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A new phytophagous species of *Eurytoma* (Hymenoptera: Eurytomidae) attacking *Werauhia gladioliflora* (Bromeliales: Bromeliaceae)

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Abstract

Eurytoma werauhia Gates, new species, is described and illustrated. This species was reared from the floral buds of *Werauhia gladioliflora* (Wendl.) (Bromeliales: Bromeliaceae), in Costa Rica. This plant represents a new host record for the genus. *Eurytoma werauhia* is compared with other known species of *Eurytoma*, primarily due to its host and metasomal coloration.

Key words: Eurytomidae, Bromeliaceae, phytophagous, Eurytoma, Werauhia

Introduction

The genus *Eurytoma* Illiger is both speciose and widely divergent in its host range (Noyes 2002). Of approximately 700 nominal species worldwide, 204 are known from the New World, with 84 known from the Neotropical region (Noyes 2002). Only 28 Neotropical species have documented host records, with none of those species known to be phytophagous in Bromeliaceae. In North America, *Eurytoma aerflora* Bugbee is associated with bromeliads, but as a primary parasitoid of *Epimorius testaceellus* Ragonot (Lepidoptera: Pyralidae) (Bugbee 1967; Heppner 1992; Noyes 2002), which consumes floral buds of *Tillandsia fasciculata* Sw. (Bromeliaceae). In the Neotropics there are no reports of phytophagous *Eurytoma* attacking Bromeliaceae, but hosts are known for only 18 of 43 South American species (Noyes 2002).

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Materials and Methods

The female description below is based on the holotype. Larval chaetotaxy follows Roskam (1982). Structures not visible on the holotype but shown in the figures are indicated by brackets. Abbreviations used are USNM (United States National Museum, Washington, D.C.) and NMCR (National Museum of Costa Rica, San José).

Eurytoma werauhia Gates, new species

(Figs. 1–15, 18, 19, 21)

Diagnosis.— F1 broadened apically with double staggered row of longitudinal sensilla in apical half, 1.2 X as long as F2; extensive reddish brown coloration on gaster laterally, ventrally and in dorsal third (medially); procoxa reticulate laterally and in anterobasal 2/3, carinate anteroapically, depressed anteriorly in basal half for reception of lower head, depression strongly carinate along outer edge and semicircular in frontal view; petiole barely 2 X as long as greatest thickness, ventral margin with several complete strong longitudinal carinae, dorsally rugose.

Female holotype.—Body length 6.2 mm. Color: black; following areas yellow: scape, pedicel, anellus, tegula, pretarsus; following areas reddish brown: all coxae, legs, gaster laterally, ventrally and in dorsal third (medially); following areas white: meso and metatibiae apically, all tarsomeres; following area brown: wing veins. Sculpture: face (Fig. 3), mesepisternum (anterior to femoral depression), metapleuron, and lateral areas of propodeum (Figs. 6, 7) covered with contiguous setigerous punctures, interstices alveolate dorsally, appearing microreticulate at low magnification; supraclypeal area and gena convex, microreticulate; lateral panel of pronotum elongate-imbricate; mesepimeron and femoral depression striate; prepectus glabrous, concave along longitudinal axis, concavity transversely carinate, ovately concave ventrally, set off from lateral concavity by robust carina (Fig. 8), [ventral prepectus fused to mesosternum posteriorly]; procoxa reticulate laterally and in anterobasal 2/3, carinate anteroapically; coxae variously microreticulate, mesocoxa more polished than metacoxa; propodeum smooth, with numerous carinae forming irregular asetose cells (Fig. 7), median channel carinate laterally, these carinae cross-connected by weaker carinae to irregular median carina; metasoma mostly glabrous (Figs. 5a, b). *Prosoma*: Genal carina well developed (Fig. 4); scrobal basin carinate laterally; interantennal projection in lateral view a semicircular lamina extending ~0.2 X length of scape; clypeus shallowly bilobate (Fig. 3); ratio of lateral ocellus:ocellocular distance:postocellar distance 10:22:29; scape reaching just above midocellus; ratio scape (minus radicle):pedicel:anellus:F1:F2:F3:F4:F5:club as 48:10:3:24:20:18:117:16:40; F1 broadening apically, with double staggered row of longitudinal sensilla in apical half (Fig. 1); C1 with discrete separation from C2+C3. *Mesosoma*: [Propleuron (Fig. 8) subtriangular; prosternum (Fig. 8) triangular, posterior margin with setigerous depressions, 4–5 cruciate setae

