**A NEW APTEROUS *ZOROTYPUS* IN MIOCENE AMBER FROM THE DOMINICAN REPUBLIC (ZORAPTERA: ZOROTYPIDAE)**

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**Abstract** – The remains of a new species of zorapteran (Polyneoptera: Anartioptera: Mystroptera: Zoraptera) are described and figured from a female preserved in Early Miocene (Burdigalian) amber from the Dominican Republic. *Zorotypus* (*Zorotypus*) *mnemosyne* Engel sp. n. is represented by a female of the apterous, blind morph (“apteron”) and can be readily distinguished from the only other Miocene zorapterans, *Z. goeleti* Engel & Grimaldi (winged morph) and *Z. palaeus* Poinar (apterous morph) in the terminal abdominal structure, the shape of the cerci, and the spination of the metafemora. Notes on the status of the recently described Jordanian amber (contemporaneous with Lebanese amber) zorapteran are provided and the genus *Paleospinosus* is synonymized with *Octozoros* Engel (new synonymy) resulting in the new combination *Z. huda* (Kaddumi). In addition, the name “*Z. confirmans* Scheven” is considered a *nomen nudum et invalidum*. However, the taxon is distinct from other Dominican amber species and is therefore validated as *Z. absonus* Engel sp. n. and distinguished from other fossil zorapterans.

**KEY WORDS:** Zoraptera, Mystroptera, Anartioptera, Dominican Republic, West Indies, *Zorotypus*, new species, palaeontology, Tertiary, taxonomy.

**Izvilleček – NOV NEKRILAT *ZOROTYPUS* V MIOCENSKEM JANTARJU IZ DOMINIKANSKE REPUBLIKE (ZORAPTERA: ZOROTYPIDAE)**

Opisani in prikazani so ostanki samice nove vrste zorapterjev (Polyneoptera: Anartioptera: Mystroptera: Zoraptera), ohranjeni v zgodnjemiocenskem (burdigalij-skem) jantarju iz Dominikanske republike. Vrsta *Zorotypus* (*Zorotypus*) *mnemosyne* Engel sp. n. je predstavljena s samico nekrlate, slepe oblike (“apteron”) in jo lahko ločimo od edinih preostalih miocenskih zorapterjev, *Z. goeleti* Engel in Grimaldi

(krilata oblika) in *Z. palaeus* Poinar (nekrilata oblika), po končnih zadkovih strukturah, obliki cerkov in bodicah na zadnjih stegnih. Podano je tudi mnenje o statusu pred kratkim opisanega zorapterja iz jordanskega jantarja (sočasen z libanonskim jantarjem), rod *Paleospinosus* pa je sinonimiziran s podrodom *Octozoros* Engel (nov sinonim). Posledica je nova kombinacija *Z. hudaе* (Kaddumi). Poleg tega je ime “*Z. confirmans* Scheven” smatrano kot *nomen nudum et invalidum*. Vendar je takson drugačen od drugih vrst iz dominikanskega jantarja in je poimenovan *Z. absonus* Engel sp. n. ter razlikovan od drugih fosilnih zorapterjev.

KLJUČNE BESEDE: Zoraptera, Mystroptera, Anartioptera, Dominikanska republika, Antili, *Zorotypus*, nova vrsta, paleontologija, terciar, taksonomija.

## Introduction

Zorapterans are minute, principally tropical insects of the Polyneoptera allied to the webspinners (order Embiodea; = Embioptera, Embiidina *auctorum*) (Engel & Grimaldi, 2000; Grimaldi & Engel, 2005). The order is one of the least understood of higher insect lineages and, indeed, even many seasoned entomologists are unfamiliar with or have never seen zorapterans. While this has been often attributed to low levels of abundance and high endemism of most species, this is not actually the case with several species (and perhaps even the majority of species) occupying distributions much wider than believed (*e.g.*, Engel, 2000, 2001, 2007a; Hinojosa-Díaz *et al.*, 2006) and in relatively decent numbers. In fact, zorapterans, which are minute and somewhat cryptic in their subcortical habitat, are perhaps more often simply overlooked during the typical collecting efforts of most field biologists.

