

**THE IMMATURES OF THE TRIBE QUADRINAREINI DEITZ
(HEMIPTERA: MEMBRACIDAE: SMILIINAE)**

STUART H. MCKAMEY AND ADAM M. WALLNER

(SHM) Systematic Entomology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, c/o National Museum of Natural History, P.O. Box 37012, Washington, D.C. 20013, USA. (e-mail: stuart.mckamey@usda.gov); (AMW) USDA-APHIS-PPQ Plant Inspection Station, 1500 Lower Rd., Linden NJ 07036. (e-mail: adam.m.wallner@usda.gov)

Abstract.—The nymphs of *Quadrinarea* Goding are described and illustrated for the first time. Previously considered endemic to Jamaica, adults were recently discovered in Dominica (new country record) and possibly Guyana. The nymphs lack the scoli on the head, thorax, or abdomen that are common among the nymphs of many membracid taxa, including some members of most other tribes of Smiliinae. We also have collection records of adults suggesting that eggs are laid in clutches and that its native host plant is *Annona muricata* L. (Annonaceae).

Key Words: Caribbean, endemic, immature stage, host plant, life history, *Annona muricata*

DOI: 10.4289/0013-8797.123.4.802

Treehopper nymphs are unique among Auchenorrhyncha in having the abdominal segment IX fused ventrally, forming a tube. When excreting excess honeydew, they evert from this tube the enclosed anal segments, which bear hydrophobic setae. The honeydew can be ejected as droplets, such as in leafhoppers, or held between the anal setae. The ability to hold the droplets has the added benefit of enticing myrmecophily, stingless bees, or vespid wasps which provides a level of protection against predators (Wood 1993). Treehopper nymphs also attempt to use the everted anal segments to attack intruders (SHM, pers. observ.). Unlike most Auchenorrhyncha, membracid nymphs are unable to jump (SHM pers. observ.).

This paper is part of the larger effort to describe the immature stages of New World treehopper genera, which has so far covered the membracine genus *Eunusa* Fonseca (McKamey 1992), the Caribbean stegaspidine genera *Antillotolania* Ramos and *Deiroderes* Ramos (McKamey and Brodbeck 2013), and the Neotropical tribes Amastrini (McKamey et al. 2015) and Thuridini (McKamey and Porter 2016).

The Caribbean treehopper fauna is speciose with most species and many genera endemic to the Greater Antilles. Nevertheless, most of these species and genera belong to tribes and subfamilies present in Central America or are species presumably introduced from Florida (Ramos 1988). Only three tribes are

thought to be endemic to the Caribbean islands: Nessorhinini and Monobelini of the subfamily Centrotinae, and Quadrinareini of the subfamily Smiliinae. Quadrinareini Deitz (1975) includes only the genus *Quadrinarea* Goding (1927) and originally included only one species from Jamaica. Ramos (1989) described another species from Jamaica. Adults of *Q. u-flava* Goding are about 4 mm long and Ramos (1989) reported the size of *Q. perezii* as "less than 3 mm." No further species have been described or recorded from other islands, leading Deitz (1975) and others to believe that both the tribe and genus were endemic to Jamaica. Nothing was known of their immature stages, host plants, or other aspects of their biology.

MATERIALS AND METHODS

The Jamaica and Guyana specimens were collected by US port inspectors of the Animal and Plant Health Inspection Service — Plant Protection and Quarantine (USDA - APHIS - PPQ) and identified by the authors. The series from Dominica is deposited in the Florida State Collection of Arthropods (FSCA) in Gainesville. Vouchers of the APHIS specimens are deposited in the National Museum of Natural History in Washington, D.C. (USNM).

Images were taken with a Canon 5Dsr camera with an adjustable 65 mm lens coordinated with Capture One Pro version 10.1.2, 64 Bit, Build 10.1.2.23 imaging software, aided by CamLift version 2.9.7.1. The specimen was illuminated using two adjustable Dynalite MH2050 RoadMax flash heads, each attached to a Manfrotto 244 arm. The light was diffused using a simple, lampshade-style cone of translucent paper between the specimen and light sources. After individual "slices" were photographed, they were compiled into a single, composite image