medially]; procoxa depressed anteriorally in basal half for reception of lower head, depression strongly carinate along outer edge (Fig. 14), semicircular in frontal view; mesopleuron/mesepisternum (Figs. 6, 8) with arcuate carinae meeting medially and forming a ridge between procoxae, procoxal depressions rugulose, subpleural area (mesosternal shelf) flat, subequal to mesocoxal diameter (Fig. 6); ratio marginal vein:postmarginal vein:stigmal vein as 55:32:25 (Fig. 15). *Metasoma*: Teardrop-shaped in lateral view, ovipositor angled slightly dorsad horizontal (Fig. 5a); gastral petiole [Mt1, difficult to see without dissection] somewhat asymmetric in lateral view (Fig. 5a), with dorsal length barely 2 X as long as greatest thickness, ~0.5 X as long as metacoxa, ventral margin with several complete strong longitudinal carinae, dorsally rugose; ratio of petiole (dorsal length measured in lateral view), Mt2 – Mt8, ovipositor sheath (all measured dorsally): 6:7:13:19:48:30:18:8:4.

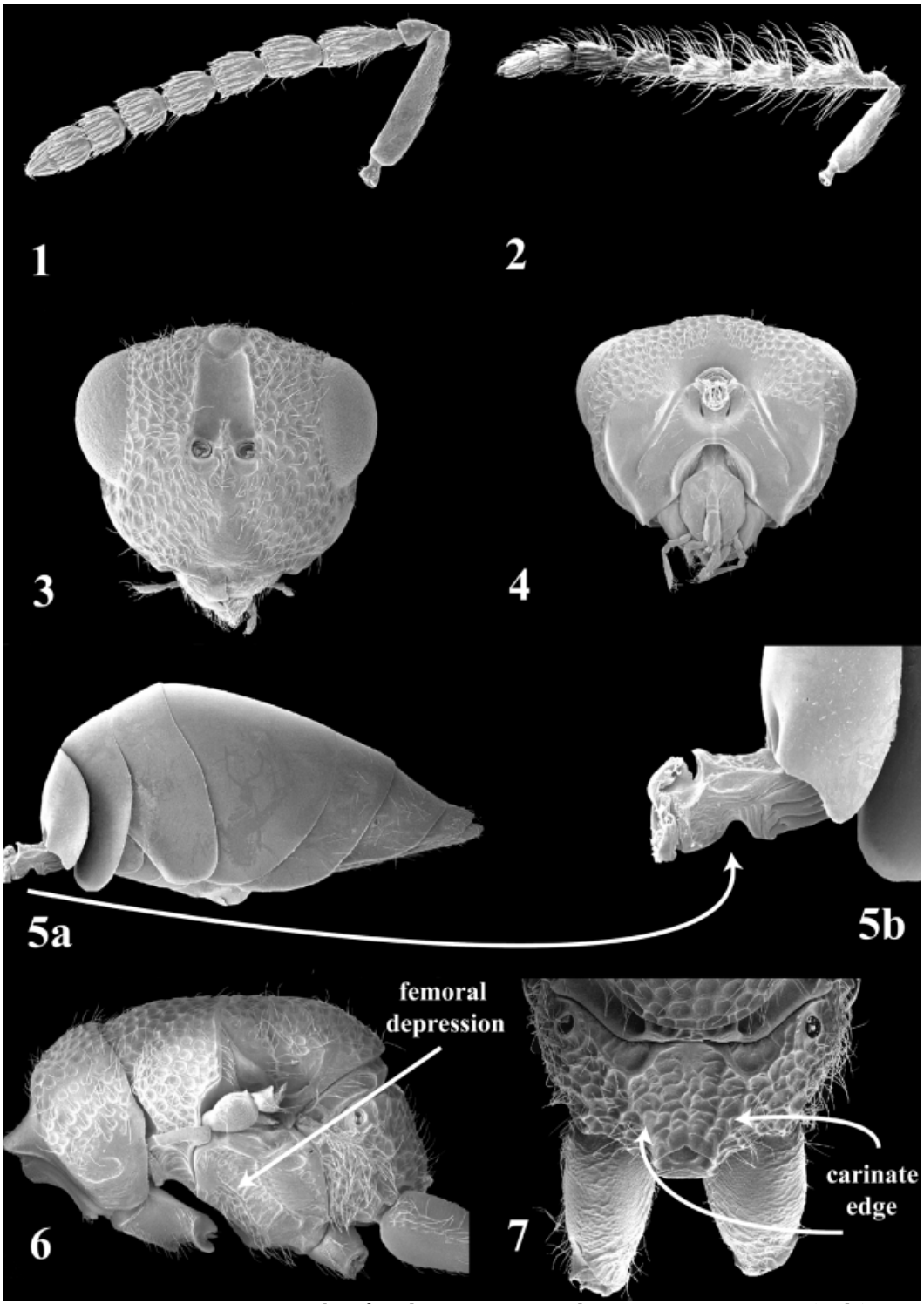
Male.— Body length 4.9–5.3 mm. Color: black, yellow and reddish-brown areas as described for female; gaster entirely black dorsally, reddish brown only laterally and ventrally. Sculpture as for female. Antennal (Fig. 2) segments pedicellate with 2 or more rows of erect setae each 1–2 X as long as width of segment; ratio scape (minus radicle):pedicel:anellus:F1:F2:F3: F4:F5:club as 48:9:3:31:27:27:25:16:33. Gastral petiole (in lateral view) cylindrical (Fig. 9), dorsal length about 3 X as long as greatest thickness, slightly longer than metacoxa, without carinae, evenly rugulose.

