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DICLIDOPHLEBIA LUCENS, N. SP. (HEMIPTERA: PSYLLIDAE) FROM COSTA RICA, A POTENTIAL CONTROL AGENT OF *MICONIA CALVESCENS* (MELASTOMATACEAE) IN HAWAII

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Abstract.—A **new species** of *Diclidophlebia* (Psyllidae: Paurocephalinae), ***D. lucens,*** is described from *Miconia calvescens* (Melastomataceae) in Costa Rica. This plant is an invasive weed in various Pacific islands and the new species described here represents a potential biological control agent. The egg, fifth instar larva, and adults are illustrated, the former being the first illustration of an egg for any species in the genus. Preliminary observations on the life cycle of this species are also provided.

Key Words: taxonomy, new species, Paurocephalinae, biological control of weeds, neotropics

Most of the approximately 3,000 described jumping plant-louse species have very narrow host plant ranges within the Dicotyledones. Some psylloids develop on crop, forest or ornamental plants where they can become important pests (Burckhardt 1994). Other species are associated with weeds and constitute potentially useful control agents. Examples are *Heteropsylla spinulosa* Muddiman et al. in Australia and New Guinea for the control of *Mimosa diplotricha* C.W. Wright ex Sauvalle (= *invisa* Martius) (Muddiman et al. 1992, Swarbrick 1997), *Prosopidopsylla flava* Burckhardt in Australia for the control of mesquite (*Prosopis* spp.) (Van Klinken 2000), and *Boreioglycaspis melaleucae* Moore in Florida for the control of *Melaleuca quinquenervia* (Cav.) S.T. Blake (Wineriter et al. 2003). Here we describe a new species of *Diclidophlebia* which is being studied as a potential biological control agent of *Miconia calvescens* Schrank and Mart ex DC. (Melastomataceae).

The pantropical genus *Diclidophlebia* Crawford has been redefined within the subfamily Paurocephalinae (Psyllidae) by Burckhardt and Mifsud (2003) to include 24 described species associated with species of seven different host plant families. Prior to the revision of Burckhardt and Mifsud (2003) *Diclidophlebia* species were assigned to six different genera, reflecting the large variation encountered in the forewing shape, pattern and venation as well as in the male and female terminalia. Of the 12 described New World species, five are known to develop on Melastomataceae: *D. fava* (Brown and Hodkinson) and *D. longitarsata* (Brown and Hodkinson) on *Miconia argentea* (Sw.) DC. (both from Panama), *D. paucipunctata* (Brown and Hodkinson) and *D. tuxtlaensis* (Conconi) on *Conostegia xalapensis* (Bonpl.) D. Don (from Panama and Mexico, respectively), and *D. heterotrichi* (Caldwell and Martorell) from *Heterotrichum cymosum* (J.W. Wendl. ex Spreng)

Urb. in Puerto Rico. Of the remaining New World species, hosts are known for four, and these are associated with Sterculiaceae, Tiliaceae, and Ulmaceae. Old World species of *Diclidophlebia* are associated with Euphorbiaceae, Malvaceae, Rhamnaceae, Sterculiaceae, and Tiliaceae.

The new species of *Diclidophlebia* described below feeds on *Miconia calvescens,* a plant that is native to the Neotropical Region that was introduced as an ornamental plant into Tahiti and subsequently into Hawaii. Because of its ability to grow quickly and to form dense stands, thereby creating deep shade that many native species cannot tolerate, *M. calvescens* is among the most threatening introduced plants on many Pacific islands (Meyer 1996). Since its introduction in 1937, this plant has taken over about two thirds of the land surface of Tahiti and directly threatens nearly half the island's endemic plant species (Meyer and Florence 1996). There is currently serious concern that this invasive weed could have similar effects in Hawaii (Medeiros et al. 1997). Herbicide spraying and hand removal are the principal control measures (Conant et al. 1996), but these methods are limited by the prolific production of very small, bird-dispersed seeds and the longevity (up to eight years) of the seed bank (Meyer 1998). Thus biological control is an important component of the long-term plan for controlling populations of *M. calvescens* on Pacific islands.

