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RESEARCH PAPER

A new species of tumbling flower beetle (Coleoptera: Mordellidae) from Baltic amber

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Abstract
A new species of tumbling flower beetle (Coleoptera: Mordellidae) *Tomoxia succinea* sp. nov. is described based on two Baltic amber specimens. The new species differs from the only extant European species of this genus, *Tomoxia bucephala* Costa, 1854, mainly in the shape of the scutellum and the length ratio of particular body parts. The fossil records of Mordellidae found in Baltic amber are summarized; their paleoecology in the Paleocene–Eocene of the Baltic region and the composition and distribution of the family Mordellidae are discussed.

Keywords Coleoptera · Mordellidae · New species · Baltic amber · Eocene · Paleoecology

Introduction

The Mordellidae Latreille, 1802 (Coleoptera: Tenebrionoidea), commonly known as tumbling flower beetles due to their irregular jumping movement, or pintail beetles on account of the special elongated posterior pygidium, include approximately 2400 extant species worldwide and only a few fossil records (Jackman and Lu 2002; Peris and Ruzzier 2013). The genus *Tomoxia* Costa, 1854 (tribe Mordellini) is represented by 52 extant species found in all zoogeographic regions except for Madagascar (Hallan 2012). *Tomoxia bucephala* Costa, 1854 is the only extant species distributed in Europe (De Jong et al. 2014).

A new *Tomoxia* species is described and identified herein, based on two Baltic amber specimens. The morphological differences and similarities between the new species and *T. bucephala* are discussed. Compared with other Mordellidae found in Baltic amber, the habitat of *Tomoxia* reflects the vegetation composition and therefore the paleoecology of the Eocene Baltic amber forest.

Material and method

The research material comprised two adult specimens in Baltic amber stored in the Laboratory-Museum of Amber Inclusions, Gdansk University, Poland. Baltic amber is amongst the largest and most significant of the world's amber deposits. It occurs primarily along the shores of the Baltic Sea in Paleogene sands dated to as early as 40 Ma ago (Ritzkowski 1997; Kosmowska-Ceranowicz 2005). The diagenetic history of Baltic amber from its origin until the present has been outlined by Gaigalas and Halas (2009) based on isotope analysis.

Photomicrographs were taken using a Leica M205 A microscope system and the Leica Application Suite (LAS

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Version 4.7) software; color filters and agave syrup were used to improve the image quality. Hand drawings and reconstruction were based on high-resolution images. CorelDRAW X7 (64 bit) and Adobe Photoshop CS4 were used for final image and text editing.

The familial/subfamilial classification employed in this paper follows that of Bouchard et al. (2005, 2011). The terminology and nomenclature follows the *Handbook of Zoology* (Beutel and Leschen 2016).

This paper has been registered in ZooBank, the ICZN official register of zoological nomenclature, with a unique digital ZooBank registration identifier (LSIDurn:lsid:zoobank.org:pub:97F1B25F-0067-456D-A024-B4A9C4B6E8ED).

All measurements given in the description below are in millimeters.

Systematic paleontology

Order **Coleoptera** Linnaeus, 1758

Suborder **Polyphaga** Emery, 1886
Superfamily **Tenebrionoidea** Latreille, 1802
Family **Mordellidae** Latreille, 1802
Tribe **Mordellini** Seidlitz, 1875

Genus ***Tomoxia*** Costa, 1854

Type species. Tomoxia bucephala Costa, 1854.

Diagnosis (emended). The diagnostic characters for the genus *Tomoxia* when compared to the other members of the tribe Mordellini are: (1) eyes finely granulated; (2) scutellum quadrilateral or irregular shaped; (3) hind tibia with a fine dorsal ridge and a lateral ridge; basal tarsomere of hindleg also with a fine dorsal ridge (Smith 1882; Liljeblad 1945; Franciscolo 1965; Jackman and Lu 2001).

