* (REISKIND 1965), and an undescribed Indonesian species.

(2) The ergatoid males considerably increase anterior mesosomal width by the development of lateral promesonotal corners and carinae in order to protect this sensitive region against biting attacks. An increase of waist segment width compared to the worker situation is frequent, but not found in all species.

(3) All ergatoid males reduce black pigmentation (leading to a light-yellowish-brown overall colouration), decrease eye size, and reduce the ocelli partially or completely. This syndrome is an indication for entirely intranidal life-cycles.

Hence, morphology suggests the ergatoid males of all species to have a similar mating and competition behaviour as it was directly observed in *C. obscurior*, *C. mauritanica*, *C. kagutsuchi*, and *C. minutior*. Pathology can also give evidence for ergatoid male fighting: within a sample of 3 ergatoid males of *C. nigra* from Tunisia (ex coll. G. Mayr, NHM Wien) was one male with two legs partially cut-off. Completed peroxidase reactions in the wound areas indicate that this male survived the amputations.

The fusion of funiculus segments 2 - 8 to a single flattened and elongated segment, reducing the total number of antennal segments from normally 12 - 13 to 6 - 9, is known in 5 species (*C. elegans* 6 - 9, *C. ulianini* 6 - 7, *C.* cf. *sahlbergi* 6, *C. batesii* 6 - 7, *C. nigra* 7 - 8) and is probably without adaptive significance. In other species, the total number of segments in ergatoid males is reduced by only 0 - 2 compared to the known or putative number in alate males.

6.3 Gyne polymorphism – an adaptive trait emerging in desert environments:

Probably gyne polymorphism is not rare in *Cardiocondyla*, but undetected in many species because of the small available sample size. It is expressed by strong variation in mesosoma dimensions and weak differences in postocular distance (a result of larger eye size of the flying macrosomatic gynes), whereas other characters are equal (Tab. 1). Thus, gyne polymorphism in *Cardiocondyla* deviates from gyne polymorphism in *Leptothorax*, *Tetramorium*, *Messor,* or *Myrmica* in which measurements of all body parts differ between micro- and macrogynes. Hence, the use of the terms macro- and microgynes is problematic in *Cardiocondyla*; instead the terms macrosomatic and microsomatic gynes are used here.

Gyne polymorphism was observed in *C. ulianini* (see also MARIKOVSKY & YAKUSHKIN 1974), *C. batesii*, *C. bicoronata* sp.n., *C. nigra*, *C. elegans*, and *C. sahlbergi.* All these species are inhabitants of Palaearctic deserts, semideserts or dry steppes and three of them are known to be monogynous. Only macrosomatic gynes have been collected in the Palaearctic desert species *C. fajumensis* (which may be a sampling artefact, since probably no nest samples but only queens in dispersal have been collected). Most remarkably, no gyne polymorphism has been observed so far in the cosmopolitan tramp species *C. mauritanica*, *C. minutior*, *C. emeryi*, and *C. obscurior*.

A distinct bimorphism of macrosomatic and microsomatic forms can be demonstrated for the species *C. nigra*, *C. bicoronata* sp.n., *C. elegans*, *C. ulianini*, and *C. sahlbergi* by calculating a mesosoma size index IMes = (ML + MW)/(2 CS). 41 microsomatic gynes of these species showed an IMes of 1.005 ± 0.016 [0.959,1.055] and 28 macrosomatic gynes one of 1.110 ± 0.016 [1.074,1.158]. The mesosoma size index of *C. batesii* reveals no distinct bimorphism but shows a strong continuous polymorphism.

Microsomatic gynes of the bimorphic species are brachypterous with forewing length amounting only 201 - 267 % of CS (as found in 8 winged specimens) while macrosomatic gynes are macropterous with a forewing length of 318 - 384 % CS (as found in 10 winged specimens). Dissections were not performed to save the rare material but it is obvious that microsomatic gynes have reduced flight muscles and are most certainly not capable of active flight. In *C. batesii*, in which gynes are continuously polymorphic instead of bimorphic, a highly significiant correlation of mesosoma size with forewing length exists with FWL/CS = 7.349 IMes - 4.402 ($r = 0.843$, $n = 14$, $p < 0.001$).

Tab. 1: Gyne dimorphism as pooled data of the *Cardiocondyla* species *C. bicoronata* sp.n. (10 microsomatic + 10 macrosomatic), *C. nigra* (10+1), *C. elegans* (10+12), *C. sahlbergi* (7+1), and *C. ulianini* (4+4). The given per cent ratios were calculated by separate intraspecific division with the arithmetic mean of microsomatic gynes. IMes = (ML + MW)/2CS.

	macrosomatic (n = 28)	microsomatic (n = 41)	P	t value
CL	99.23 ± 2.26	100.0 ± 2.02	n.s.	
CW	100.00 ± 2.43	100.0 ± 1.93	n.s.	
SL	100.38 ± 2.71	100.0 ± 2.34	n.s.	
ML	106.58 ± 2.63	100.0 ± 2.57	0.0001	10.35
MW	115.29 ± 5.26	100.0 ± 3.18	0.0001	15.04
IMes	109.83 ± 1.60	100.0 ± 1.36	0.0001	27.44
PEW	98.83 ± 4.80	100.0 ± 4.22	n.s.	
PPW	99.87 ± 3.83	100.0 ± 3.17	n.s.	
PEH	99.45 ± 4.42	100.0 ± 4.10	n.s.	
PPH	99.25 ± 4.90	100.0 ± 4.09	n.s.	
PoOc	97.86 ± 3.20	100.0 ± 2.33	0.01	3.22
PLG	99.31 ± 5.26	100.0 ± 3.92	n.s.	
sqrtPDG	99.21 ± 8.13	100.0 ± 6.42	n.s.	

As emphasised above, gyne polymorphism in *Cardiocondyla* seems to be typical for continental desert or semidesert species and seems to be absent in cosmopolitan tramp species. Within the ant genera *Monomorium*, *Aphaenogaster*, *Proformica*, and *Cataglyphis*, wing reduction in gynes is most frequently (if not exclusively) observed in arid environments (TINAUT & HEINZE 1992). Collectors of *Cardiocondyla* in desert or semidesert environments reported the nest sites to be concentrated in rare spots with less extreme living conditions, in particular where ground water horizons are less deep below soil surface (MARIKOVSKY & JAKUSHKIN 1974, DLUSSSKY 1981; own observations). Rare spots with suitable living conditions within large unsuitable areas mean a high mortality risk during or after flight dispersal and strategies to achieve a maximum density on these rare spots should be favoured. Brachypterous gynes minimize the risk of dispersal and try to found colonies near to their mother colony in an area that most probably will offer sufficient resources. Which of the four possible ways of colony foundation they follow, remains to be studied: (1) single gynes found independently, (2) a single gyne leaves its mother nest accompanied by few workers, (3) several gynes found in pleometrosis, or (4) nest-fission leading to polygynous-polycalic societies. Data available for *C. elegans, C. batesii*, and *C. ulianini* suggest monogyny and make option (4) less probable.

Overcrowding of rare spots once should increase the cost/benefit ratio of brachypterous gynes and long-range dispersal of macropterous gynes will become advantageous. As a consequence, a mixed strategy offering both brachypterous and macropterous gynes should have the highest long-term adaptive value. The putative rarity of alate males in desert ants means, that both macropterous as well as micropterous gynes usually should be mated intranidally by ergatoid males; the former should use their wings mainly to disperse to distant rare spots and not for mating flight.

The absence of gyne polymorphism in the tramp species *C. mauritanica*, *C. minutior*, *C. emeryi*, and *C. obscurior* is remarkable. By morphology, all their investigated gynes should be able to fly. Direct observations in *C. obscurior* and *C. mauritanica* confirm this view. In a field colony of *C. mauritanica* in California CREIGHTON & SNELLING (1974) observed that single females appeared at nest entrances and took flight; in one observation 8 gynes flew off within 78 minutes in a July morning. The apparent absence of alate males in this species and the presence of ergatoid males in the particular nest strongly suggest these gynes to be inseminated and to disperse for nest foundation. HEINZE & al. (1993), however, have doubted single-queen colony foundation in a *C. mauritanica* population from the Canaries (Isla la Palma); during laboratory observations, they did not note flight activity of the macropterous gynes. STUART & al. (1987) confirm intranidal insemination by alate males in *C. obscurior*. KINOMURA & YAMAUCHI (1987) observed young gynes of *C. obscurior* to copulate intranidally, mainly with ergatoid but also with alate males. A large fraction of these intranidally inseminated queens did not shed their wings and stayed within the nest for one month at least. During two flights taking place at natural light conditions in late June 1986, about 110 gynes flew off; 50 of them were already inseminated and 60 not. Males flew off later than gynes. Only the virgin gynes were mated by alate males on the floor of the cage.

An explanation for the absence of gyne polymorphism in these highly polygynous tramp species, that should be biased to reduce physical flight ability, is most difficult. The simplest explanation seems to be that gynes developed an ethological polymorphism (flyers and non-flyers) but no selection operated to correlate this with a morphological bimorphism. One might also speculate that the native habitats of tramps were not desert habitats and that a selection for gyne brachyptery did not occur.

7. Diagnosis of *Cardiocondyla*

7.1 Diagnosis of the worker:

[according to BOLTON (1982), slightly modified]:

Small to minute, monomorphic myrmicine ants. Palp formula 5,3 (16 species examined). Mandibles with 5 teeth which decrease in size from apical to basal. Clypeus with flattened and prominent projecting lateral portions, which are fused to the raised projecting median portion to form a shelf which projects forward over the mandibles. Median portion of clypeus posteriorly broadly inserted between narrow frontal lobes. Antennal scrobes absent. Eyes relatively large, situated in front of midlength of the head sides. Antennae with 11 - 12 segments, usually with a distinct 3-segmented club. Dorsal mesosoma without sutures; pronotal corners broadly rounded to bluntly angular. Propodeum unarmed to strongly bispinose. Metapleural lobes low and rounded. Petiole nodiform, with a moderate to long, usually slender, anterior peduncle. Postpetiole dorsoventrally flattened, in dorsal view always much broader than petiole. Sting large, knife blade-like in profile, without lamelliform appendages. Pilosity on dorsal body sparse to absent.

7.2 Diagnosis of species groups:

Characters such as position and size of eyes, basic type of sculpture, basic shape of mesosoma and waist, and ventral postpetiolar structures were considered as important to establish groups of related species. Here are distinguished the *C. elegans*, *C. bulgarica*, *C. batesii*, *C. nuda*, *C. shuckardi*, *C. stambuloffii*, *C. wroughtonii*, *C. emeryi*, and *C. minutior* group by considering combinations of these characters the phylogenetic significance of which, however, remains to be checked.

***C. elegans* group:** small postocular index (PoOc/CL 0.368 - 0.418), large eyes (EYE 0.235 - 0.261), long scape (SL/CS 0.790 - 0.881), long pubescence (PLG/CS 6.54 - 8.73 %). Anterior postpetiolar sternite in the median portion significantly more produced than in paramedian portions; in lateral view this anteromedian bulge forming a small obtusely rounded corner and changing into helcium with distinct angle (Fig. 69). Accessory characters: flat and frequently bicoronate foveolae on paramedian vertex with 16 - 21 µm diameter and shining interspaces; dorsal mesosoma showing a distinct metanotal depression and appearing smooth and shining at lower magnifications. The group contains the species *C. elegans* and *C. brachyceps* sp.n. which are distributed from Iberia to West Asia.

***C. bulgarica* group:** equal to former group in structure of postpetiolar sternite and similar in having flat and frequently bicoronate foveolae on paramedian vertex with 12 - 21 µm diameter and shining interspaces, similar mesosomal sculpture, and rather large eyes (EYE 0.219 - 0.258). Differing from former group by larger postocular index (PoOc/CL 0.40 - 0.47), shorter scape (SL/CS 0.75 - 0.85), and shorter, more dilute pubescence (PLG/CS 4.5 - 6.8 %, sqrtPDG 4.4 - 6.2). The group is distributed in SE Europe, N Africa, and W Central Asia and contains 7 species: *C. ulianini*, *C. gallilaeica* sp.n., *C. israelica* sp.n., *C. littoralis* sp.n., *C. bulgarica*, *C. sahlbergi*, and *C. persiana* sp.n.

***C. batesii* group:** eyes large (EYE 0.249 - 0.283). Postocular index small (PoOc/CL 0.311 - 0.420). Postpetiole rather narrow (PPW/CS 0.463 - 0.551). Anterior postpetiolar sternite completely flat, in medial portion as flat as in more lateral portions; in lateral view its anterior profile changing into helcium without distinct angle (Fig. 70). Foveolae on paramedian vertex usually flat but of diverse structure. Gastral pubescence short (PLG/CS 4.5 - 6.9 %) and rather dilute (sqrtPDG 4.1 - 6.0). The group contains *C. batesii*, *C. semirubra* sp.n., *C. kushanica*, *C. nigra*, *C. bicoronata* sp.n., *C. tenuifrons* sp.n., *C. rugulosa* sp.n., and *C. opistopsis* sp.n. Allopatric and parapatric occurrence makes taxonomic decisions most difficult in this group. The known distribution includes S Iberia, N Africa, the S Balkans, Asia Minor, the Arab Peninsula and W Asia. No tramp species are known in this group though the occurrence of *C. nigra* on the Cape Verde Islands should be caused by introduction.

***C. nuda* group:** basic type of sculpture on paramedian vertex and mesosoma microreticulate, though varying in strength. Postocular index large (PoOc/CL 0.413 - 0.492). Eyes rather small (EYE 0.218 - 0.246). Postpetiole rather narrow (PPW/CS 0.434 - 0.539), its sides in many species angulate-convex giving it a slightly hexagonal dorsal outline. Dorsal profiles of promesonotum and anterior propodeum not evenly shallowly convex; linear portions predominate which may curve down quite abruptly to a rather shallow metanotal groove, if such groove is present at all (MGr/CS 0.2 - 3.4 %). If propodeal spines are reduced to short dents, their dorsal and caudoventral profiles usually form an angle of less than 90°. The group includes *C. nuda*, *C. mauritanica*, *C. kagutsuchi*, *C. strigifrons*, *C. atalanta*, and *C. paranuda* sp.n. The members of the group are distributed around the globe. The native distribution centres are hypothetic but probably in the S Palaearctic, Oriental, and Polynesian faunal regions. The S Nearctic and Neotropic populations have most probably been founded by anthropogenic introduction.

***C. shuckardi* group:** differing from *C. nuda* group by overall mesosomal profile; the promesonotal and anterior propodeal profiles form shallow, convex curvatures, which together forming broad and rather deep metanotal depression (MGr 1.9 - 6.4 %). In lateral view propodeal spines appearing as blunt angles of usually > 90°. Postpetiole very narrow (PPW/CS 0.40 - 0.49), its sternite with an indication of 2 paramedian longitudinal carinae. Eyes small (EYE 0.199 - 0.239). Postocular index large (PoOc/CL 0.43 - 0.47). The radiation centre of this group is most probably Africa. The *C. shuckardi* group includes *C. shuckardi*, *C. fajumensis*, *C. unicalis* sp.n., *C. melana* sp.n., *C. longiceps* sp.n., and *C. venustula.*

***C. stambuloffii* group:** reduction of foveolae on vertex; pubescence hairs originating from either flat tubercles or flat pits of 4 - 10 μm diameter, at lower magnifications with a finely punctate surface appearance. Propodeal spines reduced to blunt dents. Frons very wide (FRS/CS 0.280 - 0.353). Metanotal depression deep. Except for the more distantly related *C. tibetana* sp.n., the species in this group share the following accessory characters: petiole much higher than wide, postpetiole twice as wide as petiole, eyes small (EYE 0.203 - 0.235). The group includes *C. stambuloffii*, *C. gibbosa*, *C. koshewnikovi*, and *C. tibetana* sp.n. and is distributed from SE Europe across Asia Minor eastwards to Tibet and Mongolia.

***C. wroughtonii* group:** minute. Head short, CL/CW 1.06 - 1.17. Frons wide, FRS/CS 0.256 - 0.294. Anterior postpetiolar sternite on each side with a prominent longitudinal carina ending in an anteroventral dent or curved semiconvex angle. As result, anteroventral postpetiole concave in dorsofrontal view. Petiole relative to postpetiole rather wide (PEW/PPW 0.60 - 0.71). The group includes the cosmopolitan *C. wroughtonii* and *C. obscurior* plus two species with apparently restricted range: *C. shagrinata* sp.n. from India and *C. nana* sp.n. from Borneo.

***C. emeryi* group:** minute. Head elongated, CL/CW 1.17 - 1.28. Frons narrow, FRS/CS 0.199 - 0.248. Postpetiolar sternite never completely flat, either with prominent bulge or with anterolateral dents or corners. Africa is the most probable radiation centre of this group, that includes *C. emeryi*, *C. weserka*, *C. neferka*, and *C. yemeni*.

***C. minutior* group:** minute. Head much elongated, CL/CW 1.21 - 1.32 and with very large postocular index, PoOc/CL 0.46 - 0.49. Frons rather narrow, FRS/CS 0.223 - 0.258. Postpetiolar sternite completely flat, very low postpetiole (PPW/CS 0.25 - 0.29); petiole much higher (PEH/PPH 1.15 - 1.42). Metanotal groove shallow or absent (MGr 0 - 1.9 %). Propodeal spines moderately long to short, SP/CS 0.089 - 0.147. The biggest diversity in this group is found in the Indomalayan region where *C. minutior*, *C. breviscapus* sp.n., *C. carbonaria*, *C. opaca* sp.n., *C. britteni* (India is, with some probability, the native range of the latter), *C. goa* sp.n., and *C. tjibodana* are found. The cosmopolitan tramp species *C. minutior* is the only species frequently found outside this area. It can be expected worldwide in all regions with tropical or subtropical climate.

8. Synonymic list of species and their known distribution

Cardiocondyla elegans **EMERY, 1869**
= *Cardiocondyla elegans* r. *santschii* FOREL, 1905
= *Cardiocondyla dalmatica* SOUDEK, 1925, **syn.n.**
= *Cardiocondyla provincialis* BERNARD, 1956, **syn.n.**
= *Xenometra gallica* BERNARD, 1957
entire Mediterranean, SE Europe, Asia Minor

Cardiocondyla brachyceps **sp.n.**
E Turkey, Iran, Afghanistan

Cardiocondyla ulianini **EMERY, 1889, stat.rev.**
Ukraine, Caucasus, Kyrghyztan, Kazakhstan, Afghanistan, Gobi Desert, Iran, Saudi Arabia

Cardiocondyla gallilaeica **sp.n.**
Israel

Cardiocondyla israelica **sp.n.**
Egypt, Israel

Cardiocondyla littoralis **sp.n.**
S Kazakhstan

Cardiocondyla bulgarica **FOREL, 1892**
= *Cardiocondyla elegans* var. *eleonorae* FOREL, 1911, **syn.n.**
S Yugoslavia, Bulgaria, Greece, Turkey, Asia Minor

Cardiocondyla sahlbergi **FOREL, 1913**
Asia Minor, Armenia, Caucasus, Kazakhstan, Israel, Iran, Tunisia

Cardiocondyla persiana **sp.n.**
Iran, Israel

Cardiocondyla batesii **FOREL, 1894**
S Portugal, S Spain, Algeria, Morocco

Cardiocondyla semirubra **sp.n.**
Asia Minor

Cardiocondyla kushanica **PISARSKI, 1967**
Afghanistan

Cardiocondyla nigra **FOREL, 1905**
= *Cardiocondyla elegans* var. *torretassoi* FINZI, 1936, **syn.n.**
S Portugal, Cape Verde Islands, Morocco, Algeria, Tunisia, Egypt, Cyprus, Asia Minor

Cardiocondyla bicoronata **sp.n.**
Israel, Jordan, United Arab Emirates, Yemen, Turkestan

Cardiocondyla tenuifrons **sp.n.**
Jordan

***Cardiocondyla rugulosa* sp.n.**
Yemen

***Cardiocondyla opistopsis* sp.n.**
Kuwait

***Cardiocondyla nuda* (MAYR, 1866)**
Entire Polynesia, New Guinea, Australia

***Cardiocondyla paranuda* sp.n.**
Tunisia

***Cardiocondyla atalanta* FOREL, 1915, stat.n.**
Entire Australia

***Cardiocondyla mauritanica* FOREL, 1890**
= *Cardiocondyla ectopia* SNELLING, 1974, **syn.n.**
Canary Islands, S Portugal, S Spain, Morocco, Tunisia, Libya, Malta, Egypt, Greece, Ukraine, Turkey, Israel, Jordan, Iraq, Iran, United Arab Emirates, Abu Dhabi, Oman, Afghanistan, Pakistan, N India, Nepal, Zimbabwe, Puerto Rico, Arizona, California.

***Cardiocondyla mauritanica* FOREL, morph B**
S Spain, Sinai

***Cardiocondyla kagutsuchi* TERAYAMA, 1999**
Sri Lanka, E India, Nepal, Bhutan, S China, Korea, S Japan, Philippines, Malaysia, Indonesia, Papua New Guinea, Guam, Hawaii

***Cardiocondyla strigifrons* VIEHMEYER, 1922, stat.n.**
Indonesia

***Cardiocondyla shuckardi* FOREL, 1891**
= *Cardiocondyla shuckardoides* FOREL, 1895, **syn.n.**
SE Africa, Madagascar

***Cardiocondyla venustula* WHEELER, 1908**
= *Cardiocondyla globinodis* STITZ, 1923, **syn.n.**
= *Cardiocondyla badonei* ARNOLD, 1926, **syn.n.**
Zimbabwe, Mozambique, Namibia, Puerto Rico, Florida

***Cardiocondyla melana* sp.n.**
Yemen

***Cardiocondyla longiceps* sp.n.**
Yemen

***Cardiocondyla fajumensis* FOREL, 1913, stat.n.**
= *Cardiocondyla schatzmayri* FINZI, 1936, **syn.n.**
= *Cardiocondyla nilotica* WEBER, 1952, **syn.n.**
Egypt, Sudan, Zimbabwe, Iran, Yemen, Cape Verde Island

***Cardiocondyla unicalis* sp.n.**
Iran

***Cardiocondyla stambuloffii* FOREL, 1892**
= *Cardiocondyla bogdanovi* RUZSKY, 1905; **syn.n.**
= *Cardiocondyla montandoni* SANTSCHI, 1912
= *Cardiocondyla stambuloffi* [sic!] ssp. *taurica* KARAVAJEV, 1927
Romania, Moldova, Ukraine, Bulgaria, Greece, Turkey, Armenia, Iran

***Cardiocondyla koshewnikovi* RUZSKY, 1902**
Kazakhstan, Gobi Desert, Tibet, Mongolia

***Cardiocondyla gibbosa* KUZNETZOV-UGAMSKY, 1927, stat.n.**
Kazakhstan

***Cardiocondyla tibetana* sp.n.**
Tibet, Tarim Basin

***Cardiocondyla wroughtonii* (FOREL, 1890)**
= *Cardiocondyla wroughtonii* var. *hawaiensis* FOREL, 1899
= *Cardiocondyla wroughtonii* ssp. *quadraticeps* FOREL, 1912, **syn.n.**
= *Cardiocondyla wroughtonii* var. *bimaculata* WHEELER, 1929
= *Cardiocondyla longispina* KARAVAJEV, 1935, **syn.n.**
= *Cardiocondyla yamauchii* TERAYAMA, 1999, **syn.n.**
India, Sri Lanka, Nepal, Taiwan, Japan, Hawaii, Thailand, Singapore, W Malaysia, Brunei, Indonesia, Papua New Guinea, Australia, Tanzania, Florida, Louisiana

***Cardiocondyla obscurior* WHEELER, 1929, stat. n.**
= *Cardiocondyla bicolor* DONISTHORPE, 1930, **syn.n.**
= *Cardiocondyla wroughtonii*, sensu TERAYAMA 1999 (misidentification)
Canary Islands, Germany, Israel, Kenya, India, Nepal, Japan, Taiwan, Hawai, Mariana Islands, Brazil, Puerto Rico, Virgin Islands, Florida

***Cardiocondyla shagrinata* sp.n.**
India

***Cardiocondyla nana* sp.n.**
Brunei

***Cardiocondyla emeryi* FOREL, 1881**
= *Cardiocondyla emeryi* var. *rasalamae* FOREL, 1891
= *Cardiocondyla emeryi mahdii* KARAVAJEV, 1911
= *Cardiocondyla mauritia* DONISTHORPE, 1946
Mauritius, Madeira, Canary Islands, Cape Verde Islands, St. Helena, Morocco, Israel, Egypt, Sudan, Yemen, Nigeria, Angola, Botswana, Burundi, Rwanda, Uganda, Tanzania, Cameroon, South Africa, Madagascar, Seychelles, Chagos Island, Sri Lanka, Nepal, Hawaii, entire Caribbean, Florida, Brazil

***Cardiocondyla weserka* BOLTON, 1982**
Cameroon

***Cardiocondyla neferka* BOLTON, 1982**
Ghana, Nigeria

***Cardiocondyla yemeni* COLLINGWOOD & AGOSTI, 1996**
Yemen

***Cardiocondyla minutior* FOREL 1899, stat.rev.**
= *Cardiocondyla tsukuyomi* TERAYAMA, 1999, **syn.n.**
Islands of the Indian Ocean, India, Sri Lanka, Nepal, Japan, Polynesia, Indonesia, New Guinea, Florida, entire Caribbean

***Cardiocondyla goa* sp.n.**
India

***Cardiocondyla tjibodana* KARAVAJEV, 1935**
Indonesia, Malaysia, Mariana Islands, Belize

Cardiocondyla breviscapus **sp.n.**
India

Cardiocondyla carbonaria **FOREL, 1907**
India

Cardiocondyla opaca **sp.n.**
India

Cardiocondyla britteni **CRAWLEY, 1920**
Described from England but probably introduced from India

9. *Cardiocondyla* incertae sedis

The following taxa cannot be interpreted to species level because of ambiguous original descriptions in combination with unavailable or indeterminable types. Future students of *Cardiocondyla* are recommended not to list them up in speculative synonymic lists but instead to keep them under Incertae Sedis unless types are reliably identified and investigated.

Cardiocondyla emeryi **ssp.** ***chlorotica*** **MENOZZI, 1930**; Somalia.

Type material was confirmed by the curator to be present in the museum of Bologna (Italy) but its loan was refused by the head of department. This taxon should be either a synonym of *C. wroughtonii* or *C. obscurior*.

Cardiocondyla emeryi **ssp.** ***fezzanensis*** **BERNARD, 1948**; Algeria.

Cardiocondyla gallagheri **COLLINGWOOD & AGOSTI, 1996**; Oman, Wahiba Sands, 1989.12.18, M.D.Gallagher; 5 workers. The original description suggests this taxon to be a member of either the *C. batesii* or *C. elegans* group but does not allow any futher identification. Two ethanol-stored workers, labelled "Oman, Wahiba Sands, 15.XII.89, leg. M.D.Gallagher" and "Paratype Cardiocondyla gallagheri", were sent to the author by Collingwood. A striking disagreement of their morphology with the original description and the deviation of the published collecting date from the one given on the label indicates that these specimens cannot be considered as types. They are in any structural and morphometric character typical *C. mauritanica*.

Cardiocondyla jacquemini **BERNARD, 1953**; Algeria.

Cardiocondyla emeryi **ssp.** ***nitida*** **BERNARD, 1948**; Algeria.

Cardiocondyla monilicornis **(EMERY, 1917)**; St.Thomas/Virgin Islands.
[*Xenometra monilicornis* EMERY, 1917]

The holotype, an ergatoid male, labelled "St. Thomas ....[illegible]", and "Xenometra monilicornis Emery" is present in MCSN Genova.

A decision on the species identity is not possible at the present stage. Both BARONI URBANI (1973) and KUGLER (1983) synonymized *C. monilicornis* with *C. emeryi* simply because of coincidence of type localities but not by investigating worker-associated ergatoid males of all the six species found in the Caribbean which are *C. mauritanica*, *C. obscurior*, *C. wroughtonii*, *C. venustula*, *C. minutior*, and *C. emeryi*. Only the ergatoid males of *C. obscurior* and *C. wroughtonii* can be excluded with ease from synonymy with *C. monilicornis*. In the other four species, variability of ergatoid males is not studied or this caste is completely unknown (*C. venustula*). However, the much bigger size, the much more massive waist segments and mesosoma, the more elongated head, the longer spines, and the small sqPDG clearly separate *C. monilicornis* from *C. mauritanica*, *C. minutior,* and *C. emeryi*. The characters of *C. monilicornis* do also deviate from the putative characters predicted for the unknown ergatoid male of *C. venustula*. An extensive study of males is needed to solve this puzzle.

Cardiocondyla stambulovi [sic!] **ssp. *taurica* morpha *sabulosa* ARNOLDI, 1928**; Russia [unavailable name].

Cardiocondyla stambulovi [sic!] **ssp. *taurica* morpha *salina* ARNOLDI, 1928**; Russia [unavailable name].

***Cardiocondyla elegans* ssp. *schkaffi* ARNOLDI, 1933**; Russia.

10. Treatment by species

10.1 *Cardiocondyla elegans* EMERY, 1869

Cardiocondyla elegans EMERY, 1869; Italy: Naples; [types investigated].
Cardiocondyla elegans r. *santschii* FOREL, 1905; France: Marseille [types investigated].
Cardiocondyla elegans var. *dalmatica* SOUDEK, 1925; Dalmatia [types investigated], **syn.n.**
Cardiocondyla provincialis BERNARD, 1956; France: Deptm. Var: plage de Fréjus, Sept.1934 [types investigated], **syn.n.**
Xenometra gallica BERNARD, 1957; France: bords de la Dordogne, à Pinsac (Lot); ergatoid male, erroneously considered as social parasitic gyne [types investigated].

Investigated type material: *Cardiocondyla elegans*: **lectotype** worker (fixed by present designation), original label "Naples \Boscadi, Capodimonte, 18.VI. 1866 \Typus \Cardiocondyla elegans Em., Napoli", MCSN Genova. 5 **paralectotype** workers labelled "Naples", MHN Genève (probably a gift of Emery to Forel).

C. ***elegans*** r.*santschii*: 5 **syntype** workers labelled: "C.elegans santschii Forel, type, Marseille (Santschi) VIII 04", MHN Genève. 3 **syntype** workers and 2 **syntype** gynes of *Cardiocondyla santschii*, labelled "C.elegans santschii Forel, type, Candia(Biso)", MHN Genève.

C. ***elegans*** var.*dalmatica*: 1 **syntype** worker labelled "Boka Kotorska, Dalmacia, 1923, Dr. Soudek", NHM Basel. 1 worker **syntype** labelled "Boka Kotor, Igalo VII 1922, Dr.Soudek", ZIPAS Warszawa.

C. provincialis: 2 **syntype** workers labelled "Fréjus (Var), plage IX.34, Cardiocondyla provincialis F.Bernard, type", MNHN Paris.

Xenometra gallica: 3 ergatoid male **syntypes** (plus 5 workers and 5 gynes) labelled "Pinsac (Dord.), Lepointe 1951", MNHN Paris.

Morphometrically investigated material (37 samples): **Bulgaria:** Melnik, 1985.08.28, w; **Cyprus:** Troodos Mts., 1995.09, w; **France:** Dord.: Pinsac, 1951, w, g; Marseille, 1904.08, w; Marseille, 1904.07, w; Rhone near Avignon, 1992.05, No.790, w; Rhone near Avignon, 1992.05, No.791; g; Tours-E: Amboise, 2000.0914 (samples No. 10, 12), w; Tours-E: Montlouis, 2000.0914 (samples No.3, 5), w; Tours, Loire river, 1999.09.02; w, g; Var: Frejus, 1934.09, w; **Greece:** Gytheio - 20 km NNW, 1994.06.01, w; Crete: Hania - 2 km W, 1992.05, w; Crete: Herakleion, 1906.05.15, w, g; Messenia: Koroni vic., 1997.07, w; Olympos, 1979.08, w; Sithonia: Marmaras - 5 km S, 1991.08, w; Zakinthos: Laganas, 1994.06.08, w; vic. Riza, 1994.06.05, w; **Hungary:** Mohacs, 1984.09, g; Szeged, 1997.05.10, w, g; **Italy:** Emilia: Spilamberto, 1917.06; w, g; Mantova: Migliarello, 1957.04.16; w, g; Napoli, cotype elegans (coll. Forel); w; Napoli:

Capodimonte, w; NW Italy: Candia (Biso), w, g; **Montenegro:** Boka Kotor, Igalo, 1922.07, w; Boka Kotorska, 1923, w; **Spain:** Barcelona, Bellaterra, 1975.09.05; w, g; Barcelona: Bellaterra, 1987.08; w, g; Seo de Urgell, leg. H. Franz; w; **Turkey:** Antalya: Geris - 2 km S, 1993.06.06, w; Hatay: Reyhauli - 2 km N, 1993.06.09 (samples No. 1020, 1022), w; Izmir: Ödemis - 20 km SE, 1993.05.20; w.

Description: Worker (Fig. 7, Tab. 7): Rather large species, CS 560 ± 30. Head of medium length, CL/CW 1.153. Postocular distance smaller than in related species, PoOc/CL 0.397. Eye of medium size, EYE 0.248. Scape longer than in related species, SL/CS 0.847. Pubescence length on 1st tergite much longer than in other species, PLG 41.8. Clypeus more or less glabrous, with few weak longitudinal microrugae in posterior and lateral areas. Frontal lobes and frontocentral vertex posterior of frontal carinae finely longitudinal microrugulose. Frontal carinae usually slightly converging immediately caudal of the FRS level. Whole vertex with shallow but well-demarcated simple or bicoronate foveolae of 16 - 19 µm diameter; interspaces between foveolae on paramedian vertex smaller than their diameter. Dorsal area of promesonotum with shallow foveolae of 10 - 15 mm diameter around bases of pubescence hairs, interspaces glabrous and larger than foveolar diameter. Dorsal area of propodeum glabrous but with small foveolae and very delicate microrugosity. Lateral area of mesosoma in overall impression shining but finely microreticulate-rugulose. Dorsum of waist glabrous, with scattered fragments of very fine microreticular structures. First gaster tergite glabrous. Spines well-developed but rather blunt. Petiole node wider than long. Postpetiolar sternite with anteromedian portion significantly more bulging than anteroparamedian portion; in lateral view this anteromedian bulge forming small, obtusely-angled, rounded corner and changing into helcium with distinct angle. Head, mesosoma, waist, and gaster concolorous dark to blackish brown. For morphometric data of 73 workers see Tab. 7.

Gyne (Tab. 15): Rather large, CS 635. Head of medium length (CL/CW 1.137 ± 0.015) and with slightly excavated occipital margin. Postocular distance smaller than in related species, PoOc/CL 0.390 ± 0.010. Scape much longer than in related species, SL/CS 0.803 ± 0.014. Whole body covered with very long and dense pubescence. Vertex with rather shallow but well-demarcated, closely-set, bicoronate foveolae; interspaces clearly smaller than foveolar diameter and on frontocentral and paramedian vertex with longitudinal rugulae. Frontal lobes densely rugulose. Lateral area of clypeus with few longitudinal carinulae. Promesonotum, prescutellum, and scutellum densely foveolate. Cuticular surface of dorsal waist and gaster glabrous, with scattered fragments of microreticular structures and numerous basal pits of pubescence hairs. Metapleurae microreticulate and with few longitudinal carinulae on the bulla glandulae metapleuralis. Propodeal spines well-developed but rather blunt. Petiole node in lateral view not produced caudad, in dorsal view nearly twice as wide than long. Postpetiole node twice as wide than long and with weakly concave anterodorsal margin; its sternite with a conspicuous anteroventromedial corner. Whole body concolourous medium to blackish brown. Gynes with mesosoma dimorphism. For morphometric data of 22 gynes see Tab. 15.

Comments: *Cardiocondyla elegans* shows a coefficient of variation of 10 % in PEW/CS (Tab. 6) which is far above the usual intraspecific variation in *Cardiocondyla* and could indicate unrecognized taxonomic entities. A size-corrected ratio of petiole width PEW/CS (560), computed for the assumption of equal cephalic size CS = 560 µm (slope of correction function + 0.000419), exposes differences between the W and E Mediterranean populations: 27 workers from west of Italy show significantly larger PEW/CS

(560) of 0.354 ± 0.023 than 33 workers from east of Italy with 0.310 ± 0.024, while 13 workers from Italy occupy an intermediate position with 0.333 ± 0.019. A size-corrected ratio of scape length SL/CS (560), (slope of correction function: minus 0.000191) was 0.840 ± 0.016 in W Mediterranean, 0.856 ± 0.019 in E Mediterranean, and 0.838 ± 0.016 in Italian workers.

A name for the eastern population could be *C. dalmatica* SOUDEK. The two known worker syntypes of *C. dalmatica* show SL/CS (560) of 0.874 and 0.871 and PEW/CS (560) of 0.302 and 0.321. Furthermore these types and most of the E Mediterranean workers show a more glabrous propodeum almost without pubescence and finer, frequently more approached spines. However, attempts to demonstrate a separate cluster combining long scapes with narrow petioles and low spine base distances did not have convincing results within the material available. As a consequence *C. dalmatica* is here synonymized with *C. elegans* though the issue is worth of reinvestigation. Isolation in separate Pleistocene refuge centres leading to morphological divergence but not to reproductive isolation could explain the actual situation.

Six investigated type workers of *C. elegans* from Napoli and eight investigated type workers of *C. santschii* from Marseille and Candia are almost identical in 18 investigated morphometric, structural, and pigmentation characters. The following sequence of data gives the arithmetic mean ± standard deviation of 6 *C. elegans* types and in brackets the corresponding data for 8 *santschii* types: CL 583 ± 20 (587 ± 15), CL/CW 1.146 ± 0.015 (1.148 ± 0.011), SL/CL 0.795 ± 0.008 (0.791 ± 0.007), PoOc/CL 0.403 ± 0.009 (0.396 ± 0.008), EYE 0.249 ± 0.005 (0.255 ± 0.004), dFOV 17.2 ± 0.8 (17.4 ± 0.8), SP/CL 0.108 ± 0.012 (0.099 ± 0.019), PEW/CW 0.345 ± 0.014 (0.349 ± 0.021), PPW/CW 0.609 ± 0.014 (0.611 ± 0.019), PEH/CW 0.338 ± 0.015 (0.351 ± 0.011), PPH/CW 0.320 ± 0.009 (0.323 ± 0.011), PEW/PPW 0.567 ± 0.013 (0.571 ± 0.022), sqrtPDG 4.32 ± 0.21 (4.30 ± 0.09), PLG 41.8 ± 2.0 (41.1 ± 2.5), PigCap 10.2 ± 0.8 (10.8 ± 1.6), PigMes 9.7 ± 1.0 (10.2 ± 1.4), MGr/CL 4.7 ± 0.9 (3.7 ± 0.4) %. These data leave no doubts on the synonymy of *C. santschii* with *C. elegans*. This interpretation is confirmed by the two type gynes of *C. santschii* from Candia (Biso) that show the unique *C. elegans* character combination of long scape, large PLG, and small postocular distance.

The two worker types of *Cardiocondyla provincialis* show the diagnostic *C. elegans* characters of long scape, long PLG, moderately large eyes, and small postocular distance. The only structural difference from the average *C. elegans* situation are subaverage waist ratios, but these data are typical for members of French populations. The *C. provincialis* types are paler in colour than the *C. elegans* average, but such pigmentation differences alone are not diagnostic and may be caused by fading.

The synonymy of *Xenometra gallica* with *C. elegans* was already stated by BARONI URBANI (1973). The investigation of the nest sample with the *X. gallica* types left no doubt that Bernard misidentified the ergatoid male of *Cardiocondyla elegans* as the female of a social parasite and the female castes found in this nest as the "hosts". The latter show all diagnostic characters of the worker and of the microsomatic gyne morph of *Cardiocondyla elegans*.

Cardiocondyla elegans shows a discrete gyne bimorphism in dimensions and shape of mesosoma and wing length while other measurements and characters are monomorphic. A cluster of gynes with MW 418 ± 16 [392, 442] (n = 10) can be separated from one with MW 485 ± 17 [465, 531] (n = 12) within 12 gyne samples investigated. The full similarity of the associated workers and the occurrence of both gyne types within the same nest (Barcelona: Bellaterra) indicate an intraspecific polymorphism. The microsomatic gynes with (ML*MW)/(CL*CW) 0.903 ± 0.024 [0.870, 0.940] are supposed to have weaker flight muscles and short wings. They should be mated intranidally by ergatoid males and should either stay within the mother colony, propagate by colony fission, or seek adoption in conspecific neighboured colonies. The macrosomatic gynes with (ML*MW)/(CL*CW) 1.129 ± 0.046 [1.086, 1.254], strong flight muscles, and normal wing length are suspected to disperse in the air and to found a new colony independently after having been inseminated by an ergatoid male within the mother nest

10.2 *Cardiocondyla brachyceps* sp.n.

Type material: **holotype** worker and 15 **paratype** workers labelled "Iran, Fars 1997 (15), 51 road-km W Shiraz, Chehel Chesmeh, 1940 m, 17.9.; leg. Schödl ", NHM Wien. 9 worker paratypes from the same sample in SMN Görlitz. 3 worker **paratypes** labelled "ARTVIN - Taslica, 10 km W Artvin, 1000 mH, Laubmischwald, Steinmauer, leg. Schulz 02.07.89 TÜRKEI", SMN Görlitz.

Mophometrically investigated material (3 samples): **Afghanistan:** Tangi-Gharuh, Kabul River, 1952.08.21, w; **Iran:** Shiraz-51 km W, 1997.09.17, No.15, w; **Turkey:** Artvin-10 km W, 1989.07.02, w.

Description: Worker (Fig. 23, Tab. 7): Head very short and rather straight-sided, CL/CW 1.132. Postocular distance small, PoOc/CL 0.381. Scape long, SL/CS 0.835. Occipital margin slightly excavated. Eyes moderately large, EYE 0.253. Frontal laminae, paramedian vertex, and lateral area of clypeus with weak longitudinal sculpture. Frontal carinae immediately posterior of FRS level parallel or converging. Vertex with strongly demarcated, bicoronate foveolae of 18 - 21 μm diameter; interspaces narrower than foveolar diameter (Fig. 23). Most of mesosoma surface shining and with very fine microreticulum. Dorsal area of promesonotum finely longitudinally rugulose and with bicoronate foveolae. Meso- and metapleurae laterally reticulate; at lower magnifications appearing more dull, contrasting the shining lateral parts of mesonotum and pronotum. Propodeal spines relatively thin and steep. Dorsum of waist glabrous except for a very delicate microreticulum. Petiole with elongated peduncle that is about 1.8x as long as wide; petiole node as high as wide, much wider than peduncle. Postpetiolar sternite with anteromedian portion significantly more bulging than anteroparamedian portion; in lateral view this anteromedian bulge forming small, obtusely-angled, rounded corner and changing into helcium with distinct angle. Pubescence longer. Colour variable: head medium brown to blackish brown; mesosoma and petiole usually light-orange-brown, in specimens with dark brown mesosoma orange-yellowish colour component still visible; postpetiole and gaster dark to blackish brown. For morphometric data of 10 workers see Tab. 7.

Comments: *Cardiocondyla brachyceps* workers are similar to eastern *C. elegans* workers, which may show an elongated petiolar peduncle as it is typical for *C. brachyceps*. A discriminant score D(8) = 0.3 SL/CS + 0.9 PoOc/CL - 1.5 EYE - 0.02 dFov + 0.3 PPW/CS + 0.4 PEH/CS + PPH/CS - 0.05 sqPDG separates all worker individuals of *C. brachyceps* with D(8) 0.121 ± 0.047 [0.038, 0.170] (n = 10) and of *C. elegans* with D(8) 0.287 ± 0.032 [0.237, 0.354] (n = 72). A nonmetric discrimination from *C. elegans* seems possible by the more strongly reticulate meso- and metapleurae which appear at lower magnifications more dull, contrasting the shining lateral parts of mesonotum and pronotum and by the orange-yellowish colour component of mesosoma.

Cardiocondyla brachyceps differs from any species of the *C. batesii* group by the shape of postpetiolar sternite, the elongated petiolar peduncle, the longer gastral pubescence, and the well-demarcated, bicoronate vertex foveolae with narrow interspaces.

10.3 *Cardiocondyla ulianini* EMERY, 1889, stat.rev.

Cardiocondyla elegans var. *ulianini* EMERY, 1889; Russia: Turkestan, leg. Fedtschenko [types investigated].

Investigated type material: lectotype worker (by present designation) and **paralectotype** worker, MCSN Genova, labelled "Turkestan Fedtschenko, mus. Moscou" and "Cardiocondyla elegans var. ulianini Em.". 1 **paralectotype** worker (des. by Forel as "Cotype"), MHN Genève, labelled "Cardiocondyla elegans var. ulianini Em., Turkestan".

Morphometrically investigated material (20 samples): **Afghanistan:** Bala Murghab, 1964.09, w; Kabul, 1952.05.05, w; vic. Kabul,1952.09.18, w; **China:** Fukang (44.09N, 87.58E), 1991.08.13, w; **Azerbaijdshan:** E Caucasus (Ruszky), w; **Kazakhstan:** Aralocaspi region (Ruzsky, No.N2), w; Ferghana, Andishan, 1922.09.03, w; Lepsy River (45.61N, 79.40E), 2001.07.18 (samples No. 165 and 215), w; Lake Sassy Kol (46.42N, 80.35E), 2001.08.07 (samples No. 2, 6, 210, and 261), w, g, m; **Kyrghyztan:** Tshu River (42.45N, 75.50E), 2000.07.30 (samples No 91, 182, and 263), w; **Saudi Arabia:** Hofuf, 1983.04.03, w; **Turkestan:** Turkestan, Fedschenko, w; Turkestan, Kusnetzov, w; **Ukraine:** Black Sea Nature Reserve (46.14N, 31.55E), 1982.06.13, w; Black Sea Nature Reserve (46.14N, 31.55E), 1982.06.16, w.

Description: Worker (Fig. 14a, Tab. 6): Head of medium length (CL/CW 1.149), occipital margin slightly excavated. Postocular distance larger (PoOc/CL 0.410) and scape shorter (SL/CS 0.809) than in *C. elegans*. Clypeus smooth and shining, only with suggestion of microrugae. Very weak and fine rugulae restricted to frontal lobes and frontolateral area of head (genae). Vertex completely without carinulae or microrugae, in overall impression much more shining than in *C. elegans*, and with smaller foveolae, whose diameter is smaller than width of brilliantly shining interspaces (dFOV 13.8); internal foveolar surface finely microcorrugated and never bicoronate. Frontal carinae weakly converging immediately caudal of the FRS level. Dorsal promesonotum and propodeum glabrous. Promesonotum with scattered and shallow foveolae of 10 - 12 µm diameter. Outer spine base distance much lower than in other species (SPBA/CS 0.236). Petiole narrow (PEW/CW 0.292), its node in dorsal aspect slightly longer than wide. Postpetiole almost twice as wide as petiole and low (PEW/PPW 0.517, PPH/CS 0.279). Postpetiolar sternite with anteromedian portion significantly more bulging than anteroparamedian portion; in lateral view this anteromedian bulge forming small, obtusely-angled, rounded corner and changing into helcium with distinct angle. Colour of head, mesosoma, and gaster varying from pale yellowish brown to blackish brown. For morphometric data of 38 workers see Tab. 6.

Gyne (Tab. 15): Head of medium length, CL/CW 1.158, occipital margin straight or very weakly concave. Postocular distance smaller than in other species of the *C. bulgarica* group, PoOc/CL 0.398. Scape much shorter than in *C. elegans*, SL/CS 0.764. Vertex with shallow, but well demarcated foveolae, foveolar interspaces brilliantly shining, almost without microstructures, and about as wide or slightly wider than foveolar diameter. Vertex and clypeus almost without longitudinal microsculpture except for very weak longitudinal carinulae posterior of and on frontal lobes. Dorsal mesonotum and scutellum with foveolae of 8 - 11 µm diameter and shining interspaces, which are much wider than foveolar diameter. Spines rather long (SP/CS 0.205), their axes diverging in dorsofrontal view by 70° and their bases rather closely-set (SPBA/CS 0.318). Metapleurae with very weak longitudinal rugosity. Petiole narrower than in related species, its node in dorsal view little wider than long and brilliantly shining. Postpetiole node more than twice as wide as median length, with strongly concave anterodorsal margin, its sternite with conspicuous anteromedian corner. Rather concolourous medium brown with yellowish-reddish tinge. Two distinct morphs, microsomatic-brachypterous and macrosomatic-macropterous gynes, differ significantly in mesosoma dimensions and wing size but are equal in any other measurement. For morphometric data of 8 gynes see Tab. 15.

Comments: *Cardiocondyla ulianini* is a characteristic species that differs from the related species *C. elegans*, *C. bulgarica, C. persiana* sp.n., and *C. sahlbergi* in both workers and gynes by a much narrower petiole, a much lower SPBA/CS, and smaller vertex foveolae with wider and more shining interspaces. The lower PoOc/CL is an additional difference to *C. sahlbergi*, *C. bulgarica*, and *C. persiana* sp.n., the shorter scape and PLG provide further separation from *C. elegans*. For differences to *C. gallilaeica* sp.n.and *C. israelica* sp.n. see under those species.

Three worker paratypes of *Cardiocondyla sahlbergi*, labelled by Forel "C. elegans var. sahlbergi Forel, ♂ type, Caucase (Ruszky) / Aralokaspigebiet", from the Forel collection in MHN Genève definitely belong to another species than the lectotype gyne of *C. sahlbergi* and are undistinguishable from the types of *C. ulianini* in structure and morphometry. They might even belong to the *C. ulianini* type sample since both Emery and Forel received material from Ruzsky.

Marikovsky & Yakushkin (1974) described the biology of *Cardiocondyla ulianini* from SE Kazakhstan. The narrow petiole and approached spine base visible in their figures of worker and gyne as well as the sites (lowland semidesert along the middle and lower river Ili) give a high probability for a correct determination. The similar *C. littoralis* is much rarer in this region and the sympatric *C. sahlbergi* as the next similar species has a distinctly larger petiole width and spine base distance and is not known from this region. Most probably a misidentification, however, was their "male-like ergatoid gyne" found in a nest of "*C. ulianini*" near the locality Nikolayevka in the premountain semidesert of the Zailijsky Alatau (Marikovsky & Yakushkin 1974). First of all, they apparently followed Forel's, Emery's and Bernard's tradition of misidentifying an ergatoid male as a gyne. Secondly, this ergatoid male, depicted side by side with an ergatoid male of *C. ulianini*, most probably belongs to another species. Because of the larger petiole width and spine base distance this male probably belongs to *C. sahlbergi.*

My own studies of *C. ulianini* in Kyrghyztan and Kazakhstan confirmed the statements of Marikovsky & Yakushkin (1974) on habitats, behaviour, nest populations, and general biology with the exception that eclosion of alate gynes may occur already in the beginning of August.

10.4 *Cardiocondyla gallilaeica* sp.n

Type material: holotype worker labelled "ISRAEL Sedé Eliyyahu 6.ix.1983 Argaman", SMNG Görlitz.

Description: Worker (Fig. 13, Tab. 6): Similar to *C. ulianini*. Head rather short (CL/CW 1.131) and with notably excavated occipital margin. Postocular distance rather low (PoOc/CL 0.403) and eye rather large (EYE 0.254). Clypeus with straight anteromedian margin, glabrous. Frontal laminae almost smooth and shining, with only weak fragments of microcarinulae. Vertex completely without carinulae or microrugae, in overall impression much more shining than in *C. elegans*, and with smaller, less clearly demarcated foveolae, whose diameter is clearly smaller than width of brilliantly shining interspaces (dFOV 14); weak rugulae restricted to genae. Frontal carinae immediately caudal of FRS level almost parallel. Frons much narrower than in *C. ulianini*, FRS/CS 0.225. Dorsal area of mesosoma in overall impression smooth and shining; dorsal area of promesonotum with scattered and shallow foveolae of 10 - 12 µm diameter; dorsal area of propodeum with fragments of very fine microrugae. Caudolateral area of pronotum, mesonotum, mesopleuron, and metapleuron laterally, and propodeum below spiracular level reticulate. Pronotal corners more pronounced than in *C. ulianini*. Outer spine base distance small, SPBA/CS 0.230; spines sharp but much shorter than in *C. ulianini*, SP/CS 0.071. Metanotal depression rather deep (MGr/CS 3.75 %). Waist segments almost smooth and shining. Petiole very narrow (PEW/CS 0.275), its frontodorsal profile less concave and more directed caudad, petiole node in lateral aspect lower than in *C. ulianini*, node in dorsal aspect as long as wide. Postpetiole in dorsal aspect almost twice as wide as long, twice as wide as petiole (PEW/PPW 0.498), and with slightly concave anterior margin; postpetiolar sternite with shallow anteromedian bulge. Colour of head, mesosoma, and gaster pale yellowish brown to dark brown. Morphometric data of holotype: CS 480, CL/CW 1.131, SL/CS 0.807, PoOc/CL 0.403, EYE 0.254, dFOV 14.0, FRS/CS 0.225, SPBA/CS 0.230, SP/CS 0.071, PEW/CS 0.275, PPW/CS 0.552, PEH/CS 0.308, PPH/CS 0.298, PEW/PPW 0.498, sqrtPDG 4.66, PLG/CS 6.24 %, PigCap 8, PigMes 7, MGr/CS 3.75 %.

Comments: The closely approximated frontal carinae that do not converge immediately caudal of the FRS level, the less concave anterior petiole profile, the shorter spines, the more pronounced pronotal corners, and the more excavated occiput are the best differential characters to separate *Cardiocondyla gallilaeica* sp.n.from *C. ulianini* and *C. israelica* sp.n..

10.5 *Cardiocondyla israelica* sp.n

Type material: Worker **holotype** and 1 **paratype** worker,MCZ Cambridge,labelled "Tor (Sinai),25.2.35, W.Wittmer".1 worker **paratype** ,SMNG Görlitz,labelled "Neot Hakikar Israel,21.III.1980,leg.Kugler". 1 gyne **paratype** ,SMNG Görlitz,labelled "Ein Agrabim,Israel,22.III 1980,leg.Kugler". 5 worker **paratypes** ,SMNG Görlitz,labelled "EGYPT: 31.31. E, 30.56 N, Ebn Salam Mansora, salty soil, Tamarix & Phragmites, leg. Sharaf 2002.11.07" (samples No. 23, 27 and 28). The 6 type samples were morphometrically investigated.

Description: Worker (Fig. 12, Tab. 6): Occiput slightly excavated. Vertex foveolae relatively deep and well-demarcated, bicoronate, densely-packed, interspaces much smaller than foveolar diameter. Median area of vertex longitudinally carinulate-rugulose. Median area of clypeus smooth, its lateral portions weakly longitudinally carinulate. Dorsal area of promesonotum varying from almost smooth to longitudinally carinulate-rugulose. Lateral area of mesosoma and propodeum with well-developed microreticulum, metapleuron longitudinally carinulate-rugulose. Dorsal area of postpetiole and median area of petiolar node smooth, lateral area of petiole microreticulate. Spines rather thin and erected, spine axis in lateral view deviating 45° from longitudinal mesosomal axis; spine bases much approached, SPBA/CS 0.221. Metanotal groove deep but with shallow anterior and posterior slopes. Petiole very narrow, PEW/CS 0.285, its node as wide as long. Anteroventral petiolar dent reduced, in the Tor specimens entirely lacking, in the Neot Hakikar specimen reduced to shallow obtusely-angled (130°) protrusion. Postpetiolar sternite with weak anteromedian bulge. Anterior profile of petiole node relative to dorsal profile of peduncle steeper than in *C. sahlbergi* and *C. elegans*. Pubescence on gaster tergites relatively long and dense. Rather concolorous medium brown with yellowish tinge. For morphometric data of 2 workers see Tab. 6.

Gyne (Tab. 15): Rather large, CS 637. Head short, CL/CW 1.120. Postocular index relatively large, PoOc/CL 0.430. Sculpture stronger than in related species. Vertex sculpture in overall impression approaching the condition in *C. koshewnikovi*: deep, irregular, mostly bicoronate foveolae, whose lateral demarcations are supported by longitudinal rugosity. Frontal lobes, periphery of frontal triangle, and narrow median stripe of vertex longitudinally carinulate. Lateral area of pronotum, anepisternit, meso- and metapleuron with well-expressed longitudinal carinulae. Mesonotum longitudinally carinulate-rugulose; the interspaces with scattered foveolae. Propodeal spines rather thin and with low-level origin (base centre at 57 % of metapleural-scutellomesonotal height span). Petiolar and postpetiolar nodes entirely smooth. Petiole narrow, PEW/CS 0.406. Postpetiole with rather strong anteroventral process; in dorsal view, with slightly concave anterior margin. Petiole node 1.5x as wide as long. Whole body concolourous medium to dark brown. For morphometric data of 1 gyne see Tab. 15.

Comments: The holotype and paratype workers from Tor (Sinai), leg. W.Wittmer 1935.02.25 were formerly labelled as syntypes of *Cardiocondyla elegans* var. *torretassoi* FINZI, 1936. However, after lectotype fixation for *C. torretassoi* in the syntype series from Wadi Hoff, which definitely belongs to a separate species, this sample is available to serve as types of *C. israelica* sp.n. *Cardiocondyla israelica* is in overall morphometry similar to *C. ulianini* and *C. gallilaeica* sp.n. but can be separated in both workers and gynes by its much deeper, well-demarcated, and densely-packed vertex foveolae, the stronger longitudinal sculpture on head, and the longer tergite pubescence. Further diagnostic characters separating the gyne from *C. bulgarica, C. persiana* sp.n., and *C. sahlbergi* are the very low petiole ratios with PEW/CS 0.406, PEH/CS 0.406, PEW/PPW 0.568, and PEH/PPH 1.099.