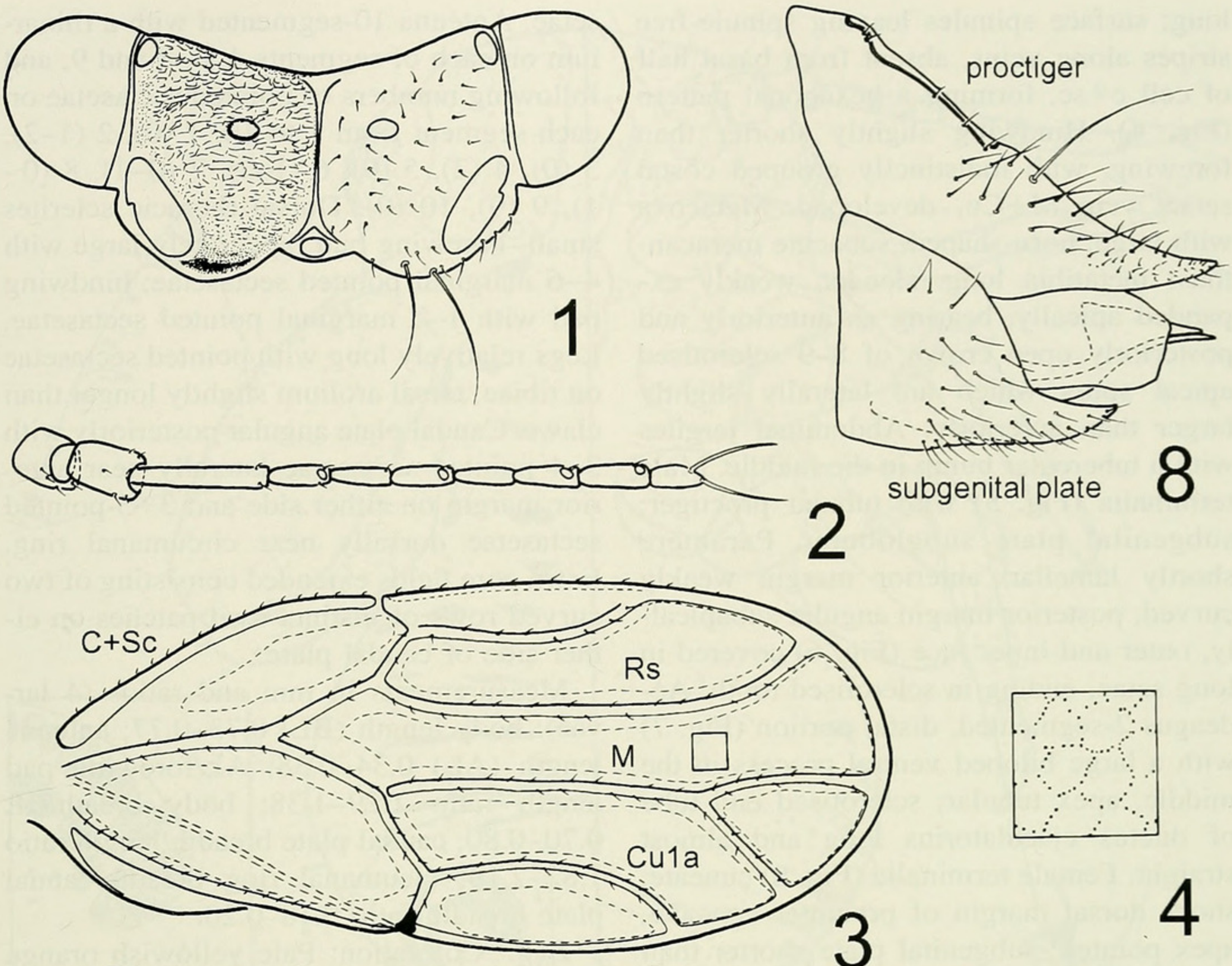
Diclidophlebia lucens Burckhardt, Hanson, and Madrigal, new species
(Figs. 1–16)

Diagnosis.—*Adult:* Body color bright orange reddish; forewing coloration uniformly yellowish orange. Forewing oblong oval; median third of vein Rs and vein M straight and subparallel; surface spinules forming cellular pattern. Metatibia weakly expanded apically with a crown of sclerotised apical spurs. Male proctiger globular (Fig. 5), parameres broadly lamellar (Fig. 6), aedeagus 2-segmented with a large bilobed ventral process in the middle of the distal segment (Fig. 7), apex tubular. Female terminalia cuneate, short, pointed apically (Fig. 8), circumanal ring cruciform.