Tomoxia succinea sp. nov.
Figures 1, 2

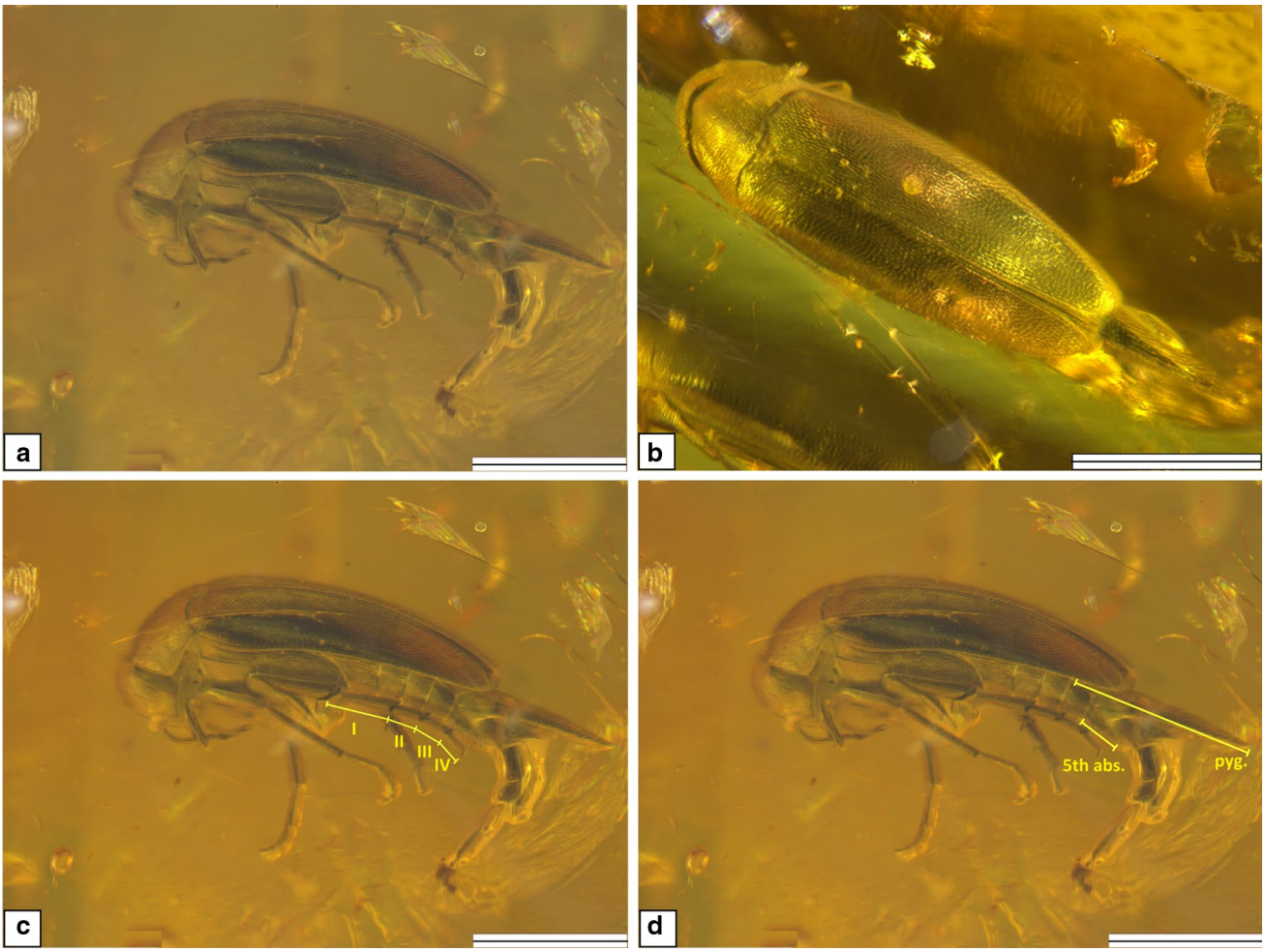

Fig. 1 Holotype of *Tomoxia succinea* sp. nov. **a** Lateral view. **b** Dorsal view. **c** I–IV: 1st to 4th hind tarsomeres; length ratio 2:1:1:1. **d** *5th abs.* the 5th abdominal sternum, *pyg*. pygidium, length ratio 1:4. Scale bar: 1 mm