10.6 *Cardiocondyla littoralis* sp.n.

Type material: holotype worker and 11 **paratype** workers, all labelled "KAZ: 46.41.57 N, 80.35.00 E, 358 m, W-Ufer des Sassy Kol, Lössboden, versalzt, hart, selten überschwemmt leg. Seifert 2001.08.07-1", SMN Görlitz. Five workers of the type series from Kazakhstan were morphometrically investigated.

Description: Worker (Fig. 14b, Tab. 6): Similar to *C. gallilaeica*. Head moderately elongated (CL/CW 1.167); occiput in dorsal aspect with evenly rounded corners, median third straight or weakly concave. Postocular distance much larger than in *C. gallilaeica* sp.n. (PoOc/CL 0.442). Eye rather large (EYE 0.249). Clypeus between level of the paramedian 1st order setae smooth, its anteromedian margin straight or weakly concave. Frontal laminae and small area posterior of them finely and densely longitudinally rugulose. Vertex completely without longitudinal microsculpture, in overall impression similar to situation in *C. ulianini*, but foveolae frequently bicoronate and with clearly defined circular margins, foveolar interspaces glabrous and on average narrower than foveolar diameter (dFOV 13 - 16). Anteromedian area of vertex glabrous. Frontal carinae immediately caudad from FRS level slightly converging, frontad incurving. Frons less narrow than in *C. gallilaeica*, FRS/CS 0.241. Dorsal area of mesosoma in overall impression shining; dorsal area of promesonotum with shallow foveolae of 9 - 16 µm diameter, interspaces clearly wider than foveolar diameter; dorsal area of propodeum shining but very finely microrugulose-reticulate. Caudolateral area of pronotum, ventrolateral area of mesonotum, mesopleuron, and propodeum below spiracular level reticulate. Metapleuron laterally with 2 - 4 curved longitudinal carinae. Outer spine base distance very small, SPBA/CS 0.223; spines sharp but on average shorter than in *C. ulianini*, SP/CS 0.087. Metanotal depression rather deep (MGr/CS 3.7 %). Waist segments almost smooth and shining. Petiole very narrow (PEW/CS 0.274), its frontodorsal profile less concave, more directed caudad, and the node lower than in *C. ulianini*; node in dorsal aspect as long as wide, tapering frontad. Postpetiole in dorsal aspect about 1.7x as wide as median length, less than 2 x as wide as petiole (PPW/PEW 1.825), and with strongly concave anterior margin; postpetiolar sternite with shallow anteromedian bulge. Colour of head, mesosoma, femora, and gaster dark brown; waist segments sometimes slightly lighter, with yellowish tinge. For morphometric data of 5 syntypes see Tab. 6.

Comments: The type specimens of *Cardiocondyla littoralis* were collected when foraging on the surface of a salty loess soil with very sparse vegetation near the margin of a lake in a semidesert. They clearly differed from the syntopic *C. uliniani* by much larger PoOc/CL, deviating vertex sculpture, larger PEW/PPW, lower petiole with less steep anterior slope, and by shorter spines. *Cardiocondyla littoralis* sp.n. is similar to the W Palaearctic *C. gallilaeica* sp.n. from which it differs by the much larger PoOc/CL and PEW/PPW, the more excavated dorsofrontal postpetiolar margin, the almost straight median third of occipital margin, and the less narrow frons with more curved frontal carinae.

10.7 *Cardiocondyla bulgarica* FOREL, 1892

Cardiocondyla elegans var. *bulgarica* FOREL, 1892; Bulgaria [types investigated].
Cardiocondyla elegans var. *eleonorae* FOREL, 1911; Turkey [types investigated], **syn.n.**

Investigated type material: *Cardiocondyla elegans* var. *bulgarica*: 4 **syntype** workers and 2 **syntype** gynes, labelled "C.elegans var. bulgarica Forel, 16 VIII, Anchialo (Bulgarien)", MHN Genève. 1 worker and 1 **syntype** gyne, labelled "Anchialo", NHM Wien. 5 **syntype** workers, labelled "Sozopolis 15 VIII, type bulgarica", NHM Basel.

C. elegans var.*eleonorae*: 4 **syntype** workers, labelled "C.e. var. eleonorae Forel, type, Plage de Cocarimali pr. Smyrne", MHN Genève.

Morphometrically investigated material (14 samples): **Bulgaria:** Anchialo,1891.08.16, w, g; Rozen - 2 km SW, 1985.08.27, w; Sozopolis,1891.08.15, w; **Greece:** Rhodos, 1933.07.30, w; **Macedonia:** Skopje: Katlanarska Banja, 1959.08.12, w. **Turkey:** Alanya - 5 km N, 1988.04.24, w; Antalya - 60 km W, Korkuteli - 15 km S, w; Aydan - 50 km NE, 1993.05.20, w; Bitlis - 10 km SW, 1993.06.14, No.1059, g; Bürdür, 1955.09.19, w, g; Denizli - 30 km SW, 1993.05.20, g; Isparta - 20 km S, 1988.04.28, w; Ödemis - 20 km SE, 1993.05.20, g; Smyrna: Cocarimali, w.

Description: Worker (Figs. 8, 9; Tab. 6): Head elongated, CL/CW 1.203. Postocular distance large, PoOc/CL 0.451. Eyes of medium size, EYE 0.241. Vertex with shallow but well-demarcated foveolae; interspaces about as wide as foveolae and glabrous. Frontal lobes and area posterior of frontal lobes finely longitudinally carinulate-rugulose. Frontal carinae immediately posterior of the FRS level almost parallel. Clypeus rather smooth, in some specimens with weak lateral carinulae and suggestions of foveolae. Mesosoma in overall impression, more or less glabrous; promesonotum with scattered, shallow foveolae; meso- and metapleurae with suggestions of longitudinal carinulae. Petiole wide, PEW/PPW 0.619. Postpetiolar sternite with weak anteromedian bulge. Head usually medium brown with warm yellowish tinge, sometimes dark brown. Mesosoma and petiole varying between yellow and medium brown, but warm yellowish tinge even in darkest specimens always visible. Postpetiole yellowish brown to dark brown. Gaster dark brown. Pigmentation contrast between dorsal head and mesosoma always expressed PigCap/PigMes 1.492 ± 0.250 [1.14, 2.00]. For morphometric data of 39 workers see Tab. 6.

Gyne (Fig. 16, Tab. 15): Head elongated, CL/CW 1.185. Postocular index large, PoOc/CL 0.444. Vertex with shallow but well-demarcated foveolae of 17 - 19 µm diameter, interspaces frequently smaller than foveolar diameter and shining, almost without microstructures. Frontal carinae immediately posterior of FRS level parallel or slightly diverging. Frontal lobes and vertex posterior of frontal lobes shining but weakly longitudinally carinulate-rugulose. Clypeus more or less smooth. Mesosoma in overall impression smooth and shining; mesonotum with scattered, praescutellum and scutellum with more numerous, shallow foveolae of 10 - 15 µm diameter and glabrous interspaces; lateral area of metapleuron longitudinally carinulate-rugulose. Petiole in profile with caudomediodorsal corner, wider than in related species: PEW/PPW 0.735. Postpetiole in dorsal view with deeply concave anterior margin, its sternite with conspicuous anteromedian corner. Head and postpetiole medium to dark brown. Mesosoma and petiole yellow to darker yellowish brown, warm yellowish tinge even in darkest specimens well-expressed. Gaster dark to blackish brown. Brightness contrast between dorsal head and lateral area of mesosoma notable, PigCap/PigMes 1.50 ± 0.25 [1.25, 2.00]. For morphometric data of 7 gynes see Tab. 15.

Comments: *Cardiocondyla bulgarica* seems to have a rather limited geographic range extending from the S Balkans across Asia Minor. The synonymy of *C. eleonorae* FOREL 1911 and *C. bulgarica* FOREL, 1892 is obvious. The type workers of *C. eleonorae* show all diagnostic characters of the *C. bulgarica* types in a "hypertypical" sense: very large CL/CW (1.231 ± 0.004), PoOc/CL (0.461 ± 0.004), and PEW/PPW (0.640 ± 0.009). They further show the *C. bulgarica*-type cephalic and mesosomal microsculpture and the warm yellowish mesosoma contrasting the darker head and gaster.

C. bulgarica is close to *sahlbergi* from which a perfect discrimination by the set of external characters considered here was not possible. Genetic evidence from mitochondrial DNA, however, indicates a heterospecifity of both taxa (Trindl and Heinze, pers. comm., October 2002). A tentative discrimination of the two species is possible by the head/mesosoma brightness contrast, the basic colour tinge, and several morphometric characters. There is almost no brightness contrast between head and mesosoma in *C. sahlbergi* with PigCap/PigMes 1.069 ±0.088 [1.00,1.43] but usually a clear contrast in *C. bulgarica* with PigCap/PigMes 1.492 ±0.250 [1.14,2.00]. The dirty brown basic tinge of mesosoma in *C. sahlbergi* differs from the warm yellowish-orange colour component usually (but not always !) seen in *C. bulgarica* . A discriminant score D(7) = +0.048 CL/CW +0.176 SL/CS

+0.94 EYE -0.126 PEH/CS +0.46 PEW/PPW -3.4 MGr/CS +0.53 sqrt(PigCap/PigMes) can separate 80 % of all worker nest sample means of *C. bulgarica* and *C. sahlbergi*. Samples with D(7) <1.09 can be considered as *C. sahlbergi* and such with D(7) > 1.14 as *C. bulgarica*.

10.8 *Cardiocondyla sahlbergi* FOREL, 1913

Cardiocondyla elegans var. *sahlbergi* FOREL, 1913; Palestine and Caucasus [type investigated].
Cardiocondyla bogdanovi, sensu RADCHENKO (1995) [misidentification, authentic material investigated].

Investigated type material: 1 **lectotype** gyne labelled "C.elegans var. sahlbergi Forel, ♀ type, Caucase (Ruszky)" and on a second label "Aralokaspigebiet", MHN Genève. If both labels are true, the terra typica should be the eastern Caucasus (present Azerbaijdzan).

Morphometrically investigated material (33 samples): **Armenia:** Metsamor, 1986.06.03, w; Khosrov Nature Reserve (n 225-86 Radchenko); 1986.06.14, w; **Azerbaijdshan:** Caucasus (probably E-Caucasus), g; **Georgia:** 41.47N, 44.46E, 1985.07.21, w; Diklo, 2000 m, 1985.08.02, w; Tbilissi, 1985.07.16, w; Tbilissi, 1985.07.20, w; Tbilissi, 1985.07.21, w; **Iran:** Maku, 39.08N,44.30E, 1973.06.23, w; 30.28N, 50.50E, 1974.05.20, g; Kangavar, 34.29N, 47.55E, 1974, g; Shiraz - 50 km W, 1997.09.21, No.27, w; **Israel:** Mikhmoret, 1980.11.25, g; Park ha Yarden, 1984.04.21 w, g; Park Canada, 1985.05.25, g; Palmahim, 1986.02.20, g; **Tunisia:** Medinine - 30 km S, 1973.06.11, w; **Turkestan:** Turkestan, "Cotyp" *ulianini* (Forel), w; Turkestan (Kuznetsov), w; **Turkey:** Aksaray - 50 km NW, 1993.06.02, w; Altunkent, 1986.07, w; Batman - 10 km N, 1993.06.14, No.1056, w; Hatay (Antiochia) – 40 N, 1900.05.15, w; Kars: Igdir, 1989.06.30, w; Kars: Igdir - 10 km SE, 1993.06.21(No 1110, 1111), w; Kayseri - 30 km SW, Incesu - 2 km NE, 1997.05.10, w; Konya: Eregli - 15 km NE, 1993.06.03, w; Konya: Karapinar, 1993.06.03, w; Ödemis - 20 km SE, 1993.05.20 w, g; Toros: Bürücek, 1947.07, w; Yalova (40.40N, 29.17E), 1989.06.23, w. **Uzbekistan:** Tashkent, 1922.06.17, w.

Description: Worker (Figs. 10, 69; Tab. 6): Head relatively long, CL/CW 1.189. Postocular distance large, PoOc/CL 0.446. Eyes of medium size, EYE 0.233 ± 0.006. Vertex with shallow, but well-demarcated, simple or bicoronate foveolae; interspaces usually narrower than foveolar diameter and glabrous, with only weak carinulae. Frontal lobes and area posterior of frontal lobes shining but weakly longitudinally carinulate-rugulose. Frontal carinae immediately posterior of FRS level frequently slightly converging sometimes parallel. Clypeus mainly smooth. Mesosoma in overall impression shining. Dorsal area of promesonotum foveolate, interspaces shining, wider than foveolar diameter, and with very weak cross-branched microcarinulae. Mesosoma laterally shining and with very weak microreticulum. Metapleurae with weak longitudinal rugosity. Postpetiolar sternite with weak anteromedian bulge. Head, mesosoma, and gaster usually concolorous dark brown; lighter-coloured specimens usually differing from *C. bulgarica* by dirty yellowish tinge and weak pigmentation contrast between dorsal head and mesosoma. PigCap/ PigMes 1.081 ± 0.096 [1.00, 1.43]. For morphometric data of 56 workers see Tab. 6.

Gyne (Fig. 15, Tab. 15): Head relatively long, CL/CW 1.172. Postocular index rather large, PoOc/CL 0.435. Vertex with well-demarcated, bicoronate foveolae of 17 - 18 µm diameter, interspaces smaller than foveolar diameter and shining, with weak cross-branched microstructures. Lateral and caudal area of clypeus, frontal lobes, and area posterior of frontal lobes longitudinally carinulate-rugulose. Mesonotum, praescutellum, and scutellum with well-developed foveolae of 18 - 20 µm diameter. Propodeum brilliantly shining. Lateral area of metapleuron longitudinally rugulose. Petiole with a caudomediodorsal corner. Postpetiole with conspicuous anteromedioventral corner, its anterior margin in dorsal view concave. 1st tergite pubescence in the type semierect (30 - 45°). Head, mesosoma, waist, and gaster rather concolourous medium brown. Morphometric date of lectotype: CL 646, ML 866, MW 454, CL/CW 1.172, SL/CS 0.753, PoOc/CL 0.439, dFOV 17, FRS/CS 0.277, SPBA/CS 0.361, SP/CS 0.175, PEW/CS 0.518, PPW/CS 0.754, PEW/PPW 0.687, PEH/CS 0.468, PPH/CS 0.358, sqrtPDG 3.59, PLG/CS 10.36 %, PigCap 10, PigMes 10. For morphometric data of 8 gynes see Tab. 15.

Comments: In his original description of *Cardiocondyla sahlbergi*, Forel explicitly referred only to a gyne from "Palestine (Sahlberg)" and a gyne from "Caucase (Ruzsky)". The first specimen could not be discovered during a search in the collections of Forel in Lausanne, Genève, and Basel but the latter gyne was found in the MHN Genève collection bearing the labelling "C.elegans var. sahlbergi Forel, type, Caucase (Ruszky)" and "Aralokaspigebiet". It was fixed by present designation as the lectotype of *Cardiocondyla sahlbergi*. A series of three workers, mounted on another pin, and with equal labelling is not conspecific with the lectotype. These workers are indistinguishable from the lecto- and paralectotypes of *C. ulianini*. They cannot be considered as syntypes of *C. sahlbergi* since the original description does not mention workers. The lectotype gyne of *C. sahlbergi* differs from the *C. ulianini* gyne by much stronger foveolae on head, mesosoma and waist, and much larger CL/CW, PoOc/CL, and PEW/CS (Tab. 15). Hence, *C. sahlbergi* cannot be considered as junior synonym of *C. ulianini*.

Cardiocondyla sahlbergi is so far not known from Europe. The known range extends from NW Asia Minor (29° E) east to Kazakhstan (77° E, Nikolayevka in the premountain semidesert of the Zailijsky Alatau) and from the Caucasus (43° N) south to Israel and Iran (29 °N). The very poor collecting activity in Egypt and Libya does not allow to conclude an isolated position of the sample from Tunisia (10° E, 33° N).

10.9 *Cardiocondyla persiana* sp.n

Type material: holotype worker labelled "IRAN, Fars 1997 (1), Shiraz, ca. 1570 m; 13.-22.9.; leg. Schödl", NHM Wien; 1 **paratype** worker with same labelling, SMN Görlitz. 6 worker **paratypes** labelled "IRAN, Fars 1997 (29), 80 km NW Shiraz, Chesmeh Bozghan, 2000 m; 22.9.; leg. Schödl", SMN Görlitz; 7 worker **paratypes** with same label NHM Wien. 3 worker **paratypes** labelled "IRAN, Fars 1997 (17), Bamoo NP, 7 km NE Shiraz, Chesmeh Mehrab, 1800 m; 18.9.; leg. Schödl", SMN Görlitz.

Morphometrically investigated material (6 samples): **Iran:** Shiraz, 1997.09, No.1, w; Shiraz - 12 km S, 1997.09.14, No.3, w, g; Shiraz - 7 km NE, 1997.09.18, No.17, w; Shiraz - 50 km N, 1997.09.19, No.24 w; Shiraz - 80 km NW, 1997.09.22, w; **Israel:** Ein Avdat, 1979.06.25, w.

Description: Worker (Fig. 11, Tab. 6): Head relatively short, CL/CW 1.158. Postocular index large, PoOc/CL 0.441. Eye relatively small, EYE 0.235. Pubescence length large, PLG/CS 6.83 ± 0.27 %. Vertex with densely-packed, well-demarcated foveolae with strong inner corona; interspaces much smaller than foveolar diameter. Median and paramedian clypeus and small stripe on median vertex smooth; lateral area of clypeus and frontal laminae usually shining and finely longitudinally carinulate. By more developed foveolae and carinulae mesosoma in overall impression less shining than in *C. sahlbergi* and *C. bulgarica*. Metanotal groove deep. Anterior margin of postpetiole in dorsal view concave. Petiole rather narrow, its node slightly wider than long. Postpetiolar sternite with weak anteromedian bulge. Dorsal head often bicoloured: anterior head back to level of antennal socket dirty yellowish, remaining vertex dark dirty brown. Mesosoma usually dirty yellowish brown to dirty brown. Waist, gaster, hind- and midfemora often blackish brown. This colour pattern typical, but not consistent throughout the population. For morphometric data of 19 workers see Tab. 6.

Gyne (Tab. 15): Head relatively short, CL/CW 1.161. Postocular index rather large, PoOc/CL 0.431. Vertex with densely packed, well-demarcated, clearly bicoronate foveolae of 18 - 19 µm diameter, interspaces much smaller than foveolar diameter. Lateral and caudal area of clypeus and frontal lobes longitudinally carinulate-rugulose. Mesonotum, praescutellum, and scutellum shining but with well-developed foveolae of 18 - 20 µm diameter. Propodeum shining. Lateral metapleuron longitudinally rugulose. Petiole with caudomediodorsal corner. Postpetiole with anteromedioventral corner, its anterior margin in dorsal view concave. Pubescence long and profuse, on first gaster tergite and postpetiole semierect (30 - 45°). Specimen showing a possibly diagnostic colour pattern: dorsal head posterior of antennal sockets dark yellowish brown, anterior of the antennal sockets light-yellowish brown; mesosoma and petiole yellowish brown; femora, postpetiole, and gaster dark to blackish brown. For morphometric data of 1 paratype gyne see Tab. 15.

Comments: *Cardiocondyla persiana* seems to be restricted to the Near East where it is a rather abundant species. The *C. persiana* worker differs from the heterogeneous *C. sahlbergi* and *C. bulgarica* cluster in particular by larger pubescence length, shorter head, and more developed microsculpture. *Cardiocondyla persiana* has larger, more strongly demarcated foveolae on vertex with a more pronounced inner corona and interspaces much narrower than foveolar diameter. The promesonotum usually shows in addition to the foveolae a fine longitudinal rugosity (that is in *C. sahlbergi* and *C. bulgarica* usually absent or weaker).

The separation of the gyne is probably more difficult (Tab. 15). Most similar is *C. sahlbergi* from which *C. persiana* can be separated by the larger maximum length of lateral prescutellar lobe and larger ML/CS. The maximum sagittal extension of the lateral prescutellar lobe is 10.9 % of ML in the *C. persiana* gyne and 8.54 - 9.51 % in 8 gynes of *C. sahlbergi*. The colour pattern is possibly diagnostic in discriminations against both *C. sahlbergi* and *C. bulgarica*.

10.10 *Cardiocondyla batesii* FOREL, 1894

Cardiocondyla batesii FOREL, 1894; Algeria [types investigated].

Investigated type material: 5 **syntype** workers labelled "C. Batesii, ♂ type, Perregaux Algerie 29 III", and 4 **syntype** gynes labelled "C. Batesii, ♀ type, Perregaux Algerie 29 III", both in MHN Genève.

Morphometrically investigated material (37 samples): **Algeria:** Perregaux, 1893.03.29, w, g; **Morocco:** Asni - 5 km S, 1995.05.07, No.386, g; Casablanca-20 km SE, 1995.05.05, g; Taza - 11 km N, 1995.05.15 (No. 660, 661), w; Rabat (Santschi), g; Rabat, 1985.04.20 w, g; **Portugal:** Lissabon, g; **Spain:** Almeria, 1996.07, w, g; Almeria: Parada, 1985.04.04, g; Almeria: Tabernas: Parada, 1988.10.30, w; Almeria: Tabernas, 1990.04.20 w, g; Pozuelo de Calatrava, w; Huesca: Sarinena, 1985.06.09 w, g; Mallorca: Puerto de Andrait, 1995.05.06 g; Guadalentin, 1996.07, w; Granada: Benalúa, 1985.05.16, w; Granada: Cenes de la Vega, 1979.04.26, g; Granada: Cenes de la Vega, 1979.04.30, w; Granada: Guadix, 1989.05.18, g; Granada: Guadix, 1989.09.25, w, g; Granada: Guadix, 2000.04, w, g; Granada: Guadix, 2000.04 (samples G7, G8, G9, G10, G16), g; Granada: Padul - 4.5 km WNW, 2001.04.18, w; Granada: Sierra Elvira, 2000.04, w, g; Granada: Sierra Elvira, 2000.04 (samples SE1, SE2, SE3, SE4, SE5, SE6, SE7, SE11), g;

Description: Worker (Fig. 17, Tab. 7): Head moderately elongated, CL/CW 1.177. Postocular index small, PoOc/CL 0.383. Occipital margin slightly concave. Eyes large, EYE 0.264. Frontal carinae slightly converging immediately posterior of FRS level. Dorsal head almost without longitudinal sculpture; weak longitudinal carinulae present on and posterior of frontal laminae. Vertex with very shallow and simple foveolae of 14 - 16 µm diameter; interspaces shining and much wider than foveolar diameter, with very fine microrugulae surrounding foveolae (Fig. 17). Mesosoma and petiole dorsally shining, but finely microreticulate. Meso- and metapleurae microreticulate-rugulose. Propodeal spines rather well-developed and with rather blunt tips. Petiole with characteristic profile: short peduncle, weakly concave anterior face, and ample node which caudal slope is much steeper than the anterior one. Petiole in dorsal view with elongated node that gradually merges with anterior peduncle. Postpetiolar sternite completely flat. Typical colour pattern bicoloured: dorsal head medium brown, mesosoma and waist light-orange brown, gaster dark brown. This distinct colour contrast is lost in rare specimens with darker brown mesosoma. For morphometric data of 36 workers see Tab. 7.

Gyne (Fig. 27, Tab. 16): Head relatively short, CL/CW 1.165. Postocular index small, PoOc/CL 0.386. Occipital margin slightly concave. Head dorsally almost without longitudinal sculpture; weak longitudinal carinulae present on and posterior of frontal laminae and on lateral area of clypeus. Vertex with very shallow and simple foveolae of 14 - 16 µm diameter; interspaces much wider than foveolar diameter, shining, with fine microstructures as in worker. Dorsal area of mesosoma foveolate, interspaces between foveolae shining, wider than foveolar diameter; Mesosoma laterally shining, finely reticulate-carinulate. Propodeal spines rather strong. Petiole profile with short peduncle, weakly concave anterior face, and node produced caudad. Petiole node in dorsal view slightly longer than wide and gradually merging with anterior peduncle. Postpetiolar sternite without any flat bulge. Dorsal area of head dark brown; mesosoma and waist usually light-orange brown, occasionally dark brown; gaster blackish brown. For morphometric data of 30 gynes see Tab. 16.

Comments: The *C. batesii* species complex forms a cluster of the similar taxa *C. batesii*, *C. semirubra* sp.n., and *C. kushanica* which are represented by specimens from remote geographic regions making a sympatry test impossible. The geographic sequence begins with *C. batesii* in S Iberia, the Balearics, and N Africa, is followed by *C. semirubra* sp.n. in Asia Minor, and is continued by *C. kushanica* in Afghanistan. Non-overlapping morphometric data and structural differences provide arguments to treat these taxa as different parapatric or allopatric species (Tab. 7).

10.11 *Cardiocondyla semirubra* sp.n.

Type material: holotype worker and 2 **paratype** workers labelled "TURKEY: Sanliurfa 20 km S Steppe, 500 m, leg. A.Schulz 1993.06.12, No 1036" and 1 **paratype** worker labelled "TURKEY: Sanliurfa 25 km E, Camlidere, Steppe, 500 m, leg. A.Schulz 1993.06.13, No 1045", all in SMN Görlitz. The two type samples from Turkey were morphometrically investigated.

Description: Worker (Figs. 18, 70; Tab. 7): Head moderately long, CL/CW 1.168. Postocular index very small, PoOc/CL 0.374. Occipital margin slightly concave. Scape short, SL/CS 0.782. Eyes relatively large, EYE 0.256. Frontal carinae immediately posterior of FRS level slightly converging. Lateral and paramedian area of clypeus, frontal laminae, and area posterior of frontal laminae finely longitudinally carinulate. A small stripe on median area of vertex often glabrous. Foveolae on vertex shallow, with weak inner corona and 16 - 19 µm diameter; interspaces shining, slightly wider than foveolar diameter, and with fine, scattered, simple or cross-branched carinulae. Mesosoma moderately shining, finely microreticulate. Median area of promesonotum finely longitudinally carinulate-rugulose. Lateral area of meso- and metapleuron finely longitudinally carinulate-rugulose. Metanotal furrow rather deep. Petiole profile with short anterior peduncle, ample node and, compared to *C. batesii*, with more concave anterior face and node not produced caudad. Petiole node in dorsal view gradually merging with a rather short anterior peduncle; much wider than in related species (PEW/CS 0.322). Postpetiolar sternite without any flat bulge. Dorsal head, gaster, coxae, femora, and tibiae dark to blackish brown; mesosoma and petiole reddish brown; postpetiole, scape, and antennal club dark brown. For morphometric data of four type workers see Tab. 7.

Comments: The *C. semirubra* worker differs from *C. batesii, C. kushanica,* and *C. bicoronata* sp.n. in particular by its unusually massive petiole that is almost as wide as high. *C. semirubra* differs from *C. brachyceps* by longer head, shorter scape, much smaller PLG, much shorter petiolar peduncle, and characteristic colour pattern.

10.12 *Cardiocondyla kushanica* PISARSKI, 1967

Cardiocondyla kushanica PISARSKI, 1967; Afghanistan: Darountah [types investigated].

Morphometrically investigated type material: worker **holotype**, 1 worker **paratype**, 5 gyne **paratypes**, all labelled "Afghanistan: Darountah, A 231 (Djelalabad), 4 et 24.1.1958, leg. K.Lindberg" (ZM Lund and SMN Görlitz)

Description: Worker (Fig. 19, Tab. 7): Head of medium length, CL/CW 1.162. Postocular distance small, PoOc/CL 0.373. Occipital margin slightly excavated. Frontal carinae immediately posterior of FRS level converging. Clypeus on whole surface longitudinally carinulate, anteriorly 5 - 6 stronger carinulae, posteriorly 6 - 7 finer carinulae. Paramedian area of vertex with irregular, bicoronate foveolae of 16 - 17 µm diameter; interspaces with perifoveolar rugae or with cross-branched carinulae which are significantly stronger than in *C. batesii* and *C. nigra* - as a consequence overall surface impression less shining. Mesosoma finely and irregularly rugulose-reticulate; similar but finer structures on petiole. Dorsum of postpetiole in overall impression smooth and shining, but clearly microreticulate. Lateral areas of meso- and metapleurae longitudinally rugulose. Spines steeper and more acute than in *C. semirubra* sp.n. and *C. batesii,* their angle diverging by 55 - 60° from longitudinal axis of mesosoma. Petiole node in dorsal aspect much longer than wide. Postpetiolar sternite completely flat. Head blackish brown; mesosoma and petiole reddish brown; postpetiole and gaster brown. For morphometric data of the two type workers see Tab. 7.

Gyne (Fig. 29, Tab. 16): Head elongated, CL/CW 1.194, with slightly excavated occipital margin. Postocular distance small, PoOc/CL 0.386. Paramedian area of vertex with rather deep, closely-set, bicoronate foveolae; the rugulose interspaces clearly smaller than foveolar diameter. Whole mesosoma more sculptured than in *C. nigra* and *C. batesii*; pronotum in addition to foveolae with transverse rugosity; meso- and metapleurae with longitudinal rugosity. Pronotal corners more developed than in *nigra*. Propodeal spines more acute and steeper than in *C. nigra* and *C. batesii*. Petiole node in lateral view roughly quadrate and not produced caudad as in *C. batesii*, dorsal peduncle profile and anterior node profile forming a distinct angle. Postpetiole almost twice as wide as petiole. Head blackish brown with reddish tinge. Mesosoma and petiole light-reddish brown. Postpetiole dark reddish brown. Gaster blackish brown. Type gynes are brachypterous, unable to fly, length of forewing only 1200 µm. For morphometric data of five paratype gynes see Tab. 16.

Comments: Low postocular distance, big eyes, and shape of waist segments indicate an allocation of *C. kushanica* to the *C. batesii* group. The gynes differ from both *C. nigra* and *C. batesii* in particular by head sculpture. On paramedian vertex, the *C. kushanica* gynes show rather deep, closely-set, and bicoronate foveolae; the interspaces are clearly smaller than the foveolar diameter and rugulose. The type gynes of *C. batesii* and *C. nigra* show rather shallow foveolae; the interspaces are at least as wide as the foveolar diameter, brilliantly shining, and with very delicate cross-branched microstructures. Based upon the data given in Tab. 16, each *C. kushanica* gyne can be separated from any gyne of *C. batesii*, *C. nigra* or *C. bicoronata* sp.n. by discriminant functions using 3 to 5 characters the reliability of which, however, remains to be tested in larger material.

The two available *C. kushanica* workers differ from those of *C. batesii* by lower PoOc/CL, PEH/CS, and MGr/CS, larger PLG, and more erect and acute spines. The only significant differences to *C. nigra* and *C. bicoronata* sp.n. seem to be the larger PPW/CS and PLG and the deviating head sculpture.

10.13 *Cardiocondyla nigra* Forel, 1905

Cardiocondyla batesii var. *nigra* Forel, 1905; Tunisia [types investigated].
Cardiocondyla elegans var. *torretassoi* Finzi, 1936; Egypt [types investigated], **syn.n.**

Investigated type material: *Cardiocondyla nigra*: 5 **syntype** workers and 5 **syntype** gynes labelled "C. Batesii For. var. nigra, Kairouan (Santschi) 159", MHN Genève.

C. elegans var. *torretassoi*: **lectotype** worker (by present designation) and 3 **paralectotype** workers, labelled "Wadi Hoff.Eg., 8.3.33, C.Koch " and "MCZ Cotype 28812", MCZ Cambridge.

Morphometrically investigated material (23 samples): **Algeria:** Biskra, 1934.11 (Dr. Normand), w; **Cape Verde:** Sao Vincente, 200 m, 1978.12.17, w; **Cyprus:** Limassol - 10 km N, 1999.05.15, w; Limassol - 30 km E, 1999.05, w; **Egypt:** Wadi Hoff, 1933.03.08, w; Sinai: Bir Gafgafa - 3 km E, 1968.04.26, w; **Morocco:** Taliouine - 30 km E, 1995.05.01, w; Rabat, 1985.04.20, w; **Portugal:** Montemor, 1996.08, w; **Tunisia:** Dahar: Chenini - 10 km E, 1993.03.04, w; Kairouan (Santschi), w, g; Kairouan, 1904.02.23 g; Medinine - 30 km S, 1973.06.02, w; Neffa - 4 km E, Djerid, 1993.03.13, w; Bahren, 1919.03.08, w; Cheri Chera, 1922.04.16, w; Lac Kelbia, 1935.03.30, w, g; Tunisia, coll. G. Mayr w, g; Tunisia, coll. Forel g; Tunis, coll. G. Mayr, w; Tunis: Sbeitla, 1997.06.07, w; **Turkey:** Sanliurfa - 45 km SE, 1993.06.11, w.

Description: Worker (Fig. 20, Tab. 8): Head of medium length, CL/CW 1.172. Postocular distance very small, PoOc/CL 0.366. Occipital margin slightly excavated. Eyes large, EYE 0.266. Frontal carinae immediately posterior of FRS level converging. Lateral clypeus longitudinally carinulate. Dorsal area of head almost without longitudinal sculpture; weak longitudinal carinulae present on and posterior of frontal laminae. Vertex with very shallow and simple foveolae of 14 - 19 µm diameter, their internal surface micro-corrugated; foveolar interspaces wider than foveolar diameter, moderately shining, and with fine cross-branched or semi-reticulate microstructures (Fig. 20). Dorsum of mesosoma and waist moderately shining and finely microreticulate. Propodeal spines rather short, steep, and acute. Petiole profile with relatively long peduncle and relatively small node, which is in dorsal view about as long as wide. Postpetiolar sternite without any flat bulge. Whole body usually concolorous dark to blackish brown, specimens with distinctly lighter mesosoma occasionally occur. For morphometric data of 44 workers see Tab. 8.

Gyne (Fig. 28, Tab. 16): Head of medium length, CL/CW 1.170. Postocular index very small, PoOc/CL 0.376. Occipital margin straight or weakly concave. Dorsal area of head almost without longitudinal sculpture; very weak longitudinal carinulae present on and posterior of frontal laminae. Vertex with very shallow and simple foveolae of 16 - 18 µm diameter; interspaces as wide as foveolar diameter, shining, with fine cross-branched microstructures. Dorsal area of mesosoma foveolate; interspaces between foveolae shining, wider than foveolar diameter and with fine cross-branched microstructures. Lateral area of mesosoma shining, finely reticulate-carinulate, lateral metapleuron longitudinally rugulose. Propodeal spines rather short. Petiole node in dorsal view as wide as long, usually circular; dorsal and lateral petiole shape frequently as depicted for the type of *C. nigra* (Fig. 28), but conditions similar to that of the *C. batesii* type (Fig. 27) do occur. Whole body concolorous dark brown. Gynes from Tunisia: Lac Kelbia-1935.03 brachypterous, with forewing length 1350 - 1400 µm. For morphometric data of 11 gynes see Tab. 16.

Comments: The syntype series of *Cardiocondyla elegans* var. *torretassoi* stored in MCZ Cambridge / Mass. consists of two different species. Only the four workers from Wadi Hoff, 1933.03.08, match the original description of Finzi: the whole body is entirely blackish and the dorsal aspect of the propodeum with less closely approximated spine bases corresponds to Finzi's figure. From this series the lectotype of C. *torretassoi* was selected. These four workers have the following morphometric data: CL 601 ± 9, CL/CW 1.208 ± 0.016, SL/CS 0.835 ± 0.006, PoOc/CL 0.372 ± 0.005, EYE 0.261 ± 0.005, dFOV 16.5 ± 0.6, SP/CS 0.100 ± 0.007, PEW/CS 0.272 ± 0.013, PPW/CS 0.509 ± 0.012, PEH/CS 0.307 ± 0.010, PPH/CS 0.264 ± 0.008, PEW/PPW 0.535 ± 0.025, sqrtPDG 5.02 ± 0.25, PLG/CS 5.52 ± 0.40 %, PigCap 10.0 ± 1.4, PigMes 10.2 ± 1.5, MGr/CS 3.75 ± 0.90 % - i.e. these specimens are not different from the W Palaearctic population of *Cardiocondyla nigra* FOREL in 15 of 17 characters with $p < 0.05$. No further differences are detectable in microsculpture and shape of head, mesosoma, and waist structures. The only significant deviation from the *C. nigra* standard is found in the much larger CL/CW and SL/CS ($p < 0.002$).

A discriminant score D(6) = - 0.228 SL/CS + 3.88 SP/CS + 0.93 PPW/CS + 2.78 PEH/CS + 2.27 PPH/CS + 1.03 PoOc/CL separates all individual workers of *C. nigra* with D(6) 2.457 ± 0.073 [2.28, 2.58] (n = 44) and of *C. batesii* with D(6) 2.727 ± 0.056 [2.62, 2.82) (n = 36). *Cardiocondyla nigra* additionally differs from *C. batesii* by the steeper, more acute, and in lateral view more narrow based spines and the lower SPBA/CS with 0.257 ± 0.009 [0.242, 0.271] in *C. batesii* and 0.231 ± 0.013 [0.199, 0.257] in *nigra*. The pigmentation contrast between head and mesosoma is significantly larger in *C. batesii,* but is no reliable discriminator because of the occasional occurrence of homogeneously dark specimens.

10.14 *Cardiocondyla bicoronata* sp.n.

Type material: holotype worker, 2 **paratype** workers, 1 **paratype** gyne labelled "JORDANIA: 1996.03.21, Shaumari Wildlife Reserve, 31.47N 36.42E, leg. Dietrich No 5" and 3 worker **paratypes** labelled "JORDANIA: 1996.03.21, Shaumari Wildlife Reserve, 31.47N 36.42E, leg. Dietrich No 6"; SMN Goerlitz. 5 **paratype** gynes labelled "JORDANIA: 1996.03.21, Shaumari Wildlife Reserve, 31.47N 36.42E, leg. Dietrich No 6"; NHM Wien.

Morphometrically investigated material (24 samples): **Israel:** Khear Jerocham, 1984.04, w; Ein Evrona, 1975.06.20, w; Khan Yunis, 1942.03.05, g; Mikhmoret, 1980.10.21, g; Bet Shemesh, 1981.04.25, w; Ein Hashofet, 1982.06.14, g; Sussita, 1982.04.15, w; Eilat, 1985.05.23, g; Tel Aviv, 1984.04.21, w, g; W Dishon, 1984.05.08, g; Bet Dagan, 1985.12.02, w; Bet Dagan, 1985.12.25, g; Bet Shea'an, 1989.11.05 w, g; **Jordan:** Abyad, (31.06N, 36.01E), 1996.10.31, w; Maan (30.11N, 36.01E), 1996.10.23, w; Quasr Burqu, 1996.03.23 w, g; Safawi (32.09N, 37.07E), 1996.11.05, w; Shaumari Reserve, 1996.03.17, w; Shaumari Reserve, 1996.03.21 (samples No.5,6), w, g; Shaumari Reserve, 1998.04.17 w, g; **Turkestan:** Turkestan, coll. G. Mayr, w; **United Arab Emirates:** Alain, Zoo, 1996, g; **Yemen:** Sana'a, 1995.03, w.

Description: Worker (Figs. 21, 22; Tab. 8): Head moderately elongated, CL/CW 1.171. Postocular index very small, PoOc/CL 0.365. Occipital margin slightly concave. Scape rather long, SL/CS 0.812. Eyes large, EYE 0.261. Frontal carinae immediately posterior of FRS level slightly converging. Dorsum of head with fine longitudinal microsculpture on median and paramedian areas of vertex. Small median stripe frequently smooth. Vertex with shallow, but well-demarcated and usually bicoronate foveolae of 17 - 19 µm diameter; interspaces shining, about as wide as foveolar diameter and with reduced microrugulae (Fig. 21). Mesosoma moderately shining, finely microreticulate-carinulate; dorsal area of promesonotum with shallow foveolae; lateral area of metapleuron with relatively strong longitudinal rugosity. Propodeal spines acute and rather steep. Petiole profile with a short anterior peduncle, an ample node that is weakly produced caudad and, compared to *C. batesii*, usually with more concave anterior face. Petiole in dorsal view with elongated node, which more or less gradually merges with anterior peduncle. Postpetiolar sternite without any flat bulge. Colour polymorphism. Most frequent colour pattern in the Near East: dorsal head and gaster blackish brown; mesosoma and petiole reddish brown; postpetiole, coxae, femora and tibiae dark brown. Concolorous blackish brown (most similar in general appearance to *C. nigra*!) or concolorous dirty yellowish brown samples (those from Turkestan) may occur. For morphometric data of 29 workers see Tab. 8.

Gyne (Tab. 16): Head moderately elongated, CL/CW 1.178. Postocular index small, PoOc/CL 0.374. Occipital margin slightly concave. Scape long SL/CS 0.786. Lateral clypeus, frontal laminae, and paramedian area of vertex longitudinally carinulate-rugulose; small median stripe of vertex usually glabrous. Vertex with well-demarcated, bicoronate foveolae of 19 µm diameter; interspaces narrower than foveolar diameter and with fine microcarinulae. Pronotum, mesonotum, and praescutellum rather deeply foveolate-carinulate-rugulose. Scutellum with few long rugae. Anepisternite weakly and lateral metapleuron strongly longitudinally rugulose. Propodeal spines shorter and more acute than in *C. batesii*. Petiole shape similar to situation in the type of *C. nigra*: in dorsal view with globular node and long and distinct anterior peduncle. Occiput, mesosoma, waist, and gaster with rough pubescence erected at 30 - 45°. Head and gaster dark brown. Mesonotum frequently blackish brown, then with contrasting, lighter brown, V-shaped area; mesonotum less frequently concolorous light-brown; remaining mesosoma and petiole usually light-brown. Darker, rather concolorous specimens may occur, but contrasting V-pattern on mesonotum often visible. Gynes from Israel: Mikhmoret-1980.10.21 and UAE: Alain Zoo-1996 brachypterous, unable to fly, length of forewing 1300 µm, 1220 µm. For morphometric data of 20 gynes see Tab. 16.

Comments: *Cardiocondyla bicoronata* is morphometrically almost identical with *C. nigra* and is considered here as a parapatric sibling species. Structural differences in the workers are the well-demarcated, usually bicoronate foveolae on paramedian vertex (in *C. nigra* the foveolae have diffuse margins and a microcorrugated inner surface) and the more rough pubescence on head, mesosoma, waist, and gaster.

Cardiocondyla bicoronata workers differ from those of *C. kushanica* by regularly circular, bicoronate foveolae on paramedian vertex and wider and more shining interspaces that have few fine, sometimes furcate carinulae (Fig. 21). There is a relative structural contrast between the densely longitudinally carinulate paramedian vertex and the more shining foveolate lateral vertex. In *C. kushanica,* the whole vertex appears more homogenous and more mat. Further differences to *C. kushanica* are the much smaller SL/CS, PPW/CS, PPH/CS, and PLG/CS as well as the smaller EYE.

The *C. bicoronata* worker differs from *C. batesii* by significantly smaller PEH/CS, PPH/CS, PPW/CS, and PoOC/CL (Tabs. 7, 8), by significantly larger, more clearly demarcated, and bicoronate vertex foveolae, by the presence of a fine longitudinal microsculpture on paramedian area of vertex and on frontal lobes, by stronger longitudinal rugosity on meso- and metapleuron (*C. batesii* is on the pleurae more microreticulate than rugulose), and by the petiolar node less produced caudad.

The *C. bicoronata* gynes differ from *C. batesii, C. kushanica* and *C. nigra* by the well-demarcated, dense, and bicoronate vertex foveolae, by the paramedian area of vertex densely and clearly longitudinally carinulate, by the longitudinally carinulate-rugulose mesonotum and scutellum, and by strongly rugulose lateral metapleuron. A discriminant score D(7) = - 0.57 SL/CS + 0.64 PoOc - 0.03 dFov + 1.42 SP/CS + 1.65 PPH/CS - 0.025 sqPDG + 1.3 PLG/CS + 1.0 separates all gynes of *C. bicoronata* with D(7) 0.914 ± 0.044 [0.82, 1.00] (n = 20) and of *C. batesii* with D(7) 1.083 ± 0.029 [1.03, 1.16] (n = 30).

10.15 *Cardiocondyla tenuifrons* sp.n

Type material: holotype worker and 2 worker **paratypes** labelled "JORDANIA: Abdallah zw. Shobek und Wadi Musa, 1996.03.30, No 1, leg. Chr. Dietrich", SMN Görlitz. The type sample was morphometrically investigated.

Description: Worker (Fig. 24, Tab. 8): Head elongated, CL/CW 1.205. Postocular distance larger than in related species, PoOc/CL 0.413. Occipital margin straight. Eyes large, EYE 0.267. Foveolae on vertex shallow, simple, of 13 - 15 µm diameter; interspaces shining, wider than foveolar diameter, with fine cross-branched to semireticulate microstructures. Frontal lobes, area posterior of frontal carinae, and clypeus finely longitudinally carinulate. Frontal lobes strongly converging immediately caudal of FRS level, FL/FR (see comments) 1.177 ± 0.023 [1.151, 1.192]. Dorsal mesosoma shining, with shallow foveolae and fine cross-branched microstructures. Ventrolateral area of mesosoma with well-developed microreticulum, metapleuron with clearly visible longitudinal sculpture. Metanotal groove very shallow. Spines steep, very short and acute. Petiole node wedge-shaped in caudal view, in lateral aspect similar to *C. nigra*. Postpetiole in dorsal view with straight anterior margin, roughly trapezoidal (in Fig. 24 slightly tilted, thus exposing an anterior excavation). Postpetiolar sternite without any flat bulge. Head and gaster blackish brown. Mesosoma and waist medium to dark brown, with yellowish-red component. For morphometric data of 3 workers see Tab. 8.

Comments: Big eye size and low postocular index allocate this species to the *C. batesii* group. *Cardiocondyla tenuifrons* can be separated from any species by its frontal carinae strongly converging caudad. The ratio FL/FR (measured as in *Myrmica*, see SEIFERT 1988) is lower than 1.12 in any sympatric species known but is 1.15 - 1.19 in *C. tenuifrons*. The most similar species in overall character combination is *C. nigra* but the latter has less converging frontal carinae, a smaller postocular index, and lower PEH/CS and PPH/CS.

10.16 *Cardiocondyla rugulosa* sp.n.

Type material: holotype worker labelled "Yemen, Sana'a, 1991.05, leg. A.van Harten", SMN Görlitz.

Description: Worker (Fig. 25, Tab. 8): Scape rather short, SL/CS 0.789. Postocular distance smaller than in related species, PoOc/CL 0.344. Occipital margin notably excavated. Eyes large, EYE 0.267. Clypeus and frontal laminae finely longitudinally rugulose. Frontal carinae immediately posterior of FRS level parallel. Whole vertex densely and finely longitudinally rugulose. Foveolae of 14 - 18 µm diameter present on paramedian vertex, barely visible and embedded within rugulae (Fig. 25). Dorsal area of promesonotum with scattered foveolae, and weakly microreticulate between superimposed longitudinal rugulae. Propodeum and petiole irregularly microreticulate. Postpetiole more shining, with very delicate microreticulum. Pronotum laterally moderately shining and microreticulate. Lateral areas of mesonotum and mesopleuron reticulate and longitudinally rugulose. Metapleuron laterally with 5 - 7 weak, longitudinal carinae. Metanotal groove rather shallow. Spines steep, short and acute. Petiole node in dorsal and lateral aspect similar to *C. batesii* but more massive. Postpetiolar sternite without any flat bulge. Head, gaster, femora, and tibiae dark brown to blackish brown. Mesosoma and postpetiole dark brown with reddish component. Petiole light-orange brown. For morphometric data of the holotype see Tab. 8.

Comments: *Cardiocondyla rugulosa* is morphometrically similar to *C. nigra*. The highly diagnostic character of *C. rugulosa* is the presence of strongly developed longitudinal rugulae or carinulae on the vertex, which are much denser than in any related species. By the much denser and stronger sculpture the surface of head, mesosoma and petiole appears mat. The shallower metanotal groove and the more massive waist segments (with larger PEH/CS, PPH/CS, and PP/CS) provide additional criteria for separation from *C. nigra*.

10.17 *Cardiocondyla opistopsis* sp.n.

Type material: holotype and 1 **paratype** worker labelled "KUWAIT: Burgan, 1988 W.Büttiker" and 3 worker **paratypes** labelled "KUWAIT: 1985", all in SMN Görlitz.

The 2 samples from Kuwait were morphometrically investigated.

Description: Worker (Fig. 26, Tab. 8): Scape rather long, SL/CS 0.825. Postocular index below range of any other species considered here, PoOc/CL 0.316. Occipital margin rather straight or weakly concave. Eyes very large, EYE 0.280. Clypeus rather smooth, with 4 - 5 weak longitudinal carinulae. Frontal laminae rather smooth, very delicately microreticulate-carinulate. Frontal carinae converging caudad. Dorsal extension of scape joint capsule in dorsal aspect clearly surpassing frontal carinae laterad. A small median stripe on vertex perfectly smooth, paramedian area of vertex only in anterior part weakly longitudinally microcarinulate. Vertex with numerous bicoronate foveolae of 17 - 19 µm diameter; foveolar interspaces about as wide as foveolar diameter, glabrous, with scattered fragments of fine cross-branched structures or microcarinulae. Despite of microsculpture, all parts of mesosoma and waist appearing in overall impression rather shining. Dorsal area of promesonotum irregularly microreticulate-carinulate, with scattered suggestions of foveolae. Propodeum and petiole microreticulate; postpetiole more shining, with very delicate microreticulum. Whole lateral area of mesosoma reticulate, but moderately shining. Region of metapleural gland bulla with 2 - 4 short and weak longitudinal carinae. Metanotal depression shallow. Spines reduced to short and sharp dents. Petiole with distinct peduncle and low node, which is in dorsal aspect as wide as long and almost circular. Postpetiolar sternite without any flat bulge. Whole body dark to blackish brown, mesosoma occasionally lighter. For morphometric data of four type workers see Tab. 8.

Comments: By the unique character combination of the extremely low postocular index, the very large eyes, the very low petiole node, and the narrow postpetiole, *C. opistopsis* is not to be confused with any other species dealt with here.

10.18 *Cardiocondyla nuda* (MAYR, 1866)

Leptothorax nudus MAYR, 1866; Fiji Islands: Ovalau [type investigated].

Investigated type material: lectotype worker (by present designation) labelled "Ovalau, Godeff.", "2768 ov" and "nuda G.Mayr, Type", NHM Wien.

Morphometrically investigated material (27 samples): **Australia:** Queensland: Cairns distr., w; Queensland: Cardwell, Kirrama Range, 1957.12, w; Queensland: Kuranda, Barron River, 1950.11.01, w; Queensland: Moggil, 1951.05.17 w, g; New South Wales: Barham, 1960.03.23 w, g; New South Wales: Bulli, 1915.05 w, g; W Australia: Gayamin Pool, lower Chittering,1955.02.19, w; **New Guinea:** Rawlinson Mts. (6.28 S,146.06 E), g; Seleo, Berlinhafen (Birò), 1896, w; Okapa-15 km NW, Moife, No.5910, w; Huon Peninsula: lower Busu River, 1955.12.05, w; **Polynesia:** Fiji: Ovalau, godeff., No.2768, w; Fiji: Saiaro, W.M. Mann, w; Fiji: Viti Levu, 1976.04.17, w; New Hebrides: Aneityum, 1930.09, w; Samoa: Upolu (Godeffroy), w; Samoa: Upolu, Alagaogao, 1962.03.19, w; Samoa: Upolu, Le Mafa, 1962.03.30 w, g; Samoa: Tutuila: Pago Pago, 1923.01.10, w; Samoa: Tutuila: Pago Pago, 1923.04.09, w; Samoa: Tutuila: Fagatogo, 1940.08.28, g; Solomon Isl.: Honiara, 1954.06.16, w; Tonga Tabu (Godeffroy), w; Wallis Isl.: Uvea, Matu-Utu,1965.02, w; Wallis Isl.: Futuna: Nuku Tapu, 1965.03/04, w; Wallis Isl.: Futuna: Mt. Puke,1965.03.09, w; Wallis Isl.: Nuku Hifala, 1965.03.30, w.

Description: Worker (Fig. 30, Tab. 9): Small size, CS 468. Head elongated, CL/CW 1.224. Postocular head parallel-sided and very long, PoOc/CL 0.469. Scape of medium length, SL/CW 0.802. Occipital margin straight or slightly concave. Frontal laminae converging immediately caudal of FRS level, FL/FR in lectotype 1.095. Eyes relatively small, EYE 0.233. Foveolae on vertex in dense honey-comb arrangement, deeply impressed, with 17 - 20 µm diameter, and usually with inner corona. Frontal laminae and clypeus with few longitudinal rugulae. Whole mesosoma and lateral petiole with strong microreticulum having mesh diameters of 5 - 13 µm (smallest on petiole sides). Metanotal groove more or less shallow. Spines longer and more erect than in *C. mauri-*

tanica and rather acute. Postpetiole in dorsal view usually with angulate-convex sides and roughly hexagonal; sides sometimes simply convex, without angular component; bulging postpetiolar sternite resulting in large PPH that is frequently larger than PEH, PEH/PPH 1.009 ± 0.026 [0.964, 1.060]. Surface of first gaster tergite shining and with very delicate microreticulum. Whole head and mesosoma of type specimen concolorous dark brown, gaster blackish brown. Lighter specimens with yellowish brown mesosomas and medium brown heads frequently occur throughout the Pacific region. For morphometric data of 34 workers see Tab. 9.

Gyne (Tab. 17): Rather small, CS 521. Head much elongated, CL/CW 1.203. Postocular head parallel-sided and very long, PoOc/CL 0.458. Occipital margin straight or slightly concave. Foveolae on vertex in dense honey-comb arrangement, deeply impressed, with 19 - 20 µm diameter, and with inner corona. Frontal laminae, clypeus, and small median stripe on vertex longitudinally carinulate-rugulose. Whole mesosoma and lateral petiole with very strong reticulum (or foveolate without interspaces). Spines short but acute. Postpetiole relatively narrow, dorsal aspect with concave anterior margin and angulate-convex sides, only slightly lower than petiole, PEH/PPH 1.061 ± 0.022 [1.028, 1.096]. Whole body concolorous dark brown. For morphometric data of 10 gynes see Tab. 17.

Comments: In agreement with the type localities given in Mayr's description the type specimen from Ovalau / Fijis was designated as lectotype. Because of misidentifications, *C. nuda* has been erroneously termed in the past as cosmopolitan tramp species. Instead, it seems to be restricted to the tropical and subtropical Pacific region. Investigation of authentic material showed that Palaearctic "*C. nuda*" (sensu PISARSKI 1967, BOLTON 1982, HEINZE & al.1993) turned out to be *C. mauritanica* while Japanese-Pacific "*C. nuda*" (TERAYAMA & al. 1992, TERAYAMA 1999) were *C. kagutsuchi*. Cosmopolitan *C. mauritanica* and Indomalayan-West Pacific *C. kagutsuchi* differ from Australasian-Polynesian *C. nuda* in particular by the wider head, the smaller postocular index, the shorter spines, the lower waist segments, and the larger ratio PEH/PPH. Furthermore, the microreticulum on lateral mesosoma and petiole is less deeply sculptured than in *C. nuda*, in which it is relatively coarse, giving a perfectly dull surface impression at magnifications < 60x. A linear discriminant score D(6) = 0.4 CL/CW + 5.0 PoOc + 3.8 SP/CS - 0.7 PEH/PPH + 1.0 PEH/CS + 3.5 PPH/CS offers a perfect separation of the *C. nuda* cluster from the *C. mauritanica* - *C. kagutsuchi* cluster even on the individual level:

C. mauritanica	(Cosmopolitan, n = 139)	D(6) 3.58 ± 0.09 [3.27, 3.80]
C. kagutsuchi	(Indomalayan-West Pacific, n = 69)	D(6) 3.47 ± 0.09 [3.23, 3.65]
C. nuda	(Australasian-Polynesian, n = 34)	D(6) 4.12 ± 0.14 [3.86, 4.40]
C. paranuda	(Tunisia, n = 1)	D(6) 4.221

10.19 *Cardiocondyla paranuda* sp.n

Type material: holotype worker labelled "TUNISIA: Medinine - 32 km SE Chabania - 6 km NW leg. H.Heatwole 1976", SMN Görlitz. Only type specimen known.

Description: Worker (Fig. 31, Tab. 9): Head elongated, CL/CW 1.224. Postocular distance very large, PoOc/CL 0.473. Scape short, SL/CW 0.775. Occipital margin straight or slightly concave. Frontal laminae converging immediately caudal of FRS level, FL/FR 1.107. Eyes small, EYE 0.220. Vertex with rather deep, well-demarcated, flat-bottomed foveolae of 16 - 18 µm diameter, showing an inner corona of 7 - 9 µm diameter; foveolae densely packed, interspaces much narrower than foveolar diameter. Clypeus and frontal laminae longitudinally carinulate; remaining dorsal head without longitudinal sculpture. Dorsal area of pronotum with scattered and very shallow foveolae of 15 - 18 µm diameter; interspaces much wider than foveolar diameter, more or less shining, and with very delicate cross-branched or semi-reticulate microsculpture. Mesonotum and propodeum dorsally with irregular foveolate-rugulose microsculpture. Whole area of lateral mesosoma strongly microreticulate, metapleuron with 3 short longitudinal carinulae. Petiole and postpetiole finely microreticulate, on petiole sides stronger. Surface of 1st gaster tergite shining, with very delicate microreticulum, and very short pubescence, PLG/CS 4.57 %. Most of pubescence hairs on first tergite of type specimen torn-off, sqrtPDG calculated from PLG and mean distance of hair base pits as 20.0 µm. Metanotal depression shallow. Spines short, acute, and rather steep, comparable to situation in *Tetramorium caespitum*. Petiole node rather massive, in dorsal view slightly wider than long, in profile with truncate-rounded dorsum. Petiolar peduncle thicker than in *C. nuda*. Postpetiole higher than petiole (PEH/PPH 0.954), with bulging sternite; in dorsal view with angulate-convex sides and slightly concave anterior margin. Whole body medium brown with yellowish tinge; waist and appendages lighter, gaster darker. Morphometric data of holotype: CS 454, CL/CW 1.224, SL/CS 0.775, PoOc/CL 0.473, EYE 0.220, dFOV 17.0, FRS/CS 0.289, SPBA/CS 0.300, SP/CS 0.114, PEW/CS 0.309, PPW/CS 0.501, PEH/CS 0.343, PPH/CS 0.359, sqrtPDG 4.26, PLG/CS 4.57 %, PigCap 8, PigMes 9, MGr/CS 2.5 %.

