NEW EXTINCT SPECIES OF THE ANT GENUS *CAREBARA* (HYMENOPTERA: FORMICIDAE) FROM THE LATE EOCENE EUROPEAN AMBERS

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Abstract.— Two new fossil *Carebara* Westwood (1840) species are described from the Late Eocene Bitterfeld and Baltic ambers: *C. kutscheri* **sp. nov.** is described based on soldier and workers, and formally could be attributed to the former genus *Pheidologeton* Mayr, 1862 (now junior synonym of *Carebara*); its workers differ clearly from those of any known fossil *Carebara* species by the much bigger, well-developed eyes, while eyes in the other species are vestigial, containing several facets, and soldier is the first known one for the fossil *Carebara* species. *Carebara groehni* **sp. nov.** is described based on male, and differs clearly from males of *C. antiqua* (Mayr, 1868) by the distinctly longer antennal scape and the shorter funicular segments. Furthermore, it is somewhat smaller (the total length is ca. 4 mm vs. ca. 5 mm in *C. antiqua*), with the gradually rounded propodeum, while propodeum in the latter species is slightly angulate. Additional data for males of *C. antiqua*, including morphometrics, is provided. Taxonomic position of several fossil species ascribed to *Carebara*, is discussed.

Key words.— *Carebara kutscheri* sp. nov., *C. groehni* sp. nov., fossils, taxonomy, Baltic and Bitterfeld ambers

INTRODUCTION

The ant genus *Carebara* was established by Westwood (1840) and until 2004 included about 175 extant species (Bolton 1995). Fernández (2004) synonymised 14 generic names with *Carebara*, including *Aeromyrma* Forel, 1891, *Erebomyrma* Wheeler, 1903 and *Oligomyrmex* Mayr, 1867. Later, Fernández (2010) synonymised one more name with *Carebara* and Fischer *et al*. (2014) proposed three new synonyms, including *Pheidologeton* Mayr, 1862. Thus, *Carebara* presently contains about 250 species distributed mainly in tropical and subtropical regions worldwide (Fischer *et al*. 2014).

The extinct species *C. antiqua* was described by Mayr (1868) from the Baltic amber based on two gynes and was originally attributed to the genus *Pheidologeton*. Later it was transferred by various authors to different genera: to *Aeromyrma* by Emery (1891), to *Erebomyrma* by Wheeler (1915), to *Oligomyrmex* by Ettershank (1966), and was considered as a member of the latter genus until Fernández' (2004) revision. Wheeler (1915) reinvestigated three gynes (including one of Mayr's type specimen) as well as four workers and three males from Baltic amber and described workers and males.

PL ISSN 0003-4541 © Museum and Institute of Zoology PAS
doi: 10.3161/00034541ANZ2019.69.3.010

Below we describe two new species, *C. kutscheri* sp. nov. and *C. groehni* sp. nov., and provide additional data for the males of *C. antiqua*.

Material and methods

We examined two workers from the Bitterfeld amber and one male from the Baltic amber and attributed them to *C. antiqua*; mentioned workers are deposited in the private collection of Mr. Manfred Kutscher (Sassnitz, Rügen, Germany), and male is deposited in the Geologisch-Paläontologisches Institut des Universität Hamburg (GPIH, collection of C. Gröhn) (now Centrum of Natural History, CeNak). The holotype (soldier) and four paratype specimens (workers) of *C. kutscheri* from Bitterfeld amber are deposited in the Geowissenschaftlicher Zentrum der Georg-August-Universitat Göttingen, Germany (GZG.BST, collection of M. Kutscher). The holotype specimen (male) of *C. groehni* from Baltic amber is deposited in GPIH (collection of C. Gröhn).

The photographs were taken with Leica Z16 APO microscope equipped with Leica DFC 450 camera and processed by LAS Core software. The line drawings are based on the original photographs in conjunction with the computer program CorelDraw 8, or made by hand.

