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ORIGINAL RESEARCH

A New Genus of Apsilocephalidae (Diptera) in Mid-Cretaceous Burmese Amber

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ABSTRACT

A new genus and species of apsilocephalid flies, *Cascomixticus tubuliferous* **gen. et sp. nov.** (Diptera: Asiloidea: Apsilocephalidae) is described from Burmese amber. Assignment to the Apsilocephalidae is based on the wing venation that is very similar to extant members of the family. The present fossil differs from known genera of this family by a long labellum bearing tactochemical papillae, a long tubular hypopharynx and a pointed labrum as well as the structure of the scape and pedicel. The long, tubular hypopharynx may have been used to obtain nectar from angiosperm flowers, however the function of the sharp-tipped labrum is unknown.

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Introduction

The Asiloidea represents a cosmopolitan superfamily of flies with variable habits. While the larvae are mostly predatory, the adults can be predaceous, herbivorous or both. Within the Asiloidea is the little-known family Apsilocephalidae with both extant and extinct representatives (Nagatomi *et al*., 1991; Gaimari & Mostovski, 2000; Hauser & Irwin, 2005; Winterton & Irwin, 2008; Zhang *et al*., 2018).

The present study describes a new genus and species of the family Apsilocephalidae in Burmese amber. A unique character of the present fossil is its extended proboscis that is longer than the head, a long, tubular, porrect hypopharynx, a sharply pointed labrum and a labellum bearing tactochemical papillae.

Materials and methods

The amber specimen originated from the Noije Bum Summit Site mine in the Hukawng Valley, located southwest of Maingkhwan in Kachin State (26º20´N, 96º36´E) in Myanmar. Based on paleontological evidence the site was dated to the late Albian of the Early Cretaceous (Cruickshank & Ko, 2003), placing the age at 97–110 million years ago (Mya). A more recent study determined the age to be 98.8 ± 0.62 Mya or at the Albian/Cenomanian boundary (Shi *et al*., 2012). Nuclear magnetic resonance spectra and the presence of araucaroid wood fibers in amber samples from the Noije Bum Summit Site indicate an araucarian tree source for the amber (Poinar *et al*., 2007).

Observations and photographs were made with a Nikon SMZ-10 R stereoscopic microscope and a Nikon Optiphot compound microscope with magnifications up to 1000 X. Helicon Focus Pro

X64 was used to stack photos for better overall clarity and depth of field. Keys used for family identification, terms, including abbreviations for wing venation, were taken from Irwin and Lyneborg (1981), Nagatomi *et al*. (1991), Hauser and Irwin (2005), and Gaimari and Mostovski (2000). Syninclusions include a small midge (Diptera: Chironomidae) (Fig. 1) adjacent to the fossil.

Systematic paleontology

Order: **Diptera Linnaeus, 1758**

Suborder: **Brachycera**

Infraorder: **Asilomorpha**

Superfamily: **Asiloidea**

Family: **Apsilocephalidae Nagatomi, Saigusa, Nagatomi, & Lyneborg, 1991**

Genus: ***Cascomixticus* gen. nov.**

LSID: urn:lsid:zoobank.org:act:4BA1D353-356F-4EBE-98A2-3091C01834BE

Diagnosis: Female fly with long, porrect proboscis with extended, tubular hypopharynx, slender pointed labrum and setiferous labellum bearing protruding sensory papillae; palps 2-segmented; eyes separated (dichoptic); ocelli 3, positioned on ocellar tubercle; pedicel longer than scape; postpedicel with single-articled, apically tapered stylus lacking a terminal process; wings hyaline except for diffuse dark stigma; Rs originating slightly distil to level of humeral cross vein; cell m3 closed and petiolate; cell dm complete, separated from cell bm that has three corners distally; tibial apex with pair of long setae; claws bifid at tip; arolium spine-like.