Zorapteran biology is fascinating and challenging, albeit little understood. All species of the order exhibit two distinctive morphological forms. These morphs are sometimes incorrectly termed “castes” like the morphologically and ethologically distinctive individuals in colonies of eusocial Isoptera, Thysanoptera, and Hymenoptera. However, zorapteran morphs are not castes in the same sense of eusocial animals in that, while gregarious, species are not truly social and these different forms are produced at different stages during the natural ontogeny of a colony. During the normal life of a colony apterous, blind individuals<sup>1</sup> predominate in the subcortical realm that forms zorapteran habitat. As resources become depleted, or as crowding occurs during population growth dispersive individuals are produced in the form of alates, complete with well developed compound eyes and ocelli. These winged individuals mate and then disperse to locate decomposing wood in which to form new colonies. Once locating a suitable location to found a new colony the alates shed their wings (*i.e.*, they become deálate) and apterous, blind individuals are again produced. This is a fascinating aspect of zorapteran biology and one worthy of more intense investigation. It is simultaneously a challenge to zorapteran taxonomy and

<sup>1</sup> These forms could be called apterogynes in contrast to the alate form. However, this term is typically applied only to reproductive females in eusocial insects and is less than ideal for wingless, reproductive males and females in a non-eusocial lineage. Accordingly the new term “*apteron*” is here used for the blind, wingless morph.

systematics as not all species are known from both sexes and both morphs (*e.g.*, *vide* Rafael & Engel, 2006). The presence of dual morphs is truly ancient within Zoraptera, with both alates and apterous individuals documented from as long ago as the middle Cretaceous (Engel & Grimaldi, 2002), and both forms are found in Tertiary amber (Engel & Grimaldi, 2000).

Herein I provide the description of a fourth species of zorapteran in New World Tertiary amber along with taxonomic notes on two other fossil species. The new species is represented by a female apteron and is distinguished from the other Miocene species of *Zorotypus* (*Z. palaeus* Poinar, *Z. goeleti* Engel & Grimaldi, and *Z. absonus* Engel). The biology and geological history of the family is summarized by Engel (2003a, 2004, 2007b) and Grimaldi & Engel (2005), with new information appended in the Discussion of the present contribution. Morphological terminology for the description follows that of Engel & Grimaldi (2000, 2002) and Rafael & Engel (2006). The age and origin of Dominican amber is briefly overviewed by Grimaldi & Engel (2005).

## Taxonomy

Genus *Zorotypus* Silvestri

Subgenus *Zorotypus* Silvestri

*Zorotypus (Zorotypus) mnemosyne* sp. n.

(Figs. 1–3)

**Holotypus:** ♀ apteron (Figs. 1–2); DR-10-1501; Early Miocene (Burdigalian) amber, Dominican Republic (specific mine unknown); deposited in the Amber Fossil Collection, Division of Invertebrate Zoology, American Museum of Natural History, New York, USA.

**Diagnosis:** The new species can be distinguished from other Dominican amber zorapterans by the following combination of attributes: pedicel as long as first flagellar article; pronotum slightly narrower than head, without crescentic ridges anteriorly, lateral borders slightly converging anteriorly; ventral metafemoral series of spines on posterior border forming an interrupted series, with proximal spine longest, positioned just before metafemoral midlength, remaining spines of equal length, shorter than proximal spine, arranged in uniform series from immediately beyond metafemoral midlength to apex (Fig. 3), all spines stout, broad at base and with tapered, toothlike apices; and monomerous, ovoid cerci, with acutely tapered apices bearing four stout elongate subapical setae and a single stout elongate apical seta.

