NUMBER 137, 23 pages 10 July 2021

BISHOP MUSEUM OCCASIONAL PAPERS

RECORDS OF THE HAWAII BIOLOGICAL SURVEY FOR 2020

NEAL L. EVENHUIS, EDITOR

BISHOP MUSEUM PRESS
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Cover: *Orasema minutissima* Howard (Hymenoptera: Eucharitidae) - a parasite of the Little Fire Ant introduced into the Hawaiian Islands (see p. 7).

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ISSN 0893-1348 (print)
ISSN 2376-3191 (online)

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RECORDS OF THE HAWAII BIOLOGICAL SURVEY FOR 2020

Editor's Preface

I am pleased to present the annual compilation of *Records of the Hawaii Biological Survey*; this year for the year 2020. The Hawaii Biological Survey, established by the Hawaii State Legislature in 1992 as a program of Bishop Museum, is an ongoing natural history inventory of the Hawaiian Archipelago. It was created to locate, identify, and evaluate all native and nonnative species of flora and fauna within the state; and by State Law to maintain the reference collections of that flora and fauna for a wide range of uses. In coordination with related activities in other federal, state, and private agencies, the Hawaii Biological Survey gathers, analyzes, and disseminates biological information necessary for the wise stewardship of Hawai‘i's biological resources.

An intensive and coordinated effort has been made by the Hawaii Biological Survey to make our products, including many of the databases supporting the papers published here, available to the widest user-community possible through our web server. Products currently available include taxonomic authority files (species checklists for terrestrial arthropods, flowering plants, nonmarine snails, marine invertebrates, fossil taxa, and vertebrates), bibliographic databases (vascular plants, nonmarine snails, and insects), specimen databases (fungi, fish, invertebrates, portions of the insect collection) and type specimens (entomology; botany—including algae and fungi; and vertebrates), collections data (lists of holdings for select groups of flies as well as Cicadellidae and Pentatomidae), detailed information and/or images on endangered, threatened, and extinct plants and animals; as well as our staff publication lists. Additional reference databases include: the list of insect and spider collections of the world (based on Arnett, Samuelson & Nishida, 1993, 'Insect and spider collections of the world') with links to institutional web site; and an authority file with full names and vital dates of almost 6,600 authors who have described flies.

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‘

Hawaii Biological Survey's "Good Guys/Bad Guys" website
http://hbs.bishopmuseum.org/good-bad/

World Diptera taxonomist list
http://hbs.bishopmuseum.org/dipterists/

Many of the new records reported here resulted from curatorial projects and field surveys funded by the National Science Foundation, the U.S. Geological Survey Biological Resources Division, the U.S. Fish & Wildlife Service, the Hawaii Department of Transportation, and the Hawaii Department of Land and Natural Resources; they are thanked for their support and partnership of the Hawaii Biological Survey over the years.

We encourage authors with new information concerning flora or fauna occurring in the Hawaiian Islands to submit their data to the editor for consideration for publication in the Records. Submission and format of papers must follow our guidelines. Information on submission of manuscripts and guidelines for contributors may be obtained at: http://hbs.bishopmuseum.org/guidelines.pdf ——*N.L. Evenhuis, editor*

Published online: 5 October 2020 ISSN (online) 2376-3191

Records of the Hawaii Biological Survey for 2020. Edited by Neal L. Evenhuis, N.L. *Bishop Museum Occasional Papers* 137: 3–5 (2020)

New Island Record for *Ochna serrulata* on Oʻahu (Ochnaceae)

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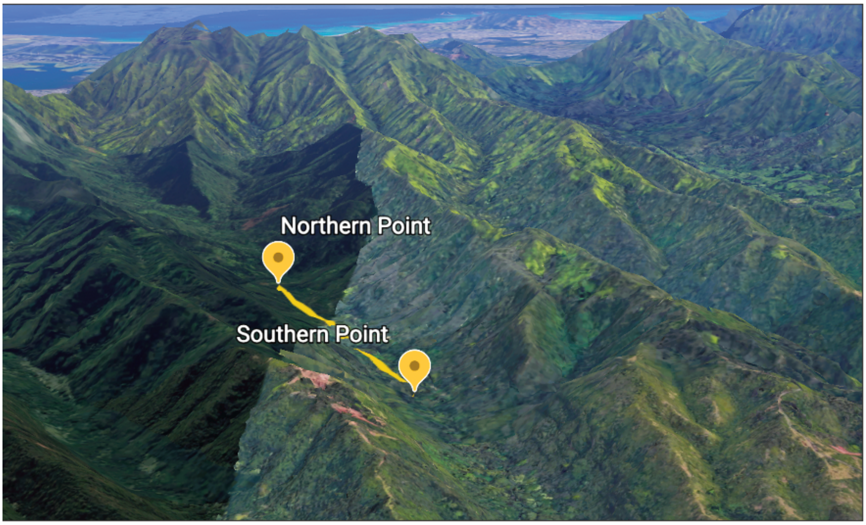
Ochnaceae