Etymology: Generic name from the Latin "casco" = old, and the Latin "mixticius" = mixed race in reference to the fossil possessing an elongate proboscis, which is a feature of species in many brachyceran families.

***Cascomixticus tubuliferous* gen. et sp. nov.** (Figs. 1-12).

LSID: urn:lsid:zoobank.org:act:023F6068-C870-4F67-8BAE-9A4E75BC812B

Holotype: Accession no. B-D-1-74 deposited in the Poinar amber collection maintained at Oregon State University.

Diagnosis: as for genus (monotypic)

Type locality: Myanmar (Burma), state of Kachin, Noije Bum Summit Site amber mine in the Hukawng Valley, SW of Maingkhwan (26º20´N, 96º36´E).

Figure 1. Left lateral view of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber. Arrow shows adjacent small midge (Diptera: Chironomidae). Scale bar = 1.5 mm.

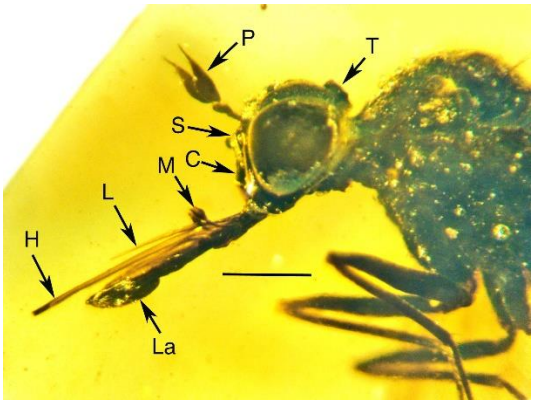

Figure 2. Left lateral view of head and pronotum of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber. C = clypeus; H = hypopharynx; L = labrum; La = labella; M = maxillary palps; P = postpedicel; S = face papillae; T = ocellar tubercle. Scale bar = 330 µm.

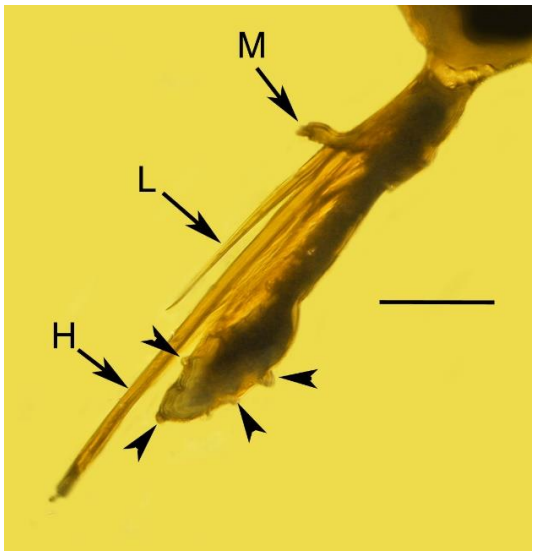

Figure 3. Lateral view of mouthparts of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber. L = labrum; H = hypopharynx; M = maxillary palps. Arrowheads show tactochemical papillae on labellum. Scale bar = 200 µm.

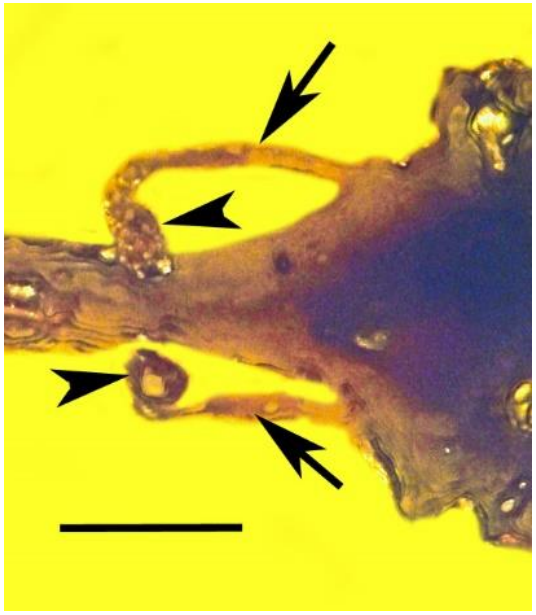

Figure 4. Dorsal view of maxillary palps of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber. Arrows show elongate basal segments; arrowheads show terminal globular segments. Scale bar = 250 µm.

