Novitates Paleoentomologicae

No. 8, pp. 1–9 1 July 2014

A diminutive pelecinid wasp from the Eocene Kishenehn Formation of northwestern Montana (Hymenoptera: Pelecinidae)

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Abstract. A new genus and species of pelecinid wasp (Proctotrupoidea: Pelecinidae) is described and figured from a single male preserved in oil shale from the middle Eocene Kishenehn Formation of northwestern Montana. ***Phasmatopelecinus leonae*** Greenwalt & Engel, new genus and species, is distinguished from other Tertiary and Mesozoic pelecinids as well as the Recent genus *Pelecinus* Latreille. Despite the fact that there are more than 15 times more fossil than living species in the family, *P. leonae* is only the second Tertiary member of the family discovered to date.

INTRODUCTION

The three very similar extant species of the family Pelecinidae are the only remaining representatives of what was a once larger and diverse clade of parasitic Hymenoptera (Johnson, 1998; Johnson & Musetti, 1999; Engel & Grimaldi, 2013). Recent species are large, distinctive, slow-flying wasps that are parasitoids on the larvae of scarab beetles, the wasps extending their elongate metasoma through the soil to reach their hosts (Johnson & Musetti, 1999). By contrast, many of the known fossil species are tiny animals, more proportionate in size to many other proctotrupoid wasps and from

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ISSN 2329-5880

which the pelecinids derive. A total of 47 fossil species in 16 genera have now been described, 45 of them within the last 10 years and the majority of those originating in the Jurassic-Cretaceous formations of Asia (summarized in Engel & Grimaldi, 2013). Although the Mesozoic diversity was assuredly greater than that of today's fauna, there has been a careless rush to describe species from the fossiliferous deposits of China and it is apparent that many of these need revision and some synonymy shall result. Most of the known fossils are compressions, with only three species having thus far been discovered as inclusions in amber (Brues, 1933; Johnson, 1998; Engel, 2002; Engel & Grimaldi, 2006, 2013).

Despite the highly distinctive gross morphology of all living and fossil pelecinids, this small group of species have been segregated into as many as three different families or subfamilies. When describing the first fossil pelecinid, *Pelecinopteron tubuliforme* Brues in mid-Eocene Baltic amber, Brues (1933) created the Pelecinopteridae, believing that the reduced number of flagellomeres and form of the metatibia were sufficiently divergent from *Pelecinus* Latreille to justify placement in a separate but obviously related family. More than forty years later, Kozlov (1974) described the first Cretaceous pelecinid as *Iscopinus baissicus* Kozlov, placing it in Pelecinidae proper based on his interpretation of a short Rs2 in the forewing. Rasnitsyn (1980) subsequently segregated *Iscopinus* Kozlov into a separate subfamily, Iscopininae, based on differences in the form of Rs2 relative to modern Pelecinidae, and Johnson (1998) later elevated the group to family rank. Subsequent to these authors numerous other Cretaceous pelecinids have been described which tend to blend the distinctions between these more isolated taxa and even a rudimentary phylogenetic analysis of these recovers a demonstrably paraphyletic Iscopininae (Shih *et al*., 2010), and the subfamily is therefore of no classificatory value. The Iscopininae was formally synonymized by Engel & Grimaldi (2013) and a revised diagnosis provided for the expanded family Pelecinidae.

Despite the impressive fossil record that has accumulated for Pelecinidae, there are few Tertiary records of the group. The only Cenozoic fossil hitherto described has been *P. tubuliforme* in middle Eocene Baltic amber (Brues, 1933; Engel, 2002) and a fragmentary specimen in Paleocene amber from Sakhalin Island (Johnson, 1998). Here we describe a second Paleogene fossil of Pelecinidae based on a single male collected from the Kishenehn Formation (Lutetian, *ca*. 46 Ma) in northwestern Montana.

