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A new soldier beetle of the extinct tribe Cacomorphocerini Fanti & Kupryjanowicz, 2018

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Abstract

A new fossil *Cacomorphocerus* Schaufuss, 1892 from Baltic amber, *i.e.*, *Cacomorphocerus coleae* **sp. nov.** is described. Related to *C. eocenicus* Bukejs, Fanti & McKellar, 2019, the new species is characterized by 12 antennomeres that are little modified, with antennomere VI saucer-shaped and asymmetrical, antennomere V enlarged and antennomeres VII and VIII squarish and sub-rectangular. The slightly modified antennae of some species of *Cacomorphocerus* confirm a relationship with the genus *Sucinorhagonycha* Kuśka, 1996. Therefore, given the synapomorphy of the antennae, *Sucinorhagonycha* is transferred from the tribe Cantharini Imhoff, 1856 to Cacomorphocerini Fanti & Kupryjanowicz, 2018 (new placement).

Key words: Cenozoic, paleontology, soldier beetles, evolution, new taxon, antennal diversity

Introduction

Based on specimens known today, *Cacomorphocerus* Schaufuss, 1892 is a genus that originated, radiated and rapidly went extinct during the Eocene (Bukejs *et al.* 2019). The genus has been found exclusively as inclusions in Baltic and Rovno ambers from the Eocene (Kazantsev 2013; Kazantsev & Perkovsky 2014; Fanti 2017). It currently consists of seven species (Schaufuss 1892; Kuśka & Kania 2010; Fanti & Damgaard 2018; Fanti & Kupryjanowicz 2018; Bukejs *et al.* 2019; and the present work). The genus *Sucinorhagonycha* Kuśka, 1996, which is very close phylogenetically to *Cacomorphocerus* (Kuśka 1996; Fanti & Pankowski 2018), is known from only two species. Both genera are characterized by 12 antennomeres but differ in the presence/absence of a basal lobe or denticle on the claws (Fanti & Pankowski 2018). In the present work, we describe a new species of *Cacomorphocerus* and discuss its morphological similarity and relationship to *Cacomorphocerus eocenicus* Bukejs, Fanti & McKellar, 2019. A key to all of these species can be found in Bukejs *et al.* (2019).

Material and methods

The specimen was cut, cleaned and polished in the Jonas Damzen (Lithuania) laboratory and was donated by the authors to the Smithsonian's National Museum of Natural History (USNM). Photos were taken with a Canon EOS70D and macro lens MPE-65mm, and assembled using focus stacking software Helicon Focus. Plates were processed using a program PhotoImpact Viewer SE and the illustration was hand drawn with ink and paper. The specimen was discovered in a quarry in Yantarny (Kaliningrad region, Russia). All specimens of Baltic amber initially attributed to the Oligocene (*e.g.,* Noetling 1883) are currently referred to the Eocene. The time interval is considered to be between the Middle (Lutetian) and Upper Eocene (Priabonian). Studies confirm that the various ambers have different geological origins and paleogeographic provenance but are roughly coeval in age (Perkovsky *et al.* 2010; Wolfe *et al.* 2015; Alekseev 2017). Baltic amber is considered Priabonian, with older material from the Middle Eocene (Wolfe *et al.* 2009; Labandeira 2014); Rovno amber from the Priabonian (Perkovsky *et al.* 2007; Perkovsky *et al.* 2010); and Bitterfeld amber from the Middle Eocene (Wolfe *et al.* 2015). This suggests that forests existed extensively throughout the Eocene period and perhaps through the beginning of the Oligocene.

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Systematic treatment

Family Cantharidae Imhoff, 1856

Subfamily Cantharinae Imhoff, 1856

Tribe Cacomorphocerini Fanti & Kupryjanowicz, 2018

Genus *Cacomorphocerus* Schaufuss, 1892

Cacomorphocerus coleae FANTI & M. K. PANKOWSKI sp. nov.
(Figs. 1–4)

Description. Adult winged, elongate, slender, entirely brown to dark brown. Female with last urite rounded and rather short antennae. Body length 6.7 mm; antennae approximately 3.7 mm.

FIGURE 1. *Cacomorphocerus coleae* **sp. nov.** in Baltic amber. Holotype, lateral view, scale bar = 1.0 mm.