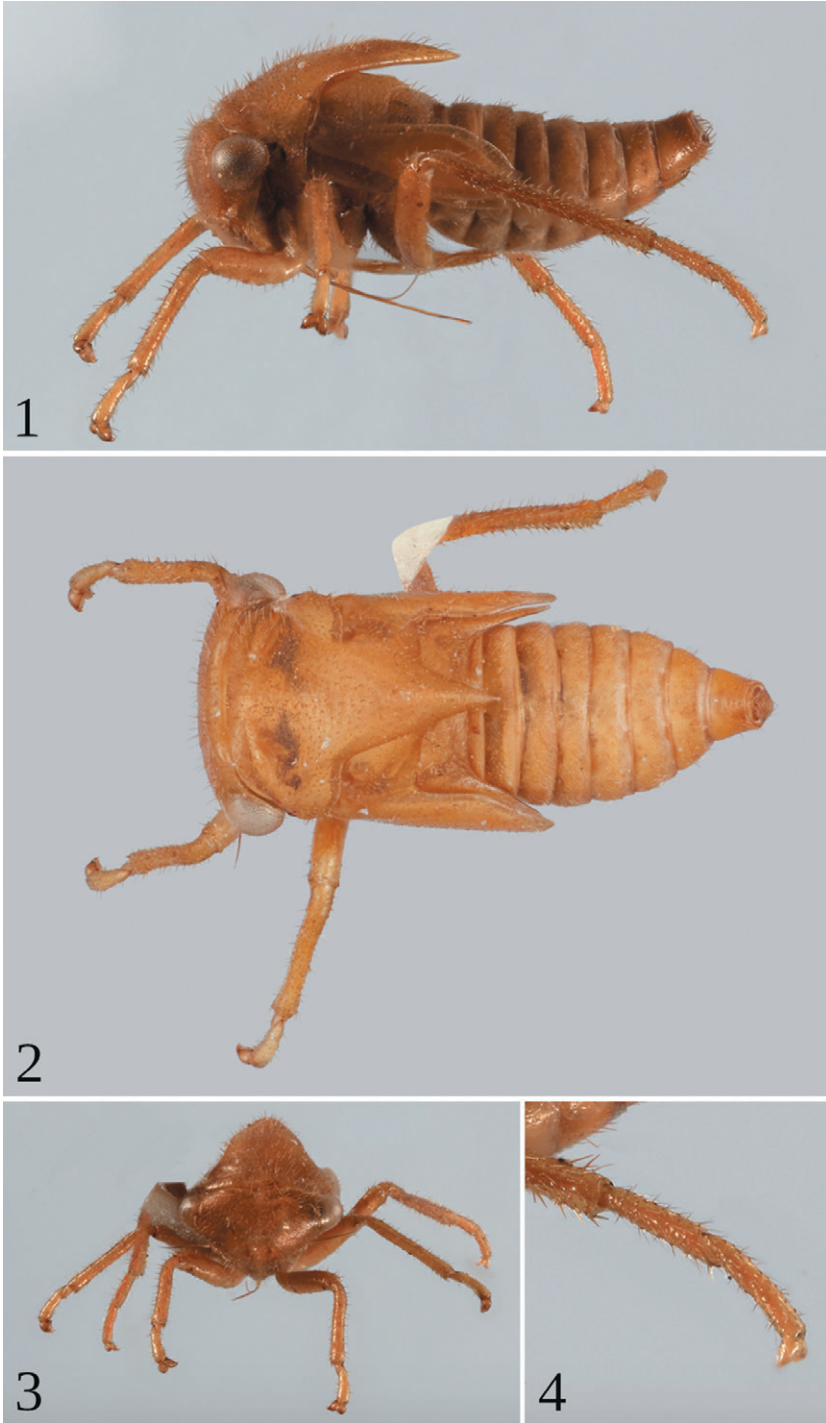
using Zerene Stacker - USDA SI-SEL Lab Bk imaging system, version 1.04, Build T201706041920. Stacked images were enhanced and edited in Adobe Photoshop CSS Extended version 12.0.

RESULTS

Quadrinarea u-flava Goding (Figs. 1–6)

Nymph Diagnosis.—Differs from all other treehopper nymphs in entirely lacking scoli or other dorsal or lateral protuberances (Figs. 1–3) and the metathoracic leg with first tarsomere longer than second tarsomere (Fig. 4). The genus is distributed in the insular Caribbean and, possibly, northern South America (see discussion).

