# A new genus and species of Dermestidae (Coleoptera) from the Eckfeld Maar crater (Middle Eocene, Germany)

JIŘÍ HÁVA & TORSTEN WAPPLER

*Eckfeldattagenus eocenicus* gen. et sp. nov. is described from the Middle Eocene Eckfeld Maar (Germany) on the basis of completely preserved specimens, representing one of the rare reports of fossil skin beetles (Coleoptera: Dermestidae: Attageninae). The new genus and species differs from all other Dermestidae by the very flat body form and pronotum, and its unique structure of the antennal club and the wrinkled elytral surface. • Key words: taxonomy, new genus, new species, fossil, Coleoptera, Dermestidae, Germany.

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*Jiří Háva, Department of Forest Protection and Entomology, Faculty of Forestry and Wood Sciences, Czech University of Life Sciences, Kamýcká 1176, CZ-165 21, Prague 6 – Suchdol, Czech Republic • Torsten Wappler (corresponding author), Steinmann Institut für Geologie, Mineralogie und Paläontologie, Universität Bonn, Nussallee 8, 53115 Bonn, Germany; twappler@uni-bonn.de*

Dermestidae commonly referred to as skin, larder and carpet beetles are characterized by a variety of ecological habits and a fascinating biology. Most genera are scavengers that feed on dry animal or plant material such as skin or pollen, animal hair, feathers, dead insects or natural fibers. They are even widely used to clean bones during the preparation of skeletons for osteological studies and forensic entomological. In the literature, the traces left on skeletal remains by the family Dermestidae have been documented for dinosaurs (Paik 2000, Roberts *et al.* 2007, Britt *et al*. 2008, Chin & Bishop 2008, Bader *et al*. 2009) and extinct mammals (Martin & West 1995, Kaiser 2000, Laudet & Antoine 2004, Fejfar & Kaiser 2005).

The cosmopolitan beetle family Dermestidae comprises more than 1460 described species (Háva 2003, 2013). According to a cladistic-based analysis of higher categories within the family Dermestidae (Lawrence & Slipinski 2005, Kiselyova & McHugh 2006), six subfamilies could be recognized: Dermestinae (including Marioutinae), Thoractinae, Trinodinae (including Thylodriadinae), Orphilinae, Attageninae and Megatominae; whereas only members of the Thoractinae are yet unknown from the fossil record. The geological history of the family was summarized by Háva & Prokop (2004) and Kirejtshuk *et al*. (2009), with new information appended in the present contribution (appendix). The earliest fossils assigned tentatively to Dermestidae are isolated elytra from the Triassic deposits of Queensland, described by Dunstan (1923), but the assignment of these fossils was doubted by Háva & Prokop (2004). The first definitive remains of the family have been recorded from the Lower Cretaceous Lebanese amber (Kirejtshuk *et al*. 2009). However, the majority of fossil dermestids were described from inclusions in Baltic (40–35 Ma BP) and Dominican Amber (20–17 Ma BP) – most of these are representing relatively modern groups, thereby relating more to questions of Tertiary biogeography than to higher-level branching patterns (Kiselyova & McHugh 2006).

Herein we provide the description of a new Paleogene dermestid beetle from the Middle Eocene Eckfeld Maar. This deposit has produced a broad spectrum of fossils ranging from organic molecules, micro-organisms, aquatic invertebrates, plants and insects and their varied associations, to a wide range of vertebrates including articulated mammals exhibiting soft tissue preservation and gut contents (*e.g*., Lutz *et al*. 2010). The new species belongs to the Attageninae of the Dermestidae and is placed in a new genus most probably closely related to the extant genus *Attagenus* Latreille, 1802.

