

# TROPIDOGYNE EUTHYSTYLA SP. NOV., A NEW SMALL-FLOWERED ADDITION TO THE GENUS FROM MID-CRETACEOUS MYANMAR AMBER

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## ABSTRACT

***Tropidogyne euthystyla***, described here, is the fourth species of this fossil genus to have been reported from amber deposits in northern Myanmar. The species are alike in features of the calyx, the shape and venation of the inferior ovary, and the absence of petals. They differ in the number and form of the styles, the lobing of the epigynous disc, and whether the flowers are apparently bisexual or unisexual. In the one species for which several flowers are available for study, *T. pentaptera*, floral diameters vary from 3.5 to 5.0 mm. The present species, known only from a single flower, is the smallest in the genus, with a floral diameter of only 2 mm. It differs from the 3 previously described species in having 2 stout, erect styles bearing a terminal stigma, whereas the other species have 2 or 3 short or long, arching styles that are decurrently stigmatic along the adaxial surface.

## RESUMEN

***Tropidogyne euthystyla***, que se describe aquí, es la cuarta especie de este género fósil que ha sido reportada de depósitos de ámbar en el norte de Myanmar. Las especies son similares en las características del cáliz, la forma y venación del ovario ínfero, y la ausencia de pétalos. Difieren en el número y la forma de los estilos, la lobulación del disco epigino, tanto si las flores son aparentemente bisexuales o unisexuales. En la única especie para la que hay varias flores disponibles para su estudio, *T. pentaptera*, los diámetros florales varían de 3,5 a 5,0 mm. La especie actual, conocida sólo a partir de una sola flor, es la más pequeña del género, con un diámetro floral de sólo 2 mm. Se diferencia de las 3 especies descritas anteriormente por tener 2 estilos robustos y erectos que llevan un estigma terminal, mientras que las otras especies tienen 2 o 3 estilos cortos o largos, arqueados que son estigmáticos decurrentemente a lo largo de la superficie adaxial.

## INTRODUCTION

Mines in the Hukawng Valley in Kachin State, northern Myanmar, have been a source of commercial amber for nearly 2000 years (Poinar et al. 2006). In recent decades, civil unrest in the region followed by governmental intervention has closed many of the mines, but amber continues to be extracted, exported to China, and sold in cities such as Tengchong in adjacent Yunnan Province (Sokol 2019; Poinar & Ellenberger 2020). Specimens of amber that contain fossils of plants or animals are much sought after by collectors; they often are ground, polished, and sold as pieces of jewelry (Poinar & Chambers 2019a, 2020a). In recent years, over 25 new genera of fossil angiosperms have been described from Myanmar amber, which is mid-Cretaceous in age (citations in Chambers & Poinar 2020; Poinar et al. 2020; Poinar & Chambers 2020b). Evidence for the age and geology of the amber deposits is summarized in the following Section.

The new species *Tropidogyne euthystyla* is similar to the three previously described species in its calyx, its inferior 10-veined ovary, and the presence of an epigynous, probably nectariferous disc. It is distinct, however, in its combination of a 2-lobed disc and two erect, terminally stigmatic styles. In *T. pikei* (Chambers et al. 2010), *T. pentaptera* (Poinar & Chambers 2017), and *T. lobodisca* (Poinar & Chambers 2019b), the epigynous disc may

be 2-, 3-, or 5-lobed. Both *T. pentaptera* and *T. lobodisca* have two styles, but theirs are slender, arched outward, and decurrently stigmatic on the inner surface. *Tropidogyne pikei* has a 3-lobed disc and three short, curved, sharply acute styles. As discussed in our earlier papers, the floral morphology of *Tropidogyne* suggests a relationship to the family Cunoniaceae, particularly to the Southern Hemisphere genus *Ceratopetalum*. While the calyx and ovary of *T. euthystyla* support this possible relationship, its stout, upright styles appear to be more similar to those of *Cunonia* (Dickson 1989, figs. 4.3B, 4.3C) than to the curved, acutely-tipped styles of *Ceratopetalum aphyllum* (op. cit., fig. 4.2F).