Nymph Description.—Length of fifth instar 2.9 mm. **OVERALL BODY.** Cross-section subcircular; chalazae on thorax and abdomen completely absent; chazal setae absent; no parts of body covered with waxlike substance; dorsal contour of abdomen in lateral view linear; overall body in dorsal view elongate. **HEAD.** Scoli or dorsal or anterior rounded protuberances absent; chalazae absent; compound eye surface microsetae present; enlarged chalazae between eyes absent; setae of frontoclypeus dense; enlarged chalazae in front of ventral margin of eye absent; enlarged chalazae adjacent to central or dorsal margin of eye absent; frons not extending over central margin of eye. **PROTHORAX.** Premetopidium scoli absent; postmetopidium scoli absent; posterior extension of pronotum surpasses posterior margin of metanotum; dorsal pronotal single medial horn bud absent; pronotal lateral margin concave in lateral view; lateral pronotal horn buds absent; metopidial sulcus not incised, continuous with adjacent surfaces above and below it; apex narrowly acute (Fig. 2).



Figs. 1-4. Fifth instar of *Quadrinarea u-flava*. 1-3, Habitus in lateral, dorsal (right metathoracic leg white portion due to paper mounting point; left metathoracic leg not shown), and anterior view, respectively. 4, Portions of abdomen and metathoracic tibia, showing the extended metathoracic first tarsomere.

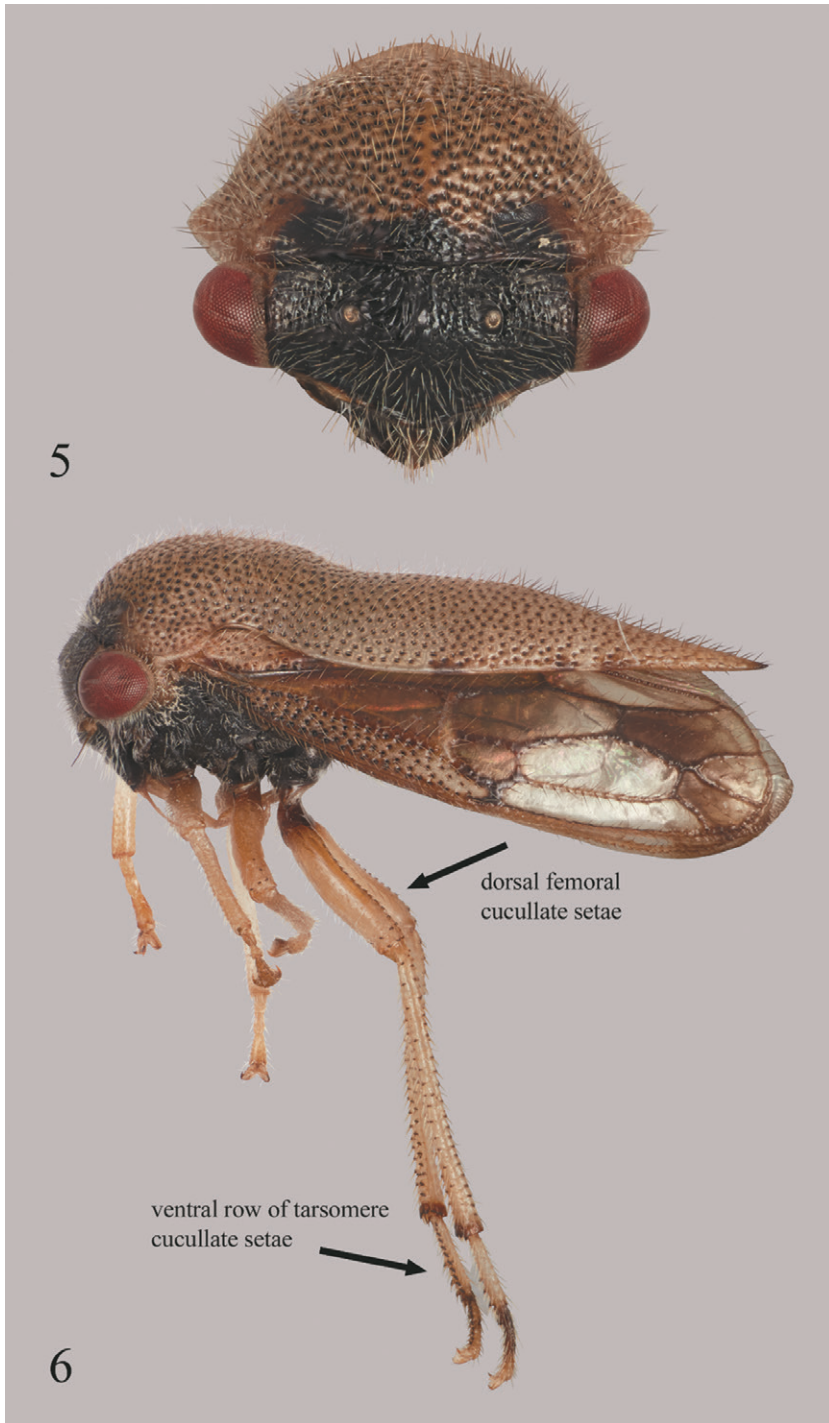
MESOTHORAX. Dorsal structures absent; forewing pad anterior costal margin straight (Fig. 1); forewing pad surface chalazae absent; forewing pad costal chalazae absent; lateral chalazae absent. **METATHORAX.** Dorsal structures absent. **LEGS.** Chalazae of tibia absent; prothoracic tibia subcylindrical; metathoracic tarsal length distinctly longer than pro- and meso-thoracic tarsal length; metathoracic leg with first tarsomere longer than second tarsomere (Fig. 4). **ABDOMEN.** Terga III-VIII ventrolateral margins without enlarged chalazae or other lateral extensions such as lamellae; dorsal scoli absent; terga III-VIII lateral rows of enlarged setae not manifested; segment IX distal half tubular in cross-section; dorsal length subequal to length of segment VIII; dorsal structures before apex absent; dorsal structures at apex absent; ventral extension subequal to dorsal extension; fused portion of segment IX distal to unfused portion; unfused portion distally not bifurcate.

