

A third new genus and species of spider beetle, *Okamninus annae* n. gen., n. sp. (Coleoptera: Ptinidae), from Dominican amber

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Abstract

A new genus, *Okamninus* MYNHARDT & PHILIPS, n. gen. (Coleoptera: Ptinidae), and its type species, *Okamninus annae* MYNHARDT & PHILIPS, n. sp. is described from Dominican amber. This new genus can be distinguished from all other spider beetles by a conspicuous bilobed protrusion on the pronotum. Based on overall habitus and unique combination of characters, it can be most closely aligned with the extant spider beetle genus *Ptinus* LINNAEUS, although its small body size and nine-segmented antennae are similar to that of the extant genus *Ptinus* GORHAM, as well as some spider beetles that are associated with ants. We discuss morphological affinities of *Okamninus* with two other known Dominican amber species, including *Electrognostus intermedius* PHILIPS & MYNHARDT and *Oviedinus hispaniolensis* BELLÉS, as well as with extant spider beetles.

Keywords: Dominican amber, Ptinidae, spider beetle, myrmecophily.

1. Introduction

Spider beetles are a diverse group of insects and, although occupying a wide range of habitats worldwide, they are predominantly distributed throughout the drier temperate and subtropical regions of the world (HOWE 1959; PHILIPS & BELL 2010). Approximately 70 described genera and close to 700 species of spider beetles are known.

The majority of spider beetles can be recognized by their spider-like morphology, with heads deflexed downwards and hidden under the pronotum, hence the latter appears similar to the prosoma of spiders, as well as relatively long legs, and antennae that resemble a fourth pair of legs. Based on morphology, the group can be distinguished from closely related anobiine beetles by the presence of closely-inserted antennal bases and the absence of a lateral pronotal margin.

The biology of the group is diverse. They can be collected in various substrates, including stored food products and herbaria (HINTON 1941; VERDCOURT 1993), dung (HOWE 1959; WEBSTER & WHITTAKER 2005), the nests of birds (HOWE 1959; CUTLER & HOSIE 1966), rodents (HICKS 1959), and social insects such as bees (LINSLEY & McSWAIN 1942; MAJKA et al. 2007) and ants (for reviews, see LAWRENCE & REICHARDT 1966, 1969). Spider beetles are presumed to subsist largely as scavengers. Those that are known biologically typically feed on a variety of detritus or accumulated organic material (HOWE 1959; PHILIPS & BELL 2010).

While the morphology of spider beetles varies greatly among taxa, they are generally small, measuring between 1–4 mm, and body forms most often fit into one of two major superficial categories that include the elongate bod-

ied “bostrichoid-“ like species (CROWSON 1967; PHILIPS 2000), and the remarkably different and often hairless, globoid-shaped species. In addition to more typical spider beetles, eight genera are closely associated with various species of ants. These myrmecophilous taxa are distinct morphologically, bearing highly modified structures, such as the presence of trichomes (patches of setae presumed to be associated with exocrine glands) on the pronotum, elytra, or legs; reduced or enlarged antennae; and, modified mouthparts that are often reduced in size (LAWRENCE & REICHARDT 1969; PHILIPS 1998). Considering the morphological variability of spider beetles, it is not surprising that spider beetle taxonomy has been in flux for the last ~100 years.

As a group, the spider beetles have undergone continuous taxonomic revision, and the phylogenetic relationships within the superfamily Bostrichoidea remain unsettled. However, the beetles referred to commonly as “spider beetles” have comprised a generally well-supported monophyletic group, based on morphological (PHILIPS 2000; MYNHARDT unpublished) and molecular (HUNT et al. 2007; BELL & PHILIPS 2012) data. Historically, the group has been recognized as a unique family (the Ptinidae; e.g., BELLES 1984; DOWNIE & ARNETT 1996) or a subfamily within the family Anobiidae (e.g., CROWSON 1981; LAWRENCE & NEWTON 1995). Herein we will follow the classifications in the recent catalogues of BOROWSKI & ZAHRADNÍC (2007) and BOUCHARD et al. (2011) and consider the spider beetles as a subfamily, the Ptininae, within the family Ptinidae LATREILLE. One should be aware that the relationships among the three main groups of the Bostrichoidea (i.e., the bostrichids, anobiids, and ptinids), each of which form mono-

phylogenetic lineages in some phylogenies, are still somewhat equivocal (see BELL & PHILIPS 2012).

