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Short communication

A mid-Cretaceous Lauraceae flower, *Cascolaurus burmitis* gen. et sp. nov., in Myanmar amber

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ABSTRACT

An actinomorphic staminate flower in mid-Cretaceous Myanmar amber is described as *Cascolaurus burmitis* gen. et sp. nov. in the family Lauraceae. The fossil most closely resembles extant unisexual flowers of the genus *Litsea* Lam. in the Tribe Laureae, however the size difference of the two whorls of perianth members, 3 whorls of tetrasporangiate anthers with apical valves arranged in 2 rows with introse dehiscence in whorls 1 and 2 and extrose dehiscence in whorl 3, plus the extremely large staminal glands, distinguish the fossil from extinct and extant genera of Lauraceae. *Cascolaurus burmitis* gen. et sp. nov. is the first Cretaceous Lauraceae flower in amber and the best preserved of all known Cretaceous flowers of that family.

1. Introduction

A number of significant fossils have been discovered in mid-Cretaceous amber from Myanmar (Burma) and scientists continue to describe new genera of plants and invertebrates from this source. While the botanical inclusions still trail behind the 252 families of arthropods known from this site (Rasnitsyn et al., 2016), the few angiosperms flowers that have been described from Myanmar amber are significant in showing the diversity that was present at that period in the earth's history (Poinar and Chambers, 2005; Poinar et al., 2007b, 2008, 2013, 2016; Chambers et al., 2010).

The present study describes a new genus of flowers of the family Lauraceae in Myanmar amber as *Cascolaurus burmitis* gen. et sp. nov. This staminate, trimerous actinomorphic flower with two perianth whorls of unequal tepals, three whorls of fertile tetrasporangiate stamens and enlarged staminal glands associated with the stamens of the third whorl, closely resembles extant flowers of the genus *Litsea* Lam. in the Tribe Laureae. The fossil adds to the diversity of previously described Early to mid-Cretaceous flowers of the family Lauraceae (Friis et al., 2011).

2. Materials and methods

The specimen originated from the Noije Bum 2001 Summit Site mine excavated in the Hukawng Valley and located southwest of Maingkhwan in Kachin State (26°20′N, 96°36′E) in Myanmar (Cruickshank and Ko, 2003, figs. 1-3). Based on paleontological evidence, this site was dated to the late Albian of the Early Cretaceous (Cruickshank and Ko, 2003), placing the age at 97 to 110 Ma. A more recent study using U–Pb zircon dating determined the age to be 98.79 ± 0.62 Ma or at the Albian/Cenomanian boundary (Shi et al., 2012). Nuclear magnetic resonance (NMR) spectra and the presence of araucaroid wood fibers in amber samples from the Noije Bum 2001 Summit Site indicate an araucarian tree source for the amber (Poinar et al., 2007a). Observations and photographs were made with a Nikon SMZ-10 R stereoscopic microscope and Nikon Optiphot compound microscope with magnifications up to 800×. Helicon Focus Pro X64 was used to stack photos for better depth of field. The specimen is deposited in the Poinar amber collection at Oregon State University, Corvallis, OR.

3. Systematic paleontology

The fossil flower is staminate and post-anthesis, thus pollen grains are difficult to find. Due to its combination of characters, the flower cannot be assigned to any modern genus and is described in a new fossil genus.

Order Laurales
Family Lauraceae Jussieu
Tribe Laureae

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Genus *Cascolaurus* gen. nov.
Type species: *Cascolaurus burmitis* gen. et sp. nov.

Figs. 1–7

Diagnosis. Flower actinomorphic, with two unequal perianth whorls of three separate tepals each and three whorls of fertile stamens. The outer perianth whorl consists of three small, broad erect pubescent tepals with entire margins and rounded apices. The inner perianth whorl consists of three large, broad revolute tepals with pointed apices, entire margins and hispid hairs on the adaxial surfaces (Figs. 1–3). A pistillode and staminodes are absent. The anthers have four pollen sacs, which open by means of valves, those of the two outer whorls introse and those of the third (inner) whorl extrose (Figs. 3, 4, 7). Stamens of the inner whorl each bear a pair of greatly enlarged exposed glands, some of which are confluent (Figs. 3, 6, 7).

