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A new species of Eocene fossil *Malthodes* (Coleoptera: Cantharidae) with a rarely observed aedeagus

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Abstract

A new *Malthodes* (Coleoptera, Cantharidae, Malthininae) in Eocene amber from Poland (Baltic amber) is illustrated and described here: *Malthodes* (*s. str.*) *maximiliani* **sp. nov.** The new species of soldier beetle is characterized by its small body size and last tergites and last sternite distinct from similar taxa. Notably, the specimen has a partially visible aedeagus, a characteristic rarely seen in fossil *Malthodes* of the nominotypical subgenus; it has been observed in only three fossil species of this subgenus.

Key words: soldier beetle, paleoentomology, Eocene, Baltic amber, aedeagus

Introduction

The genus *Malthodes* Kiesenwetter, 1852 is a soldier beetle that is small in body size (typically 2–5 mm) but rich in diversity. It includes over 600 living species distributed in the Holarctic region (Delkeskamp 1977). The genus is also well represented in the fossil record, primarily in Baltic amber (*e.g.,* Kazantsev 2013, 2021; Fanti 2017a, 2017b; Fanti & Damgaard 2018; Fanti & Sontag 2019; Parisi & Fanti 2019, 2020; Pankowski & Fanti 2023). It is also known from coeval Rovno (Kazantsev 2010; Kazantsev & Perkovsky 2014) and Bitterfeld ambers (Fanti 2019b), as well as compression fossils in the Oligocene deposits of Brunstatt, France (Förster 1891) and in the Miocene deposits of Vlădiceni, Romania (Pintilioaie *et al.* 2021). In addition, the genus has been found at an indeterminate specific level in Eocene Belarus amber (Alekseev 2022). *Malthodes* currently includes six extant subgenera: *Malthodes* Kiesenwetter, 1852; *Hiranous* Takahashi, 2021; *Maltharcus* Weise, 1892; *Micromalthodes* Takahashi, 2021; *Podistrina* Fairmaire, 1875; and *Sohayakimalthodes* Takahashi, 2021, as well as the fossil subgenus †*Libertimalthodes* Kupryjanowicz & Fanti, 2019. Some of these extant subgenera, however, may be of dubious validity (Wittmer 1970; Brancucci 1980).

Here we describe a new Eocene species found in Baltic amber. Discoveries of *Malthodes* species in various fossil deposits can be helpful to phylogenetic, biogeographical, and ecological-climatic reconstructions. The genus is well diversified, with species adapted to many different environments that include coastal areas, mountains, and islands, in hot as well as cold climates. The genus is often found in amber due to its minute size that favors entrapment in fossil resins. Fortunately, males of *Malthodes* are rather easily distinguishable on a specific level due to their sometimes extreme modifications of the last abdominal segments, which are indeed species-specific. Females of the genus usually cannot be identified to species.

Material and methods

The amber piece was cleaned and polished, and the inclusion was photographed by Artur R. Michalski (Wrocław, Poland) with a Canon EOS 600D digital camera mounted on a Bresser microscope, with the addition of focus

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stacking software. The photographs were processed with PhotoImpact Viewer SE. The illustration was made free-hand with china ink. Baltic amber is currently referred to the Middle Eocene climatic optimum with sedimentation in two different stages: Bartonian and Priabonian, approximately 45.0–38.0 Mya (Bukejs *et al.* 2019). The holotype discussed herein is deposited in the Museum of Comparative Zoology at Harvard University in Cambridge, Massachusetts (USA).

Systematic paleontology

Family Cantharidae Imhoff, 1856

Subfamily Malthininae Kiesenwetter, 1852

Tribe Malthodini Böving & Craighead, 1931

Genus *Malthodes* Kiesenwetter, 1852

Subgenus *Malthodes* Kiesenwetter, 1852

Malthodes (*Malthodes*) *maximiliani* FANTI & M. V. PANKOWSKI sp. nov.

(Figs. 1–2)

Description. Adult, winged, male defined on the basis of the last urites strongly modified. Body length: about 2.0 mm (the body is moderately bent). Entirely blackish-dark brown without yellow spots on elytra.