In addition to extant spider beetles, several presumably extinct spider beetles have been described (for a summary see BELLÉS & VITALI 2007). The first formal descriptions of fossil spider beetles include a new species in the diverse genus *Ptinus* LINNAEUS, and the new genus and species *Sucinoptinus sucini* BELLES & VITALI (BELLÉS & VITALI 2007), although various papers have described potential spider beetle taxa from numerous deposits (HEYDEN 1859; HEYDEN & HEYDEN 1866; HAUPT 1956; MADDY et al. 1994; FIELD et al. 2000). Based on a recent paper redescribing several hydrophilid fossil beetles from some of the same deposits, it is likely that specimens originally described as ptinids may have been done so erroneously (FIKÁČEK et al. 2010).

Two new fossil spider beetle genera have recently been described from Dominican amber, and provide potentially useful characteristics in terms of spider beetle systematics and phylogeny. *Electrognostus* PHILIPS & MYNHARDT represents a potential transitional species between the extant genera *Ptinus* and the ant associate *Gnostus* WESTWOOD; or, alternatively, it represents one of the oldest representatives of myrmecophilous spider beetles known (PHILIPS & MYNHARDT 2011). In addition, the new genus *Oviedinus* BELLÉS was described from Dominican amber and includes seven extant species (BELLÉS 2010). The present paper describes a third genus, *Okamninus* n. gen., with its single representative species, *O. annae* n. sp., making it the third taxon described from Dominican amber. We also hypothesize the potential phylogenetic placement of the new genus within the Ptininae.

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2. Material and methods

The holotype originated from Dominican Republican amber from La Toca Mines. The mine is located north of the city of Santiago de los Caballeros, in the Cordillera Septentrional. The new species described herein is estimated to be between 15–10 million years old, reigning from the Early Miocene to Middle Miocene periods (ITURRALDE-VINENT & MACPHEE 1996).

The specimen was ground down and polished with diamond film to flatten surfaces and to prevent distortion of specimen images that occurs in rounded pieces of amber in the procedure as follows:

A preliminary flat surface was created by cutting with a jeweler's saw and/or abrading with sandpaper. With a flat surface at the desired orientation, the amber was mounted on a lapping tool with mounting wax (MWH135-T wax) by setting the mount on a slide warmer set at 60 °C to soften the wax. Based on our procedure, Dominican Republican amber can withstand 60 °C temperatures and wiping with acetone without any visible damage.

Once mounted on a lapping tool, a second, rough flat surface was created with sandpaper. The amber-mount was screwed onto a tripod polisher, and polished by hand on 400 and 600 grit SiC sandpaper to create a flat surface the desired distance from the insect. To reduce wear on the tripod polisher's feet, we placed strips of teflon tape on the sandpaper so that the polisher's feet slid on the tape while the amber was abraded. It was very easy to create flat but extremely scratched surfaces with the sandpaper.

Removal of scratches from this rough surface was done with diamond films using the Model 920 polishing machine and diamond films. A glass plate (PN 0705-012) was attached to the lapping plate of the polishing machine with electrical tape. As some amber pieces can have areas of uneven hardness, the films seemed to be better than polishing cloths at cutting evenly into such samples. Additionally, diamond films lasted longer than aluminum oxide films.

The diamond film was attached to the glass as follows. Water was puddled onto the glass, and a dry disk of diamond film was lowered onto it so that there were no bubbles. A clean sheet of plastic (usually the package the film came in) was placed over the film and a 3-inch wide brayer (ink roller) was used to force out extra water from beneath the diamond film.

The tripod polisher feet were set so that the amber stuck out from the feet roughly twice the diameter of the grit of the film. Thus for the 30 µm diamond grit film, the amber stuck out 60 µm.

A deionized water flow was started onto the film. The tripod polisher was set on the film and held beside a wet synthetic sponge. The polishing machine was then started with a very slow rotation speed (roughly 20–30 rpm). Hand pressure was adjusted so that polishing was smooth and without chattering. Since the amber is so soft, the polishing progress was checked every 30–60 seconds, and the sample was rinsed with deionized water, wiped dry using a clean 100 % cotton cloth and inspected by eye or with a stereo microscope.

We used 30, 9, 3, 1 and 0.5 µm diamond films. The 30 µm diamond film creates a beautifully flat but totally scratched surface. The smaller diamond grit films progressively removed the scratches. The diamond films were kept clean with water continuously flowing onto the film and by using a sponge to continuously wipe the film to remove any particles. Note that just a single particle of contaminating grit can create a bad scratch on the amber.