#### MATERIALS AND METHODS

The specimen of *Tropidogyne euthystyla* is enclosed in a block of amber that was obtained from mines at the Noije Bum 2001 Summit Site in Kachin Province, Myanmar. The currently accepted age for this amber is  $98.79 \pm 0.63$  Mya, reported by Shi et al. (2012) on the basis of U-Pb radiometric dating of volcanic zircons deposited contemporaneously with the amber. Other recent authors who have described fossil angiosperms from this site (e.g., Crepet et al. 2016; Liu et al. 2018) agree in their use of this date, which approximates the mid-Cretaceous Albian/Cenomanian boundary. The geology of the Noije Bum site and lithology of its amber-containing marine sediments is described in detail by Cruickshank and Ko (2003). The source of the amber is resin from trees of the conifer family Araucariaceae, perhaps the Southern Hemisphere genus *Agathis* (Poinar et al. 2007).

Observations and photographs were made with a Nikon SMA-10R stereoscopic microscope at 80 $\times$  and a Nikon Optiphot microscope with magnifications up to 600 $\times$ . Helicon Focus Pro X54 was used to stack photographs for better depth of field. Background details were removed to improve image clarity.

#### DESCRIPTION

***Tropidogyne euthystyla*** Poinar, K. Chambers, & F.E. Vega, **sp. nov.** (Figs. 1–3). TYPE: MYANMAR (BURMA). KACHIN: amber mine in the Hukawng Valley SW of Maingkhwan, 26°20'N, 96°36'E, 2020, *unknown amber miner s.n.* (HOLOTYPE: Catalog number B-An-21, deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon 97331, U.S.A.).

Flower short-pedicellate, bisexual (?), 2 mm in diameter as measured between sepal tips, calyx epigynous, sepals 5, lanceolate, ascending, 1.1 mm long, 0.4 mm wide, minutely puberulent abaxially, apex acute, venation of 1–3 main veins from the base with a reticulum of veinlets above (Figs. 1, 3), marginal veins connected between adjacent sepals (Figs. 1, 2), petals 0, stamens 5 or 10 (?), filaments broken off to near the base in the fossil (Fig. 1), ovary inferior, epigynous nectar disc 0.7 in diameter, 2-lobed, surface pitted (Figs. 1, 2), styles 2, columnar, erect, 0.784 mm long, stigmas terminal (Figs. 1, 2), inferior portion of pistil obconic, minutely puberulent, height 0.35 mm, width 0.7 mm at the apex, prominently 10-veined, the alternate veins connected to sepal mid-nerves (Figs. 1, 2), pedicel (as preserved) 0.6 mm long, glabrous. Pollen unknown.

**Etymology.**—Species epithet from the Greek “euthys,” straight or upright, and “stylos,” pillar or column, for the erect styles.

#### DISCUSSION

*Tropidogyne euthystyla*, like other species of the genus, has rather firm, lanceolate sepals arising around the apex of a distinctly 10-veined inferior ovary. Sepals in all the known species have 1–3 major veins from the base, which are interconnected by a network of anastomosing veinlets throughout the body of the sepal (Fig. 3). The sepals, as well as the inferior ovary, are puberulent in *T. euthystyla*, whereas these structures are glabrous in the other 3 species. The epigynous disc in species of *Tropidogyne* is conspicuously pitted and in life was probably glandular and nectariferous (Chambers et al. 2010, fig. 2; Poinar & Chambers 2019b, fig. 1). It is assumed that the flower of *T. euthystyla* is bisexual, owing to the presence of one or two basal stubs of broken-off filaments (Fig. 1). In the 3 other species of the genus, flowers were either bisexual (*T. pikei*; Chambers et al. 2010), unisexual (*T. lobodisca*; Poinar & Chambers 2019b), or indeterminate based on available fossils (*T. pentaptera*; Poinar & Chamber 2017). As noted below, *T. euthystyla* differs from the other species in having two erect styles, each with a terminal stigma. In *T. pentaptera* and *T. lobodisca*, the paired styles are slender, arched outward, and decurrently stigmatic on their adaxial surface, while *T. pikei* has 3 short, curved, acute styles whose stigmatic surface is indistinct.