Comments: Morphometric and structural similarities suggest a close relation to Pacific *C. nuda*, from which it differs by extremely small PLG, small EYE, and large PEW/PPW, with all these data outside of the range of variation known for *C. nuda*. Less obvious differences are the smaller diameter and the less dense arrangement of vertex foveolae and the more massive petiole node (however, specimens with massive petioles that have a truncate-rounded dorsal profile may occur in Pacific *C. nuda*). The separation from *C. mauritanica* and *C. mauritanica* morph B is easily possible by much smaller PEH/PPH, much larger PoOc/CL, much smaller PLG/CS, and more erect spines. Heatwole's sample originally included also an ergatoid male with a morphology similar to the ergatoids of *C. mauritanica*. This specimen was unfortunately lost by a handling accident.

10.20 *Cardiocondyla atalanta* FOREL, 1915, stat.n.

Cardiocondyla nuda var. *atalanta* FOREL, 1915; Australia: Kimberley district [type investigated].

Investigated type material: type worker labelled "Kimberley district\ N.V.Austr. Mjöberg \ Cardiocondyla nuda Mayr v. atalanta ♂ type Forel", MNH Genève.

Morphometrically investigated material (2 samples)**: Australia:** NW Australia: Kimberley district, leg. Mjöberg, w; S Australia: Flinders Ranges (31.22 S, 138.38 E), 1999.01.06, w

Description: Worker (Fig. 32, Tab. 9): Small size. Head much shorter than in *C. nuda*, CL/CW 1.159. Postocular distance long, PoOc/CL 0.464. Anterior clypeal margin slightly concave. Scape of medium length, SL/CW 0.797. Occipital margin straight or slightly concave. Frons wider than in *C. nuda*, FRS/CS 0.282, frontal carinae converging immediately caudal of FRS level, FL/FR in type 1.092. Eyes relatively small, EYE 0.229. Sculpture of head, dorsal mesosoma, and waist significantly weaker than in *C. nuda*. Vertex between levels of frontal carinae weakly reticulate-carinulate-foveolate, laterally from this area meshes of a stronger reticulum enclose foveolae of 18 - 19 µm diameter that show flat inner tubercles of 8 - 9 µm diameter. Frontal laminae and median area of vertex immediately caudal of frontal triangle finely carinulate-rugulose. Pronotum shining and with very fine microreticulum; strength of microreticulum on dorsal mesosoma increasing across mesonotum towards propodeum. Lateral area of mesonotum, mesopleuron, lateral propodeum, and metapleuron with well-developed reticulum. Dorsal area of waist smooth, only weakly microreticulate. Metanotal groove shallow. Spines rather short and acute. Propodeal lobe lower and shorter than in type of *C. nuda*. Petiole massive and with short peduncle, its frontal face in profile less concave than in *C. nuda* type, the node about as wide as long. Postpetiole about as high as petiole, in dorsal view with more convex than angulate sides and straight anterior margin (which in *C. nuda* more ore less concave); postpetiolar sternite without prominent structures except for very shallow paramedian bulbs. Surface of 1st gaster tergite shining and with very delicate microreticulum. Head and mesosoma of type specimen concolorous yellowish brown, gaster blackish brown. For morphometric data of two workers see Tab. 9.

Comments: *C. atalanta* is apparently closely related to *C. nuda*. It differs from the latter in particular by the shorter head, shorter spines, and a wider petiole. The two available workers of *C. atalanta* from NW and S Australia could be separated from *C. nuda* by a discriminant D(3) = 2.0 CL/CW + 1.8 SP/CS - 0.7 PEW/CS:

C. atalanta (n=2) D(3) 2.304 ± 0.050 [2.269, 2.340]

C. nuda (n=34) D(3) 2.457 ± 0.036 [2.405, 2.578]

It remains to be tested in larger material if these morphological differences are consistent. The fact that these differences are expressed in sympatry, with both taxa occurring in Australia, favours a hypothesis on heterospecifity.

10.21 *Cardiocondyla mauritanica* FOREL, 1890

Cardiocondyla nuda var. *mauritanica* FOREL, 1890; Kairouan/ Tunisia [types investigated].
Cardiocondyla ectopia SNELLING, 1974; Orange Co. / California [types investigated], **syn.n.**

Investigated type material: *Cardiocondyla mauritanica*: 5 **syntype** workers and 4 **syntype** gynes labelled "C. nuda r. mauritanica Forel, Kairouan 18 IX Santschi", MHN Genève.

C. ectopia: 3 **paratype** workers and 2 **paratype** gynes labelled "CALIF., Orange Co.: Seal Beach, 0-25' 17-VII-1972 R.R. Snelling No 72-9" and "PARATYPE Cardiocondyla ectopia R.R. Snelling", LACM Los Angeles and SMN Görlitz.

Morphometrically investigated material (84 samples): **Abu Dhabi:** Park, 1995.03, w; **Afghanistan:** Kandahar, 1953.01.12, g; Kandahar - Kunar, 1953.01.18 w, g; Kandahar - Kunar, 1953.01.22 w, g; **Caribbean:** Puerto Rico: Aguada, 1987.04.06 (samples No. 455,462), w; Puerto Rico: Isla Culebra: Humacao, 1982.08.26, w; Puerto Rico: Isla Culebrita, 1991.10.02, w; Puerto Rico: Lobos, 1983.10.12, g; Puerto Rico: Mayaguez, Isla Maria Langa, 1983.03.08, w, g; Puerto Rico: Mona Island, 1982.07.03, w; Puerto Rico: San Juan: Carolina, 1983.02.23, w; Puerto Rico: San Juan: Carolina, 1985.04.02, w; Puerto Rico: San Juan: Carolina, 1986.06.15, w, g; **Egypt:** Assuan (leg. Karavajev), w; Gizeh, 1994.04.27 g; Hurghada Gifthun, 1992.09.12, w; Cairo, 1957.10.30, w; **Greece:** Crete: Iraklion district, 1990.04, w; Crete: Zaros, 1992.05, w; Crete: Rhethimnon, Georgioupoli, Kavros, 1994.08.27, g; Cyklades: Paros, 1994.05, g; **India:** Him. Pradesh: Kullu - 10 km N, 1996.10, w; Him. Pradesh: Kullu - 20 km E, 1996.10, w; Punjab: Chandigarh, 1978.08.21, w; **Indonesia:** Lombok: Senaru, 1999.12.21-17, w, g; **Irak:** Mesopotamia, 1918.10.18 (W.E.Evans), w; **Iran:** Basht (30.20N, 51.15E), 1974.05.25, w, g; Shiraz - 10 km SSW, 1997.09.14, w; Shiraz - 16 km ESE, 1997.09.16, w; Shiraz - 7 km NE, 1997.09.18, No.17, w; **Israel:** Ein Yahav, 1985.11.10, w; Tal Yeroham, 1966.03.27 w, g; Tel Aviv, 1984.04, g; **Jordan:** Hammamat Main, 1996.11.01, w; Rum (29.34N, 35.25E), 1996.11.07, w; Wadi Mujib, 1998.11.02, w; **Libya:** Tripolis, Dernah, 1906.08, w; **Malta:** without locality, 1984, w; **Morocco:** Agdz. Qued Draa 20 - 28 km E, 1991.05.09, w; Ait Ourir - 8 km E, 1995.05.09 w, g; Zagora - 11S, 1998.05.29, w; **Nepal:** Thak, Jomosom, 1974.03.01, g; **Oman:** Kayma Desert, 1993.05.03, w; Wahiba Sands, 1989.12.15, w; **Papua New Guinea:** Bismarck - Archipel, g; **Pakistan:** Swat: Madyan, 1974.06.22, w; **Philippines:** Luzon: S of Baguio, Bridall Falls, 1999.02.16, g; **Portugal:** Montemor, 1991.07, w; **Spain:** Canaries: Isla Fuerteventura, 1989.12, w; **Spain:** Canaries: Isla Hierro, 1989.03.03, w, g; Canaries: Isla Lanzarote, Costa Taguise, 1988.10, w; Canaries: Isla La Palma, Barranco de los Angustias, 1990.04.05, w; Canaries: Isla Tenerife: Puerto de la Cruz, 1999.04, w, g; Ceuta, 1979.04.14, g; Almeria: La Hoya, 1988.06.28, g; Granada: Motril, 1993.09, w, g; Granada: Motril, 2000.04 (samples 1, 4a, 6, 10, 14), w, g; Granada: Sierra Elvira, 2000.04, g; Granada: Guadix, 2000.04, g; **Tunisia:** Gabes (Oasis), Forel, w; Hammamet - 80 km S, 1993.03.02 w, g; Kairouan - 18..09.18, w, g; Tabarka, 1995.10.08, g; **Turkey:** Inkumia, 1984.06 (Collingwood), w; Kayseri - 30 km SW, 1997.05.10, g; Kayseri - 30 km SW: Incesu - 2N, 1997.05.10, w; Mersin: Silifke - 15 km SE, 1993.05.29, w; **Ukraine:** Crimea: Bachcysarai - SW, 1995.08.12, w; **United Arab Emirates:** Alain, Zoo, 1995.02, w; Dubai, Municipality, 1998 (K.Valsan), w; **USA:** Arizona: Pinal /Gila River, 1995.05.25, w; California: Los Angeles Co.: Downey, 1968.06.06, w; California: Los Angeles Co.: Long Beach, 1967.09.19, w; California: Orange Co.: Seal Beach, 1972.07.17, w, g; California: Orange Co.: Tustin, 1970.06.06, w; California: San Joaquin Co.: Stockton, 1992.01.27, g; California: Ventura Co.: Port Hueneme, 1985.03.21, w, g; Florida: Bahia Honda, 1981.12.10, w, g; **Zimbabwe:** Zambesi, 1995.07, g.

Description: Worker (Fig. 33, Tab. 9): Head elongated, CL/CW 1.183. Postocular index large, PoOc/CL 0.447. Eyes relatively small, EYE 0.232. Frontal carinae immediately caudal of the FRS level parallel or only very slightly converging. Foveolae on vertex not separated by interspaces, deeply impressed, with 17 - 22 µm diameter and on paramedian vertex usually without inner corona. Longitudinal sculpture on vertex relatively well developed but obscured by their merging with strong foveolar margins. Median vertex and frontal laminae finely longitudinally carinulate; clypeus with few longitudinal rugae. Whole mesosoma usually with well-developed microreticulum, but less strong than in *C. nuda*; samples with weak mesosomal microsculpture, meaning mildly shining overall surface appearance, may occur locally throughout the range. Metapleuron laterally longitudinally rugulose. Surface of 1st gaster tergite completely glabrous, a delicate microreticulum, as present in *C. nuda* and *C. paranuda*, is absent, but fragmentary reticulate structures may occur. Metanotal groove more or less shallow. Spines short and blunt. Petiole narrow, PEW/CS 0.265, node slightly longer than wide. Postpetiole relatively narrow, roughly hexagonal in dorsal aspect, with completely flat sternite, and distinctly lower than petiole, PEH/PPH 1.146 ± 0.034 [1.057 - 1.256]. Colour variable. Typically, dorsal head dark brown, mesosoma and waist orange brown, gaster dark to blackish brown. Lighter brown or, on the other hand, concolorous blackish brown samples may locally occur throughout the range.

Morphometric data of 103 Palaearctic, W Oriental, and Ethiopic workers:

CS 516 ± 21 [460, 568], CL/CW 1.181 ± 0.021 [1.126, 1.224], SL/CS 0.813 ± 0.012 [0.787, 0.841], PoOc/CL 0.446 ± 0.009 [0.426, 0.467], EYE 0.233 ± 0.005 [0.222, 0.246], dFOV 18.2 ± 1.0 [15, 20], FRS/CS 0.265 ± 0.008 [0.248, 0.286], SPBA/CS 0.269 ± 0.010 [0.239, 0.296], SP/CS 0.090 ± 0.014 [0.047, 0.119], PEW/CS 0.268 ± 0.011 [0.239, 0.298], PPW/CS 0.487 ± 0.014 [0.458, 0.533], PEH/CS 0.331 ± 0.008 [0.309, 0.350], PPH/CS 0.288 ± 0.009 [0.271, 0.318], PEW/PPW 0.553 ± 0.021 [0.486, 0.616], sqrtPDG 3.73 ± 0.29 [3.15, 4.64], PLG/CS 6.44 ± 0.43 [5.43, 7.73] %, MGr/CS 2.20 ± 0.50 [1.1, 3.4] %.

Morphometric data of 36 American workers:

CS 508 ± 18 [474, 538], CL/CW 1.188 ± 0.016 [1.159, 1.224], SL/CS 0.812 ± 0.010 [0.792, 0.849], PoOc/CL 0.450 ± 0.006 [0.436, 0.461], EYE 0.231 ± 0.005 [0.223, 0.241], dFOV 16.6 ± 0.8 [15, 18], FRS/CS 0.268 ± 0.006 [0.255, 0.277], SPBA/CS 0.266 ± 0.008 [0.251, 0.281], SP/CS 0.089 ± 0.011 [0.054, 0.108], PEW/CS 0.254 ± 0.011 [0.233, 0.287], PPW/CS 0.483 ± 0.009 [0.465, 0.508], PEH/CS 0.325 ± 0.008 [0.313, 0.341], PPH/CS 0.285 ± 0.006 [0.271, 0.296], PEW/PPW 0.525 ± 0.017 [0.494, 0.565], sqrtPDG 3.72 ± 0.23 [3.35, 4.32], PLG/CS 6.23 ± 0.21 [5.73, 6.78] %, MGr/CS 1.88 ± 0.47 [1.1, 3.0] %.

Gyne (Fig. 38, Tab. 17): Head of medium length, CL/CW 1.171. Postocular index large, PoOc/CL 0.434. Occipital margin straight or weakly concave. Frontal carinae diverging caudad. Head sculpture comparable to worker. Whole dorsal area of mesosoma densely and deeply foveolate; lateral area of mesosoma with longitudinal rugosity superimposing the microreticulum. Spines short and blunt. Shape of waist similar to worker but segments slightly wider and higher. Postpetiole significantly lower than petiole, PEH/PPH 1.154 ± 0.036 [1.089, 1.230]. Dorsal area of head, dorsal area of mesosoma, and gaster in typical case dark to blackish brown, lateral area of mesosoma and petiole lighter brown. Concolorous dark brown or lighter brown specimens may occur. For morphometric data of 46 gynes see Tab. 17.

Comments: The cosmopolitan *C. mauritanica* is one of the most abundant and most widely distributed *Cardiocondyla* species of the world and comprises about 12 % of all investigated samples. It is mainly a species of semi-deserts and other xerothermous habitats. Throughout the cosmopolitan range of *C. mauritanicas* only minor variation in morphometry is detectable. *C. mauritanica* specimens from India (Punjab, Himachal Pradesh) have a slightly narrower postpetiole and slightly shorter spines. Furthermore, there is a certain trend from NW Africa east to India to have the petiole node lower and more rounded in profile (not quadrate as in the Tunisian type population).

The Old World population and the American population (the latter has been named *C. ectopia*) are almost identical in body shape, surface structures, and morphometry. In both workers and gynes the American specimens are fully within the range and very close to the mean values of Old World *C. mauritanica* though weak statistic differences are detectable in worker petiole width and strength of sculpture (see above). Conspecifity is further indicated by the high similarity of the characteristic ergatoid males from typical *C. mauritanica* and *C. ectopia* populations and by mDNA data (Trindl and Heinze, pers. comm., October 2002).

10.22 *Cardiocondyla mauritanica* FOREL, 1890, morph B

Investigated material: Egypt: Sinai: Ein Chadjiah, 1968.04.23, 1 worker; **Spain:** Granada: Motril, 2000.04 (leg. Heinze), 11 workers out of four nests of typical *Cardiocondyla mauritanica*.

Description: Worker (Fig. 34, Tab. 9): Differing from typical *C. mauritanica* by following characters: Head shorter, CL/CW 1.148. Occipital margin as a rule more excavated. Anteriomedian clypeal margin between lateral major setae slightly concave. Median and paramedian areas of vertex densely longitudinally carinulate, interspaces of carinulae with foveolae of 17 - 20 µm diameter. Mesosomal sculpture more reduced.

Propodeal spines reduced to rectangular or obtusely angled corners. Dorsal propodeal profile sloping down in posterior half. Waist segments more shining. Petiole much wider and higher, in lateral view with only slightly concave anterior profile and more narrowly rounded dorsal profile, petiolar spiracle frequently situated on high conical tubercle. Postpetiole wider and higher, with more rounded sides in dorsal view (not roughly hexagonal as in typical *C. mauritanica*), spiracle frequently situated on small conical tubercle. Head and postpetiole dark brown, mesosoma and waist light-orange brown, gaster blackish. For morphometric data of 12 workers see Tab. 9.

Tab. 2: Morphometric data of the cosmopolitan population of *Cardiocondyla mauritanica* and of normal and aberrant specimens in a local population from Motril, S Spain. Means are significantly different for: * $p < 0.01$, ** $p < 0.002$, *** $p < 0.001$, **** $p < 0.0001$.

	morph B Motril (n = 11)	p	normal morph Motril (n = 12)	normal morph cosmopolitan (n = 132)
CL	539 ± 13 [514, 565]	***	563 ± 16 [536, 581]	556 ± 22 [499, 612]
CL/CW	1.148 ± 0.020 [1.115, 1.182]	***	1.187 ± 0.023 [1.132, 1.216]	1.183 ± 0.020 [1.126, 1.224]
SL/CS	0.807 ± 0.015 [0.787, 0.833]		0.809 ± 0.013 [0.788, 0.827]	0.813 ± 0.011 [0.787, 0.849]
PoOc/CL	0.424 ± 0.007 [0.417, 0.441]	****	0.446 ± 0.007 [0.430, 0.454]	0.447 ± 0.008 [0.426, 0.467]
EYE	0.230 ± 0.005 [0.220, 0.237]		0.230 ± 0.004 [0.225, 0.239]	0.232 ± .005 [0.222, 0.246]
dFOV	17.9 ± 1.1 [16, 20]		17.6 ± 0.9 [17, 19]	17.8 ± 1.2 [15, 20]
FRS/CS	0.261 ± 0.006 [0.254, 0.272]		0.261 ± 0.010 [0.248, 0.283]	0.265 ± 0.007 [0.248, 0.286]
SPBA/CS	0.276 ± 0.011 [0.263, 0.301]	*	0.264 ± 0.010 [0.252, 0.293]	0.268 ± 0.010 [0.239, 0.296]
SP/CS	0.064 ± 0.006 [0.055, 0.079]	****	0.083 ± 0.010 [0.067, 0.105]	0.091 ± 0.013 [0.047, 0.119]
PEW/CS	0.309 ± 0.017 [0.279, 0.338]	****	0.268 ± 0.010 [0.251, 0.290]	0.265 ± 0.013 [0.233, 0.298]
PPW/CS	0.519 ± 0.016 [0.493, 0.545]	***	0.494 ± 0.012 [0.476, 0.516]	0.485 ± 0.012 [0.458, 0.533]
PEH/CS	0.353 ± 0.011 [0.339, 0.378]	****	0.333 ± 0.007 [0.325, 0.345]	0.329 ± 0.008 [0.309, 0.350]
PPH/CS	0.303 ± 0.009 [0.291, 0.317]	**	0.291 ± 0.009 [0.282, 0.313]	0.287 ± 0.008 [0.271, 0.318]
PEW/PPW	0.594 ± 0.022 [0.567, 0.627]	****	0.543 ± 0.017 [0.519, 0.569]	0.546 ± 0.024 [0.485, 0.615]
sqrtPDG	4.07 ± 0.26 [3.69, 4.50]		3.76 ± 0.35 [3.30, 4.44]	3.73 ± 0.27 [3.15, 4.64]
PLG/CS [%]	7.17 ± 0.27 [6.58, 7.62]	***	6.47 ± 0.43 [5.81, 7.51]	6.37 ± 0.39 [5.43, 7.73]
MGr/CS [%]	2.26 ± 0.59 [1.3, 3.2]		2.36 ± 0.49 [1.7, 3.2]	2.10 ± 0.51 [1.1, 3.4]

Comments: Except for one isolated worker specimen from the Sinai Peninsula, the *Cardiocondyla mauritanica* morph B specimens were found together with normal *C. mauritanica* workers in (at least) 4 out of 17 laboratory colonies collected near Motril/ Spain in April 2000 by Juergen Heinze. Tab. 2 shows the local population of *C. mauritanica* from Motril to be almost identical with the cosmopolitan population in any character while morph B significantly differs in a number of characters.

It is not clear if this intranidal associations of two well-different worker morphs represent a normal situation, or if they could represent different species. Morph B specimens show peculiarities suggesting developmental irregularities leading to the expression of abnormal characters and of intercaste characters. Including the sample from Sinai, the mesosoma shows in 9 out of 13 specimens a promesonotal suture and in 5 out of 13 specimens rudimentary or less reduced metanotal structures and the orifice of the waist spiracles is situated on abnormally exposed, conic tubercles. These traits suggest morph B more likely to represent a mutant or epigenetic modification rather than being a different species. It may be a rare mutant that is abundant in the population of Motril or a modification induced by environmental factors during transport and rearing of the laboratory nests. However, it is difficult to call form B as ordinary intercaste. Intercastes are not rare in many *Cardiocondyla* species, but in contrast to the morph B example, no obvious deviations in surface structures, or head and waist shape were seen in all these cases. The case remains mysterious.

10.23 *Cardiocondyla kagutsuchi* TERAYAMA, 1999

Cardiocondyla kagutsuchi TERAYAMA, 1999; Ishigaki Island /Okinawa /Japan) [types investigated].
Cardiocondyla nuda sensu TERAYAMA & al. 1992.
Cardiocondyla nuda sensu TERAYAMA 1999 [authentic material investigated].

Investigated type material: *Cardiocondyla kagutsuchi*: 6 worker **paratypes** labelled "Cardiocondyla kagutsuchi Terayama, 1999 \ Paratype \ Omoto-dake, Ishigaki-jima, Okinawa Pref.\ VII 1988, K. Yamauchi leg.", SMN Görlitz.

Morphometrically investigated material (36 samples): **Bhutan:** Puntsholing, 1972.04.05, w; **China:** Nanning(23°N, 108°E), 1966.06.02, w; **India:** Calcutta (Rothney), w; East India (Rothney, Smith), w; Uttar Pradesh: Dehra - 10 km SE, 1996, No.552, w; **Indonesia:** Bogor, 1999.12.18-I1, w, g; Sulawesi-Utara: Dumoga Bone N.P. (0.35 N, 24.02 E), 1988.05, w; **Japan:** Nagasaki Pref.: Mt. Unzen, w; Nagasaki Pref.: Mt. Unzen, 1983.08.20, w; Okinawa: Ada, 1994.09.22, w, g; Okinawa: Ishigaki-jima: Omoto-dake, 1988.06, w, g; Okinawa: Izena-jima, 1985.03.31, w; Ogasawara Isl.: Chichi-jima (27.05 N, 142.11 E), 1972.07.29, w; Ogasawara Isl.: Miyanohama Chichi-jima, 1977.02.11, w; **Korea:** Kusang, base (34.50 N, 127.35 E), g; **Malaysia:** Sarawak: Gn. Mulu Nat.Park, 1978.03, w; Sarawak: Long Pala, 1977.10.20, w; Ulu Gombak, 2000.05.07 (samples M1, M2, M6) w, g; **Nepal:** Pokhara vic., 1995.11, No.975, w; Pokhara - 27 km NW, 1995.11 (sample No. 980), w, g; **Papua New Guinea:** St. Barbe, Malai Island (5.53 S, 147.56 E), w; **Philippines:** Mindanao: Surigao 15 km W, Bayagnan Island, 2000.02.07, w; Luzon: Sagada, Echo Valley, 1999.02.21, g; Luzon: Benguel, W of Baguio, 1992.02.17, w; Luzon: Gonogon, Chico River, 1999.02.21, w, g; Paloc, 1995.01, w; Paloc, Prison Settlement, 1995.02, w; **Polynesia:** Guam: Ylig Bay, 1958.12, w; Hawaii: Maui: Kapalua, 1990.02.23, w; Hawaii: Oahu: Waikane Trail, 1989.09.30, w, g; **Singapore:** Singapore (leg. H.Overbeck), w; **Sri Lanka:** Bandarawella, 1988.01.16, w; Nuwara Eliya: Labukele, 1988.01.16, w.

Description: Worker (Fig. 35, Tab. 9): Head elongated, CL/CW 1.182. Postocular index large, PoOc/CL 0.445. Eyes relatively small, EYE 0.230. Frontal carinae immediately caudal of FRS level parallel or very slightly converging. Foveolae on vertex without interspaces, deeply impressed, with 15 - 21 µm diameter, and with inner corona (flat tubercle) of 7 - 9 µm diameter. Longitudinal sculpture on vertex reduced; only frontal laminae, clypeus, and narrow area on anteromedian vertex finely longitudinally carinulate; weak semicircular rugosity is present around antennal fossae. Lateral area of mesosoma on whole surface regularly and strongly microreticulate; longitudinal sculpture except for 4 weak and short carinulae on metapleuron entirely absent; dorsal promesonotum with more irregular reticulum, whose meshes having twice the diameter than those on lateral area of mesosoma. Whole surface of petiole and postpetiole shining, but with very fine microreticulum. Cuticular surface of first gaster tergite shining and almost without microsculpture. Metanotal groove more or less shallow. Propodeal spines reduced to blunt dents. Petiole profile as in *C. mauritanica,* except for slender peduncle. Petiole node slightly longer than wide. Postpetiole narrower than in *C. mauritanica*; in dorsal view with distinctly angulate sides and straight anterior margin that is clearly shorter than posterior margin; differing from *C. strigifrons* by PPW/PPL 1.231 ±0.029 [1.191 - 1.274] (n = 7); postpetiolar sternite flat. Colour polymorphism: most frequent light morphs with a yellowish to medium brown mesosoma and waist, head a little darker, gaster blackish brown, and antennal club dark brown; rarer dark morphs (Philippines) with blackish brown head and gaster and dark brown mesosoma and waist. For morphometric data of 66 workers see Tab. 9.

Gyne (Tab. 17): Head of medium length, CL/CW 1.165. Scape longer than in *C. mauritanica*, SL/CS 0.807. Postocular index large, PoOc/CL 0.436. Occipital margin more or less straight. Frontal carinae parallel. Foveolae on vertex without interspaces, deeply impressed, with 17 - 19 µm diameter, and with inner corona or flat tubercle of 7 - 9 µm diameter. Longitudinal sculpture on vertex reduced; only frontal laminae, clypeus, and a narrow stripe on anteromedian area of vertex longitudinally carinulate; weak semicircular rugosity present around antennal fossae. Whole dorsal area of mesosoma densely and deeply foveolate-reticulate; lateral area of metapleuron with 6 - 8 longitudinal carinulae. Postpetiole notably foveolate, petiole only weakly sculptured. Spines very short. Shape of waist similar to *C. mauritanica* but petiolar peduncle more slender. Postpetiole with two anteroventral longitudinal carinulae and significantly lower than petiole: PEH/PPH 1.145 ± 0.045 [1.061, 1.227]. Postpetiole narrower than in *C. mauritanica*: PPW/CS 0.503. Pubescence longer and denser than in *C. mauritanica*. More or less concolourous dark to medium brown. For morphometric data of 15 gynes see Tab. 17.

Comments: K. Yamauchi (pers comm. 2001) reported for all six of his study sites on Okinawa, in Malaysia, and in Indonesia that this species nested in shallow soil in open, disturbed areas with bare or weakly herbaceous ground. *Cardiocondyla kagutsuchi* shows a high structural and morphometric similarity to *C. mauritanica* and both are undoubtedly sister species. *Cardiocondyla kagutsuchi* is maintained here as species though it may represent only the SE Palaearctic-Indo-Malayan population of *C. mauritanica*, which has shorter spines, a lower petiole, a narrower postpetiole, a longer scape, and longer gaster pubescence. A discriminant score D(6) = 2.8SP/CS + 2.8PPW/CS + 2.3PEH/CS - 0.34SL/CS - 5PLG/CS - 1.6PEW/PPW separates all worker nest sample means of *C. kagutsuchi* with D(6) 0.593 ± 0.052 [0.510, 0.690] (n = 34) and of cosmopolitan *C. mauritanica* with D(6) 0.907 ± 0.059 [0.788, 1.035] (n = 66). D(6) is 0.578 in the types of *C. kagutsuchi*, 0.982 in the types of *C. mauritanica*, and 0.957 in the types of *C. ectopia.*

In its range extending over Uttar Pradesh, E India, Sri Lanka, Nepal, Bhutan, S China, S Korea, S Japan, Okinawa, Ogasawara, Guam, Singapore, Malaysia, Indonesia, the Philippines, Hawaii, and Papua New Guinea, *C. kagutsuchi* seems to replace *C. mauritanica.* The fact that *C. mauritanica*, a most widely distributed cosmopolitan tramp species, could not substantially penetrate the range of *C. kagutsuchi* is intriguing. There are only 3 samples which are determined as *C. mauritanica*: a worker and gyne sample from Lombok / Indonesia and 2 single gynes from Baguio / Philippines and the Bismarck Archipelago / Papua New Guinea. As explanation might be offered that *C. mauritanica* and *C. kagutsuchi* are parapatric species which freely hybridise when in contact but the hybrids have a strikingly reduced fertility or fitness. In island situations, the alleles of eventually intruding aliens are thus completely eliminated by the much more numerous resident species or, in continental situations, we should have a very narrow hybrid zone (SEIFERT 1995) as it is expected to occur on the Indian subcontinent. *C. kagutsuchi* seems not to have crossed the Pacific to reach California. The Californian *C. mauritanica* population was most probably introduced from the W Palaearctic via the Atlantic islands, the Caribbean and the southern states of the USA. The above taxonomic interpretation derived from morphology is supported by most recent mDNA data (Trindl and Heinze, pers. comm., October 2002) indicating heterospecifity of *C. mauritanica* and *C. kagutsuchi* and conspecifity of *C. mauritanica* and *C. ectopia*. Hybridising experiments should be done to bring futher clarity into the issue.

Tab. 3: Morphometric comparison of paratypes of *Cardiocondyla kagutsuchi* from Okinawa: Omoto-dake and of 6 Japanese samples of *C. kagutsuchi* from 4 sites outside Omoto-dake. Means significantly different for: * $p < 0.01$, *** $p < 0.001$.

	C. kagutsuchi Japan outside Omoto-dake (n = 16)	p	***C. kagutsuchi*** Omoto-dake (n = 4)
CS	521 ± 23 [477, 552]		527 ± 19 512, 553]
CL/CW	1.165 ± 0.017 [1.141, 1.202		1.172 ± 0.012 [1.158, 1.186]
SL/CS	0.825 ± 0.011 [0.814, 0.855]		0.828 ± 0.002 [0.825, 0.829]
PoOc/CL	0.445 ± 0.010 [0.413, 0.456]		0.450 ± 0.006 [0.442, 0.455]
EYE	0.231 ± 0.005 [0.223, 0.239]		0.232 ± 0.005 [0.226, 0.239]
DFov	16.6 ± 1.1 [15, 19]		17.5 ± 0.6 [17, 20]
FRS/CS	0.270 ± 0.009 [0.260, 0.286]	*	0.260 ± 0.004 [0.256, 0.266]
SPBA/CS	0.256 ± 0.011 [0.232, 0.283]		0.260 ± 0.007 [0.252, 0.269]
SP/CS	0.069 ± 0.009 [0.046, 0.083]		0.074 ± 0.007 [0.065, 0.083]
PEW/CS	0.270 ± 0.016 [0.248, 0.313]		0.261 ± 0.009 [0.248, 0.268]
PPW/CS	0.453 ± 0.012 [0.434, 0.473		0.444 ± 0.006 [0.437, 0.452]
PEW/PPW	0.595 ± 0.027 [0.548, 0.662]		0.587 ± 0.015 [0.568, 0.602]
PEH/CS	0.314 ± 0.006 [0.302, 0.326]	***	0.300 ± 0.006 0.293, 0.307]
PPH/CS	0.284 ± 0.009 [0.264, 0.294]		0.276 ± 0.005 0.271, 0.282]
sqrtPDG	3.52 ± 0.23 [3.13, 3.93]		3.70 ± 0.24 [3.45, 3.99]
PLG/CS [%]	7.34 ± 0.32 [6.75, 7.85]	*	6.77 ± 0.21 [6.54, 7.04]
MGr/CS [%]	2.12 ± 0.47 [1.5, 2.9]		1.67 ± 0.43 [1.2, 2.2]

TERAYAMA (1999) and YAMAUCHI (pers comm., July 2000) stated that *C. kagutsuchi* from Japan and Okinawa (= *C. nuda* sensu TERAYAMA & al. 1992, TERAYAMA 1999) had a chromosome number of 2n = 28 (males n = 14) and only ergatoid males without a promesonotal suture. A restricted local population (= *Cardiocondyla* sp. 4 TERAYAMA & al. 1992 = *C. kagutsuchi* TERAYAMA 1999) from Omoto-dake, a small area on the Ishigaki island / Okinawa islands, was reported to have 2n = 27 (males n = 13) and to produce both alate and ergatoid males, the latter of which were said to have a distinct promesonotal suture. These chromosomal and demographic differences prompted TERAYAMA (1999) to consider both populations as heterospecific. However, an accidental nature of the observed differences cannot be excluded. Furthermore the karyotype differences must not necessarily generate reproductive isolation since a correct meiotic pairing of a fused with two homologous unfused chromosomes and a correct subsequent disjunction to give balanced gametes is possible. The high morphologic similarity of both populations (Tab. 3) is used here as argument to consider them as conspecific as long as the consistency of the karyotype differences and their possible consequences on reproductive isolation is not reasonably demonstrated. If a heterospecifity could be shown, *C. nuda* sensu TERAYAMA & al. 1992 must be described as new species for reasons of its striking distinctness from *C. nuda* (MAYR, 1866).

10.24 *Cardiocondyla strigifrons* VIEHMEYER, 1922, stat.n.

Cardiocondyla nuda ssp. *strigifrons* VIEHMEYER, 1922; Java [type investigated].

Investigated type material: 1 worker **type** labelled "Java" and "Cardiocondyla nuda Mayr strigifrons Viehm.", ZM Berlin.

Morphometrically investigated material (4 samples): **Indonesia:** Bali Isl., 1939 (Springer), g; Bali BG, 1999.12.29-I4, w, g; Cibodas, 2000.01.05-I6, w, g; Java, w.

Description: Worker (Figs. 36, 37; Tab. 9): Head longer than in *C. kagutsuchi,* CL/CW 1.222; postocular head sides in type specimen notably converging and more linear (Fig. 36), in other specimens less converging and more rounded (Fig. 37). Median third of anterior clypeal and of occipital margin frequently slightly concave. Postocular index large, PoOc/CL 0.449. Eyes small, EYE 0.220. Frontal carinae immediately caudal of FRS level slightly converging, FL/FR in the type 1.087. Paramedian and lateral areas of vertex with deeply impressed foveolae of 16 - 19 µm diameter, usually with inner corona or flat tubercle of 7 - 9 µm diameter, interspaces much smaller than foveolar diameter, foveolar margins in close contact with longitudinal rugae and their anastomosae. Frontal laminae, clypeus and median area of vertex longitudinally carinulate-rugulose. Median area of vertex between sagittal levels of frontal carinae with few carinulae, scattered and small foveolae imbedded in interspaces. Anterolateral area of vertex and antennal fossae weakly longitudinally rugose. Sculpture of dorsal promesonotum very different from *C. kagutsuchi*: with foveolae of 16 - 18 µm diameter; foveolar interspaces in type and other specimens as wide as foveolae and shining, only with fragments of very delicate microreticulum; in other specimens foveolae more densely packed and imbedded in irregular rugulose-reticulate structures. Dorsal area of propodeum clearly microreticulate. Lateral area of mesosoma on whole surface regularly and strongly microreticulate; longitudinal sculpture except for 5 - 6 weak and short carinulae on ventrolateral area of metapleuron entirely absent. Whole surface of petiole and postpetiole shining but finely microreticulate. Cuticular surface of first gaster tergite shining, without microsculpture or with very fine microreticulum. Propodeal spines reduced to blunt dents. Dorsal profile of mesosoma in type and few other specimens curved (Fig. 36): promesonotum and propodeum convex, metanotal groove shallow, tips of spines significantly lower than top level of mesosoma. Dorsal profile of mesosoma in most other specimens from mesonotum caudad to spine tip more or less straight, interrupted only by shallow metanotal groove, tips of spines almost as high as top level of mesosoma (Fig. 37). Petiole profile similar to that of *C. mauritanica.* Petiole node in dorsal aspect slightly longer than wide. Postpetiole in dorsal view with clearly angulate sides and slightly concave anterior margin that is a little shorter than posterior margin; wider than in *C. kagutsuchi,* PPW/PPL 1.333 ±0.035 [1.293 - 1.383] (n = 7). Postpetiolar sternite in type specimen with flat anteromedian bulb, in other specimens with a small rectangular anteromedian corner and 2 curved paramedian carinae or bulbs (i.e. there are 3 weakly prominent structures). Whole body dark brown or blackish, appendages and mandibles lighter. Morphometric data of type worker: CS 555, CL/CW 1.230, SL/CS 0.822, PoOc/CL 0.449, EYE 0.220, dFOV 18, FRS/CS 0.262, SP/CS 0.062, SPBA/CS 0.254, PEW/CS 0.292, PPW/CS 0.480, PEH/CS 0.324, PPH/CS 0.292, PEW/PPW 0.609, sqrtPDG 4.03, PLG/CS 6.39 %, MGr/CS 1.53 %. For morphometric data of all 7 workers see Tab. 9.

Gyne (Tab. 17): Head elongated, CL/CW 1.215. Occipital margin more or less straight. Scape moderately long, SL/CS 0.799. Median portion of anterior clypeal margin straight. Frontal carinae in posterior half rather straight and parallel. Vertex with densely packed and deep foveolae of 16 - 18 μm diameter, demarcated by (or arranged between) longitudinal rugulae. Clypeus and frontal laminae longitudinally carinulate-rugulose; rugae on lateral area of clypeus incurving frontad, with two rugae fusing to a single semicircular ruga on anteriormost area of clypeus. Whole dorsal area of pronotum, mesonotum, praescutellum, scutellum, and anterodorsal area of propodeum with densely-arranged and deep foveolae. Lateral area of pronotum, mesopleuron, and lateral area of propodeum strongly microreticulate. Lateral lobes of praescutellum widely separated. Propodeal spines reduced to acutely-angled dents. Petiole node smooth, but finely microreticulate and with few, fine microrugae; in dorsal aspect circular or slightly longer than wide; lateral aspect of petiole as in *C. mauritanica.* Postpetiole less shining and with few shallow foveolae and microreticulum; in dorsal view with straight or slightly concave anterior margin and markedly angulate sides forming an angle of 115 - 130°; PPW/PPL 1.375 ± 0.042 [1.298 - 1.416] (n = 6). Postpetiolar sternite with 2 curved paramedian carinae or bulbs, a blunt anteromedian corner is occasionally present. Concolorous dark or blackish brown, appendages lighter. For morphometric data of 6 gynes see Tab. 17.

Comments: The different head shape, the larger PPW/PPL, and the deviating dorsal mesosomal sculpture provide good arguments arguments to separate *C. strigifrons* from *C. kagutsuchi. Cardiocondyla strigifrons* shows considerable variation in mesosoma and head shape of workers (compare Figs. 36 and 37) as well as in structure of postpetiolar sternite which suggests the possible existence of sister species. In two sites in Indonesia, nests were found in shallow soil in open, disturbed areas with bare or weakly vegetated ground (Yamauchi, pers.comm. 2001).

10.25 *Cardiocondyla shuckardi* FOREL, 1891

Cardiocondyla shuckardi FOREL, 1891; Madagascar [types investigated].
Cardiocondyla nuda var. *shuckardoides* FOREL, 1895; Madagascar [types investigated], **syn.n.**

Investigated type material: *Cardiocondyla shuckardi*: 2 **syntype** workers labelled by Forel "C. shuckardi Forel ♂ , Imerina Madagascar (Camboué)" and with a printed red label "Type", MHN Genève. 1 **syntype** worker labelled by Forel "C. shuckardi Forel ♂ Type Antananarivo (Camboué)", MHN Genève.

C. nuda var. *shuckardoides*: 2 **syntype** workers labelled by Forel "C. nuda Mayr v. shuckardoides Forel ♂, Antananarivo (Sikora)" and with a printed red label "Type", MHN Genève.

Morphometrically investigated material (8 samples): **Madagascar:** Antananarivo (Camboué), w; Antananarivo (Sikora), w; Imerima (Camboué), w; Madagascar, w; Madagascar (Sikora), w; Madagascar, 1896 (Sikora), w; Tananarivo (Staudinger), w; **Zimbabwe:** S Rhodesia, Umtali (Arnold), 1920.03.06, w.

Description: Worker (Fig. 39, Tab. 10): Head moderately elongated, CL/CW 1.166. Anterior clypeal margin between levels of frontal carinae rather straight, in the types of *C. shuckardoides* with a median concavity. Median occipital margin usually slightly excavated, in the *C. shuckardoides* types straight. Postocular distance large, PoOc/CL 0.450. Scape of medium length, SL/CS 0.814. Eye small, EYE 0.221. Frontal carinae immediately caudal of FRS level almost parallel, in the *C. shuckardoides* types slightly converging. Anteromedian area of vertex longitudinally carinulate. Paramedian areas of vertex always carinulate-rugulose; other sculptural elements extremely variable: in types of *C. shuckardi*, foveolae almost or completely absent and weak, irregular, reticulate structures may occur; in the types of *C. shuckardoides*, paramedian areas of vertex strongly reticulate (20 μm); transitions between these extremes occurring. Frontal laminae and caudal clypeus finely carinulate-rugulose. Anterior area of clypeus with 3 - 6 longitudinal, curved carinae. Promesonotum and waist in the types of *C. shuckardi* glabrous or smooth with very shallow foveolae, dorsal area of propodeum glabrous or transversally microrugulose-reticulate, meso- and metapleuron and lateral area of propodeum reticulate. Petiole node in dorsal view slightly wider than long. Ventral area of postpetiole with 2 very shallow paramedian, longitudinal carinae or elongated bulbs, in dorsal view with a straight anterior margin and convex sides. Gastral pubescence in distance and length rather variable, longest hairs found in the types of *C. shuckardoides*, shortest in those of *C. shuckardi*. Metanotal depression with shallow slopes and moderately deep. Spines reduced to blunt angles. Whole body usually dark to blackish brown. For morphometric data of 14 workers see Tab. 10.

Comments: *Cardiocondyla shuckardi* is treated here as a polymorphic Malagasy and SE African species. The occurrence of transitions between the different sculpture and pubescence types observed in the type specimens of *C. shuckardi* and *C. shuckardoides* and the high overall similarity of these taxa suggest conspecifity.

10.26 *Cardiocondyla venustula* W.M. WHEELER, 1908

Cardiocondyla venustula W.M. WHEELER, 1908; Puerto Rico [types investigated].
Cardiocondyla globinodis STITZ, 1923; Namibia: Omaruru [type investigated], **syn.n.**
Cardiocondyla badonei ARNOLD, 1926; Mozambique [syntypes investigated], **syn.n.**

Investigated type material: *Cardiocondyla venustula*: **lectotype** worker (by present designation, in NHM Los Angeles) and 5 **paralectotype** workers labelled "Coamo Springs Porto Rico W.M.Wheeler", NHM Los Angeles and SMN Görlitz. 7 **paralectotype** workers labelled "Culebra I. W.M.Wheeler.", NHM Los Angeles and SMN Görlitz.

C. globinodis: 1 **type** worker labelled "Deutsch-Sw.-Afr. Omaruru 21.-22.6.1911", "Hamb. Dtsch.-sw.afr.Studienr.1911 W.Michaelsen leg.", and "Cardiocondyla globinodis Stz", ZM Berlin.

C. badonei: 1 **syntype** worker labelled "Amatongas forest P.E.A. –2.1917 Nat Museum S. Rhodesia", "M.C.Z. Paratype 29057", "Cardiocondyla shuckardi For. r. badonei Arn. det. G.Arnold 1953", MCZ Cambridge. 2 **syntype** workers labelled "Cardiocondyla shuckardi For st. badonei Ar" \"Port. East Afr. Amatongas forest IX 17" \ "Type", NHM Basel.

Morphometrically investigated material (13 samples): **Mozambique:** Amatongas forest, 1917.02, w; **Namibia:** Omaruru, 1911.06.21/22, w; **Puerto Rico:** Coamo Springs (W.M. Wheeler), w; Punta Salinas, 1981.07, w; Aguada, 1987.04.06, w; Aguada, 1987.04.16 g; Camp Tortuguero, 1950.10.27, w; Culebra Island (W.M. Wheeler), w; San Juan (W.M. Wheeler), w, g; San Juan, Carolina, 1986.06.11, w; San Juan, Ft. Buchanan, 1950.06.17, w; **USA:** Florida: Daytona Beach - 13 km N, 1947.12, g; **Zimbabwe:** S Rhodesia, Umtali (Arnold), 1920.06.08, w;

Description: Worker (Fig. 40, Tab. 10): Head moderately elongated, CL/CW 1.185. Anterior clypeal margin between levels of frontal carinae usually slightly concave. Median occipital margin usually slightly excavated. Postocular distance large, PoOc 0.454. Scape long, SL/CS 0.842. Eye rather small, 0.228. Frontal carinae immediately caudal of FRS level slightly converging or parallel. Paramedian area of vertex strongly reticulate (in the *C. globinodis* type reticulate-rugulose), meshes having 16 - 20 µm inner diameter and showing flat central tubercle of 8 - 9 µm diameter. Anteromedian area of vertex and frontal laminae strongly longitudinally carinulate; caudal area of clypeus finely carinulate-rugulose. Anterior area of clypeus with 5 - 10 longitudinal curved carinulae. In Caribbean population and the *C. globinodis* type pronotum dorsofrontally finely transversally rugulose-reticulate, dorsal area of pronotum moderately shining but clearly microreticulate-microrugulose; dorsal area of propodeum mildly shining but regularly reticulate; lateral area of pronotum, and meso- and metapleurae finely to strongly reticulate, region of metapleural gland bulla with 3 - 4 weak longitudinal rugae. In specimens of SE African population whole mesosoma frequently strongly microreticulate, though small smooth patches may occur. Spines reduced to blunt obtusely-angled dents, interspinal area shining, very delicately microreticulate-rugulose. Metanotal groove deep but with shallow slopes. Petiole and postpetiole more or less shining but very finely reticulate-rugulose. Petiolar node in dorsal view nearly as wide as long and almost globular, in lateral view with rounded dorsal profile which slightly produced caudad in some SE African specimens. Anterior margin of postpetiole in dorsal view slightly concave, its sides convex. Ventral area of postpetiole with indication of 2 paramedian curved carinae. Gastral pubescence long and rather dense. Whole ant dark brown. For morphometric data of 24 workers see Tab. 10.

Gyne (Tab. 18): Head moderately elongated, CL/CW 1.182. Anterior clypeal margin between levels of frontal carinae usually slightly concave. Median occipital margin usually slightly excavated. Postocular distance large, PoOc 0.441. Scape long, SL/CS 0.815. Frontal carinae immediately posterior of FRS level slightly converging or parallel. Vertex strongly reticulate, in centre of meshes with flat tubercle; anteromedian vertex, frontal laminae, and clypeus strongly carinulate. Dorsal area of pronotum, whole mesonotum and scutellum, dorsal area of propodeum, postpetiole, and dorsal area of petiole strongly reticulate; mesonotum and scutellum with few superimposed longitudinal rugulae. Interspinal area smooth. Lateral area of petiole shining but finely reticulate. Lateral area of mesosoma reticulate, but finer than on dorsal area of mesosoma. Metapleuron longitudinally rugulose, more coarse and upcurved in region of metapleural gland bulla. Spines reduced to short dents. Petiolar node in dorsal view slightly wider than long, in lateral view semicircular and slightly produced caudad. Anterior margin of postpetiole in dorsal view concave, its sides angulate-convex. Anteroventral area of postpetiole with 2 suggested paramedian, curved carinae (or longitudinal bulbs). Whole body with profuse and subdecumbent pubescence. Dark to medium brown. For morphometric data of 4 gynes see Tab. 18.

Comments: *Cardiocondyla venustula* belongs to the *C. shuckardi* species complex of which 6 species occur in the Ethiopian, W Palaearctic, and Malagasy faunal regions. The nominal population found in Puerto Rico and Florida is most probably an anthropogeneous introduction from Africa. This population, the type of *C. globinodis* from Namibia, the syntypes of *C. badonei* from Mozambique, and another specimen from Zimbabwe form a cluster that can be separated from the *C. shuckardi* cluster by a discriminant score D(9) = -0.34 SL/CS - 1.1 EYE + 0.8 FRS/CS + 1.3 SPBA/CS + 2.6 PEW/CS + 2.7 PPW/CS + 1.3 PEH/CS + 1.7 PPH/CS - 8.0 MGr/CS with D(9) 2.433 ±0.089 [2.25, 2.61] (n = 24) in *C. venustula* and 2.834 ±0.094 [2.69, 3.05] (n = 14) in *C. shuckardi.* D(9) is 2.35 and 2.55 in the two type series of *C. venustula*, 2.58 in the type of *C. globinodis*, and 2.41 in the type series of *C. badone*i, but 2.87 in the *C. shuckardi* types and 2.88 in the *C. shuckardoides* types.

10.27 *Cardiocondyla melana* sp.n

Type material: holotype worker and 1 **paratype** worker, labelled "YEMEN: Sana'a 1991"; further 9 **paratype** workers labelled "YEMEN: Sana'a 1991.09.21", "YEMEN: Sana'a 1991.10", "YEMEN: Al Mahwit 1991.06", "YEMEN: Al Mahwit 1991.09", "YEMEN: Al Mahwit 1991", "YEMEN: Al Mahwit 1993", "YEMEN: Wadi Surdad 1993", "YEMEN: Hasta 1992.10" (all stored in SMN Görlitz).

Description: Worker (Fig. 41, Tab. 10): Head much elongated, CL/CW 1.250. Anteromedian clypeal margin and median occipital margin straight or slightly concave. Postocular distance very large, PoOc/CL 0.462. Scape of medium length, SL/CS 0.816. Eye small, EYE 0.221. Lateral area of clypeus with few longitudinal curved carinulae and semierect pubescence. Frontal carinae immediately caudal of FRS level parallel. Sculpture on dorsal area of head variable in strength, but overall impression of vertex even in specimens with stronger sculpture still shining. Frontal laminae and vertex caudally of them strongly to weakly longitudinally carinulate. Foveolae on lateral vertex always flat and, in more strongly-sculptured specimens, embedded within longitudinal rugulae. Promesonotum and waist smooth and shining, with fragmentaric rugulae. Dorsal area of propodeum shining but rugulose-microreticulate. Meso- and metapleuron and propodeum laterally reticulate. Petiole node slightly wider than long. Ventral postpetiole with 2 very shallow paramedian, longitudinal carinae or elongated bulbs, in dorsal view with straight anterior margin and convex sides. Metanotal depression with shallow slopes and less deep than in *C. fajumensis*. Spines reduced to blunt angles. Whole body dark to blackish brown. For morphometric data of 11 workers see Tab. 10.

Comments: *Cardiocondyla melana* differs from the closely related SE African *C. shuckardi* by non-overlapping CL/CW data and a much more slender postpetiole.

10.28 *Cardiocondyla longiceps* sp.n.

Type material: holotype gyne plus 3 **paratype** gynes labelled "YEMEN: Isl. Socotra Hadibo, 1993.04.14 leg. A. van Harten"; 4 **paratype** gynes labelled "YEMEN: Taiz(L) leg. A. van Harten 1998.08.24", all in SMN Görlitz.

Description: Worker: unknown, predicted data given in Tab. 10.

Gyne (Fig. 45, Tab. 18): Closely related to *C. fajumensis* but size and head length index outside the range of this species. Head extremely elongated, CL/CW 1.254. Anterior clypeal margin and occipital margin convex, in most median parts straight. Postocular distance large, PoOc/CL 0.444. Scape long, SL/CS 0.815. Clypeus and frontal laminae densely longitudinally rugulose-carinulate. Anterior clypeus with profuse erect pubescence, appearing bearded. Frontal carinae immediately behind FRS level parallel or slightly converging caudad. Vertex and anterior pronotum strongly reticulate, the meshes with bicoronate foveolae. Mesonotum strongly longitudinally rugulose, interspaces foveolate. Propodeum and postpetiolar dorsum strongly foveolate-reticulate. Petiole more smooth but weakly reticulate-rugose. Lateral mesosomal sclerites strongly longitudinally rugulose. Petiole node in dorsal view globular, as long or slightly longer than wide. Postpetiole with straight or slightly concave anterior margin and convex sides, its sternite with 2 shallow, paramedian longitudinal bulbs. Spines reduced to right or blunt angles. Pubescence on whole body long and profuse. Lateral mesosoma, propodeum and waist light-yellowish brown. Dorsum of antennal funiculus, dorsal head, gaster, and dorsum of mesosoma from scutellum to metanotum distinctly darker. For morphometric data of 7 gynes see Tab. 18.

Comments: The fact that only gynes of *Cardiocondyla longiceps* sp.n. were available but only workers in the related sympatric species *C. melana* sp.n. makes an assessment of possible synonymies difficult. Predictions of morphometric data of the *C. melana* sp.n. gyne and the *C. longiceps* sp.n. worker (by estimation of worker-gyne changes in *C. fajumensis*, *C. mauritanica*, and *C. nuda*) indicate that *C. longiceps* sp.n. has a longer scape, a longer head, a coarser sculpture with bicoronate and larger foveolae on the vertex, a lighter colour, and smaller sqrtPDG. The predicted SL/CS is 0.848 in the *C. longiceps* sp.n. worker (real value in *C. melana* sp.n. 0.816) and the real SL/CS is 0.815 in the *C. longiceps* sp.n. gyne (predicted value for *C. melana* sp.n. 0.785). *C. longiceps* sp.n. is most similar to sympatric *C. fajumensis* in structure and body shape but non-overlapping morphometric data (Tab. 18) and the characteristic clypeal pubescence strongly indicate heterospecifity.

10.29 *Cardiocondyla fajumensis* Forel, 1913, stat.n.

Cardiocondyla nuda var. *fajumensis* Forel, 1913; Fajum /Egypt [types investigated].
Cardiocondyla emeryi ssp. *schatzmayri* Finzi, 1936; Egypt [types investigated], **syn.n.**
Cardiocondyla nilotica Weber, 1952; Sudan [type investigated], **syn.n.**

Investigated type material: *Cardiocondyla fajumensis*: 4 **syntype** gynes labelled "Cardiocondyla nuda var. fajumensis For., ♀ type, Fajum (U.Sahlberg)", MHN Genève.

C. emeryi ssp. *schatzmayri*: 5 **syntypes** stored in MCZ Cambridge under the number "M.C.Z. Cotype 28813"; comprising 1 worker labelled "Heluan Egitto 2.3.33 C.Koch", 1 gyne labelled "Kirdassah Eg. 2.9.33 W.Wittmer", 1 gyne labelled "Atar El Nabi 6.8.33 Eg. W.Wittmer", 1 gyne labelled "W.Halfa Sudan 12.2.1933 A.Schatzmayr", 1 gyne labelled "Alessandria 13.1.33 Egitto meks Schatzm.Koch".

C. nilotica: **holotype** worker labelled "Equat Angio-Egypt Sudan, Jul-Aug. 1939 NA Weber No.1234", "El Duein White Nile 2.vii 1939 1234", "Holotype Cardiocondyla nilotica Weber ´52", MCZ Cambridge.

Morphometrically investigated material (17 samples): **Cape Verde:** Santo Antao: pass height, 1000 m, 1978.12.27, w, g; **Egypt:** Alexandria, 1933.01.13, g; Assint, Sorghum, 1976, w; Atar El Nabi, 1933.08.06, g; Heluan, 1933.03.02, w; Kairo - 90 km SSW: Fajum, g; Kirdassah, 1933.09.02, g; **Iran:** 30.28 N, 50.50 E, 1974.05.22, g; **Sudan:** El Duein/White Nile, 1937.07.02, w; Wadi Halfa, 1933.02.12, g; Wadi Halfa, 1962.01 g; Wadi Halfa - N, Faras-W, 1962.02, w; **Yemen:** Al Mahrah, S. Ba Angood, 1997.02.12, No.3366, g; Al Mahrah, S. Ba Angood, 1997.02.13, No.3376, w; Bani Mansoor, 1991.04, w; Mabar, 1992.05 (Mahyoub), g; Sana'a, 1991.09.04, g.