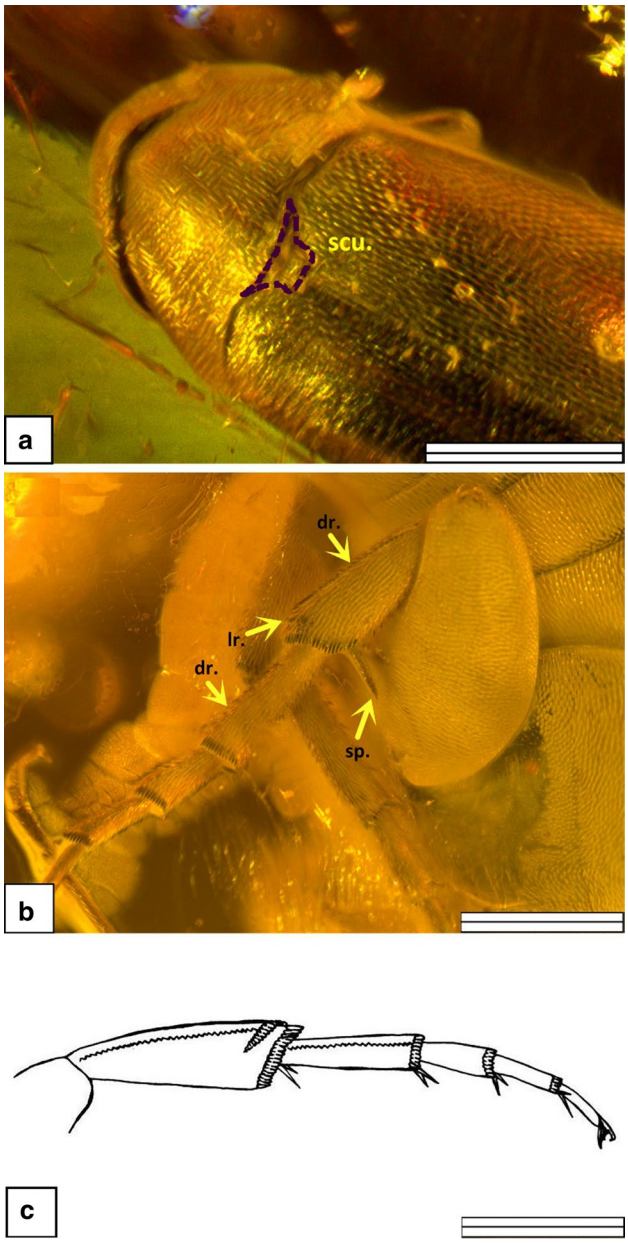

Fig. 2 Detailed morphological structures. **a** Highlighted scutellum shape (holotype). *scu.* scutellum. **b** Detailed hind leg structures (paratype). *dr.* fine dorsal ridge, *lr.* lateral ridge, *sp.* subapical spines on tibia and tarsomere. **c** Schematic drawing of hind tibia and tarsi. Scale bar: 0.5 mm

Etymology. From *succinum*, Latin for amber.

Type material. Holotype 5715 and paratype 5743 (reference ID for the collection of the Laboratory-Museum of Amber Inclusions, Gdansk University), adult specimens; sex unknown.

LSID number. LSIDurn:lsid:zoobank.org:act:0E01A684-3C9E-4C43-82CF-82180FFDC9CC.

Diagnosis (emended). The differential specific diagnosis for *Tomoxia succinea* sp. nov. is: (1) the length to width ratio of the pronotum is 1:2, slightly narrower than the elytra at base; (2) the length ratio between the last abdominal sternum and pygidium is 1:4; (3) the length ratio of the hind tarsomeres is 2:1:1:1; (4) the form of the scutellum is transitional, ranging from triangular to quadrilateral.

Description. The body of the holotype is 2.6 mm long, that of the paratype is 2.9 mm long; edge-shaped, widest at base of prothorax, much narrower posteriorly, lying in lateral view, curled up with a slightly convex abdomen.