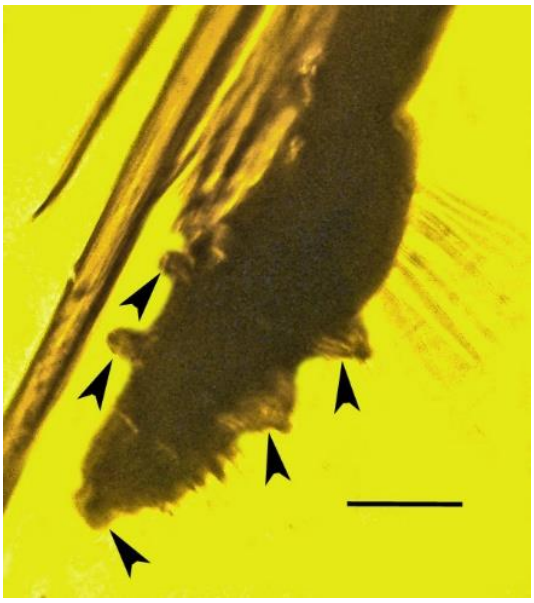

Figure 5. Detailed view of the labellum of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber showing tactochemical papillae (arrowheads). Scale bar = 65 µm.

Figure 6. Head of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber. Note dichoptic eyes. Upper arrow shows ocellar tubercle. Lower arrow shows postpedicel with terminal stylus (second antennae image removed). Scale bar = 180 µm. Insert shows tip of stylus. Scale bar = 10 µm.

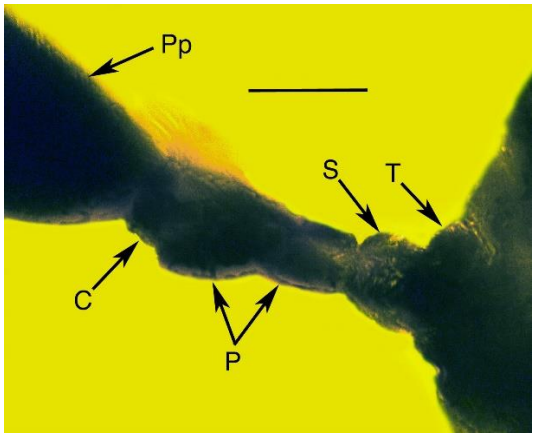

Figure 7. Base of antenna of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber showing torulus (T); scape (S); pedicel (P) with narrow basal and swollen anterior portions; connective (C) and postpedicel (Pp). Scale bar = 35 µm.

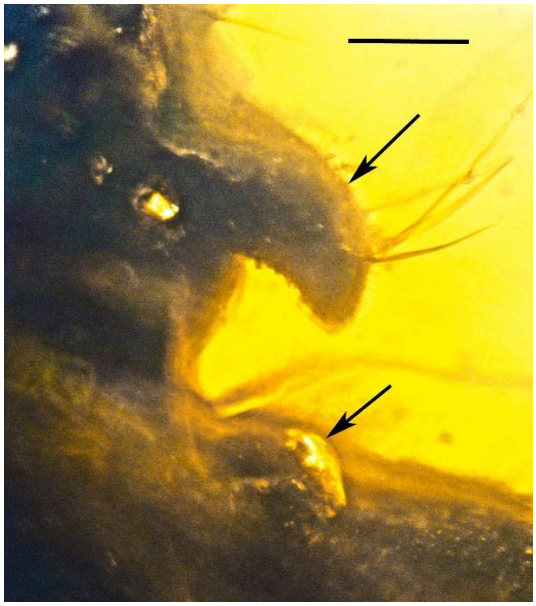

Figure 8. Scutellum (top arrow) and sub-scutellum (bottom arrow) of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber. Scale bar = 100 µm.