Ochna serrulata (Hochst.) Walp. **New island record**

Ochna serrulata is an ornamental shrub native to South Africa. This species has glabrous, dark green, narrowly elliptical leaves with leaf margins that are prominently toothed, and raised lenticels on its brown bark (du Toit & Obermeyer 1976). It is cultivated for its yellow flowers and conspicuous, persistent red sepals, to which black fruits are attached, a trait that is shared across the *Ochna* genus, giving these shrubs their common name, "Mickey Mouse bush" (Herbarium Pacificum Staff 1998; Staples & Herbst 2005). Its fruits depend primarily on bird dispersal, although other vectors, such as humans and water, may also play important roles in its reproductive ecology (Gosper *et al.* 2006). It is becoming invasive in a wide range of habitats in Australia and has been identified as an especially high risk invader in southeastern Queensland (Gosper *et al.* 2006). This plant is similarly categorized as "High Risk" according to the Hawaii-Pacific Weed Risk Assessment (PIER 2008). *Ochna serrulata* was reported as naturalized on the island of Hawaiʻi, and has been found spreading from gardens on Maui, although it has not yet been recorded as naturalized there (Herbarium Pacificum Staff 1998; Starr *et al.* 2003). Its relative, *O. thomasiana*, is more common in cultivation (Staples & Herbst 2005) and has been recorded as naturalized on Oʻahu, Lānaʻi, Maui, and most recently on Kauaʻi (Oppenheimer 2003; Imada 2019). *Ochna serrulata* can be distinguished from the more widespread *O. thomasiana* by its narrower leaf shape and highly serrated leaf margins, rather than the "bristle-toothed margins" characteristic of *O. thomasiana*, with which it is sometimes confused (Whistler 2000; Starr *et al.* 2003).

We found *O. serrulata* naturalizing in Moanalua Valley on Oʻahu, beginning 1.8 km into the Moanalua Valley Trail and extending along 1.5 km of it (Fig. 1). Approximately 60 individuals of various size classes, including 20 seedlings, were observed, most frequently in shaded areas dominated by the alien *Psidium cattleyanum*. A couple of isolated individuals were recorded, but the plants were generally found in small clusters of around 2–6, with the largest cluster including approximately 30 individuals, moderately spaced along the side of the trail (Fig. 2). Two plants were fruiting at the time of the survey, and the tallest individual seen was around 2 m. New leaves were glossy and dark green in color, but older leaves were observed to have a rusty tinge to them. The undersides of the leaves were lighter and less shiny. Residential areas near the trail as well as the areas surrounding Moanalua Botanical Garden were surveyed for a likely source of this naturalization, but no cultivated plantings were found.

a)



b)

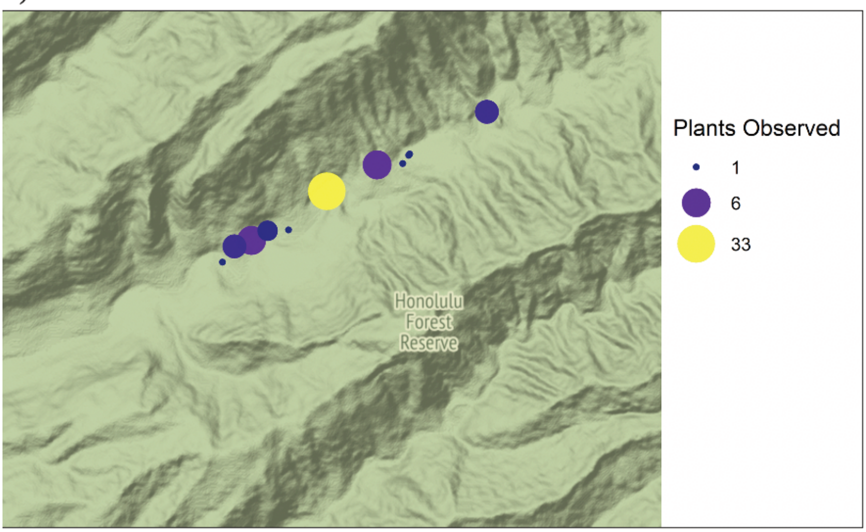


Figure 1. Distribution of *Ochna serrulata* in Moanalua Valley. **a**) Overview of the path along Moanalua Valley Trail along which *Ochna serrulata* was sighted, with the southern and northern points labeled with yellow markers (Google Earth, Maxar Technologies). **b**) Visual representation, created using the ggmap package in R (Kahle & Wickham 2013), showing where the clusters of *Ochna serrulata* were located along the Moanalua Valley Trail. The size and color of the points reflect the number of plants observed at each location.

Material examined: **O'AHU**: Moanalua Valley Trail, in understory of dense *Psidium cattleyanum* forest, naturalized along trail, more than 30 individuals in this area (21.38061, -157.86513), 16 Jun 2019, *K. Brock & C. Imada s.n.* (BISH 778860); Moanalua Valley, near the Kaholuamanu Picnic Grounds sign (21.378738, -157.868238), along trail in an alien-dominated area with *Livistona chinensis* and near *Citharexylum caudatum*, *Hibiscus tiliaceus*, *Syzygium cumini*, *Psidium cattleyanum*, and variegated *Pandanus tectorius*, 13 Jul 2020, *R.M. Steinbach 1* (BISH).