## Material and methods

The Fossillagerstätte of Eckfeld is a deposit of a maar lake, which was formed during the early middle Eocene. The

basin was initially formed by volcanic explosions, resulting in deep depressions on top of diatremes that was soon occupied by a lake. Following early stages with succeeding volcanoclastic and predominantly siliciclastic sedimentation, the lake became meromictic and the finely laminated bituminous claystone ("oilshale") was formed in the quiet anoxic bottom layer of the lake. The oilshale contains biomarkers and lithified bacteria, algae, a great diversity of tracheophytes, numerous arthropods, few molluscs and a wide range of vertebrates, documenting a highly diverse terrestrial flora and fauna representing an ecosystem towards the end of the middle Eocene (*e.g.*, Neuffer *et al.* 1996; Lutz *et al.* 1998, 2010; Wilde & Frankenhäuser 1998; Lutz & Neuffer 2000; Wappler 2002, 2003a, b; Wappler & Engel 2003, 2006; Wappler & Andersen 2004; Wappler *et al.* 2004, 2005; Wappler & Heiss 2006; Wappler & Petrulevičius 2007; Petrulevičius *et al.* 2008; Dlussky *et al.* 2008, 2009). The Eckfelder Maar insect taphocoenosis contains a total of nearly 4700 fossil specimens. Most of them are in good condition with a potential for exceptional details of preservation. This fossil record documents a highly diverse terrestrial fauna and flora, while aquatic life is rather poorly represented. The insect taphocoenosis is predominantly composed of Coleoptera (84%) (*e.g.*, Lutz 1993, Wappler 2003a, b).

The crater structure at the Eckfeld Maar near Manderscheid, Eifel, Germany, originally had a diameter of 900 m and a depth of about 170 m. The depth of the maar lake initially exceeded 110 m and might have reached 150 m (Pirrung *et al.* 2001). Rapid sedimentation over a 250.000 year period combined with anoxic alkaline conditions resulted in the absence of bioturbation and explains the perfect preservation of fossils within the oil-shale laminae (Mingram 1998).

Biochronologically the biota of the Eckfeld Maar represent the late Geiseltalium of the European Land Mammal Ages (ELMA), which corresponds to the middle part of the Lutetian of the global geochronological time scale (Franzen 1993). Argon $^{40/39}$Ar dating of basalt from the diatreme breccia underlying the lake sediments resulted in an age of 44.3 ± 0.4 Ma at Eckfeld (Mertz *et al.* 2000).

The specimens examined in the present work were gathered from the collection of the Naturhistorisches Museum Mainz, Landessammlung für Naturkunde Rheinland-Pfalz (NHMM). The type specimens are equipped with red, printed labels bearing the text as follows: "HOLOTYPE (or PARATYPE, respectively), *Eckfeldattagenus eocenicus* gen. et sp. nov. J. Háva & T. Wappler det. 2013".

The specimens were studied by immersing the slab in glycerine to prevent oxidation. All metrics were made using an ocular micrometer and are given in millimetres. The nomenclature of dermestids is based on the interpretations of Lawrence & Slipinski (2005) and Háva (2007).

## Systematic palaeontology

Family Dermestidae
Subfamily Attageninae

***Eckfeldattagenus* gen. nov.**
Figure 1

*Type species.* – *Eckfeldattagenus eocenicus* sp. nov. (by monotypy).

*Diagnosis.* –
Adult female: Body length 5.5–6.3 mm. The antennae consist of the 11 antennomeres, antennal club consist of two antennomeres (Fig. 1D). Last antennal antennomere is long, oval. Pronotum is long trapezoidal, with a clear wrinkled surface structure. Elytra long, parallel, with a clear wrinkled structure.

Adult male: Externaly similar to female, but differs by the structure of antennae, with the 10$^{th}$ segment being slightly more prolonged (Fig. 1F, G).

*Remarks.* – *Eckfeldattagenus* is similar to genera belonging to the Attageninae and in particular to the genus *Attagenus* according to a Prosternum not forming a "collar", therefore, mouthparts are free, but on the other hand it differs from all other Dermestidae by the very flat body form, the outline of the pronotum, and its unique structure of the antennal club and the wrinkled elytral surface.