Fifth instar larva: Antenna 10-segmented. Forewing bud relatively large, with 4–6 marginal sectasetae. Legs moderately long, tarsal arolium only slightly longer than claws. Caudal plate angular posteriorly; area of extra pore fields extended, separated into two curved rows of distinct oval patches. Sectasetae pointed. Caudal plate laterally near fore margin with 3–4 sectasetae on either side, and near the circumanal ring with 3+3 sectasetae.

Description.—*Adult:* Coloration: Bright orange reddish (male more reddish than females), eyes grey. Antenna dirty yellowish, apices of segments 4, 6 and 8, and entire segments 9 and 10 brown. Ventral face of head and abdomen bright orange. Legs and terminalia yellowish. Forewing transparent, yellowish orange, apex of vein Cu_{1b} brown; hindwing transparent, whitish.

Structure: Head (Fig. 1) weakly inclined from longitudinal body axis, about as wide as mesoscutum. Vertex trapezoidal, surface finely sculptured with microscopic setae; median suture fully developed. Eyes subglobular. Genae evenly rounded, with a pair of long setae on either side of frons. Frons forming large triangular sclerite. Antenna (Fig. 2) 10-segmented, with a single, large subapical rhinarium on each of segments 4, 6, 8 and 9; margin of rhinaria bearing long spines proximally and short ones distally; terminal setae distinctly longer than segment 10. Clypeus flattened, pyriform. Thorax weakly arched, with fine microsculpture and microscopic setosity; mesoscutellum swollen, metascutellum with small subacute tubercle. Forewing (Fig. 3) oblong oval, widest in middle; pterostigma ending beyond middle of vein Rs; vein Rs relatively straight in median third, curved in a 45° angle towards fore margin apically; vein M straight, subparallel to basal two-thirds of vein Rs; veins M_{1+2} and M_{3+4} relatively short; vein Cu_{1a} weakly curved, moderately



Figs. 1–8. *Diclidophlebia lucens.* 1, Head, dorsal view. 2, Antenna. 3, Forewing. 4, Portion of cell Rs indicating cellular pattern of surface spinules. 5, Male terminalia, in profile. 6, Paramere, inner face. 7, Distal portion of aedeagus. 8, Female terminalia, in profile.

long; surface spinules leaving spinule-free stripes along veins, absent from basal half of cell c+sc, forming a hexagonal pattern (Fig. 4). Hindwing slightly shorter than forewing, with indistinctly grouped costal setae; vein $M+Cu_1$ developed. Metacoxa with large, horn-shaped, subacute meracanthus; metatibia long, slender, weakly expanded apically, bearing an anteriorly and posteriorly open crown of 8–9 sclerotised apical spurs which are laterally slightly larger than anteriorly. Abdominal tergites with a tubercular bump in the middle. Male terminalia (Fig. 5) with tubular proctiger; subgenital plate subglobular. Paramere shortly lamellar, anterior margin weakly curved, posterior margin angular subapically, outer and inner face (Fig. 6) covered in long setae, ending in sclerotised tooth. Aedeagus 2-segmented, distal portion (Fig. 7) with a large bilobed ventral process in the middle, apex tubular; sclerotised end tube of ductus ejaculatorius long and almost straight. Female terminalia (Fig. 8) cuneate, short; dorsal margin of proctiger concave, apex pointed; subgenital plate shorter than proctiger, abruptly narrowed in apical third, pointed; circumanal ring cruciform.

Measurements in mm and ratios (3 ♂, 3 ♀): head width (HW) 0.33–0.38; Antenna length (AL) 0.36–0.38; forewing length (WL) 0.74–0.94; male proctiger length (MP) 0.10–0.12; paramere length 0.09; length of distal portion of aedeagus 0.08–0.10; female proctiger length 0.28–0.30; AL/HW 1.00–1.15; antennal segment 3/antennal segment 4 length ratio 1.50–3.00; WL/HW 2.24–2.57; WL/forewing width ratio; rostrum length/HW 0.30–0.36; metatibia length/HW 0.68–0.78; MP/HW 0.29–0.36; FP/HW 0.80–0.84; FP/circumanal ring length ratio 2.24–2.69; FP/female subgenital plate length ratio 1.75–1.81.