Material Examined.—*Quadrinarea u-flava* Goding, 5 adults, 2 nymphs, USDA APHIS PPQ Interception, intercepted at Atlanta, GA, JAMAICA, 08 Jan 2004 (USNM). *Quadrinarea* sp., 1 nymph, USDA APHIS PPQ Interception, intercepted at JFK International Airport, NY, JAMAICA, 22 Jan 1997, *Annona muricata*, on fruit (USNM). 6 adults, DOMINICA: 25 West Kirkland Heights [in St. Andrew Parish, around Kingston], 9-IX-2013, collected by J. Goldsmith, on *Annona muricata* (FSCA). *Quadrinarea u-flava*, 1 adult, GUYANA (see discussion below) (USNM).

Biology.—Species of *Quadrinarea* are small and infrequently collected. Based on the single collection lot of five adults and two nymphs intercepted by APHIS, and the large series of adults (13 males, 47 females) from Dominica, it is likely that *Quadrinarea* females lay

eggs in clutches and may display egg guarding behavior as in the smiliine tribes Polyglyptini, Tragopini, and some Amastrini (Wood 1993; McKamey pers. obs.). It is unknown if they are attended by ants or other hymenopterans. The putative host plant (from the APHIS intercept and the FSCA Dominica series) is the fruit of soursop, also known as graviola, guyabano, and guanábana (*Annona muricata* L., Annonaceae). It is believed that this plant species probably originated in the Antilles in the Caribbean (Padmanabhan and Paliyath 2016, Sanusi et al. 2018), so it may be a native host of *Quadrinarea*.

Discussion.—Adults of *Quadrinarea* are mainly distinguished by wing venation, the degree of its coverage by the pronotum, by a row cucullate setae dorsally on the metathoracic femur (Fig. 6) and another ventrally on the metathoracic tarsomeres (Fig. 6); no cucullate setae are developed in treehopper nymphs. Although *Quadrinarea* nymphs generally lack structures present in other membracid taxa, this absence is in itself highly diagnostic. Most species of the other tribes in Smiliinae, except Thuridini (McKamey and Porter 2016) and Tragopini (Tode 1966) bear conspicuous, large scoli on the abdomen, thorax, and even head. If *Q. u-flava* spread from Jamaica to Dominica, or the reverse, by “stepping-stones,” it may still occur on intermediate islands of the Antilles, so collectors should be vigilant. There was also a single adult specimen of *Q. u-flava* Goding obtained from USDA APHIS PPQ Interception, intercepted at the John F. Kennedy International Airport in New York on November 8, 2020, with origin indicated as Guyana with host, unfortunately, in baggage on “bark of an unknown wood.” While it is possible that the specimen was truly from Guyana, which would represent the first non-Antillean record, it is also possible that the traveler started or had a layover in Jamaica. It is unknown if the



Figs. 5–6. Adult color variant of *Quadrinarea u-flava* in anterior and lateral views, respectively, with diagnostic cucullate setae on metathoracic femora and tarsomere indicated.

traveler was also trying to bring in sour-sop fruits. A biogeographical analysis is needed to explore the origins of this genus, but that is beyond the scope our study.