Not all features of the examined specimens were properly visible and measurable, hence we measured only visible details (accurate to 0.01 mm), particularly:

HL – maximum length of the head in dorsal view, measured in a straight line from the anteriormost point of clypeus to the mid-point of occipital margin; for the holotype soldier of *C. kutscheri* we used two total measurements: HL_1 measured from the anteriormost point of clypeus to the upper level of occipital margin, and HL_2 measured from the anteriormost point of clypeus to the lower level of the occipital emargination;

HW – maximum width of the head in dorsal view behind (above) the eyes;

SL – maximum length of the scape measured in a straight line from its apex to the articulation with condylar bulb;

SW – maximum width of the scape;

1^{st}L, 2^{nd}L, 11^{th}L – maximum length of the corresponding funicular segments;

OL – maximum diameter of the eye;

OcL – maximum diameter of the central ocellus;

ML – diagonal length of the mesosoma in lateral view from the anterior margin of the neck shield to the posterior margin of the metapleural lobes (soldier and workers), or from the anterio-dorsal margin of the scutum to the posterior margin of the metapleural lobes (males);

MH – height of the mesosoma, measured from the upper level of the scutum perpendicularly to the level of the lower margin of mesopleuron (males), or from the upper level of the pronotum to the level of the lower margin of mesopleuron (soldier and workers);

PNW – width of the pronotum in dorsal view;

PL – maximum length of the petiole, measured from the posterodorsal margin of the petiole to the articulation with the propodeum;

PH – maximum height of the petiole in profile, measured from the uppermost point of the petiolar node perpendicularly to the virtual line between the tip of subpetiolar process and posteroventral points of petiole;

PW – maximum width of the petiole in dorsal view;

PPL – maximum length of the postpetiole between its visible anterior and posterior margins;

PPH – maximal height of the postpetiole in profile;

PPW – maximum width of the postpetiole in dorsal view;

ESL – maximum length of the propodeal spine in profile, measured along the spine from its tip to the deepest point of the propodeal constriction at the base of the spine;

HTL – maximum length of the hind tibia;

FWL – length of the forewing;

FWW – width of the forewing;

*mcu*L, *1+2r*L, *3r*L – length of the corresponding cells on the forewing;

*mcu*W*1+2r*W*3r*W – width of the corresponding cells on the forewing.

Approximate Total length is calculated as the sum of HL + ML + PL + PPL + length of the gaster.

For simplicity, we give ratios of various measurements (e.g. HL/HW) rather than name and abbreviate various indices (e.g. CI) as we have done elsewhere.

Taxonomy

Carebara kutscheri Radchenko, Dlussky et Gröhn sp. nov.
(Figs 1–2)

Localities. Germany, Saxony, Bitterfeld amber, Late Eocene, Priabonian stage, 33.9–37.8 Ma.

Description. Soldier (Figs 1, A, B, 2, A, B). Body length ca. 6 mm. Head very slightly longer than wide, with somewhat convex sides, not strongly concave occipital margin and widely rounded occipital corners. Anterior clypeal margin convex, distinctly notched medially. Eyes well developed, but not big. Antennae 11-segmented with distinct 2-segmented apical club, scape very short, far from reaching occipital margin of

head; first funicular segment long, subequal to total length of 1st to 3rd segments.

Details of structure of mesosoma barely visible in specimen, but it is quite long, 1.74 times longer than width of pronotum; pronotum with convex anterior margin and rounded humeral corners. Propodeum with relatively short, slightly curved spines.

Petiolar node seems flattened in antero-posterior direction, cuneiform (seen in profile). Postpetiole (seen from above) wider than long, with rounded anterolateral corners. Middle and hind tibiae with simple spur.

Head dorsum mainly smooth, only genae and frontal lobes with fine, regular, longitudinal rugulosity. Sculpture of mesosoma and waist is barely visible, but they seem smooth.

Pilosity on head, body and legs is invisible (only a few long hairs present on petiole and postpetiole), but this may be due to features of specimen retention.

Workers (Figs 1, C, 2, C). Total length ca. 2.2–2.5 mm. Head longer than wide, with somewhat convex sides, slightly concave occipital margin and rounded occipital corners. Eyes well developed, relatively big. Anterior clypeal margin convex, but widely shallowly concave medially. Antennae 11-segmented, with distinct 2-segmented apical club, scape short, not reaching occipital margin of head, first funicular segment long, subequal to total length of 1st to 3rd segments.

Promesonotal dorsum convex, metanotal groove deep. Anterior margin of pronotum slightly convex, with narrowly rounded humerial corners, delineated by distinct carina. Propodeum with short but sharp recurved denticles, which directed mostly upward and curved forward at the tip. Petiole with long peduncle, anterior surface of node strongly concave, node not high, with rounded dorsum. Postpetiole with gradually rounded dorsum, lower than petiole, somewhat longer than height. Middle and hind tibiae with simple spur.