The genus *Tropidogyne*, as first described, was based on the species *T. pikei*, in which the epigynous disc

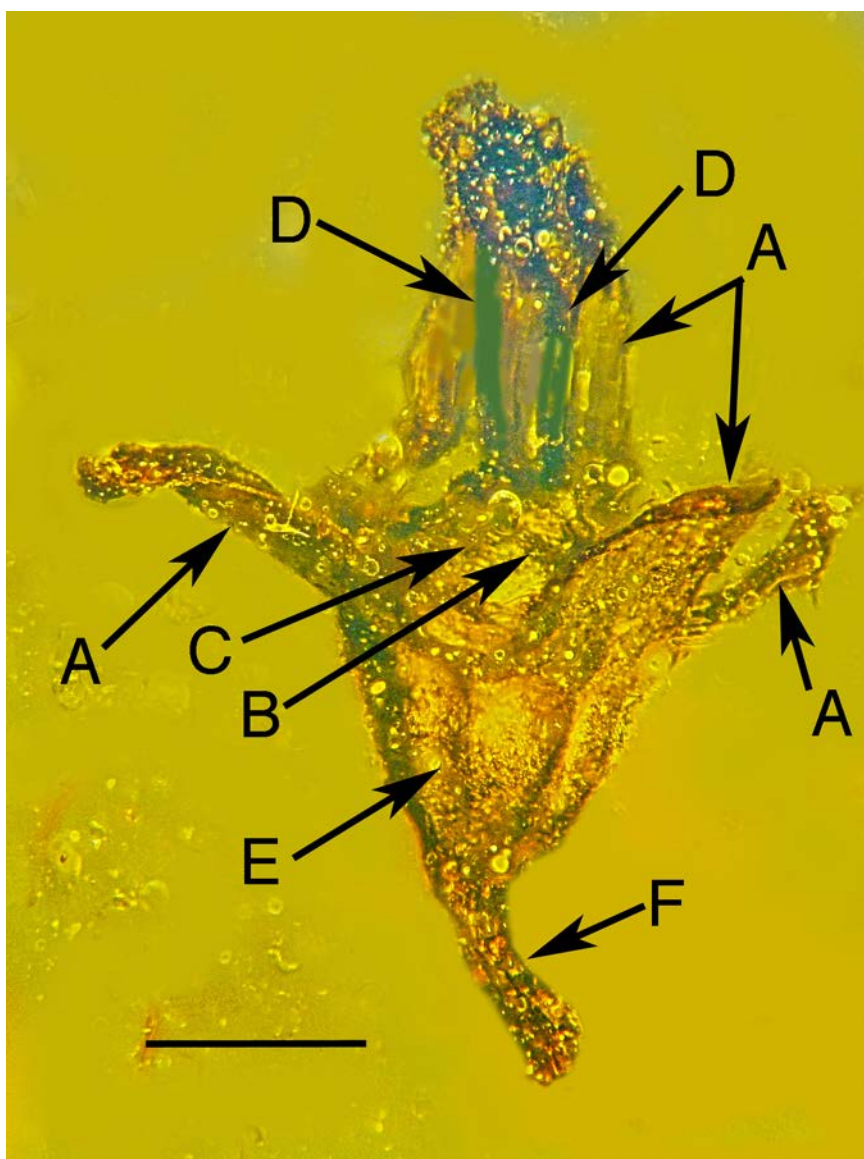


FIG. 1. *Tropidogyne euthystyla*. Lateral view of flower. **A.** Sepals. **B.** Basal stub of filament. **C.** Epigynous disc. **D.** Styles. **E.** Inferior ovary. **F.** Pedicel. The sepal on the right is abnormally reduced and distorted. Note the connection of marginal veins between one sepal and the next. Scale bar = 0.56 mm.

is distinctly 3-lobed. The inferior ovary is 10-veined, with a darkly pigmented spot at the apex of each vein. The 10 stamens are mostly represented by broken off filaments, the one remaining anther being small but apparently functional (pollen grains are present near the open thecae). A second species, *T. pentaptera*, is represented by 7 flowers, most of which show no evidence of having possessed stamens. However, in the holotype flower there is a single persistent stamen with a short filament and well-developed anther (Poinar & Chambers 2017, fig. 5). In the other 6 flowers, the stamens may have been deciduous or, alternatively, the stamens may have been lacking, making the flowers functionally pistillate. In the third species, *T. lobodisca*, the flower is