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Published online: 23 March 2021 ISSN (online) 2376-3191

Records of the Hawaii Biological Survey for 2020. Edited by Neal L.
Evenhuis, N.L. *Bishop Museum Occasional Papers* 137: 7–18 (2021)

urn:lsid:zoobank.org:pub:A423690D-7D97-492A-B49D-F58B550A1884

New record in the Hawaiian Islands of *Orasema minutissima* (Hymenoptera: Eucharitidae), an ant-parasitic wasp and a potential biocontrol agent against the Little Fire Ant, *Wasmannia auropunctata* (Hymenoptera: Formicidae)

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Abstract. *Orasema minutissima* Howard (Hymenoptera: Eucharitidae) is recorded from the Hawaiian Islands for the first time. It has been established on the island of Hawaiʻi since at least 2019. The wasp is a parasitoid of the immature stages of *Pheidole* and *Wasmannia* (Formicidae: Myrmicinae), both of which are significant pests on several of the Hawaiian Islands. Already found in substantial numbers, the wasp is a potential biological control agent for *Wasmannia auropunctata*, the Little Fire Ant.

INTRODUCTION

The Little Fire Ant (LFA) or electric ant, *Wasmannia auropunctata* (Roger) (Hymenoptera: Formicidae) is an increasingly important exotic pest. This species occurs throughout the warmer regions of the New World, with a potential native range from northern Argentina to Mexico and most of the Caribbean (Wetterer and Porter, 2003). The ant has been introduced into many different countries, including Australia, the Galapagos Islands, central West Africa, Melanesia (New Caledonia, Solomon Islands, Fiji), Polynesia (Tahiti, Wallis, Futuna and Hawaiʻi), the mainland USA (Florida), and Israel (Wetterer & Porter 2003; Vonshak *et al.* 2009; Foucaud *et al.* 2010; Tindo *et al.* 2012; Wetterer 2013; Bousseyroux *et al.* 2018). The LFA is ranked as one of the 100 top most invasive species, and in alien (invasive) habitats is regarded as a serious threat to both native and agricultural ecosystems (Wetterer & Porter 2003; Vonshak *et al.* 2006). It is generally a pest of humans in urban landscapes, although in Cameroon its artificial spread was promoted as a means of controlling cacao pests (Bruneau De Mire 1969). The LFA was first recorded on the islands of Hawaiʻi and Kauaʻi in 1999 (Conant & Hirayama 2000). By 2015, it had further spread to the islands of Maui and Oʻahu (Vanderwoude *et al.* 2015) and Lānaʻi (http://stoptheant.org/lfa-in-hawaii/). Based on molecular evidence, the proposed origin of the populations in Hawaiʻi is from Florida (Mikheyev & Mueller 2007; Foucaud *et al.* 2010). Another exotic ant species, *Pheidole megacephala* (Fabricius) was first reported in Hawaiʻi as early as 1879 and has been documented to have impacts on both native species and crop losses (Smith 1879; Vanderwoude *et al.* 2015). No para-

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sitoids or specific natural enemies of either of these genera have been documented previously from the Hawaiian Islands.

There are few parasitoids of ant brood, but Eucharitidae (Hymenoptera: Chalcidoidea) are known to specialize on their immature stages. Eggs of Eucharitidae are deposited on or into plant tissue, away from the ant nest, and the minute first-instar larvae (planidia) use a variety of behaviors to associate with foraging ants and get carried back to the ant brood (Clausen 1941; Baker *et al.* 2020). The subfamily Oraseminae are specialists on ants in the subfamily Myrmicinae, which include *Pheidole*, *Wasmannia* and *Solenopsis* (Heraty 1994a,b, 2000; Murray *et al.* 2013; Baker *et al.* 2020). Species of *Orasema* are distributed throughout the New World, although they are most common in tropical regions (Baker *et al.* 2020). *Orasema* deposit single eggs away from the host into punctures made by their expanded ovipositor into plant tissue, with the active planidia attaching to or being picked up by foraging ants directly, or utilizing an intermediate Hemipteran or Thysanopteran host that is collected by the ants and provided as a food source to the ant larva (Clausen 1941; Das 1963; Wilson & Cooley 1972; Beshear 1974; Heraty 1994b, 2000; Herreid & Heraty 2017; Baker *et al.* 2020). Development proceeds on the pupa of their myrmicine ant host and adults must emerge from the nest, likely protected by acquired semiochemicals (Vander Meer *et al.* 1989). Species attacking the fire ant genera *Wasmannia* and *Solenopsis* occur in four distinct species groups: the *xanthopus* species group, which are parasitoids of *Solenopsis* (Heraty *et al.* 1993); the *stramineipes* species group, which are mostly parasitoids of *Pheidole* and *Wasmannia* (Heraty 1994b, 2000; Burks *et al.* 2018); the *bakeri* species group, which are mostly parasitoids of *Pheidole* with the exception of one species in Mexico also attacking *Solenopsis*; and the *coloradensis* species group, which includes a species that is a parasitoid of both *Pheidole* and *Solenopsis* (Baker & Heraty 2020).

Orasema minutissima is a common and abundant parasitoid of *W. auropunctata* in both the Caribbean and mainland South America (Heraty 1994a,b; Burks *et al.* 2018). It belongs to the *Orasema stramineipes* species group, which was recently revised (Burks *et al.* 2018). The species has three distinct size morphs: the smallest morph attacks the brood of *Wasmannia*, while the two larger morphs likely attack different castes of species of *Pheidole* (Heraty 1994a; Burks *et al.* 2018). *Orasema minutissima* is extremely common on most of the islands in the Caribbean, but notably has not been found in Florida and it is less common on mainland Central America and northern South America (cf. map in fig. 3 of Burks *et al.* 2018). The species is heavily female biased. Of the three different size morphs, Burks *et al.* (2018) examined a total of 1,032 females and 19 males (small morph), 97 females and three males (medium morph), and only one female of the large morph. Given that these are from museum collections and represent a variety of collection methods, this would suggest that the bias is real, and that the species may be largely parthenogenetic. The medium and large-sized morphs identified as *O. minutissima* are known only from islands ranging between Hispaniola and Trinidad. Importantly, the small and larger morphs with geographic samples from Colombia (Gorgona Island), Cuba, Dominica, St. Lucia, Tortola and Trinidad all share an identical haplotype for the 28S-D2, COI gene, which is distinct from all other species of *Orasema* sampled (Burks *et al.* 2018). Specimens have been collected in nests of both *Wasmannia* (Gahan 1940; Heraty 1994a) and *Pheidole* (Burks *et al.* 2018) confirming the host associations. Thus, we have a single widespread and common species that attacks two different genera of Myrmicinae.