Whole body smooth. Head margins, mesosomal dorsum and petiolar and postpetiolar nodes with very sparse, quite long thin erect to suberect hairs. Pilosity on legs is absent.

***Measurements and ratios*: soldier**, holotype: HL_1 1.74, HL_2 1.79, HW 1.69, SL 0.83, OL 0.23, ML 1.72, PNW 0.99, PL 0.65, PW 0.39, PPL 0.34, PPW 0.57, ESL 0.18, HTL 1.31 mm; HL_1/HW 1.03, HL_2/HW 1.06, SL/HL_2 0.51, SL/HW 0.49, PL/PPL 1.92, OL/HL_2 0.13, PL/PW 1.67, PL/PPL 1.92, PL/HL_2 0.36, PPL/PPW 0.59, ESL/HW 9.39; **workers**, paratypes from the peace of amber no. GZG.BST.27.178: paratype 1: HL 0.59, SL 0.34, OL 0.12, ML 0.79, MH 0.31, PL 0.23, PH 0.18, PPL 0.14, PPH 0.13, HTL 0.35 mm; HL/OL 4.92, SL/HL 0.59, ML/MH 2.54, PL/PH 1.29, PL/PPL 1.64, PL/HL 0.40, PPL/PPH 1.10; paratype 2: HL 0.53, SL 0.36, ML 0.73, MH 0.30, PL 0.22, PH 0.18, PPL 0.13, PPH 0.14, HTL 0.36 mm; SL/HL 0.68, ML/MH 2.43, PL/PH 1.21, PL/PPL 1.70, PL/HL 0.41, PPL/PPH 0.91.

Queens and males. Unknown.

Type material. Holotype soldier, No. GZG.BST.27.173 (collection of M. Kutscher); paratypes, 3 workers from the same piece of amber as the holotype; 2 workers, No. GZG.BST.27.178 (collection of M. Kutscher).

Etymology. The species is dedicated to Mr. Manfred Kutscher, who generously provided material for investigation.

Remarks. Workers of *C. kutscheri* are very similar to those of *C. antiqua* in the structure of the body, including shape of the propodeal denticles and

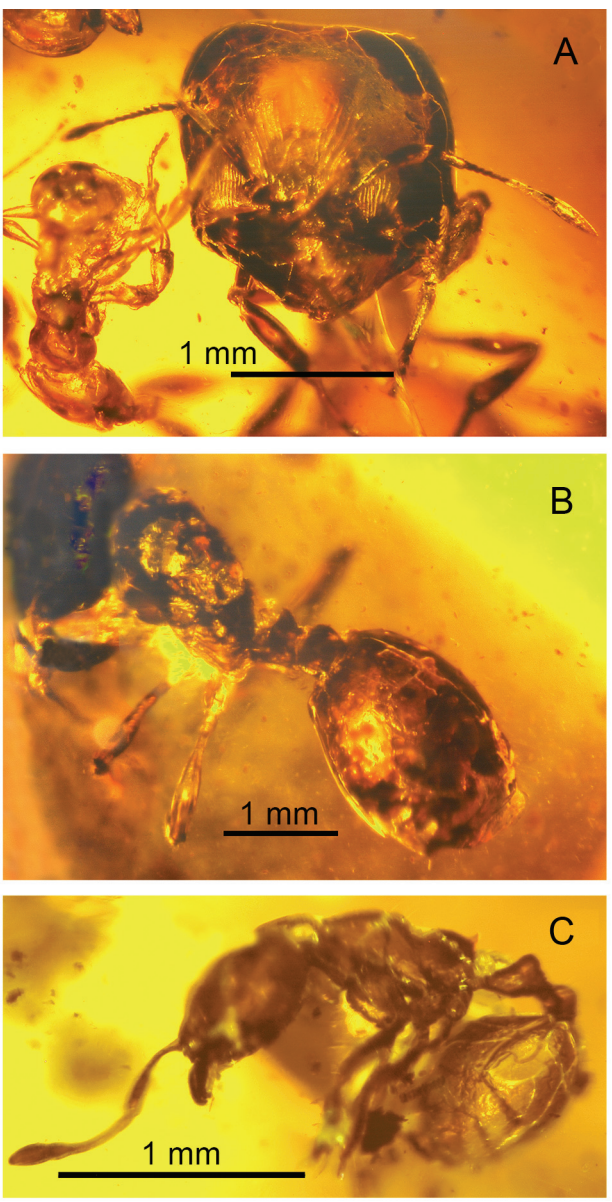

Figure 1. *Carebara kutscheri* sp. nov., photos of the details of structure; A, B – soldier, holotype; C – worker, paratype; A – head, dorsal view; B – mesosoma, waist and gaster, dorso-lateral view; C – body, lateral view.