Head prognathous, rounded and slightly convex behind eyes, rather elongated anteriorly, with shallow and thin punctation, slightly covered by pronotum. Eyes wide, rounded, convex, prominent, inserted in lateral part of head. Mandibles poorly visible. Maxillary palps four-segmented, equipped with setae, palpomere I short and robust, palpomere II elongate and cylindrical, palpomere III of intermediate length between first two palpomeres, palpomere IV securiform. Labial palps three-segmented with last palpomere elongate and securiform. Antennae 12-segmented, pubescent, not particularly long and reaching middle of elytra, filiform with medial antennomeres modified, insertion rather far to upper margin of eyes and close together; scape robust and club-shaped; pedicel short, approximately 0.6 times as long as scape; antennomere III filiform, as long as scape; antennomere IV filiform, slightly shorter than antennomere III; antennomere V as long as antennomere IV, sturdier and enlarged; antennomere VI saucer-shaped with a concavity on the side; antennomere VII saucer-shaped, asymmetrical, with rounded and long lobes; antennomere VIII flat and wide with a small concavity on a side; antennomeres IX–XII filiform with antennomere XII longer and slightly rounded at apex. Relative length ratios of antennomeres 1–12 equal to 14:7:13:12:12:6:4: 11:12.12:12:14. Pronotum elongate, sub-quadrate, narrower than head, sparsely covered with shallow punctation, surface strongly concave in the middle, anterior margin straight and not bordered, posterior margin rounded, sides sinuous, posterior corners rounded and without denticles. Scutellar shield triangular. Elytra very long, surpassing the last abdominal segment, parallel-sided, slightly rugose and equipped with raised short setae, wider than pronotum and about as wide as head, apexes rounded. Hind wings slightly infuscate and slightly longer than elytra, almost completely covered by elytra. Metasternum gibbous, pubescent; ventrites transverse, robust, with setae. Last urite rounded both dorsal and ventral side. Legs slender and not particularly long, densely pubescent with short setae; coxae very large and robust; trochanters globular, short; femora slightly enlarged and slightly curved; tibiae subcylindrical, thin, with a long and very curved spur on the side near the apex, pro- and mesotibiae shorter than pro- and mesofemora, metatibiae longer than metafemora; tarsi 5-segmented; tarsomere 1 elongate and robust; protarsomere 2 about 1.5 times shorter than protarsomere 1, mesotarsomere 2 almost half the length of mesotarsomere 1; metatarsomere 2 approximately 1.7–1.8 times shorter than metatarsomere 1; tarsomere 3 shorter than tarsomere 2 and flat at sides; tarsomere 4 bilobed and very flat; tarsomere 5 slender; claws thin, pointed at apex and with a small and obtuse denticle basally.

FIGURE 2. *Cacomorphocerus coleae* **sp. nov.** in Baltic amber. A: Holotype, lateral view, scale bar = 1.0 mm. B: Holotype, dorso-lateral view, scale bar = 1.0 mm. C: Holotype, detail of legs, scale bar = 0.5 mm. D: Holotype, detail of legs, scale bar = 0.5 mm.

FIGURE 3. *Cacomorphocerus coleae* **sp. nov.** in Baltic amber. A: Holotype, detail of head, pronotum and left antenna, scale bar = 0.5 mm. B: Holotype, detail of metasternum and ventrites, scale bar = 0.5 mm. C: Holotype, detail of last ventrites, scale bar = 0.5 mm. D: Holotype, detail of last ventrites, scale bar = 0.5 mm.

Etymology. Named in honor of paleobiologist Dr. Selina Cole. A mentor to the second author, she generously shares her time and knowledge and inspires with her love of science.

Holotype. Female, adult specimen included in a yellow Baltic amber piece: Accession No. USNM PAL 706454 in the Smithsonian's National Museum of Natural History (USNM).

Type locality. Yantarny, Baltic Sea Coast, Sambian Peninsula, Kaliningrad Region, Russia.

Type strata. Baltic amber, Middle-Upper Eocene, Prussian Formation, also known as the "blue earth" formation.

Syninclusions. Many botanical remains, gas vesicles (air bubbles), Diptera (a Chironomidae male with a disarticulated leg, and another small indeterminable specimen), various unidentified insect parts.