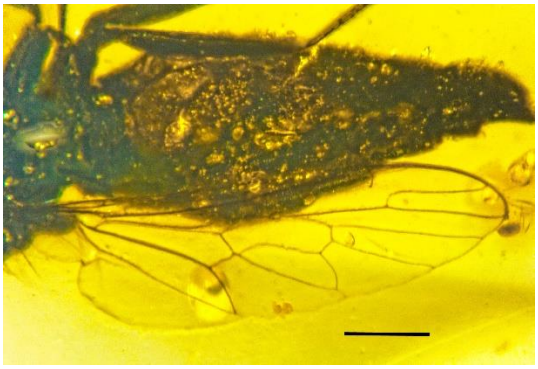

Figure 9. Right wing of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber. Scale bar = 400 µm.

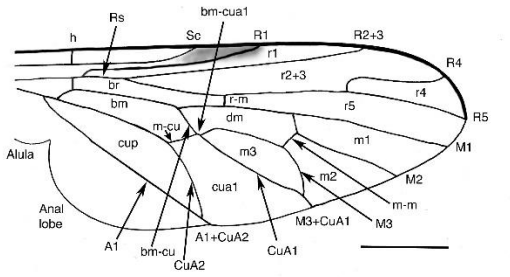

Figure 10. Wing venation of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber. Scale bar = 430 µm.

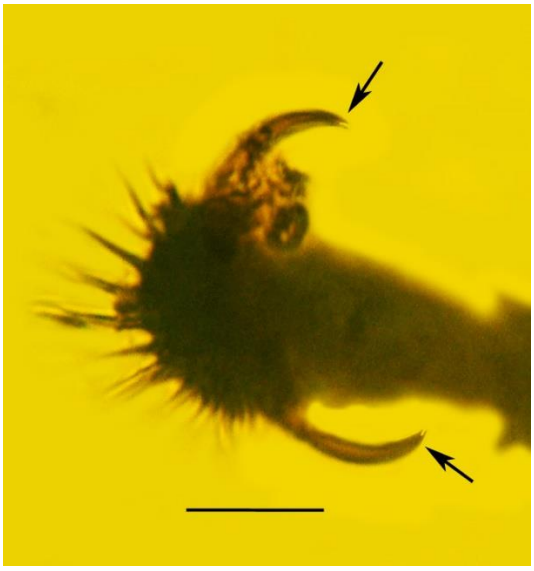

Figure 11. Metatarsal claws of *Cascomixticus tubuliferous* **gen et sp. nov.** in Burmese amber. Note setiferous tip of tarsomere. Arrows show minute bifurcation in tip of claws. Scale bar = 12 µm.

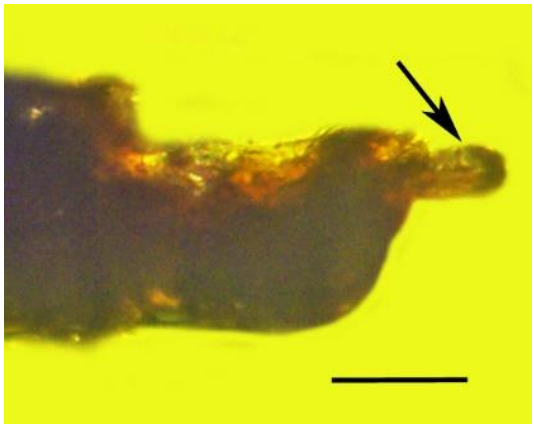

Figure 12. Tip of abdomen of *Cascomixticus tubuliferous* **gen. et sp. nov.** in Burmese amber. Arrow shows cercus. Scale bar = 70 µm.