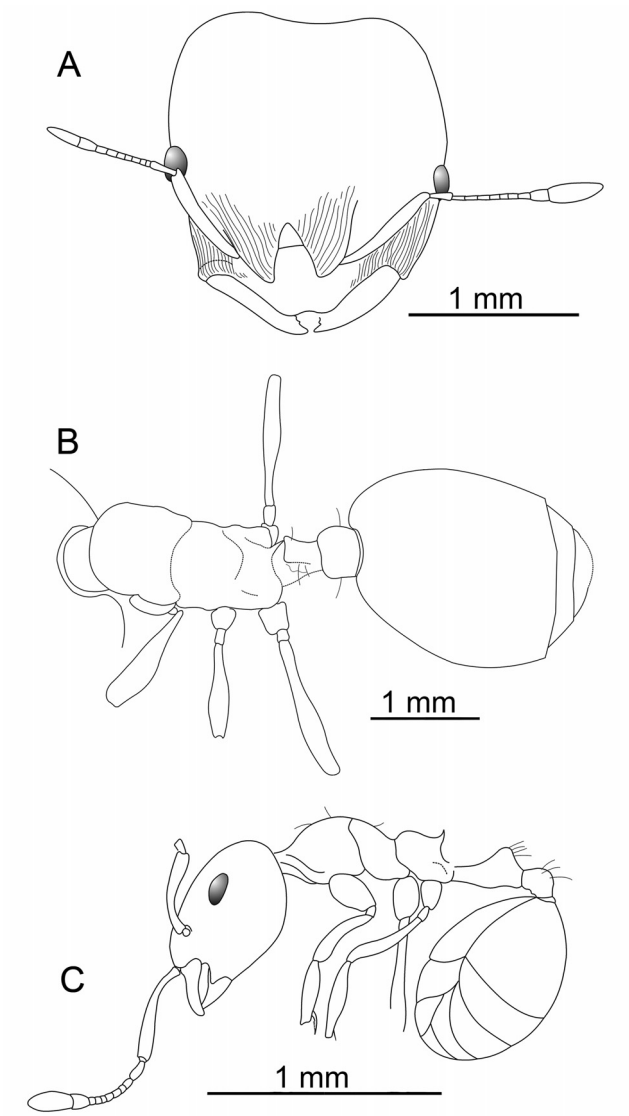

Figure 2. *Carebara kutscheri* sp. nov., line drawings of the details of structure; A, B – soldier, holotype; C – worker, paratype; A – head, dorsal view; B – mesosoma, waist and gaster, dorso-lateral view; C – body, lateral view.

antennae, but they differ clearly from the latter by the much bigger eyes, by the completely smooth and shiny body and by the much less abundant hairs on the body and lack of hairs on the legs and antennal scape. Workers of *C. kutscheri* resemble *C. nitida* (Dlussky, 2002) in body sculpture, but differ by the much bigger eyes and the differently shaped propodeal denticles.

Based on characteristics of the soldier, this species might be placed in the former genus *Pheidolegeton*. No other soldier of fossil *Carebara* species was known till now. Nevertheless, soldiers of *C. kutscheri* differ clearly from the extant "*Pheidologeton*" soldiers in the head sculpture: its head dorsum is smooth, only the genae and the frontal lobes are with fine, regular, longitudinal rugulosity, whereas head of the extant species is quite coarsely longitudinally rugose, often with the transversal rugosity on the occiput.

Carebara groehni Radchenko et Dlussky sp. nov.
(Figs 3, 4, A, B)

Localities. Jantarny, Kaliningrad Prov., Russia, Baltic amber, Late Eocene, Priabonian stage, 33.9–37.8 Ma.