A key to the genera is given below:

| | | |
|---|---|---|
| 1(5) | antennomeres of antennal club compact | |
| 3(4) | antennal club consist of two antennomeres | *Eckfeldattagenus* gen. nov. |
| 4(3) | antennal club consist of three antennomeres | *Attagenus* Latreille, 1802 |
| 5(1) | antennomeres of antennal club loosely joined | |
| 6(7) | cuticle bicolorous or unicolorous with bicolorous pubescence | *Novelsis* Casey, 1900 |
| 7(6) | cuticle and pubescence unicolorous, terminal antennomere very long, arenicollis species | |
| 8(9) | profemora stout | *Araphonotos* Beal & Kadej, 2008 |
| 9(8) | profemora slender | *Sefrania* Pic, 1899 |

*Eckfeldattagenus* gen. nov. differs from the genus *Egidyella* Reitter, 1899 (tribe Egidyellini) by the five visible abdominal ventrites (in the genus *Egidyella* six ventrites are visible).

*Etymology.* – The new generic name is a combination of Eckfeld (type locality from were the specimens are found), and *Attagenus*, type genus for one of the most abundant pests in stored products. The gender is masculine.

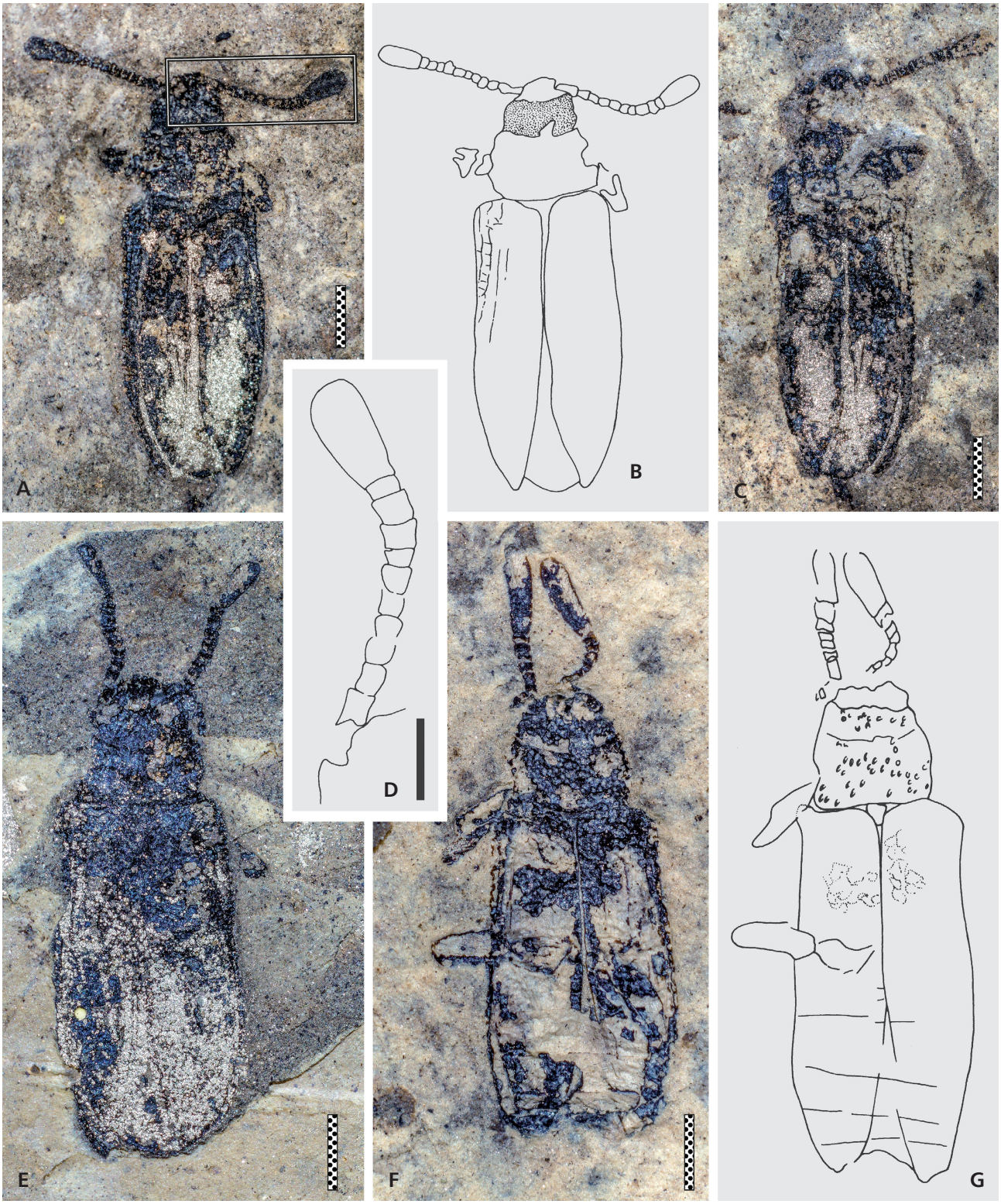


**Figure 1.** *Eckfeldattagenus eocenicus* gen. et sp. nov. • A – holotype (PE 2000/995a, LS). • B – habitus diagram of A. • C – counterpart of holotype (PE 2000/995b, LS). • D – detail of antennae in A. • E – paratype (PE 2000/996a, LS). • F – paratype (PE 2000/997a, LS), arrows indicating the presences of relatively short and thin hairs. • G – habitus diagram of F. Dotted scale bar = 1 mm; solid scale bar = 0.5 mm.

***Eckfeldattagenus eocenicus* sp. nov.**
Figure 1

2003a *Attagenus*? sp. indet. Wappler; p. 95, abb. 64, pl. 11, fig. h, i.
2003b *Attagenus*? sp. indet. Wappler; p. 95, abb. 64, pl. 11, fig. h, i.

*Type material.* – Holotype (female) (PE 2000/995 a+b). Paratype: 1 spec. (female) (PE 2000/996 a+b), 1 spec. (male) (PE 2000/997 a+b). The type material is deposited in the Naturhistorisches Museum Landessammlung für Naturkunde Rheinland-Pfalz, Mainz, Germany.

*Type locality.* – Eckfeld Maar near Manderscheid, Eifel Mountains, Germany.