ACKNOWLEDGMENTS

We thank Taina Litwak and Alyssa Seemann (USDA/ARS Systematic Entomology Laboratory) for taking and processing photographs, Mark Rothschild (Research Associate, Florida State Collection of Arthropods) and Susan Halbert (Florida Department of Agriculture and Consumer Services) for lending the Dominica specimens, and Lewis L. Deitz (North Carolina State University) and Christopher Dietrich (Illinois Natural History Survey) for comments on earlier drafts. Mention of trade names or commercial products in this publication is solely for the purpose of providing specific information and does not imply recommendation or endorsement by the USDA. The USDA is an equal opportunity provider and employer.

LITERATURE CITED

- Deitz, L. L. 1975. Classification of the higher categories of the New World treehoppers (Homoptera, Membracidae). North Carolina Agricultural Experiment Station Technical Bulletin 225: 1–177.
- Goding, F. W. 1927. New Membracidae. III. *Journal of the New York Entomological Society* 35(2): 167–170. <https://www.biodiversitylibrary.org/page/51221415#page/185/mode/lup>.
- McKamey, S. H. 1992. Reappraisal of the Neotropical treehopper genus *Eunusa* Fonseca (Homoptera: Membracidae), with ecological notes. *Annals of the Entomological Society of America* 85(3): 253–257.
- McKamey, S. H. and B. V. Brodbeck. 2013. Immature stages and hosts of two plesiomorphic, Antillean genera of Membracidae (Hemiptera) and a new species of *Antillotolania* from Puerto Rico. *ZooKeys* 301: 1–12. <https://doi.org/10.3897/zookeys.301.4234>.
- McKamey, S. H. and M. J. Porter. 2016. First immature of the New World treehopper tribe Thuridini (Hemiptera, Membracidae, Smiliinae) with a new synonym, a new combination, and a new country record. *ZooKeys* 557: 85–91. <https://doi.org/10.3897/zookeys.557.6602>.
- McKamey, S. H., A. M. Wallner, and M. J. Porter. 2015. Immatures of the New World Treehopper tribe Amastrini (Hemiptera: Membracidae: Smiliinae) with a key to genera. *ZooKeys* 524: 65–87. <https://doi.org/10.3897/zookeys.524.5951>.
- Padmanabhan, P. and G. Paliyath. 2016. Annonaceous Fruits, pp. 169–173. *In* Cabellero, B., P. M. Finglas, and F. Toldrá, eds. *The Encyclopedia of Food and Health*. Elsevier Ltd. 4006 pp.
- Ramos, J. A. 1988. Zoogeography of the Auchenorrhynchos Homoptera of the Greater Antilles (Hemiptera). pp. 61–70. *In* Liebherr, J., ed. 1988. *Zoogeography of Caribbean Insects*. Ithaca; London: Cornell University Press. 298 pp.
- Ramos, J. A. 1989. New West Indian Membracidae (Homoptera: Auchenorrhyncha). *Caribbean Journal of Science* 25(3–4): 154–163.
- Sanusi, B. S. and M. F. Abu Bakar. 2018. Sour-sop—*Annona muricata*. pp. 391–395. *In* Rodrigues, S, E. de Oliveira Silva, and E. S. de Brito, eds. *Exotic Fruits Reference Guide*. Elsevier Ltd. 488 pp. <https://doi.org/10.1016/B978-0-12-803138-4.00053-8>.
- Tode, W. D. 1966. Taxionomische Untersuchungen an der südamerikanischen Membracidengattung *Tragopa* Latreille, 1829, und deren Neugliederung. *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 63: 265–328.
- Wood, T. K. 1993. Diversity in the New World Membracidae. *Annual Review of Entomology* 38: 409–435. <https://doi.org/10.1146/annurev.en.38.010193.002205>.