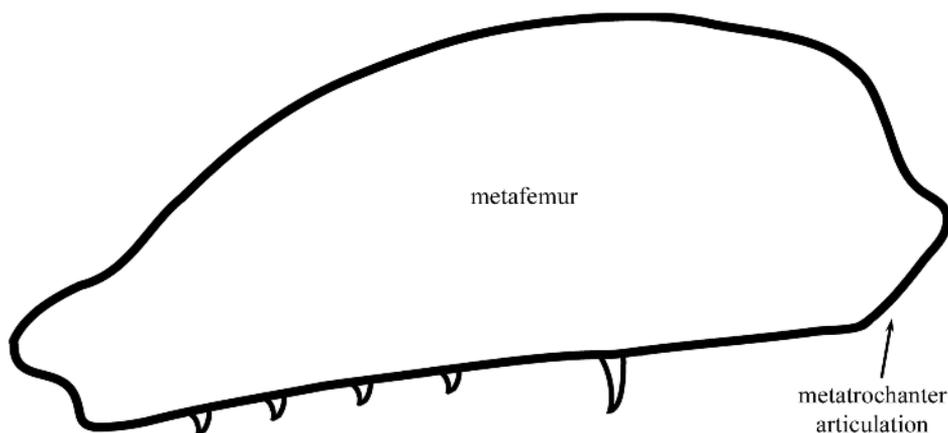
**Description:** ♀ (apteron): Total body length 2.27 mm (excluding antennae); integument imbricate and reddish brown (Figs. 1–2). Head subtriangular, without compound eyes, ocelli, or fontanelle. Antenna with nine articles (left antenna broken at apex and with only eight complete articles); pedicel as long as first flagellar arti-



**Figs. 1–2:** Photomicrographs of holotype female of *Zorotypus (Zorotypus) mnemosyne* sp. n. (AMNH DR-10-1501) in Early Miocene (Burdigalian) amber from the Dominican Republic; 1) Oblique, ventral-lateral aspect; 2) Dorsal aspect.

cle. Pronotum slightly narrower than head, without crescentic ridges anteriorly, lateral borders slightly converging anteriorly, medial length apparently subequal to posterior width, lateral borders with stiff, elongate erect to suberect setae, disc with a few scattered erect, stiff, elongate setae; mesonotum slightly wider than long, distinctly shorter than pronotum, with scattered, stiff, elongate, posteriorly-directed setae, such setae intermingled with a few shorter, stiff, erect or suberect setae; metanotum wider than long, shorter than mesonotum, setation as described for mesonotum. Legs with sparse, scattered, short, fine setae; procoxa with two stiff, stout, elongate setae on mediolateral margin; metafemur swollen, ventral surface with spines along posterior (inner) border, without spines or setae on anterior (outer) border; posterior metafemoral series of spines forming a discontinuous series (Fig. 3), with proximal spine longest, positioned just before metafemoral midlength, remaining spines of equal length, shorter than proximal spine, arranged in uniform series from immediately beyond metafemoral midlength to apex (Fig. 3), all spines stout, broad at base, with tapered toothlike apices. Apical margins of abdominal terga with a few, stiff, stout, erect or posteriorly-directed setae, those erect setae in paramedian areas, those laterally slightly longer; cercus monomerous, ovoid, with acutely tapered apex bearing four stout elongate subapical setae and a single stout elongate apical seta.

♂ and alates unknown.



**Fig. 3:** Metafemur of *Zorotypus (Zorotypus) mnemosyne* sp. n. (AMNH DR-10-1501) in Early Miocene (Burdigalian) amber from the Dominican Republic.

**Derivatio nominis:** The specific epithet is a noun in apposition and is the name of Mnemosyne, Greek goddess of memory and mother of the muses.