Description: Worker (Fig. 43, Tab. 10): large species, CS 594 ± 28. Head much elongated, CL/CW 1.205. Postocular distance large, PoOc/CL 0.445. Scape very long, SL/CS 0.862. Eyes very small (EYE 0.211) and with fine setae of 7 - 13 µm length. Occipital margin straight. Paramedian area of vertex strongly reticulate, meshes with bicoronate foveolae of 19 - 21 µm diameter. Median area of vertex, frontal laminae, and clypeus longitudinally carinulate. Frontal carinae slightly converging immediately posterior of FRS level. Dorsal area of promesonotum moderately shining and weakly carinulate-reticulate. Propodeum and lateral area of mesosoma finely reticulate. Metanotal impression very deep. Spines reduced to blunt rectangular corners. Petiole with long peduncle and a massive node, dorsal profile evenly rounded in lateral view, as long as wide and circular in dorsal view. Postpetiole narrow and ventrally with 2 suggested paramedian, longitudinal carinae, PPW/CS 0.430. Head yellowish to dirty yellowish brown, mesosoma and waist yellowish, gaster dark to blackish brown. 1 worker from Yemen: Al Mahrah 1997.02.13-3376 with much darker colour, petiole node more produced caudad, much longer tergite pubescence, and stronger mesosomal sculpture than in Palaearctic conspecifics. For morphometric data of 9 workers see Tab. 10.

Gyne (Fig. 44, Tab. 18): Large species, CS 631 ± 17. Head much elongated, CL/CW 1.185. Postocular index large, PoOc/CL 0.432. Occipital margin straight. Scape long, SL/CS 0.815. Frontal carinae immediately caudal of FRS level parallel or slightly converging. Eyes with conspicuous hairs, longest hairs measuring 12 - 18 µm. Head sculpture comparable to worker, but foveolae (or meshes) with larger mean diameter, dFov 21 - 26 µm. Mesonotum and scutellum strongly longitudinally rugulose, with weak anastomosae. Propodeum reticulate; mesopleurae finely and metapleurae strongly longitudinally rugulose; pronotum and anepisternit rugulose with scattered foveolae. Spines reduced to obtusely angled corners. Petiole node as long as wide and circular in dorsal view. Postpetiole narrow, PPW/CS 0.496, ventrally with 2 suggested paramedian, longitudinal carinae. Dorsal area of head posterior of level of antennal insertions dark brown, anterior of this light-orange brown. Mesosoma laterally, propodeum and waist light-orange brown to medium brown; mesonotum and scutellum often slightly darker. Gaster dark brown. Gynes from Yemen: Al Mahrah 1997.02.12-3366 in morphometry and most structural characters equal to type gynes and other Palaearctic conspecifics, but differing by darker colour, petiole node produced more caudad in lateral view, and dorsal mesosoma sculpture with the transverse component not weaker than the longitudinal one (i.e., clearly reticulate-foveolate). For morphometric data of 17 gynes see Tab. 18.

Comments: All investigated types of *C. emeryi* ssp. *schatzmayri*, originating from 5 different localities, belong to the same species. These types as well as the type of *C. nilotica* are in structure, body shape, morphometrics, eye setae, and pigmentation inseparable from the types of *C. nuda* var. *fajumensis*.

10.30 *Cardiocondyla unicalis* sp.n.

Type material: holotype worker labelled "IRAN LORESTAN Ma'amulan 6.VIII.73 33°20'N / 47°54'E A.SENGLET", SMN Görlitz.

Description: Worker (Fig. 42, Tab. 10): large, CS 610. Head extremely short, CL/CW 1.126. Postocular distance large, PoOc/CL 0.451. Scape long, SL/CS 0.837. Eyes extremely small (EYE 0.199), with very few microsetae of 4 - 6 µm length. Occipital margin straight. Sculpture on head, mesosoma and waist much weaker than in *C. fajumensis*. Foveolae on paramedian area of vertex shallow, but rather large (dFov 19 µm), frequently bicoronate, with irregular margins; interspaces between foveolae usually present but much narrower than foveolar diameter. Median and paramedian areas of vertex and frontal laminae longitudinally carinulate. Clypeus with few weak longitudinal rugae. Frontal carinae immediately behind FRS level slightly converging, FL/FR 1.101. Dorsal area of promesonotum, lateral area of pronotum, and waist glabrous; dorsal area of propodeum shining but with shallow microreticulum; lateral area of mesonotum, mesopleuron, lateral area of propodeum, and metapleuron more deeply microreticulate. Metapleuron additionally with 3 longitudinal rugae. Mesosoma slender and with deep metanotal impression. Spines reduced to blunt corners. Petiole node as long as wide and circular in dorsal view. Postpetiole very narrow (PPW/CS 0.411), its sternite with 2 suggested paramedian carinae. Head and gaster dark brown, mesosoma and waist medium brown.

Morphometric data of holotype: CS 610, CL/CW 1.126, SL/CS 0.837, PoOc/CL 0.451, EYE 0.199, dFOV 19.0, FRS/CS 0.270, SPBA/CS 0.250, SP/CS 0.051, PEW/CS 0.272, PPW/CS 0.411, PEH/CS 0.290, PPH/CS 0.278, PEW/PPW 0.661, sqrtPDG 4.01, PLG/CS 4.75 %, MGr/CS 4.92 %.

Comments: The unique combination of rare characters justifies the description of *C. unicalis*, based upon a single specimen. These characters are extremely small eyes, very narrow postpetiole, very short head, large size, the long scape, slender mesosoma with a deep metanotal impression, and reduced spines. The next similar species is *C. fajumensis*, from which it differs by the extremely small CL/CW, being fully outside the expected range of variation in *C. fajumensis*. Further differences to *C. fajumensis* are the weaker sculpture, the smaller eyes, the shorter scape, and the darker colour.

10.31 *Cardiocondyla stambuloffii* Forel, 1892

Cardiocondyla stambuloffii Forel, 1892; Bulgaria [types investigated].
Cardiocondyla bogdanovi Ruzsky, 1905; Caucasus: Armenia (now Turkey) [description and topotypical specimen; types probably lost], **syn.n.**
Cardiocondyla montandoni Santschi, 1912; Romania [types investigated].
Cardiocondyla stambuloffi [sic!] ssp. *taurica* Karavajev, 1927; Ukraine [syntypes investigated].

Investigated type material. *Cardiocondyla stambuloffii*: 3 **syntype** workers and 3 **syntype** gynes labelled "C.stambuloffii Forel, type, 17 VIII, Anchialo (Bulgarien)", MHN Genève; 1 gyne, 3 worker **syntypes** labelled "Anchialo, 17 VIII", NHM Wien; 2 **syntype** workers labelled "Anchialo 17 VIII, type stambuloffii", NHM Basel; 1 **syntype** gyne labelled "Bulgarien. Anchialo." and "Cardiocondyla stambuloffii For.", ZM Berlin.

C. bogdanovi: 1 worker from the type locality labelled "Caucasus Aralich Horváth 1893 \ Cardiocondyla bogdanovi Ruzsk. det. B.Pisarski \ Inst.Zool.P.A.N. Warszawa 92/60 \ topotype", ZIPAS Warszawa [This specimen is not a type but a candidate for a neotype fixation].

C. montandoni: 3 **syntype** workers labelled "Cardiocondyla montandoni, Lacu Sarat, Roumanie, Montandon", MHN Genève; 2 **syntype** workers labelled "Roumanie, Lacu Sarat, A.L.Montandon", NHM Basel.

C. taurica: 1 **syntype** worker labelled "ssp. Taurica \ Enishary bl. Koktebelya 16.VI. 1920 Karavajev \ 4357. coll. Karavaievi \ Cardiocondyla stambuloffi ssp. taurica Karaw. Typus" and 1 **syntype** worker labelled "4357. coll. Karavaievi", IZ Kiev. The locality label is in handwritten Cyryllic letters with difficult distinction of "k" and "n" giving other possible reading as "Ekishary bl. Konteblya..."]:

Morphometrically investigated material (21 samples): **Bulgaria:** Anchialo,18..08.17, w, g; Burgas (Forel), w; Sozopol - 4 km S, 1985.09.17, w; **Greece:** Korinos - 8 km NE, 1991.08.16, w; **Iran:** Khoy (38.41 N, 45.08 E), 1973.06.24, w; **Moldavia:** Val du Berlad, w; **Romania:** Delta of Danube River, Letea Forest, 1985, w; Lacu Sarat, w; **Turkey:** Armenia: Aralikh (39.52 N, 44.31 E), 1893, w; Artvin - 10 km W, 1989.07.02, w; Kars: Digor - S, 1986.06.15, w; Kars: Igdir - 10 km SE, 1993.06.21 (No 1, No 1108), w; Kars: Igdir, 1989.06.30, w; Kars: Kagizman, 1986.06.18, w; Konya: Karapinar, 1993.06.03, w; Konya: Karapinar - 30 km E, 1993.06.03, w; **Ukraine:** Black Sea Nature Reserve (46.14 N, 31.55 E), 1981.06.17, w; Black Sea Nature Reserve (46.14 N, 31.55 E), 1983.04.28, w; Crimea: Feodosia, 1981.08.14, w; Enishary nr. Koktebel, 1920.04.16, w;

Description: Worker (Fig. 46, Tab. 11): Head relatively short, CL/CW 1.157. Postocular distance large, PoOc 0.444. Scape relatively short, SL/CS 0.783. Eye small, EYE 0.225. Frons broad, FRS/CS 0.325. Occipital region with reduced sculpture, shining. Vertex strongly longitudinally rugulose; interspaces between carinulae shining, with small flat tubercles of 7 - 10 µm diameter around bases of pubescence hairs. Foveolae or reticular structures on vertex completely lacking; occasionally (as in type of *C. taurica*) semireticular structures present on paramedian area of vertex. Frontal laminae and clypeus longitudinally carinulate. At least pronotum, but usually whole dorsal area of mesosoma glabrous. Lateral area of mesosoma in overall impression shining, meso- and metapleurae longitudinally rugulose-carinulate. Propodeal spines reduced to blunt dents. Petiole very narrow, less than half as wide as postpetiole (PEW/PPW 0.485), much higher than wide. Petiole node with small and very shining dorsal surface that is almost circular in dorsal view. Postpetiole in dorsal aspect with concavity in anterior margin, nearly twice as wide as long, ratio PPW/ PPL in 21 measured specimens 1.806 ± 0.065 [1.666, 1.919]; postpetiolar sternite flat, with very weak anteromedian bulb. Whole body concolorous brown, dark brown, or blackish brown. For morphometric data of 47 workers see Tab. 11.

Gyne (Fig. 50, Tab. 17): Much larger than worker, CS 676 ± 5. Head short, CL/CW 1.145. Postocular index very large, PoOc/CL 0.464. Postocular head significantly wider than preocular head. Occipital margin straight. Frontal carinae immediately caudal of FRS level diverging. Mesosoma very massive, MW 542 ± 5. Occipital region shining, rather smooth except for small punctures around hair bases. Vertex longitudinally rugulose; interspaces between carinulae shining, with small punctures of 8 - 10 µm diameter around bases of pubescence hairs (at magnifications above 400 x, these punctures appear usually as flat tubercles). Foveolae or reticular structures on vertex completely lacking. Frontal laminae and clypeus strongly longitudinally carinulate. Pronotum shining, rather smooth except for punctures at hair bases and weak transverse rugulae. Mesonotum shining, with small punctures of 10 - 11 µm diameter at hair bases, anterior part more smooth, posterior part with shallow longitudinal carinulae. Praescutellum with similar punctures. Scutellum longitudinally carinulate. Lateral area of propodeaum, mesopleuron and metapleuron more strongly, anepisternite more weakly longitudinally rugulose. Propodeal spines reduced to blunt dents. Petiole very high; dorsal plane glabrous, ending in a caudal corner. Postpetiole more than twice as wide as long, PPW/CS 0.866, almost twice as wide as petiole; postpetiolar sternite with a strong anteromedian process. Pubescence on first gaster tergite subdecumbent (30°) and extremely dense, sqrtPDG 2.72. Whole body more or less concolorous medium to dark brown, mesosoma sclerites occasionally with lighter patches. For morphometric data of 5 gynes see Tab. 17.

Comments: The W Palaearctic population of *C. stambuloffii* shows minor geographic variation. *Cardiocondyla bogdanovi* was described from the Caucasus in a sample collected by K.A.Satunin: "Erivansk. Gub., Aralych, about 3000 feet, worker, gyne 7.IX.1900". RADCHENKO (1995) assumed that types of *C. bogdanovi* were lost and did not state the exceptional need for neotype fixation for a name that had not been under current use. Unfortunately Radchenko has not considered text and figures of Ruzsky's description and fixed a neotype in a member of the unrelated *C. bulgarica* group. To prevent damage from taxonomy, the case must be considered in detail. Ruzsky (1905) gave an, in his terms, unusually detailed description with two figures. I translate here only the directly descriptive statements of possible diagnostic value. Ruzsky's comparisons with other species are omitted since it is unclear which species he really meant (Ruzsky's "*C. elegans*", for instance, may belong to five different species). The translation of Ruzsky's description of *C. bogdanovi* is:

"Worker ... Clypeus mat, with longitudinal rugae. Frontal triangle longitudinally carinulate, weakly shining. Head mat, covered with many longitudinal, carinulate rugae in the interspaces of which are found small, round, superficial punctures, each of which carrying in its centre a short, acute hairlet. Sculpture on lateral occiput almost reduced, for that reason very shining. Spines as in *C. stambulovi*, having the form of short, broad, and blunt dents. Mesosoma and waist segments shining. Lateral mesosoma longitudinally rugulose. Promesonotum with short (stronger than on head) longitudinal rugae, the interspaces with small punctures. Base and slope (between spines) of propodeum almost glabrous, with very weak, superficial shagreened rugosity and appressed hairlets. Petiole [meant is the petiole node, B.S.] in dorsal view as long as wide. Postpetiole broad, more than twice as wide as petiole, but lower. Waist segments and gaster smooth and shining. Blackish brown, with brownish-yellow scape, legs, and petiolar peduncle. Length 1.8 - 2.2 mm..."

"Gyne. Head a little wider than mesosoma. Midthorax slightly convex. Propodeum with spines in the form of strong, broad, and blunt dents. Petiole with a very narrow cylindrical peduncle; in profile view high, rounded above, with a steep, slightly convex frontal face, caudal face steep but slightly concave. Postpetiole very wide (twice as wide as petiole), with a broadly excavated anterior margin, with angulate-rounded lateral corners, its width equal to anterior mesosomal width. Clypeus mat, with many longitudinal rugae. Sculpture of head surface as in worker, i.e. longitudinal, weak rugae in the interspaces of which are many rounded pits that carry in their centre a short whitish hairlet. Pronotum, mesonotum, praescutellum, and scutellum with similar rugae and pits as on head, but rugae here weaker so that pits appear more clearly. Sides of mesosoma entirely longitudinally rugulose. Base and slope of propodeum smooth and shining. Waist segments smooth and shining. Mesosoma and petiole with few appresssed hairs; on postpetiole and gaster, in contrast, very numerous whitish hairs..."

RUZSKY (1905: fig. 2) depicts the waist segments of a worker in dorsal view, which is in full agreement with the situation in the *C. stambuloffii* type (Fig. 46): the petiole node is circular in dorsal aspect, PEW/PPW is about 0.45 according to the drawing, the postpetiole is twice as wide as long, and weakly concave at anterior margin. RUZSKY (1905: fig. 3), illustrates the lateral aspect of the mesosoma and the waist of the gyne, which is in agreement with the type gyne of *C. stambuloffii* (Fig. 50): it shows a massive mesosoma with a thoracic index ML/MH of 1.80, short and blunt, but massive propodeal spines, and a very high petiole node.

The descriptions of both worker and gyne, leave no doubt that Ruszky's verbal statements and figures of *C. bogdanovi* must be attributed to a member of the *C. stambuloffii* group and the high similarity with the type specimens of *C. stambuloffii* strongly indicates a synonymy with this species. This is also confirmed by a topotypical worker specimen from Aralych /Armenia, leg. Horváth 1893 (site now in Turkey) that is, except for its larger CL/CW, in all structural and 12 morphometric characters very close to the population mean of *C. stambuloffii*. The other species of the *C. stambuloffii* group, *C. koshewnikovi* and *C. gibbosa*, and the related *C. tibetana* sp.n. can be excluded from synonymy with *C. bogdanovi* with a high probability. *Cardiocondyla koshewnikovi* has a much more eastern distribution and its petiole node is slightly wider than long. The *C. tibetana* sp.n. types differ by a much larger relative petiole width, with PEW/PPW 0.556. The *C. gibbosa* types differ from *C. bogdanovi* by the absence of punctures or foveolae around the hair bases on vertex. The tiny pits of 4 - 5 µm diameter at hair bases are just visible with modern high-resolution stereomicroscopy at numeric apertures of > 0.22 and magnifications of > 220 x. The microscopic equipment available for Ruzsky in his time most probably excludes that he could have noted such structures, but undoubtedly he could see structures of twice the size such as observed in *C. stambuloffii*.

RADCHENKO (1995) raised *C. bogdanovi* to a species and fixed a neotype of *C. bogdanovi* with the data "neotype: worker, Armenia: Khosrovskij Zapovednik, Vedinskij uchastok, N.225-86, 14 VI 1986 (A.Radchenko)". RADCHENKO's drawings and descriptions indicate that he has performed an unjustified taxonomic act. Fig 2e of his "*bogdanovi*" neotype shows vertex foveolae with a diameter observed in the *C. elegans* and *C. batesii* group (Fig 2w, 2d), being two times larger than in *C. stambuloffii* (Fig 2z). Further he gives for the gynes of his "*bogdanovi*" a thoracic index TI (sensu RADCHENKO 1995; comparable to ML/MH sensu SEIFERT 1996) of 2.13 - 2.44, indicating a low, much elongated mesosoma. The TI of the *C. bogdanovi* gyne in Ruzsky's drawing is 1.80, that of the *C. stambuloffii* type gynes from Anchialo 1.74 - 1.80, and Radchenko gives for his *C. stambuloffii* 1.77 - 1.85, indicating in all cases the massive mesosoma typical for *C. stambuloffii*. The gynes of the *C. elegans* and *C. bulgarica* group have, according to my own measurements, TI always larger than 1.95 (*C. elegans* 1.96, 2.05, 2.06, 2.12; *C. ulianini* 2.13; *C. bulgarica* 1.96, 2.01, 2.03; *C. persiana* sp.n. 2.05, 2.13; *C. sahlbergi* 1.97, 2.08; *C. israelica* sp.n. 2.25).

Two investigated workers from the nest series, from which Radchenko´s neotype was taken, were typical *C. sahlbergi* specimens, which strikingly differ from *C. stambuloffii* by the absence of longitudinal rugosity on vertex, by the presence of wide vertex foveolae, by a much narrower frons, longer spines, a much wider and lower petiole, and much more dilute tergite pubescence. The differential data of these specimens (first number) and those of the Palaearctic mean of *C. sahlbergi* (second number) against the *C. bogdanovi* specimen from the type locality (third number) and the Palaearctic mean of *C. stambuloffii* (fourth number) do not need further comments: FRS/CS 0.250 and

0.260 vs. 0.326 and 0.325, dFov 17.5 and 17.2 vs. 7.0 and 8.4, SP/CS 0.122 and 0.119 vs. 0.078 and 0.073, PEW/PPW 0.566 and 0.586 vs. 0.464 and 0.485, PEH/PEW 1.088 and 1.054 vs. 1.399 and 1.282; sqPDG 4.60 and 4.88 vs. 3.75 and 3.57. These data give clear evidence that RADCHENKO (1995) performed an erroneous neotype fixation in a species which is not even related to *C. bogdanovi*. As a consequence, this neotype fixation is invalid according to Article 75.3.5 of ICZN and must be suppressed. If ever fixing a neotype for *C. bogdanovi*, this should be done most adequately in the topotypical specimen from the ZIPAS Warszawa collection which fully matches the original description.

Cardiocondyla montandoni is in each structural and morphometric character close or equal to *C. stambuloffii*. The synonymy of *C. montandoni* is clearly evidenced by the data measured in five syntype workers: CS 525 ± 6, CL/CW 1.146 ± 0.011, SL/CS 0.773 ± 0.005, PoOc/CL 0.441 ± 0.005, EYE 0.220 ± 0.007, dFOV 8.6 ± 0.5, SP/CS 0.075 ± 0.007, PEW/CS 0.294 ± 0.010, PPW/CS 0.595 ± 0.023, PEH/CS 0.364 ± 0.007, PPH/CS 0.302 ± 0.012, PEW/PPW 0.495 ± 0.014, sqrtPDG 3.56± 0.16, PLG/CS 6.18 ± 0.30 %, MGr/CS 3.24 ± 0.67 %.

The syntypes of *Cardiocondyla taurica* are fully consistent with the intraspecific variability of *C. stambuloffii*. The two syntype workers have the data: CS 517 ± 12, CL/CW 1.156 ± 0.009, SL/CS 0.782 ± 0.013, FRS/CS 0.322 ± 0.013, PoOc/CL 0.432 ± 0.006, EYE 0.229 ± 0.001, dFOV 8.0 ± 0.0, SP/CS 0.084 ± 0.004, PEW/CS 0.292 ± 0.025, PPW/CS 0.598 ± 0.018, PEH/CS 0.377 ± 0.021, PPH/CS 0.302 ± 0.015, PEW/PPW 0.488 ± 0.028, sqrtPDG 3.41± 0.07, PLG/CS 6.78 ± 0.13 %, MGr/CS 2.34 ± 0.23 %.

10.32 *Cardiocondyla koshewnikovi* RUZSKY, 1902

Cardiocondyla koshewnikovi RUZSKY, 1902; Lake Aral: mouth of river Syr Darya [types investigated].

Investigated type material: M.Ruzsky sent type specimens to A. Forel and to the late G. Mayr, which are still present in the collections of MHN Genève and NHM Wien. These ants were mounted by Forel and Mayr in a different way but the original labels of Ruzsky written with a pencil and the high morphometric (coefficient of variation in CS, SL/CS, PoOc, EYE, PEW/SC, PPW/CS only 1.3 - 1.5 %) and structural similarity indicate that all 5 syntypes in MHN Genève and NHM Wien came from the same source. In detail these types are: **lectotype** worker (by present designation) labelled by Ruzsky "Card. koshewnikovi Umg.d.Aralsees 1902 M.R." and carrying a blue printed label "Cotypus"; 1 **paralectotype** worker, originally from the same pin but transferred by the author to another pin and labelled with a laser printer and identical text "Card. koshewnikovi Umg.d.Aralsees 1902 M.R.", both in MHN Genève; 1 **paralectotype** worker labelled by Forel "Card. stambuloffii koshewnikovi Ruzsky Umgbg.d.Aralsees (Ruzsky)" and carrying a blue printed label "Cotypus"; MHN Genève. 1 **paralectotype** worker labelled by Ruzsky with a pencil "Card. koshewnikovi, Aralsee W 5." and by G. Mayr in ink "Aralsee Ruzsky", NHM Wien; 1 **paralectotype** worker with same mode of preparation labelled by G. Mayr "Aralsee, Coll. G.Mayr" and "stambuloffi v. koshasnikovi [writing error, B.S.] Ruzsky, Type", NHM Wien.

Comments: The published type locality "Ust'ye rek Syr-Darya, Raim" (= "mouth of river Syr-Darya, Raim") does not contradict to the labelling "Umgebung des Aralsee". Hence, these specimens can be accepted as types of Ruzsky.

RADCHENKO (1995) believed that type specimens of *C. koshewnikovi* from Lake Aral have been lost and he "fixed" a neotype without, however, publishing its collecting date and locality. Furthermore he did not publish any character of discriminative value. Hence, Radchenko's neotype fixation is invalid according to the articles 75.3.2 - 75.3.6 of ICZN.

Morphometrically investigated material (13 samples): **China:** Gobi, Fukang, 1991.08.13, w; Tibet (ex coll. G. Mayr), w; Tibet (No. 193, ex coll. G. Mayr), w; Tibet (No. 199, ex coll. G. Mayr), w; **Mongolia:**

Char Us Nuur (47°46'N, 92°02'E), 1966.07.10; w; Gobi Desert (43°14'N, 99°00'E), 1997.08.16 (No. 159 and 183); Bayan Jisa (45°00'N, 100°52'E), 1997.08.19 (No 202); **Kazakhstan:** Vicinity of the Lake Aral (Ruzsky), w; Saissan depression (47°42'N, 85°18'E), 2001.07.25 (No. 180 and 247), w, g, m; Lake Sassy Kol (46°42'N, 80°35'E), 2001.08.07, w; **Turkestan:** no exact site given (coll. G. Mayr), w.

Description: Worker (Fig. 47, Tab. 11): Head moderately long, CL/CW 1.155. Postocular distance rather large, PoOc/CL 0.444. Scape slightly longer than in *C. stambuloffii*, SL/CS 0.791. Eyes small, EYE 0.219. Frontal carinae immediately behind FRS level converging caudad. Whole clypeus, frontal laminae, and vertex anteromedianly longitudinally carinulate-rugulose. Remaining vertex strongly longitudinally rugulose (in the type specimens these rugulae form together with weaker anostomosae a semi-reticulum whose meshes carry in their centre flat tubercles of 7 - 9 µm diameter around bases of pubescence hairs; in other specimens reticulum almost lacking). Pronotum anteriorly transversely rugulose. Mesosoma dorsally on most of its surface longitudinally carinulate-rugulose; rugae usually stronger than in *C. stambuloffii*; triangular area anterior of spine bases or whole dorsal propodeum glabrous and only with a very fine superficial reticulum. Lateral area of mesonotum, mesopleurae, lateral area of propodeum, and metapleurae longitudinally rugulose. Spines as short as in *C. stambuloffii*, but more acute. Propodeal dome more steeply sloping caudad than usually seen *C. stambuloffii*. Spine bases much more approached than in *C. stambuloffii*. Nodes of waist segments smooth. Petiole with a high node that is in dorsal view slightly wider than long. Postpetiole in dorsal view with straight or very weakly concave anterior margin, relatively narrower than in *C. stambuloffii*: ratio PPW/PPL 1.704 ± 0.075 [1.612, 1.846] n=23. Concolorous medium to dark brown with yellowish tinge. For morphometric data of 31 workers see Tab. 11.

Gyne (Tab. 17): Much larger than *C. stambuloffii*, CS 767 ± 27; head shorter, CL/CW 1.106. Postocular index very large, PoOc/CL 0.476. Postocular head much wider than preocular head, overall shape of head capsule trapezoidal. Occipital margin straight. Frontal carinae immediately caudal of FRS level converging caudad. Mesosoma massive, MW 624 ± 48. Whole dorsal head capsule fully microsculptured and covered with dense subdecumbent pubescence, thus appearing entirely mat, in particular occipital region in contrast to *C. stambuloffii* not shining. Clypeus, frontal laminae and vertex posterior of frontal laminae clearly longitudinally rugulose; remaining vertex more finely and densely longitudinally rugulose (the rugulae partially form a semireticulum); interspaces between rugulae with densely-packed tubercles of 8 - 10 µm diameter that form the bases of pubescence hairs. Foveolae on vertex completely lacking. Mesonotum because of shallower microsculpture more shining than vertex, rugulose, with small tubercles of 8 - 11 µm diameter at hair bases. Scutellum longitudinally rugulose, with similar tubercles in the interspaces. Whole propodeum, metapleuron, mesopleuron and anepisternite densely carinate, clearly stronger sculptured than in *C. stambuloffi*. Propodeal spines reduced to rather blunt dents. Petiole very high, dorsum less shining than in *C. stambuloffii*, clearly wider than long and not ending in a caudal corner. Postpetiole more than twice as wide as long and almost twice as wide as petiole, PPW/CS 0.862; postpetiolar sternite with strong and acute anteromedian dent. Whole body with dense subdecumbent to decumbent pubescence; pubescence on first gaster tergite extremely dense, sqrtPDG 2.46. Whole body more or less concolorous medium brown, mesosoma sclerites occasionally with lighter patches; appendages lighter. For morphometric data of 6 gynes see Tab. 17.

Comments: *Cardiocondyla koshewnikovi* is considered here as a Central Asian sister species of the W Palaearctic *C. stambuloffii*. The gynes are outstanding by a head size clearly above the upper extremes of any known Palaearctic species including *C. stambuloffii* and they additionally differ from the latter by a much stronger sculpture. The workers are more similar but can be separated on the individual level by a discriminant function using corrected data in which allometric variance was removed:

$$D(4) = - 0.38\ SL/CS_{cor} + 2.1\ SPBA/CS_{cor} + 1.24\ PPW/CS_{cor} - 2.0\ PPH/CS_{cor}$$

D(4) is 0.737 ± 0.086 [0.59, 0.87] in 31 Central Asian *C. koshevnikovi* specimens, 1.157 ± 0.089 [0.91, 1.36] in 47 W Palaearctic *C. stambuloffii* individuals, 0.78 in the type series of *C. koshewnikovi*, 1.17 in the type series of *C. stambuloffii*, 1.16 in the type series of *C. montandoni*, 1.10 in the topotypical specimen of *C. bogdanovi*, and 1.22 in the type series of *C. taurica*. Accessory discriminative characters of *C. koshewnikovi* are the sharper propodeal spines and the more sloping prespinal profile of propodeum. Moister spots in deserts or semideserts, which are frequently salty and situated at the margins of lakes or rivers, are reported as habitats of this species. Two nests were completely dug out by the author in the Saissan Depression 25 July 2001 in a moist *Phragmites* stand in the dune valley of a semidesert. One or two simple entrances (in one nest hidden under fragments of dead *Phragmites* leaves) led to one vertical duct that passed through three levels of horizontal galleries or chambers in the upper 10 cm of soil. One nest contained 7 ergatoid males, 5 freshly eclosed alate gynes, 35 gyne pupae, 5 gyne prepupae and 440 workers. Another nest contained 409 workers and as much as 27 dealate gynes, the reproductive status of which was not checked.

10.33 *Cardiocondyla gibbosa* Kuznetzov-Ugamsky, 1927

Cardiocondyla elegans gibbosa Kuznetzov-Ugamsky, 1927 [types investigated].

Investigated type material: lectotype worker (by present designation) and 3 **paralectotype** workers labelled "Cardiocondyla elegans gibbosa nov. 1927, Suzak 3 VII 1923" and "Turkestan Suzak Kusnezov", NHM Basel. Suzak is situated at 44.07 N, 63.27 E and belongs now to Kazakhstan.

Description: Worker (Fig. 48, Tab. 11): Head relatively long, CL/CW 1.195. Postocular distance large, PoOc/CL 0.458. Eye small, EYE 0.220. Anterior clypeal margin convex to straight. Clypeus, frontal laminae, and anterior area of vertex (about 60 % of total vertex surface) longitudinally carinulate-rugulose; strongest rugae mediofrontally of eyes. Interspaces between rugae relatively smooth, foveolae completely absent; tiny pits around bases of pubescence hair only visible with high-resolution stereomicroscopy (objective with numeric aperture 0.23, magnification 250 - 320x); tiny pits of 4 - 5 µm diameter well-visible on perfectly smooth posterior 40 % of vertex surface. Mesosoma in overall impression shining, with more profuse pubescence than in most other species. Frontal and dorsolateral areas of pronotum and propodeum dorsally glabrous. Ventrolateral area of pronotum, whole mesonotum, ventrolateral area of propodeum, mesopleurae, and metapleurae to a varying degree longitudinally rugulose with shining interspaces; the strongest rugae on meso- and metapleurae. Propodeal spines reduced to obtusely-angled corners. Waist segments entirely smooth, their shape as in *C. stambuloffii*, though postpetiole less than twice as wide as long. Gaster pubescence longer than in related species, PLG/CS 7.73 %. More or less concolorous medium to dark brown. For morphometric data of 4 workers see Tab. 11.

Comments: *Cardiocondyla gibbosa* is closely related to *C. stambuloffii*. The unique type of head sculpture, the much longer pubescence, and the more elongated head are sufficient arguments for heterospecifity. *Cardiocondyla gibbosa* is superficially similar to *C. tibetana* sp.n. but the shorter scape, the smaller eye, the much smaller dFOV, the larger postocular index, the wider postpetiole, and the longer pubescence enable a clear separation.

10.34 *Cardiocondyla tibetana* sp.n

Type material: holotype worker (the specimen with CW = 510) and 2 **paratype** workers labelled "S Takklamakan Desert: 81.41 E, 36.52 N, Cele Research Station, 1996.08.26", SMN Görlitz; 2 **paratype** workers pierced on minute pins in the same block of *Sambucus* pith and labelled "Tibet coll. G.Mayr", NHM Wien.

Description: Worker (Fig. 49, Tab. 11): Head moderately elongated, CL/CW 1.161. Scape longer, frons narrower, and eye distinctly larger than in members of *C. stambuloffii* group; SL/CS 0.849, FRS/CS 0.284, EYE 0.250. Postocular distance shorter than in *C. gibbosa*, PoOc/CL 0.424. Clypeus, frontal laminae, median and paramedian vertex very densely longitudinally carinulate-rugulose; distance between carinulae on central vertex only 4 - 5 µm. Carinulae on lateral area of vertex interrupted and with much larger, more or less shining interspaces. Poorly visible hair base punctures of only 5 - 8 µm diameter scattered in the interspaces; many of hair bases without surrounding micropunctures (Fig. 49 shows no average situation). Foveolae completely absent. Posterior third of head almost glabrous, only scattered hair base punctures present. Pronotum glabrous. Dorsal parts of mesonotum and propodeum mainly smooth and shining, longitudinal carinulae may occur. Mesonotum laterally with interrupted, meso- and metapleurae with stronger, more continuous longitudinal rugulosity. Propodeal spines reduced to very short dents. Petiole much lower and postpetiole much narrower than in members of *C. stambuloffii* group, PEH/CS 0.316, PPW/CS 0.502. Petiole node wider than long. Whole body rather concolorous medium to blackish brown, appendages and sometimes clypeus lighter with yellowish tinge. For morphometric data of five workers see Tab. 11.

Comments: The unique character combination of *Cardiocondyla tibetana* sp.n. enables a safe distinction from any known Palaearctic species both by morphometry, body shape, and microstructures. The minute hair base punctures and full absence of any foveolae on the vertex, as well as the shape of the spines and postpetiole are the reasons for positioning *C. tibetana* sp.n. near the *C. stambuloffii* group. However, the larger eye size, the narrower frons, the lower petiole height and postpetiole width indicate affinities to both the *C. elegans* and the *C. bulgarica* groups.

10.35 *Cardiocondyla wroughtonii* (FOREL, 1890)

Emeryia wroughtonii FOREL, 1890; Poona / India [types investigated].
Cardiocondyla wroughtonii: FOREL 1892.
Cardiocondyla wroughtonii var. *hawaiensis* FOREL, 1899; Hawaii: Molokai [type investigated].
Cardiocondyla wroughtonii ssp. *quadraticeps* FOREL, 1912; Singapore [types investigated], **syn.n.**
Cardiocondyla wroughtonii var. *bimaculata* WHEELER, 1929; Taiwan [types investigated].
Cardiocondyla longispina KARAVAJEV, 1935; Java [types investigated], **syn.n.**
Cardiocondyla yamauchii TERAYAMA, 1999; Okinawa /Japan [types investigated], **syn.n.**

Investigated type material: *Cardiocondyla wroughtonii*: **holotype** (ergatoid male) and 3 **paratype** workers labelled by Forel "Poona, Wroughton, s^r feuiles Eugenia jambolana, B_4", NHM Basel. 1 **paratype** worker, labelled by Forel himself "Wroughtonii Forel, Poona, Wroughton" and by G. Mayr "Wroughtonii, Forel, Type", NHM Wien. In his original description of *C. wroughtonii*, Forel erroneously considered the extremely deviating ergatoid male of this species as worker of a separate genus, *Emeryia*, that he believed to be a social parasite of *Cardiocondyla*. This ergatoid male was found together with workers and females of a *Cardiocondyla* species nesting in the space between the two layers of leaves of *Eugenia jambolana* in Poona / India (FOREL 1890). Later Forel corrected his mistake (FOREL 1892). Formally, the above-mentioned workers have no paratype status since the original description of *Emeryia wroughtonii* did not directly refer to them. However, their undoubted conspecifity with the holotype and their strong genetic relatedness give them a high taxonomic significance.

C. wroughtonii var. *hawaiensis*: **type** worker labelled "C.wroughtonii For. r. hawaiensis Forel type, Iles Sandwich" and "Molockai Mts., 3000 ft. Perkins IX 1893", MHN Genève.

C. wroughtonii ssp. *quadraticeps*: 3 **syntype** workers 2 **syntype** gynes, labelled "Singapore H.Overbeck" and "Cardiocondyla wroughtonii For quadraticeps For", ZM Berlin.

C. wroughtonii var. *bimaculata*: 5 **syntype** workers and 1 **syntype** gyne labelled "Karashisho Silvestri \ Wm.M.Wheeler \ Cotypes var. bimaculata Wheeler \ M.C.Z.Cotype 1-3 20746", MCZ Cambridge.

C. longispina: 5 **syntype** workers labelled "Tjibodas, Java Karavaiev \ 5377. Coll. Karavaievi \ Cardiocondyla longispina Karav. Typus"; IZ Kiev.

C. yamauchii: 3 **paratype** workers from the same sample as holotype: "Ada, Okinawa-jima Okinawa Pref. 12.VI.1991 K.Yamauchi leg." and "Cardiocondyla yamauchii Terayama, 1999, Paratype", SMN Görlitz.

Morphometrically investigated material (40 samples): **Australia:** Queensland: Mackay (Turner 302) w, g; Queensland: Mackay, 1907 (R.E. Turner No.244), w, g; **Brunei:** Lamunin vic.: Bukit Sulang, 1982.08.09; w; **Hawaii:** Molockai Mts. (Perkins), 1893, w; Sandwich Isl., 1912 (No.215), w, g; Kurtistown (19.35 N, 155.03 W), 1994.08.17, w; **India:** Poona (Wroughton), w; Rishikesh - 10 km NW, 1996.10.11, No.576, w; **Indonesia:** Amboina (Karavajev No. 2676), w; Bogor, 1999.12.18 - I5, w; Lombok, 1999.12.25 - I8, w; Sulawesi Utara: Dumoga Bone N.P.,1985, w; Sulawesi Utara: Dumoga Bone N.P.,1985.02.11, w; W Java: Tjibodas, w; **Japan:** Okinawa: Ada, 1991.06.12, w; Okinawa: Ada, 1993.07.02 - 4, w, g; **Malaysia:** Alor Setar, 1947.05, w, g; Kuala Lumpur vic., 1989.03/04, w, g; Kinabalu Park, 1996.02.27, w, g; Kinabalu Park, 1996.03.24; w; Negeri Sembilan: Pasoh Forest Reserve, 1994.03/04, w; Negeri Sembilan: Pasoh For. Res.,1994.11, w; Gombak, 1973.09.29, w; **Papua New Guinea:** Marobe prov., Wau, 1979.11.25, w; **Philippines:** Luzon: Benguet, W of Baguio, 1999.02.17, w; Luzon: S of Baguio, Bridal Falls, 1992.02.16, w; Luzon: Sagada, Echo Valley, 1999.02, w; Luzon: Sagada, Mt. Ampacao, 1999.02.20, w; Luzon: NE of Sagada, Banga'an, 1999.02.22, w; Luzon: S of Sagada, Bagnen, Mt. Polis, 1999.02.26, w; **Singapore:** Singapore (leg. H. Overbeck), w, g; **Sri Lanka:** Peradeniya, 1914.05, w, g; **Taiwan:** Karashisho (leg. Silvestri), w; **Thailand:** 1967.05.06, w; **Tanzania:** Dar es Salam, 1978.12, w; **USA:** Florida: Dade Co., Tamiami Trail, 1945.08.18, w, g; Florida: Bradenton (Reynolds), 1939.05 w; Florida: Lake Alfred, 2000 (R. J. Stuart), w, g; Florida: Lake Placid, Archbold St., 1944.04.12, w; New Orleans, 1979.06, w.

Description: Worker (Figs. 51, 57; Tab. 12): Small size CS 415. Head short, CL/CW 1.125. Scape short, SL/CS 0.776. Postocular index large, PoOc/CL 0.440. Eyes medium-sized, EYE 0.234. Frons very wide, FRS/CS 0.273, frontal carinae immediately behind FRS level parallel or slightly diverging. Anterocentral clypeal margin straight or slightly notched; central occipital margin usually straight or with very weak concavity. Whole head and mesosoma without any notable rugosity. Paramedian and lateral areas of vertex with deep (sometimes shallower) foveolae of 17 - 21 µm diameter which are frequently arranged densely honey-comb like and show an inner corona of 9 µm diameter; median area of vertex weakly foveolate-carinulate. Whole surface of mesosoma and waist densely foveolate-reticulate, the meshes with lower diameters than on vertex. Metanotal groove in lateral view deep and usually with steep anterior and posterior slopes. Propodeal spines longer than in *C. obscurior*, SP/CS 0.198, bases more approached. Axis of petiolar peduncle in lateral aspect deviating by 30° from longitudinal axis of petiole node. Postpetiolar sternite with characteristic anteroventral corners; in dorsal view convex petiole sides meeting with concave anterior margin in a distinct angle. *Light morph* (90 % of samples): whole ant entirely light-yellowish except for diffuse brown band in posterior half of 1st gaster tergite; this band band may be interrupted medianly, being reduced to lateral patches (seen in Wheeler's var. *bimaculata*), PigG1 16 ± 18 %. *Dark morph* (10 % of samples): Head, mesosoma, waist, and appendages light-yellowish brown; funicular club blackish brown; 1st gaster tergite and sternite dark brown, following segments substantially brighter, PigG1 93 ± 4 %. For morphometric data of 79 workers see Tab. 12.

Gyne (Tab. 19): Very small, CS 442. Head short, CL/CW 1.146 Postocular index relatively large, PoOc/CL 0.436 Scape short, SL/CS 0.757. Central occipital margin more or less straight. Anterior clypeal margin between level of frontal carinae usually straight. Frontal carinae strongly diverging caudad immediately behind FRS level. With exception of 4 - 5 longitudinal rugae on metapleuron, whole head and mesosoma without any rugosity. Paramedian area of vertex with deep, densely arranged foveolae of 17 - 20 µm diameter, showing inner coronae of 9 µm diameter. Whole surface of mesosoma and waist densely foveolate, foveolae on dorsal mesosoma similar to those on vertex, those on lateral area of mesosoma and in particular on waist with significantly lower diameters. Propodeal spines acute, and directed caudad, longer than in other Palaearctic species, SP/CS 0.203; ratio SPBA/SP 1.714 ± 0.101 [1.64, 1.89] (n = 5). Postpetiole with marked anteroventrolateral corners; in dorsal view, its convex sides meet the concave anterior margin in a distinct angle. Head, mesosoma, and waist yellowish, small patches at wing insertions notably darker; antennal club slightly infuscate; first gaster segment except for small areas near postpetiole dark brown, following gaster segments lighter brown to yellowish brown. For morphometric data of 16 gynes see Tab. 19.

Comments: *Cardiocondyla wroughtonii* shares diagnostic characters such as short head, widely distant frontal carinae, marked anterolateral corners of petiole sternite, long spines, small size, and steep slopes of the metanotal groove with its sister species *C. obscurior* and *C. shagrinata* sp.n.

Worldwide geographic variability is rather low in *C. wroughtonii*, some taxonomically described forms may deviate in few characters. The type worker of the subspecies *C. w. hawaiensis* from Hawaii has less dense and less deep vertex foveolae and less sharp anterior postpetiolar corners, but is in the majority of characters consistent with the *C. wroughtonii* types from Poona. The same is true for the syntypes of *C. longispina*, which, however, show lower waist measures and a shallower metanotal groove. The type workers and gynes of *C. w.* ssp. *quadraticeps*, *C. w.* var. *bimaculata*, and *C. yamauchii* are in each morphometric and structural character consistent with the population means of cosmopolitan *C. wroughtonii.* The types of all these 6 taxa can be clustered together and separated from the *C. obscurior* cluster by discriminant functions (see discussion under *C. obscurior* and Fig. 71).

10.36 *Cardiocondyla obscurior* WHEELER, 1929, stat.n.

Cardiocondyla wroughtonii var. *obscurior* WHEELER, 1929; Taiwan: Eisei [description].
Cardiocondyla bicolor DONISTHORPE, 1930; Israel [type investigated], **syn.n.**
Cardiocondyla wroughtonii (sensu KINOMURA & YAMAUCHI 1987, misidentification) [photo documentation].
Cardiocondyla wroughtonii (sensu STUART & al. 1987, misidentification) [authentic material investigated].

Cardiocondyla wroughtonii (sensu TERAYAMA & al 1992, misidentification) [authentic material investigated].
Cardiocondyla wroughtonii (sensu HEINZE & HÖLLDOBLER 1993, misidentification) [authentic material investigated].
Cardiocondyla wroughtonii (sensu TERAYAMA 1999, misidentification) [authentic material investigated].

Investigated type material: *Cardiocondyla bicolor*: **holotype** worker labelled "Palestine: Drs. D.Scheinkin & J.Carmin B.M.1930-163\ On Ficus sycamore\ bicolor Donisthorpe\ Type"; 1 worker **paratype** labelled "Palestine: Drs. D.Scheinkin & J.Carmin B.M.1930-163\ On Ficus sycamore\ bicolor Donis.\ Cotype"; BMNH London.

Morphometrically investigated material (26 samples): **Brazil:** Bahia: Una, 1998.03, w, g; **Germany:** Berlin - City, 1999, w; **Caribbean:** Bermuda: Paget Parish, 1997.09.13, w; Puerto Rico: Aguada, 1987.04.06 - 471, w; Puerto Rico: Cayo Icacos, 1982.07.16, w; Virgin Islands: Guana Isl. (18.29 N, 64.34 W), 1993.07, w; **Hawai**: Kurtistown (19.35 N, 155.03 W), 1994.08.17, w; Hilo (19.40 N, 155.04 W), 1994.08.17, w; **India:** Uttar Pradesh: Dehra Dun - 10 km SE, 1996, g; **Israel:** "Palestine 1930", w; Tel Aviv, 1945.12, w, g; W. Ara, Cardi, 1974.08.28, w; **Japan:** Ogasawara Isl.: Chichi-jima, 1972.08.01, w; Okinawa: Ishigaki-jima, 1991.06.05, w, g, m; Okinawa: Nago, 1993.06.30 - 3, w, g; **Kenya:** Kajiado, 1999.10, w; **Polynesia**: Anatahan Island (16.23 N, 145.42 E), 2002.04.02, w; **Nepal:** Pokhara, 1988, g; **Spain:** Tenerife: Puerto de la Cruz, 1999.04, No.91, w; Tenerife: Puerto de la Cruz, 1999.04, No.92, w; Tenerife: Puerto de la Cruz, 1999.04, No.93, w; **Taiwan:** Kagi (leg. R. Takahashi), 1927.01.11, g; **USA:** Florida: Gainesville, 1983, w; Florida: Gainesville, University Campus, 1984.08.10, w, g; Florida: Lake Placid, 1985 (R J Stuart), w, g; Florida: Volusia Country: Deland, 1997.10.10, w, g.

Description: Worker (Figs. 52, 56, 71; Tab. 12): Small size CL 428. Head very short, CL/CW 1.108. Scape short, SL/CS 0.780. Postocular index rather large, PoOc/CL 0.435. Eyes medium-sized, EYE 0.232. Frons wide, FRS/CS 0.270, frontal carinae immediately behind FRS level parallel or slightly diverging. Anterior clypeal margin between level of frontal carinae frequently slightly notched; median occipital margin usually slightly concave; overall head shape posterior of eyes less rounded than in *C. wroughtonii*. Whole head and mesosoma without any notable rugosity. Paramedian and lateral areas of vertex with deep (sometimes shallower) foveolae of 17 - 21 µm diameter, frequently in dense honey-comb like arrangement, usually showing an inner corona of 9 µm diameter; median vertex weakly foveolate-carinulate. Whole surface of mesosoma and waist densely foveolate-reticulate, the meshes with lower diameters than on vertex. Metanotal groove in lateral view usually with rather steep anterior and posterior slopes, occasionally shallower than in *C. wroughtonii*. Propodeal spines long, shorter than in *C. wroughtonii*, SP/CS 0.178; outer spine base distance wider than in *C. wroughtonii*, SPBA/CS 0.293. Petiolar peduncle in lateral aspect deviating 30° from longitudinal axis of petiole node that is often more square-shaped than in *C. wroughtonii*. Postpetiole as a rule more massive than in *C. wroughtonii*, as in this species with characteristic anteroventrolateral corners; in dorsal view, convex sides meeting concave anterior margin in distinct angle. Head, mesosoma, and waist brightly yellowish or yellowish brown, antennal club usually notably infuscated. In contrast to dark morph of *C. wroughtonii*, all gaster segments dark blackish brown, PigG1 98 ± 4 %. For morphometric data of 39 workers see Tab. 12.

Gyne (Tab. 19): Very small size, CS 460. Head very short, CL/CW 1.122. Postocular index shorter than in *C. wroughtonii*, PoOc/CL 0.423. Scape rather short, SL/CS 0.755. Median occipital margin and anterior clypeal margin between level of frontal carinae straight or slightly concave. Frontal carinae immediately caudal of FRS level diverging or subparallel. With exception of 4 - 5 longitudinal rugae on metapleuron, whole head and mesosoma without any rugosity. Paramedian area of vertex with deep, densely arranged foveolae of 18 - 22 μm diameter, showing inner coronae of 9 μm diameter. Whole surface of mesosoma and waist densely foveolate, foveolae on dorsal mesosoma similar to those on vertex, those on lateral area of mesosoma and in particular on waist with significantly lower diameters. Propodeal spines long, but shorter than in *C. wroughtonii*, SP/CS 0.187, ratio SPBA/SP 1.942 ± 0.138 (n = 8). Postpetiole with sharp anteroventrolateral corners; in dorsal view, its convex sides meet the concave anterior margin in a distinct corner. Head, mesosoma, and waist yellowish, small patches at wing insertions notably darker; antennal club frequently infuscate; all gaster segments on whole surface brown to dark blackish brown. For morphometric data of 20 gynes see Tab. 19.

Comments: The three investigated gynes from the MCZ collection, labelled by Wheeler "Kagi, Formosa 11.1.1927 R.Takahashi Wm.M.Wheeler\ Cotypes\ var. obscurior Wheeler" fully match the conception of *C. obscurior* presented here but cannot be considered as genuine type material. These gynes were the basis of a second description, published on 7 March 1930 (WHEELER 1930). Wheeler's first description, published on 22 October 1929, was based upon one worker and a headless dealate queen collected at Eisei / Formosa (WHEELER 1929). These specimens were not available from MCZ Cambridge and are believed to be lost. Hence, the identity of *C. obscurior* was concluded from the text of the 1929 description. This conclusion is supported by the identity of the sympatric sample from Kagi. In the case of *C. wroughtonii* vs. *C. obscurior* we have the rare case of a useful pigmentation character that was already recognized by WHEELER (1929). He distinguished two varieties of *C. wroughtonii*: a var. *bimaculata* that has "the dorsal surface of the first gastric segment largely occupied by a broad transverse, dark brown spot which is notched in the middle behind" and another form, his var. *obscurior*, that has the "whole gaster dark brown". All 20 worker samples of *C. obscurior* available for this study are in agreement with Wheeler's description and light morphs are so far not known in *C. obscurior*. About 90 % of 39 studied worker samples of *C. wroughtonii* were light morphs matching Wheeler's definition of *C. bimaculata*, while dark morphs of *C. wroughtonii* approaching his definition of *C. obscurior* are so far only known from the Philippines and Malaysia and these have the caudal gaster segments lighter than the first. Hence, it is justified to refer the name *C. obscurior* WHEELER, 1929 to the sister species of *C. wroughtonii*.

TERAYAMA (1999) used the alleged inability of *C. obscurior* to produce alate males as prime argument for a heterospecifity from *wroughtonii*. However, both entities definitely produce alate and ergatoid males (Yamauchi in lit. 3 July 2000, my own material). Average differences in chromosome numbers seem to exist but the numbers are not constant. *C. wroughtonii* from the Okinawa Islands had 2n = 56 chromosomes while sympatric *C.obscurior* had 2n = 52 chromosomes (Yamauchi in lit., 3 July 2000). A *C. obscurior* sample from Gainesville/Florida had 2n = 48 (Francoeur in lit., 19 October 2000).

The best indication for a separate species identity is given by differences in morphometry, gastral pigmentation pattern, and selection of nest habitats. *C. obscurior* was reported to nest in cavities of bushes and trees 2 - 5 m above the ground level; it was found in dead twigs of trees such as *Erythrina variegata* (Okinawa), in dwarf coconuts (Brazil), galls of *Acacia* trees (Brazil), in a dead twig on a tree (Florida), on a *Ficus* tree (Israel), in the gall of a *Tamarix* bush (Israel), and in the cavity of a coconut high in the tree (Zanzibar). *C. wroughtonii*, in contrast, was reported to nest near to or on the ground; it was found in hollow stems of dead *Eulalia* grasses (Okinawa), in a dead twig on the ground (New Orleans/USA), between layers of *Eugenia jambolana* leaves (India), in litter (Sulawesi), and "under leaves in a silk patch" (Tanzania).

The workers of *C. obscurior* differ from *C. wroughtonii* by darker gaster pigmentation, shorter head, smaller postocular distance, narrower frons, wider and higher waist segments, wider spine base distance, and shorter spine length. The discriminant

D(10) = 0.13 ln (PigG1 + 100) - 0.35 CL/CW - 0.17 PoOc/CL - 0.68 FRS/CS + 1.33 SPBA/CS - 2.13 SP/CS + 0.7 PEW/CS + 1.34 PPW/CS + 0.12 PEH/CS + 0.65 PPH / CS

separates worker nest sample means of *C. wroughtonii* with D(10) 0.941 ± 0.051 [0.822, 1.027] (n = 39) and of *C. obscurior* with D(10) 1.128 ± 0.028 [1.095, 1.182] (n = 20).

The synonymies listed under *C. wroughtonii* are strongly confirmed by these values: D(10) is 0.946 in 3 syntypes of *C. wroughtonii*, 0.919 in the type of *C. w.* var. *hawaiensis*, 0.958 in 3 syntypes of *C. w.* ssp. *quadraticeps*, 0.907 in 3 syntypes of *C. w.* var. *bimaculata*, 0.884 in 3 syntypes of *C. longispina*, 0.926 in 3 syntypes of *C. yamauchii*, but 1.154 in the 2 syntypes of *C. bicolor* (Fig. 71).

Individual gynes can be separated by a discriminant function

D(6) = 0.29 MW/CS + 0.34 ML/CS - 0.13 CL/CW - 1.52 PoOc/CL - 3.0 SP/CS + 1.056 PPW/CS + 0.35ln(PigG1 + 100)

with D(6) 1.603 ± 0.033 [1.532, 1.660] (n = 20) in *C. obscurior* and 1.417 ± 0.044 [1.308, 1.482] (n = 16) in *C. wroughtonii*. The alleged cotype gynes of *obscurior* from Kagi / Formosa have D(6) 1.564 and 1.568.

In the laboratory of Yamauchi, males of *C. obscurior* and gynes of *C. wroughtonii* produced hybrids; the opposite mating combination so far not (Yamauchi in lit. 3 July 2000). Whether hybridisation plays a role under natural conditions remains obscure and is most difficult to detect with the methods applied here.

Ergatoid males were investigated from two sites in *C. wroughtonii* and from three sites in *C. obscurior*. The sparse material indicates significant differences in the following characters:

(1) the ratio of maximum cephalic width caudal of the eyes / across the eyes is 1.037 - 1.048 in *C. obscurior* and 1.000 - 1.008 in *C. wroughtonii*.

(2) SL/CS is 0.537 - 0.557 in *C. obscurior* and 0.603 - 0.655 in *C. wroughtonii*.

(3) PEW/PPW is 0.565 - 0.600 in *C. obscurior* and 0.646 - 0.649 in *C. wroughtonii*.

(4) the anterior postpetiolar margin is more strongly concave in *C. obscurior*.

There is no suggestion that *C. yamauchii*, described from Okinawa, could be heterospecific from *C. wroughtonii* and that "*C. wroughtonii*" sensu TERAYAMA 1999 from Okinawa could be different from *C. obscurior*. Selection of nest habitat, the pigmentation characters, and in particular the results of high-precision morphometry (Tab. 4, Fig. 71) strongly support this interpretation.

Tab. 4: Worker discriminant score D(10) and the 10 morphometric characters to calculate D(10) of *C. wroughtonii* from Okinawa (= *C. yamauchii* TERAYAMA, 1999, junior synonym), of cosmopolitan *C. wroughtonii*, of *C. obscurior* from Okinawa (= *C. wroughtonii* sensu TERAYAMA 1999, misidentification), and of cosmopolitan *C. obscurior.*

	C. wroughtonii Okinawa (n = 6)	*C. wroughtonii* cosmopolitan (n = 73)		*C. obscurior* Okinawa (n = 5)	*C. obscurior* cosmopolitan (n = 34)
D(10)	0.919± 0.044	0.932 ± 0.054		1.085 ± 0.025	1.118 ± 0.034
PigG1	24 ± 2	22 ± 28		98 ± 2	98 ± 4
PPW/CS	0.438 ± 0.011	0.437 ± 0.011		0.452 ± 0.008	0.457 ± 0.012
PEH/CS	0.330 ± 0.007	0.327 ± 0.011		0.338 ± 0.006	0.341 ± 0.011
PPH/CS	0.307 ± 0.006	0.303 ± 0.011		0.316 ± 0.012	0.316 ± 0.010
SP/CS	0.204 ± 0.016	0.197 ± 0.015		0.176 ± 0.007	0.179 ± 0.012
PoOc/CL	0.447 ± 0.004	0.439 ± 0.010		0.434 ± 0.004	0.435 ± 0.008
PEW/CS	0.285 ± 0.021	0.276 ± 0.012		0.285 ± 0.011	0.292 ± 0.013
SPBA/CS	0.275 ± 0.015	0.278 ± 0.011		0.283 ± 0.008	0.295 ± 0.012
FRS/CS	0.270 ± 0.008	0.273 ± 0.008		0.275 ± 0.004	0.269 ± 0.005
CL/CW	1.130 ± 0.015	1.125 ± 0.023		1.126 ± 0.014	1.106 ± 0.019

10.37 *Cardiocondyla shagrinata* sp.n

Type material: holotype worker labelled by Forel "C.Wroughtonii Forel ☿ South Konkan (Wroughton) I/10", MZ Lausanne; 2 **paratype** workers with the same labelling in SMN Görlitz ["South Konkan" is in W India approximately at 18°N 73°E].