Cascolaurus burmitis gen. et sp. nov.
Figs. 1–7

Holotype description (curatorial # B-An-3).

Total length flower, 5.8 mm; greatest width, 5.2 mm; receptacle fleshy; stipe robust, 2.7 mm in length; first (outer) perianth whorl composed of 3 short, separate, broad tepals 1.8 mm in length and 1.4 mm in greatest width; second (inner) perianth whorl composed of 3 large, separate tepals 4.1 mm in length and 1.4 mm in greatest width; stamens 9, in three whorls, with distinct filaments 0.8 mm in length attached basally to anthers that are 1.0 mm wide; anther pores arranged in pairs, one above the other. The distinctly marginate valve flaps range from 242 to 340 μm in length. The dorsum of the anthers appears to be covered with peltate scales 40–50 μm wide (Fig. 5). The six glands associated with the inner whorl of stamens, some of which have coalesced, extend to the top of the flower and appear between the anthers. The exposed portions of the glands range from 240 to 480 μm in length. Several of the glands are covered with nectar secretions. The glands are attached to the filaments by elongate basal stalks.

Etymology. The generic name is from the Latin “cascus” = old and the Latin “laurus” = a kind of laurel. The specific epithet indicates the geographic origin of the fossil.

Type species. Holotype male flower (curatorial # B-An-3) deposited in the Poinar amber collection maintained at Oregon State University.

Type locality and horizon. Hukawng Valley southwest of Maingkhwan in Kachin State (26°20′N, 96°36′E), Myanmar, uppermost Albian–lowermost Cenomanian (mid- Cretaceous).

Comments

The unisexual staminate flower, the two perianth whorls differing in size, stamens with filaments clearly differentiated from the anthers, 3 whorls of tetrasporangiate anthers with apical valves arranged in 2 rows with introse dehiscence in whorls 1 and 2 and