**Comments:** The new species can be distinguished from the only other apterous zorapteran in Dominican amber, *Z. palaeus*, by the absence of a subapical spine on the anterior (outer) ventral margin of the metafemur, the absence of stiff long setae on the anterior and posterior ventral margins of the metafemur, the larger number of spines in the apical series, and the proximal spine being distinctly larger than the apical series of spines, and the anteriorly-converging lateral borders of the pronotum. *Zorotypus mnemosyne* can be separated from *Z. goeleti* by the monomerous cerci (dimerous in the latter species), the broader pronotum that is slightly narrower anteriorly than posteriorly (distinctly narrower than the head and slightly converging posteriorly in the latter species), and the more numerous stubby, toothlike spines (spines long, thin, and setalike in the latter species). Lastly, *Z. mnemosyne* can be segregated from *Z. absonus* (vide infra) by the discontinuous metafemoral series (uniform series in *Z. absonus*), the large proximal metafemoral spine (second spine is largest in *Z. absonus*), narrower pronotum that narrows slightly anteriorly (about as wide as head and quadrate in *Z. absonus*), and the shorter first flagellar article that is as long as the pedicel (first flagellar article longer than pedicel in the latter species, in this feature *Z. absonus* is somewhat intermediate between the other Dominican amber fossil species and many modern species such as *Z. juninensis* Engel).

***Zorotypus (Zorotypus) absonus* sp. n.**

*Zorotypus (Zorotypus) confirmans* Scheven, 1990: 214, figs. 22–23, *nomen nudum et invalidum*. Scheven, 2004: 119.

**Holotypus:** Same specimen discussed and figured by Scheven (1990); Early Miocene (Burdigalian) amber, Dominican Republic (specific mine unknown) in the Lebendige Vorwelt of Joachim Scheven.

**Diagnosis:** This species can be distinguished from other Dominican amber fossil species by the following combination of traits: first flagellar article slightly longer than pedicel; broad, quadrate pronotum (about as wide as the head) lacking crescentic ridges anteriorly; short forewing R, terminating just beyond wing midlength; hind wing stem of M present near wing base; metafemur with six ventral spines arranged in a continuous series, second spine from base longest; and monomerous cerci.

**Derivatio nominis:** The specific epithet is taken from the Latin *absonus*, meaning “different”, and is a reference to the distinct difference between this species and other living and fossil zorapterans.

**Comments:** The name *Z. confirmans* cannot be considered available or valid for two reasons. Firstly, Scheven (1990) provided no description of the species (*i.e.*, “be accompanied by a description or definition *that states in words characters that are purported to differentiate the taxon*”: ICZN, 1999: Art. 13.1.1, emphasis my own). Contrary to the ICZN (1999) criterion for “description” or “definition” Scheven (1990: 214) states only, “it is perfectly indistinguishable from several now living species of *Zorotypus*. In allusion to this fact, the name *Zorotypus confirmans* n.sp. is given because the fossil confirms the contention of this paper that all living things make their first appearance in the geological record as separate and finished organisms.” As such, the author provides no characters that are purported to differentiate the taxon and instead contends that no such features exist for this species. As such the name proposed by Scheven (*op. cit.*) is a *nomen nudum*. Given that such characters do exist as evidenced by Scheven’s own figures the species is newly validated herein (*vide supra*). Secondly, the name *Z. confirmans* was established in the proceedings of a meeting held in the Summer of 1990. The proceedings were subsequently distributed to conference attendees and summarized the series of lectures given during the event. Under ICZN (1999) Article 9.9 such conference proceedings are not considered valid and nomenclatural acts appearing therein are not available in zoological nomenclature. Accordingly, the name established by Scheven (*op. cit.*) is also a *nomen invalidum*.