Description. Male Total length ca. 4.0 mm. Head width is not properly measurable in the holotype specimen, but head seems as broad as long, gradually rounded above eyes, occipital margin very finely convex. Eyes very large and convex, situated distinctly in front of midlendth of sides of head, very close to mandibles, so that genae are extremely short, strip-like. Ocelli also very big and prominent, their maximum diameter 1.6 times scape width. Palp formula 3, 2. Frontal lobes short and subvertical, antennal sockets fully exposed. Antennae long, 13-segmented; scape twice as long as 2nd funicular segment and ca. 3 times as long as wide; length of 3rd and 4th segments subequal to 2nd segment; 2nd segment ca. 1.3 times as long as 1st one; apical segment the longest, subequal to scape length; 1st segment ca. 1.75 as long as wide; 2nd to 4th segments ca. twice as long as wide, 5th to 11th segments ca. 1.5 times as long as wide. Mandibles quite small, extending apically, masticatory margin distinct, with 3 sharp teeth. Clypeus convex (seen in profile), its anterior margin somewhat prominent, not notched medially.

Mesosoma quite short, scutum convex, overlapping pronotum, without notauli, propodeum gradually rounded, without distinctly defined dorsal and posterior surfaces, with no teeth or tubercles. Petiole distinctly longer than height, anterior surface of its node concave, posterior one convex and gradually sloping posteriorly, dorsal surface widely rounded; postpetiole subglobular, as high as petiole. Gaster pointed at tip, with small genitalia. Legs long and slender. Middle and hind tibiae with well developed simple spur.

Forewing big, surpassing tip of gaster, 2.6 times as long as wide, with closed cells *mcu*, *1+2r* and *3r*. Vein *3M* and cross-vein *rs-m* completely reduced so that cell *rm* absent; vein *2Cu* short, does not merge with vein *A*, so that cell *cua* absent. Cell *mcu* trapezoid, quite narrow, 1.7 times as long as wide; cell *1+2r* heptagonal, 2.4 times as long as wide; cell *3r* long, 3.4 times as long as wide.

Whole body and appendages smooth and shiny. Head, mesosoma and gaster with quite long, somewhat curved, sparse suberect hairs. Antennal scape, femora and tibiae with not abundant subdecumbent to

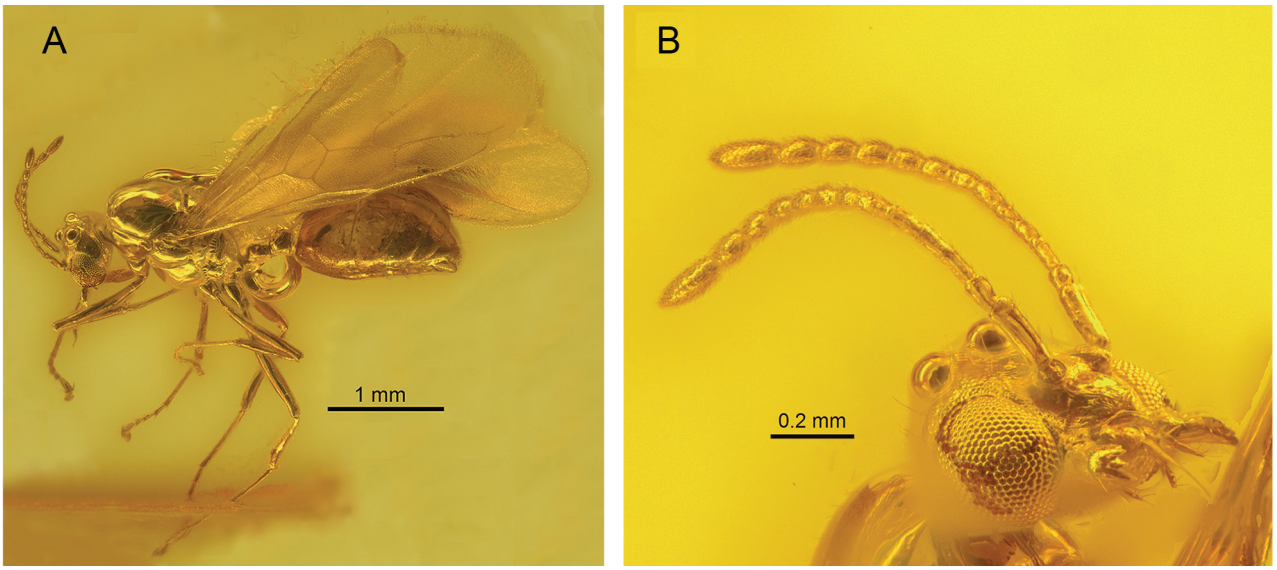

Figure 3. *Carebara groehni* sp. nov., holotype, male, photos of the details of structure; A – body, lateral view; B – head and antennae, lateral view.

suberect hairs, funicular segments and tarsi with subdecumbent hairs

Body colour reddish-brown, mesosoma somewhat darker, appendages lighter (note that colour of amber specimens might be artificial).