From field studies in Dominica in 2009 and 2010, we know that the small form prefers to oviposit into the leaf surface of broadleaf ferns, and the larger morphs prefer short emergent broad-leaf dicot plants. In contrast to other species of *Orasema,* all morphs of *O. minutissima* are readily sampled in yellow pan traps (YPTs), which make them easier to survey. The potential of this parasitoid for biological control of the LFA has been discussed (Heraty, 1994a), but never attempted. A new establishment on Hawai‘i and not on other islands with *Wasmannia* may offer an opportunity to monitor their impact on ant populations. Furthermore, it will be interesting to observe if they attack *P. megacephala*, which has been recorded as a host of *Ivieosema fraudulenta* (Reichensperger) (Oraseminae) from Ethiopia (Reichensperger 1913), but never by a New World species of *Orasema*.

MATERIALS AND METHODS

Sampling. The first observation of *O. minutissima* was made by DVR in Hilo using Yellow Pan Traps (YPT) that consisted of a yellow plastic bowl [i.e., 13.5 oz (0.4 liter), 7" × 1 ¾" (17.5 cm × 4.5 cm)], with water and a few drops of non-scented liquid soap, that was placed on the ground. Similar YPT traps were used by MTJ and EB at Hilo and the Keauohana Forest Reserve, two sites known to be infested by *Wasmannia*. WDP had been monitoring several sites in Hawai‘i (Fig. 2), Maui, and O‘ahu as part of a separate insect survey project. On Maui and O‘ahu, *Wasmannia* was not present at either site being sampled, but *Pheidole* were present. His YPTs consisted of yellow 8 ounce (0.24 liter) plastic “shave ice” flower cups, readily available at local restaurant supply stores and online, filled with water and about 5 ml of yellow colored dish soap; traps were placed in the field for two weeks and the specimens air-dried. Bowl size (larger or smaller) is not likely to affect monitoring for presence or absence of *O. minutissima*. WDP also sampled with Yellow Sticky Board Traps (YSBT) consisting of 10" × 12" (25.40 cm x 30.48 cm) cards from HTG Supply (htgsupply.com; Callery, PA) cut into 10" × 3" (25.4 cm × 7.5 cm) strips and hung from branches approximately 3–4 ft (0.91–1.22 m) above ground at each field location (Fig. 2). After two weeks, the YSBTs were replaced with new traps and specimens stuck to the exposed traps were removed using Aliphatic Naphtha (Crown Brand V.M.&P. NAPHTHA®), soaked in same solutions for about one hour until all adhesive materials were dissolved, and then air-dried. Specimens of *Orasema* were either air-dried or chemically dried from ethanol using HMDS (Heraty & Hawks 1998) and then point-mounted and deposited in either the Entomology Research Museum, University of California, Riverside, CA (UCRC_ENT) or the Bernice P. Bishop Museum, Honolulu, HI (BPBM) (Appendix). Individuals were assigned a unique barcode and databased in the Heraty lab FileMaker Pro database.

Sequencing. Specimens from 95% ethanol were extracted using DNeasy Blood and Tissue Kit (Qiagen, Valencia, CA, USA) with 1 μL RNase A added after incubation. PCR products were purified with DNA Clean & Concentrator-5 kits (Zymo Research, Irvine, CA, USA). PCR product concentrations were determined using Nanodrop 2000c (Thermo Scientific, Waltham, MA, USA). Two regions of ribosomal DNA were PCR amplified individually and Sanger-sequenced with the following primer sequences: 28S D2 rDNA (D2-F: CGGGTTGCTTGAGAGTGCAGC; D2-Ra: CTCCTTGGTCCGTGTTTC) and ITS2 (ITS2-F: TGTGAACTGCAGGACACATG; ITS2-R2: TCTCGCCTGCTCTGAGGT). The following thermocycler protocol was used: initial denaturization: 94 °C 3 min., 34 cycles

Table 1. ***Orasema minutissima*** **specimens sequenced.**

specimen id	28S-D2	ITS2	Country	size class	D number
235958	KY349472*	MW575764	Brit. Virgin Islands	small	0424
235964	KY349465*	MW575761	St. Lucia	small	0437
235966	KY349458*	MW575757	Dominica	medium	2766
235967	—	identical	Dominica	medium	2765
235968	KY349457*	MW575758	Dominica	medium	2764
235969	KY349463*	identical	Dominica	small	2763
235970	KY349462*	MW575760	Dominica	small	2762
271392	KY349464*	MW575762	Dominica	small	2830
271393	KY349459*	identical	Dominica	medium	2831
271395	KY349456*	MW575756	Dominica	large	2833
412118	KY349466*	identical	Trinidad	small	3800
412119	KY349467*	MW575763	Trinidad	small	3801
412127	KY349469*	identical	Trinidad	small	3809
412131	KY349471*	identical	Trinidad	small	3814
412132	KY349470*	—	Trinidad	small	3810
447074	KY349473*	—	Colombia	small	4207
447075	KY349455*	MW575755	Colombia	small	4208
456205	identical	identical	Puerto Rico	small	2808
468543	MW357878	MW357873	Hawai‘i	small	6943
468544	MW357879	identical	Hawai‘i	small	6944