Scheven (1990) argued that this species was a demonstration of stasis in the geological record as evidenced by his contention that no difference between the fossil and any other species existed. I must respectfully disagree with his conclusions. Firstly, the Dominican amber fauna is exceedingly young in age (merely Early Miocene) and largely modern in composition. Most insect lineages, even genera, are of great antiquity and so one would not necessarily expect to find “intermediate” forms in such a young deposit. Indeed, the fossil record abounds with stem-group lineages, many of which are preserved in amber (*e.g.*, Arillo & Engel, 2006; Engel & Grimaldi, 2005; Grimaldi & Engel, 2005), but most of greater age than Dominican

amber, including examples for the order Zoraptera (Engel & Grimaldi, 2002). A deposit as young as Dominican amber would be expected to show some morphological “stasis” in contrast to the older (Cretaceous) amber deposits in which examples of transitional forms are far more numerous. Nonetheless, the Dominican amber fauna does have a few species with notable plesiomorphies relative to their modern counterparts, and an example of this comes from the Zoraptera – *Z. goeleti*, unlike modern zorapterans, has dimerous cerci (Engel & Grimaldi, 2000). The utility of young ambers such as those from the Dominican Republic and southern Mexico rests not in their ability to capture forms so ancient that they link major lineages of insects (e.g., links between families or orders, which are much more ancient) but instead in the changing distribution of relatively modern lineages. These deposits demonstrate significant geographic extinctions of modern lineages that are today not found in those areas but did occur there as recently as the Early Miocene. Such examples include, augochlorine bees of the genus *Neocorynura* (Engel, 1995), orchid bees (Engel, 1999), stingless bees (Camargo *et al.*, 2000), dustywings of the genus *Spiloconis* (Engel & Grimaldi, 2007), mastotermitid termites (Krishna & Emerson, 1983; Krishna & Grimaldi, 1991), cuckoo wasps of the genus *Ceratochrysis* (Engel, 2006), orussid wood wasps (Engel, 2008), ants of the genus *Leptomymex* (Baroni Urbani and Wilson, 1987), wood gnats of the genus *Valeseguya* (Grimaldi, 1991), along with many more. Lastly, as highlighted by the diagnosis (*vide supra*) and the comparative comments (*vide infra*) provided herein the species established here as *Z. absonus* does exhibit specific differences.

*Zorotypus absonus* differs from *Z. goeleti* by the monomerous cerci; broad pronotum (about as wide as the head); absence of crescentic ridges anteriorly on the pronotum; short forewing R, terminating just beyond wing midlength; hind wing stem of M present near wing base; and metafemur with six ventral spines, the second from the base longest, and with the metafemoral spines arranged in a uniformly-spaced series (*vide* figures of Scheven, 1990). *Zorotypus palaeus* and *Z. absonus* both have a uniformly-arranged metafemoral series of spines but the number is greater and the second spine is distinctly longer than the others in the latter species. Differences from *Z. mnemosyne* are provided under the Comments section for that species (*vide supra*).

#### Subgenus *Octozoros* Engel

*Zorotypus (Octozoros)* Engel, 2003b: 148. Species typicum: *Zorotypus nascimbenei* Engel & Grimaldi, 2002, by original designation.

*Paleospinosus* Kaddumi, 2005: 171. Species typicum: *Paleospinosus huda* Kaddumi, 2005, by monotypy. **Syn. n.**

**Comments:** The specimen of a zorapteran is interesting and significant but clearly does not represent a new genus. A cursory examination of the literature would have easily revealed it to be a species of *Zorotypus*, subgenus *Octozoros*. The venation is not as reduced as indicated by Kaddumi’s (2005) table or line drawing as a typical zorapteran venation can be seen in his color photograph of the specimen (his

figs. 165–166). Zorapteran venation is represented only by lightly infusate lines (the veins are not tubular) and while the author indicates jugate setae (*vide* Engel & Grimaldi, 2002) to be present they are, in fact, clearly absent, with some of the typical marginal setae apparently having been misinterpreted for the more distinctly-hooked structures found in other fossil zorapterans. While Kaddumi's systematic work on the zorapteran is faulty, his discovery is nonetheless significant and can be congratulated. Accordingly, the genus *Paleospinosus* is a junior synonym of *Zorotypus* (*Octozoros*), resulting in the following new combination:

*Zorotypus* (*Octozoros*) *hudae* (Kaddumi), comb. n.

*Paleospinosus hudae* Kaddumi, 2005: 171.

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