Description: Worker (Figs. 53, 55; Tab. 12): Small size CS 426. Head extremely short, CL/CW 1.099. Scape short, SL/CS 0.760. Postocular index smaller than in *C. wroughtonii*, PoOc/CL 0.427. Eyes small, EYE 0.222. Frons very wide, FRS/CS 0.285, frontal carinae immediately behind FRS level slightly diverging caudad. Anteromedian clypeal margin notched, median occipital margin in 2 of 3 specimens notched. Whole body surface without any carinulae, rugae, or clearly visible foveolae. Paramedian area of vertex with very dense, somewhat irregular reticulum, whose meshes have an inner diameter of 6 - 8 µm. Frontal lobes, median area of head posterior of frontal lobes, and dorsal area of mesosoma densely shagreened. Lateral area of mesosoma and waist with dense reticulum, whose meshes with inner diameter of 4 - 5 µm. Metanotal groove in lateral view with very steep slopes. Propodeal spines long and acute, slightly diverging and incurved in dorsal view, SP/CS 0.184. Outlines of promesonotal plane in dorsal view trapezoid, i.e. sides more or less continuously linearly diverging from level of metanotal groove frontad to the very pronounced, angulate pronotal "shoulders"; anterior margin of dorsal plane only weakly convex (in *C. wroughtonii* and *C. obscurior*, sides of dorsal mesonotal plane firstly showing a strong convex divergence frontad from the level of metanotal groove; this curvature is replaced by weaker and more linear divergence frontad to the less pronounced and more rounded pronotal "shoulders"). Axis of petiolar peduncle in lateral aspect deviating by 15° from longitudinal axis of petiole node. Postpetiole with anteroventrolateral corners (weaker than in typical *C. wroughtonii* and *C. obscurior*); in dorsal view, the strongly convex sides form with the concave anterior margin a blunt angle and converge significicantly more than in *C.*

wroughtonii. Head, mesosoma, waist, and appendages yellow or light-yellowish brown; gaster dark brown. For morphometric data of 3 workers see Tab. 12.

Comments: *Cardiocondyla shagrinata* sp.n. seems to have a restricted distribution and it is easily distinguished from the cosmopolitan sister species *C. wroughtonii* and *C. obscurior* by its characteristic sculpture and dorsal aspect of mesosoma (Figs. 52 - 57). Morphometrically, *C. shagrinata* sp.n. is most similar to *C. obscurior* from which it differs by the larger FRS/CS and much smaller dFov.

10.38 *Cardiocondyla nana* sp.n.

Type material: holotype worker labelled "BRUNEI: Ulu Temburong L.P.-283.m.T. 22.ii.82.MC.Day", BMNH London.

Description: Worker (Fig. 54, Tab. 12): Smallest known *Cardiocondyla* species, CS 366. Head extremely short, CL/CW 1.069. Scape rather long, SL/CS 0.818. Postocular index large, PoOc/CL 0.464. Eyes without any microsetae and small, EYE 0.220. Median third of anterior clypeal margin deeply, median third of occipital margin slightly concave. Frontal carinae immediately caudal of FRS level slightly diverging, FRS/CS 0.266. Anterior clypeus smooth, not shining. Frontal laminae and anteromedian vertex with weak microsculpture, consisting of an irregular mixture of corrugated, foveolate, and carinulate elements. Paramedian and lateral areas of vertex with a unique sculpture: densely-arranged, deeply impressed, and flat-bottomed foveae of 19-23 µm diameter show a well-demarcated central ring of 8-9 µm diameter which is connected with the outer ring through 2-4 very fine microcarinulae (frequently in a characteristic 90° cross-wire arrangement, in other foveae the number of microcarinulae may be reduced below 2). Whole lateral area of mesosoma, anterior area of pronotum, and dorsal area of propodeum strongly microreticulate; dorsal area of promesonotum similarly foveate as paramedian vertex. Longitudinal sculpture on whole mesosoma, including metapleural gland bulla, completely absent. Petiole strongly microreticulate, postpetiole shining, very finely microreticulate. Spines long and thin, in profile deviating from longitudinal mesosomal axis by 45°. Metanotal groove deep. Petiole in profile with almost linear (only slightly concave) anterior face and semicircular dorsum. Anterior postpetiolar sternite instead of corners with a strong, curved carina on each side; in frontal view, anterior sternite thus appearing deeply concave. Petiole in dorsal view with rather slender peduncle and almost globular node, which is slightly longer than wide. Postpetiole in dorsal view with a concave anterior margin and convex sides. Surface of 1st gaster tergite shining, with sparser pubescence than in other members of *C. wroughtonii* group. All body parts light-yellowish. For morphometric data of the holotype see Tab. 12.

Comments: *Cardiocondyla nana* sp.n. is a species with unique combination of extremely small size, short head, long scape, long spines, very sparse pubescence, peculiar type of microsculpture, and characteristic shape of petiole and postpetiolar sternite.

10.39 *Cardiocondyla emeryi* Forel, 1881

Cardiocondyla emeryi Forel, 1881; St.Thomas / Virgin Islands [types investigated].
Cardiocondyla emeryi var. *rasalamae* Forel, 1891; Madagascar [types investigated].

Cardiocondyla emeryi ssp. *mahdii* KARAVAJEV, 1911; Khartoum / Sudan [types investigated].
Cardiocondyla nuda ssp. *nereis* W.M. WHEELER ,1927; Norfolk Island [types investigated].
Cardiocondyla mauritia DONISTHORPE, 1946; Mauritius [type investigated].

Investigated type material: *Cardiocondyla emeryi*: 2 **syntype** workers labelled by Forel "Cardiocondyla Emeryi Forel ♂ Antilles St. Thomas (Forel)", MHN Genève.

C. emeryi var. *rasalamae*: 2 **syntype** workers labelled by Forel "C. emeryi ♂ Forel v. rasalamae Forel, Antananarivo Camboúe", MHN Genève. 1 **syntype** worker labelled by Forel "C. emeryi ♂ Forel v. rasalamae Forel, Antananarivo (Camboúe)" and by G. Mayr "Emeryi v. rasalamae Forel, Type", NHM Wien.

C. emeryi ssp. *mahdii*: 3 **syntype** workers labelled by Karavajev "Cardiocondyla mahdii sp.n. Karaw., Khartum 1900 W.K.", MHN Genève and NHM Basel.

C. nuda ssp. *nereis*: 4 **syntype** workers and 3 **syntype** gynes labelled "Norfolk I, A.M.Lea \ Wm.M.Wheeler \ M.C.Z. CoType 27887 \ subsp. nereis Wheeler", MCZ Cambridge.

C. mauritia: 1 **type** worker labelled "Mauritius 1941-45, 102, R.Mamel", "Pres.by Imp.Inst.Ent.B.M.1947-128", "Cardiocondyla mauritia H.Donisthorpe 1945 TYPE", BMNH London.

Morphometrically investigated material (81 samples): **Aldabra Islands:** Dune d'Messe, 9.22 S, 46.20 E, 1971.05.13, w; **Angola:** Luanda - 6.5 km S, 1949.08.23, w; **Botswana:** Shanobe, 1975.06.23, w; **Brazil:** Bahia: Itabuna, 1998, w; **Burundi:** Barage, 1977.10.23, w; **Cameroon:** Mbalmayo, 1993.11, w; Nkoemvon, 1980, w; **Cape Verde:** Cap Verde Island, 1989, g; Fogo: Cha des Chaldeiras, 1979.11.03, w; Sao Vicente: Rib.Juliao, 1953, w; **Caribbean:** Barbados: N of Bridgetown, 1995.01.01, w, g; Cuba: Cienfuegos, 1933.07.31, No.17, g; Cuba: Cienfuegos, 1933.08, w; Cuba: Cienfuegos, 1933.08.31, No.31c, w; Cuba: Cienfuegos, 1933.12, w; Cuba: Pinar del Rio: Majagua, 1930.01.03, w; Cuba: Pinar del Rio: Mariel, 1930.01.20, w; Cuba: Pinar del Rio: Mariel, 1931.02.06, w; Cuba: San Antonio de los Banos, Pazos, w; Grenada (Weber), w; Puerto Rico: Camp Tortuguero, 1950.10.27, w; Puerto Rico: Cayo Congo, 1983.05.20, w; Puerto Rico: Desecheo, 1981.05.10, w; Puerto Rico: Dorado, 1985.08.06 (samples No. 223, 225), w;: Puerto Rico: Humacao: Cayo Luis Pena, 1982.10.09, w; Puerto Rico: Humacao: San Lorenzo - 10 km SSW, 1989.07.26 (samples No.33, 38), w, g; Puerto Rico: Mayaquez, 1936.02/03, w; Puerto Rico: Mona Island, 1982.06.29, w; Puerto Rico: Ponce Agr. Exp.Stat., 1980.02.27, w; Puerto Rico: Punta Salinas, 1981.07, w; Puerto Rico: Salinas, 1950.07.01, w; Puerto Rico: Salinas, 1988.04.28 - 515, w; Puerto Rico: San Lorenzo, carr. 7740, km 1.2, 1979.04.03 (samples No. 0, 12), w; Puerto Rico: San Lorenzo, carr. 7740, km 1.3, 1979.05.22, g; St. Kitts (Weber), w; Virgin Islands, Dutch Cayo, 1982.11.10, w; Virgin Islands, Guana Isl.(18.29N, 64.34W), 1993.07, g; Virgin Islands: Guana Isl. (18.29 N, 64.34 W), 1993.10.27, w; Virgin Islands, St.Thomas (Forel), w; West Indies: Anguilla (18.13 N, 63.02 W), 1980.04.04, w; Tobago: Plymouth, 2000.08 (samples No. T14, T23, T33), w; **Chagos Islands:** Diego Garcia (7.18 S, 72.26 E), 1971.05.13, w; **Egypt:** Siwa Oasis (29.33 N, 25.11 E), 1935.06.30, w; **Israel:** Jaffa (leg. André), w; Michmoret, 1980.11.30, w; Tel Aviv, 1944.09.10, w; **Madagascar:** Antananarivo (Camboué), w; **Mauritius:** Mauritius 1941 - 1945, w; **Madeira:** Furado (Schmitz), w; Funchal (Schmitz), w; Funchal, 1960.11, w, g; Madeira, 1933.08.19, w; Paul do Mar, 2001.06.14, w; **Morocco:** Agadir: Hotel Hacienda, 1992.05, w; **Nepal:** Kathmandu, 1988.06, w; **Nigeria:** Gambari, 1969.06.10, w; Ibadan, 1987.10, w; **Polynesia:** Hawaii: Mokapun Oahu, 1938.06.22, w; Norfolk Island, 1915, w, g; **Rwanda:** Barage, 1977, w; **South Africa:** Durban, 1914.09.26, w; Transvaal: Nelspruit, 1980, w; **Spain:** Isla Gomera: Playa del Gran Rey, 1981.05.05, w; Isla Lanzarote, Costa Taguise, 1988.10 (A. Norris), w; **Sri Lanka:** Bandarawella, 198801.15, w; **Sudan:** Khartoum, 1900, w; Wadi Halfa, 1962.01.28, w; **Uganda:** Ruwenzori: Semliki Forest, 1952, w; **USA:** Florida: Miami, 1911.11.05, w; **Seychelles:** Little Sister Island, 1975, w; **St. Helena:** Ascension, 1958, w; **Tanzania:** Ibaya - 1 km N (3.58 S, 37.47 E), 1996, w; Lindi (9.59 S, 39.42 E), 1936.10.22, w; **Yemen:** Al Mahrah, S. Ba Angood, 1997.02.13 (samples No. 0, 3376) w; **Zimbabwe:** Bembesi, 1913.01.12, w.

Description: Worker (Figs. 6, 58, 59; Tab. 13): Small size, CS 411. Head elongated, CL/CW 1.229. Scape short, SL/CS 0.758. Postocular index large, PoOc/CL 0.467. Eyes medium-sized, EYE 0.246. Frons very narrow, FRS/CS 0.215, frontal carinae immediately behind FRS level slightly converging and then diverging. Occipital margin more or less straight, with a suggested concavity. Whole head and mesosoma without longitudinal rugosity, except for small patches with weak carinulae mentioned below. Anterior clypeal margin with weak median concavity; central surface of clypeus in type specimens of *C. emeryi* with suggestions of flat foveolae, in type specimens of *C. emeryi* var. *rasalamae* with fine, interrupted fragments of carinulae and without any foveolae. Vertex in types of *C. emeryi* with deeply impressed, flat-bottomed foveolae of 17 - 19 µm diameter in densely-packed honey-comb arrangement; foveolae showing an inner corona (tubercle) of 8 - 9 µm diameter (Fig. 58); median vertex with weak, interrupted longitudinal carinulae. Vertex in types of *C. e.* var. *rasalamae* in overall impression rather shining, structure and strength of sculpture radically different from that in types of *C. emeryi* (Fig. 59), showing shallow, but well-demarcated foveolae of 14 - 17 µm diameter, which occasionally possess an inner corona (tubercle); interspaces about as wide as foveolar diameter, much shining, with very fine cross-branched microcarinulae that may completely surround foveolae (= perifoveolar reticulum). Whole surface of mesosoma in types of *C. emeryi* with well-pronounced and dense microreticulum with meshes of 9 - 12 µm diameter; dorsal mesosoma additionally with scattered foveolae. Dorsal area of mesosoma in the types of *C. emeryi* var. *rasalamae* much less deeply sculptured than in *C. emeryi* types, moderately shining, with shallow foveolae similar to those on vertex; lateral area of mesosoma entirely reticulate but more delicately than in *C. emeryi* types. Petiole, except for the more smooth dorsal surface with well-pronounced and dense microreticulum that is weaker the *C. emeryi* var. *rasalamae* types. Postpetiole more smooth, with finer reticulum. Promesonotal dorsum showing in profile a continuous shallow convexity, not abruptly sloping into the moderately deep metanotal groove. In *C. emeryi* types, anterodorsal profile of propodeum convex, caudodorsal profile linear and slightly sloping downwards, spines deviating from longitudinal mesosomal axis by 40°. In *C. e.* var. *rasalamae* types, whole dorsal profile of propodeum very shallowly convex, not sloping downwards, spines less erect. Petiole node in dorsal view distinctly longer than wide; petiolar peduncle moderately long. Postpetiole in dorsal view wider than long, with shallowly concave anterior margin and evenly convex sides; postpetiolar sternite showing a conspicuous anteroventral prominence or bulge, without dents or carinae (Fig. 6). Different colour variants known: in most frequent variant whole body yellowish except for blackish gaster and terminal segment of antennal club; sometimes whole body dark or dirty brown. For morphometric data of 115 workers see Tab. 13.

Gyne (Tab. 19): Very small size. Head elongated, CL/CW 1.180. Scape very short, SL/CS 0.731. Postocular index large, PoOc/CL 0.448. Occipital margin more or less straight. Anteromedian clypeal margin between level of frontal carinae straight to slightly concave. Frons very narrow, FRS/CS 0.216, frontal carinae in posterior part almost parallel. Vertex in the *emeryi* morph with deeply impressed, flat-bottomed foveolae of 16 - 17 µm diameter in densely-packed arrangement, foveolae showing an inner tubercle of 8 - 9 µm diameter; vertex sculpture in the *rasalamae* morph similar, but foveolar diameter a little smaller and arrangement less dense. Clypeus and narrow median stripe of anterior vertex frequently with short fragments of weak carinulae. Whole mesosoma without elements of longitudinal sculpture, except for 4 - 6 weak longitudinal carinae on lateral area of metapleuron. Whole dorsal area of mesosoma with deep, densely-packed foveolae; in the *rasalamae* morph foveolae less deep. Lateral area of mesosoma and petiolar peduncle reticulate. Petiole node foveolate, in dorsal view longer than wide, axis of petiolar peduncle deviating in lateral view from petiolar node axis by 45°. Spines well-developed, their axis deviating in lateral view by 18 - 30° from longitudinal mesosomal axis. Postpetiole with a strong anteroventral bulge, in dorsal view wider than long, with strongly convex sides, slightly concave anterior margin, and foveolate. Gaster tergites shining, but with very fine microreticulum. Colour bimorphism. Light form: lateral area of mesosoma, waist, and appendages yellowish; scutellum, gaster, and antennal club dark brown; remaining body parts yellowish brown. Dark form: whole body dark brown; coxae, femora, tibiae, scape, base of funiculus, and ventrolateral area of pronotum yellowish. For morphometric data of 12 gynes see Tab. 19.

Comments: The type specimens of *C. emeryi* and *C. emeryi* var. *rasalamae* show the external morphology of separate species. However, a consistency of these differences was not demonstrable on a larger scale and both taxa are assumed to represent different genotypes of the same polymorphic species. The cosmopolitan population of *C. emeryi* shows extreme polymorphism in microsculpture clearly exceeding the usual intraspecific variability known for *Cardiocondyla.* 55 % of the specimens show deeply impressed and densely packed vertex foveolae (named here sculpture score 3 or SC3, as found in the type specimens of *C. emeryi*, Fig. 58). 26 % of the specimens show shallow, well-distant vertex foveolae, which are surrounded by a perifoveolar reticulum (named here sculpture score 1 or SC1, as found in the type specimens of *C. e.* var. *rasalamae, C. e.* ssp. *mahdii*, and *C. nuda* ssp. *nereis*, Fig. 59). 19 % of the specimens show an intermediate sculpture type (sculpture score 2 or SC2, as found in the type specimen of *C. mauritia*). SC1 and SC3 were so far not observed within the same sample but were twice observed at the same site. The linear correlation coefficient between sculpture score and the following morphometric characters is highly significant ($p < 0.0001$) for 115 investigated specimens: -0.611 (SL/CS), 0.484 (PEH/CS), 0.435 (PEW/CS), 0.401 (PPW/CS), 0.353 (PPH/CS), and 0.349 (dFOV). The arithmetic means of these characters in specimens of the 3 sculpture types are as follows:

	SL/CS	PEW/CS	PPW/CS	PEH/CS	PPH/CS	dFov
SC1 (n = 30)	0.771	0.254	0.469	0.320	0.330	15.43
SC2 (n = 22)	0.764	0.261	0.474	0.327	0.334	15.86
SC3 (n = 63)	0.752	0.269	0.483	0.334	0.339	16.21

SC3 specimens predominate in the Caribbean and adjacent regions. They have significantly shorter scapes and wider and higher waist segments than SC1 specimens, which predominate in E and N Africa and the Near East. Intermediate SC2 specimens are most abundant on the Atlantic islands and in Central Africa and show also intermediate morphometric characters. The distribution pattern of SC3 suggests American SC3 specimens to have been anthropogenically introduced from W Africa via the intensive shipping connections that were established as early as 400 years ago in connection with the transport of plant material and slaves. Some of the Atlantic islands were used as stopovers in this routes. N and E African SC1 populations developed notable morphological divergence from the W African SC3 populations in the precultural period and their anthropogenic transport to America began much later and was less strong. The spreading by human commerce all over the world should have lead to repeated local encounters and hybridising of SC3 (*C. emeryi*) and SC1 (*C. emeryi* var. *rasalamae*) populations and stopped their beginning divergence.

10.40 *Cardiocondyla weserka* BOLTON, 1982

Cardiocondyla weserka BOLTON, 1982; Cameroon [types investigated].

Investigated type material: holotype worker labelled "Cameroun Nkoemvon 1980. M D.Jackson" and "Cardiocondyla weserka Bolton det. B.Bolton, 1981", BMNH London.

Description: Worker (Fig. 61, Tab. 13): Small size. Head much elongated, CL/CW 1.231. Scape rather short, SL/CS 0.790. Postocular index large, PoOc/CL 0.440. Eyes medium-sized, EYE 0.247, without clearly visible microsetae. Frons narrow, FRS/CS 0.229, frontal carinae immediately behind FRS level slightly converging and then diverging. Occipital margin more or less straight. Whole head and mesosoma without longitudinal sculpture, except for small patches with weak carinulae mentioned below. Anterior clypeal margin with median concavity. Vertex with deeply impressed, flat-bottomed foveolae of 16 - 18 µm diameter in densely-packed honey-comb arrangement; foveolae showing an inner corona (tubercle) of 8 - 10 µm diameter; median vertex posterior of frontal triangle with 2 - 3 very short longitudinal carinulae. Frontal laminae and clypeus foveolate. Pronotal shoulders rather developed, but rounded, not angulate. Dorsal mesosoma profile from pronotum caudad to propodeum at spiracular level rather linear, convex curvatures only indicated, metanotal groove shallow. Dorsal area of promesonotum irregularly reticulate, width of meshes 5 - 7 µm, scattered foveolae present. Dorsal area of propodeum irregularly reticulate-corrugated-foveolate; whole lateral area of mesosoma strongly microreticulate. Propodeal spiracle very small, inner diameter only 5 µm. Spines long, strong, and incurved; in lateral view deviating from longitudinal mesosomal axis by 20°. Petiole except for the more smooth and finely microreticulate dorsum with well-pronounced and dense microreticulum; node distinctly longer than wide, with narrow dorsal plane; node in lateral view massive, petiolar peduncle moderately long. Postpetiole in dorsal view wider than long, with angulate-convex sides and concave anterior margin, rather smooth, finely microreticulate; postpetiolar sternite rather flat, with well-pronounced, rounded anterolateral corners. Head, mesosoma, waist, and gaster dark brown; lateral pronotum and appendages lighter. Morphometric data of holotype: CS 404, CL/CW 1.231, SL/CS 0.790, PoOc/CL 0.440, EYE 0.247, dFOV 17, FRS/CS 0.229, SPBA/CS 0.296, SP/CS 0.212, PEW/CS 0.265, PPW/CS 0.455, PEH/CS 0.357, PPH/CS 0.289, PEW/PPW 0.572, PEH/PE 1.346, sqrtPDG 4.07, PLG/CS 7.62 %, MGr/CS 1.79 %.

Comments: *Cardiocondyla weserka* is most similar to *C. neferka* in surface structures, shape of head and waist segments, and morphometry. The only significant difference is the shape of the mesosoma. The dorsal propodeal profile is much less convex in *C. weserka*, which gives the whole dorsal mesosoma profile a more linear appearance (Figs. 60, 61), allthough the difference is less expressed than suggested by the figures in BOLTON (1982). Furthermore, the pronotum of the *C. weserka* type does not show the conspicuous anterolateral pronotal corners seen in *C. neferka*. I have doubts whether these suggested differences between both taxa can be confirmed after the study of more material, nevertheless it is better to maintain the present status until further information is available.

10.41 *Cardiocondyla neferka* BOLTON, 1982

Cardiocondyla neferka BOLTON, 1982; Ghana [types investigated].

Investigated type material: holotype worker labelled "Mampong GHANA 10.2.70 P.Room" and "Cardiocondyla neferka Bolton det. B.Bolton, 1981", BMNH London.

Morphometrically investigated material (2 samples): **Ghana:** Mampong, 1970.02.10, w; **Nigeria:** Gambari, 1969.06.10, w.

Description: Worker (Fig. 60, Tab. 13): Small size. Head elongated, CL/CW 1.224. Scape short, SL/CS 0.770. Postocular index large, PoOc/CL 0.447. Eyes medium-sized, EYE 0.243, EyeHL 5. Frons narrow, FRS/CS 0.227, frontal carinae immediately behind FRS level slightly converging and then diverging. Occipital margin more or less straight. Whole head and mesosoma without longitudinal sculpture. Anterior clypeal margin straight or with a suggested concavity. Vertex with deeply impressed, flat-bottomed foveolae of 15 - 18 µm diameter in densely-packed arrangement; foveolae showing an inner corona (flat tubercle) of 8 - 9 µm diameter. Frontal laminae and clypeus with scattered smaller foveolae. Pronotal shoulders well-developed, each forming a rounded angle of 120°. Dorsal promesonotal profile slightly convex, dorsal propodeal profile with stronger convexity. Metanotal groove well-developed, in profile with shallow (30°) anterior and posterior slope. Propodeal spiracle very small, inner diameter 6 µm. Spines long, strong, slightly incurved; in lateral view deviating from longitudinal mesosomal axis by 20°. Dorsal area of promesonotum irregularly microreticulate-corrugated, frontal area of pronotum in the transitional zone from dorsal plane to declivity foveolate. Dorsomedian area of propodeum rather shining, finely microreticulate. Whole lateral area of mesosoma strongly microreticulate. Petiole node longer than wide, dorsal plane rather smooth, only microreticulate, node in lateral view massive and strongly microreticulate, peduncle relatively short. Postpetiole in dorsal view little wider than long, with distinctly concave anterior margin and angulate-convex sides; postpetiolar node shining, but finely microreticulate; postpetiolar sternite rather flat, with well-pronounced anterolateral corners, resembling situation in *C. wroughtonii*. First gaster tergite shining but with a very fine, widely-meshed microreticulum. Holotype: whole body light-yellowish brown; Gambari worker: head, mesosoma, and petiole light-yellowish brown, postpetiole little darker, antennal club dark brown, gaster blackish brown. For morphometric data of 2 workers see Tab. 13.

Comments: The approximated frontal carinae, the elongated head, and the type of head sculpture suggest an allocation of *Cardiocondyla neferka* to the *C. emeryi* group.

10.42 *Cardiocondyla yemeni* COLLINGWOOD & AGOSTI, 1996

Cardiocondyla yemeni COLLINGWOOD & AGOSTI, 1996; Yemen [type investigated].

Investigated type material: 1 **paratype** worker labelled "YEMEN: Sana'a (sandy path) 05 03 1993 leg. C.A.Collingwood", "Cardiocondyla yemeni ♂", and "Typus", SMN Görlitz. 1 topotypical worker, without postpetiole and gaster, labelled "YEMEN Sana'a 17 III 93" (day not clearly legible, other possible reading "27 III 93") and "Cardiocondyla yemeni sp.n. Collingwood & Agosti 1996".

Morphometrically investigated material (3 samples): **Yemen:** Sana'a, 1993.03.05, w; Sana'a, 1993.03.17[27?], w; Sana'a (P), leg. A. van Harten, 1998.04.03 - 3350, 4 gynes.

Description: Worker (Fig. 62, Tab. 13): Very small size CS 377. Head long, CL/CW 1.260. Scape extremely short, SL/CS 0.724. Postocular index large, PoOc/CL 0.453. Eyes rather prominent, with large ommatidia of 13 µm diameter, minute setae absent, EYE 0.238. Frons narrow, FRS/CS 0.242, frontal carinae slightly converging immediately behind FRS level. Anterior clypeal margin with straight or slightly concave medial portion, occiput weakly excavated. Clypeus and frontal laminae rather smooth, not shining and weakly shaginate-carinulate. A small median stripe on vertex weakly carinulate. In the paratype, paramedian and lateral areas of vertex with moderately deep, bicoronate foveolae, their interspaces moderately shining and with a perifoveolar reticulum; in the topotypical worker foveolae deeper and more densely packed; diameter of foveolae 13 - 16 μm diameter. Whole surface of mesosoma mat; dorsal area of mesosoma rather mat, irregularly foveolate-shagrinate-microreticulate; lateral area of mesosoma more strongly reticulate. Waist segments weakly reticulate. Spines short, their axis in lateral view deviating by 45° from longitudinal mesosomal axis. Metanotal groove in lateral view invisible. Petiole in profile with rather short peduncle and rounded dorsum of node that appears almost globular in dorsal view. Axis of petiolar peduncle in lateral aspect deviating by 40° from longitudinal axis of petiole node. Postpetiole in dorsal view with convex sides that meet with the straight anterior margin without a distinct corner; postpetiolar sternite with strong anteroventral corners, resembling situation in *C. wroughtonii*. Surface of 1st gaster tergite shining, but weakly microreticulate. All body parts light-yellowish brown. For morphometric data of 3 workers see Tab. 13.

Gyne (Tab. 19): Very small, CS 450. Head much elongated, CL/CW 1.222. Postocular index large, PoOc/CL 0.440. Scape extremely short, SL/CS 0.714. Occipital margin slightly concave or almost straight. Anterior clypeal margin with a suggested median concavity. Frontal carinae slightly converging immediately caudal of FRS level, in most caudal portion diverging. With exception of 5 - 6 longitudinal rugae on metapleuron and weak longitudinal rugosity on vertex and median area of clypeus, whole head and mesosoma without any rugosity. Vertex with deep foveolae of 16 - 17 μm diameter in dense honey-comb arrangement and with inner coronae of 8 - 9 μm diameter. Whole surface of mesosoma and waist densely foveolate, foveolae on dorsal area of mesosoma similar to those on vertex, those on lateral area of mesosoma and in particular on waist with slightly lower diameters. Cuticular surface of 1st gaster tergite shining, with delicate, but fully developed microreticulum. Propodeal spines acute, directed caudad (in lateral view diverging from longitudinal axis of mesosoma by only 25 °), and shorter than in *C. wroughtonii*, SP/CS 0.130. Postpetiole with sharp anteroventral corners, similar to situation in *C. wroughtonii*. Postpetiole in dorsal view with angulate-convex sides and straight anterior margin not forming distinct anterior corners. Petiolar node in dorsal view globular, about as wide as long. Head, mesosoma, and waist light-yellowish brown, antennal club blackish brown, gaster entirely blackish brown. For morphometric data of 4 gynes see Tab. 19.

Comments: The morphometric character combination of the *C. yemeni* worker is unique and provides an easy distinction from any known species (Tabs. 13, 19). The gynes of *C. yemeni* have a unique combination of extremely short scape, narrow postpetiole, and elongated head, and can be distinguished from other species with anterolateral postpetiolar sternite corners by a collective index (SL*PPW) / CS*CW/CL of 0.271 ± 0.006 [0.262, 0.275] (n = 4), which is much lower than in *C. obscurior* (0.322 ± 0.014 [0.296, 0.353] n = 20) or *C. wroughtonii* (0.305 ± 0.008 [0.296, 0.320] n = 15).

10.43 *Cardiocondyla minutior* FOREL, 1899, stat.rev.

Cardiocondyla nuda var. *minutior* FOREL, 1899; Hawaii: Honolulu and Molockai [types investigated].
Cardiocondyla tsukuyomi TERAYAMA, 1999; Ada / Okinawa Island [types investigated], **syn.n.**

Investigated type material: *Cardiocondyla minutior*: two **syntype** workers labelled "C.nuda Mayr v. minutior type Forel, Hawai" and "Molockai Mts., 3000 ft. Perkins 1893", MHN Genève.

C. tsukuyomi: 6 **paratype** workers from the same sample as holotype, labelled: "VI 1988 K.Yamauchi leg., Ada, Okinawa-jima Okinawa Pref." and "Cardiocondyla tsukuyomi Terayama, 1999, Paratype", SMN Görlitz.

Morphometrically investigated material (40 samples): **Aldabra Islands:** Takamaka, 1968.02, w; **Brazil:** Bahia: Itabuna, 1995.04, w; Bahia: Ceplac, 1995.04, w; **Caribbean:** Puerto Rico: Isla Mona, 1982.07.02, w; Puerto Rico: Isla Parguera, 1985.01.13, w; Puerto Rico: San Lorenzo, carr. 7740, km 1.3, 1979.05.22 - 8, w; Tobago: Arnos Vale Beach, 2000.08 (samples T17, T18), w; Tobago: Stone Haven Bay, 2000.08 - T8, w; Trinidad: Curepe, 1976.08, w; Trinidad: Curepe, 1976.07.18, w; **Chagos Islands:** Diego Garcia, 1971.06.16, w; **India:** Uttar Pradesh: Dehra - 10 km SE, 1996 (samples No. 557, 564, 569), w; **Japan:** Okinawa Isl.: Ada, 1988.06, w; Okinawa Isl.: Iriomote-jima (24.19 N, 123.48 E), 1975.03.09, w; Okinawa Isl.: Ishigaki-jima, 1993.07.11, w, g; Ryukyu Isl.: Hirara, Miyako 1952, w; **Nepal:** Kathmandu, 1983.08.27 (MG Allen), w; Kathmandu, 1988.06, w; Sangu (28.02 N, 84.36 E), 1961.11, w, g; **Polynesia:** Mariana Isl.: Guam, Yigo, 1958.12, w; Hawaii, 1912, w; Hawaii: Molockai Mts. (Perkins), 1893, w; Hawaii: Pohakuloa, 6500', 1956.12, w, g; Hawaii: Kilauea, 1930.04.05, g; Marqueas: Kopaafaa Hivaoa, 1927.02.08, g; Society Isl.: Moorea, Pt.Vaipahu, Mt. Rotui trail, 1991.01.29, No.M - 40, w; Society Isl.: Moorea, Opunuho Valley, 2 km S Paopoa, 1992.03.31, w; Society Isl.: Tahiti: Hitiaa, 1928.02.20, g; **Sri Lanka:** Nuwara Eliya, Gavaramana (samples 1 and 2), 1988.01.16, w; Nuwara Eliya: Labukele, 1988.01.16, w; **USA:** Florida: Miami Vic., 1924, w; Florida: Pensacola, 1943.08.10, w; Florida: Pensacola, 1943.10.06 w, g; Florida: Richmond, 1945.08.22, w; Florida: Lake Placid, 1985.12, w.

Description: Worker (Fig. 63, Tab. 14): Small size, CS 418. Head elongated, CL/CW 1.259. Postocular distance very large, PoOC/CL 0.475. Scape short, SL/CS 0.756. Eye rather small, EYE 0.233, with notable microsetae, the longest measuring 6 - 10 µm. Occipital margin straight or very weakly concave. Frontal carinae slightly converging immediately caudal of FRS level. Anterior clypeal margin with suggested median concavity. Clypeus, frontal laminae, frontal triangle, and very narrow anteromedian stripe of vertex longitudinally carinulate (in some specimens from N India and Nepal such carinulae cover the whole median and paramedian vertex, with reduction of foveolae in these areas). Except for longitudinal rugae on preocular surface, semicircular rugae around antennal fossae, and few short, longitudinal rugae on metapleuron; whole body without any rugosity. Sculpture on paramedian vertex similar to situation in the *C. emeryi* types, showing deeply impressed, flat-bottomed foveolae of 13 - 18 µm diameter in dense honey-comb arrangement (if not displaced by longitudinal carinulae). Foveolae with an inner corona (margin of a flat tubercle) of 7 - 8 µm diameter. Mesosoma on whole surface sculptured, rather mat: dorsal mesosoma densely and strongly reticulate-foveolate; lateral mesosoma densely and strongly reticulate; metapleuron with 1 - 4 longitudinal rugae. Waist segments with fully developed, but shallower and finer reticulum than on mesosoma, nodes sometimes slightly shining. First gaster tergite often with very fine microreticulum. Pubescence on whole body long and dense, sqrtPDG 3.34. Dorsal profile of mesosoma rather straight or weakly convex, metanotal groove only suggested or entirely absent. Spines short and acute, their axis in profile deviating by 40 - 45° from longitudinal axis of mesosoma. Petiole in profile with concave anterior face and rounded node that is in dorsal view circular and as long as wide. Postpetiole very low, its sternite completely flat, without any anteroventral bulge;

in dorsal view with angulate-convex sides and straight anterior margin. Colour of head, mesosoma, and waist varying considerably from dirty yellowish to dark dirty brown, gaster dark to blackish brown. For morphometric data of 72 workers see Tab. 14.

Gyne (Tab. 19): Very small size. Head elongated, CL/CW 1.228. Scape rather short, SL/CS 0.755. Postocular index very large, PoOc/CL 0.459. Eyes with numerous hairs, the longest of them 8 - 11 µm long. Occipital margin more or less straight. Anteromedian clypeal margin straight to slightly convex. Vertex with deeply impressed, flat-bottomed, densely-packed foveolae of 15 - 18 µm diameter which show an inner corona of 7 - 9 µm diameter. Paramedian and median areas of vertex with suggested longitudinal rugae. Frontal laminae and clypeus with few longitudinal carinulae. Whole dorsal area of mesosoma with deep, densely-packed foveolae, fragments of longitudinal rugae visible on mesonotum. Lateral lobes of praescutellum connected by a very thin junction or entirely separated. Lateral area of mesosoma foveolate-reticulate, region of metapleural gland bulla with longitudinal rugae. Propodeal spines well-developed, their axis deviating from mesosomal axis in lateral view by 25 - 30°. Petiole node foveolate-reticulate, in dorsal view circular. Postpetiole in dorsal view strongly foveolate-reticulate, distinctly wider than long, with straight anterior margin and strongly convex sides. Postpetiolar sternite very flat, without any bulge. Whole body covered by long and dense pubescence. Dorsum of gaster shining, with fine microreticulum. For morphometric data of 14 gynes see Tab. 19.

Comments: The Indomalayan region is apparently the radiation centre of the *C. minutior* group. At least six species (*C. minutior, C. tjibodana, C. breviscapus* sp.n., *C. goa* sp.n., *C. carbonaria* and *C. opaca* sp.n.) are found there, and India is most probably the origin of *C. britteni.* Among these seven species it was only *C. minutior* that became a cosmopolitan tramp species.

Intraspecific variability in *C. minutior* is rather low within the huge range of its distribution, extending over the Neotropic, Polynesian, Australasian, Indo-Australasian, and Oriental regions. Samples from central Sri Lanka have significantly smaller eyes, those from Okinawa, N India, and Nepal shorter heads but all these deviating populations are in the vast majority of other characters consistent with the overall average.

Cardiocondyla tsukuyomi is in body shape and any structural and morphometric character consistent with the worldwide population of *C. minutior* as it is with the types of *C. minutior* from Hawaii. The 3 studied type workers of *C. tsukuyomi* and 4 topotypical non-type workers from Okinawa do not differ from the *C. minutior* population from outside Okinawa (Tab. 5). Recent mDNA studies have shown that *tsukuyomi* and *minutior* cluster closely together, while *C. tjibodana* and *C. minutior* could represent separate evolutionary lines (Trindl & Heinze, pers. comm. October 2002).

The *C. minutior* worker can be easily separated from *C. emeryi* by a much lower postpetiole, that shows no anteroventral bulge, by much larger FRS/CS, by an almost absent metanotal groove, by very low sqrtPDG, by longer tergite pubescence, and more developed microsetae on eyes, the longest measuring 6 - 10 µm.

K. Yamauchi (pers. comm 2001) reported for Okinawa the nesting in shallow soil in open, disturbed areas with bare or weakly herbaceous ground. The Japanese population of *C. minutior* is reported to have a karyotype of 2n = 30 and to produce alate and ergatoid males. The latter perform lethal fighting for exclusive mating (TERAYAMA 1999).

Tab. 5: Morphometric data of *Cardiocondyla minutior* from Okinawa (= topotypical population of *C. tsukuyomi* TERAYAMA, 1999 syn.n.) and of the world population except Okinawa. All data do not differ significantly except for CL/CW (*p < 0.01).

	C. minutior from Okinawa (= *C. tsukuyomi*) (n = 7)	p	*C. minutior* worldwide except Okinawa (n = 65)
CL	466 ± 7 [455, 477]		465 ± 19 [421, 504]
CL/CW	1.236 ± 0.020 [1.211, 1.266]	*	1.262 ± 0.024 [1.213, 1.319]
SL/CS	0.750 ± 0.007 [0.742, 0.759]		0.757 ± 0.010 [0.741, 0.785]
PoOc/CL	0.473 ± 0.007 [0.467, 0.487]		0.475 ± 0.007 [0.460, 0.495]
FRS/CS	0.245 ± 0.005 [0.238, 0.253]		0.246 ± 0.007 [0.232, 0.259]
SPBA/CS	0.288 ± 0.006 [0.283, 0.298]		0.288 ± 0.010 [0.268, 0.314]
EYE	0.235 ± 0.005 [0.229, 0.242]		0.233 ± 0.006 [0.216, 0.245]
dFOV	14.1 ± 0.7 [13, 15]		14.8 ± 1.2 [13, 18]
SP/CS	0.125 ± 0.009 [0.117, 0.140]		0.129 ± 0.010 [0.104, 0.148]
PEW/CS	0.279 ± 0.009 [0.264, 0.292]		0.284 ± 0.011 [0.258, 0.323]
PPW/CS	0.465 ± 0.009 [0.452, 0.478]		0.477 ± 0.013 [0.449, 0.510]
PEH/CS	0.331 ± 0.004 [0.327, 0.336]		0.334 ± 0.012 [0.309, 0.364]
PPH/CS	0.274 ± 0.004 [0.268, 0.281]		0.270 ± 0.009 [0.250, 0.294]
PEW/PPW	0.599 ± 0.017 [0.576, 0.623]		0.596 ± 0.016 [0.559,0.639]
sqrtPDG	3.19 ± 0.06 [3.10, 3.26]		3.31 ± 0.24 [2.88,3.95]
PLG/CS [%]	7.74 ± 0.11 [7.56, 7.86]		7.78 ± 0.46 [6.78,8.63]
MGr/CS [%]	0.40 ± 0.39 [0.0, 1.0]		0.43 ± 0.47 [0.0,1.9]

10.44 *Cardiocondyla goa* sp.n.

Type material: holotype worker labelled "Indien_02: Kerala, Periyar Sanctuary, vic. Thekkady, 20, 500-1000 m H, 02.-05.01.1997, leg. A.Schulz, K.Vock"; 3 **paratype** workers labelled "Indien_02: Kerala, Periyar Sacntuary, vic Thekkady, 12, 500-1000 mH, 02.-05.01.1997, leg. A.Schulz, K.Vock"; 1 **paratype** gyne labelled "Indien_04: Goa, district Canacona, Cortigao Sanctuary, 100 mH, 06.-10.01.1997, leg. A.Schulz, K.Vock"; all types SMN Görlitz.

Morphometrically investigated material (4 samples): **India:** Goa distr.: Canacona (15°N, 74°E), 1997.01 (samples No. 44, 47), g; Kerala distr.: Thekkady (9.36N, 77.11E), 1997.01 (samples No. 12, 20), w.

Description: Worker (Fig. 65, Tab. 14): Small size, CS 420. Head elongated, CL/CW 1.225. Postocular distance very large, PoOC/CL 0.476. Scape longer than in related species, SL/CS 0.775. Eye rather small, EYE 0.228; with notable microsetae, the longest 6 - 7 µm long. Occipital margin straight. Frontal carinae slightly converging immediately caudal of FRS level or parallele. Anterior clypeal margin in median third straight. Posterior area of clypeus and a narrow anteromedian stripe on vertex longitudinally carinulate. Frontal laminae with few foveolae and few longitudinal rugulae. Paramedian area of vertex with deeply impressed and densely arranged, flat-bottomed foveolae of 15 - 17 µm diameter; foveolae with inner corona (margin of flat tubercle) of 7 - 8 µm diameter. Dorsal area of promesonotum irregularly foveolate-microrugulose, dorsolaterally with fragmentaric longitudinal rugae. Propodeum and whole lateral area of mesosoma strongly microreticulate, inter- and infraspinal area of propodeum more shining, more finely microreticulate-rugulose; 2 longitudinal curved rugae on metapleural gland bulla. Waist segments strongly microreticulate (on dorsum of nodes weakly); both segments in dorsal view and at lower magnifications appearing gently shining. First gaster tergite shining, with very fine microreticulum. Pubescence on whole body long and dense, sqrtPDG 3.49. Dorsal mesosoma profile slightly convex or straight, metanotal groove entirely absent, a very shallow mesopropodeal concavity individually present. Spines short and acute, their axis in profile deviating by 40 - 45° from longitudinal axis of mesosoma. Spine bases more approached than in *C. minutior*. Petiole in profile with concave anterior face and rounded node that is in dorsal view circular. Postpetiole very low, its sternite completely flat, without any anteroventral bulge; in dorsal view with convex sides and straight or slightly convex anterior margin. Head and mesosoma very dark to blackish brown, waist segments in one specimen lighter, gaster blackish brown. For morphometric data of four workers see Tab. 14.

Gyne (Tab. 19): Very small size. Head elongated, CL/CW 1.220. Scape short, SL/CS 0.739. Postocular index very large, PoOc/CL 0.463. Eyes with numerous hairs, the longest 8 - 11 µm long. Occipital and anteromedian clypeal margin more or less straight. Vertex with deeply impressed, flat-bottomed, densely-packed foveolae of 14 - 16 µm diameter; foveolae showing an inner corona of 7 - 9 µm diameter. Median area of vertex with few longitudinal rugae. Frontal laminae and clypeus longitudinally carinulate-rugulose. Whole dorsal area of mesosoma with deep, densely-packed foveolae; median area of mesonotum with 3 - 4 longitudinal rugulae. Lateral area of mesosoma foveolate-reticulate, lateral area of metapleuron with longitudinal rugae. Propodeal spines shorter than in *C. minutior*, their axis deviating from mesosomal axis in lateral view by 30°. Petiole node foveolate-reticulate, in dorsal view circular. Postpetiole in dorsal view more strongly foveolate-reticulate, distinctly wider than long, with straight anterior margin and strongly convex sides. Postpetiolar sternite very flat, without any bulge. Whole body covered by dense pubescence that is shorter than in *C. minutior*. Dorsum of gaster shining, but with fine microreticulum. Whole body blackish brown, appendages lighter. For morphometric data of 2 gynes see Tab. 19.

Comments: The most eye-catching difference of *C goa* sp.n. to cosmopolitan *C. minutior* is the darker pigmention: the sum of head and mesosoma pigmentation score PigCap + PigMes is 14.9 ± 2.9 [10, 20] in 45 *C. minutior* workers and 23.2 ± 1.0 [22, 24] in 4 workers of *C. goa* sp.n., i.e. even the dark morph of *C. minutior* is still lighter than the blackish brown *C. goa* sp.n.. Morphometry confirms heterospecifity. *Cardiocondyla goa* sp.n. has a longer scape, a shorter head, shorter tergite pubescence, and a narrower frons, spine base, and postpetiole. Based upon sample means, workers can be separated by a discriminant function

D(7) = 0.2 CL/CW - 2.9 SL/CS + 2.8 FRS/CS + 3 SPBA/CS + 0.7 PPW/CS + 0.4 PEH/CS + 3 PLG/CS

with D(7) 0.110 ± 0.000 [0.110, 0.110] in two samples of *C. goa* sp.n. and 0.317 ± 0.045 [0.224, 0.458] in 37 samples of *C. minutior*. Compared to *C. tjibodana*, *C. goa* sp.n. has a longer scape, a shorter head, a shorter tergite pubescence, a wider postpetiole, and a narrower spine base. Based upon sample means, workers can be separated by a discriminant function

D(7) = - 1.0 CL/CW + 2.5 SL/CS - 2.8 SPBA/CS - 1.0 SP/CS - 0.9 PEW/CS + 2.2 PPW/CS - 4 PLG/CS with D(7) 0.333 ± 0.001 [0.333, 0.334] in two samples of *C. goa* sp.n. and 0.137 ± 0.042 [0.068, 0.188] in 12 samples of *C. tjibodana*. The pigmentation differences of *C. goa* sp.n. and *C. tjibodana* are still stronger than those of *C. goa* sp.n. and *C. minutior*.

10.45 *Cardiocondyla tjibodana* KARAVAJEV, 1936

Cardiocondyla tjibodana KARAVAJEV, 1936; Java [types investigated].

Investigated type material: 2 **syntype** workers labelled "Tjibodas, Jawa Karavaiev \5375. Coll. Karavaiievi \Cardiocondyla tjibodana Karavaiev typ.", IZ Kiev.

Comment: The two specimens fully match the description of Karavajev. However, the number of specimens is in disagreement with the original description that states: "...Tjibodas, W. Java, W. Karawajew, Nr.5375, 1 Arbeiter..." and "...Küste von Bantam, Java, an der Sundastrasse, gegenüber Meeuwen Eiland, 7.I.1913, Nr.5376, 1 Arbeiter...". Sample No. 5376 was not seen. In case of its discovery and if representing a different species, a lectotype of *C. tjibodana* should be fixed in a specimen of sample 5375.

Morphometrically investigated material (13 samples): **Caribbean:** Belize: Blancaneaux (17 N, 89 W), 1997.11, w; **Indonesia:** Bogor, 1999.12.21 - I3, w, g; W Java: Tjibodas (Karavajev No.5375), w; Sulawesi-Utara: Dumoga Bone N.P. (0.35 N, 24.02 E), 1988.05, w; **Malaysia:** Ulu Gombak, 1999.08.20 - M4, w; **Philippines:** Luzon: Sagada, Mt. Ampacao, 1999.02.20 (sample No. 15), w; Luzon: Sagada, Mt. Ampacao, 1999.02.26 (sample No. 23), w; Luzon: NE of Sagada, Banga'an, 1999.02.23, w; Luzon: Gonogon, Chico River, 1999.02.21, w; Luzon: W of Baguio, Benguet, Asin Hot Spring, 1999.02.17, w; Mindanao: Surigao 15 km W, Bayagnan Island, 2000.02.07, w; **Polynesia**: Anatahan Island (16.23 N, 145.42 E), 2002.04.02, w; **New Guinea:** Biak I.: Mokmer, 1959.05.26, w;

Description: Worker (Fig. 66, Tab. 14): Small size. Head elongated, CL/CW 1.261. Postocular distance very large, PoOC/CL 0.479. Scape short, SL/CS 0.762. Eye rather small, EYE 0.238, with notable setae, the longest measuring 6 - 10 µm.. Occipital margin straight or very weakly concave. Frontal carinae more approached than in *C. minutior*, on average more diverging immediately frontad from FRS level. Anterior clypeal margin between level of frontal carinae straight or slightly concave. Lateral clypeus with 2 - 3 curved longitudinal rugae. Caudal clypeus, frontal laminae and narrow anteromedian stripe of vertex longitudinally carinulate. Except for longitudinal rugae on preocular surface, semicircular rugae around antennal fossae, and few short, longitudinal rugae on metapleuron, whole body without any rugosity. Paramedian area of vertex with densely-arranged, deeply impressed, flat-bottomed foveolae of 13 - 18 µm diameter. Foveolae with inner corona (margin of flat tubercle) of 7 - 8 µm diameter. Mesosoma on whole surface sculptured, overall surface impression mat: mesosoma dorsally densely and strongly reticulate-foveolate, laterally densely and strongly reticulate; metapleuron with 1 - 4 longitudinal rugae. Waist segments with shallower and finer reticulum than on mesosoma, nodes sometimes slightly shining. First gaster tergite often with very fine microreticulum. Pubescence on whole body long and dense, sqrtPDG 3.23. Dorsal profile of mesosoma rather straight or weakly convex, metanotal groove only suggested or entirely absent. Spines short and acute, their axis in profile deviating by 40 - 45° from longitudinal mesosomal axis. Petiole in profile with concave anterior face and rounded node that is in dorsal view circular or slightly longer than wide. Postpetiole very low, its sternite completely flat, without any anteroventral bulge; in dorsal view with angulate-convex sides and straight anterior margin. Head light-orange brown to dark brown, mesosoma and waist always warm orange or yellow, gaster dark to blackish brown. For morphometric data of 24 workers see Tab. 14.

Gyne (Tab. 19): Very small size. Head much elongated, CL/CW 1.223. Scape short, SL/CS 0.739. Postocular index very large, PoOc/CL 0.457. Eyes with numerous hairs, the longest measuring 12 µm. Occipital margin straight. Median section of anterior clypeal margin very slightly convex. Vertex with deeply impressed, flat-bottomed, densely-packed foveolae of 14 - 16 µm diameter which show an inner corona of 7 - 9 µm diameter. Anteromedian area of vertex with 4 - 5 longitudinal carinulae. Frontal laminae and posterior area of clypeus longitudinally carinulate. Whole area of dorsal mesosoma with deep, densely-packed foveolae. Lateral lobes of praescutellum separated. Lateral area of mesosoma foveolate-reticulate, region of metapleural gland bulla with longitudinal rugae. Propodeal spines well-developed, their axis deviating from mesosomal axis in lateral view by 25°. Petiole less strongly reticulate, petiolar node in dorsal view circular. Postpetiole in dorsal view more strongly reticulate, distinctly wider than long, with straight anterior margin and strongly convex sides. Postpetiolar sternite very flat, without any bulge. Whole body covered by long and very dense pubescence that is on 1st gaster tergite more dense than in *C. minutior*. Dorsum of gaster shining, but with fine microreticulum. Head, antennal club, gaster, mesonotum, praescutellum, scutellum, and metanotum dark brown. Lateral area of pronotum, anepisternite, and waist segments warm yellowish-orange. Appendages light-yellowish. For morphometric data of one gyne see Tab. 19.

Comments: *Cardiocondyla tjibodana* is supposed here to be the sister species of *C. minutior*, having its distributional centre in the Malayan region. It is found on the larger islands of the Philippines, Malaysia, Indonesia, and New Guinea, nesting in shallow soil in open, disturbed areas with bare or weakly herbaceous ground (Yamauchi, pers. comm. 2001). The occurence of *C. minutior* in this region seems to be concentrated to smaller islands, in particular to the islands of Polynesia. *C. tjibodana* seems not to have the dispersal capacity of *C. minutior*, though the *C. tjibodana* samples from Belize and Anatahan indicate spreading to remote zoogeographical regions. The workers of *C. tjibodana* differ from *C. minutior* by smaller waist measures and by a warm orange-yellowish tinge of the mesosoma. The latter character is rarely seen in *C. minutior* that usually shows a dirty colour component. A discriminant score D(3) = + 0.3 PEW/CS + 4.0 PPW/CS + 0.7 PPH/CS tentatively separates samples of *C. tjibodana* with D(3) 2.031 ± 0.035 [1.975, 2.078] (n = 13) and of *C. minutior* with D(3) 2.182 ± 0.064 [2.095, 2.336] (n = 37). Future investigations must exclude that *C. tjibodana* is only a morph of *C. minutior.*

10.46 *Cardiocondyla breviscapus* sp.n.

Type material: 3 **syntype** workers labelled "INDIA: Coimbatore 25.ix.79 J.Noyes", BMNH London. [Coimbatore is situated at 11.00 N, 76.58 E].

Description: Worker (Fig. 64, Tab. 14): Small size. Head much elongated, CL/CW 1.279. Postocular distance very large, PoOC/CL 0.485. Scape extremely short, SL/CS 0.716. Eye small, EYE 0.223; notable eye setae, the longest measuring 8 µm. Occipital margin weakly concave. Frontal carinae slightly converging immediately caudal of FRS level and more approached than in *C. minutior*, FRS/CS 0.228. Anterior clypeal margin with a suggested median concavity. Clypeus, frontal laminae, frontal triangle, median and paramedian vertex longitudinally carinulate-shagreened. Except for semicircular rugulae around antennal fossae and few short, longitudinal rugae on lateral metapleuron, whole body without any rugosity. Vertex laterally with deeply impressed, flat-bottomed foveolae of 13 - 16 µm diameter in dense honey-comb arrangement. Foveolae with inner corona (margin of flat tubercle) of 7 - 8 µm diameter. Foveolae on median third of vertex reduced. Dorsal area of promesonotum longitudinally carinulate-shagreened, with scattered foveolae. Lateral area of mesosoma reticulate. Waist segments more shining but with fully developed and finer reticulum than on mesosoma. Pubescence on whole body dense, sqrtPDG 3.35. Dorsal profile of mesosoma rather straight or weakly convex, metanotal groove only indicated or entirely absent. Spines rather short, still acute, their axis in profile deviating by 40 - 45° from longitudinal mesosomal axis. Petiole in profile with concave anterior face and rounded node that is in dorsal view circular. Postpetiole low, its sternite rather flat, in contrast to *C. minutior* with a shallow anterolateral bulb on each side that is best-visible in laterodorsal view; postpetiole in dorsal view with semicircular sides and straight anterior margin. Head, mesosoma, and waist light-yellowish. Scape light-yellowish, whole funiculus except 1st segment dark brown. Gaster contrastingly blackish brown. For morphometric data of three workers see Tab. 14.

Comments: *Cardiocondyla breviscapus* sp.n. is a sister species of *C. minutior*, which shows SL/CS and FRS/CS data below the lower extremes known in the cosmopolitan *C. minutior* population. Heterospecifity is further indicated by the presence of the shallow anterolateral bulbs on the postpetiolar sternite and a stronger reduction of the foveolae on the vertex in *C. breviscapus* sp.n..

10.47 *Cardiocondyla carbonaria* FOREL, 1907

Cardiocondyla carbonaria FOREL, 1907; Matheran / India [type investigated].

Investigated type material: 1 **type** worker labelled by Forel "C.carbonaria, ♂ type Forel\ India or. Biró 1902 \ Matheran [Bombay 50 km E, Matheran 19°N, 73°E] 800 m", MHN Genève.