Head rather large, almost of prothoracic width, finely punctured; eyes large, ellipsoidal, finely faceted and granulated, apparently not reaching occiput, hairy. Antennae long, filiform. Mouthpart is invisible due to preservation. Pronotum trapezoidal or quadrilateral from dorsal view, length to width ratio 1:2, slightly narrower than elytra at base. Anterior lobe moderate, not distinctly narrow, slightly protruding inwards, anterior angles not visible from above; lateral margins gradually curved from anterior to posterior angles; posterior margin sinuate, posterior lobe slightly protruding backwards. Scutellum irregular quadrilateral. Elytra elongated, cuneate; sculpture reticulate with rather obvious and fine punctures; leather luster, lateral margin rounded and smooth; posterior margin narrow and rounded, not sharp. Mesothorax and metathorax enlarged, flat, covered by fine setae. Middle tibiae as long as first three segments of same pair of legs; hind tibiae with a fine but obvious dorsal ridge and a lateral ridge close to subapical side. Basal tarsomere of hindleg also with fine dorsal ridge; last two tarsomeres of hindleg slightly longer, length ratio of four hind tarsomeres 2:1:1:1; pair of subapical spines preserved on each tarsomere. Five abdominal sterna with length ratio 3:2:2:2:4, compact and neatly connected, no appendix structure between each. Pygidium elongated and pointed; length ratio between last abdominal sternum and pygidium is 1:4.

Remarks. The holotype has an unusual leathery shiny gloss; the paratype has a natural black color pattern on the elytra. The beetle cuticle is punctured, setae are well developed on the body, dorsally and ventrally, regularly in a posterior direction. Genital structure is not clear due to the preservation. Paratype body surface covered by fine white layer, which is typical for Baltic amber inclusions due to the effect of the air during preservation.

Discussion

Worldwide, over 50 species of *Tomoxia* have been recorded. The general body plan of species in the genus *Tomoxia* does not vary significantly, which increases the difficulty

associated with taxonomic studies of members of this genus and leads to unclear descriptions and classifications. For example, after a detailed review of North American Mordellidae, only four species were retained in the genus *Tomoxia* (Jackman and Lu 2001). South African (Franciscolo 1957, 1965, 1967) and North American (Liljeblad 1945) *Tomoxia* species are mainly identified based on tiny structures such as segments of the maxillary palps. Due to preservation issues, it is often difficult to study such small structures in Baltic amber specimens, so we focused on the gross morphology. Compared with the representative North American species *Tomoxia inclusa* LeConte, 1862 and *Tomoxia lineella* LeConte, 1862, *Tomoxia succinea* sp. nov. has no surface color stripe, a scutellum with a sharper outline, and slightly longer antennae. The new species differs from the closely related genera *Tomoxioda* Ermisch, 1950 and *Paratomoxioda* Ermisch, 1954 in having a fine dorsolateral ridge on the hind tibiae, posterior angles of the pronotum that are not sharp, and an anterior pronotum that is inseparably connected with the head (Horák 2007). Compared with the only European extant species *Tomoxia bucephala*, *Tomoxia succinea* sp. nov. has a longer pygidium and hind tarsi, the body shape is more cuneate than streamlined, and the scutellum has a transitional form, ranging from triangular to quadrilateral. However, the obviously wide head, finely granulated eyes, and the similarity in the type and position of the appendix structures on the hindlegs suggest a close relationship between *T. bucephala* and *T. succinea* sp. nov.