Fifth instar larva: Coloration: Orange; cephalothoracic sclerite orange brownish. Antenna, legs and wing-buds yellowish. Caudal plate orange, brownish laterally.

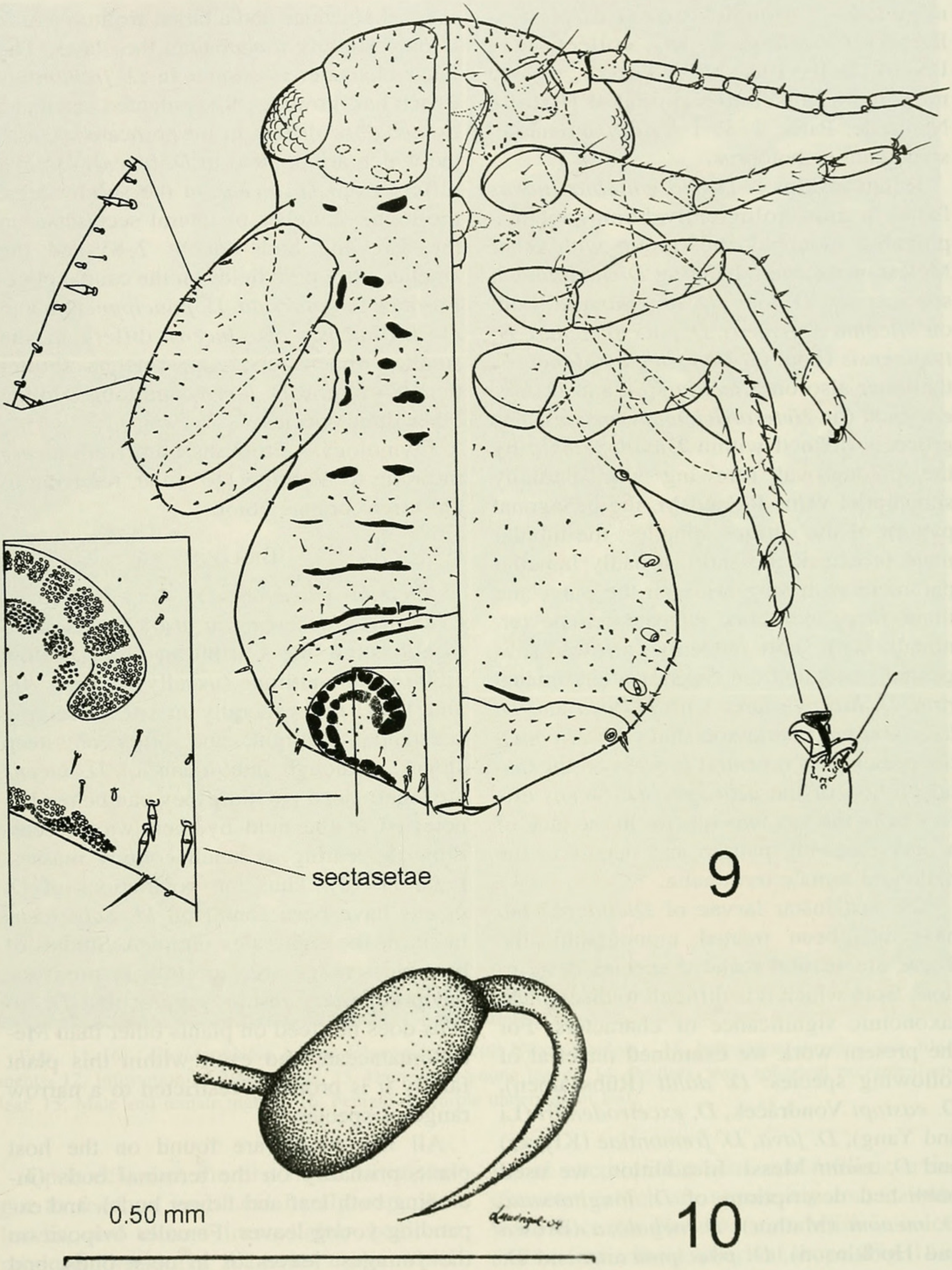
Structure (Fig. 9): Body elongate, sparsely covered in microscopic rod and normal setae. Antenna 10-segmented with a rhinarium on each of segments 4, 6, 8 and 9, and following numbers of pointed sectasetae on each segment from 1 to 10: 1 (0), 2 (1–2), 3 (0), 4 (2), 5 (0), 6 (1–2), 7 (0–1), 8 (0–1), 9 (0), 10 (0). Dorsal thoracic sclerites small. Forewing bud moderately large with 4–6 marginal pointed sectasetae; hindwing pad with 1–2 marginal pointed sectasetae. Legs relatively long with pointed sectasetae on tibiae; tarsal arolium slightly longer than claws. Caudal plate angular posteriorly with 3–4 pointed sectasetae laterally near anterior margin on either side and 3+3 pointed sectasetae dorsally near circumanal ring. Extra pore fields extended consisting of two curved rows of distinct oval patches on either side of caudal plate.