Head exposed, elongated, covered by short setae and shallow punctation. Eyes large, very prominent, convex, rounded, inserted in the lateral-upper part of head. Mandibles falciform, elongated. Maxillary palpi 4-segmented, with last palpomere robust, globular, and distally pointed. Labial palpi 3-segmented, with last palpomere globular and distally pointed. Antennae filiform, 11-segmented, relatively long surpassing the apex of elytra and approximately reaching the sixth-seventh tergite; antennomere I elongated, robust, club-shaped (enlarged from the middle to the apex); antennomere II elongated, rather thin, about 1.6–1.7 times shorter than antennomere I; antennomere III moderately more robust and slightly shorter than antennomere II; antennomere IV elongated, enlarged apically, the longest except scape and last antennomere; antennomeres V–VIII subequal in length (antennomere VI very slightly shorter), shorter than previous one; antennomeres IX–X slightly shorter than previous ones; antennomere XI elongated, rounded at apex; all antennomeres have several long setae. Pronotum transverse, narrower than head, surface almost flat with shallow punctation and short setae, sides straight and bordered, posterior and anterior margins rather bordered, corners rounded. Elytra short (revealing five tergites completely uncovered plus one uncovered in part), wider than pronotum, covered with shallow punctation and several erect setae, parallel-sided, strongly rounded at apexes, without apical yellow spots. Hind wings infuscate, exceeding the elytra and last abdominal segments. Legs slender, pubescent; coxae elongated and stout; trochanters elongated with rounded apex; femora enlarged, curved; tibiae cylindrical and thin, pro- and mesotibiae slightly shorter than pro- and mesofemora, metatibiae approximately as long as metafemora. Tarsi 5-segmented, pubescent; tarsomere I thin, elongated; tarsomere II shorter than tarsomere I; tarsomere III shorter than second; tarsomere IV strongly bilobed with lobes rounded at apex; tarsomere V elongated, slightly curved, slender; claws simple without tooth. Metasternum with rounded posterior margin, covered with many dispersed setae. Sternites transverse and pubescent. Penultimate tergite (tg9) elongated, rather wide with sides very slightly bent and enlarged apically; last tergite (tg10) narrower than penultimate tergite, short, in a small lobe shape rounded apically; last sternite (st9) with an elongated lobe shape (thinner from middle to apex), apically rounded and therefore without emargination-concavity. Aedeagus partially visible with parameres that are very long, thin but globular and robust apically. Female unknown.

Etymology. The species is named after Maximilian G. Pankowski, the second author's brother, friend, and partner in paleontological projects.

Holotype. Male, inclusion in Baltic amber, deposited in the Museum of Comparative Zoology (MCZ) with catalog number MCZ:Ent:PALE-45868.