Fossils of Mordellidae found in Baltic amber are assigned to two tribes: Mordellistenini Ermisch, 1941a, b and Mordellini Seidlitz, 1875 (Germar 1813; Ermisch 1941b; Kubisz 2003; Odnosum and Perkovsky 2010; Perkovsky and Odnosum 2013) (Table 1), with comparatively high diversity observed in fossil Mordellidae species. During this study, a total of 39 mordellid specimens in the Laboratory-Museum of Amber Inclusions, Gdansk University were examined, amongst which members of the genus *Mordellistena* Costa, 1854 are the most common. The highest species richness of extant Mordellidae occurs in the tropical zone. In the subtropical and warm temperate zones, the species richness is slightly, but not considerably, lower than that in the tropical zone (Table 2). Therefore, the warm climate of Paleocene-Eocene times in the Baltic Sea region (Askin and Spicer 1995) would not have affected the total biodiversity of Mordellidae, but it could have impacted the vegetation composition and ecology (Sadowski 2017; Euro+Med PlantBase 2011). Extant members of *Mordellistena* are widely distributed across all climatic zones (Table 2). Their larvae are generally pith borers and they have a wide range of host plants, including species of Asteraceae von Berchtold and Presl, 1820, Fabaceae Lindley, 1836, Fagaceae Dumortier, 1829, Menispermaceae Jussieu, 1789, Poaceae Barnhart, 1895, Sapindaceae Jussieu, 1789, Juglandaceae de Candolle, 1818, and Tiliaceae Jussieu, 1789 (Ford and Jackman 1996; Jackman and Lu 2002). Inclusions of Fabaceae, Fagaceae, and Poaceae are not uncommon in Baltic amber (Sadowski 2017). By comparison, the larvae of *Tomoxia bucephala* normally grow in the stems of plants belonging to the genera *Populus* Linnaeus, 1753 and *Salix* Linnaeus, 1753 (family Salicaceae) (Burakowski et al. 1987; Borowiec 1996). Related Salicaceae species are very rare in Baltic amber, with only one described: *Saliciphyllum succineum* (Sadowski 2017). The presence of only three fossil records of the chrysomelid genus *Crepidodera* in Baltic amber also

Table 1 List of fossil records of Mordellidae found in Baltic amber

Species	Depository
Falsomordellistena eocenica† (Kubisz 2003)	ISEA Krakow collection
Glipostena ponomarenkoi† (Odnosum and Perkovsky 2010)	Klesov locality SIZC K collection, (Rovno amber)
Glipostena sergeli† (Ermisch 1941a)	Hoffeins/Deutsches Entomologische Institut collection
Mordellistena amplicollis† (Ermisch 1941a, b)	Hoffeins/Deutsches Entomologische Institut collection
Mordellistena antiqua† (Ermisch 1941a, b)	Scheele collection, University of Hamburg
Mordellistena goeckei† (Ermisch 1941a, b)	Scheele collection, University of Hamburg
Mordellistena korschefskyi† (Ermisch 1941a, b)	Hoffeins/Deutsches Entomologische Institut collection
Mordellistena soror† (Ermisch 1941a, b)	Hoffeins/Deutsches Entomologische Institut collection
Mordellistena sp.	Laboratory-Museum of Amber Inclusions, Gdansk University
Mordella inclusa (Germar 1813)	Halle collection
Mordella scheelei† (Ermisch 1941a, b)	Scheele collection, University of Hamburg
Mordella sp.	Hoffeins/Deutsches Entomologische Institut collection
Mordella sp.	Laboratory-Museum of Amber Inclusions, Gdansk University
Mordellaria friedrichi† (Perkovsky and Odnosum 2013)	Schmalhausen Institute of Zoology SIZC collection
Tomoxia succinea sp. nov.†	Laboratory-Museum of Amber Inclusions, Gdansk University

†The extinct fossil taxa

Table 2 Species richness of Mordellidae in different climatic zones

Regions	Genera	Species	Dominant genera
Southeast Asia	30	183	*Gilpa, Mordella, Mordellistena*
West Africa	25	62	*Mordellina, Mordellistena*
Amazon region	19	129	*Mordella, Mordellistena*
East China	14	27	*Mordella, Mordellina*
Apennines	14	120	*Mordella, Mordellistena*
Balkans	10	77	*Mordellistena*
Central Europe	13	110	*Mordella, Mordellistena*
West Europe	15	115	*Mordella, Mordellistena*
North Europe	12	99	*Mordella, Mordellistena*
Siberia	3	3	*Mordella, Mordellistena, Stenalia*
Quebec, Canada	2	3	*Mordellistena*
British Columbia, Canada	1	1	*Mordella*

Purple tropical zone, Yellow subtropical zone, Green warm temperate zone, Grey cold temperate zone

support the scarcity of Salicaceae in the Baltic amber forest, because these beetles are oligophagous—they feed on *Salix* and *Populus* species (Bukejs et al. 2016). In the Early Cenozoic, they may have subsisted on *Saliciphyllum*, like *Tomoxia* but unlike *Mordellistina*, reflecting their relative abundance.

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