*Stratigraphic occurrence.* – Middle Eocene (ELMA Geiseltalian, MP13, 44.3 ± 0.4 Ma).

*Diagnosis.* – As for the genus (*vide supra*).

*Description.* – Holotype measurements: total length 6.3 mm, pronotum length 0.9 mm, elytra length 4.1 mm, antennae length 4.2 mm, terminal antennomere length 0.7 mm. The antennae consist of the 11 antennomeres, with a two-segmented antennal club. Last antennal antennomere is long, oval, and covered with dark, relatively short and thin subrecumbent hairs. Pronotum is long trapezoidal, with a clear wrinkled surface structure. Elytra long, parallel, with a clear structure wrinkled surface.

*Etymology.* – *Eocenicus* in reference to the Eocene age of the fossil.

*Discussion.* – Because of the preservation style, compression fossils cannot be easily compared to amber fossils or extant genera and species. Nonetheless, they can be diagnosed moderately well and differentiated with reasonable certainty from other extinct and extant genera. In some aspects, *Eckfeldattagenus* resembles members of the related genus, *Attagenus* Latreille, 1802 (*vide supra*). The latter contains about 180 recent species. Only eight fossil species are known worldwide; two species from Early Oligocene deposits in Colorado (*A. aboriginalis* Wickham, 1913 and *A. sopitus* Scudder, 1900), one species from Middle Miocene deposit in Germany (*A. extinctus* Heyden & Heyden, 1865), four species from the Eocene Baltic amber (*A. hoffeinsorum* Háva, Prokop & Herrmann, 2006a, *A. obesus* Háva, Prokop & Herrmann, 2008, *A. balticus* Háva, Prokop & Herrmann, 2008 and *A. yantarnyi* Háva & Bukejs, 2012), and one species from Dominican amber (*A. ambericus* Háva & Prokop, 2004). The newly described species differs from all fossil and recent species by the presence of very flat form of the body, a unique structure of the antennal club, indicating even some sexual dimorphism expressed by the length of the 10$^{th}$ antennomer, and a more elongated, trapezoidal outline of the pronotum.