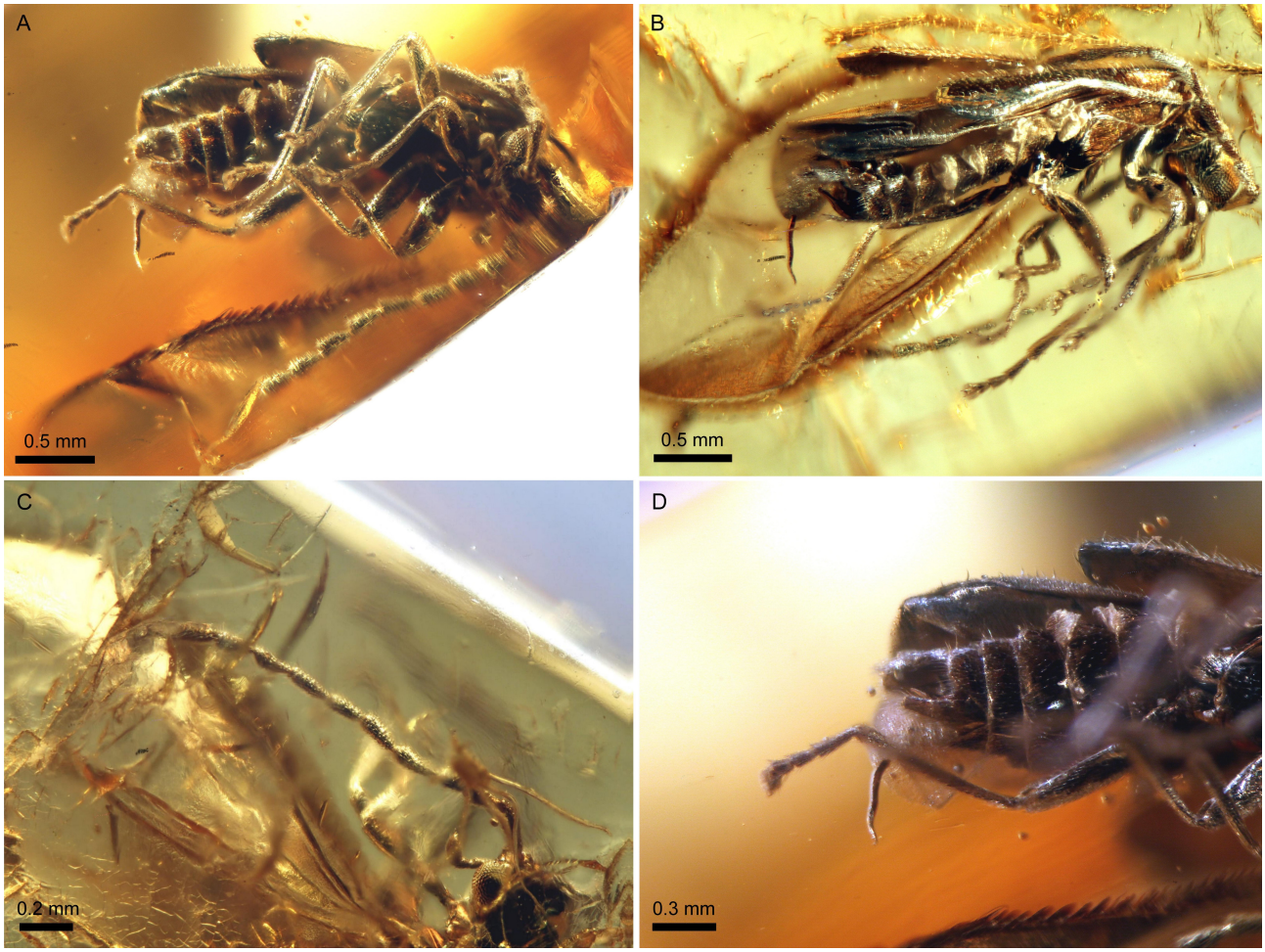

FIGURE 1. *Malthodes* (*Malthodes*) *maximiliani* **sp. nov.** holotype, in Baltic amber. A, ventral view; B, lateral view; C, detail of antenna; D, detail of last abdominal segments (ventro-lateral view).

Type locality. Gdańsk area, Mierzeja Wiślana (Wisła River estuary area), Poland.

Type horizon. Middle Eocene: Bartonian-Priabonian (45.0–38.0 Mya).

Syninclusions. Air bubbles, botanical fragments, and an insect antenna.

Systematic placement. The pronotal shape, short elytra, the last maxillary palpomere globular and distally pointed, and the last adominal segments modified place this species in the genus *Malthodes* Kiesenwetter, 1852 and its nominotypical subgenus. It is distinguishable from the fossil subgenus *Libertimalthodes* Kupryjanowicz & Fanti, 2019, which shows long elytra covering and surpassing the last abdominal segments, and features a very large aedeagus and a last sternite that is little modified (Fanti 2019; Kupryjanowicz & Fanti 2019; Pankowski & Fanti 2023).

Differential diagnosis. The species most similar to *Malthodes maximiliani* **sp. nov.** are *M. neumanni* Fanti, 2019 from Bitterfeld amber, and the taxa *M. nublar* Kupryjanowicz & Fanti, 2019 and *M. kotejai* Kuśka & Kupryjanowicz, 2005 from Baltic amber (Kuśka & Kupryjanowicz 2005; Fanti 2019b; Kupryjanowicz & Fanti 2019). However, these three species have last tergites that differ from the new species. In addition, the last sternite (st9) of these species is elongated but with a slightly emarginated-concave apex, whereas in the new species the apex of st9 is straight and obtuse.

Remarks. The yellow amber piece measures approximately 6x5x2 mm and weighs 0.1 grams after preparation. The inclusion is complete.