Measurements and ratios. HL 0.57, OL 0.34, OcL 0.10, SL 0.20, SW 0.07, 1stL 0.08, 2ndL 0.10, 11thL 0.20, ML 1.38, MH 0.83, PL 0.31, PH 0.19, PPL 0.21, PPH 0.18, HTL 0.75, FWL 3.46, FWW 1.33, *mcu*L 0.44, *mcu*W 0.26, *1+2r*L 0.81, *1+2r*W 0.34, *3r*L 0.88, *3r*W 0.26 mm; HL/OL 1.69, SL/HL 0.35, SL/2ndL 2.00, SL/SW 3.08, 2ndL/1stL 1.43, ML/MH 1.66, PL/PH 1.63, PL/PPL 1.48, PL/HL 0.55, PPL/PPH 1.14.

Workers and queens. Unknown.

Type material. Holotype, male, GPIH No. 4991, coll. Gröhn No. 6802.

Etymology. The species is dedicated to Mr. Carsten Gröhn, who collected the holotype specimen.

Remarks. *C. groehni* differs clearly from males of *C. antiqua,* first of all, by the structure of antennae. Scape in *C. groehni* is distinctly longer than in *C. antiqua*: SL/HL 0.35 vs. 0.27, ca. 3 times vs. 2 times as long as wide, and twice as long as the 2nd funicular segment vs. both being subequal in length. Furthermore, funicular segments in *C. groehni* are relatively shorter than in *C. antiqua*: the 2nd segment ca. 1.3 vs. 1.6 times as long as the 1st one; the 2nd to 4th segments ca. twice as long as wide, the 5th to 11th segments ca. 1.5 times as long as wide, but the 2nd to 10th segments are subequal in length and 2.3 times as long as wide in *C. antiqua*. Lastly, length of the apical segment in *C. groehni* is subequal to the scape length, but it is ca. 1.5 times as long as the scape in *C. antiqua*.

In addition, male of *C. groehni* is somewhat smaller: the total length is ca. 4 mm vs. ca. 5 mm in *C. antiqua*, and propodeum in the latter species is slightly angulate.

Additional data to *Carebara antiqua*

Carebara antiqua (Mayr, 1868)
(Figs 4, C; 5)

Localities. Jantarny, Kaliningrad Prov., Russia,, Baltic amber, Late Eocene, Priabonian stage, 33.9–37.8 Ma.

Material examined. 1 male, GPIH No. 4992, coll. Gröhn No. 6749.

Insofar as Wheeler (1915) provided comprehensive description of the males of *C. antiqua,* we do not formally redescribe them but give some additions and measurements.

Measurements and ratios. Total length 4.90, HL 0.72, OL 0.40, OcL 0.11, SL 0.20, SW 0.10, 1stL 0.10, 2ndL 0.21, 11thL 0.33, ML 1.82, MH 1.12, PL 0.52, PH 0.30, PPL 0.31, PPH 0.30, HTL 0.83 mm; HL/OL 1.77, SL/HL 0.27, SL/2ndL 0.94, SL/SW 2.00, 2ndL/1stL 2.00, ML/MH 1.63, PL/PH 1.82, PL/PPL 1.67, PL/HL 0.73, PPL/PPH 1.04.

Wheeler (1915, p. 48) noted: “second [funicular] joint longer than the scape and any of the succeeding joints, which are subequal and cylindrical”. This is correct, but terminal funicular segment seems the longest, at least 1.5 times as long as the second one.

He also noted (ibid., p. 49): “Hairs slender, short, suberect, covering the body but absent on the legs”.