A final polish was made by hand with just a few passes over Multitex polishing cloth (PN PMT08 A) in a small puddle of Type SBT colloidal silica. The amber piece was then removed and remounted to polish the other side. If the amber is clear and optically uniform, it is best to leave 5–6 mm of amber above and below the insect. By doing this, any scratches on the surface will be out of focus in pictures. If the amber is not clear, the final surface must be closer to the insect but must have correspondingly fewer scratches.

Images of specimens (Fig. 1) were taken using a JVC KY-F75 U camera and Diagnostic Instruments T45 C coupler attached to a Leica MZ16 microscope on an axial carrier with a 2 x apochromatic objective. Darkfield illumination was provided by a Diagnostic Instruments Brightfield/Darkfield base. The images shown are montages created from thru-focal series of images by Automontage software from Syncroscopy.com.

3. Systematic palaeontology

Order Coleoptera

Family Ptinidae

Subfamily Ptininae

Genus *Okamninus* MYNHARDT & PHILIPS nov.

Type species: *Okamninus annae* MYNHARDT & PHILIPS n. sp.

Etymology: The generic name is derived from the word “Okamninus” (Slovenian for “fossil”).

Diagnosis: The genus can be distinguished from other spider beetle genera by the unique parallel-sided pronotum from the base to approximately the apical ¼ with a bilobed anterior extension at middle that extends beyond the eyes when viewed from above. This genus also has only nine, compared to the typical 11 antennomeres, although this characteristic is not unique among spider beetles. The same antennomere count is also found in another similar Dominican amber fossil taxon, *Electrognostus* PHILIPS & MYNHARDT, in the extant and likely distantly related New World genus *Pitnus* GORHAM, and also in some species of the Australian myrmecophile, *Polyplocotes* WESTWOOD (see BELL & PHILIPS 2009).

Generic description: Size small, ~1.65 mm in length. Body elongate, roughly parallel-sided, very slightly convex, covered with sparse, long setae; integument surface shiny, only slightly obscured with setae. Head strongly declined, vertical, barely visible in dorsal view; eye small, approximately oval in shape, positioned laterally; clypeus raised as medial carina over mouthparts, mouthparts largely hidden. Antenna with nine antennomeres, interantennal space appearing narrow, especially apically. Pronotum parallel-sided from base to about apical ¼, approximately round in cross-section; anterior margin raised above head, with small rounded projections on either side of mid-line. Scutellum visible, apex broadly rounded, parallel-sided at base. Prosternum not visible; mesosternum shorter than metasternum, metasternum convex, width approximately 2 x length; metepisternum somewhat broad, contacting anterolateral edge of hind coxa. Abdomen about as wide