Description. Body non-metallic, 4.5 mm long; head porrect, length (without proboscis), 550 µm; width head, 650 µm; eyes dichoptic, diameter eye, 420 µm; ocelli 3, positioned on ocellar tubercle 170 µm in length on top of head; face flat with clypeus slightly protruding; short papillae on face beneath antennal insertions; proboscis 1.0 mm in length, longer than head length, porrect; length labium, 770 µm; length labellum, 290 µm; hypopharynx extended, not appearing protrusible, tube-like with blunt tip, length, 950 µm, with internal salivary canal; labrum slender, pointed, 600 µm in length; palps 2-segmented, length 240 µm, first segment elongated and acutely curved at apex, second segment globular; antennae 400 µm long; torulus short, length 20 µm; scape short, length, 22 µm; pedicel with narrow basal and wider anterior portion; length both portions together, 60 µm; short connective (L = 10 µm) between pedicel and postpedicel; postpedicel triangular-shaped, length, 280 µm; single-articled style approximately 90 µm in length, mechanoreceptor on tip not obvious; thorax slender, length, 1.0 mm; scutellum protruding, length, 200 µm; subscutellum small, protruding, length, 125 µm; wing hyaline except for diffusely darkened stigma between termination of veins Sc and R1; length wing, 2.5 mm; costal termination at R5; vein R1 thickened, slightly swollen before joining C; R1 meeting C slightly past mid-wing; Rs originating slightly distal to level of humeral cross vein; R4+5 and M1+2 meeting wing margin; base of vein R4 curved at 45 degree angle, then curved upwards at C; cell cup long; cells bm and dm closed, subequal in length, with cross vein complete; cell bm with three corners distally; cell m3 closed and petiolate; length of Sc vein 0.4 times wing length; stalk of M3+CuA1 vein approximately equal to m-m cross vein; cross vein bm-cua1 horizontal; R2+3 meeting C about halfway between termination of R1 and R4; cell br complete; anal lobe convex, length, 750 µm; width, 300 µm; alular lobe convex, length, 280 µm, width, 220 µm; halter large, length, 370 µm; length scale-like projection beneath halter, 8 µm; legs elongate, last pair of legs longer and wider than first two pairs; base of all tibia with a pair of long setae; length metafemur, 730 µm; length metatibia, 1.0 mm; length metatarsus, 900 µm; tarsi 5-segmented with distal segment shortest; tip of 5th tarsomere spinose; claws paired, with tips bifid; empodium spine-like; abdomen elongate, length, 2.5 mm; cerci short, 1-segmented; length, 50 µm.

Etymology: Specific epithet is from the Latin "tubus" = pipe and the Latin "fero" = display, in reference to the long tubular, hollow hypopharynx.

Comments: *Cascomixticus tubuliferous* **gen. et sp. nov.** possesses a body shape and basic wing venation (including a m3 closed cell and long cup cell) typical of members of the Apsilocephalidae (Irwin & Lyneborg, 1981; Nagatomi *et al.*, 1991; Gaimari & Mostovski, 2000; Hauser & Irwin, 2005). The presence of a horizontal cross vein bm-cua1 and the hind leg longer and thicker than the other legs also align *Cascomixticus* with members of the Apsilocephalidae (Winterton & Irwin, 2008).

Discussion

The family Apsilocephalidae contains the extant North American genus *Apsilocephala* Kröber (1914), the Tasmanian genera *Clesthentia* White (1914) and *Clesthentiella* Nagatomi, Saigusa, Nagatomi & Lyneborg (1991) and the New Zealand genus *Kaurimyia* Winterton & Irwin (2008). *Apsilocephala* has the antennal style much longer that the postpedicel; *Clesthentia* and *Clesthentiella* have vein R5 ending before the wing apex (Nagatomi *et al.*, 1991); and *Kaurimyia* has the scape and pedicel wider than long and the antennal style deflexed ventrally at base (Winterton & Irwin, 2008). None of the above genera have a proboscis longer than the head as in *Cascomixticus.*