Measurements in mm and ratios (4 larvae): body length (BL) 0.73–0.77; antenna length (AL) 0.34–0.38; AL/forewing pad length ratio 1.29–1.38; body breath/BL 0.70–0.80; caudal plate breadth/length ratio 1.82–2.16; cicumanal ring breadth/caudal plate breadth ratio 0.18–0.20.

Egg: Coloration: Pale yellowish orange when young, becoming dark when mature; empty chorion blackish after larva ecloses.

Structure (Fig. 10): Elongate ovoid, with a basal pedicel and an apical filament; about 0.1 mm wide by 0.25 mm long (excluding pedicel and apical filament). Apical filament very long (about as long as egg itself), and curved upward and backward above egg.

Type material.–Holotype ♂: Costa Rica, Cartago, Sabanilla de Tucurrique, 800 m, xi.2000, *Miconia calvescens* (P. Hanson); collection in the field 20.xi.2000, samples from the greenhouse plant x-xii.2000 (The Naturhistorisches Museum, Basel, dry mounted). Paratypes: 23 ♂, 71 ♀, 31 larvae (Natural History Museum, London: 10 ♂, 6 ♀ dry mounted; 3 ♂, 3 ♀, 8 larvae, slide mounted; 50 ♀, 10 fifth instar larvae in 95% ethanol—Naturhistorisches Museum, Basel: 4 ♂, 6 ♀, 4 larvae, dry mounted; 3 ♂, 3 ♀, 9 larvae, slide mounted—Muséum d'Histoire Naturelle, Genève: 1 ♂, 1 ♀, dry



Figs. 9–10. *Diclidophlebia lucens.* 9, Fifth instar larva, left dorsal, right ventral face; with details of forewing pad, extra pore fields and apex of hind leg. 10, Egg.

mounted—National Museum of Natural History, Washington, DC, collection in USDA Beltsville, MD: 1♂, 1 ♀, dry mounted—Muséum National d'Histoire Naturelle, Paris: 1 ♂, 1 ♀, dry mounted), same data as holotype.

Relationships.—*Diclidophlebia lucens* forms a morphologically homogeneous, probably monophyletic, group with other Melastomataceae inhabiting *Diclidophlebia* species, viz. *D. fava, D. longitarsata* (both on *Miconia argentea*), *D. paucipunctata, D. tuxtlaensis* (both on *Conostegia xalapensis,* the latter also on *Miconia* sp.), and *D. heterotrichi* (on *Heterotrichum cymosum*). The group is defined within *Diclidophlebia* by the oblong-oval forewing with partially subparallel veins Rs and M, the hexagonal pattern of the surface spinules, the tubular male proctiger, the short, broadly lamellar paramere with long setae on the outer and inner face, the short, cuneate female terminalia with short suddenly narrowed subgenital plate, and the cruciform circumanal ring. *D. lucens* shares with *D. fava* and *D. longitarsata,* both associated with *Miconia,* the presence of a ventral process on the distal portion of the aedeagus. *D. lucens* differs from the last two species in the lack of a dark forewing pattern and details in the male and female terminalia.