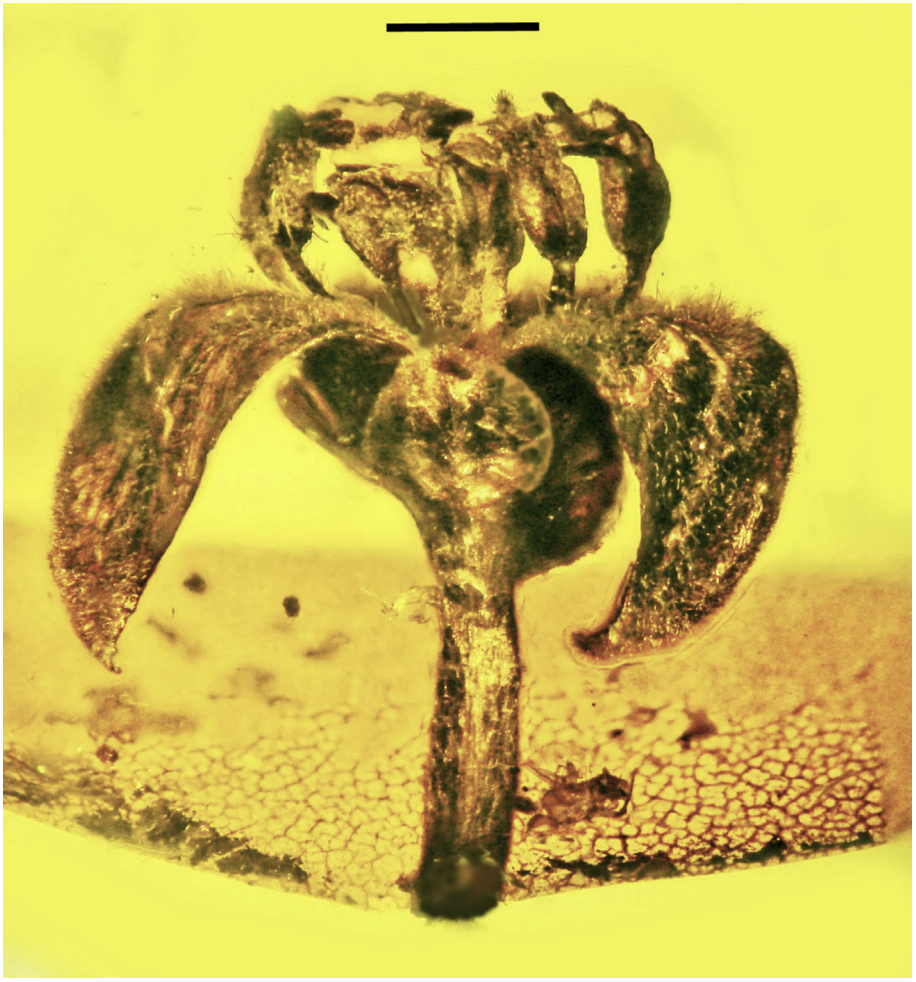

Fig. 1. Lateral view of *Cascolaurus burmitis* gen. et sp. nov. in Myanmar amber. Scale bar = 1.1 mm.

Fig. 2. Flower head of *Cascolaurus burmitis* gen. et sp. nov. in Myanmar amber. Arrows show exposed glands. Scale bar = 0.9 mm.

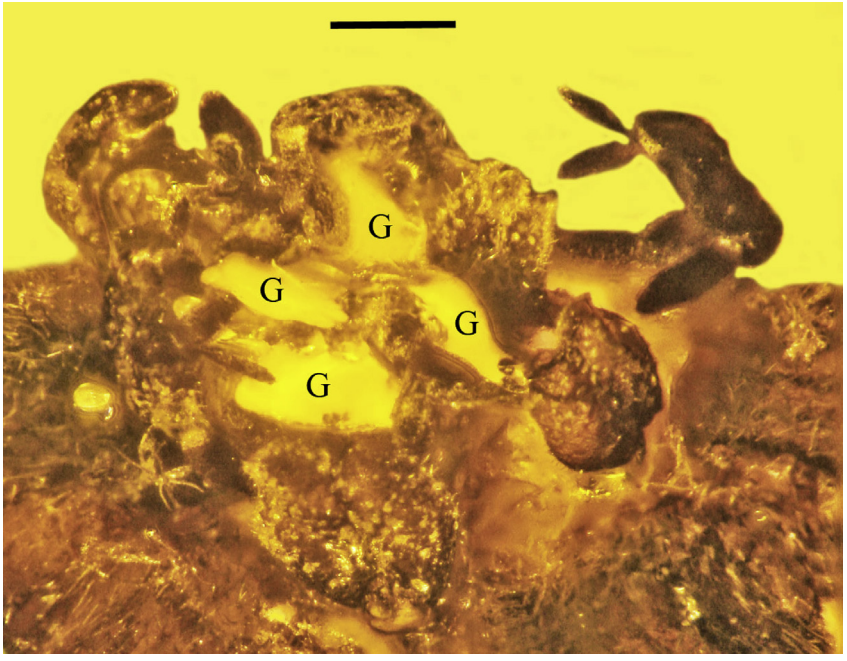

Fig. 3. Top view of *Cascolaurus burmitis* gen. et sp. nov. in Myanmar amber. G = glands with secretions. Scale bar = 340 μm.

extrose dehiscence in whorl 3, and extremely large staminal glands distinguish the fossil from extinct and extant genera of the Lauraceae (Rohwer, 1993).

While the flower is clearly post-anthesis, a few putative pollen grains were located amidst hairs covering the tops of the inner whorl of tepals. These putative grains were spheroidal, apolar, inaperturate with a greatly reduced exine and ranged from 25 to 28 μm in diameter (Fig. 4, insert). While it was not possible to determine if the exine was spinulose, the observed features are similar to those found in extant pollen grains of the family (Van der Merwe et al., 1990).