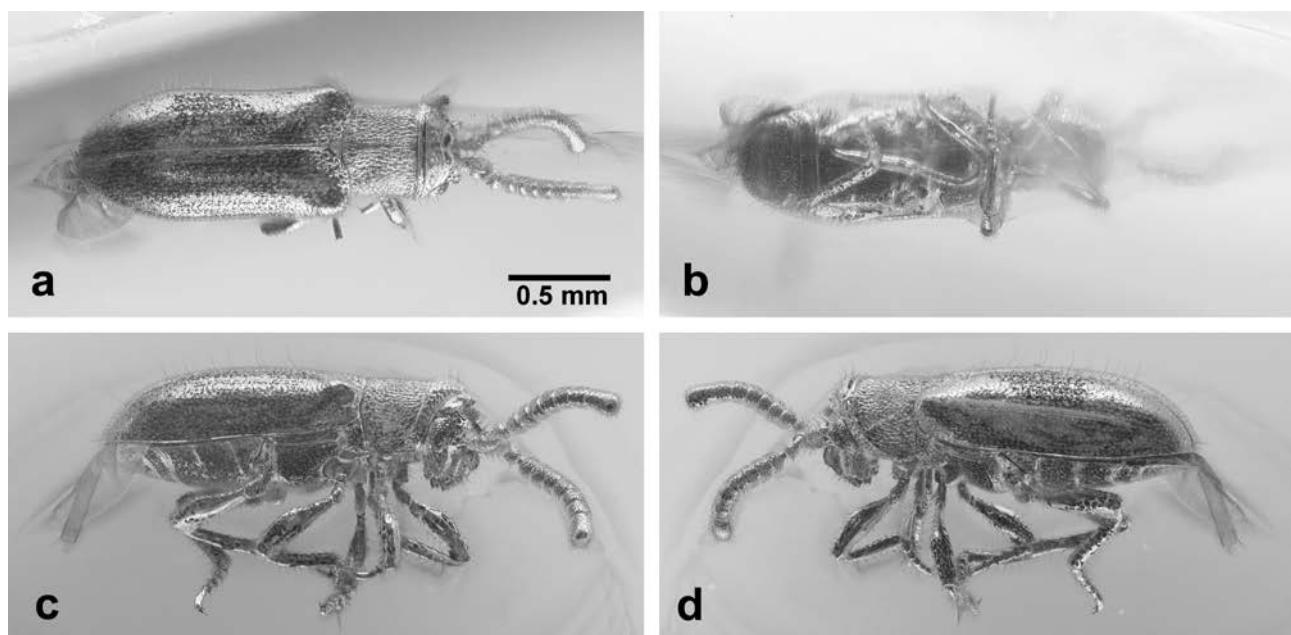


Fig. 1. *Okamninus annae* MYNHARDT & PHILIPS n. gen., n. sp., holotype (AMNH DR2013-1); a: dorsal habitus; b: ventral view; c: lateral (right) view; d: lateral (left) view.

as body, slightly longer than wide, five ventrites present, fourth reduced. Elytra not fused, parallel-sided, humeral angle produced; each elytron with five visible rows of large punctures basally, long, erect setae present; hind wing fully developed, venation not visible on exposed apical half. Procoxa semi-quadrata, conspicuous, projecting, approximately as long as protrochanter, protrochanter obliquely truncate at apex; mesocoxa somewhat triangular, shorter than mesotrochanter; metacoxa transverse and roughly rectangular, reaching metepisternum, metatrochanter conspicuous; femora elongate, subpedunculate; tarsus short and more or less compact, five tarsomeres present, fifth elongate.

Okamninus annae MYNHARDT & PHILIPS n. sp.

Fig. 1

H o l o t y p e : Specimen AMNH DR2013-1 is deposited in the American Museum of Natural History (AMNH). The specimen is complete and maintained in a ground down, polished (see Materials & Methods) piece of amber.

E t y m o l o g y : The specific epithet is derived from and used in honor of the name of the first author's mother, ANNA.

T y p e l o c a l i t y : La Toca mines, mountain region north of Santiago (Cordillera Septentrional) of the Dominican Republic.

D i a g n o s i s . – This new species can be distinguished from other spider beetles by a relatively simple, parallel-sided pronotum from the base to apical $\frac{1}{4}$. Also unique is a conspicuous bilobed protrusion on the head, which appears in lateral view as two medial teeth. Lateral to the teeth are two tufts of setae. In dorsal view, two obvious antennal fossae ridges covered with a small setal tuft are also present. This combination of tufts and projections is unique and not known for any other known spider beetle.

D e s c r i p t i o n o f h o l o t y p e : Sex unknown. Total body length 1.65 mm. Integument dark brown. Hind wings fully developed.

H e a d : Scarcely, coarsely punctate, fine erect setae present on clypeal edge, frons, and between eyes; eye oval in shape, slightly narrowing near ventral-most edge, bearing up to eight small ommatidia at widest diameter; antennal fossae distinctly carinate except ventrally; antennae approximately $\frac{1}{2}$ total length of body, each antennomere covered with short semi-erect setae; scape widest at apex, about twice as long as each of antennomeres 2–8, ultimate (9th) segment greater in length than length of previous two combined, tip rounded.

P r o n o t u m : Rugose, with occasional irregular punctures scattered on disc, especially along raised anterior margin; two anterior transverse carinae at anterior $\frac{1}{4}$ slightly projecting anteriorly, surface between carinae smoother than that seen posteriorly; pronotum parallel-sided except sides converging on anterior $\frac{1}{4}$, with scattered short setae distributed throughout; non-punctulate narrow strip of

pronotum extending approximately two thirds of pronotal length towards anterior edge.

L e g : Setose, covered in fine setae; profemora slightly curved and subpedunculate, as long as tibia. Pro-, meso-, and metatarsi about equal in length, fifth tarsomere approximately twice as long as basal four, basal four subequal in length, claws simple.