28S-D2 GenBank accession numbers marked by an asterisk were used in Burks *et al*. (2018); ITS2 accessions are all new. Specimen ID numbers are associated with a prefix UCRC_ENT00 and deposited in UCRC, with full collection data presented in Appendix 1. D numbers are the DNA voucher codes. Identical refers to sequences that were captured but not deposited in GenBank.

(94 °C 1 min.; 55 °C 1 min., 72 °C 1 min.), final extension: 75 °C 7 min. PCR samples were sent to Retrogen Inc (San Diego, CA, USA) for Sanger sequencing on an Applied Biosystems 3730xl DNA Analyzer. Deposition of molecular vouchers is indicated in the Material Examined sections. GenBank accession numbers are listed in Table 1.

Measurements. To investigate the different size classes within *O. minutissima* and infer the ant host, measurements were taken for 31 specimens of the total body length (anterior margin of head to apex of gaster) and fore wing length (apex of humeral plate to most distal margin of wing membrane). For specimens from Hawai‘i, all of the small specimens were measured from material that was dried using the HMDS method; the two larger specimens were air-dried but this appeared to have minimal impact on body length. Identification numbers for specimens measured are UCRC_ENT00422315–16, 422320, 468555–67, 468588 (see Appendix for details). Measurements of the Neotropical material included specimens of three size classes (small, medium, large) from across the range of *O. minutissima*, including the British Virgin Islands, Colombia (Gorgona Island), Dominica, Puerto Rico, and Trinidad (Appendix); all of these specimens were dried with HMDS. For the Neotropical specimens, we chose only material that had been sequenced for either 28S-D2 or ITS2 (all with identical sequences) to guarantee that they were all forms with the identical haplotype of *O. minutissima*.

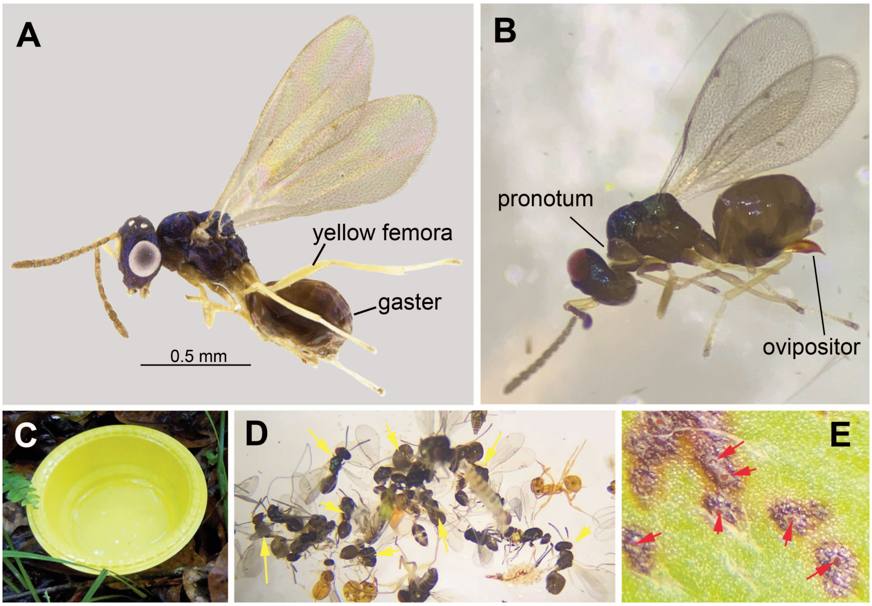

Fig. 1. *Orasema minutissima*. **A**, habitus of dry-mounted specimen. **B**, habitus of ethanol-preserved specimen. **C**, yellow pan trap. **D**, portion of YPT sample with numerous *O. minutissima* females (yellow arrows). **E**, egg punctures (red arrows) in surface of swordfern leaf.

RESULTS AND DISCUSSION

Distribution in Hawai'i

To date, *O. minutissima* has only been collected in the vicinity of Hilo on the island of Hawai'i at or near sites 5, 6, 8, 10 and 13 despite continuous trapping at the other sites (Fig. 2, Appendix). *Orasema minutissima* (Howard) was first discovered on the island of Hawai'i near Hilo in October 2019 (Fig. 1) using yellow pan traps (YPTs, Fig. 1C). Subsequent sampling in September 2020 at two sites on Hawai'i Island by MTJ found *O. minutissima* in at least half of 24 YPTs at one site and in most of 10 traps at another, with as many as 10 wasps collected in an individual trap, suggesting that the species is well established (Fig. 1D). Additional collections made during a survey initiated across Hawai'i in April 2019 using yellow sticky board traps (YSBT) and a different type of YPT recovered *O. minutissima* at 5 out of 17 sites where *Wasmannia* was also present (Fig. 2). Of the sites where no *Orasema* were collected, only site 7 (Hilo) and 17 (Whittington Beach Park) are low enough in elevation to also have *Wasmannia*; the other sites with no *Orasema* are likely too high (>1800 m) to have *Wasmannia*. From this limited sampling, it is unclear if the *Orasema* is distributed only in eastern Hawai'i, or if it may be more widespread across the island. Mostly females have been recovered, but one male was sampled on a YSBT at site 8. Sampling using both YPTs and YSBTs failed to recover these wasps from either O'ahu or Maui, suggesting that it is established only on the island of Hawai'i, although none of the sites sampled had *Wasmannia* present. This is the first