MATERIAL AND METHODS

A single specimen (Fig. 1) was collected from the Disbrow Creek site on the Middle Fork of the Flathead River in northwestern Montana by Leona Constenius in 1985. Exposures there are from the middle sequence of the Coal Creek member of the Kishenehn Formation, which has been estimated to be 46.2 ± 0.4 Ma (Lutetian) by $^{40}Ar/^{39}Ar$ analysis and 43.5 ± 4.9 Ma by fission-track analysis (Constenius, 1996).

The compression fossil was immersed in 95% ethanol for examination and photography. The specimen was photographed using an Olympus SZX12 microscope, DP-25 camera, and DPM imaging software and measurements were taken with the DP2-BSW software. Obscuring matrix was removed from the fossil with a 23-gauge short-bevel hypodermic needle while the specimen was immersed in alcohol and under 10X magnification. Venational terminology is from Mason (1986), while other details of the format and terminology generally follow Johnson & Musetti (1999), Engel (2002), and Engel & Grimaldi (2006, 2013).

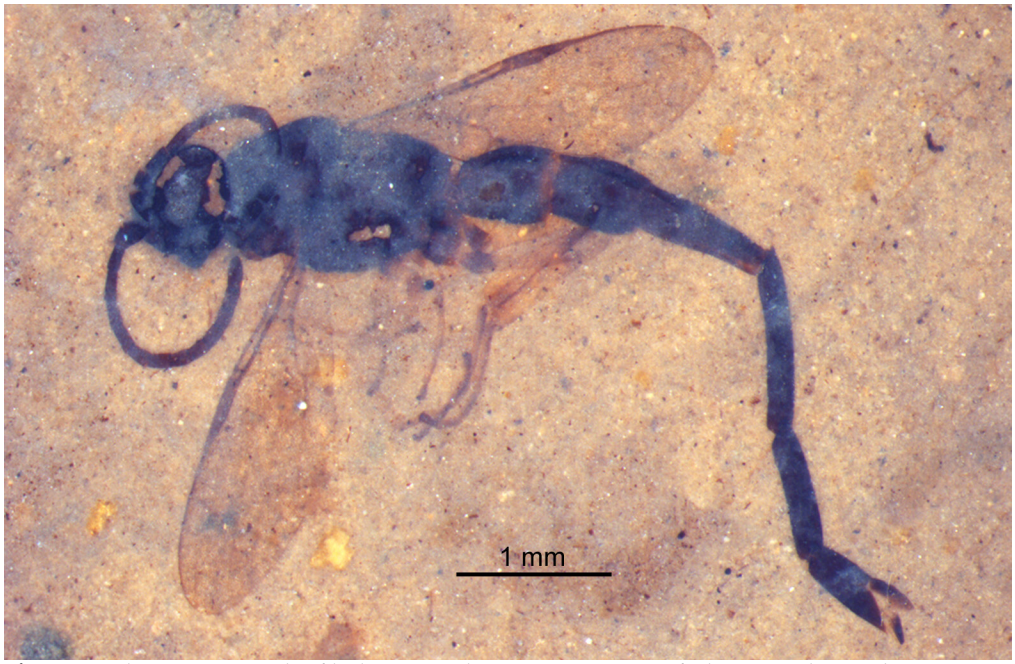


Figure 1. Photomicrograph of holotype male (USNM 546098) of *Phasmatopelecinus leonae*, new genus and species, from the Eocene Kishenehn Formation.