The last instar larvae of *Diclidophlebia* have not been treated monographically. There are several isolated species descriptions from which it is difficult to discern the taxonomic significance of characters. For the present work we examined material of following species: *D. dahli* (Rübsaamen), *D. eastopi* Vondráček, *D. excetrodendri* (Li and Yang), *D. fava, D. fremontiae* (Klyver) and *D. xuani* Messi. In addition, we used published descriptions of *D. longitarsata, D. menoni* (Mathur), *D. nebulosa* (Brown and Hodkinson), *D. paucipunctata* and *D. tuxtlaensis. Diclidophlebia dahli, D. eastopi, D. excetrodendri, D. menoni* and *D. xuani* have 9-segmented antennae and the tarsal arolium is much larger than the claws, in contrast to *D. lucens,* which has 10-segmented antennae and a tarsal arolium which is only slightly longer than the claws. The latter character is similar in *D. fremontiae* which has, however, 9-segmented antennae. *D. nebulosa* differs in the truncate sectasetae which are pointed in *D. lucens. D. fava* differs from *D. lucens* in the shorter legs, the higher number of lateral sectasetae on the forewing buds (about 7–8) and the smaller extra pore fields on the caudal plate. From *D. longitarsata, D. paucipunctata* and *D. tuxtlatensis, D. lucens* differs in the smaller dimensions; e.g., antenna shorter than 0.4 mm in *D. lucens* and longer in the other three species.

Etymology.—From the Latin verb *lucere* meaning to be bright, to shine, referring to the bright orange color.

Biology

Miconia calvescens is very scarce in Costa Rica, occurring in just a few isolated locations on the Caribbean slope, below 1,000 meters altitude (usually between 700 and 1,000 m), generally in sites receiving substantial sunlight, and often on steep slopes. Although individuals of *D. lucens* are small-sized psyllids, they can be readily detected in the field by their waxy secretions (appearing as small cottony masses, Figs. 11–13). Thus far, populations of *D. lucens* have been found on *M. calvescens* in six of the eight sites sampled. Studies of host-plant range are currently in progress, but preliminary results suggest that *D. lucens* does not feed on plants other than Melastomataceae, and even within this plant family it is probably restricted to a narrow range of species.

All life stages are found on the host plant, primarily on the terminal buds (including both leaf and flower buds), and expanding young leaves. Females oviposit on the youngest leaves or in open buds, and rarely on the outer surface of closed buds. An egg may be laid on either the upper or lower surface of the leaf, often into the small space between a vein and the leaf lamina.

Figs. 11–16. *Diclidophlebia lucens* (photographs with Nikon Coolpix). 11, Infestation showing wax filaments. 12, Infestation of flower buds. 13, Damage to young leaves. 14, Psyllids, wax, spherical excrement on leaf. 15, Male and female mating. 16, Female on purple underside of leaf.

Upon eclosion, the first instar larvae begin to feed on buds and barely expanded leaves, and almost immediately begin to produce long waxy filaments under which they become concealed. All five larval instars produce these filaments and when populations are high these cottony masses of wax can become quite extensive. The larvae also produce spherical globules of liquid excrement, about one millimeter in diameter, which are apparently coated with wax, since the globules are whitish in color and maintain their spherical shape (Fig. 14). The psyllids do not appear to be regularly tended by ants, although more field observations are required. Thus far, no parasitoids have been reared from *D. lucens*; although various parasitoids are known from

Psylloidea in Costa Rica, none have yet been reared from psyllids on Melastomataceae (Noyes and Hanson 1996).

Duration of the various life stages appears to be similar to that reported for *D. tuxtlaensis* in Mexico (Conconi 1972). In the latter species the duration of the stages are: eggs, 3 days; first instar larvae, 3–5 days; second instar larvae, 4–5 days; third instar larvae, 5–7 days; fourth instar larvae, 4–5 days, fifth instar larvae, 5–6 days. Thus, the time from oviposition to eclosion of the next generation of adults ranges from about 24 to 31 days, depending upon the temperature. Conconi (1972) reported that wing buds first appear in the second instar larvae and that each successive instar becomes slightly more active, except for late fifth instars which become inactive. The same author also reported that adult longevity varied from 30 to 38 days. While males and females of *D. lucens* are readily distinguishable as adults (males being smaller, brighter red, and with enlarged genitalia, Figs. 15–16), no sexual differences have been found for distinguishing the larvae (nor were any found by Conconi 1972). Adults are generally quite inactive except when disturbed.

The insect is easily reared on potted plants under greenhouse conditions. Ongoing studies will determine the effects of *D. lucens* on *M. calvescens.* Preliminary observations suggest that by feeding near the apical meristem, this species potentially retards growth and reproduction. Moreover, high populations appear to result in premature dehiscence of infested leaves.

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