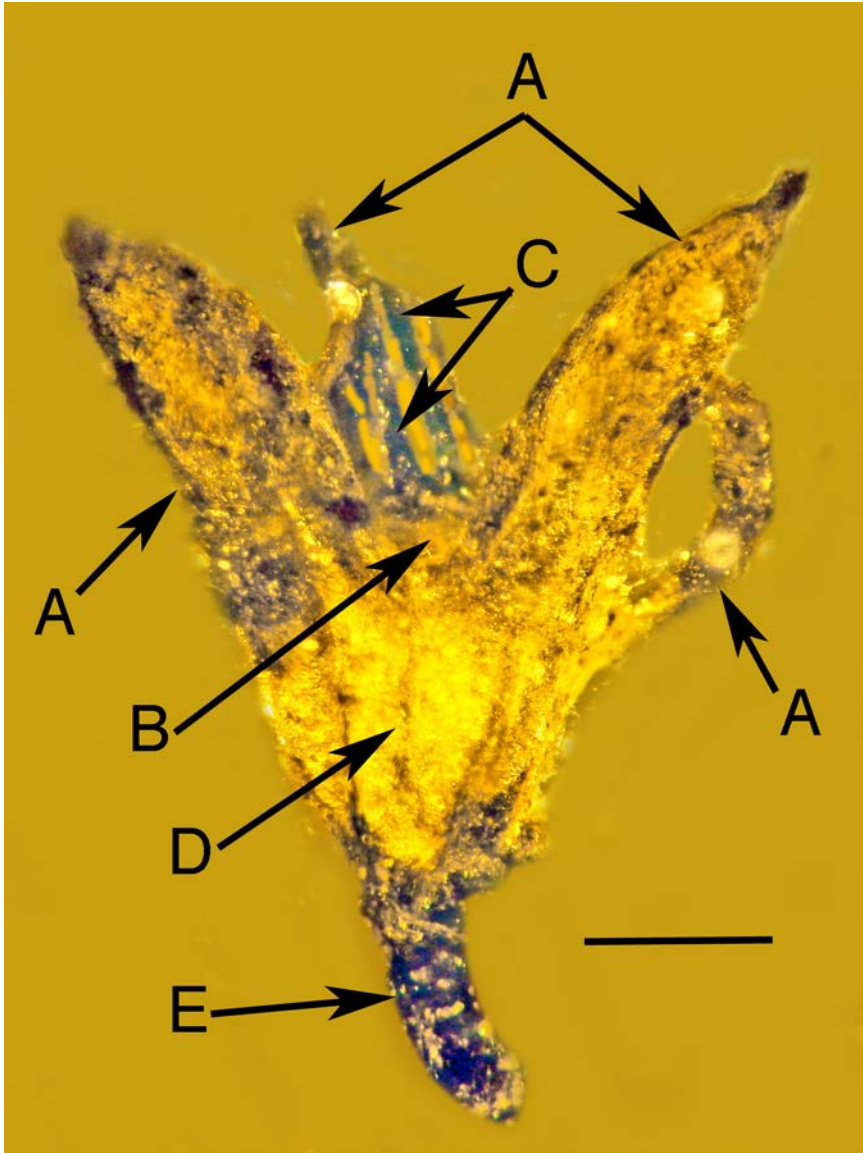


FIG. 2. *Tropidogyne euthystyla*. Lateral view of flower. A. Sepals. B. Epigynous disc. C. Styles. D. Inferior ovary. E. Pedicel. Styles have been outlined for clarity. Scale bar = 0.50 mm.

pistillate, the androecium being represented by two sepal-like staminodia (Poinar & Chambers 2019b, figs. 1, 2). The gynoecium is characterized by 2 slender, arched, acutely tipped styles, which are decurrently stigmatic along their inner surface like that of *T. pentaptera* (Poinar & Chambers 2017, figs. 5, 6). The epigynous disc is convex, 5-lobed, and rugosely pitted as in *T. pentaptera* and *T. euthystyla*.