Extinct genera of the family Apsilocephalidae described from Burmese amber include *Burmapsilocephala cockerelli* Gaimari & Mostovski (2000), which has an antennal stylus

2.5 times longer than combined antennal segments 1-3 and a proboscis less than the head length (Gaimari & Mostovski, 2000), which distinguishes it from *Cascomixticus.* Also, from Burmese amber is *Kumaromyia burmitica* Grimaldi & Hauser (Grimaldi et al. 2011); however, this species has a smaller body size (L = 2.7 mm) than *C. tubuliferous* (L = 4.5 mm), a one-segmented palp, minute second and third antennal articles, an incomplete apex of Sc, C ending between apices of R5 and M1, and the apex of M3 meeting the apex of CuA at the wing margin (Grimaldi *et al.*, 2011). All these features separate *K. burmitica* from *C. tubuliferous*.

The Burmese amber *Kuhwahldyia indefinita* Solórzano Kraemer & Cumming (2019), is described as being near the family Apsilocephalidae. However, in this species, veins M3 and CuA1 meet the wing margin separately, a stigma is absent, cell cup is open and M-Cu vein is curved. Also, the mouthparts of *Kuhwahldyia* are smaller than those of *Cascomixticus*. The Burmese amber genus *Myanmarpsilocephala* Zhang *et al.* (2018) has a long arista-like stylus and open cell m3, which distinguishes it from *Cascomixticus.* The Burmese amber genus *Irwinimyia* Zhang *et al.* (2018) has cell bm with four corners distally, a thick stylus and the hind leg similar in size to the other legs, which distinguishes it from *Cascomixticus* (Zhang *et al.*, 2018).

A single species of Apsilocephalidae, *Apsilocephala vagabunda* (Cockerell, 1927), was described from the Florissant Fossil Beds in Colorado, USA (Hauser & Irwin, 2005). The pear-shaped postpedicel, short square pedicel, straight M3 vein, open br cell and absence of a horizontal bm-cua1 vein distinguishes *A. vagabunda* from *Cascomixticus*. While the extended mouthparts of *Cascomixticus* separate it from other apsilocephalids, an elongate proboscis has developed convergently in other families of orthorrhaphous Brachycera, including in species of Acroceridae, Apioceridae, Bombyliidae, Mydidae, Nemestrinidae, Tabanidae, Therevidae, Zhangsolvidae and Vermileonidae (Arillo *et al.*, 2015). Such a proboscis can be used to obtain pollen and nectar from flowers but in the Tabanidae, the proboscises are also used to obtain vertebrate blood meals.

The mouthparts of *Cascomixticus* would appear to be adapted for both piercing and sucking although there is no way of knowing if the sharply pointed labrum could have been used to impale small invertebrate prey, thus the function of this structure remains unknown. The tubular hypopharynx of *Cascomixticus* could have been used to imbibe water, plant nectar and exudates from flowers, like the habits of adult therevids (Winterton *et al.*, 2001; Hauser *et al.*, 2017). Even if the nectar had dried, *Cascomixticus* could have released secretions from the long salivary duct within the hypopharynx to moisten the nectar before consuming it (Brown *et al.*, 2009).

The sensory papillae on the labellum of *Cascomixticus* are interesting and appear to be a unique feature within the Asiloidea and Empidoidea (Cumming & Sinclair, 2009). It is likely that they served as tactochemical receptors. The papillae on the face beneath the antennal insertions of *Cascomixticus* could be what Cole (1969) described as "shining callosities" on the upper face below the antennal bases of the therevid genus *Chromolepida* Cole. *Cascomixticus tubuliferous* presents novel features of an early lineage of the Asiloidea. These features add to the morphological diversity that existed in mid-Cretaceous Asilomorpha.

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Conflict of interest statement

No potential conflict of interest was reported by the authors.

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