Currently, the Laurales are divided into several families, all except two (Calycanthaceae and Monimiaceae s. str.) of which have valvate anthers. The Momimiaceae have unisexual flowers but the perianth is absent or tetramerous. The Siparunaceae have bisporangiate anthers that dehisce by a single hinged valve. The Atherospermataceae and Hernandiaceae have bisporangiate anthers and flowers of Calycanthaceae and Gomortegaceae are bisexual (Friis et al., 2011).

Following the treatment of Rohwer (1993), *Cascolaurus burmitis* gen. et sp. nov. falls in the Laureae (Lauraceae) and based on its features, closely resembles the unisexual flowers in the genus *Litsea*

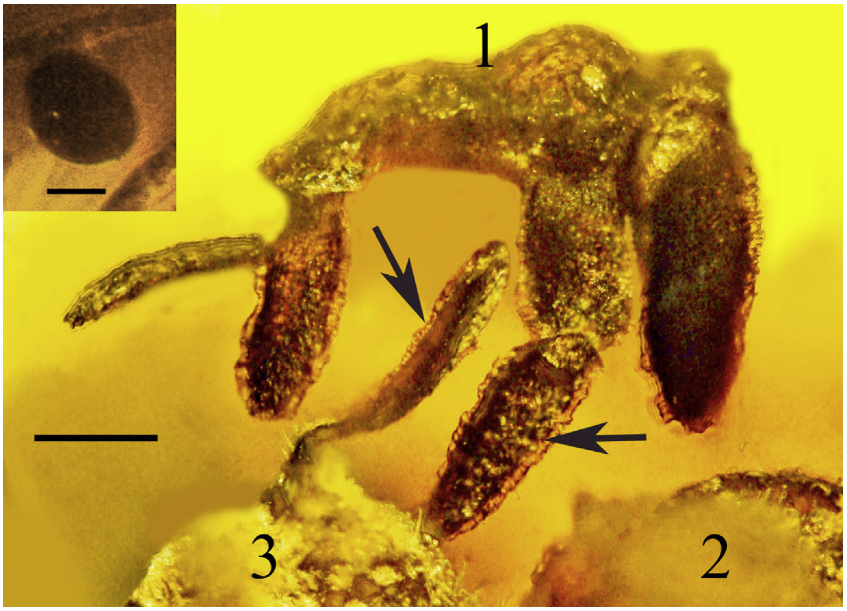

Fig. 4. Anthers of *Cascolaurus burmitis* gen. et sp. nov. in Myanmar amber showing first whorl (1) with introse dehiscence opposite anther of third whorl (3) with extrose dehiscence (arrows show flaps of third whorl anther pointing to outside of flower). A portion of a second whorl anther (2) is also present. Scale bar = 140 μm. Insert shows putative pollen grain. Scale bar = 13 μm.

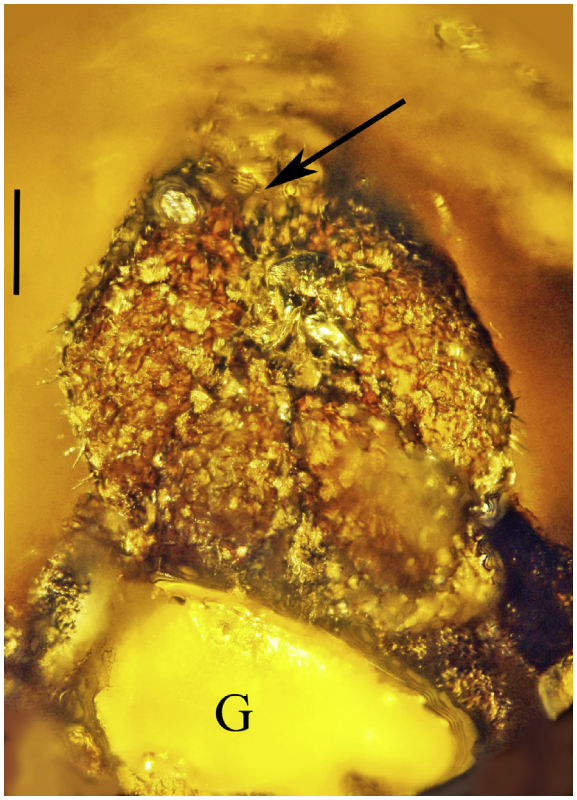

Fig. 5. Peltate scales covering dorsum of anther of *Cascolaurus burmitis* gen. et sp. nov. in Myanmar amber. Arrow shows attachment point with filament. G = portion of gland. Scale bar = 143 μm.