Description: Worker (Fig. 68a, Tab. 14): Head much elongated, CL/CW 1.282. Scape longer than in other members of the *C. minutior* group but shorter than in *C. opaca* sp.n., SL/CS 0.789. Postocular distance large, PoOc/CL 0.474. Eye medium-sized, EYE 0.243. Eye setae well-developed, the longest about 15 µm. Occipital margin and anterior clypeal margin rather straight. Frons narrow, frontal carinae immediately behind the FRS level parallel. Whole body including gaster with perfectly mat surface appearance caused by a very dense and fine microsculpture. Clypeus posteriorly shagreened, with six longitudinal, curved carinae. Frontal lobes shagreenate-microfoveolate. Frontal triangle narrow and smooth. Median area of vertex longitudinally carinulate, intercarinular spaces foveolate. Paramedian and lateral areas of vertex with deeply impressed, closely adjacent foveolae of 14 - 16 µm diameter that usually show a flat inner tubercle of 8 - 9 µm diameter. Dorsal area of mesosoma finely shagreenate-foveolate with few short, longitudinal microcarinae; lateral area of mesosoma densely reticulate. Dorsal profile of mesosoma almost straight, with nearly absent metanotal depression. Spines acute, of medium length, their bases more distant than in related species. Petiole high, with rather short peduncle, its dorsal profile truncate-convex; its surface microreticulate-shagreened, the dorsum more shagreened. Postpetiole low; its sternite very flat, anterolaterally with a short and curved costa on each side; in dorsal aspect distinctly wider than long, with convex sides, straight anterior margin, and completely shagreened. Exposed surfaces of tergites completely mat, very finely and densely shagreened; tergite pubescence long and dense, PLG/CS 8.3 %. Head and mesosoma dorsally with apressed pubescence. Whole body blackish brown except for light-yellowish antennae, trochanter, distal ends of femora, tibiae, and tarsi. Morphometric data of the type worker: CS 434, CL/CW 1.282, SL/CS 0.789, PoOc/CL 0.474, EYE 0.243, dFOV 15, SP/CS 0.136, FRS/CS 0.233, SPBA/CS 0.306, PEW/CS 0.297, PPW/CS 0.482, PEH/CS 0.348, PPH/CS 0.265, PEW/PPW 0.617, sqrtPDG 3.01, PLG/CS 8.30 %, PigCap 11, PigMes 12, MGr/CS 0.9 %.

Comments: Morphometry and body shape of *C. carbonaria* clearly allocate it to the *C. minutior* group. The unique microsculpture of the gaster tergites separate *C. carbonaria* and *C. opaca* sp.n. from every species of the group. Furthermore, the ratio FRS/SPBA/SL is only 0.965 in *C. carbonaria* but is 1.124 ± 0.042 [1.039 - 1.228] in all other 6 species of the *C. minutior* group.

10.48 *Cardiocondyla opaca* sp.n.

Type material: holotype worker labelled "Indien_04: Goa, distr. Canacona, Cortigao Sanctuary, 100 mH, 06.-10.01.1997, leg. A.Schulz, K.Vock 33", SMN Görlitz. The type was morphometrically investigated.

Description: Worker (Fig. 68b, Tab. 14): Head much elongated, CL/CW 1.253. Scape much longer than in any other species of the *C. minutior* group, SL/CS 0.836. Postocular distance large, PoOc/CL 0.468. Eye medium-sized, EYE 0.235. Eye setae well-developed, the longest 13 µm. Occipital margin and anterior clypeal margin slightly concave in median third. Frons very narrow, FRS/CS 0.221, frontal carinae immediately behind FRS level parallel. Whole body including gaster with perfectly mat surface, caused by a very dense and fine microsculpture of differing structure. Clypeus densely shagreened, with five longitudinal curved carinulae. Frontal lobes shagreened, in lateral parts with few short longitudinal carinulae. Frontal triangle narrow and smooth. Whole head densely shagreened. On paramedian and lateral area of vertex, obscured within dense shagreen, foveolae of 12 - 13 µm diameter are present, that have an inner corona of 7 µm diameter; foveolar interspaces slightly smaller than foveolar diameter. Dorsal area of promesonotum with few foveolae of 8 - 9 µm diameter, obscured within dense shagreen. Remaining mesosoma fully and strongly microreticulate. Dorsal profile of mesosoma almost straight, metanotal depression almost absent. Spines triangular and short; their bases more approached than in related species. Waist measurements much lower than in any related species. Petiole low, with a rather long peduncle, its dorsal profile evenly curved. Petiole coarsely microreticulate, its dorsum more shagreened. Postpetiole very low; its sternite very flat, anterolaterally with a short, curved costa on each side; in dorsal aspect completely shagreened, as long as wide, with angulate-convex sides and straight anterior margin. Exposed surfaces of tergites completely mat, very finely and densely shagreened; tergite pubescence long and dense, PLG/CS 7.5 %. Head and dorsal mesosoma with striking pubescence, standing from body surface at angle of 25 - 30°. Whole body blackish except for light-brown antennae, trochanter, and distal ends of femora, and whitish yellow tibiae and tarsi. Morphometric data of the type worker: CS 424, CL/CW 1.253, SL/CS 0.836, PoOc/CL 0.468, EYE 0.235, dFOV 12.6, SP/CS 0.092, FRS/CS 0.221, SPBA/CS 0.254, PEW/CS 0.245, PPW/CS 0.409, PEH/CS 0.283, PPH/CS 0.251, sqrtPDG 3.31, PLG/CS 7.47 %, PigCap 12, PigMes 12, MGr/CS 0.0 %.

Comments: The different head sculpture and the much rougher pubescence of *Cardiocondyla opaca* sp.n., its more closely approximated spine bases, the longer scape, the shorter spines, and the much lower waist measurements justify to separate it from *C. carbonaria*. Division of morphometric differences between *C. carbonaria* and *C. opaca* sp.n. by the standard deviation known within the world population of *C. minutior* workers may indicate how large some differences are: PPW/CS differs by 8.1, PEH/CS by 5.4, SPBA/CS by 5.2, SL/CS by 4.7, PEW/CS by 4.7, and SP/CS by 4.4 standard deviations of *C. minutior*. Hence, there is a very low probability that the observed differences could represent intraspecific variation.

10.49 *Cardiocondyla britteni* CRAWLEY, 1920

Cardiocondyla britteni CRAWLEY, 1920; England: West Didsbury near Liverpool [type investigated].

Investigated type material: 1 **type** worker labelled "Cardiocondyla britteni Crawley" and "West Didsbury 12-5-1919 B.h.H. Butter Beans", UM Oxford.

Only the type worker which has been found among Butter Beans was investigated. The term "Butter Bean" is ambiguous but most frequently it was referred to *Dolichos lablab* (now *Lablab purpureus*) that has its main cultivation areas in India and E Africa. No species of the *C. minutior* group has been found so far in Africa. Hence, there is some probability that the native source country of *C. britteni* is India or the Oriental region from where it has been imported via the Liverpool harbour.

Description: Worker (Fig. 67, Tab. 14): minute size. Head much elongated, CL/CW 1.249. Postocular distance very large, PoOC/CL 0.482. Scape short, SL/CS 0.741. Eye small, EYE 0.226. Occipital margin weakly concave. Anterior clypeal margin convex. Clypeus smooth. Frontal laminae and a small area caudal of them finely longitudinally carinulate. Dorsum of vertex, mesosoma, and waist in overall impression distinctly shining. Vertex with very shallow and small foveolae of 4 - 10 µm diameter; foveolar interspaces brilliantly shining and much wider than foveolar diameter, occasionally with fragments of a very fine perifoveolar microreticulum. Surface structure of dorsal promesonotum similar to vertex. Whole propodeum as well as meso- and metapleurae reticulate. Lateral area of pronotum smooth, finely microreticulate. Petiolar and postpetiolar nodes shining, with very fine microreticulum. Dorsum of gaster smooth and with fragments of very fine microreticulum. Petiole node in dorsal view almost globular, postpetiole with straight frontal margin and angulate-convex sides. Metanotal groove entirely absent. Spines shorter than in *C. minutior*, almost triangular. Microsetae on eyes sparser and shorter than in *C. minutior*. Pubescence on whole body shorter and less dense than in *C. minutior*, sqrtPDG 4.25. Petiole in profile with concave anterior face and rounded node. Postpetiole very low, its sternite very flat, without any prominent structures. Antennal club, gaster, propodeum, meta- and mesopleurae dark to blackish brown. Vertex, promesonotum, waist, and appendages light-yellowish brown. Morphometric data of the type worker: CS 402, CL/CW 1.249, SL/CS 0.741, PoOc/CL 0.482, EYE 0.226, dFOV 7.0, SP/CS 0.089, FRS/CS 0.242, SPBA/CS 0.283, PEW/CS 0.268, PPW/CS 0.473, PEH/CS 0.333, PPH/CS 0.272, PEW/PPW 0.563, sqrtPDG 4.25, PLG/CS 6.61 %, PigCap 7, PigMes 9, MGr/CS 0.0 %.

Comments: By morphometry and body shape, *Cardiocondyla britteni* is undoubtedly a member of the *C. minutior* group. It differs from all other species of this group by much smaller and shallower foveolae on vertex, the shining head and dorsal areas of mesosoma, the shorter spines, and the larger sqrtPDG.

11. Key and comparative tables to workers

1a Postpetiolar sternite in anterodorsolateral view with prominent anterolateral corners and its anterior margin appearing concave in this viewing position. Minute species with CS < 470. 2

1b Postpetiolar sternite in anterodorsolateral view without prominent anterolateral corners. 8

2a Head short (CL/CW < 1.19), Frons wider (FRS/CS > 0.254). *C. wroughtonii* group. ... 3

2b Head longer, frons narrower. 6

3a Very small (CL < 390); paramedian and lateral areas of vertex with densely-arranged, deeply impressed, and flat-bottomed foveae of 19 - 23 µm diameter showing a well-demarcated central ring of 8 - 9 µm diameter, which is connected with the outer ring through 2 - 4 very fine micocarinulae (Fig. 54, Tab. 12). Borneo. .... ***C. nana* sp.n.**

3b Larger (CL > 390); foveolae on paramedian areas of vertex smaller and with simpler internal structure or completely absent. 4

4a Clearly structured foveolae on head and mesosoma present. Outlines of promesonotal plane in dorsal view not trapezoid and without anterolateral corners (Figs. 56, 57). 5

4b Whole body surface without any clearly visible foveolae, carinulae, or rugae. Outlines of the promesonotal plane in dorsal view trapezoid and with blunt anterolateral corners (Figs. 53, 55; Tab. 12). India. .... ***C. shagrinata* sp.n.**

5a First and following gaster tergites not equally dark. Light morph: whole dorsum of gaster with light pigmentation except for a diffuse brown band in posterior half of 1st gaster tergite; Dark morph: the first gaster tergite may be almost entirely dark, but then following segments less dark. Use discriminant functions (Figs. 51, 57; Tab. 12). Cosmopolitan tramp species. .... ***C. wroughtonii***

5b First and following gaster tergites equally dark. Use discriminant functions (Figs. 52, 56; Tab. 12) . Cosmopolitan tramp species. .... ***C. obscurior***

6a Spines long (SP/CS > 0.16), Scape longer (SL/CS > 0.75) Afrotropical. 7

6b Spines and scape shorter (Fig. 62, Tab. 13). S of the Arab Peninsula. .... ***C. yemeni***

7a Dorsal mesosoma profile from pronotum caudad to propodeum at spiracular level rather linear, convex curvatures only indicated, metanotal groove shallow. Pronotal shoulders more rounded (Fig. 61). .... ***C. weserka***

7b Dorsal promesonotal profile slightly convex, dorsal propodeal profile with stronger convexity. Metanotal groove well-developed, in profile with shallow (30°) anterior and posterior slopes. Pronotal shoulders well-developed, each forming a rounded angle of 120° (Fig. 60). .... ***C. neferka***

8a Foveolae on vertex reduced, but flat tubercles or pits of < 11 µm diameter present. Frons wide (FRS/CS > 0.28). Petiole about half as wide as postpetiole, PEW/PPW 0.46 - 0.53. Metanotal groove distinct. Spines reduced to blunt dents or corners. *C. stambuloffii* group. 9

8b At least one character strongly deviating. 12

9a Eye small (EYE < 0.240). Petiole high (PEH/CS > 0.335). Scape shorter (SL/CS < 0.835). 10

9b Eye larger. Petiole lower. Scape longer (Fig. 49, Tab. 11). Central Asia. ... ***C. tibetana* sp.n.**

10a Pubescence on 1st gaster tergite shorter (PLG/CS < 7.2 %). Vertex with small tubercles of 6 - 10 µm diameter around bases of pubescence hairs, accessory semireticular structures may be present. 11

10b Pubescence on 1st gaster tergite longer (PLG/CS > 7.2 %). Vertex without small tubercles or semireticulate structures, tiny pits around bases of pubescence hairs with diameters of 4 - 5 µm may be visible on paramedian vertex (better visible on the smooth posterior 40 % of head area) (Fig. 48, Tab. 11). Central Asia. ..... ***C. gibbosa***

11a Petiole node in dorsal view small and circular. Spines very short and blunt. Caudodorsal propodeal profile not sloping down to spine base. Ratio postpetiolar width versus maximum median length of postpetiolar node 1.806 ± 0.065 [1.666, 1.919]. Spine bases less approached, SPBA/CS 0.287 (Fig. 46, Tab. 11). S Europe east to Volga River, Near East, Caucasus.......... ***C. stambuloffii***

11b Petiole node in dorsal view wider than long. Caudodorsal propodeal profile sloping down to spine base. Spines very short, but acute. Ratio postpetiolar width versus maximum median length of postpetiolar node 1.704 ± 0.075 [1.612, 1.846]. Spine bases more approached, SPBA/CS 0.260 (Fig. 47, Tab. 11). Kazakhstan east to Mongolia and Tibet. .... ***C. koshewnikovi***

12a FRS/PPH < 0.722. Small size, CS 386 - 457. Postpetiole as high as petiole and with conspicuous ventral bulge. Head elongated: CL/CW 1.19-1.27. Postocular index large (PoOc/CL 0.455 - 0.490). Spines moderately long (Figs. 58, 59; Tab. 13). Cosmopolitan tramp species. .... ***C. emeryi***

12b FRS/PPH > 0.722. 13

13a Index PPH/PoOc*CL < 306. Small size (CS 379 - 450), Large postocular index (PoOc/CL 0.460 - 0.495), Low postpetiole (PPH/CS 0.249 - 0.0294). Gastral pubescence dense. Metanotal groove absent or very shallow. *C. minutior* group. 14

13b Index PPH/PoOc*CL > 306. Character combination in at least one character different. 20

14a Dorsum of vertex and mesosoma in overall impression mat. Vertex with well-impressed foveolae of 13 - 18 µm diameter. Spines longer (SP/CS 0.104 - 0.147). Gastral pubescence distance much smaller (sqPDG 2.73 - 3.41). 15

14b Dorsum of vertex and mesosoma in overall impression shining. Vertex with very shallow and small foveolae of 4 - 10 µm diameter; foveolar interspaces brilliantly shining and much wider than foveolar diameter, occasionally with fragments of very fine perifoveolar microreticulum. Spines shorter (SP/CS 0.89). Gastral pubescence distance larger (sqPDG 4.25) (Fig. 67, Tab. 14). Most probably Oriental. .... ***C. britteni***

15a Cuticular surface of first gaster tergite shining, only a delicate, widely-meshed microreticulum may be present. 17

15b Cuticular surface of first gaster tergite mat, caused by very dense and fine shagreened microsculpture. 16

16a Scape much longer, SL/CS 0.836; spine bases much aproached, SPBA/CS 0.254; waist segments much narrower, PEW/CS 0.245, PPW/CS 0.409; petiole low, PEH/CS 0.283. Foveolar interspaces on paramedian vertex only slightly smaller than foveolar diameter (Fig. 69B, Tab. 14). India. .... ***C. opaca* sp.n.**

16b Scape shorter, SL/CS 0.789; spine bases less aproached, SPBA/CS 0.306; waist segments much wider, PEW/CS 0.297, PPW/CS 0.482; petiole much higher, PEH/CS 0.348. Foveolar interspaces on paramedian vertex much lower than foveolar diameter (Fig. 69A, Tab. 14). India.. .... ***C. carbonaria***

17a Scape longer (SL/CS 0.740 - 0.785). Postpetiolar sternite completely flat..................... 18

17b Scape shorter (SL/CS < 0.740). Postpetiolar sternite flat but with shallow antero-lateral bulbs best visible in anterolaterodorsal view. Median third of vertex without foveolae (Fig. 64, Tab. 14). India. .... ***C. breviscapus* sp.n.**

18a Very dark; mesosoma and dorsal head blackish brown, PigCap + PigMes 23 - 24. Use disciminant functions (Fig. 65, Tab. 14). India. .... ***C. goa* sp.n.**

18b Lighter; mesosoma and dorsal head light-yellowish to dark dirty brown, PigCap + PigMes 10 - 21. Use disciminant functions. 19

19a Discriminant 0.3 PEW/CS + 4.0 PPW/CS + 0.7 PPH/CS > 2.085. Colour of mesosoma varying from dark dirty brown to light-yellowish brown, usually without warm orange component (Fig. 63, Tab. 14). Cosmopolitan tramp species. ... ***C. minutior***

19b Discriminant 0.3 PEW/CS + 4.0 PPW/CS + 0.7 PPH/CS < 2.085. Mesosoma with warm orange-yellowish tinge (Fig. 66, Tab. 14). Mainly Indo-Australian. ... ***C. tjibodana***

20a Eyes large (EYE 0.249 - 0.283). Postocular index small (PoOc/CL 0.311 - 0.420) Postpetiole rather narrow (PPW/CS 0.463 - 0.551). Anterior postpetiolar sternite completey flat, in median portion as flat as in more lateral portions; in lateral view its anterior profile chanes into the helcium without a distinct angle (Fig. 70). *C. batesii* group. 29

20b Eyes medium sized (EYE 0.224 - 0.262). Postocular index larger (PoOc/CL 0.368 - 0.466) Postpetiole wider (PPW/CS 0.478 - 0.654). Anterior postpetiolar sternite in median portion significantly more produced than in paramedian portions; in lateral view this anteromedian bulge forms a small obtusely rounded corner that changes into the helcium with a distinct angle (Fig. 69). *C. elegans* and *C. bulgarica* group. 21

20c Eyes small (EYE 0.199 - 0.246). Postocular index large (PoOc/CL 0.413 - 0.492) Postpetiole narrow (PPW/CS 0.403 - 0.545). 36

21a Petiole with a slender peduncle that is in dorsal view 1.8 x as long as wide (Fig. 23). Petiole low (PEH/CS 0.269 - 0.327), postpetiole low and narrow (PPH/CS 0.232 - 0.291, PPW/CS 0.448-0.556), postocular index small (PoOc/CL 0.368 - 0.396) (Fig. 23, Tab. 8). Asia Minor to Afghanistan. .... ***C. brachyceps* sp.n.**

21b Petiole with a thicker peduncle. Waist ratios and postocular index frequently larger. 22

22a Scape long (SL/CS 0.790 - 0.881), postocular index smaller (PoOc/CL 0.378 - 0.422), gastral pubescence long (PLG/CS 6.54 - 8.88 %). Compare with *C. israelica* sp.n. (Fig. 7, Tab. 6). Mediterranean, Balkans, Asia Minor. .... ***C. elegans***

22b SL/CS and PLG/CS smaller, PoOc/CL on average larger. 23

23a Spine base centre positioned very low (in lateral view at height level of spiracle); spines short (SP/CS 0.071). Frons very narrow (FRS/CS 0.225). Anterior profile of petiole only weakly concave. Foveolae on vertex small (dFov 14), their interspaces larger than foveolar diameter. PEW/PPW 0.498 (Fig. 13, Tab. 6). Israel. .... ***C. gallilaeica* sp.n.**

23b Spine base higher; frons wider. 24

24a Foveolae on vertex small (dFov 12 - 16), their interspaces wider than foveolar diameter. Petiole much narrower than postpetiole, PEW/PPW 0.480 - 0.566. Spine bases much approached (SPBA/CS 0.204 - 0.255) (Fig. 14a, Tab. 6). Ukraine to Tibet. .... ***C. ulianini***

24b Foveolae on vertex larger (dFov 16 - 21), their interspaces as wide or smaller than foveolar diameter. 25

25a Postocular index smaller, PoOc/CL 0.421. Petiole much narrower than postpetiole, PEW/PPW 0.512. Spine bases much approached, SPBA/CS 0.221. Vertex foveolae relatively deep and well-demarcated, bicoronate, densely-packed, interspaces much smaller than foveolar diameter. Anterior profile of petiole node relative to dorsal profile of peduncle steeper than in *C. elegans*. Anteroventral petiolar dent reduced (Fig. 12, Tab. 6). Sinai, Israel. .... ***C. israelica* sp.n.**

25b PoOc/CL and PEW/PPW larger. 26

26a Spine bases much approximated, SPBA/CS 0.223. Spines short, SP/CS 0.087. Width and height of waist segments low (PEW/CS 0.274, PEH/CS 0.306, PPW/CS 0.500, PPH/CS 0.277) (Fig. 14b, Tab. 6). Semideserts of Kazakhstan. ... ***C. littoralis* sp.n.**

26b Spine bases wider, spines longer, width and height ratios of all waist segments larger. 27

27a Vertex with larger, more strongly demarcated foveolae with more pronounced inner corona and interspaces much narrower than foveolar diameter. Promesonotum usually showing in addition to foveolae a fine longitudinal rugosity. Gastral pubescence longer (PLG/CS 6.40 - 7.38 %), head shorter (CL/CW 1.123 - 1.193). Anterior profile of petiole node relative to dorsal profile of peduncle steeper (Fig. 11, Tab. 6). Israel, Iran. .... ***C. persiana* sp.n.**

27b Vertex with smaller, less strongly demarcated foveolae with less pronounced inner corona and larger foveolar interspaces. Promesonotum more shining, only with scattered shallow foveolae and usually without fine longitudinal rugosity. Gastral pubescence shorter (PLG/CS 5.04 - 6.96 %), head longer (CL/CW 1.153 - 1.254). Anterior profile of petiole node relative to dorsal profile of peduncle less steep. 28

28a Brightness contrast between head and mesosoma low or absent (PigCap/PigMes 1.00 - 1.43). Mesosoma with dirty brown colour component. Nest sample means of +0.048 CL/CW +0.176 SL/CS +0.94 EYE -0.126 PEH/CS +0.46 PEW/PPW - 3.4 MGr/CS +0.53 sqrt(PigCap/PigMes) > 1.14 (Fig. 10, Tab. 6). Tunisia, Near East, Asia Minor, Caucasus, Uzbekistan, Kazakhstan. .... ***C. sahlbergi***

28b Brightness contrast between head and mesosoma expressed (PigCap/PigMes 1.14 - 2.00). Mesosoma with warm yellowish colour component occurring independently from variation in mesosomal darkness. Nest sample means of +0.048 CL/CW +0.176 SL/CS +0.94 EYE -0.126 PEH/CS +0.46 PEW/PPW -3.4 MGr/CS +0.53 sqrt(PigCap/PigMes) < 1.09 (Figs. 8, 9; Tab. 6). Balkans and Asia Minor. ... ***C. bulgarica***

29a Postocular index larger than 0.340. 30

29b Postocular index smaller than 0.340. Eyes very large, EYE 0.278 - 0.283. Postpetiole very narrow, PPW/CS 0.454 - 0.467 (Fig. 26, Tab. 8). Kuwait. ... ***C. opistopsis* sp.n.**

30a Frontal lobes not or weakly converging immediately caudal of the FRS level, FL/FR < 1.12. Postocular distance smaller, PoOc/CL < 0.409. 31

30b Frontal lobes strongly converging immediately caudal of the FRS level, FL/FR 1.15 - 1.19. Postocular distance larger, PoOc/CL 0.409 - 0.418 (Fig. 24, Tab. 8). Jordan. .... ***C. tenuifrons* sp.n.**

31a Whole vertex except of occipital third densely longitudinally rugulose-carinulate, more developed sculpture producing a mat surface appearance on head, mesosoma and petiole. Waist segments more massive than in *C. nigra* and *C. bicoronata* sp.n. (Fig. 25, Tab. 8). Yemen. .... ***C. rugulosa* sp.n.**

31b Less than 30 % of vertex longitudinally rugulose-carinulate. 32

32a Petiole node very massive (PEW/CS 0.300 - 0.369). Foveolae on vertex shallow, with weak inner corona; interspaces shining, slightly wider than foveolar diameter, and with fine, scattered, simple or cross-branched carinulae. Dorsal surface of head, gaster, coxae, femora, and tibiae dark to blackish brown; mesosoma and petiole reddish brown; postpetiole, scape, and antennal club dark brown (Fig. 18, Tab. 7). Asia Minor. .... ***C. semirubra* sp.n.**

32b Petiole node much less massive (PEW/CS 0.236 - 0.311). 33

33a Gastral pubescence longer, PLG/CS > 6.6 %. Paramedian vertex with irregularly-margined, bicoronate foveolae; the more sculptured interspaces with relatively strong perifoveolar rugae or cross-branched carinulae produce a less shining overall surface impression (Fig. 19). Spines steep and acute, their angle deviating by 55 - 60° from longitudinal axis of mesosoma. Head blackish brown; mesosoma and petiole reddish brown; postpetiole and gaster brown (Tab. 7). Afghanistan. .... ***C. kushanica***

33b Gastral pubescence shorter, PLG/CS < 6.7 %. Paramedian vertex with regularly-circular foveolae; the more shining interspaces with only fine perifoveolar rugae or cross-branched carinulae produce a more shining overall surface impression. 34

34a Postocular distance, spine base distance, as well as width and height of waist segments larger. Spines deviating by 45° from longitudinal mesosomal axis, rather long, but with blunt tip. Discriminant -0.228 SL/CS +3.88 SP/CS +0.93 PPW/CS +2.78 PEH/CS +2.27 PPH/CS +1.03 PoOc/CL > 2.61. Posterior slope of petiole node much steeper than anterior slope; peduncle rather short and gradually melting with node. Usually bicoloured: dorsal head medium brown, mesosoma and waist light-orange brown, gaster dark brown; specimens with darker brown mesosomas occuring (Fig. 17, Tab. 8). S Iberia, Morocco, Algeria. .... ***C. batesii***

34b Postocular distance, spine base distance, as well as width and height of waist segments smaller. Spines steeper, shorter and more acute. Discriminant -0.228 SL/CS +3.88 SP/CS +0.93 PPW/CS +2.78 PEH/CS +2.27 PPH/CS +1.03 PoOc/CL < 2.62. Colour variable. 35

35a Paramedian vertex with well-demarcated, usually bicoronate foveolae. Pubescence on whole body more rough. Distribution of microsculpture on vertex more inhomogeneous, frontal laminae and vertex posterior of frontal laminae usually densely longitudinally carinulate (Figs. 21, 22; Tab. 8). Israel, Jordan, Arab Peninsula, Turkestan. .... ***C. bicoronata* sp.n.**

35b Foveolae on paramedian vertex with more irregular margins and a microcorrugated inner surface. Pubescence on whole body more appressed. Vertex in overall impression more homogeneously shining; frontal laminae and vertex posterior of the frontal laminae usually not densely carinulate (Fig. 20, Tab. 8). Cape Verde, S Iberia, Morocco to Sinai, Cyprus. .... ***C. nigra***

36a Propodeal spines in lateral view appearing as blunt angles of 95 - 120°. Sides of postpetiole in dorsal view always rounded convex. Promesonotal and anterior propodeal profiles forming shallowly convex curvatures which together form a wide metanotal depression (Figs. 39 - 43). *C. shuckardi* group. 37

36b Propodeal spines short, but appearing in lateral view as smaller angles of 60 - 95°. Sides of postpetiole in many species in dorsal aspect angulate-convex, outlines of postpetiole thus suggestedly hexagonal. Promesonotal and anterior propodeal profiles not forming evenly convex curvatures; as result, metanotal depression not as wide or absent (Figs. 30 - 37). *C. nuda* group. 41

37a Head very short, CL/CW 1.13, gastral pubescence very short, PLG/CS 4.75 %; Large size, CS 610; small eyes, EYE 0.199 (Fig. 42, Tab. 10). Iran. .... ***C. unicalis* sp.n.**

37b Head more elongated, CL/CW 1.14-1.29, gastral pubescence longer, PLG/CS 5.3 - 8.1 %. 38

38a Head very long, CL/CW 1.22 - 1.29; scape rather short, SL/CS 0.80 - 0.84. Whole body dark to blackish brown (Fig. 41, Tab. 10). NE Africa and south of Arab Peninsula. .... ***C. melana* sp.n.**

[note: worker of closely related, sympatric species *C. longiceps* sp.n. unknown; it should have CL/CW 1.27 and SL/CS 0.85].

38b Head shorter, CL/CW 1.14 - 1.23; character combination different. 39

39a Postpetiole wider, PPW/CS 0.45-0.49; Metanotal depression shallower; MGr 1.6-3.6; Scape rather short, SL/CS 0.79-0.84 (Fig. 39, Tab. 10). Homogeneously medium to dark brown. SE Africa and Madagascar. .... ***C. shuckardi***

39b Postpetiole narrower, PPW/CS 0.40-0.45; Metanotal depression deeper; MGr 2.5-6.2; Scape rather long, SL/CS 0.81-0.87. 40

40a Eye larger, EYE 0.219-0.239. Whole body dark brown. Smaller, CS 467-572 µm (Fig. 40, Tab. 10). Africa, Carribean, Florida. .... ***C. venustula***

40b Eye smaller, EYE 0.201 - 0.217. Size bigger, CS 556 - 633 µm. Usual colour: head yellowish to dirty yellowish brown, mesosoma and waist yellowish, gaster dark to blackish brown. Dark morphs may occur (Fig. 43, Tab. 10). N Africa and S of Arab Peninsula. .... ***C. fajumensis***

41a Postpetiole as high as petiole, PPH/CS 0.32 - 0.39. 42

41b Postpetiole lower than petiole, PPH/CS 0.26 - 0.32. 44

42a Australasian and Polynesian. Pubescence on dorsum of gaster longer, PLG/CS 5.6-7.3 %. Scape longer, SL/CS 0.77-0.83. 43. Eye larger, EYE 0.224-0.246. 43

42b W Palaearctic. Pubescence on dorsum of gaster short, PLG/CS 4.6 %. Scape short, SL/CS 0.775. Frontal carinae widely separated, FRS/CS 0.289. Eye smaller, EYE 0.220 (Fig. 31, Tab. 9). Tunisia. .... ***C. paranuda* sp.n.**

43a Head much elongated, CL/CW 1.18-1.31. Dorsal pronotum and waist microsculptured, not shining. Petiole node in dorsal aspect longer than wide. PEW/PPW 0.515-0.604 (Fig. 30, Tab. 9). Discriminant 2.0 CL/CW +1.8 SP/CS -0.7 PEW/CS >2.4 .... ***C. nuda***

43b Head shorter, CL/CW 1.17. Dorsal pronotum and waist shining. Petiole node in dorsal aspect as wide as long. PEW/PPW 0.592 (Fig. 32, Tab. 9). Discriminant 2.0 CL/CW +1.8 SP/CS -0.7 PEW/CS <2.4. Australia .... ***C. atalanta***

44a Postpetiolar sternite with either flat anteromedian bulb or small rectangular anteromedian corner. Width of postpetiole much larger than median node length, PPW/PPL 1.293-1.383. Head much elongated, CL/CW 1.18-1.26. Promesonotum dorsally with foveolae of 16 - 18 µm diameter. Whole body dark brown or blackish (Figs. 36, 37; Tab. 9). Indonesia. .... ***C. strigifrons***

44b Postpetiolar sternite without weak anteromedian prominence. Character combination in at least one character clearly deviating. 45

45a Nest sample means of discriminant D(6) = 2.8 SP/CS +2.8 PPW/CS +2.3 PEH/CS -0.34 SL/CS -5 PLG/CS -1.6 PEW/PPW < 0.74 (Fig. 35, Tab. 9). SE Palaearctic, Indomalayan, Polynesian. .... ***C. kagutsuchi***

45b Nest sample means of discriminant D(6) = 2.8 SP/CS +2.8 PPW/CS +2.3 PEH/CS -0.34 SL/CS -5 PLG/CS -1.6 PEW/PPW > 0.74 (Figs. 33, 34). Cosmopolitan tramp species. 46

46a Dorsal propodeal profile not sloping down in posterior half. Propodeal spines not very blunt. Whole body more slender: Head longer, waist segments narrower and lower, CL/CW 1.13-1.22, PEW/CS 0.23-0.30, PPW/CS 0.46-0.53, PEH/CS 0.31-0.35, PPH/CS 0.27-0.32. Spiracles of waist segments not situated on high conical tubercles. Postpetiole with angulate-convex sides in dorsal view (Fig. 33, Tab. 9). Cosmopolitan tramp species. .... ***C. mauritanica***

46b Dorsal propodeal profile sloping down in posterior half. Propodeal spines reduced to rectangular or obtusely angled corners. Whole body more thickset: Head shorter, waist segments wider and higher, CL/CW 1.11-1.18, PEW/CS 0.28-0.34, PPW/CS 0.48-0.55, PEH/CS 0.34-0.38, PPH/CS 0.29-0.32. Spiracles of waist segments frequently situated on high conical tubercles. Postpetiole with more rounded sides in dorsal view (Fig. 34, Tab. 9). S Iberia, Sinai. Mutant of *C. mauritanica*? .... ***C. mauritanica*** (morph B)

Tab. 6: Morphometric data of the species of the *Cardiocondyla bulgarica* group.

	C. ulianini (n = 38)	*C. littoralis* (n = 5)	*C. gallilaeica* (n = 1)	*C. israelica* (n = 3)	*C. israelica* (n =8)	*C. sahlbergi* (n = 56)	*C. bulgarica* (n = 39)
CS	523 ± 23 [490, 568]	486 ± 14 [468, 501]	480	519 ± 9 [519, 524]	512 ± 13 [483, 524]	517 ± 26 [460, 564]	518 ± 15 [472, 560]
CL/CW	1.149 ± 0.019 [1.098, 1.181]	1.167 ± 0.015 [1.152, 1.190]	1.131	1.152 ± 0.008 [1.143, 1.158]	1.138 ± 0.015 [1.119, 1.158]	1.189 ± 0.020 [1.153, 1.254]	1.203 ± 0.019 [1.165, 1.248]
SL/CS	0.809 ± 0.018 [0.768, 0.847]	0.792 ± 0.008 [0.780, 0.800]	0.807	0.816 ± 0.012 [0.805, 0.828]	0.816 ± 0.009 [0.804, 0.828]	0.798 ± 0.015 [0.752, 0.823]	0.811 ± 0.014 [0.784, 0.836]
PoOc/CL	0.410 ± 0.008 [0.397, 0.432]	0.442 ± 0.009 [0.431, 0.454]	0.403	0.421 ± 0.009 [0.416, 0.431]	0.421 ± 0.008 [0.410, 0.431]	0.446 ± 0.011 [0.428, 0.465]	0.451 ± 0.008 [0.424, 0.466]
EYE	0.251 ± 0.005 [0.242, 0.262]	0.249 ± 0.004 [0.244, 0.253]	0.254	0.245 ± 0.002 [0.244, 0.247]	0.248 ± 0.004 [0.244, 0.255]	0.233 ± 0.006 [0.219, 0.247]	0.241 ± 0.007 [0.227, 0.254]
dFOV	13.8 ± 1.1 [12, 16]	15.0 ± 1.2 [13, 16]	14.0	16.7 ± 0.60 [16, 17]	16.6 ± 0.60 [16, 17]	17.0 ± 0.9 [14, 19]	17.6 ± 0.7 [16, 19]
FRS/CS	0.259 ± 0.007 [0.243, 0.272]	0.241 ± 0.005 [0.234, 0.248]	0.225	0.257 ± 0.0 [0.257, 0.257]	0.269 ± 0.010 [0.257, 0.282]	0.259 ± 0.009 [0.237, 0.275]	0.259 ± 0.010 [0.241, 0.282]
SPBA/CS	0.236 ± 0.011 [0.204, 0.255]	0.223 ± 0.012 [0.206, 0.238]	0.230	0.221 ± 0.0 [0.221, 0.221]	0.220 ± 0.003 [0.217, 0.225]	0.281 ± 0.017 [0.249, 0.322]	0.283 ± 0.01 [0.265, 0.315]
SP/CS	0.120 ± 0.012 [0.099, 0.149]	0.087 ± 0.019 [0.066, 0.113]	0.071	0.126 ± 0.006 [0.122, 0.133]	0.133 ± 0.010 [0.122, 0.149]	0.117 ± 0.016 [0.084, 0.155]	0.116 ± 0.011 [0.092, 0.136]
PEW/CS	0.292 ± 0.018 [0.261, 0.336]	0.274 ± 0.009 [0.263, 0.286]	0.275	0.285 ± 0.007 [0.272, 0.292]	0.282 ± 0.009 [0.270, 0.296]	0.331 ± 0.024 [0.281, 0.401]	0.349 ± 0.019 [0.296, 0.382]
PPW/CS	0.565 ± 0.025 [0.494, 0.626]	0.500 ± 0.011 [0.487, 0.514]	0.552	0.556 ± 0.006 [0.553, 0.563]	0.562 ± 0.012 [0.548, 0.585]	0.564 ± 0.029 [0.509, 0.654]	0.564 ± 0.022 [0.519, 0.642]
PEH/CS	0.337 ± 0.012 [0.310, 0.364]	0.306 ± 0.004 [0.299, 0.310]	0.308	0.324 ± 0.008 [0.316, 0.330	0.327 ± 0.011 [0.311, 0.345	0.348 ± 0.020 [0.292, 0.388]	0.340 ± 0.011 [0.309, 0.370]
PPH/CS	0.279 ± 0.010 [0.255, 0.299]	0.277 ± 0.006 [0.271, 0.286]	0.298	0.306 ± 0.011 [0.294, 0.313]	0.303 ± 0.010 [0.286, 0.313]	0.307 ± 0.013 [0.276, 0.337]	0.315 ± 0.014 [0.287, 0.357]
PEW/PPW	0.517 ± 0.022 [0.480, 0.566]	0.548 ± 0.008 [0.535, 0.556]	0.498	0.512 ± 0.008 [0.504, 0.519]	0.512 ± 0.008 [0.504, 0.519]	0.586 ± 0.024 [0.531, 0.633]	0.619 ± 0.023 [0.570, 0.667]
sqrtPDG	4.88 ± 0.31 [4.29, 5.67]	4.63 ± 0.38 [4.20, 5.07]	4.66	3.89 ± 0.14 [3.78, 4.05]	4.00 ± 0.13 [3.78, 4.17]	4.87 ± 0.34 [4.12, 5.77]	5.13 ± 0.35 [4.28, 6.12]
PLG/CS [%]	5.93 ± 0.37 [5.04, 6.69]	6.90 ± 0.18 [6.74, 7.13]	6.24	7.19 ± 0.22 [7.04, 7.44]	7.16 ± 0.24 [6.82, 7.53]	5.89 ± 0.49 [5.04, 6.96]	5.67 ± 0.34 [5.10, 6.50]
MGr/CS [%]	3.46 ± 0.70 [2.4, 5.4]	3.70 ± 0.56 [3.3, 4.7]	3.75	4.05 ± 1.45 [2.5, 5.3]	3.44 ± 1.07 [2.0, 5.3]	3.87 ± 0.94 [2.3, 6.6]	3.18 ± 0.61 [1.5, 4.2]

Tab.7: Morphometric data of the workers of the *Cardiocondyla elegans* group (*C. elegans* and *C. brachyceps* sp.n.) and of the *C. batesii* complex (*C. batesii*, *C. semirubra* sp.n., and *C. kushanica*).

	C. elegans (n = 73)	*C. brachyceps* (n = 10)	*C. batesii* (n = 36)	*C. semirubra* (n = 4)	*C. kushanica* (n = 2)
CS	560 ± 30 [495, 618]	563 ± 27 [498, 587]	518 ± 10 [499, 548]	552 ± 10 [540, 560]	508 ± 5 [504, 512]
CL/CW	1.153 ± 0.021 [1.100, 1.224]	1.132 ± 0.022 [1.093, 1.164]	1.177 ± 0.016 [1.143, 1.210]	1.168 ± 0.023 [1.137, 1.190]	1.162 ± 0.002 [1.161, 1.163]
SL/CS	0.847 ± 0.021 [0.790, 0.881]	0.835 ± 0.019 [0.817, 0.869]	0.791 ± 0.011 [0.776, 0.814]	0.782 ± 0.010 [0.773, 0.795]	0.828 ± 0.009 [0.821, 0.834]
PoOc/CL	0.397 ± 0.009 [0.378, 0.422]	0.381 ± 0.009 [0.368, 0.396]	0.383 ± 0.009 [0.369, 0.408]	0.374 ± 0.006 [0.366, 0.379]	0.373 ± 0.007 [0.368, 0.378]
EYE	0.248 ± 0.007 [0.235, 0.261]	0.253 ± 0.004 [0.244, 0.260]	0.264 ± 0.006 [0.251, 0.277]	0.256 ± 0.003 [0.252, 0.258]	0.270 ± 0.006 [0.265, 0.274]
dFOV	17.4 ± 0.7 [16, 19]	19.2 ± 0.9 [18, 21]	15.5 ± 0.7 [14, 17]	17.3 ± 1.3 [16, 19]	16.5 ± 0.7 [16, 17]
FRS/CS	0.259 ± 0.010 [0.232, 0.288]	0.255 ± 0.011 [0.235, 0.273]	0.245 ± 0.005 [0.231, 0.251]	0.257 ± 0.004 [0.252, 0.261]	0.262 ± 0.0
SPBA/CS	0.260 ± 0.020 [0.213, 0.292]	0.239 ± 0.019 [0.214, 0.282]	0.257 ± 0.009 [0.242, 0.271]	0.254 ± 0.011 [0.245, 0.268]	0.248 ± 0.0
SP/CS	0.111 ± 0.013 [0.074, 0.138]	0.126 ± 0.008 [0.113, 0.136]	0.117 ± 0.008 [0.100, 0.130]	0.096 ± 0.010 [0.083, 0.106]	0.100 ± 0.004 [0.098, 0.103]
PEW/CS	0.330 ± 0.034 [0.276, 0.404]	0.297 ± 0.017 [0.265, 0.322]	0.282 ± 0.011 [0.256, 0.301]	0.322 ± 0.032 [0.300, 0.369]	0.269 ± 0.004 [0.266, 0.272]
PPW/CS	0.572 ± 0.027 [0.516, 0.638]	0.517 ± 0.032 [0.448, 0.556]	0.533 ± 0.011 [0.509, 0.556]	0.518 ± 0.015 [0.501, 0.536]	0.532 ± 0.001 [0.531, 0.532]
PEH/CS	0.330 ± 0.016 [0.298, 0.367]	0.299 ± 0.018 [0.269, 0.327]	0.330 ± 0.008 [0.315, 0.346]	0.326 ± 0.027 [0.303, 0.363]	0.306 ± 0.010 [0.299, 0.313]
PPH/CS	0.299 ± 0.015 [0.270, 0.344]	0.257 ± 0.016 [0.232, 0.291]	0.286 ± 0.008 [0.262, 0.299]	0.267 ± 0.013 [0.252, 0.284]	0.287 ± 0.003 [0.285, 0.289]
PEW/PPW	0.575 ± 0.035 [0.505, 0.653]	0.576 ± 0.027 [0.515, 0.604]	0.529 ± 0.014 [0.501, 0.566]	0.623 ± 0.067 [0.573, 0.721]	0.506 ± 0.008 [0.500, 0.511]
sqrtPDG	4.14 ± 0.28 [3.52, 4.77]	4.83 ± 0.43 [4.09, 5.44]	4.84 ± 0.30 [4.41, 5.61]	5.37 ± 0.59 [4.84, 6.21]	4.73 ± 0.01 [4.72, 4.74]
PLG/CS [%]	7.60 ± 0.52 [6.54, 8.88]	7.68 ± 0.53 [6.88, 8.73]	5.55 ± 0.32 [4.48, 6.02]	5.39 ± 0.22 [5.18, 5.71]	6.89 ± 0.07 [6.84, 6.94]
MGr/CS [%]	4.41 ± 0.91 [2.4, 6.2]	4.08 ± 1.09 [2.4, 5.4]	3.82 ± 0.60 [2.7, 5.6]	4.38 ± 0.95 [3.3, 5.4]	2.56 ± 0.25 [2.4, 2.7]
PEH/PEW		1.008 ± 0.011 [0.993, 1.024]	1.173 ± 0.035 [1.119, 1.245]	1.012 ± 0.023 [0.985, 1.040]	1.140 ± 0.055 [1.101, 1.179]
PigCap/ Mes			1.41 ± 0.27 [1.00, 2.25]		

Tab.8: Morphometric data of the workers of the other species of the *Cardiocondyla batesii* group.

	C. tenuifrons (n = 3)	*C. nigra* (n = 44)	*C. bicoronata* (n = 29)	*C. rugulosa* (n = 1)	*C. opistopsis* (n = 4)
CS	509 ± 3 [506, 512]	531 ± 17 [488, 580]	546 ± 18 [502, 582]	576	553 ± 14 [540, 569]
CL/CW	1.205 ± 0.005 [1.199, 1.209]	1.172 ± 0.025 [1.125, 1.227]	1.171 ± 0.022 [1.126, 1.226]	1.168	1.171 ± 0.017 [1.149, 1.189]
SL/CS	0.804 ± 0.004 [0.802, 0.809]	0.810 ± 0.017 [0.778, 0.842]	0.812 ± 0.019 [0.776, 0.843]	0.789	0.825 ± 0.009 [0.812, 0.831]
PoOc/CL	0.413 ± 0.005 [0.409, 0.418]	0.366 ± 0.010 [0.342, 0.381]	0.365 ± 0.011 [0.342, 0.397]	0.344	0.316 ± 0.004 [0.311, 0.320]
EYE	0.267 ± 0.001 [0.266, 0.268]	0.266 ± 0.008 [0.249, 0.282]	0.261 ± 0.007 [0.249, 0.279]	0.267	0.280 ± 0.002 [0.278, 0.283]
dFOV	14.0 ± 1.0 [13, 15]	16.2 ± 1.1 [14, 19]	17.3 ± 0.7 [16, 19]	17.7	18.0 ± 0.8 [17, 19]
FRS/CS	0.238 ± 0.005 [0.234, 0.243]	0.247 ± 0.011 [0.223, 0.267]	0.238 ± 0.007 [0.230, 0.249]	0.250	0.244 ± 0.005 [0.237, 0.247]
SPBA/CS	0.237 ± 0.005 [0.232, 0.241]	0.231 ± 0.013 [0.199, 0.257]	0.234 ± 0.011 [0.215, 0.259]	0.240	0.234 ± 0.008 [0.224, 0.242]
SP/CS	0.093 ± 0.009 [0.083, 0.101]	0.097 ± 0.010 [0.073, 0.114]	0.102 ± 0.012 [0.082, 0.126]	0.101	0.073 ± 0.005 [0.069, 0.081]
PEW/CS	0.272 ± 0.001 [0.272, 0.273]	0.268 ± 0.016 [0.236, 0.311]	0.266 ± 0.012 [0.245, 0.290]	0.276	0.283 ± 0.009 [0.272, 0.295]
PPW/CS	0.516 ± 0.004 [0.511, 0.519]	0.501 ± 0.018 [0.463, 0.539]	0.506 ± 0.018 [0.476, 0.551]	0.537	0.463 ± 0.006 [0.454, 0.467]
PEH/CS	0.325 ± 0.001 [0.324, 0.326]	0.299 ± 0.009 [0.285, 0.325]	0.303 ± 0.010 [0.279, 0.312]	0.329	0.271 ± 0.018 [0.246, 0.286]
PPH/CS	0.288 ± 0.006 [0.282, 0.293]	0.260 ± 0.010 [0.237, 0.281]	0.260 ± 0.011 [0.236, 0.284]	0.289	0.259 ± 0.010 [0.244, 0.267]
PEW/PPW	0.528 ± 0.005 [0.525, 0.534]	0.535 ± 0.022 [0.494, 0.596]	0.526 ± 0.017 [0.493, 0.574]	0.514	0.611 ± 0.015 [0.599, 0.632]
sqrtPDG	5.57 ± 0.48 [5.12, 6.07]	5.09 ± 0.36 [4.13, 6.04]	5.15 ± 0.37 [4.23, 6.04]	5.48	5.34 ± 0.29 [4.94, 5.61]
PLG/CS [%]	5.37 ± 0.21 [5.13, 5.51]	5.40 ± 0.43 [4.54, 6.59]	5.38 ± 0.32 [4.86, 6.27]	5.41	5.13 ± 0.34 [4.85, 5.62]
MGr/CS [%]	2.00 ± 0.20 [1.8, 2.2]	4.07 ± 0.89 [2.2, 5.6]	3.41 ± 0.62 [2.4, 4.9]	2.10	2.15 ± 0.95 [0.9, 3.2]
PEH/PEW	1.192 ± 0.004 [1.188, 1.196]	1.119 ± 0.052 [0.994, 1.221]	1.140 ± 0.056 [1.040, 1.296]	1.195	0.959 ± 0.048 [0.905,1.019]
PigCap/ Mes		1.06 ± 0.12 [0.89, 1.57]			

Tab. 9: Morphometric data of the workers of the *Cardiocondyla nuda* group.

	C. mauritanica morph B (n = 12)	*C. mauritanica* (n = 136)	*C. paranuda* (n = 1)	*C. kagutsuchi* (n = 69)	*C. strigifrons* (n = 7)	*C. nuda* (n = 34)	*C. atalanta* (n =2)
CS	506 ± 14 [488, 533]	514 ± 21 [460,568]	482 ± 0	519 ± 25 [455, 581]	531 ± 14 [512, 555]	468 ± 24 [422, 516]	463 ± 12 [454,471]
CL/CW	1.151 ± 0.021 [1.115, 1.182]	1.183 ± 0.020 [1.126, 1.224]	1.224 ± 0.0	1.181 ± 0.023 [1.141, 1.247]	1.222 ± 0.031 [1.178, 1.263]	1.224 ± 0.022 [1.184, 1.307]	1.170 ± 0.015 [1.159,1.180]
SL/CS	0.805 ± 0.017 [0.775, 0.833]	0.813 ± 0.011 [0.787, 0.849]	0.775 ± 0.0	0.829 ± 0.011 [0.805, 0.860]	0.815 ± 0.006 [0.807, 0.823]	0.802 ± 0.016 [0.767, 0.827]	0.780 ± 0.023 [0.764,0.798]
PoOc/CL	0.425 ± 0.007 [0.417, 0.441]	0.447 ± 0.008 [0.426, 0.467]	0.473 ± 0.0	0.446 ± 0.011 [0.413, 0.471]	0.458 ± 0.011 [0.441, 0.469]	0.469 ± 0.007 [0.456, 0.492]	0.464 ± 0.001 [0.463,0.464]
EYE	0.230 ± 0.005 [0.220, 0.237]	0.232 ± 0.005 [0.222, 0.246]	0.220 ± 0.0	0.231 ± 0.006 [0.218, 0.245]	0.224 ± 0.005 [0.220, 0.233]	0.233 ± 0.006 [0.224, 0.246]	0.232 ± 0.004 [0.229,0.234]
dFOV	17.8 ± 1.1 [16, 20]	17.8 ± 1.2 [15, 20]	17.0 ± 0.0	17.1 ± 1.3 [15, 21]	16.3 ± 1.0 [15, 18]	17.6 ± 1.0 [16, 20]	18.2 ± 1.2 [17.3,19.0]
FRS/CS	0.262 ± 0.006 [0.254, 0.272]	0.265 ± 0.007 [0.248, 0.286]	0.289 ± 0.0	0.268 ± 0.010 [0.250, 0.290]	0.262 ± 0.007 [0.253, 0.271]	0.268 ± 0.009 [0.253, 0.279]	0.276 ± 0.009 [0.269,0.282]
SPBA/CS	0.276 ± 0.010 [0.263, 0.301]	0.268 ± 0.010 [0.239, 0.296]	0.300 ± 0.0	0.255 ± 0.012 [0.227, 0.283]	0.255 ± 0.016 [0.235, 0.278]	0.286 ± 0.017 [0.271, 0.320]	0.285 ± 0.008 [0.279,0.291]
SP/CS	0.065 ± 0.006 [0.055, 0.079]	0.090 ± 0.013 [0.047, 0.119]	0.114 ± 0.0	0.068 ± 0.011 [0.042, 0.090]	0.070 ± 0.013 [0.057, 0.091]	0.115 ± 0.013 [0.095, 0.144]	0.101 ± 0.007 [0.096,1.06]
PEW/CS	0.308 ± 0.017 [0.279, 0.338]	0.265 ± 0.013 [0.233, 0.298]	0.309 ± 0.0	0.269 ± 0.012 [0.246, 0.313]	0.274 ± 0.015 [0.250, 0.292]	0.285 ± 0.012 [0.254, 0.314]	0.304 ± 0.005 [0.301,0.308]
PPW/CS	0.516 ± 0.019 [0.480, 0.545]	0.486 ± 0.012 [0.460, 0.533]	0.501 ± 0.0	0.455 ± 0.010 [0.434, 0.479]	0.471 ± 0.018 [0.440, 0.488]	0.502 ± 0.019 [0.474, 0.539]	0.514 ± 0.001 [0.514,0.515]
PEH/CS	0.353 ± 0.011 [0.339, 0.378]	0.329 ± 0.009 [0.309, 0.350]	0.343 ± 0.0	0.312 ± 0.008 [0.293, 0.332]	0.324 ± 0.009 [0.315, 0.338]	0.348 ± 0.017 [0.321, 0.390]	0.343 ± 0.001 [0.342,0.344]
PPH/CS	0.303 ± 0.008 [0.291, 0.317]	0.288 ± 0.008 [0.271, 0.318]	0.359 ± 0.0	0.280 ± 0.009 [0.263, 0.304]	0.285 ± 0.013 [0.268, 0.307]	0.345 ± 0.020 [0.315, 0.395]	0.346 ± 0.001 [0.345,0.346]
PEW/PPW	0.597 ± 0.022 [0.567, 0.627]	0.545 ± 0.023 [0.486, 0.616]	0.618 ± 0.0	0.592 ± 0.022 [0.534, 0.662]	0.582 ± 0.017 [0.558, 0.609]	0.567 ± 0.019 [0.515, 0.604]	0.592 ± 0.008 [0.586,0.598]
sqrtPDG	4.13 ± 0.32 [3.69, 4.78]	3.73 ± 0.27 [3.15, 4.64]	4.26 ± 0.00	3.55 ± 0.23 [3.13, 4.15]	3.59 ± 0.28 [3.27, 4.03]	3.67 ± 0.25 [3.30, 4.42]	4.06 ± 0.30 [3.84,4.27]
PLG/CS [%]	7.08 ± 0.43 [6.00, 7.62]	6.37 ± 0.39 [5.43, 7.73]	4.57 ± 0.00	7.09 ± 0.38 [6.26, 7.98]	6.93 ± 0.60 [6.19, 7.69]	6.31 ± 0.36 [5.58, 7.31]	5.56 ± 0.47 [5.23,5.90]
MGr/CS [%]	2.34 ± 0.63 [1.3, 3.2]	2.13 ± 0.51 [1.1, 3.4]	2.50 ± 0.00	2.04 ± 0.54 [0.8, 3.3]	2.21 ± 0.52 [1.5, 3.1]	1.35 ± 0.52 [0.2, 2.6]	1.60 ± 0.57 [1.2,2.0]

Tab. 10: Morphometric data of the workers of the *Cardiocondyla shuckardi* group.

	C. longiceps prediction	*C. melana* (n = 11)	*C. shuckardi* (n = 14)	*C. venustula* (n = 24)	*C. fajumensis* (n = 9)	*C. unicalis* (n = 1)
CS		504 ± 17 [470, 522]	554 ± 29 [501, 602]	519 ± 29 [467, 572]	594 ± 28 [556, 633]	610 ± 0.0
CL/CW	1.271	1.250 ± 0.025 [1.219, 1.291]	1.166 ± 0.019 [1.135, 1.202]	1.185 ± 0.021 [1.139, 1.231]	1.205 ± 0.014 [1.176, 1.219]	1.126 ± 0.0
SL/CS	0.848	0.816 ± 0.013 [0.797, 0.838]	0.814 ± 0.019 [0.792, 0.842]	0.842 ± 0.017 [0.808, 0.867]	0.862 ± 0.011 [0.840, 0.874]	0.837 ± 0.0
PoOc/CL	0.456	0.462 ± 0.007 [0.449, 0.472]	0.450 ± 0.009 [0.432, 0.462]	0.454 ± 0.009 [0.429, 0.468]	0.445 ± 0.006 [0.438, 0.454]	0.451 ± 0.0
EYE		0.221 ± 0.005 [0.211, 0.227]	0.221 ± 0.004 [0.212, 0.230]	0.228 ± 0.005 [0.219, 0.239]	0.211 ± 0.006 [0.201, 0.217]	0.199 ± 0.0
dFOV	18.2	16.3 ± 2.3 [12, 19]	17.8 ± 5.1 [0, 23]	18.2 ± 1.1 [16, 20]	20.3 ± 0.9 [19, 22]	19.0 ± 0.0
FRS/CS		0.255 ± 0.006 [0.242, 0.262]	0.274 ± 0.009 [0.251, 0.289]	0.261 ± 0.011 [0.246, 0.283]	0.269 ± 0.010 [0.256, 0.286]	0.270 ± 0.0
SPBA/CS		0.262 ± 0.007 [0.253, 0.274]	0.281 ± 0.010 [0.261, 0.298]	0.246 ± 0.014 [0.223, 0.284]	0.258 ± 0.010 [0.246, 0.272]	0.250 ± 0.0
SP/CS	0.063	0.057 ± 0.006 [0.048, 0.066]	0.060 ± 0.012 [0.046, 0.091]	0.049 ± 0.010 [0.028, 0.075]	0.055 ± 0.010 [0.038, 0.068]	0.051 ± 0.0
PEW/CS	0.261	0.274 ± 0.015 [0.257, 0.301]	0.304 ± 0.008 [0.285, 0.315]	0.278 ± 0.010 [0.259, 0.297]	0.277 ± 0.012 [0.263, 0.302]	0.272 ± 0.0
PPW/CS	0.426	0.429 ± 0.016 [0.403, 0.454]	0.466 ± 0.011 [0.451, 0.490]	0.424 ± 0.014 [0.404, 0.452]	0.430 ± 0.011 [0.415, 0.446]	0.411 ± 0.0
PEH/CS	0.302	0.310 ± 0.011 [0.294, 0.336]	0.323 ± 0.009 [0.308, 0.338]	0.305 ± 0.009 [0.290, 0.321]	0.302 ± 0.011 [0.284, 0.316]	0.290 ± 0.0
PPH/CS	0.289	0.283 ± 0.008 [0.271, 0.297]	0.308 ± 0.008 [0.294, 0.329]	0.288 ± 0.010 [0.265, 0.304]	0.287 ± 0.007 [0.272, 0.297]	0.278 ± 0.0
PEW/ PPW	0.613	0.639 ± 0.024 [0.619, 0.701]	0.652 ± 0.018 [0.613, 0.690]	0.655 ± 0.026 [0.590, 0.689]	0.645 ± 0.020 [0.619, 0.677]	0.661 ± 0.0
sqrtPDG	3.47	4.16 ± 0.31 [3.74, 4.74]	3.81 ± 0.40 [3.30, 4.50]	3.67 ± 0.31 [3.14, 4.60]	3.91 ± 0.23 [3.62, 4.27]	4.01 ± 0.0
PLG/CS [%]	7.23	6.67 ± 0.26 [6.28, 7.20]	7.19 ± 0.55 [6.12, 7.98]	7.32 ± 0.49 [6.40, 8.10]	6.13 ± 0.45 [5.26, 6.92]	4.75 ± 0.0
MGr/CS [%]		3.09 ± 0.48 [2.4, 4.1]	2.76 ± 0.59 [1.6, 3.6]	3.95 ± 0.84 [2.5, 5.7]	5.15 ± 0.59 [4.4, 6.2]	4.92 ± 0.0

Tab. 11: Morphometric data of the workers of the *Cardiocondyla stambuloffii* group.