A comparison with the three described compression fossils *Attagenus aboriginalis* Wickham, 1913 [Colorado (Early Oligocene: Florissant)], *Attagenus extinctus* C. Heyden & L. Heyden, 1865 [Germany (Middle Miocene)] and *Attagenus sopitus* Scudder, 1900 [(Early Oligocene: Florissant)], reveals that *E. eocenicus* gen. et sp. nov. differs mainly by the following characters: (1) body maximum length 5.5–6.3 mm, long, parallel; (2) antennae very long, antennal club composed of two antennomeres in male and two in female (*Attagenus* antennal club consists of three antennomeres).

## Conclusions

1. Tertiary fossils of dermestid beetles are clearly more related to the extant fauna even though the two Cretaceous records represent members of extant families (comp. appendix). Interestingly, basalmost members of the Thorictinae, sister group to the remainder of Dermestidae are completely absent from the fossil record yet.

2. Although cosmopolitan in distribution, dermestid beetles species are most active during warmer climate conditions (*e.g.*, Klok & Harrison 2013, fig. 5).

3. The temperature requirements of dermestids did not conflict with the interpretations of Middle Eocene climatic conditions in the Eifel region based on the macrobotanical record. Grein *et al*. (2011) and Wappler *et al*. (2012) concluded that during middle Eocene climate at the Central European locality the mean annual temperature was in the order of above 20 °C, probably around 22 °C. The summers were rather hot with temperatures of the warmest month between 24.7 °C and 27.9 °C. It is interesting, therefore, that the majority of insect species from the Eckfeld Maar are today found in the Southern Hemisphere but are known from Cenozoic fossils in Europe and other parts of the Northern Hemisphere (*e.g.*, Wappler 2003a, p. 181ff).

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## Appendix

Geological records of Dermestidae (updated from Háva & Prokop 2004, Kirejtshuk *et al*. 2009).