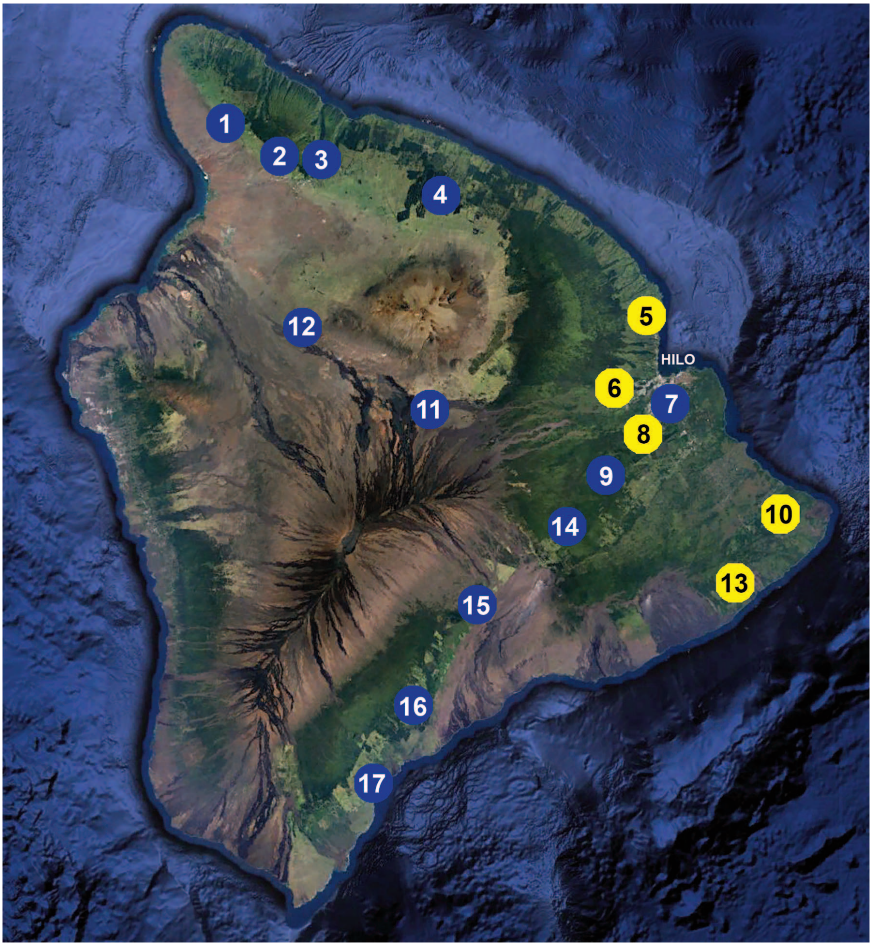

Fig. 2. Yellow Sticky Board sampling sites on Hawai‘i Island: (1) Koai‘a Tree Sanctuary; (2) Waimea Town; (3) UH Mealani Research Station; (4) Kalōpā State Recreation Area; (5) Kawainui Stream; (6) Kaumana; (7) Hilo Town; (8) Pana‘ewa Zoo; (9) Kurtistown; (10) Pahoa District Park; (11) Pu‘u Huluhulu; (12) Route 200 Saddle Road; (13) Kaimu-Chain of Craters Road; (14) Wright Road, Volcano Village; (15) Hawai‘i Belt Road; (16) Pahala and (17) Whittington Beach Park. *Orasema minutissima* were sampled at sites 5, 6, and 10 in 2019; at site 8 in 2019-2021; and at site 13 in 2020-2021 (yellow circles). Satellite image credited to Google Earth.

record of a eucharitid wasp in the Hawaiian Islands, and its accidental introduction has the potential to offer some form of biological control over the invasive LFA.

Sequencing

Two gene regions, 28S-D2 and ITS2, were sequenced for two of the specimens from Hilo following the protocols and primers outlined in Baker *et al.* (2020) and Burks *et al.*