Differential diagnosis. *Cacomorphocerus coleae* **sp. nov.** is characterized by 12 antennal articles that are little modified, with antennomere VI saucer-shaped and asymmetrical, antennomere V enlarged and antennomeres VII and VIII difform. With its central antennomeres little modified, *C. coleae* **sp. nov.**, appears related to *C. eocenicus* Bukejs, Fanti & McKellar, 2019. *C. eocenicus*, however, is distinguishable based on its smaller size (about 5.2 mm instead of 6.7 mm for *C. coleae* **sp. nov.**), the different shape of its modified antennomeres VI–VIII, and for antennomere V that is less dilated and shorter (Bukejs *et al.* 2019). *C. coleae* **sp. nov.** is also similar to *Sucinorhagonycha samsockorum* Fanti & Pankowski, 2018. However, *S. samsockorum* possesses claws without lobes or teeth (an important diagnostic character at the taxonomic level for the family Cantharidae), as well as antennomeres IV–V that are slightly dentate and antennomeres III and VII that are very little modified (Fanti & Pankowski 2018).

Remarks. The amber piece measures 32 x 23 x 6 mm and weighs 2.4 grams. The inclusion is complete and easily visible except for a white cotton-like cloud (emulsion), not particularly thick, localized in some ventral parts around the head, the side of the ventrites and the last urite.

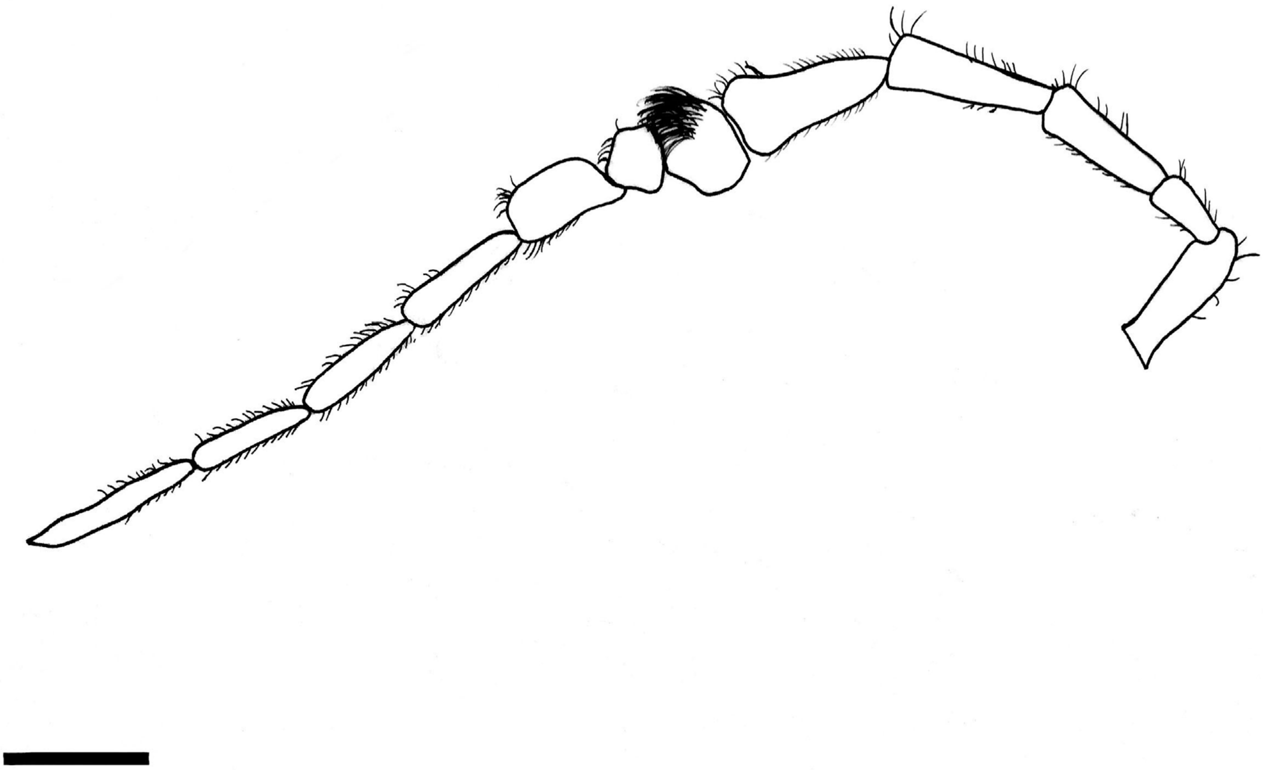

FIGURE 4. *Cacomorphocerus coleae* **sp. nov.** in Baltic amber. Drawing of antenna by Mary Pankowski, scale bar = 0.5 mm.