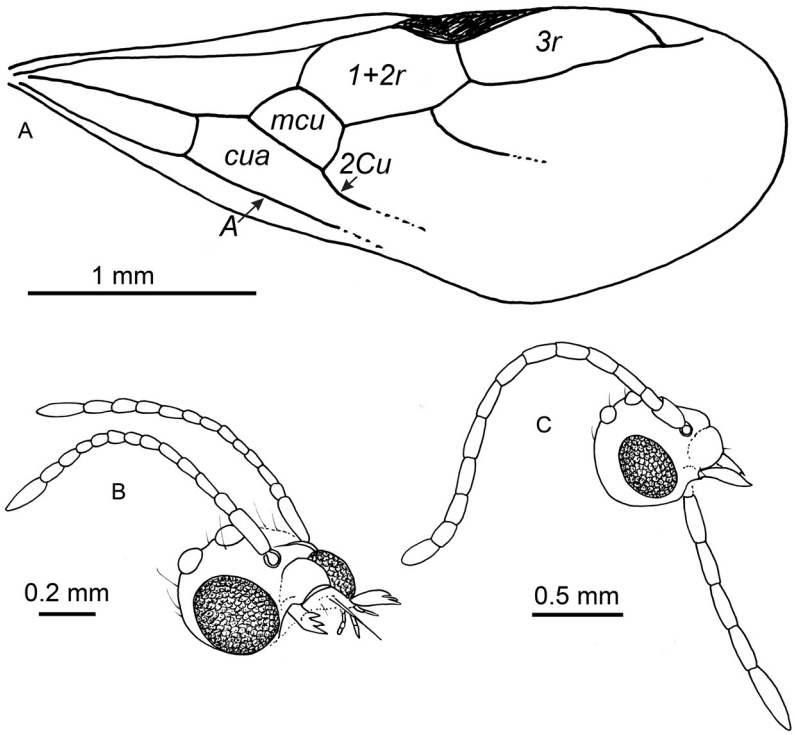

Figure 4. *Carebara groehni* sp. nov., holotype, male, line drawings of the details of structure A – body, lateral view; B – head and antennae, lateral view; C – antiqua, male, head and antennae, lateral view.

Nevertheless, femora of all legs of the examined specimen have quite long, though not numerous, suberect hairs on the inner surface, combined with subdecumbent hairs on the inner and outer surfaces; tibiae with even more abundant short subdecumbent to decumbent hairs.

Discussion

Seven extinct species were, until recently, attributed to *Carebara* (Fernández 2004,Fischer *et al*. 2014, Bolton 2018): *C. antiqua* (Mayr, 1868) from Baltic and Bitterfeld amber; *C. nitida* (Dlussky, 2002) and *C. ucrainica* (Dlussky, 2002) from Rovno amber (these three ambers are contemporary, Late Eocene, Priabonian stage, 33.9–37.8 Ma); *C. sophiae* (Emery, 1891) from Sicilian amber (Early Oligocene, Rupelian stage, 27.8–34.9 Ma); *C. thorali* (Théobald, 1937) from France, Bouch-du-Rhôn (Late Oligocene, Chattian stage, 23–27.8 Ma); *C. schossnicensis* (Assmann, 1870) from Silesia (at the end of XIX century this locality was in Germany, now in Poland) (Middle – Late Miocene, ca. 7–15 Ma), and *C. rugiceps* (Heer, 1849) (originally described as *Myrmica rugiceps*) from Germany, Oeningen (Late Miocene, Sarmatian [=Messinian] stage, 5.3–7.2 Ma). Records of one more never described species of the genus *Carebara* from Bitterfeld amber (Dlussky and Rasnitsyn 2009; *Oligomyrmex* sp. nov. sensu mentioned authors) actually refer to the male of the genus *Temnothorax* Mayr, 1861 (our unpublished data).

C. rugiceps were described based on the imprints and most of the important diagnostic generic features are barely visible, except the wings. However, forewing venation in *Carebara* gynes and males is very similar and often almost identical to those of some other Myrmicinae genera, e.g. *Solenopsis* Westwood, 1840, *Lophomyrmex* Emery, 1892, some *Aphaenogaster* Mayr, 1853 and *Pheidole* Westwood, 1839. As a result, a number of fossil species, including *Myrmica rugiceps* Heer, 1849, were transferred from various genera to the morphogenus *Paraphaenogaster* Dlussky, 1981 (Dlussky and Perfilieva 2014; Dlussky and Putyatina 2014; Radchenko and Perkovsky 2016).

C. schossnicensis (originally placed to the genus *Pheidologeton*) was described based only on the forewing imprint and its venation was almost identical to that of *Myrmica rugiceps* (Assmann 1870); so, *C. schossnicensis* might, with equal probability, be attributed to the genus *Carebara* or to the morphogenus *Paraphaenogaster*, or even to some other myrmicine genera. The same may be true for *C. thorali*, which was described based on male.