The fruits of *Ceratopetalum*, with which the genus *Tropidogyne* has been compared, have been found as fossils in Eocene to Miocene deposits of Australia and Patagonia (Barnes & Hill 1999; Gandolfo & Hermsen 2017). In this genus, fruits are indehiscent and bear persistent, spreading sepals which act as wings during fruit



FIG. 3. *Tropidogyne euthystyla*. Sepal showing reticulate venation. Scale bar = 0.18 mm.

dispersal (anemochory per Dickison 1989, p. 63). Of the ca. 10 species of *Ceratopetalum*, all but one are apetalous like *Tropidogyne* (Bradford et al. 2004). Rather than comprising a glandular-pitted epigynous disc, as in *Tropidogyne*, the nectary of *Ceratopetalum* is enlarged, ring-shaped, and surrounds the base of the styles (Dickison 1989, fig. 4.2F). As noted above, the straight, erect styles of *T. euthystyla* more resemble those of the genus *Cunonia* than *Ceratopetalum*, while the arcuate, decussately stigmatic styles of *T. pentaptera* and *T. lobodisca* are like those illustrated for the related Cunoniaceae genus *Vesselowskyia* (op. cit., fig. 4.3E). According to Bradford et al. (2004, p. 94), the floral disc in Cunoniaceae “is most often distinct from the ovary but may be adnate to it,” as it is in all the known species of *Tropidogyne*.

The flower of *Tropidogyne euthystyla*, just 2 mm in diameter, is smaller than any of the other 3 species, but it is comparable in size to flowers of several genera of Cunoniaceae. Table 1 gives a comparison of floral diameters in the 4 species of *Tropidogyne* and in selected species of the latter family. Flowers in the size range of *T. euthystyla* can be found in *Pseudoweinmannia*, *Vesselowskyia*, and *Weinmannia*. Despite their size, small flowers may be conspicuously arranged in large, compact inflorescences such as the dense, raceme-like panicles of *Weinmannia heterophylla* (Bradford et al. 2004, fig. 37) or the globose heads of *Pancheria elegans* (op. cit., fig. 38).

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TABLE 1. Floral diameters of four *Tropidogyne* species and selected species in eight genera of Cunoniaceae. Diameters based on the estimated distance between the tips of opposing sepals.

| Species                                | Approximate Flower Diameter (mm) | Reference               |
|----------------------------------------|----------------------------------|-------------------------|
| <i>Karrabina biagiana</i>              | 6.7                              | Hopkins et al. 2013     |
| <i>Anodopetalum biglandulosum</i>      | 5.2                              | Barnes & Rozefelds 2000 |
| <i>Tropidogyne pikei</i> (fossil)      | 5.1                              | Chambers et al. 2010    |
| <i>Schizomeria carrii</i>              | 4.2                              | Hopkins 2018            |
| <i>Cunonia koghicola</i>               | 3.8                              | Pillon et al. 2008      |
| <i>Ceratopetalum gummiiferum</i>       | 3.5                              | Rozefelds & Barnes 2002 |
| <i>Tropidogyne pentaptera</i> (fossil) | 3.4–5.0                          | Poinar & Chambers 2017  |
| <i>Tropidogyne lobodisca</i> (fossil)  | 3.4                              | Poinar & Chambers 2019b |
| <i>Pseudoweinmannia lachnocarpa</i>    | 2.6                              | Rozefelds & Pellow 2011 |
| <i>Tropidogyne euthystyla</i> (fossil) | 2.0                              | Present paper           |
| <i>Vesselowskyia rubifolia</i>         | 1.5                              | Rozefelds et al. 2001   |
| <i>Weinmannia auriformis</i>           | 1.4                              | Rogers 2002             |

36). The inflorescence of *Ceratopetalum* is described as “thyrsoid to cymiform” (op. cit., p. 103). To find several attached flowers together in a block of amber is rare (although not unknown—see *Micropetasos*, Poinar et al. 2013; *Endobeuthos*, Poinar & Chambers 2018; *Dispariflora*, Poinar & Chambers 2019a), and it seems unlikely that we will ever learn what type of inflorescence was present in *T. euthystyla*.

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