SYSTEMATIC PALEONTOLOGY

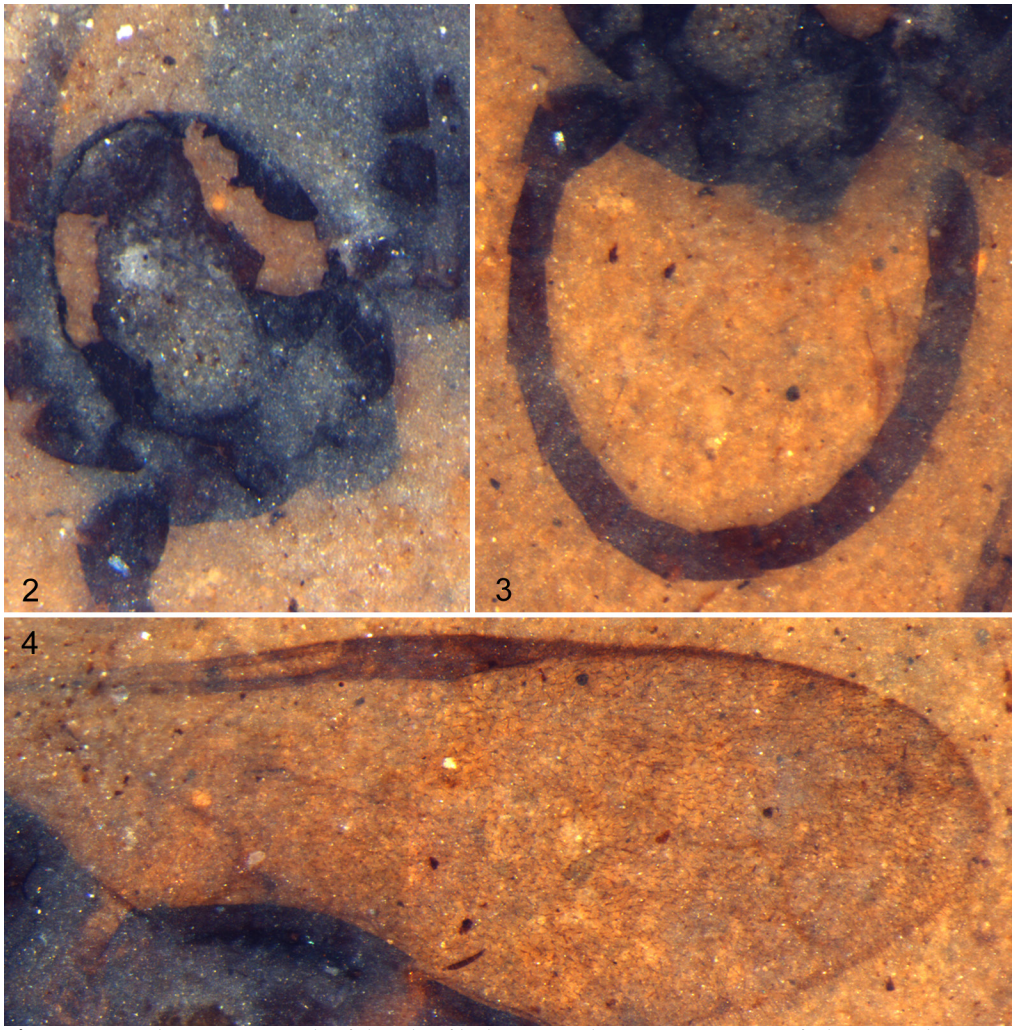
Family Pelecinidae Haliday

Phasmatopelecinus Greenwalt & Engel, new genus

ZooBank: urn:lsid:zoobank.org:act:519D6657-E48B-4900-90CB-CE3C5C7ED73C

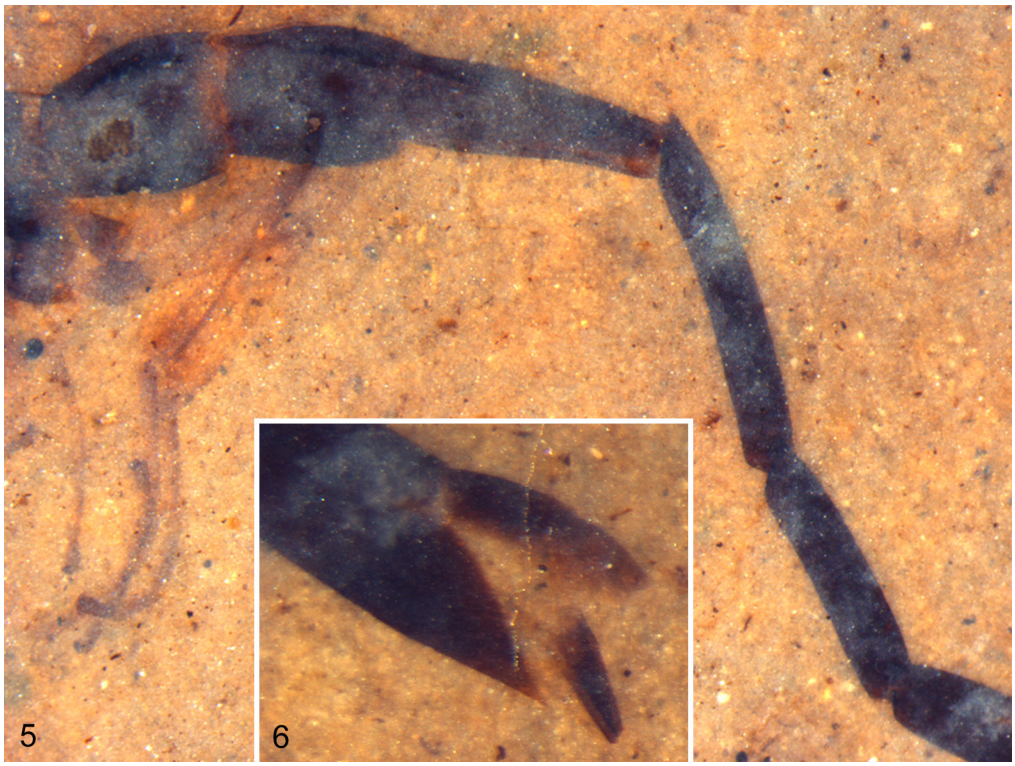
Diagnosis: *Phasmatopelecinus leonae* Greenwalt & Engel, new species.

Description: ♂: Body size minute relative to modern species (*ca*. 6.7 mm). Head subspherical (Figs. 1, 2), slightly higher than wide, equal in length to first metasomal segment; compound eyes large, with defined malar space greater than width of scape; antenna with 14 antennomeres (Fig. 3), positioned at midpoint of face; scape short, slightly longer than wide; pedicel wider than long; flagellum filiform, individual flagellomeres longer than wide, particularly basal four and apicalmost flagellomeres; basal four flagellomeres each with length more than 2x apical width; flagellomeres 5–11 shorter, lengths less than twice apical width. Mesosoma equal in length to combined lengths metasomal segments II and III; pronotum collar-like; mesonotum slightly arched; mesepisternum perhaps longitudinal furrow (opening in integument along mesepisternum may correspond to furrow observable in other taxa such as *Pelecinopteron* Brues); propodeum short, distinctly and strongly areolate. Forewing hyaline, with uniformly scattered microtrichia, without infuscations, with only two tubular veins (C and Sc+R) (Fig. 4); pterostigma elongate, tapering to point along apical wing margin; R extending beyond pterostigma, reaching to