Variation.—Females vary in length between 5.8–6.5mm. In females, the yellow areas vary from bright, clear yellow to varyingly infused with black, especially the mesofemur. The pro- and metafemora may be nearly all black but the base and apex generally retain a small amount of yellow. On some males and females the anterolateral edge of the pronotum may be carinate, and in the case of a few males it projects outward as a perceptible flange.

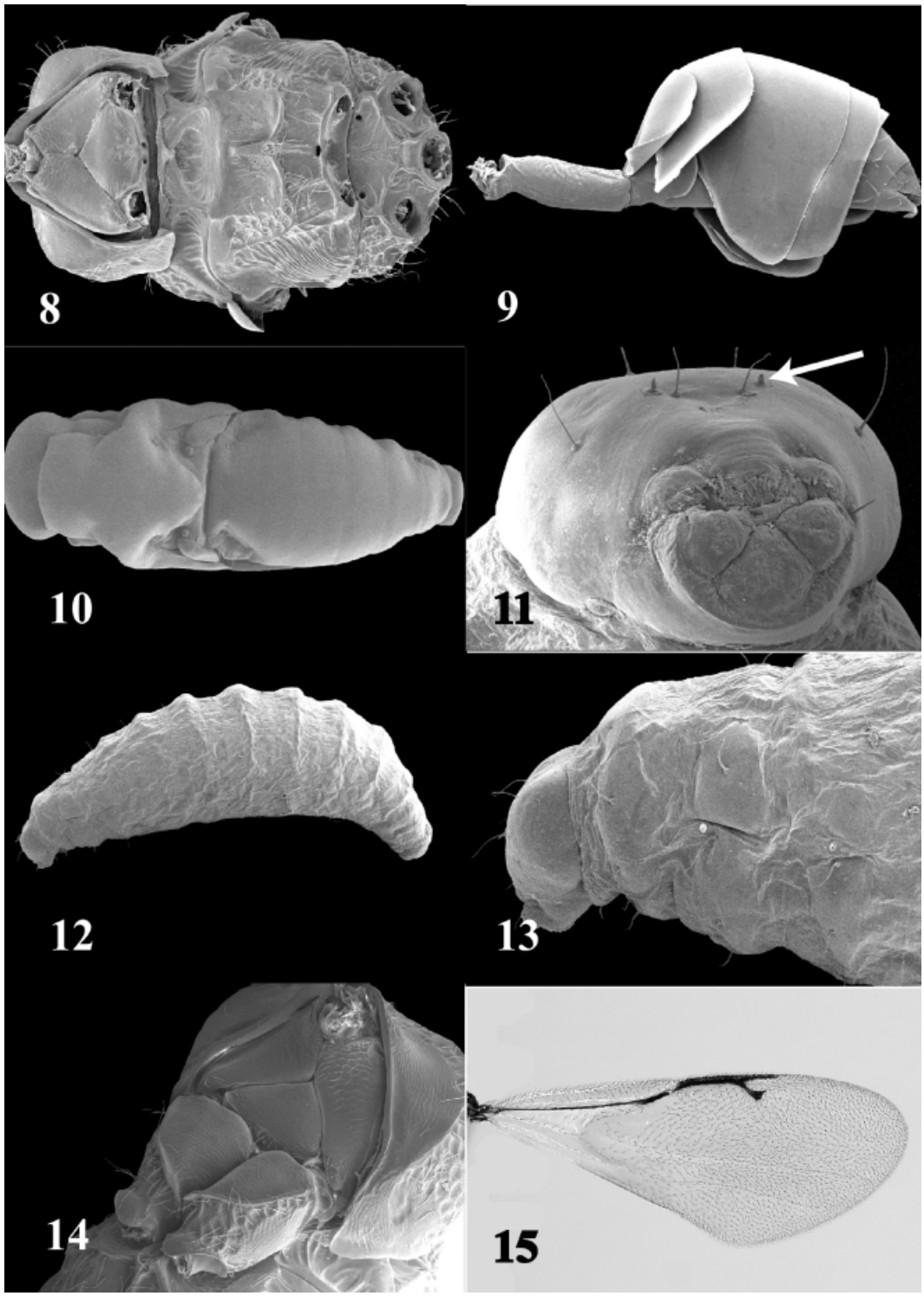
Larval Description.—Length final instar 7.5–8.5 mm; maximum width 1.9–2.7 mm.

Body barrel-shaped, broadest medially, tapering anteriorly and posteriorly (Fig. 12). Color whitish, greenish tinge when alive or in ethanol. Antenna ~2.0x as long as broad (Fig. 11, arrow). Mandibles of type 1, heavily sclerotized. Setae moderately to heavily sclerotized, long, conspicuous (Figs. 11–13). TH1–2 with four dorsal setae (2 Ds and 2 Di), one pair pleural setae (P), one pair lateral setae (L), and one pair ventral setae (V); TH3 with two dorsal setae (2 Ds), one pair pleural setae (P), one pair lateral setae (L), and one pair ventral setae (V); A1–8 each with less conspicuous pair Ds setae, a single pair P (A1 has two pair) and a single pair V setae (sometimes absent). AS with two pair inconspicuous dorsal setae, ventral setae absent. One larva lacks V setae from both A2 and A3 and has an additional single dorsal seta medially on T3.

Pupal Description.— Length 4.5–6.2 mm; maximum width 1.2–1.9 mm.
The pupal stage is the obtect form typical of most Chalcidoidea, and lacks distinguishing features; glabrous (Fig. 10).



FIGURES 1–7. *Eurytoma werauhia*, female, except as noted: 1, antenna; 2, antenna (male); 3–4, anterior, posterior head; 5a, lateral metasoma; 5b, lateral petiole; 6, lateral mesosoma; 7, propodeum.



FIGURES 8–15. *Eurytoma werauhia*, female, except as noted: 8, ventral mesosoma; 9, lateral metasoma (male); 10, dorsal pupa; 11, anteroventral head, larva; 12, lateral habitus, larva; 13, anterolateral habitus, larva; 14, procoxae; 15, fore wing.