| Taxon | Fossil type | Epoche | Locality | References |
|---|---|---|---|---|
| **Subfamily Dermestinae** | | | | |
| Tribe Dermestini | | | | |
| *Dermestes* Linnaeus | | | | |
| *Dermestes larvalis* Cockerell (larvae) | Inclusion | Cretaceous (Albian) | Myanmar | Cockerell (1917), Ross & York (2000), Zherikhin & Ross (2000) |
| *Dermestes pauper* Heer | Compression | Early Miocene | Radoboj | Heer (1847) |
| *Dermestes progenior* Zhantiev | Inclusion | Eocene (Lutetian) | Rovno | Zhantiev (2006), Háva (2008) |
| *Dermestes tertiarius* Wickham | Compression | Eocene–Olicocene | Florissant, CO | Wickham (1912) |
| *Dermestes vetustus* Zhantiev | Inclusion | Eocene (Lutetian) | Rovno | Zhantiev (2006), Háva (2008) |
| *Dermestes* sp. | Inclusion | Eocene (Lutetian) | Baltic | Larsson (1978) |
| *Dermestes* sp. | Inclusion | Eocene (Lutetian) | Baltic | Spahr (1981) |
| **Subfamily Attageninae** | | | | |
| Tribe Attagenini | | | | |
| *Attagenus* Latreille | | | | |
| *Attagenus aboriginalis* Wickham | Compression | Eocene–Olicocene | Florissant, CO | Wickham (1913) |
| *Attagenus ambericus* Háva & Prokop | Inclusion | Miocene (Burdigalian) | Dominican Republic | Háva & Prokop (2004) |
| *Attagenus balticus* Háva, Prokop & Herrmann | Inclusion | Eocene (Lutetian) | Baltic | Háva *et al*. (2008) |
| *Attagenus extinctus* C. Heyden & L. Heyden | Compression | Middle Miocene | Salzhausen, Germany | Heyden & Heyden (1865) |
| *Attagenus hoffeinsorum* Háva, Prokop & Herrmann | Inclusion | Eocene (Lutetian) | Baltic | Háva *et al*. (2006a, 2008) |
| *Attagenus obesus* Háva, Prokop & Herrmann | Inclusion | Eocene (Lutetian) | Baltic | Háva *et al*. (2008) |
| *Attagenus sopitus* Scudder | Compression | Eocene–Olicocene | Florissant, CO | Scudder (1900) |
| *Attagenus yantarnyi* Háva & Bukejs | Inclusion | Eocene (Lutetian) | Baltic | Háva & Bukejs (2012) |
| *Attagenus* sp. | Inclusion | Eocene (Lutetian) | Baltic | Larsson (1978) |
| *Attagenus* sp. | Inclusion | Eocene (Lutetian) | Baltic | Spahr (1981) |
| ***Eckfeldattagenus eocenicus* gen. et sp. nov.** | **Compression** | **Eocene (Lutetian)** | **Eckfelder maar** | **this study** |
| **Subfamily Megatominae** | | | | |
| Tribe Anthrenini | | | | |
| *Anthrenus* O.F. Müller | | | | |
| *Anthrenus* sp. (larvae) | Inclusion | Eocene (Lutetian) | Baltic | Larsson (1978) |
| *Anthrenus* sp. | Inclusion | Eocene (Lutetian) | Baltic | Spahr (1981) |
| *Anthrenus* (*Nanthrenus*) *ambericus* Háva, Prokop & Herrmann | Inclusion | Eocene (Lutetian) | Baltic | Háva *et al*. (2006a, 2008) |
| *Anthrenus* (*N.*) *electron* Háva, Prokop & Kadej | Inclusion | Eocene (Lutetian) | Baltic | Háva *et al*. (2006b) |
| *Anthrenus* (*N.*) *groehni* Háva, Prokop & Herrmann | Inclusion | Eocene (Lutetian) | Baltic | Háva *et al*. (2006a) |
| *Anthrenus* (*N.*) *kerneggeri* Háva, Prokop & Herrmann | Inclusion | Eocene (Lutetian) | Baltic | Háva *et al*. (2008) |
| Tribe Megatomini | | | | |
| *Amberoderma* Háva & Prokop | | | | |
| *Amberoderma beali* Háva & Prokop | Inclusion | Miocene (Burdigalian) | Dominican Republic | Háva & Prokop (2004) |
| *Cryptorhopalum* Guérin-Méneville | | | | |
| *Cryptorhopalum ambericum* Háva & Prokop | Inclusion | Miocene (Burdigalian) | Dominican Republic | Háva & Prokop (2004) |
| *Cryptorhopalum dominicanum* Háva & Prokop | Inclusion | Miocene (Burdigalian) | Dominican Republic | Háva & Prokop (2004) |
| *Cryptorhopalum electron* Beal | Inclusion | Miocene (Burdigalian) | Mexico, Dominican Republic | Beal (1972), Háva & Prokop (2004) |
| *Cryptorhopalum jantaricum* Háva & Prokop | Inclusion | Miocene (Burdigalian) | Dominican Republic | Háva & Prokop (2004) |
| *Globicornis* Latreille | | | | |
| *Globicornis ambericus* Háva, Prokop & Herrmann | Inclusion | Eocene (Lutetian) | Baltic | Háva *et al*. (2006a, b) |