about three-quarters of distance to wing apex; r-rs arising near midpoint of pterostigma; Rs branching prior to tangent with pterostigmal apex; Rs1 and Rs2 spectral, elongate; Rs1 arching anteriorly at origin before curving gently to extend toward wing margin; Rs2; first medial cell



Figures 2–4. Photomicrograph of details of holotype male (USNM 546098) of *Phasmatopelecinus leonae*, new genus and species. **2.** Detail of head in lateral view. **3.** Left antenna. **4.** Right forewing.

roughly quadrate (elongate and narrowly rectangular in *Pelecinopteron*: Engel, 2002); 2cu-a distinctly distad 1m-cu; veins more strongly pigmented in basal third of wing. Hind wing not preserved. Metafemur about as long as metatibia (Figs. 1, 5); metatibia gradually swollen toward apex; metabasitarsus long, much longer than succeeding tarsomere and nearly as long as combined lengths of remaining tarsomeres. Metasoma 7-segmented (Figs. 1, 5, 6); terga and sterna I–III distinctly separate, not fused laterally, those of segments IV and V without visible sutures; first two segments not elongate, subquadrate in form (Fig. 5), first slightly higher than second, each faintly constricted posteriorly; segment III greatly elongate and tapering in height across length (Fig. 5), nearly twice as high basally as apically; segments IV and V elongate, narrowly tubular (Fig. 5); segment VI elongate, slightly wider than V (Fig. 1); tergum VII minute (Fig. 6), apparently largely hidden by VI in life, longer than wide, length less than height of segment VI.