	C. gibbosa (n = 4)	*C. stambuloffii* (n = 47)	*C. koshewnikovi* (n = 31)	*C. tibetana* (n = 5)
CS	518 ± 9 [508, 526]	526 ± 18 [484, 583]	557 ± 27 [504, 613]	526 ± 15 [516, 552]
CL/CW	1.191 ± 0.020 [1.176, 1.219]	1.157 ± 0.019 [1.108, 1.199]	1.155 ± 0.023 [1.120, 1.199]	1.161 ± 0.015 [1.139, 1.180]
SL/CS	0.800 ± 0.016 [0.784, 0.823]	0.783 ± 0.013 [0.747, 0.807]	0.791 ± 0.020 [0.751, 0.834]	0.849 ± 0.012 [0.834, 0.865]
PoOc/CL	0.458 ± 0.004 [0.455, 0.464]	0.444 ± 0.007 [0.428, 0.460]	0.444 ± 0.010 [0.427, 0.467]	0.424 ± 0.002 [0.421, 0.427]
EYE	0.218 ± 0.006 [0.214, 0.228]	0.225 ± 0.005 [0.209, 0.235]	0.219 ± 0.008 [0.203, 0.234]	0.250 ± 0.003 [0.247, 0.253]
dFOV	4.8 ± 0.5 [4, 5]	8.3 ± 0.6 [7, 10]	8.0 ± 0.9 [6, 10]	7.0 ± 1.0 [6, 8]
FRS/CS	0.311	0.325 ± 0.012 [0.294, 0.353]	0.329 ± 0.011 [0.302, 0.352]	0.284 ± 0.004 [0.280, 0.291]
SPBA/CS	0.244	0.287 ± 0.013 [0.251, 0.309]	0.260 ± 0.010 [0.239, 0.286]	0.225 ± 0.014 [0.209, 0.241]
SP/CS	0.058 ± 0.013 [0.041, 0.068]	0.073 ± 0.009 [0.053, 0.096]	0.073 ± 0.009 [0.056, 0.096]	0.052 ± 0.011 [0.041, 0.065]
PEW/CS	0.282 ± 0.014 [0.266, 0.294]	0.293 ± 0.013 [0.274, 0.334]	0.294 ± 0.020 [0.264, 0.348]	0.284 ± 0.009 [0.277, 0.300]
PPW/CS	0.570 ± 0.010 [0.559, 0.581]	0.604 ± 0.021 [0.558, 0.664]	0.590 ± 0.028 [0.543, 0.647]	0.521 ± 0.024 [0.482, 0.545]
PEH/CS	0.374 ± 0.005 [0.368, 0.377]	0.375 ± 0.012 [0.343, 0.402]	0.382 ± 0.017 [0.348, 0.414]	0.319 ± 0.005 [0.312, 0.326]
PPH/CS	0.306 ± 0.006 [0.300, 0.315]	0.306 ± 0.010 [0.286, 0.326]	0.322 ± 0.016 [0.297, 0.354]	0.272 ± 0.007 [0.263, 0.278]
PEW/PPW	0.493 ± 0.018 [0.476, 0.512]	0.485 ± 0.015 [0.457, 0.518]	0.499 ± 0.021 [0.468, 0.539]	0.545 ± 0.018 [0.531, 0.574]
sqrtPDG	3.74 ± 0.32 [3.40, 4.09]	3.56 ± 0.24 [3.19, 4.06]	3.31 ± 0.22 [2.87, 3.85]	3.56 ± 0.19 [3.28, 3.77]
PLG/CS [%]	7.62 ± 0.33 [7.29, 7.99]	6.26 ± 0.41 [5.47, 7.18]	6.08 ± 0.61 [4.57, 7.18]	6.20 ± 0.42 [5.81, 6.90]
MGr/CS [%]	4.02 ± 0.96 [2.7, 4.9]	3.42 ± 0.71 [2.2, 5.3]	3.61 ± 1.01 [1.9, 6.2]	3.10 ± 0.96 [1.6, 4.1]

Tab. 12: Morphometric data of the workers of the *Cardiocondyla wroughtonii* group.

	C. wroughtonii (n = 78)	*C. obscurior*	*C. shagrinata* (n = 3)	*C. nana* (n = 1)
CS	415 ± 18 [381, 458]	429 ± 19 [398, 470]	426 ± 8 [418, 433]	366
CL/CW	1.125 ± 0.022 [1.080, 1.174]	1.109 ± 0.020 [1.073, 1.148]	1.099 ± 0.009 [1.090, 1.107]	1.069
SL/CS	0.776 ± 0.024 [0.731, 0.831]	0.781 ± 0.018 [0.736, 0.814]	0.760 ± 0.005 [0.754, 0.763]	0.818
PoOc/CL	0.440 ± 0.010 [0.413, 0.468]	0.434 ± 0.009 [0.418, 0.452]	0.427 ± 0.004 [0.424, 0.431]	0.464
EYE	0.234 ± 0.007 [0.219, 0.248]	0.232 ± 0.004 [0.220, 0.241]	0.222 ± 0.005 [0.219, 0.227]	0.220
dFOV	19.3 ± 1.2 [17, 22]	19.1 ± 0.9 [17, 21]	6.3 ± 0.6 [6, 7]	21.0
FRS/CS	0.273 ± 0.008 [0.254, 0.294]	0.270 ± 0.006 [0.256, 0.280]	0.285 ± 0.002 [0.283, 0.286]	0.266
SPBA/CS	0.278 ± 0.011 [0.251, 0.302]	0.292 ± 0.012 [0.271, 0.325]	0.292 ± 0.010 [0.281, 0.301]	0.277
SP/CS	0.198 ± 0.015 [0.154, 0.249]	0.180 ± 0.012 [0.152, 0.202]	0.184 ± 0.007 [0.179, 0.192]	0.192
PEW/CS	0.277 ± 0.013 [0.251, 0.323]	0.291 ± 0.012 [0.265, 0.319]	0.279 ± 0.008 [0.270, 0.284]	0.264
PPW/CS	0.437 ± 0.011 [0.408, 0.460]	0.456 ± 0.011 [0.431, 0.479]	0.446 ± 0.006 [0.441, 0.450]	0.426
PEH/CS	0.328 ± 0.011 [0.296, 0.352]	0.340 ± 0.010 [0.317, 0.369]	0.333 ± 0.003 [0.330, 0.335]	0.336
PPH/CS	0.304 ± 0.011 [0.275, 0.332]	0.315 ± 0.010 [0.292, 0.333]	0.308 ± 0.006 [0.304, 0.312]	0.289
PEW/PPW	0.633 ± 0.023 [0.580, 0.705]	0.639 ± 0.021 [0.600, 0.685]	0.622 ± 0.030 [0.601, 0.644]	0.606
sqrtPDG	5.06 ± 0.26 [4.47, 5.79]	5.13 ± 0.25 [4.60, 5.79]	4.87 ± 0.04 [4.84, 4.90]	5.60
PLG/CS [%]	6.44 ± 0.42 [5.55, 7.36]	6.38 ± 0.34 [5.54, 7.01]	6.22 ± 0.34 [5.98, 6.47]	6.29
MGr/CS [%]	3.53 ± 0.90 [1.4, 5.6]	3.72 ± 0.94] [1.0, 5.7	3.21 ± 0.58 [2.5, 3.6]	2.50
PigG1	21 ± 26 [0, 100]	98 ± 3 [83, 100]		

Tab. 13: Morphometric data of the workers of the *Cardiocondyla emeryi* group.

	C. emeryi aggr. (n = 115)	*C. yemeni* (n = 2)	*C. weserka* (n = 1)	*C. neferka* (n = 2)
CS	411 ± 13 [386, 457]	377 ± 3 [375, 380]	404	408 ± 11 [401, 416]
CL/CW	1.229 ± 0.020 [1.171, 1.283]	1.260 ± 0.017 [1.248, 1.272]	1.231	1.224 ± 0.028 [1.196, 1.251]
SL/CS	0.759 ± 0.014 [0.728, 0.791]	0.724 ± 0.006 [0.720, 0.729]	0.790	0.770 ± 0.001 [0.769, 0.770]
PoOc/CL	0.467 ± 0.008 [0.446, 0.490]	0.453 ± 0.004 [0.450, 0.456]	0.440	0.447 ± 0.0 [0.447, 0.447]
EYE	0.245 ± 0.005 [0.231, 0.257]	0.238 ± 0.001 [0.237, 0.238]	0.247	0.243 ± 0.001 [0.242, 0.244]
dFOV	15.9 ± 0.9 [14, 19]	14.5 ± 0.7 [14, 15]	17.0	16.5 ± 0.7 [16, 17]
FRS/CS	0.215 ± 0.007 [0.199, 0.229]	0.242 ± 0.008 [0.236, 0.248]	0.229	0.227 ± 0.002 [0.225, 0.229]
SPBA/CS	0.280 ± 0.011 [0.244, 0.312]	0.266 ± 0.004 [0.264, 0.269]	0.296	0.271 ± 0.008 [0.263, 0.279]
SP/CS	0.134 ± 0.011 [0.098, 0.158]	0.102 ± 0.025 [0.085, 0.120]	0.212	0.204 ± 0.003 [0.202, 0.207]
PEW/CS	0.263 ± 0.014 [0.220, 0.296]	0.275 ± 0.006 [0.271, 0.279]	0.265	0.264 ± 0.003 [0.262, 0.267]
PPW/CS	0.478 ± 0.016 [0.441, 0.520]	0.431 ± 0.003 [0.429, 0.433]	0.455	0.478 ± 0.001 [0.478, 0.479]
PEH/CS	0.329 ± 0.012 [0.287, 0.353]	0.338 ± 0.015 [0.327, 0.348]	0.357	0.348 ± 0.007 [0.341, 0.355]
PPH/CS	0.336 ± 0.011 [0.307, 0.369]	0.264	0.289	0.294 ± 0.005 [0.289, 0.299]
PEW/PPW	0.551 ± 0.020 [0.497, 0.603]	0.633	0.572	0.552 ± 0.006 [0.547, 0.558]
sqrtPDG	4.25 ± 0.27 [3.81, 5.59]	3.56	4.07	3.78 ± 0.21 [3.57, 3.98]
PLG/CS [%]	6.72 ± 0.38 [5.19, 7.58]	6.73	7.62	7.52 ± 0.24 [7.28, 7.77]
MGr/CS [%]	3.20 ± 0.56 [2.0, 4.4]	0.55 ± 0.21	1.79	3.54 ± 0.68 [2.9, 4.2]

Tab. 14: Morphometric data of the workers of the *Cardiocondyla minutior* group.

	C. minutior (n = 72)	*C. goa* (n = 4)	*C. tjibodana* (n = 26)	*C. breviscapus* (n = 3)	*C. britteni* (n = 1)	*C. carbonaria* (n = 1)	*C. opaca* (n = 1)
CS	420 ± 15 [380, 450]	420 ± 4 [417, 425]	404 ± 14 [380, 442]	387 ± 10 [379, 398]	402	434	424
CL/CW	1.260 ± 0.025 [1.211, 1.319]	1.225 ± 0.046 [1.167, 1.278]	1.260 ± 0.023 [1.200, 1.301]	1.279 ± 0.007 [1.271, 1.283]	1.249	1.282	1.253
SL/CS	0.756 ± 0.009 [0.741, 0.785]	0.775 ± 0.011 [0.760, 0.787]	0.759 ± 0.012 [0.740, 0.788]	0.716 ± 0.011 [0.705, 0.727]	0.741	0.789	0.836
PoOc/CL	0.474 ± 0.007 [0.460, 0.495]	0.476 ± 0.012 [0.462, 0.787]	0.479 ± 0.007 [0.464, 0.490]	0.485 ± 0.003 [0.483, 0.489]	0.482	0.474	0.468
EYE	0.232 ± 0.006 [0.216, 0.245]	0.228 ± 0.007 [0.220, 0.235]	0.239 ± 0.005 [0.221, 0.246]	0.223 ± 0.006 [0.217, 0.229]	0.226	0.243	0.235
dFOV	14.8 ± 1.2 [13, 18]	15.6 ± 0.4 [15.1, 16.0]	14.3 ± 0.9 [13, 16]	14.7 ± 0.6 [14, 15]	7.0	15.0	12.6
FRS/CS	0.246 ± 0.006 [0.232, 0.258]	0.235 ± 0.003 [0.233, 0.239]	0.240 ± 0.008 [0.223, 0.259]	0.228 ± 0.004 [0.224, 0.232]	0.242	0.233	0.221
SPBA/CS	0.288 ± 0.010 [0.268, 0.314]	0.267 ± 0.011 [0.253, 0.279]	0.286 ± 0.009 [0.262, 0.303]	0.286 ± 0.004 [0.283, 0.290]	0.283	0.306	0.254
SP/CS	0.129 ± 0.010 [0.104, 0.156]	0.112 ± 0.006 [0.108, 0.122]	0.132 ± 0.008 [0.116, 0.148]	0.128 ± 0.003 [0.125, 0.131]	0.089	0.136	0.092
PEW/CS	0.284 ± 0.011 [0.258, 0.323]	0.266 ± 0.017 [0.242, 0.280]	0.265 ± 0.010 [0.250, 0.288]	0.291 ± 0.010 [0.280, 0.300]	0.268	0.297	0.245
PPW/CS	0.476 ± 0.013 [0.449, 0.510]	0.454 ± 0.022 [0.424, 0.477]	0.443 ± 0.010 [0.427, 0.459]	0.488 ± 0.014 [0.478, 0.504]	0.473	0.482	0.409
PEH/CS	0.333 ± 0.011 [0.309, 0.364]	0.318 ± 0.030 [0.274, 0.339]	0.337 ± 0.010 [0.325, 0.365]	0.339 ± 0.008 [0.334, 0.348]	0.333	0.348	0.283
PPH/CS	0.270 ± 0.009 [0.250, 0.294]	0.256 ± 0.012 [0.241, 0.269]	0.261 ± 0.008 [0.247, 0.282]	0.287 ± 0.008 [0.278, 0.294]	0.272	0.265	0.251
PEW/PPW	0.595 ± 0.016 [0.559, 0.639]	0.586 ± 0.020 [0.571, 0.615]	0.598 ± 0.014 [0.571, 0.630]	0.596 ± 0.011 [0.585, 0.607]	0.563	0.617	0.617
sqrtPDG	3.30 ± 0.23 [2.88, 3.95]	3.49 ± 0.35 [3.31, 4.01]	3.21 ± 0.23 [2.73, 3.59]	3.35 ± 0.10 [3.24, 3.41]	4.25	3.01	3.31
PLG/CS [%]	7.78 ± 0.44 [6.78, 8.63]	6.97 ± 0.31 [6.63, 7.33]	7.69 ± 0.37 [6.85, 8.54]	7.33 ± 0.12 [7.20, 7.44]	6.61	8.30	7.47
MGr/CS [%]	0.45 ± 0.47 [0.0, 1.9]	0.44 ± 0.36 [0.00,0 .76]	0.60 ± 0.45 [0.0, 1.2]	0.39 ± 0.25 [0.2, 0.7]	0.00	0.90	0.00

12. Comparative tables to gynes

Tab. 15: Morphometric data of the gynes of the *Cardiocondyla elegans* and *C. bulgarica* group.

	C. elegans (n = 22)	*C. ulianini* (n = 8)	*C. persiana* (n = 1)	*C. israelica* (n = 1)	*C. sahlbergi* (n = 8)	*C. bulgarica* (n = 7)
CS	635 ± 13 [615, 659]	615 ± 6 [608, 625]	612	637	596 ± 10 [586, 613]	585 ± 8 [576, 600]
CL/CW	1.137 ± 0.015 [1.111, 1.171]	1.158 ± 0.024 [1.115, 1.182]	1.161	1.120	1.172 ± 0.013 [1.154, 1.195]	1.185 ± 0.016 [1.164, 1.206]
SL/CS	0.802 ± 0.013 [0.776, 0.828]	0.764 ± 0.009 [0.753, 0.777]	0.751	0.778	0.761 ± 0.012 [0.747, 0.785]	0.773 ± 0.019 [0.753, 0.796]
ML/CS	1.423 ± 0.054 [1.344, 1.483]	1.414 ± 0.048 [1.350, 1.482]	1.475	1.412	1.359 ± 0.038 [1.328, 1.447]	1.352 ± 0.034 [1.291, 1.379]
MW/CS	0.716 ± 0.060 [0.637, 0.855]	0.714 ± 0.051 [0.654, 0.763]	0.765	0.652	0.668 ± 0.040 [0.633, 0.759]	0.684 ± 0.009 [0.676, 0.700]
PoOc/CL	0.390 ± 0.010 [0.377, 0.411]	0.398 ± 0.009 [0.377, 0.408]	0.431	0.430	0.435 ± 0.008 [0.425, 0.445]	0.444 ± 0.008 [0.434, 0.455]
dFOV	17.9 ± 1.2 [16, 20]	14.9 ± 1.0 [13, 16]	19.0	19.0	18.1 ± 0.83 [17, 19]	18.3 ± 0.95 [17, 19]
SP/CS	0.164 ± 0.009 [0.146, 0.180]	0.205 ± 0.011 [0.190, 0.223]	0.178	0.178	0.179 ± 0.013 [0.159, 0.196]	0.183 ± 0.016 [0.162, 0.209]
PEW/CS	0.500 ± 0.014 [0.460, 0.519]	0.443 ± 0.017 [0.423, 0.469]	0.494	0.406	0.513 ± 0.011 [0.494, 0.531]	0.551 ± 0.022 [0.522, 0.582]
PPW/CS	0.737 ± 0.012 [0.713, 0.767]	0.754 ± 0.030 [0.719, 0.799]	0.726	0.714	0.736 ± 0.022 [0.690, 0.755]	0.750 ± 0.022 [0.715, 0.778]
PEW/ PPW	0.678 ± 0.017 [0.638, 0.714]	0.588 ± 0.016 [0.555, 0.608]	0.680	0.568	0.698 ± 0.014 [0.680, 0.716]	0.735 ± 0.011 [0.721, 0.749]
PEH/CS	0.435 ± 0.012 [0.416, 0.457]	0.454 ± 0.010 [0.440, 0.467]	0.450	0.406	0.461 ± 0.016 [0.438, 0.480]	0.468 ± 0.022 [0.436, 0.500]
PPH/CS	0.375 ± 0.012 [0.355, 0.393]	0.356 ± 0.012 [0.342, 0.376]	0.355	0.368	0.365 ± 0.011 [0.349, 0.382]	0.393 ± 0.014 [0.369, 0.403]
sqrtPDG	3.51 ± 0.24 [3.19, 3.93]	3.93 ± 0.15 [3.71, 4.21]	3.46	3.89	3.56 ± 0.22 [3.23, 3.99]	3.80 ± 0.14 [3.62, 4.05]
PLG/CS [%]	11.04 ± 0.43 [9.92,1 1.87]	10.94 ± 0.42 [10.21, 11.31]	11.45	9.96	11.07 ± 0.40 [10.36, 11.58]	11.20 ± 0.60 [10.61, 12.33]

Tab. 16: Morphometric data of the gynes of the *Cardiocondyla batesii* group.

	C. batesii (n = 30)	*C. kushanica* (n = 5)	*C. nigra* (n = 11)	*C. bicoronata* (n = 20)
CS	578 ± 12 [548, 598]	582 ± 8 [576, 596]	621 ± 10 [602, 638]	612 ± 16 [584, 639]
CL/CW	1.165 ± 0.016 [1.138, 1.195]	1.194 ± 0.012 [1.175, 1.205]	1.170 ± 0.010 [1.155, 1.188]	1.178 ± 0.020 [1.137, 1.218]
SL/CS	0.760 ± 0.014 [0.723, 0.782]	0.783 ± 0.005 [0.774, 0.787]	0.768 ± 0.012 [0.751, 0.792]	0.786 ± 0.011 [0.763, 0.812]
ML/CS	1.395 ± 0.045 [1.319,1.468]	1.370 ± 0.016 [1.349, 1.389]	1.376 ± 0.033 [1.328, 1.463]	1.434 ± 0.053 [1.355, 1.512]
MW/CS	0.653 ± 0.034 [0.602, 0.717]	0.669 ± 0.010 [0.657, 0.680]	0.628 ± 0.060 [0.590, 0.724]	0.676 ± 0.055 [0.606, 0.754]
PoOc/CL	0.386 ± 0.008 [0.370, 0.403]	0.386 ± 0.007 [0.378, 0.396]	0.376 ± 0.005 [0.369, 0.382]	0.374 ± 0.009 [0.360, 0.388]
dFOV	16.6 ± 0.8 [15, 18]	18.2 ± 0.8 [17, 19]	17.2 ± 0.8 [16, 18]	19.2 ± 0.9 [17, 21]
SP/CS	0.157 ± 0.010 [0.138, 0.181]	0.159 ± 0.010 [0.142, 0.166]	0.155 ± 0.014 [0.126, 0.174]	0.144 ± 0.010 [0.127, 0.159]
PEW/CS	0.347 ± 0.010 [0.331, 0.376]	0.337 ± 0.002 [0.334, 0.339]	0.348 ± 0.012 [0.337, 0.371]	0.350 ± 0.018 [0.319, 0.385]
PPW/CS	0.608 ± 0.012 [0.589, 0.649]	0.616 ± 0.016 [0.600, 0.641]	0.577 ± 0.013 [0.550, 0.594]	0.599 ± 0.016 [0.570, 0.632]
PEW/PPW	0.571 ± 0.012 [0.540, 0.594]	0.548 ± 0.015 [0.526, 0.563]	0.604 ± 0.016 [0.584, 0.624]	0.584 ± 0.026 [0.545, 0.623]
PEH/CS	0.369 ± 0.009 [0.351, 0.391]	0.360 ± 0.010 [0.345, 0.370]	0.350 ± 0.008 [0.340, 0.366]	0.366 ± 0.013 [0.343, 0.387]
PPH/CS	0.317 ± 0.009 [0.298, 0.338]	0.318 ± 0.008 [0.307, 0.328]	0.294 ± 0.009 [0.280, 0.311]	0.293 ± 0.012 [0.275, 0.316]
sqrtPDG	3.89 ± 0.33 [3.42, 4.82]	3.94 ± 0.12 [3.82, 4.13]	4.11 ± 0.35 [3.60, 4.59]	4.18 ± 0.33 [3.70, 4.98]
PLG/CS [%]	9.11 ± 0.46 [8.29, 10.01]	9.43 ± 0.69 [8.22, 9.86]	8.56 ± 0.31 [8.00, 9.20]	8.70 ± 0.42 [7.68, 9.28]

Tab. 17: Morphometric data of the gynes of the *Cardiocondyla nuda* and *C. stambuloffii* group.

	C. mauritanica (n = 47)	*C. kagutsuchi* (n = 15)	*C. nuda* (n = 10)	*C. strigifrons* (n = 6)	*C. stambuloffii* (n = 5)	*C. koshewnikovi* (n = 6)
CS	560 ± 17 [518, 596]	559 ± 15 [528, 585]	521 ± 16 [498, 548]	571 ± 14 [556, 592]	676 ± 5 [670, 680]	767 ± 24 [743, 805]
CL/CW	1.170 ± 0.016 [1.137, 1.202]	1.162 ± 0.027 [1.120, 1.220]	1.203 ± 0.019 [1.181, 1.236]	1.215 ± 0.009 [1.198, 1.223]	1.145 ± 0.008 [1.137, 1.157]	1.106 ± 0.021 [1.086, 1.136]
SL/CS	0.785 ± 0.009 [0.768, 0.808]	0.804 ± 0.015 [0.771, 0.830]	0.779 ± 0.014 [0.754, 0.797]	0.799 ± 0.005 [0.793, 0.805]	0.700 ± 0.007 [0.688, 0.706]	0.658 ± 0.013 [0.634, 0.671]
ML/CS	1.503 ± 0.022 [1.459, 1.553]	1.497 ± 0.028 [1.455, 1.538]	1.506 ± 0.018 [1.482, 1.535]	1.515 ± 0.029 [1.457, 1.535]	1.403 ± 0.018 [1.391, 1.436]	1.379 ± 0.033 [1.335, 1.413]
MW/CS	0.760 ± 0.019 [0.716, 0.807]	0.771 ± 0.024 [0.733, 0.818]	0.784 ± 0.021 [0.754, 0.826]	0.755 ± 0.012 [0.745, 0.774]	0.803 ± 0.009 [0.796, 0.819]	0.812 ± 0.044 [0.772, 0.889]
PoOc/CL	0.434 ± 0.008 [0.415, 0.459]	0.435 ± 0.012 [0.420, 0.453]	0.458 ± 0.004 [0.454, 0.465]	0.445 ± 0.005 [0.440, 0.454]	0.464 ± 0.006 [0.460, 0.468]	0.476 ± 0.004 [0.470, 0.482]
dFOV	17.7 ± 1.3 [15, 20]	17.2 ± 1.0 [16, 19]	18.5 ± 1.1 [17, 20]	16.8 ± 1.0 [16, 18]	9.6 ± 0.5 [9, 10]	9.2 ± 0.8 [8, 10]
SP/CS	0.099 ± 0.010 [0.075, 0.119]	0.076 ± 0.011 [0.052, 0.090]	0.147 ± 0.009 [0.129, 0.161]	0.091 ± 0.006 [0.086, 0.101]	0.118 ± 0.016 [0.097, 0.138]	0.128 ± 0.009 [0.117, 0.142]
PEW/CS	0.300 ± 0.011 [0.276, 0.323]	0.300 ± 0.013 [0.277, 0.323]	0.326 ± 0.015 [0.294, 0.347]	0.296 ± 0.017 [0.277, 0.322]	0.455 ± 0.021 [0.419, 0.472]	0.438 ± 0.042 [0.397, 0.493]
PPW/CS	0.531 ± 0.017 [0.506, 0.591]	0.501 ± 0.017 [0.463, 0.525]	0.566 ± 0.020 [0.531, 0.588]	0.526 ± 0.010 [0.515, 0.542]	0.866 ± 0.027 [0.823, 0.890]	0.862 ± 0.023 [0.837, 0.904]
PEW/PPW	0.565 ± 0.023 [0.512, 0.636]	0.599 ± 0.015 [0.575, 0.637]	0.576 ± 0.022 [0.551, 0.610]	0.563 ± 0.030 [0.522, 0.595]	0.525 ± 0.011 [0.509, 0.540]	0.507 ± 0.039 [0.462, 0.558]
PEH/CS	0.360 ± 0.009 [0.339, 0.381]	0.348 ± 0.013 [0.321, 0.362]	0.386 ± 0.019 [0.362, 0.412]	0.363 ± 0.008 [0.355, 0.376]	0.521 ± 0.012 [0.508, 0.531]	0.531 ± 0.019 [0.512, 0.563]
PPH CS	0.312 ± 0.010 [0.285, 0.333]	0.306 ± 0.012 [0.285, 0.327]	0.364 ± 0.019 [0.336, 0.384]	0.306 ± 0.009 [0.297, 0.319]	0.420 ± 0.004 [0.416, 0.425]	0.426 ± 0.009 [0.409, 0.437]
sqrt PDG	3.38 ± 0.26 [2.94, 4.19]	3.17 ± 0.12 [2.95, 3.44]	3.52 ± 0.25 [3.16, 3.93]	3.14 ± 0.27 [2.83, 3.62]	2.72 ± 0.20 [2.46, 2.93]	2.46 ± 0.14 [2.24, 2.63]
PLG CS [%]	7.52 ± 0.43 [6.78, 8.73]	7.87 ± 0.23 [7.33, 8.21]	7.27 ± 0.27 [7.03, 7.93]	7.02 ± 0.50 [6.35, 7.51]	8.30 ± 0.71 [7.22, 9.18]	6.92 ± 0.21 [6.64, 7.19]

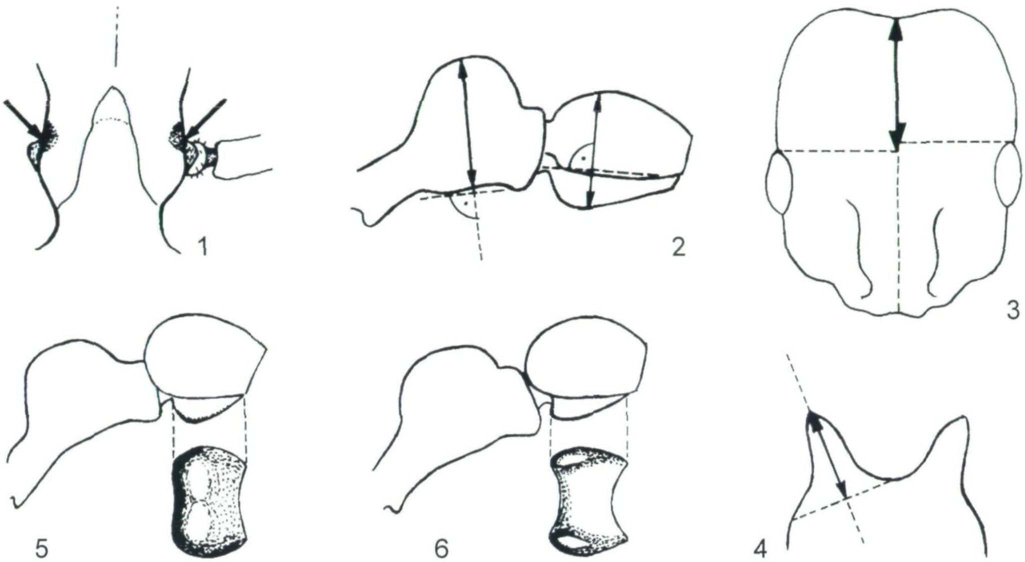
Tab. 18: Morphometric data of the gynes of the *Cardiocondyla shuckardi* group.

	C. longiceps (n = 7)	*C. fajumensis* (n = 17)	*C. melana* (prediction)	*C. venustula* (n = 4)
CS	570 ± 9 [560, 586]	631 ± 17] [592, 656		603 ± 10 [588, 612]
CL/CW	1.254 ± 0.015 [1.229, 1.273]	1.185 ± 0.020 [1.148, 1.215]	1.233	1.182 ± 0.008 [1.172, 1.189]
SL/CS	0.815 ± 0.010 [0.802, 0.828]	0.815 ± 0.012 [0.791, 0.841]	0.785	0.810 ± 0.022 [0.794, 0.843]
ML/CS	1.520 ± 0.013 [1.497, 1.538]	1.545 ± 0.025 [1.500, 1.582]		1.564 ± 0.006 [1.558, 1.572]
MW/CS	0.745 ± 0.009 [0.735, 0.757]	0.762 ± 0.016 [0.735, 0.783]		0.777 ± 0.018 [0.755, 0.799]
PoOc/CL	0.444 ± 0.006 [0.435, 0.452]	0.432 ± 0.007 [0.422, 0.444]	0.450	0.441 ± 0.008 [0.432, 0.452]
dFOV	19.3 ± 1.0 [19, 21]	22.0 ± 1.9 [19, 26]	17.3	18.2 ± 1.0 [17, 19]
SP/CS	0.083 ± 0.012 [0.059, 0.094]	0.078 ± 0.011 [0.059, 0.101]	0.075	0.074 ± 0.006 [0.066, 0.079]
PEW/CS	0.310 ± 0.011 [0.293, 0.323]	0.325 ± 0.011 [0.300, 0.346]	0.308	0.344 ± 0.020 [0.316, 0.362]
PPW/CS	0.493 ± 0.013 [0.476, 0.516]	0.496 ± 0.017 [0.459, 0.531]	0.497	0.504 ± 0.015 [0.487, 0.523]
PEW/PPW	0.629 ± 0.018 [0.605, 0.651]	0.655 ± 0.013 [0.627, 0.679]	0.667	0.684 ± 0.027 [0.650, 0.715]
PEH/CS	0.351 ± 0.010 [0.335, 0.363]	0.350 ± 0.011 [0.329, 0.370]	0.360	0.363 ± 0.008 [0.354, 0.374]
PPH/CS	0.320 ± 0.011 [0.308, 0.334]	0.319 ± 0.012 [0.297, 0.334]	0.314	0.334 ± 0.017 [0.313, 0.351]
sqrtPDG	3.15 ± 0.16 [2.94, 3.45]	3.46 ± 0.28 [2.95, 4.00]	3.77	3.39 ± 0.19 [3.24, 3.64]
PLG/CS [%]	8.65 ± 0.36 [8.03, 9.01]	7.50 ± 0.49 [6.50, 8.75]	7.99	8.16 ± 0.32 [7.82, 8.59]

Tab. 19: Morphometric data of the gynes of the *C. minutior*, *C. emeryi*, and *C. wroughtonii* group.

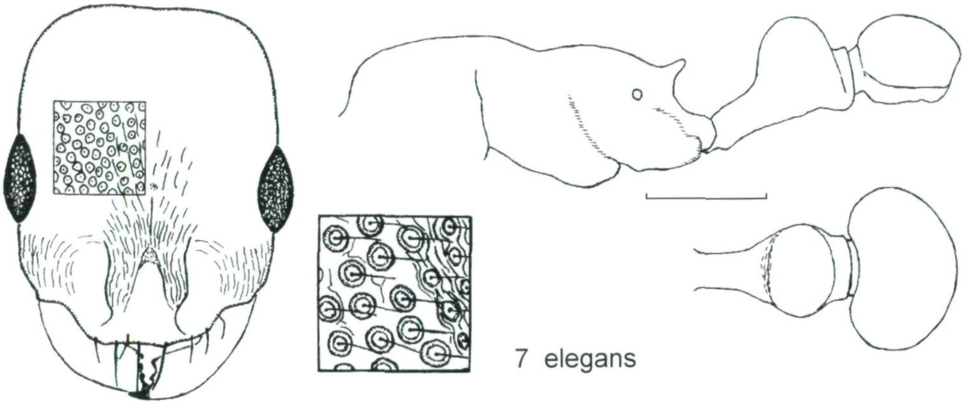
	C. minutior (n = 14)	*C. goa.* (n = 2)	*C. tjibodana* (n = 1)	*C. emeryi* (n = 12)	*C. yemeni* (n = 4)	*C. wroughtonii* (n = 16)	*C. obscurior* (n = 20)
CS	457 ± 9 [440, 476]	457 ± 2 [456, 459]	448	463 ± 7 [451, 474]	450 ± 13 [431, 460]	442 ± 15 [413, 470]	460 ± 18 [418, 486]
CL/CW	1.228 ± 0.024 [1.192, 1.280]	1.220 ± 0.008 [1.214, 1.225]	1.223	1.180 ± 0.016 [1.151, 1.208]	1.222 ± 0.017 [1.202, 1.237]	1.146 ± 0.021 [1.109, 1.172]	1.122 ± 0.021 [1.079, 1.166]
SL/CS	0.755 ± 0.008 [0.743, 0.767]	0.739 ± 0.017 [0.727, 0.751]	0.739	0.731 ± 0.012 [0.717, 0.756]	0.714 ± 0.016 [0.692, 0.728]	0.757 ± 0.018 [0.723, 0.794]	0.755 ± 0.21 [0.708, 0.784]
ML/CS	1.473 ± 0.026 [1.420, 1.515]	1.467 ± 0.014 [1.467, 1.487]	1.471	1.441 ± 0.021 [1.409, 1.483]	1.416 ± 0.013 [1.405, 1.433]	1.387 ± 0.024 [1.349, 1.435]	1.347 ± 0.037 [1.280, 1.420]
MW/CS	0.757 ± 0.017 [0.714, 0.788]	0.768 ± 0.005 [0.764, 0.771]	0.748	0.772 ± 0.018 [0.747, 0.809]	0.747 ± 0.007 [0.737, 0.752]	0.703 ± 0.018 [0.668, 0.741]	0.720 ± 0.025 [0.683, 0.769]
PoOc/CL	0.459 ± 0.009 [0.442, 0.470]	0.463 ± 0.013 [0.454, 0.472]	0.457	0.448 ± 0.008 [0.435, 0.456]	0.440 ± 0.005 [0.436, 0.447]	0.436 ± 0.008 [0.413, 0.447]	0.423 ± 0.007 [0.408, 0.435]
dFOV	15.7 ± 1.4 [13, 18]	15.5 ± 0.7 [15, 16]	15.0	16.0 ± 0.7 [15, 17]	16.2 ± 0.5 [16, 17]	19.1 ± 0.9 [17, 21]	19.2 ± 1.1 [18, 22]
SP/CS	0.141 ± 0.010 [0.130, 0.166]	0.128 ± 0.008 [0.122, 0.133]	0.138	0.176 ± 0.007 [0.164, 0.185]	0.130 ± 0.005 [0.125, 0.137]	0.203 ± 0.008 [0.186, 0.215]	0.193 ± 0.011 [0.172, 0.214]
PEW/CS	0.311 ± 0.007 [0.300, 0.321]	0.312 ± 0.0	0.288	0.312 ± 0.011 [0.299, 0.327]	0.312 ± 0.012 [0.299, 0.327]	0.300 ± 0.010 [0.285, 0.318]	0.308 ± 0.014 [0.277, 0.333]
PPW/CS	0.513 ± 0.015 [0.482, 0.538]	0.524 ± 0.0	0.475	0.558 ± 0.016 [0.516, 0.574]	0.464 ± 0.014 [0.450, 0.477]	0.464 ± 0.008 [0.448, 0.476]	0.479 ± 0.013 [0.461, 0.506]
PEW/PPW	0.606 ± 0.021 [0.577, 0.661]	0.596 ± 0.0	0.606	0.559 ± 0.016 [0.534, 0.580]	0.673 ± 0.032 [0.626, 0.695]	0.646 ± 0.017 [0.622, 0.678]	0.644 ± 0.029 [0.589, 0.700]
PEH/CS	0.356 ± 0.010 [0.339, 0.372]	0.373 ± 0.0	0.371	0.364 ± 0.010 [0.343, 0.376]	0.368 ± 0.005 [0.364, 0.373]	0.355 ± 0.010 [0.336, 0.371]	0.360 ± 0.009 [0.345, 0.379]
PPH/CS	0.290 ± 0.010 [0.275, 0.308]	0.286 ± 0.0	0.283	0.367 ± 0.011 [0.341, 0.387]	0.311 ± 0.009 [0.298, 0.318]	0.322 ± 0.012 [0.302, 0.355]	0.330 ± 0.009 [0.314, 0.343]
sqrtPDG	3.09 ± 0.12 [2.93, 3.29]	3.12 ± 0.0	2.77	3.88 ± 0.14 [3.68, 4.09]	3.69 ± 0.30 [3.44, 4.11]	4.62 ± 0.26 [4.26, 5.11]	4.61 ± 0.21 [4.19, 5.14]
PLG/CS [%]	8.66 ± 0.42 [7.81, 9.50]	7.48 ± 0.0	8.49	7.15 ± 0.35 [6.51, 7.81]	7.77 ± 0.64 [7.21, 8.40]	8.10 ± 0.58 [7.02, 9.00]	7.81 ± 0.46 [7.01, 8.52]
PigG1						46 ± 17 [20, 90]	96 ± 8 [69, 100]

13. Figures

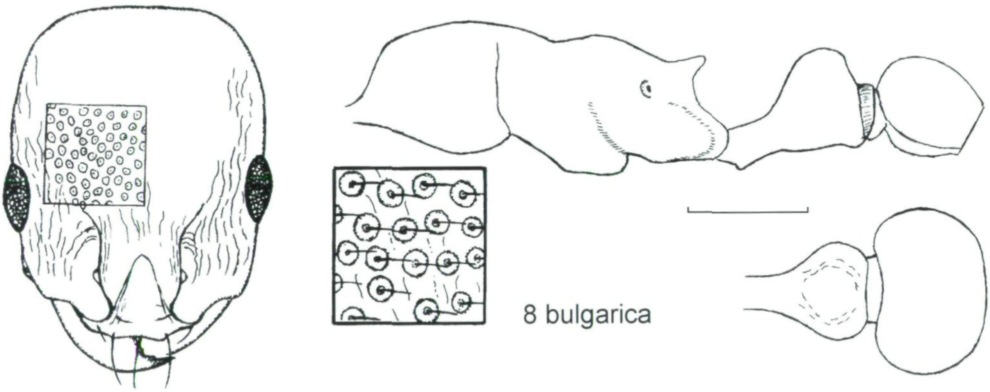


Figs. 1 - 6: (1) Frontal lobes and scape insertions; the arrows show the end points of the measure FRS. (2-4) Measurings of (2) petiole height PEH and postpetiole height PPH, (3) postocular distance PoOc; in case of head asymmetry the left and right PoOc are averaged, and (4) propodeal spine length SP. (5, 6) Lateral aspects of waist segments and ventral aspects of postpetiolar sternites of (5) *Cardiocondyla emeryi*, and (6) *Cardiocondyla obscurior*.

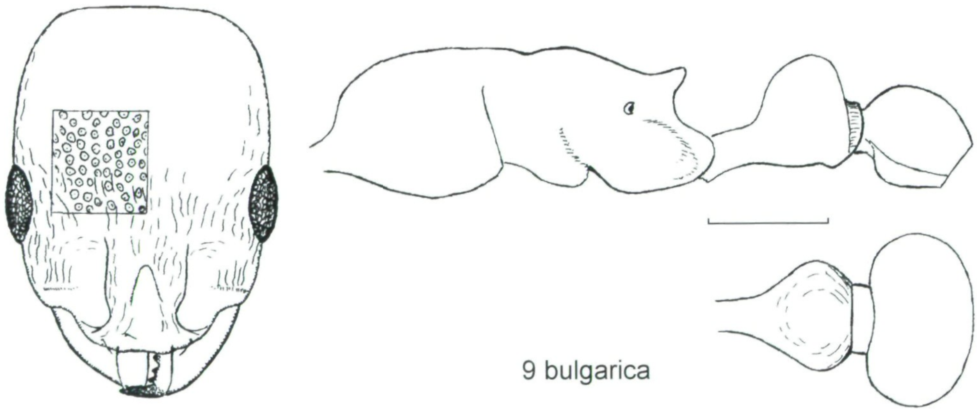
Fig. 7 - 68 (following pages): Workers: dorsal aspect of head and waist, lateral aspect of mesosoma and waist, and detail drawing of head sculpture; detail showing situation in centre of square depicted in drawing of head; scale bar equaling 85 µm in case of sculputure and 213 µm in case of worker head, mesosoma, and waist. Gynes: dorsal aspect of head and dorsal and lateral aspect of mesosoma and waist; scale bar equaling 270 µm in case of gyne heads and 338 µm in case of gyne mesosoma and waist: (7) *C. elegans*, syntype of *C. santschii*; (8) *C. bulgarica*, syntype; (9) *C. bulgarica*, syntype of *C. elegans* var. *eleonorae*; (10) *C. sahlbergi*, Tbilissi; (11) *C. persiana* sp.n., type; (12) *C. israelica* sp.n., type; (13:) *C. gallilaeica*, type; (14a) *C. ulianini*, type; (14b) *C. littoralis* sp.n., type; (15) *C. sahlbergi*, type; (16) *C. bulgarica*, syntype; (17) *C. batesii*, type; (18) *C. semirubra* sp.n., type; (19) *C. kushanica*, type: (20) *C. nigra*, type; (21) *C. bicoronata* sp.n., Turkestan; (21) *C. bicoronata* sp.n., Israel; (23) *C. brachyceps* sp.n., type; (24) *C. tenuifrons* sp.n., type; (25) *C. rugulosa*, type; (26) *C. opistopsis* sp.n., type; (27) *C. batesii*, type; (28) *C. nigra*, type; (29) *C. kushanica*, type; (30) *C. nuda*, type; (31) *C. paranuda* sp.n., type; (32) *C. atalanta*, type; (33) *C. mauritanica*, type; (34) *C. mauritanica*, morph B; (35) *C. kagutsuchi*, type; (36) *C. strigifrons*, type; (37) *C. strigifrons*, Bali; (38) *C. mauritanica*, type; (39) *C. shuckardi*, type, Imerima; (40) *C. venustula*, type, Coamo Springs; (41) *C. melana* sp.n., type; (42) *C. unicalis* sp.n., type; (43) *C. fajumensis*; (44) *C. fajumensis*, type; (45) *C. longiceps* sp.n., type; (46) *C. stambuloffii*, type; (47) *C. koshewnikovi*, type; (48) *C. gibbosa*, type; (49) *C. tibetana* sp.n., type; (50) *C. stambuloffii*, type; (51) *C. wroughtonii*, Bogor; (52) *C. obscurior*, Una; (53) *C. shagrinata* sp.n., type; (54) *C. nana* sp.n., type; (55) *C. shagrinata* sp.n., dorsal aspect of mesosoma, type; (56) *C. obscurior*, dorsal aspect of mesosoma; (57) *C. wroughtonii*, dorsal aspect of mesosoma; (58) *C. emeryi*, type; (59) *C. emeryi*, type of *C. emeryi* var. *rasalamae*;. (60) *C. neferka*, type; (61) *C. weserka*, type; (62) *C. yemeni*, type; (63) *C. minutior*; (64) *C. breviscapus* sp.n., type; (65) *C. goa* sp.n., type; (66) *C. tjibodana*; (67) *C. britteni*, type; (68a) *C. carbonaria*, type; (68b) *C. opaca* sp.n., type.



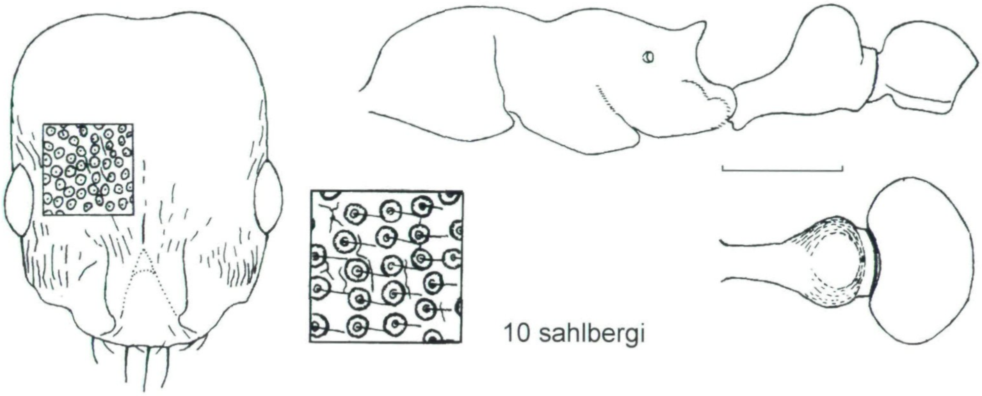
7 elegans



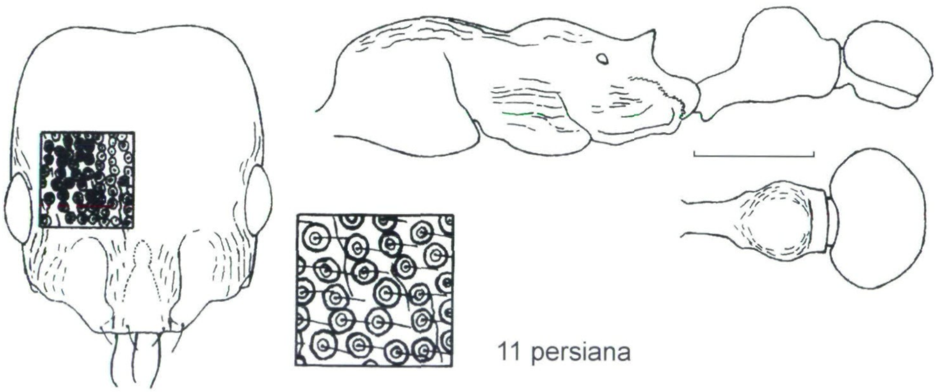
8 bulgarica



9 bulgarica



10 *sahlbergi*



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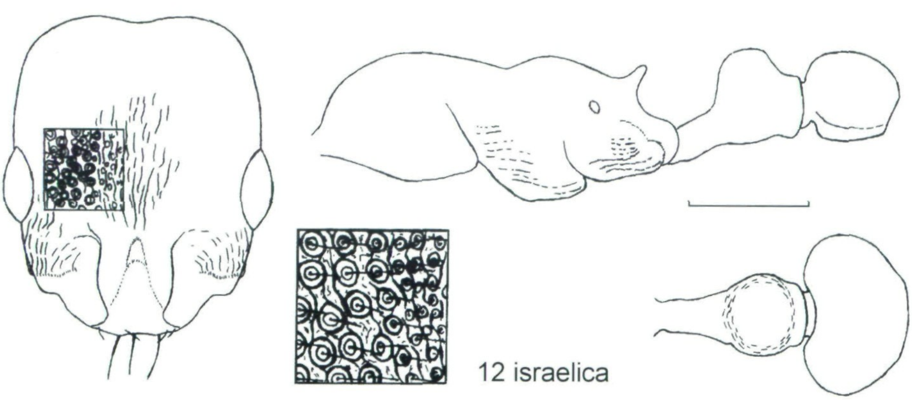
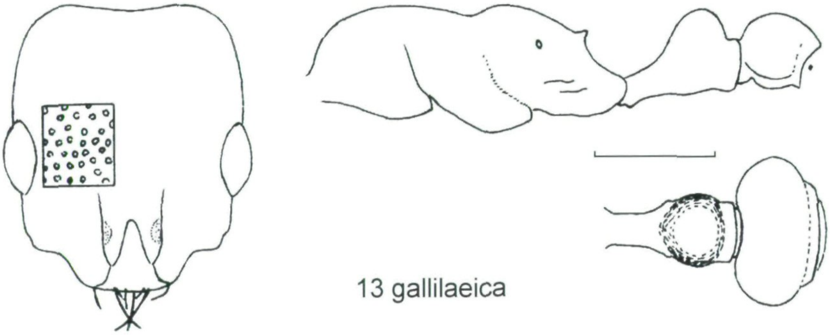
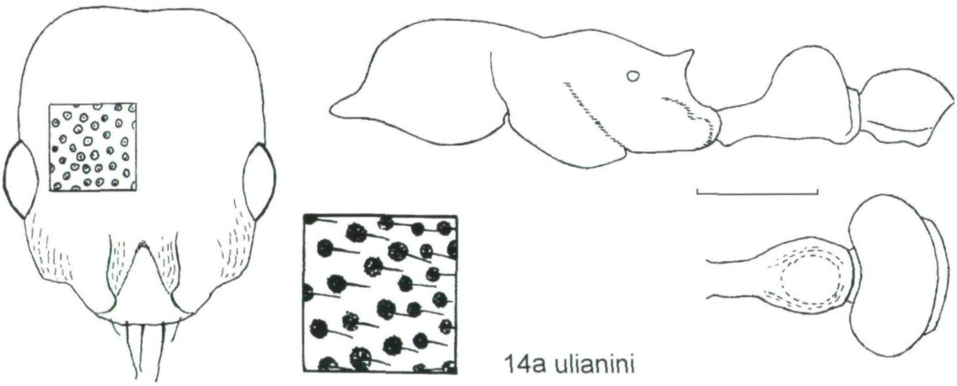