Type specimens.— Holotype ♀, here designated. Costa Rica, Puntarenas, Monteverde, Tilarán Mtns, Pacific slope, Upper San Luis river watershed, 1050m, 10°17'10"N 84°47'40"W, 24.xi–7.xii.2002, A. Cascante-Marin (USNM). Paratypes, 7♀ 18♂, same data as holotype (4♀, 11♂, USNM; 3♀, 7♂ MNCR).

Etymology.— This species is named for the genus of bromeliad with which it is associated.

Host.—Reared from floral buds of *Werauhia gladioliflora*.

Distribution.—Known from a single locality in Costa Rica.

FIGURES 16–21. *Werauhia gladioliflora*: 16, flowering specimen, in situ; 17, infested inflorescence; 18, male of *E. werauhia* drowned in bractal mucilage; 19, dissected floral bud with *E. werauhia* larva; 20, floral buds with damage by *E. werauhia*: emergence holes and necrotic interiors; 21, dissected floral bud with *E. werauhia* pupa.

Discussion

Eurytoma werauhia was discovered during a study of the reproductive biology of epiphytic bromeliads in a premontane tropical forest in Costa Rica. Although species near *E. werauhia* have been collected from other sites in the Neotropics (Costa Rica and Brazil) and associated with flowers of bromeliads (*e.g.*, *Tillandsia* sp.), no information about their interactions with the bromeliad is available. The discovery of *E. werauhia* in the Upper San Luis Valley of Monteverde, Costa Rica, consuming the flowers of *Werauhia gladioliflora* is the first instance in which phytophagy is documented for bromeliad-associated species of *Eurytoma*. *Werauhia gladioliflora* (Fig. 16) is a medium to large (leaf length = 36–80cm) size bromeliad distributed from México to northern South America. In Costa Rica, it grows in humid forests from sea level up to 1200 m (Morales 2000) and flowers from October throughout December, until the end of the rainy season in the Monteverde area. This species is bat-pollinated and the flowers remain open during one night; usually a plant opens a single flower per night (Cascante-Marín et al., *in prep.*). The flowers are borne in a single spike (inflorescence length = 40–108 cm; 9–36 flowers per inflorescence) (Figs. 16, 17) and the floral buds are completely hidden by a bract. Adult females of *E. werauhia* oviposit into the developing inflorescence, presumably depositing a single egg per ovule, although this has yet to be documented. The larva manages to enter the floral bud by an unknown manner through the calyx surrounding the corolla. A single larva develops inside the floral bud while feeding on the immature pollen grains from the anthers, sometimes eating the style, but leaving the ovary untouched (Figs. 19–21). The larva pupates (Fig. 21) inside the floral bud with the adult emerging after 6–7 weeks by chewing an exit hole through the calyx and the bract covering the floral bud (Figs. 17, 20). Some newly eclosed specimens occasionally become trapped in the plant's mucilage (Fig. 18) in failed emergence attempts. During pupation, the floral development is arrested, thus inhibiting the anthesis. Since the flowers develop acropetally (base to apex) along the spike, infected buds are easily detected as those missing in the sequence of flower opening along the inflorescence.

Eurytoma werauhia belongs to the widespread subfamily Eurytominae, whose members are chiefly primary/secondary parasitoids, but with a few strictly phytophagous genera such as *Tetramesa* Walker, *Risbecoma* Subba Rao, *Austrodecatoma* Girault, *Systole* Walker, and *Ausystole* Bouček (Bouček 1988). The phytophagous species are mainly miners, gallers or seed-eaters known from at least 10 plant families (Zerova 1978), for example, Annonaceae, Apiaceae, Boraginaceae, Fabaceae, Myrtaceae, Orchidaceae, Poaceae, Podocarpaceae, Rubiaceae, and Vitaceae. Associations among eurytomids and epiphytic plants are exclusive to the Neotropical region, primarily Central and South America, but possibly extending into the southern United States (Gates, pers. obs. and label data) Species of *Aranedra* Burks and *Foutsia* Burks have been reared from root galls on Araceae (*Dieffenbachia* and *Philodendron*), and several new species of *Rileya* Ashmead are known