Figures 5–6. Metasoma of holotype male (USNM 546098) of *Phasmatopelecinus leonae*, new genus and species. **5.** Metasomal segments I–V, basal half of segment VI. **6.** Apical half of metasomal segment VI, tergum fractured and partially pulled away to expose largely hidden tergum VII.

Etymology: The name is a combination of *phasmatos* (Greek, meaning "spectral" or "apparition") and *Pelecinus* (type genus of the family Pelecinidae). The name is masculine.

Phasmatopelecinus leonae Greenwalt & Engel, new species
ZooBank: urn:lsid:zoobank.org:act:65392B26-08A7-48E6-AB5C-F4E53D744098
(Figs. 1–6)

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

Description: ♂: As described for the genus with the following additions: Body length 6.70 mm; forewing length 2.65 mm, maximal width 0.84 mm. Head, mesosoma, and metasoma generally black, lighter along margins of metasomal segments and appearing reddish brown as preserved; metacoxa and metatrochanter brown; metafemur and metatibia pale orangish brown; metarsus brown, darker more apically. Head length 0.72 mm, width 0.64 mm. Antennal length 2.1 mm; scape short, length 0.13 mm, apical width twice basal width; pedicel length 0.09 mm; flagellomere lengths 1–12: 0.18 mm, 0.18 mm, 0.18 mm, 0.16 mm, 0.14 mm, 0.14 mm, 0.13 mm, 0.13 mm, 0.13 mm, 0.14 mm, 0.13 mm, 0.21 mm. Compound eye large, oval, height 0.61 mm, width 0.47 mm. Malar space distinct, subequal to scape, length 0.12 mm. Mesosomal length 1.44 mm. Forewing (right wing more completely preserved, left wing is fainter and

veins are not visible); pterostigma elongate, length 0.5 mm, maximal width 0.095; basal vein and first free abscissa Rs lightly pigmented, each abscissa about equal in length and relatively straight; first abscissa Rs+M very faintly preserved, roughly parallel to first free abscissa Cu; 1cu-a confluent with basal vein; M+Cu faintly pigmented as preserved; Cu beyond 2cu-a lightly pigmented then becoming particularly faint, perhaps nebulous, extending to near wing margin. Hind wing not preserved. Legs generally slender and typical for Pelecinidae; metafemur slender, 0.74 mm long, maximal width 0.2 mm; metatibia long, gradually more swollen apically, 0.88 mm long, width in basal third 0.07 mm, apical width 0.17 mm; metatarsus 0.87 mm long, metabasitarsus about 50% of total length of metatarsus. Metasoma elongate, length 4.63 mm; segment I length 0.60 mm, basal height 0.33 mm, apical height 0.47 mm; segment II length 0.63 mm, height 0.44 mm; segment III elongate, tubular, length 0.86 mm, basal height 0.28 mm, apical height 0.19 mm; segment IV elongate, tubular, length 1.1 mm, height 0.16 mm; segment V elongate, tubular, length 0.81 mm, height 0.18 mm; segment VI length 0.67 mm, height 0.24 mm; tergum VII conical, length 0.14 mm.

♀: Unknown.

HOLOTYPE: ♂, USNM #546098, Coal Creek Member, Kishenehn Formation, Lutetian (Eocene), Disbrow Creek site along middle fork of Flathead River, northwestern Montana; Leona Constenius collector; deposited in the Department of Paleobiology, National Museum of Natural History, Washington, DC.

ETYMOLOGY: The specific epithet is a matronym honoring Leona Constenius who collected the holotype and only-known specimen.