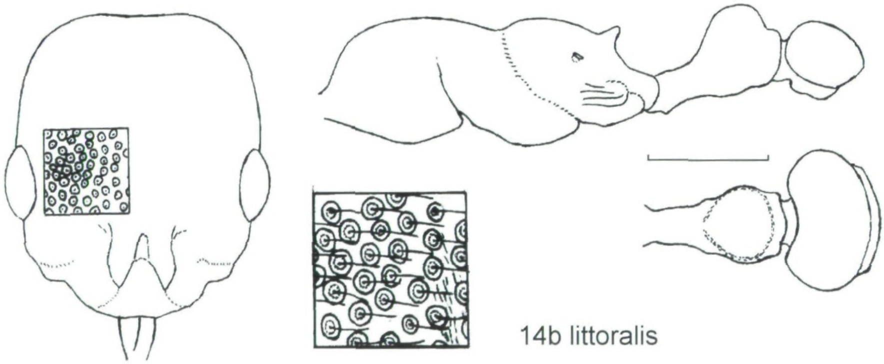
12 *israelica*



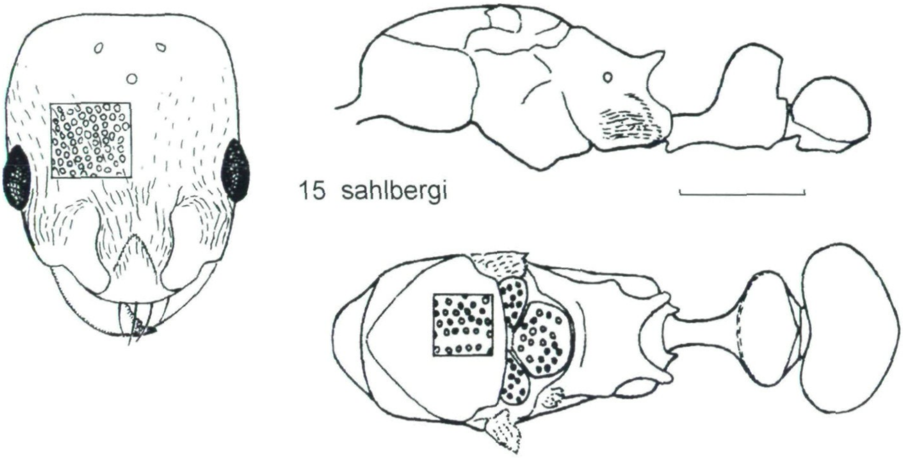
13 gallilaeica



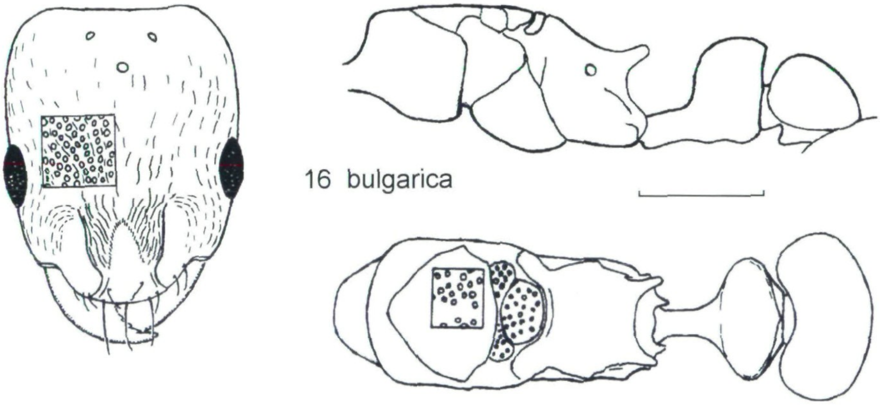
14a ulianini



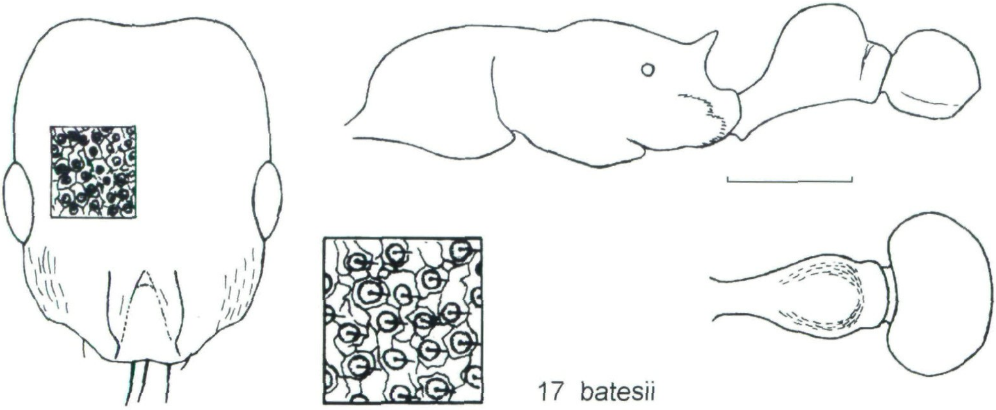
14b littoralis



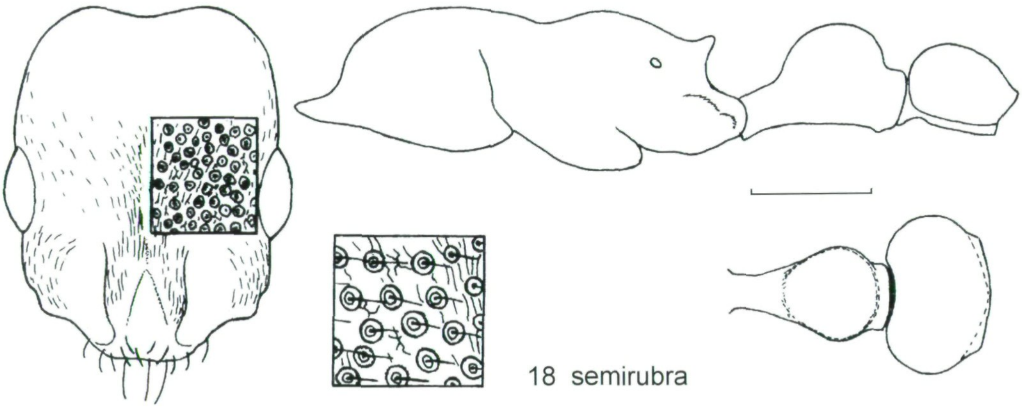
15 sahlbergi



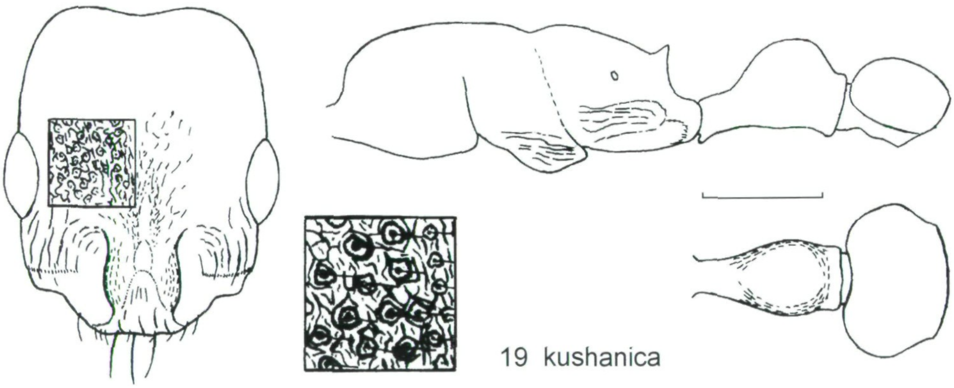
16 bulgarica



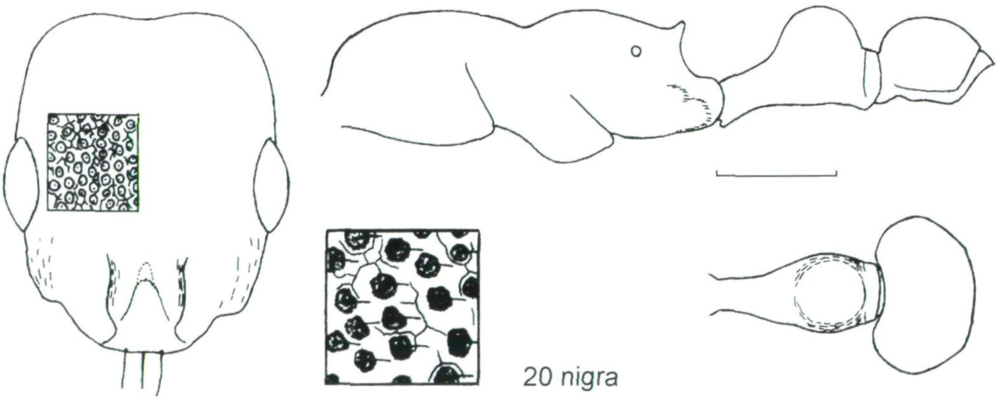
17 batesii



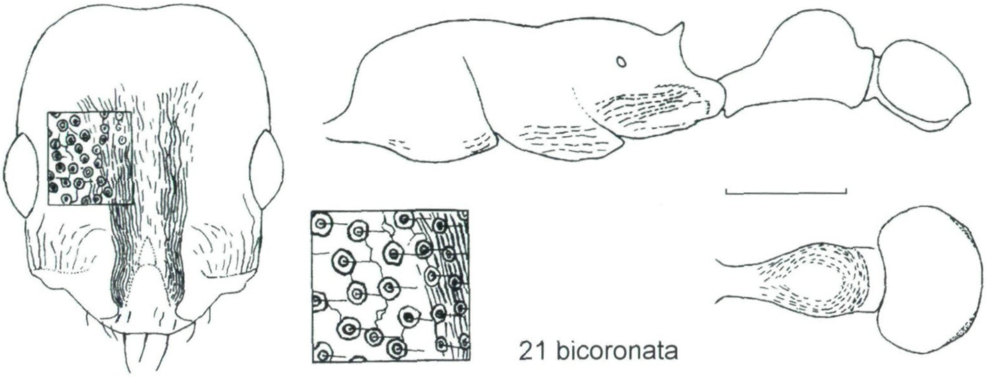
18 semirubra



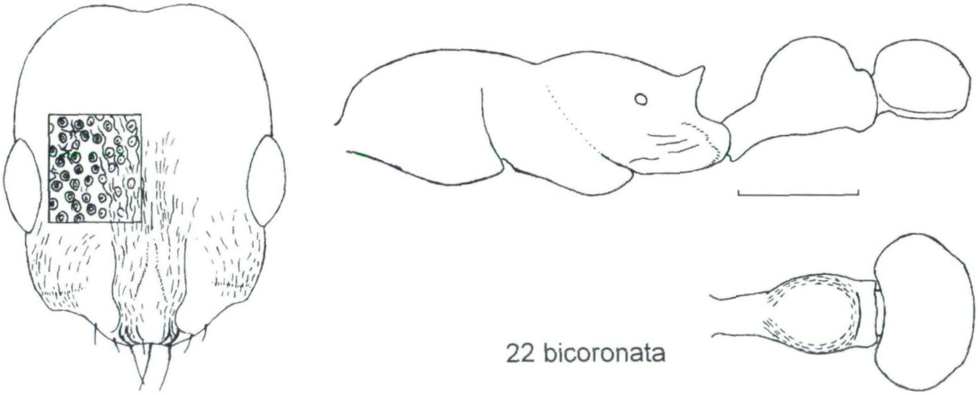
19 kushanica



20 nigra



21 bicoronata



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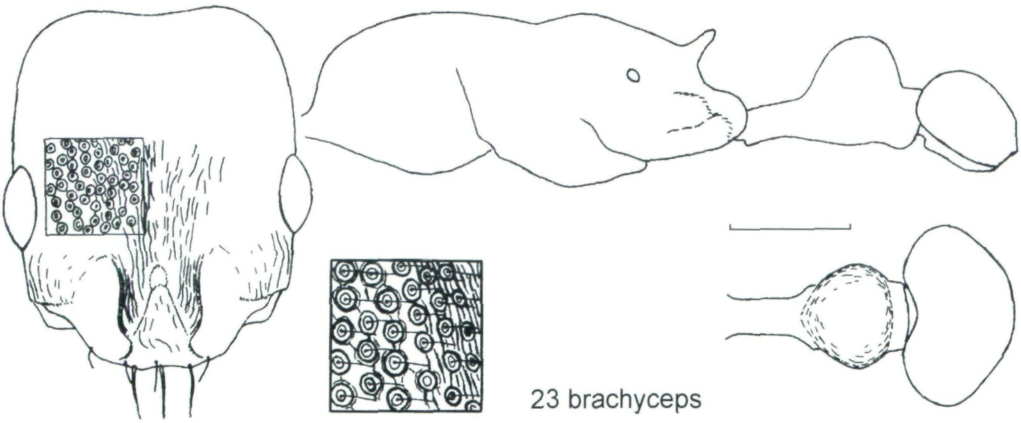

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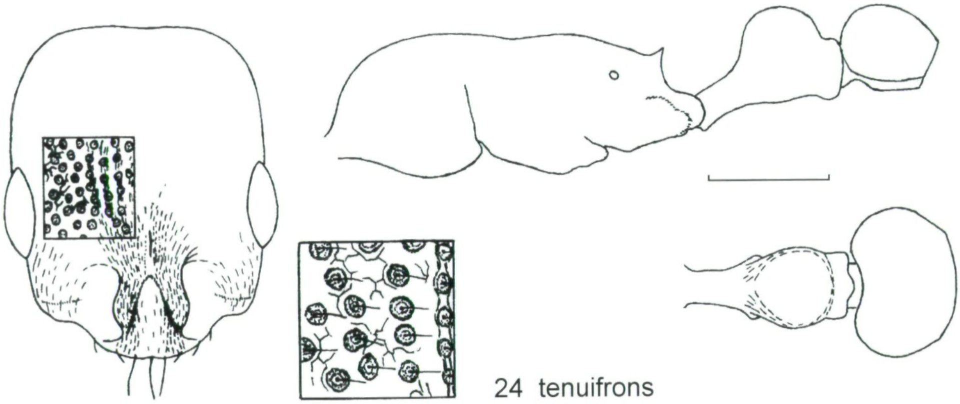

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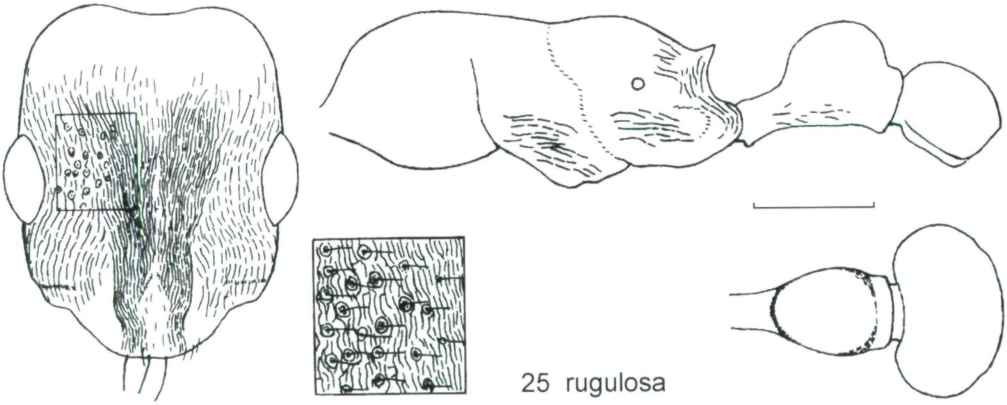

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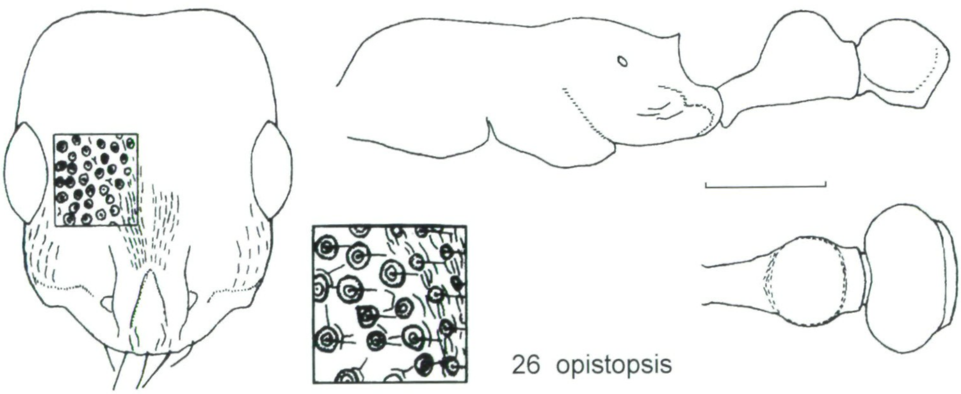

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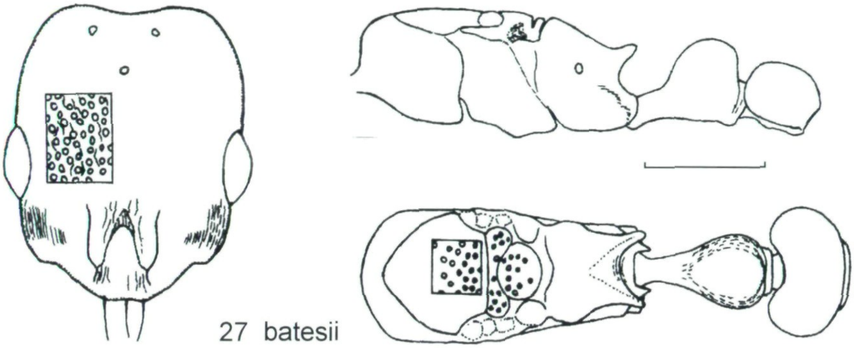

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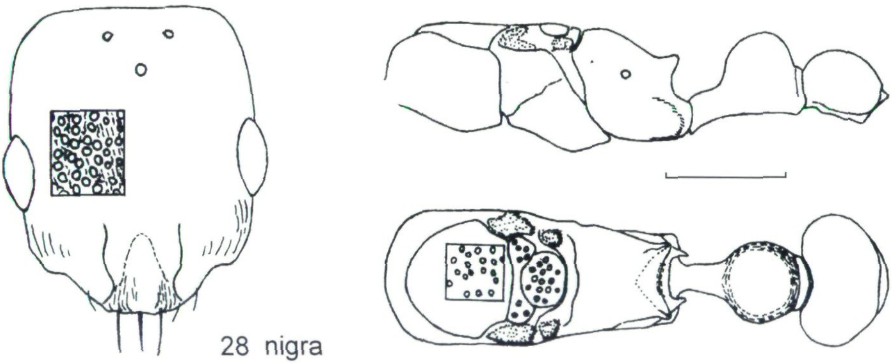

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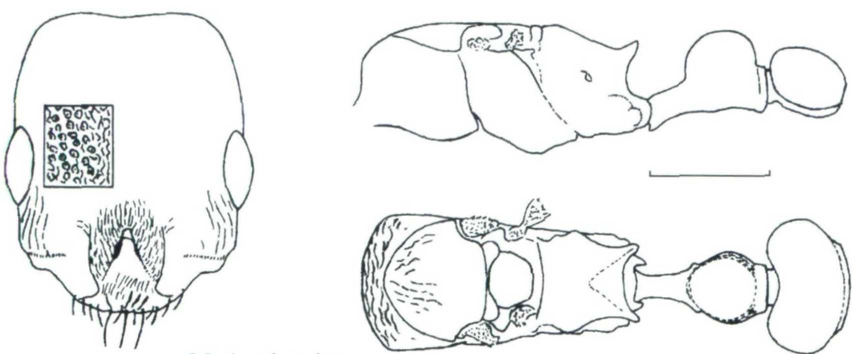

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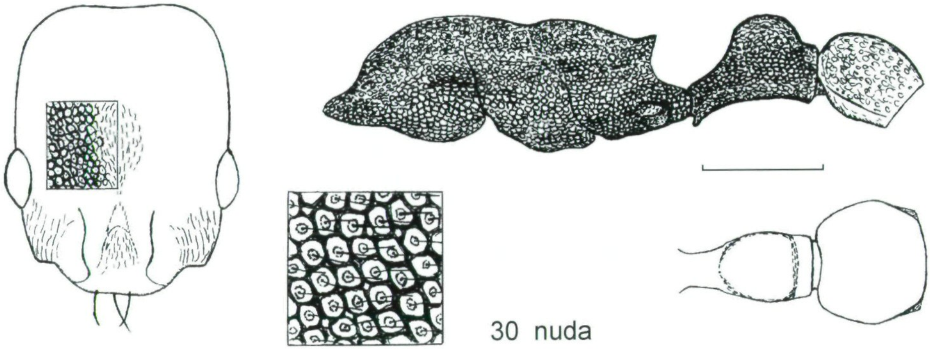

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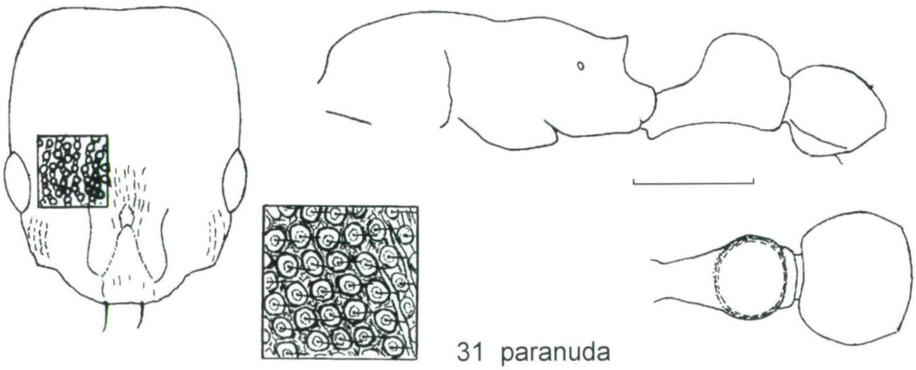

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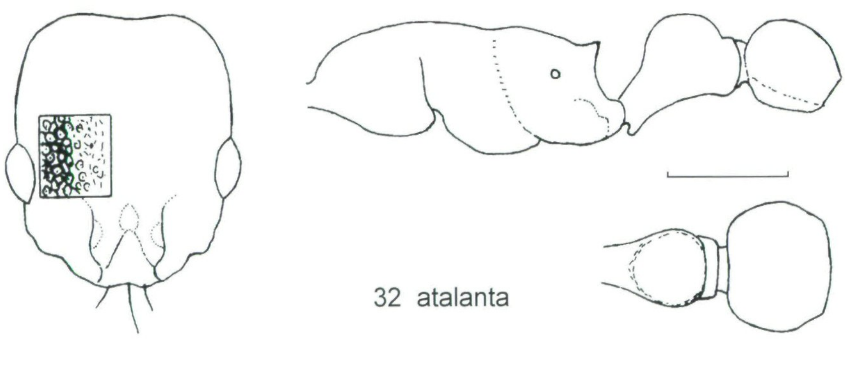

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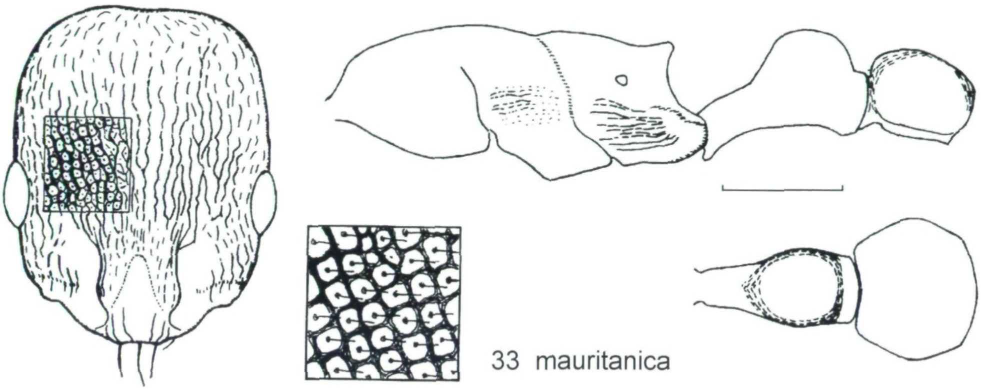
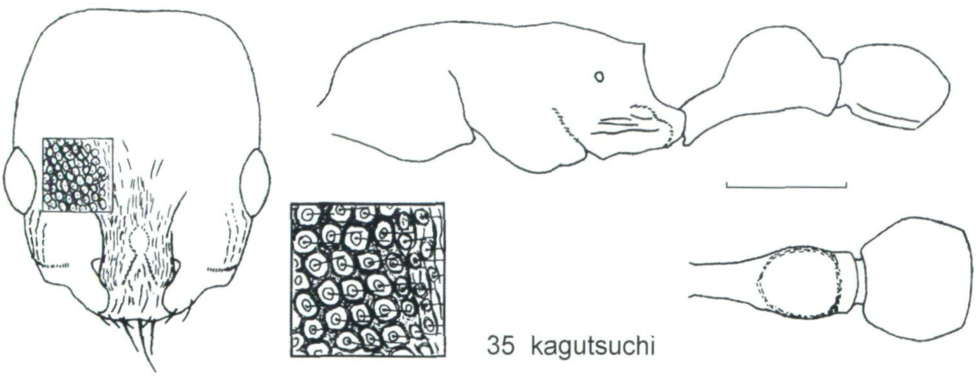


33 mauritanica

34 mauritanica morph B



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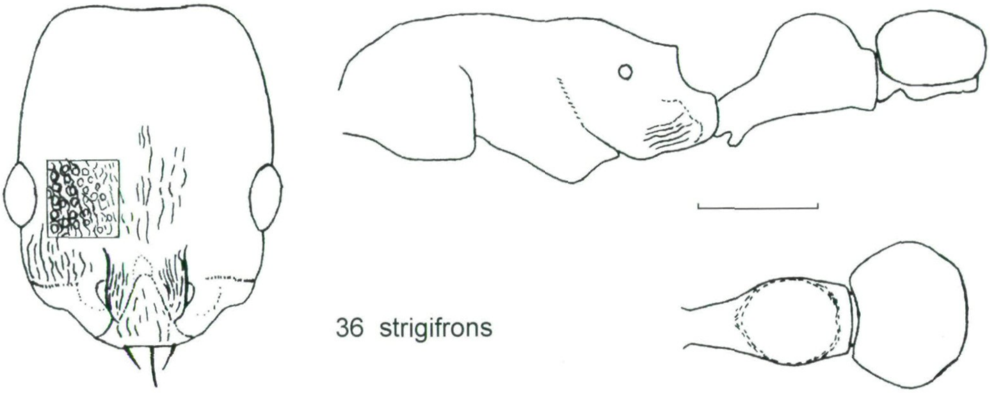

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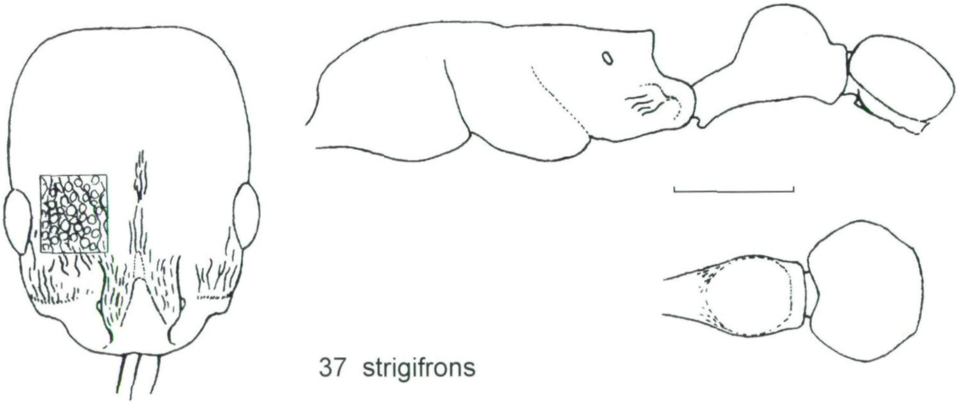

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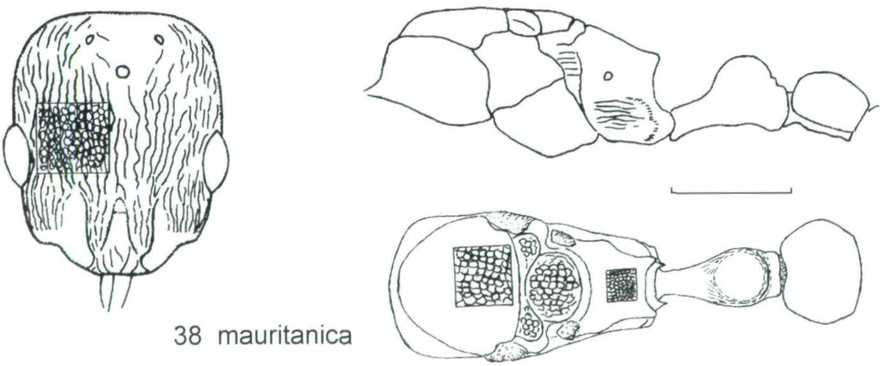
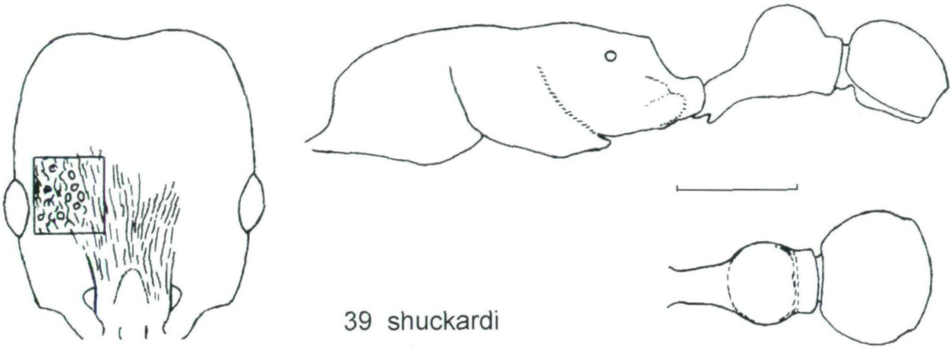


38 mauritanica



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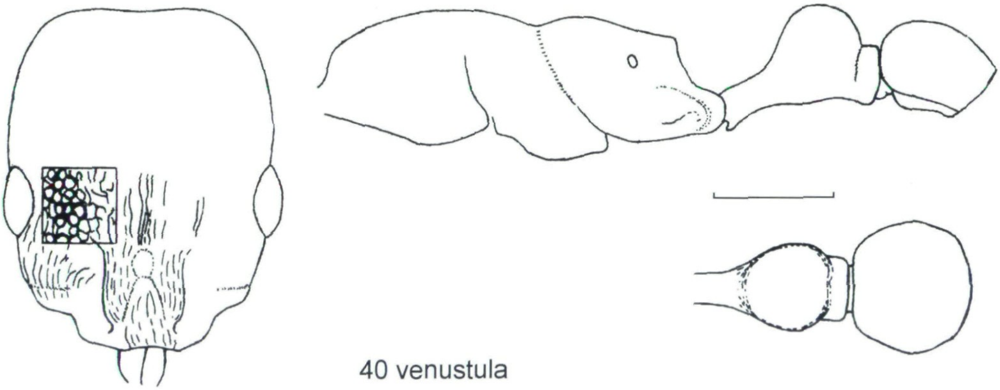

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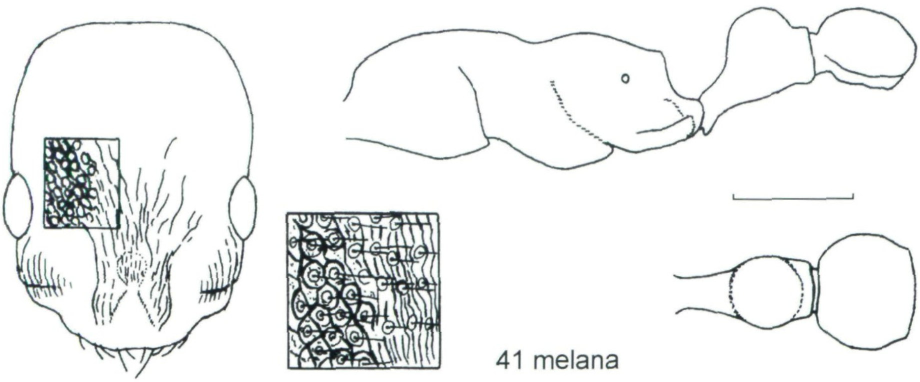

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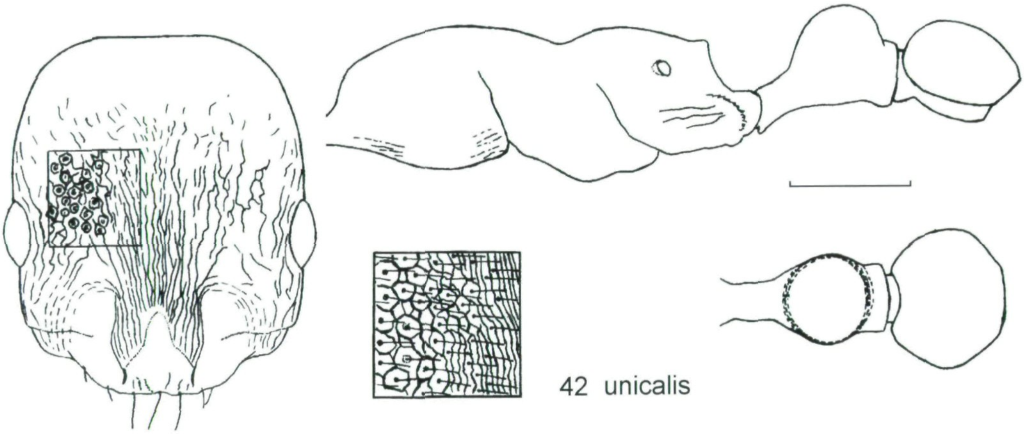
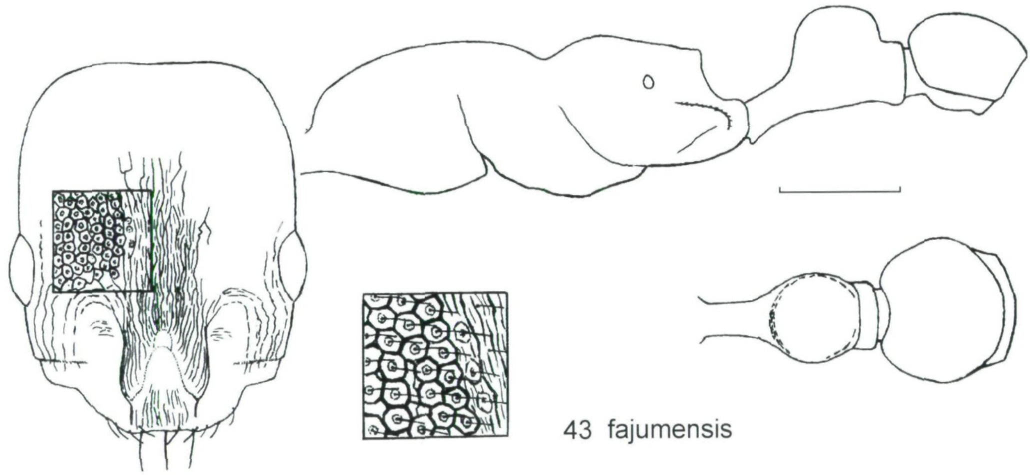
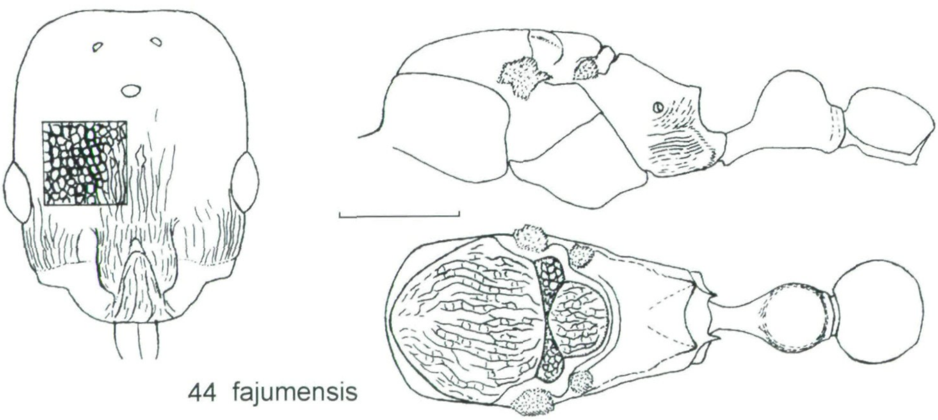


42 unicalis



43 fajumensis



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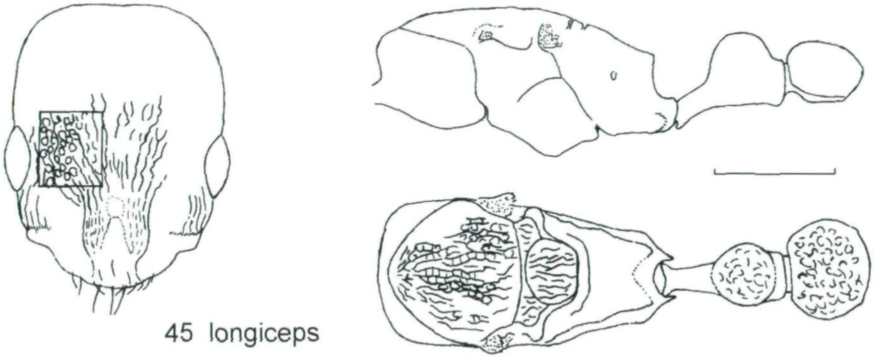

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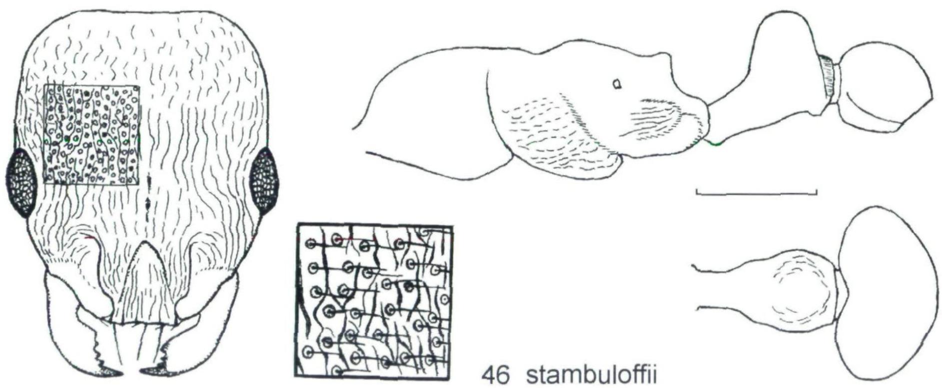
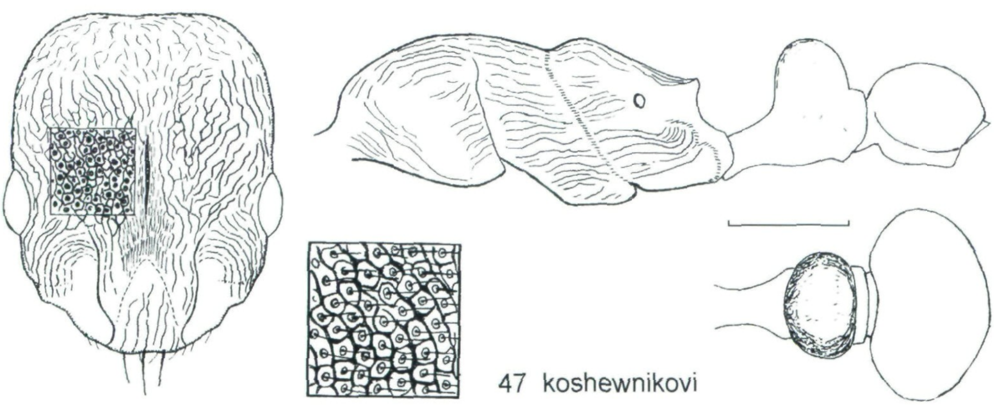


46 stambuloffii



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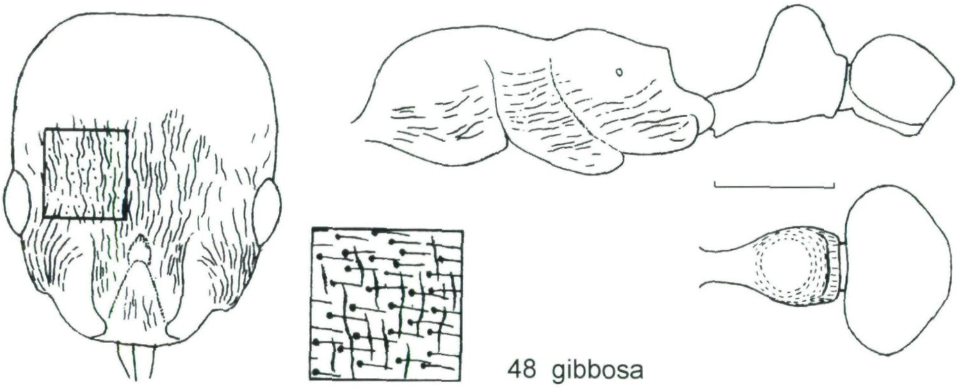

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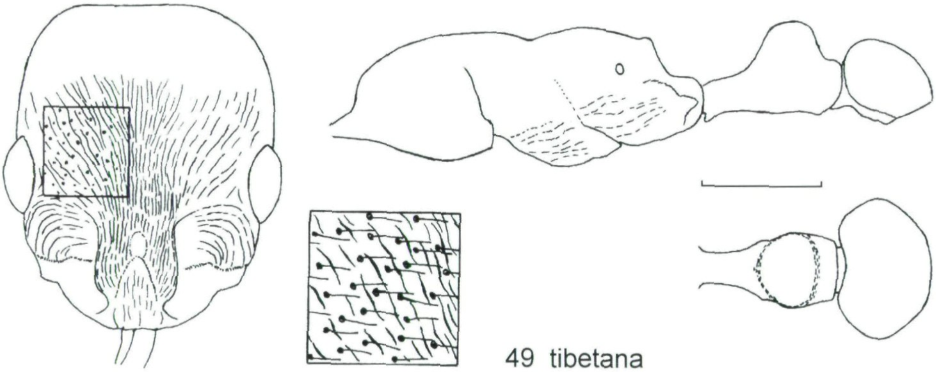

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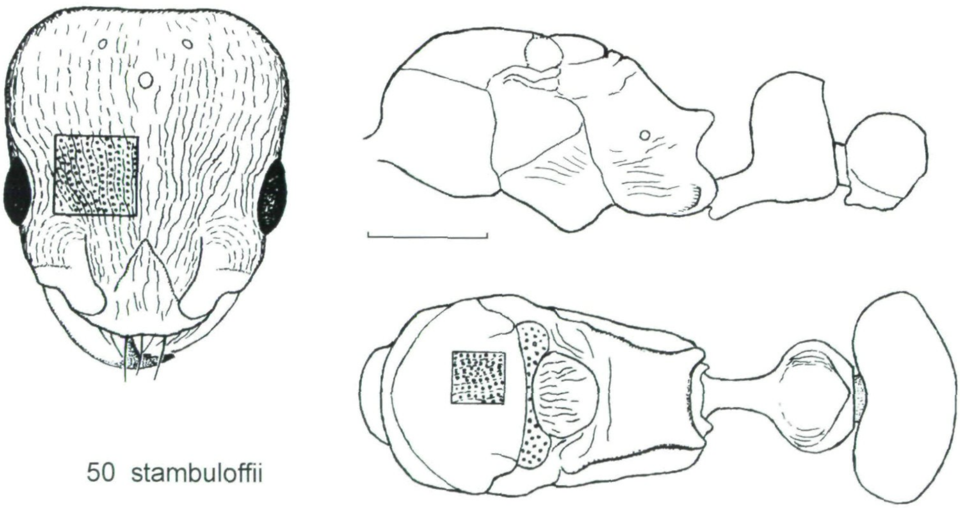

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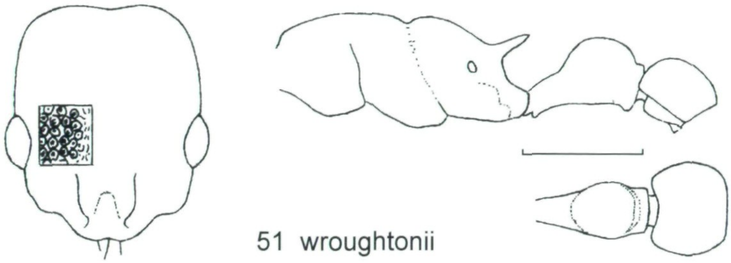

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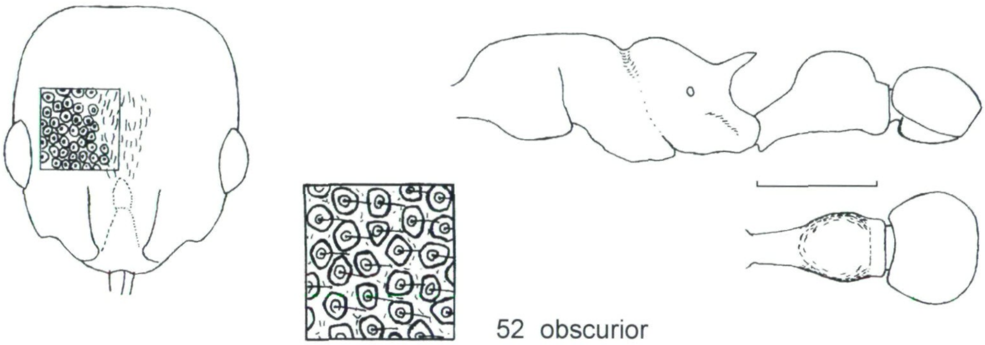

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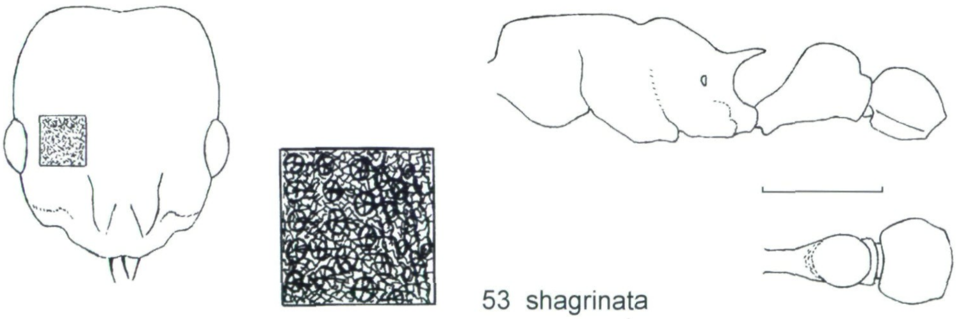

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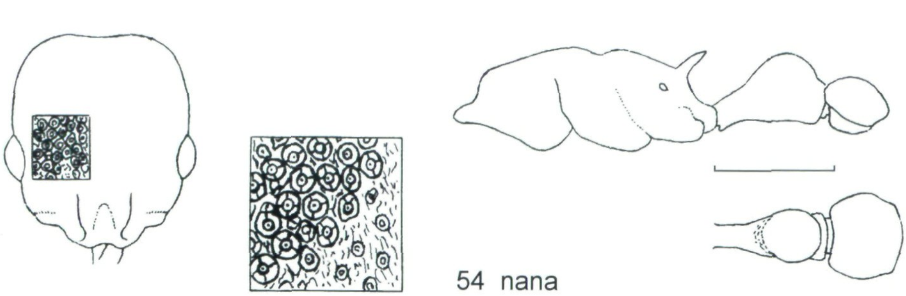

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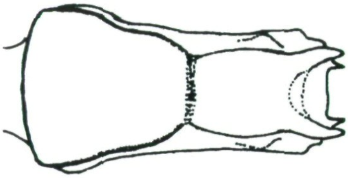

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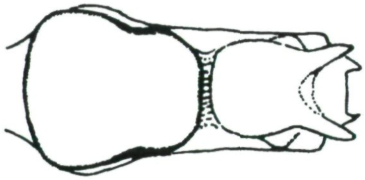

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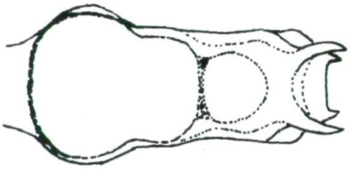

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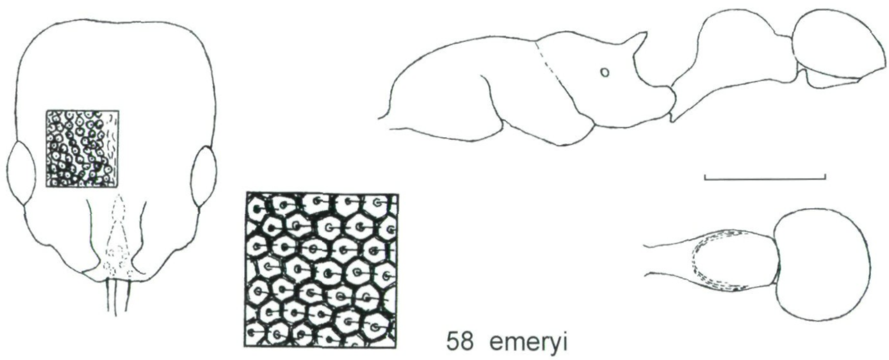

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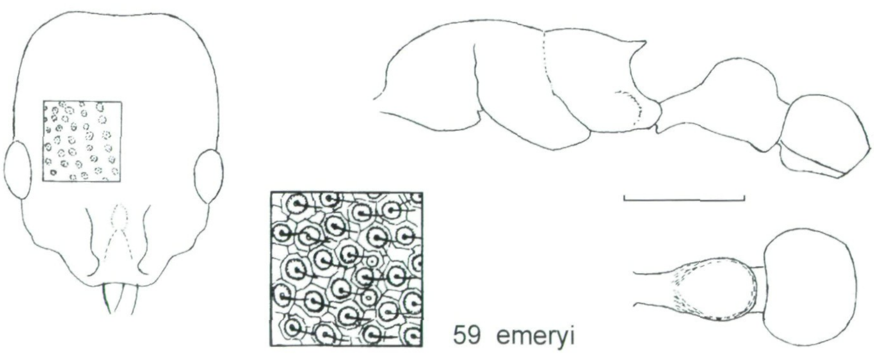

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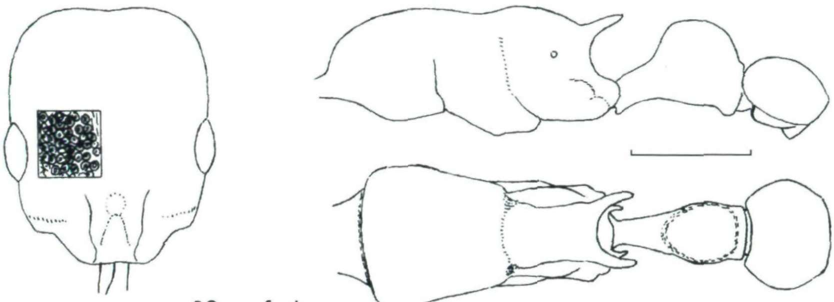

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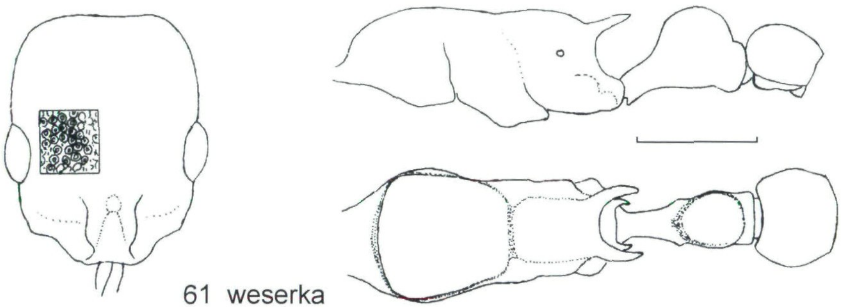

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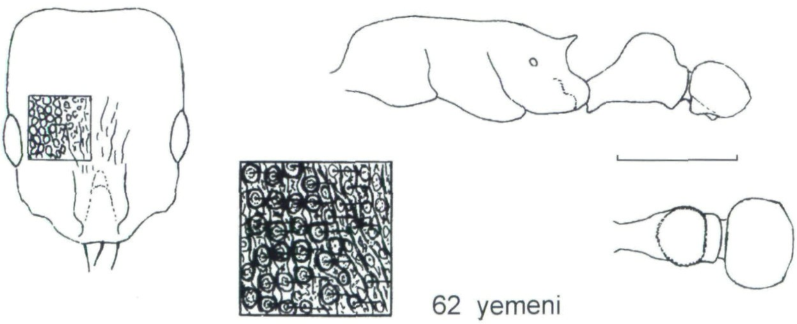

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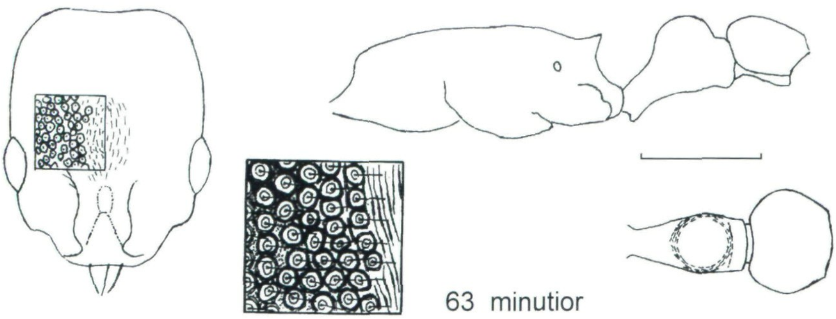
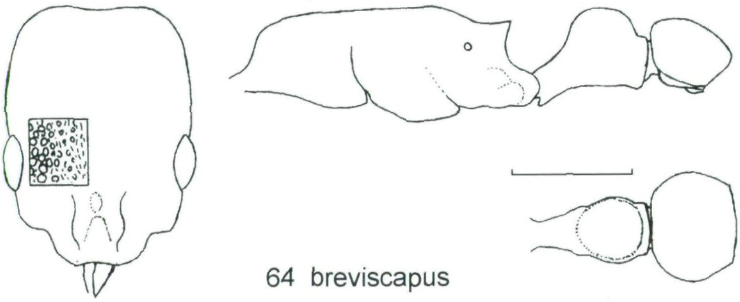
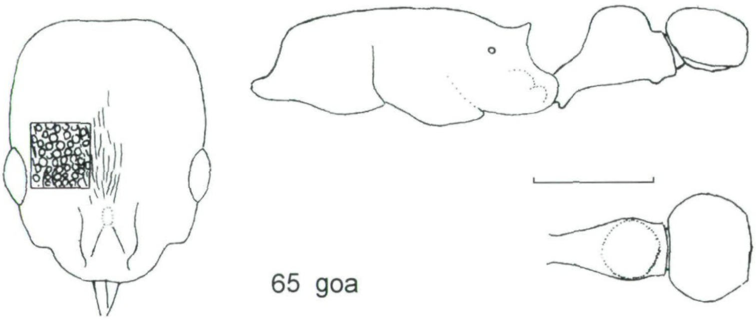


63 minutior



64 breviscapus



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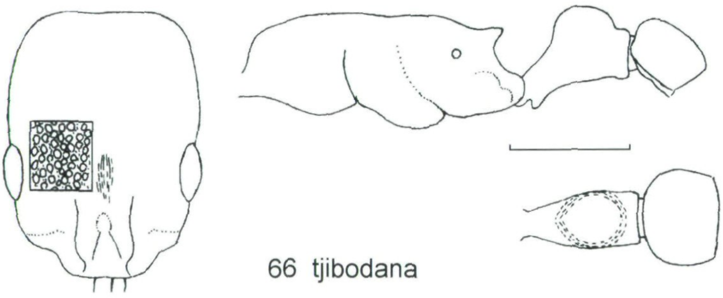

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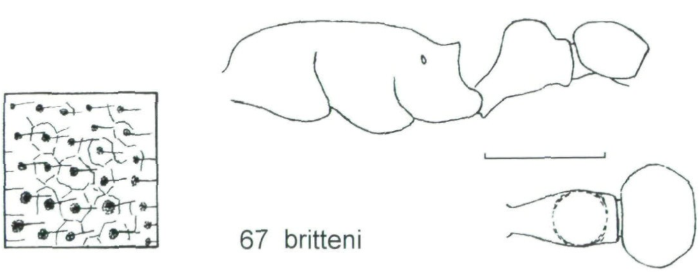

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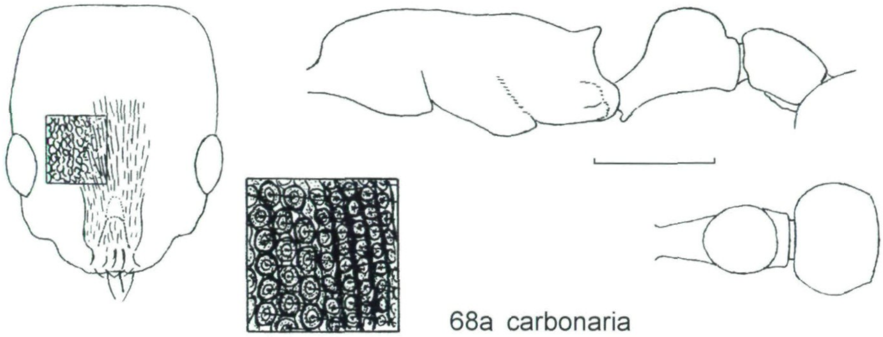
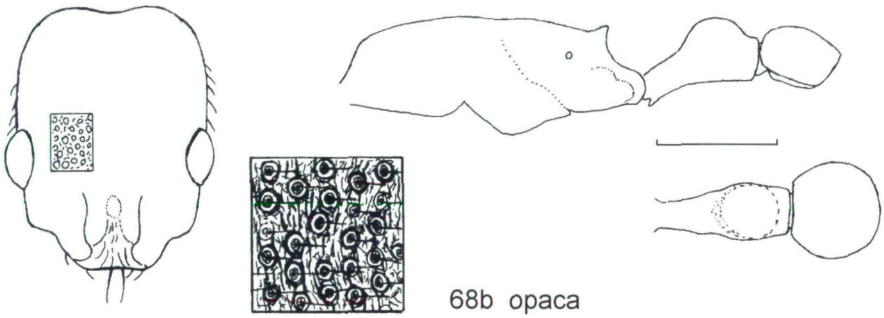
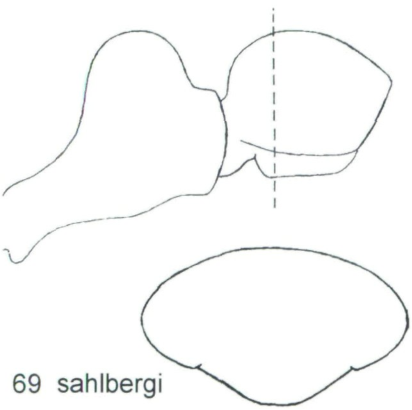


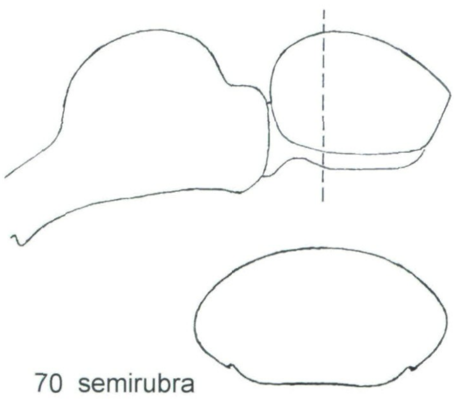
68a carbonaria



68b opaca



69 sahlbergi



70 semirubra

Figs. 69, 70: Waist segments of (69) *C. sahlbergi* and (70) *C. semirubra* sp.n. in lateral view and frontal section of postpetiole at the level marked by the dashed line.

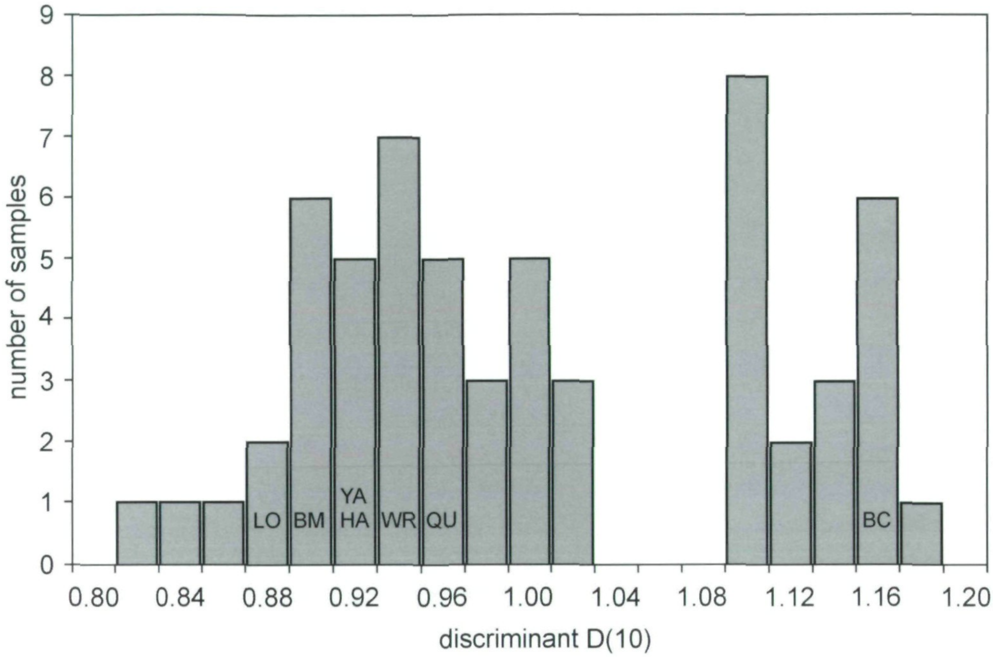


Fig. 71: Separation of worker samples of *Cardiocondyla wroughtonii* and of *C. obscurior* by the discriminant D(10) = 0.13 ln(PigG1 + 100) - 0.35 CL/CW -0.17 PoOc/CL - 0.68 FRS/CS + 1.33 SPBA/CS - 2.13 SP/CS + 0.7 PEW/CS + 1.34 PPW/CS + 0.12 PEH/CS + 0.65 PPH/CS. The position of type series is marked by the following acronyms: LO - *C. longispina,* BM - *C. bimaculata,* YA - *C. yamauchii,* HA - *C. hawaiensis,* WR - *C. wroughtonii,* QU - *C. quadraticeps,* BC - *C. bicolor.*

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