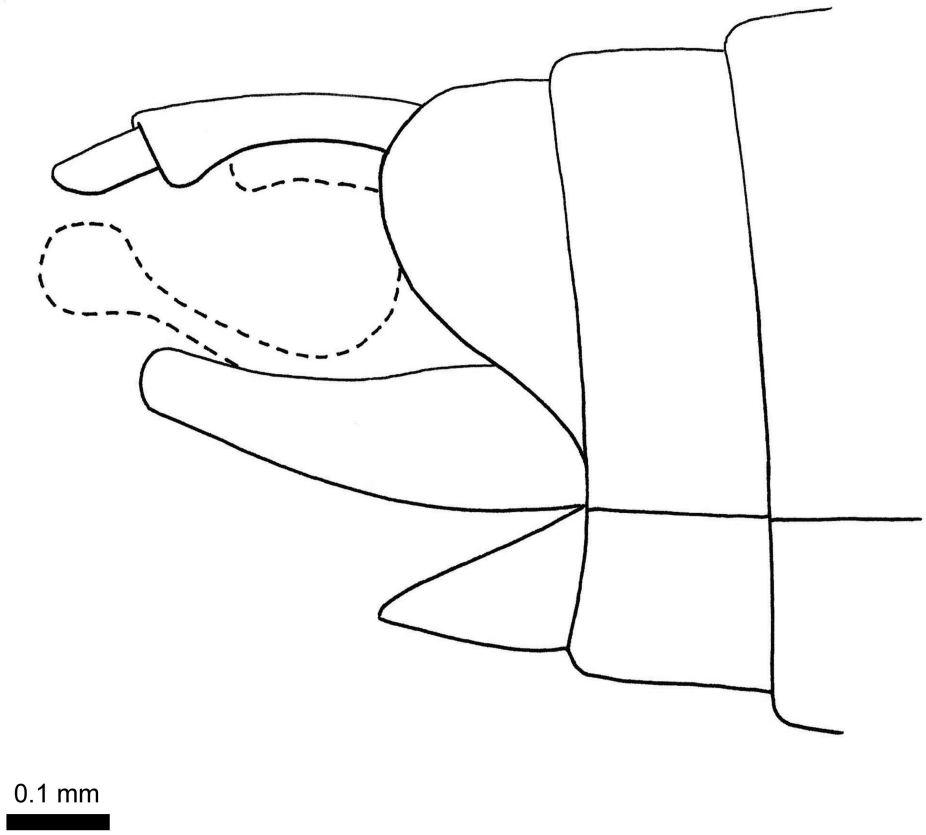

FIGURE 2. *Malthodes* (*Malthodes*) *maximiliani* **sp. nov.** in Baltic amber. Reconstruction of last abdominal segments.

Discussion

The aedeagus, the reproductive organ of male insects, is referenced to distinguish one species from another in a wide variety of taxa. The form of the aedeagus is also important for taxonomic and diagnostic purposes for beetles, and specifically for Cantharidae genera (Brancucci 1980; Ramsdale 2002), including *Malthodes* Kiesenwetter, 1852. Unfortunately, the aedeagus is not visible in the vast majority of fossil specimens. In *Malthodes* of the nominotypical subgenus, it is only partially visible in specimens of three fossil species: *Malthodes rovnoensis* Kazantsev & Perkovsky, 2014 from Rovno amber, and *Malthodes gedanicus* Fanti & Sontag, 2019 and *M. nublar* Kupryjanowicz & Fanti, 2019 from Baltic amber (Kazantsev & Perkovsky 2014; Fanti & Sontag 2019; Kupryjanowicz & Fanti 2019). In three other species from Baltic amber, *M. giannii* Parisi & Fanti, 2020, *M. immortalis* Parisi & Fanti, 2020, and *M. unimol* Parisi & Fanti, 2020, the aedeagus is extremely poorly visible and of unclear form (Parisi & Fanti 2020). In contrast, the subgenus *Libertimalthodes* Kupryjanowicz & Fanti, 2019 is characterized by a large aedeagus that can be more easily observed (Fanti & Michalski 2018; Kupryjanowicz & Fanti 2019; Fanti 2019a, 2021; Pankowski & Fanti 2023), in contrast to that of the subgenus *Malthodes,* which is almost always very small and inserted into the abdomen through a thin peduncle.

As noted in Parisi & Fanti (2020) and Pankowski & Fanti (2022), the number of *Malthodes* species alive when Baltic amber was formed is surely greater than the number of species currently living in this area. It is therefore likely that the genus evolved well before the Eocene; however, no species has yet been found in Paleocene or Cretaceous deposits (Fanti 2017a, 2021). This could certainly be due to a relative lack of Cretaceous ambers containing numerous insect inclusions, except for a notable exception: Burmese (Kachin) amber. This amber, however, was likely formed in areas and environments very different from those of fossil *Malthodes*, a distinctly Laurasian genus, since no living or fossil Gondwanan specimens of this genus are known. Thus, even though *Malthodes* likely originated before the Eocene, we may never discover a specimen that confirms it.

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