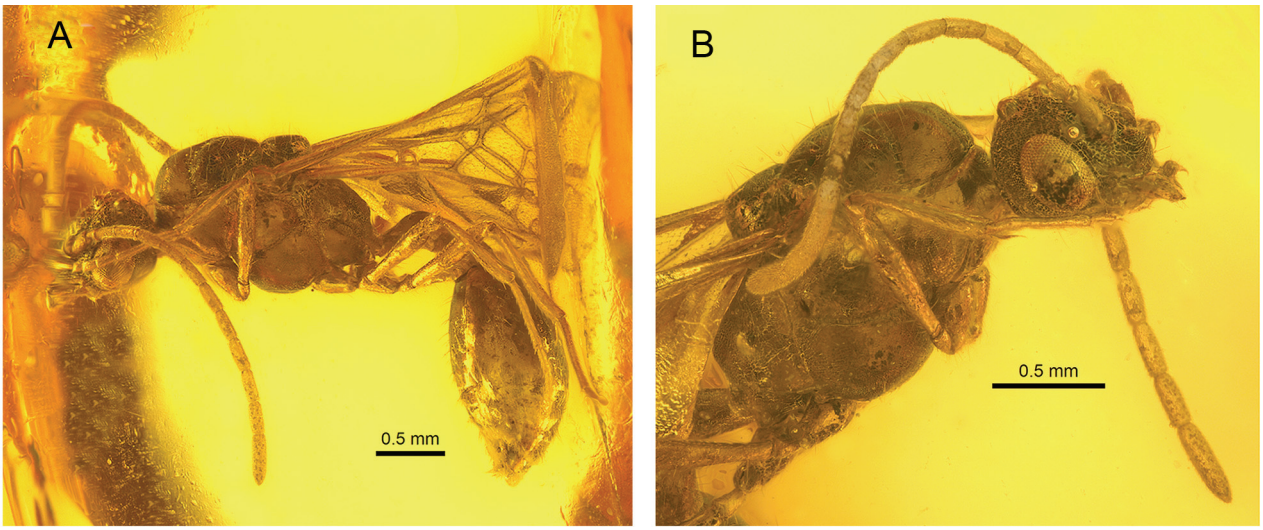

Figure 5. *Carebara antiqua*, male, photos of the details of structure; A – body, lateral view; B – mesosoma, head and antennae, lateral view.

Thus, only amber species mentioned above undoubtedly belong to *Carebara*, and *C. sophiae* (described based on single male) from Sicilian amber is the most peculiar among them – at least it differs clearly from males of *C. antiqua* and *C. groehni*. Its head is subtriangular (seen in profile), segments of the antennal funiculus are extremely long, ca. four times as long as wide, the petiole is also very long with low node, and the external genitalia are big (Emery 1891).

Five *Carebara* species are described nowadays from the Late Eocene European ambers based on 18 specimens (four gynes, four males, 9 workers and one soldier). Compared to other Myrmicinae genera from the mentioned ambers, *Carebara* is a quite speciose genus. Thus, including yet to be described species, there are at least 16 known amber species of *Temnothorax*, eight of *Myrmica* Latreille, 1804, seven of *Aphaenogaster*, six of *Eocenomyrma* Dlussky et Radchenko, 2006 and five of *Monomorium* Mayr, 1855 and *Carebara*. That is, six listed genera comprise about 60% of all known species (80), and remaining 20 genera contain from one to four species each. At the same time, *Carebara* is not among the genera represented by the greatest number of worker specimens. The richest in this respect are the genera *Temnothorax* and *Monomorium* each represented by about 100 specimens; the next richest is *Fallomyrma* with 48 specimens; the genera *Aphaenogaster* and *Myrmica* comprise about 35 and 20 specimens, respectively.

Species of *Carebara* in the Late Eocene were most probably not arboreal and, similarly to modern species, were dwellers of soil or leaf litter, that's why they were rarely trapped in resin and subsequently amber.

Acknowledgements

We are sincerely grateful to Mr. Manfred Kutscher (Sassnitz, Rügen, Germany) for providing us the type material of *C. kutscheri* and to Ekaterina Martynova (Schmalhausen Institute of zoology of NAS of Ukraine, Kyiv, Ukraine) for taking images of the holotype specimen of *C. groehni* and of the male of *C. antiqua*.

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Received: April 25, 2019
Accepted: June 30, 2019
Printed: September 30, 2019