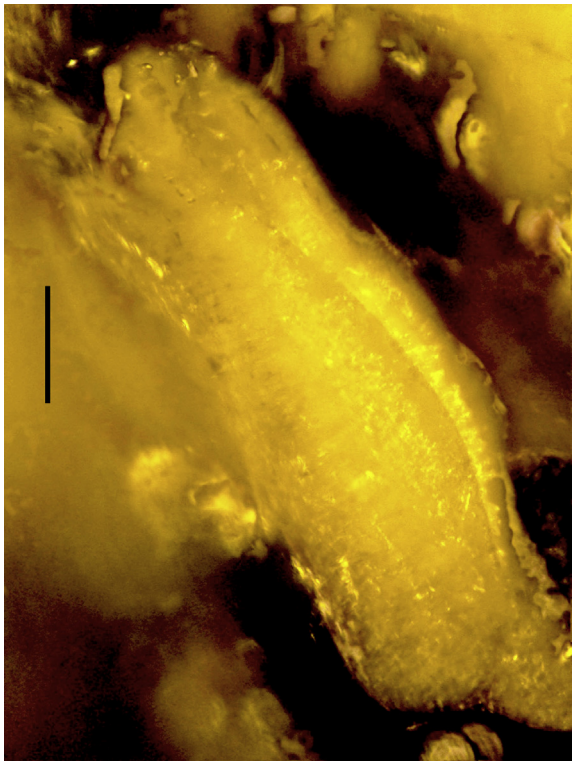

Fig. 6. Elongate gland of *Cascolaurus burmitis* gen. et sp. nov. in Myanmar amber. The partial gland on the left is covered with a liquid deposit that is probably nectar. Scale bar = 74 μm.

Lam. that has trimerous flowers with 9 stamens with the third whorl bearing glands and 4-locular anthers with the pollen sacs arranged in two rows. However *Litsea* has subequal tepals and the pollen sacs are all introse or laterose. *Sassafras* Presl. has mostly unisexual trimerous flowers with 9 fertile stamens with the third whorl possessing glands. The anthers can be 4-locular with pollen sacs arranged in two pairs above each other. However all three rows of pollen sacs in *Sassafras* are usually introse. *Parasassafras* Long also has trimerous, unisexual flowers with 9 fertiles stamens, the third whorl bearing glands. But the tepals are subequal and anthers of all three whorls have introse pollen sacs. *Cinnadenia* Kosterm.

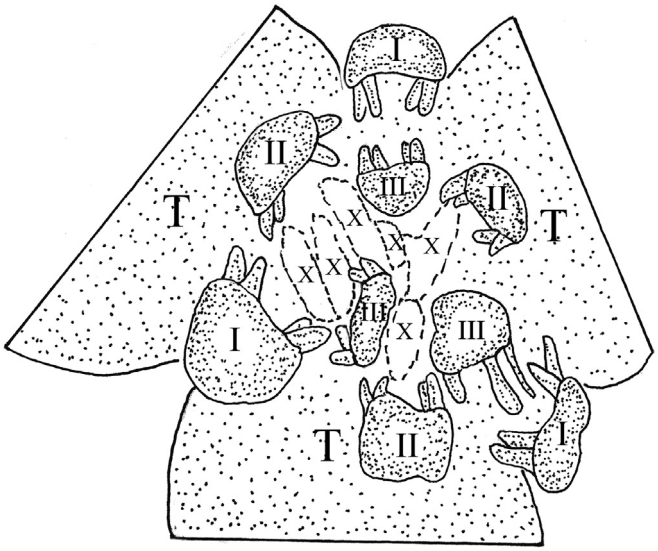

Fig. 7. Drawing of top of *Cascolaurus burmitis* gen. et sp. nov. in Myanmar amber showing the three whorls of stamens (series I, II and III) and six glands (X). T = inner series of tepals. Scale bar = 740 μm.