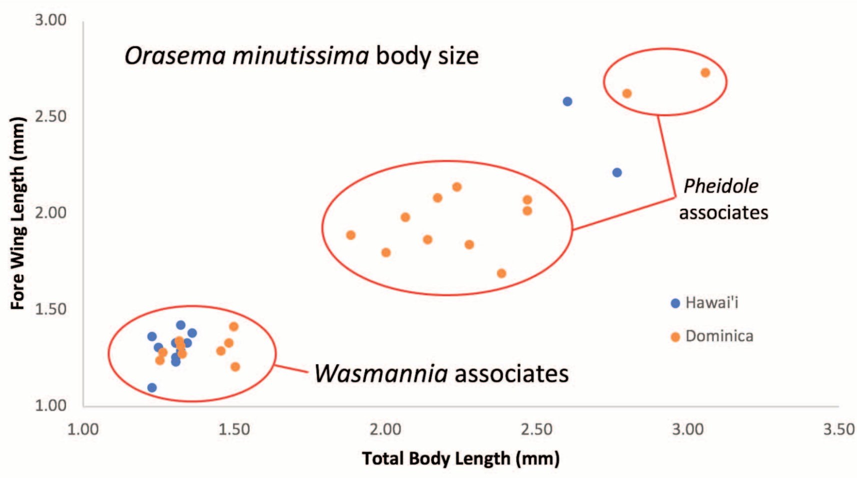

Fig. 3. Size classes of *Orasema minutissima* females. Neotropical refers to samples from various islands in the Caribbean and in the Pacific Ocean from Gorgona Island off the coast of Colombia (see Appendix 1). All Neotropical specimens measured were sequenced for 28S-D2, COI and ITS2, and have an identical haplotype (Burks *et al*. 2018 and this study).

(2018). The second ITS2 read for D6944 was not of high enough quality to deposit on GenBank but was identical for the sequence obtained. The 28S-D2 sequences were identical to other specimens of *O. minutissima* that have been sequenced from the Caribbean and Colombia (Gorgona Island) (Burks *et al.* 2018), and for the ITS2 obtained in this study (Table 1).

Origin of *Orasema minutissima*
There have been no purposeful introductions of this wasp to Hawai‘i. It is most likely that they were imported along with a new accidental importation of *Wasmannia*. Given that *O. minutissima* is not known to occur in Florida, it is not likely to have come with the initial population from Florida, which was the place of origin proposed by Mikheyev & Mueller (2007) and Foucaud *et al.* (2010). Thus, a separate introduction of *Wasmannia* from one of the localities where it is currently distributed, along with its parasitoid, is inferred. However, given that the current gene regions of the wasp have identical haplotypes across the range of the species, no further inference of origin can be made at this time.

Measurements and size classes
A total of 13 specimens were measured from Hawai‘i and another 18 from various Neotropical islands (Fig. 3). All but two of the specimens from Hawai‘i fell into the small size morph class, which is associated with parasitism of *Wasmannia* (Burks *et al.* 2018). The two larger sized specimens appear to be intermediate in size to the medium and large morphs from the Neotropical material (Fig. 3). The number of measurements for the Neotropical specimens is meager, but we felt it important to only measure sequenced specimens, as closely related species in the complex can be difficult to separate based on morphology alone (Burks *et al.* 2018). Larger samples from the Caribbean support the

separation of size classes, but the large and medium classes are rarely sampled. Pupae of the small size class have been found only with with brood of *Wasmannia* in the Caribbean. A single pupa of a medium-size morph was recovered from a nest of *Pheidole* in Dominica, and in an area where both the medium and large morph specimens were collected. We assume that the medium and large size classes are associated with different castes of *Pheidole*. On Hawai‘i, we assume that the larger size class also indicates an association with *Pheidole*; however, it is also possible that they are developing on the queen brood of *Wasmannia*.

Host plants

In Jamaica, *Orasema minutissima* have been collected from *Chamissoa altissima* (Jacq.) Kunth (Amaranthaceae), *Gynerium sagittatum* (Aubl.) Beauv. (Poaceae) and *Zapoteca ?formosa* (Kunth) H.M. Herm. (Fabaceae), although no oviposition was observed (Heraty 1994a; Burks *et al.* 2018). In Dominica, the small morph has been observed to oviposit on ferns (*Cyathea tenera* (J.E. Smith) Moore, Cyathaceae; *Nephrolepis biserrata* Schott, Polypodiaceae; *Thelypteris opposita* (Vahl) Ching, Thelypteridaceae), whereas the larger size morphs preferentially oviposit on a variety of short (6–12" high) broad-leaf plants (*Coccoloba uvifera* L., Polygonaceae; *Simarouba amara* Aublet, Simaroubaceae; miscellaneous Fabaceae and Rubiaceae). Single eggs are deposited into excavations made into the leaf surface by the enlarged ovipositor (Fig. 1B), with the punctures usually surrounded by a brown scarring of the leaf tissue. In east Hawai‘i, egg punctures, eggs and planidia have been found on alien swordfern (*Nephrolepis brownii* (Desv.) Hovenkamp & Miyam., Polypodiaceae) (Fig. 1E), a ground fern with large-lobed fronds (*Microsorum grossum* (Langsdorff & Fischer) S.B. Andrews, Polypodiaceae), and strawberry guava (*Psidium cattleyanum* Sabine, Myrtaceae) at the Keauohana Forest Reserve site. While the oviposition scars may cause some cosmetic damage when numbers are high, the leaves usually recover as they mature.

Biological control potential

Heraty (1994a) proposed that *O. minutissima* was one of the few species that may have an impact as a biological control agent against *Wasmannia*. When present, especially in moist island habitats in the Caribbean, *O. minutissima* can be extremely common. However, their impact on the ant population numbers has not yet been assessed within an experimental framework. Their purposeful importation as a biological control agent to other islands, especially to islands in the Pacific, has not been implemented. The primary issues for treating this as a coordinated biological control effort lie with the difficulty of transport and a need for quarantining with the capability for continuous rearing to test for negative impacts against native species. With regard to the Hawaiian introduction, there are no native myrmicine ants on any of the Hawaiian Islands, and in any case Oraseminae are specific only to that ant subfamily (Murray *et al.* 2013; Baker *et al.* 2020). The impacts of cosmetic damage to native vegetation will likely be minimal, but this should be assessed in the future. It will be necessary to sample for presence of the wasp on island locations that have *Wasmannia* present to assess the presence and spread of *Orasema*. However, *O. minutissima* has been discovered at a time where the spread of the parasitoid and its impact on *Wasmannia*, and potentially *Pheidole*, can be monitored to see if they have any effect on lowering population densities.