| Taxon | Fossil type | Epoche | Locality | References |
|---|---|---|---|---|
| *Globicornis rakovici* Háva | Inclusion | Eocene (Lutetian) | Baltic | Háva (2008) |
| *Globicornis* sp. | Inclusion | Eocene (Lutetian) | Baltic | Larsson (1978) |
| *Globicornis* sp. | Inclusion | Eocene (Lutetian) | Baltic | Spahr (1981) |
| *Megatoma* Herbst | | | | |
| *Megatoma electra* Zhantiev | Inclusion | Eocene (Lutetian) | Baltic | Zhantiev (2006), Háva (2008) |
| *Megatoma* sp. | Inclusion | Eocene (Lutetian) | Baltic | Hieke & Pietrzeniuk (1984) |
| *Miocryptorhopalum* Pierce | | | | |
| *Miocryptorhopalum kirkbyae* Pierce (larvae) | Compression | Miocene | Calico Mts, CA | Pierce (1960) |
| *Orphinus* Motschulsky | | | | |
| *Orphinus* sp. | Inclusion | Eocene (Lutetian) | Baltic | Larsson (1978) |
| *Orphinus* sp. | Inclusion | Eocene (Lutetian) | Baltic | Spahr (1981) |
| *Phradonoma* Jacquelin du Val | | | | |
| *Phradonoma ambericum* Háva, Prokop & Herrmann | Inclusion | Eocene (Lutetian) | Baltic | Háva *et al*. (2008) |
| *Trogoderma* Dejean | | | | |
| *Trogoderma larvalis* Háva, Prokop & Herrmann | Inclusion | Eocene (Lutetian) | Baltic | Hava *et al*. (2006a) |
| *Trogoderma* sp. | Inclusion | Eocene (Lutetian) | Baltic | Hieke & Pietrzeniuk (1984) |
| **Subfamily Orphilinae** | | | | |
| Tribe Orphilini | | | | |
| *Orphilus* Erichson | | | | |
| *Orphilus dubius* Wickham | Compression | Eocene–Olicocene | Florissant, CO | Wickham (1912) |
| **Subfamily Trinodinae** | | | | |
| Tribe Trinodini | | | | |
| *Evorinea* Beal | | | | |
| *Evorinea amberica* Háva, Prokop & Herrmann | Inclusion | Eocene (Lutetian) | Baltic | Háva *et al*. (2008) |
| *Oisenodes* Kirejtshuk, Háva & Nel | | | | |
| *Oisenodes azari* Kirejtshuk, Háva & Nel | Inclusion | Lowermost Eocene | Chevrière, France | Kirejtshuk *et al*. (2010) |
| *Oisenodes clavatus* Kirejtshuk, Háva & Nel | Inclusion | Lowermost Eocene | Chevrière, France | Kirejtshuk *et al*. (2010) |
| *Oisenodes gallicus* Kirejtshuk, Háva & Nel | Inclusion | Lowermost Eocene | Chevrière, France | Kirejtshuk *et al*. (2010) |
| *Oisenodes metepisternalis* Kirejtshuk, Háva & Nel | Inclusion | Lowermost Eocene | Chevrière, France | Kirejtshuk *et al*. (2010) |
| *Oisenodes oisensis* Kirejtshuk, Háva & Nel | Inclusion | Lowermost Eocene | Chevrière, France | Kirejtshuk *et al*. (2010) |
| *Oisenodes transversus* Kirejtshuk, Háva & Nel | Inclusion | Lowermost Eocene | Chevrière, France | Kirejtshuk *et al*. (2010) |
| *Trinodes* Dejean | | | | |
| *Trinodes puetzi* Háva & Prokop | Inclusion | Eocene (Lutetian) | Baltic | Háva & Prokop (2006), Háva *et al*. (2006a) |
| *Trinodes* sp. | Inclusion | Eocene (Lutetian) | Baltic | Larsson (1978) |
| *Trinodes* sp. | Inclusion | Eocene (Lutetian) | Baltic | Spahr (1981) |
| Tribe Cretonodini | | | | |
| *Cretonodes* Kirejtshuk & Azar | | | | |
| *Cretonodes antounazari* Kirejtshuk & Azar | Inclusion | Aptian | Lebanon | Kirejtshuk *et al*. (2009) |
| GENERA INCERTAE SEDIS | | | | |
| *Reeveana* Dunstan | | | | |
| *Reeveana intermedia* Dunstan | Compression | Late Triassic | Queensland, Australia | Dunstan (1923) |
| *Reeveana major* Dunstan | Compression | Late Triassic | Queensland, Australia | Dunstan (1923) |
| *Reeveana minor* Dunstan | Compression | Late Triassic | Queensland, Australia | Dunstan (1923) |
| *Tryoniopsis* Dunstan | | | | |
| *Tryoniopsis granulata* Dunstan | Compression | Late Triassic | Queensland, Australia | Dunstan (1923) |
| *Tryoniopsis punctata* Dunstan | Compression | Late Triassic | Queensland, Australia | Dunstan (1923) |