Discussion

The family Cantharidae Imhoff, 1856 seems to have evolved during the Cretaceous (McKenna *et al.* 2015; Fanti 2017), when almost all species found to date had 11-segmented, filiform or pectinate antennae (Fanti & Ellenberger 2016, 2018; Poinar & Fanti 2016; Fanti *et al.* 2018; Peris & Fanti 2018), with the exception of a genus and species recently described from the Cenomanian Agdzhakend amber (Azerbaijan) with apparent 14 antennomeres (Kazantsev & Perkovsky 2019). The 11-segmented antennae are considered to be an ancestral character state of the adult beetle (Minelli 2005). Subsequently, the family appears to have suffered, as indeed most of all fauna, a devastating extinction at the end of the Cretaceous (Fanti *et al.* 2018), confirmed by the fact that the genera of soldier beetles living in the Cretaceous have been not found in the following period. Immediately afterward, however, Cantharidae experienced a rapid radiation starting in the Paleocene and continuing into the Eocene, with significant diversity preserved in amber and as compression fossils in rocks, with the advent of many new genera (Fanti 2017; Fanti *et al.* 2018). As highlighted by Bukejs *et al.* (2019), the genera evolving during the Eocene included *Cacomorphocerus* Schaufuss, 1892 and *Sucinorhagonycha* Kuśka, 1996, along with numerous other genera (Kuśka 1996; Kuśka & Kania 2010; Fanti & Damgaard 2018; Fanti & Kupryjanowicz, 2018) that are characterized by the presence of supernumerary antennomeres (from 12 to 19). For example, a few species of Cantharini from Baltic amber show supernumerary articles (Fanti 2017). In addition, a representative of the subfamily Chauliognathinae *i.e., Chauliognathus pristinus* Scudder, 1876 described from two compression fossils from the Florissant Formation in Colorado, also appears to have 12 antennomeres (Scudder 1876, 1900; Fanti 2017), but the antennae are poorly preserved and more specimens are needed to confirm this character state. As noted above, only one species of Cantharidae with supernumerary antennomeres has been found in the Cretaceous (Kazantsev & Perkovsky 2019). No representatives of the tribe Cacomorphocerini Fanti & Kupryjanowicz, 2018 with the supernumerary antennomeres have been found except in Baltic and Rovno ambers. Such taxa remain unknown from other regions, despite the availability of well-investigated Eocene deposits from the United States (such as the Florissant Formation) that have produced various species of Cantharidae (Fanti 2017; Bukejs *et al.* 2019). Similarly, other more recent European deposits, such as those at Brunstatt, Rott, Radoboj and Oeningen (Fanti 2017), have not yielded such taxa although they contain Cantharidae.

The present records suggest a likely European origin, and certainly Laurasian, of the genus *Cacomorphocerus*. It's difficult, however, to identify the progenitor of the *Cacomorphocerus* or the whole tribe Cacomorphocerini. The genera belonging to this tribe have supernumerary articles and some of these, especially the antennomeres VII-VIII (sometimes also the antennomere IX), are saucer-shaped (Bukejs *et al.* 2019; Fanti & Damgaard 2018; Fanti & Kupryjanowicz 2018). The species *Sucinorhagonycha samsockorum* Fanti & Pankowski, 2018, *Cacomorphocerus eocenicus* Bukejs, Fanti & McKellar, 2019 and *Cacomorphocerus coleae* **sp. nov.**, have 12-segmented antennae but with little-modified antennomeres VI-VII (Bukejs *et al.* 2019; Fanti & Pankowski 2018). The other known species of *Sucinorhagonycha* (*S. kulickae* Kuśka, 1996) has completely filiform antennae (Kuśka 1996; Kubisz 2000). Therefore, we suggest that the antennal morphology supports the presence of a common ancestor with filiform antennae (Bukejs *et al.* 2019). The morphology indicates affinity between *Cacomorphocerus* Schaufuss, 1892 and *Sucinorhagonycha* Kuśka, 1996, and therefore the latter genus is transferred here to the tribe Cacomorphocerini (new placement).

It's worth noting that among extant soldier beetles, almost all species have 11 antennomeres. Among those with 12 antennomeres are some species of the Australian genus *Heteromastix* Boheman, 1858 (which, however, is placed in another subfamily and is not related to the tribe Cacomorphocerini). A few extant species possess just 10 antennomeres or, in one case, only nine (Fanti 2017). Moreover, some species of Mediterranean *Malthodes* Kiesenwetter, 1852 have the eleventh antennomere strongly reduced and globular. One final note of interest: The presence of supernumerary antennomeres can be found abundantly today, above all in the Elateroidea (Minelli 2017), the large superfamily to which the soldier beetles belong. Clearly, the antennae of soldier beetles have a fascinating evolutionary story to tell.

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