from galls on roots of Orchidaceae (*Cattleya, Laelia*; see Felt 1965; Kraus and Tanoue 1999), Cyclanthaceae (*Dicranopygium*; Gates pers. obs.), and Araceae (Burks 1971; Gates accepted). *Eurytoma orchidearum* (Westwood) has been found feeding on the buds and pseudobulbs of various species of *Cattleya*, *Laelia*, *Epidendrum*, *Brassavola*, and *Cypripedium* (Orchidaceae) (Swezey 1945; Tanada 1953; DeSantis 1979, 1980). It is expected that some related species within *Rileya* may be reared from galled aerial roots on *Tillandsia* (Bromeliaceae) (M. Gates, pers. obs.).

This paper represents the first documentation of a phytophagous eurytomid attacking an identified epiphytic bromeliad. All other recorded bromeliad-eurytomid associations are based upon label data or rearings from buds of unidentified bromeliads (A. Costa, pers. comm.) and have not definitively demonstrated phytophagy. Previously reported interactions among bromeliads and phytophagous insects have mainly described the effect of mining weevils (Coleoptera) on the plant vegetative tissues (*e.g.* Frank 1999; Benzing 2000) and no effect on the plant's reproductive organs has been shown. Our preliminary data suggest that *Eurytoma werauhia* detrimentally impacts the reproductive success of *W. gladioliflora* by affecting the floral display and reducing the potential reproductive output (Cascante-Marín *et al.,* unpubl.). A similar interaction has been described between a drosophilid fly and the shrub *Centropogon solanifolius* (Campanulaceae) in the same area of Monteverde (Weiss 1996) in which the fly larvae feed on the pollen without affecting further floral anthesis, but alter the flower sex expression. Given the wide distribution of *W. gladioliflora*, it is expected a similar distribution pattern for *E. werauhia* could potentially exist and that future field observations could expand our knowledge of its distribution and/or host range considerably.

Eurytoma werauhia keys to the *brevipetiolata* species-group (Bugbee 1967) based upon its elongate gastral petiole being roughly as long as broad and much shorter than the length of the metacoxa. It then keys to the *Tylodermatis* complex based upon coloration and form of the gaster and falls out at couplet 2 with *E. prunicola* Walsh and *E. celtigalla* Bugbee. Comparison, even with the naked eye, reveals that neither species is conspecific with *E. werauhia*: both sexes of *E. celtigalla* have an unmodified (acarinate) procoxa, a broadly depressed and finely carinaceous/punctate propodeum, a reticulate femoral depression, and an F1 that is only just longer than broad (female), and the male has a distinct swollen ventral plaque on the scape; both sexes of *E. prunicola* also have an unmodified (acarinate) procoxa and a finely reticulate femoral depression, but differ from *E. celtigalla* and *E. werauhia* by the robust ventral plaque (occupying apical third of scape in male), densely setose face, and thickened marginal vein. Additionally, *E. prunicola* and *E. celtigalla* are entomophagous on gall-forming Cynipidae on *Quercus* spp. and Cecidomyiidae on *Celtis* spp., respectively, and neither species is recorded from Costa Rica (Noyes 2002). In Bugbee's (1975) key to the species of *Eurytoma* of Central America, *E. werauhia* will not key beyond the first couplet because it lacks supraclypeal striae and does not attack gall-forming Cynipidae. We have compared specimens of *E. werauhia* to other spe-

cies of *Eurytoma* from the Neotropical region for which no identification keys are extant (as represented in USNM) and find nothing possessing its combination of size, color, morphology and host preference. The only known Neotropical species of *Eurytoma* similar to *E. werauhia* are undescribed and reside in the USNM.: 1) a series reared from the flowers of an unknown bromeliad in Brazil has much larger (up to 10.0 mm), differently colored individuals, but otherwise correspond morphologically to *E. werauhia*; 2) a small series associated with the flowers of *Tillandsia compressa* Bertero and *T. melanocrater* L. Smith in Costa Rica has similarly sized individuals, but they differ in the form of the gaster, wing setation, and sculpture.

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