also has trimerous, unisexual flowers with 9 stamens and 4-locular anthers with the pollen sacs arranged in two pairs above each other. However the tepals are subequal and pollen sacs are all introse (Rohwer, 1993). Of these four extant genera of Lauraceae with flowers similar to the fossil, *Litsea* is the only genus well represented in Myanmar today, with some 44 species of shrubs and trees (Kress et al., 2003). Some similarities, especially the unequal tepals and the somewhat longitudinally cleft glands, also occur between the fossil and members of the genus *Caryodaphnopsis* Airy-Shaw. However the flowers of *Caryodaphnopsis* are bisexual, the outer tepals are scale-like and they possess conspicuous staminodes of whorl four (Rohwer, 1993).

4. Discussion

The enlarged staminal glands of *Cascolaurus burmitis* gen. et sp. nov. are rare in other members of the Laureae, however they occur in the bisexual Neotropical genus *Pleurothyrium* Nees ex Lindl. of the Perseeae Nees (van der Werff, 1993). In *Pleurothyrium*, the glands always grow outward and can protrude between the six outer stamens. In some species of *Pleurothyrium*, the glands become confluent and form a large, pillow-like mass with the anthers embedded in the surface, which resembles the condition found in *Cascolaurus burmitis* gen. et sp. nov. A detailed examination of the fossil glands shows what appears to be a liquid deposit over or adjacent to some of them (Fig. 6). This deposit is probably nectar secreted from the staminal glands. There are two types of nectar-producing glands in Lauraceae, staminal and staminodial glands. The staminodial glands are primarily found in bisexual flowers and are usually lacking in dioecious species like the fossil (Rohwer, 2009). Nectar production in *Umbellularia californica* (Hook. & Arn.) Nutt. occurs when the epidermal cells of the glandular surface break down and release nectar as a sticky secretion (Kasapligil, 1951). The same process appears to have occurred in the flower of *Cascolaurus burmitis* gen. et sp. nov.

There are many classifications proposed for the family Lauraceae. Those presented previous to 1995 are summarized by van der Werff and Richter (1996). One of the latest is the system submitted by Rohwer (2000) who used both morphological and molecular data to compare generic lineages. Rohwer (2000) discovered that the genetic divergence within the family is low and provided evidence that there was an early separation into a Gondwanan and a Laurasian–South American group. Based on its resemblance to members of the genus *Litsea* and its geographic location, *Cascolaurus burmitis* gen. et sp. nov. probably belongs in the terminal group of the Laurasian–South American group. *Litsea* is an Asian-American disjunct genus that may have migrated between the Old World and New World more than once (Rohwer, 2000). With the absence of well preserved Cretaceous fossils from the southern hemisphere, *Cascolaurus burmitis* gen. et sp. nov. may represent one of the basal lineages of this group, suggesting that at least one element of the Laurasian–South American group evolved in Laurasia and then migrated to the Americas.

5. Concluding remarks

Based on sedimentary fossils, the Lauraceae can be traced back to the Early Cretaceous with floral remains from the early Albian, Cenomanian and Turonian (Friis et al., 2011). *Cascolaurus burmitis* gen. et sp. nov. is the first Cretaceous Lauraceae flower in amber and the best preserved of all known Cretaceous flowers of the family. Cenozoic species of *Persea* Mill. and *Treptostemon* Chambers, Poinar & Chanderbali have been described in Dominican amber (Chambers et al., 2011, 2012) and *Cinnamomum prototypum* Conw. was described from Baltic amber (Conwentz, 1886). The circa 100 Ma date for *Cascolaurus burmitis* gen. et sp. nov. is consistent with Rohwer's (2000) belief that Lauraceae with a modern-looking flower structure have been present for at least some 100 million years.

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