DISCUSSION

Phasmatopelecinus leonae is a fascinating discovery not only for it being only the second pelecinid known from the Tertiary, but in that it is an interesting intermingling of features, some of which are more similar to *Pelecinus* than to the other Paleogene fossil genus, *Pelecinopteron*. For instance, *P. leonae* has a well-defined malar space that more closely approximates that of the living species and shares with them 14 antennomeres. Although the metasoma is more slender and elongate in the male of *P. leonae* as in *P. tubuliforme* and other fossil groups, and resembling the female metasoma of *Pelecinus*, the seventh metasomal segment is largely hidden (only six segments are visible externally in males of *Pelecinus*: Johnson & Musetti, 1999). Despite the slender appearance of the metasoma in *P. leonae*, unlike that of *P. tubuliforme* the apicalmost segment is not enlarged or falcate, and the sixth segment, while slightly more swollen than the preceding segments, lacks ventral tubercles or teeth so characteristic of the latter species (Engel, 2002). Forewing r-rs arises near the midpoint the pterostigma, a trait intermediate between the proximal origin in *P. tubuliforme* and the more apical origin in *Pelecinus*. *Phasmatopelecinus* has the metabasitarsus longer than the immediately succeeding tarsomere and lacks forewing membrane infuscated patterns, features similar to *P. tubuliforme*. Unlike either *Pelecinopteron* or *Pelecinus*, the first two metasomal segments are thicker and not elongate, in this regard more closely resembling some Cretaceous genera such as *Henopelecinus* Engel & Grimaldi, *Protopelecinus* Zhang & Rasnitsyn, and some *Sinopelecinus* Zhang *et al*. (*e.g*., Zhang *et al*., 2002; Zhang & Rasnitsyn, 2004, 2006; Engel & Grimaldi, 2006).

There is now known to be considerable variation in the venation of pelecinid wings (*e.g*., Shih *et al*., 2010), with veins of varying degrees being reduced from tubular

to nebulous to even spectral (*sensu* Mason, 1986). The forewing Rs in particular can be variously developed with the branches being largely spectral in most species. It is important to note that spectral veins in compression fossils may be notoriously difficult to locate or may even be altered or obliterated by the process of fossilization. Thus, exceptional care must be taken when attempting to locate and document potentially spectral versus absent veins in the forewings of fossil pelecinids and other lineages of Apocrita. The present fossil certainly has a venation that is largely similar in gross details to that of *Pelecinus*, *Pelecinopteron*, *Henopelecinus*, *Protopelecinus*, and *Zoropelecinus* Engel & Grimaldi (*i.e.*, most of those genera formerly classified as Pelecininae). Other pelecinid groups either have more fully developed and tubular wing venation, or the system of veins more dramatically reduced putatively with entire longitudinal veins absent. The possibility that spectral or even nebulous veins in those genera with reduced venation were overlooked or simply were not preserved should be carefully investigated. Indeed, a comprehensive revision of the Mesozoic record of Pelecinidae is needed in order to better ascertain the diversity of species, accurately reflect the disparity present among these lineages, and clarify evolutionary relationships within the family as well as its placement among other living and extinct proctotrupoids.

ACKNOWLEDGEMENTS

We are grateful to the USNM for permitting us to prepare and study the present material, to Conrad C. Labandeira for support of the senior author's work in the Department of Paleobiology, and to two anonymous reviewers for their helpful comments. This is a contribution of the Division of Entomology, University of Kansas Natural History Museum and contribution number 287 of the 'Evolution of Terrestrial Ecosystems Consortium' of the USNM.

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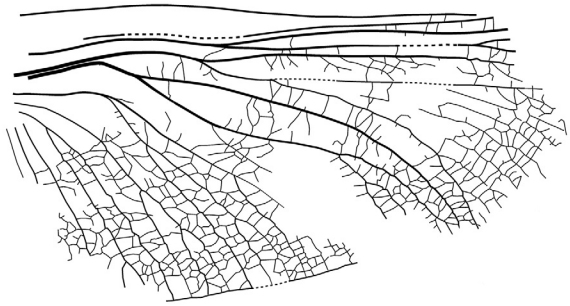

Pharciphyzelus lacefieldi Beckemeyer & Engel, 2011

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ISSN 2329-5880