E l y t r o n : Punctate, with large punctures near base, decreasing abruptly in size after approximately 4 punctures, extending over length of elytra as finer punctures separated by single puncture diameter; five visible rows of setae basally, nine visible dorsal rows of setae along puncture rows; setation dense at humeral angles, decreasing to finer setae accompanying fine punctures; humeral angles slightly produced.

A b d o m e n : Bearing five ventrites, 1–3 subequal in length, penultimate segment half the length of the third when measured at lateral edge; fifth segment nearly 4x length of penultimate measured medially.

4. Comparison and spider beetle systematics

There is no doubt that the new genus *Okamninus* is a spider beetle, based on characters typically found in the majority of taxa in the family. This includes closely inserted antennae, the absence of an apical antennal club, and the reduced penultimate abdominal ventrite.

When compared to other spider beetles, however, the combination of characters found in *Okamninus* is unique and distinguishes it from any other known species. The most diagnostic feature in *O. annae* is the presence of lobed, tooth-like projections on the head, in addition to lateral tufts of setae adjacent to the projections. These projections appear to be positioned on the vertex above the eyes, and are not present in any other known spider beetle genus. In contrast, similar pronotal (but not cephalic) projections seen in *O. annae* are found in various bostrichids.

Currently, the phylogenetic relationship between spider beetles and other related Bostrichoidea (including bostrichids) remains contentious and is beyond the scope of this paper. But within the spider beetles, the new genus *Okamninus* appears very similar to species currently recognized in the Holarctic genus, *Ptinus*. Based on an unpublished analysis, and considering the characters shared with *Ptinus*, *Okamninus* presents what has previously considered to be a “basal” spider beetle body shape (PHILIPS 2000); however, recent evidence in a much larger study (MYNHARDT et al., in prep.), suggests that body shape is not a reliable character in separating unique clades of spider beetles. It appears, instead, that mouthpart structure separates basal spider beetles from derived clades. Since we are unable to dissect specimens found in amber, unfortunately little comparison can be made to infer phylogenetic affinities to extant taxa. If we consider other *Ptinus*-like charac-

ters, such as a visible scutellum, the conspicuous and numerous rows of elytral punctures, pedunculate (rather than flattened) femora, and the presence of fully formed hind wings, we suspect that *Okamninus* is most closely aligned with the genus *Ptinus* and other taxa within the diverse, heterogeneous tribe Ptiniini as currently recognized (BELLÉS 1982). Phylogenetic hypotheses for the spider beetles will be addressed in a future paper.

In comparison to the other Dominican amber species, *Oviedinus hispaniolensis*, *Okamninus* is significantly different. *Oviedinus hispaniolensis*, similar to the majority of species in the genus *Ptinus*, bears 11-segmented antennae as well as a basally-constricted pronotum found in species of the subgenus *Ptinus* (*Gynopterus*). *Okamninus* appears much more similar to the recently described Dominican amber genus *Electrognostus*, sharing similar small size and reduced, 9-segmented antennae; however, the apical antennomere is rounded instead of the truncate tip found in *Electrognostus*. Truncate antennae are found in species of the myrmecophilous genus *Gnostus*, which may be related to a myrmecophilous habit (LAWRENCE & REICHARDT 1969; BELL & PHILIPS 2009; PHILIPS & MYNHARDT 2011) but not all myrmecophilous ptinids bear modified antennae, as seen in the ant-associated genus *Diplocotidus* (BELL & PHILIPS 2008). In addition, when compared to *Electrognostus*, evidence of pronotal trichomes is lacking entirely in *O. annae*. In terms of biology, *Okamninus* bears no characters that would indicate a myrmecophilous habit, unless one considers the cephalic tufts as potential trichomes; however, we have no reason to believe a connection to myrmecophily at this time.

Rather, the close resemblance of *Okamninus* with many *Ptinus*-like spider beetles and the fact that it was deposited in amber may instead suggest a xylophagous (wood boring) habit. A single species of extant spider beetle, *Ptinus lichenum* MARSHAM, has been documented boring into wood (BELLÉS 1980), and larvae of the species *Ptinus antillanus* BELLÉS have been reported mining leaves of the herb *Tournefortia gnaphalodes* LINNAEUS (PHILIPS et al. 1998). Hence, it is possible that an association with live plants and this species of spider beetles evolved millions of years ago, and could therefore explain the presence of *Okamninus* in amber. Further work to address behavioral and morphological evolution of spider beetles, with inclusion of this unique new genus, is currently in progress (MYNHARDT in prep.).

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