ACKNOWLEDGMENTS

We thank Chrysalyn Dominguez and Luke Kresslein for comments on an earlier draft of this paper. This research has been supported in part by USDA National Institute of Food and Agriculture Hatch project 1015803 to JMH. Funding of yellow sticky card sampling was generously provided to WDP by The Atherton Family Foundation and The Dana Anne Yee Foundation. We are grateful to Clinton Yamada and Robert Lee, State of Hawaiʻi Department of Transportation, Highways Division and the County of Hawaiʻi, Department of Parks and Recreation for allowing us to collect on their lands.

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Appendix. Material examined for this study.

Hawaiian Material Examined (deposited in UCRC or BPBM, with UCRC_ENT00 code [abbreviated UC]; DNA number = Dxxxx)**: USA: Hawaiian Islands: Hawai‘i I.**: Hilo, 112 m, 19°41'52"N 155°05'44"W, 14-17 Oct 2019, Valle Rogers, along boundary between lawn and forest, YPT, 0406.19 [6♀, BPBM: UC422320, UCRC: UC468543 (**D6943**), UC468544 (**D6943**), UC468555–57]. Hilo, 108 m, 19°41'56"N 155°05'45"W, 18 Sep 2020, M.T. Johnson, vegetation along outside fence, YPT [23♀, BPBM: UC422386–95, UCRC: UC499508–20]. Kalapana, Kaimu, Chain of Craters Road, mi 21, 18 m, 19°21'40"N 154°58'38"W, 28 Nov–12 Dec 2020, W.D. Perreira, YBST [17♀, UCRC: UC4995722–38]. Kaumana Dr., 434 m, 19°40'52"N 155°09'20"W, 28 May–8 Jun 2020, W.D. Perreira, YSBT [1♀, UCRC: UC468563 (large form)]. Kawainui Stream, 65m, 19°49'13"N 155°05'42"W, 26 Oct–9 Nov 2019, W.D. Perreira, YSBT [1♀, UCRC: UC468558]. Pahoa District Park, 200 m, 19°29'35"N 154°56'51"W, 29 Feb–14 Mar 2020, W.D. Perreira, YSBT [2♀, BPBM: UC422315–16 (16 = large form)]. Pahoa District Park, 200 m, 19°29'35"N 154°56'51"W, 8–22 Jun 2020, W.D. Perreira, YSBT [3♀, UCRC: UC468559–61]. Pana‘ewa Zoo, 35 m, 19°19'16"N 155°04'16"W, 27 Dec–8 Jan 2020, W.D. Perreira, YSBT [40♀ 1♂, UCRC: UC499539–79]. Pana‘ewa Zoo, 35 m, 19°19'16"N 155°04'16"W, 8–20 Jun 2020, W.D. Perreira, YSBT [1♀, UCRC: UC468562]. Hwy 130, Keauohana For. Res., 240 m, 19°24'51"N 154°57'08"W, 25 Sep 2020, M.T. Johnson, along forest edge, YPT [10♀, BPBM: UC422317–19, UCRC: UC499501–507].

Neotropical Material Examined (deposited in UCRC, with UCRC_ENT00 code [abbreviated UC], unless otherwise indicated; DNA number = Dxxxx followed by size class: s = small, m = medium, l = large; coordinates in italics estimated from google earth)**: British Virgin Islands: *Tortola***: Mt. Sage Nat. Pk., Sage Mt., 18°24'14"N 64°39'39"W, 10 Dec–8 Jan 1993, M.A. Ivie & T. Hughes, nr. toilets, flight intercept trap #4 [1♀, UC235958 (**D0424s**)]. **Colombia: *Cauca***: PNN Gorgona, El Saman, 5m, 2°58'0"N 78°11'0"W, 6–22 Mar 2001, H. Torres, Malaise trap, M.1476 [1♀, UC447075 (**D4208s**)]. PNN Gorgona, El Saman, 5 m, 2°58'0"N 78°11'0"W, 7–25 May 2001, H. Duque, malaise trap, M.1844 [1♀, UC447074 (**D4207s**)]. **Dominica:** Central Forest Reserve, 337 m, 15°26'29"N 61°19'40"W, 15 May 2009, J. Heraty, rainforest, sweep, H09-018 [1♀, UC235970 (**D2762s**)]. Northern Forest Reserve Sympa trail (upper site), 390 m, 15°31'55"N 61°21'35"W, 14 May 2010, J. Heraty, H10-016 [3♀, UC271392 (**D2830s**), UC271393 (**D2831m**), UC271395 (**D2833l**)]. Sulphur Springs, pools trail, 290 m, 15°14'21"N 61°20'50"W, 16 May 2009, J. Heraty, rainforest, sweep, H09-019 [2♀, UC235966 (**D2766m**), UC235967 (**D2765m**)]. Sulphur Springs, pools trail, 290 m, 15°14'21"N 61°20'50"W, 20 May 2009, J. Heraty, rainforest, sweep, H09-025 [2♀, UC235968 (**D2764m**), UC235969 (**D2763s**)]. **Puerto Rico: Maricao:** Maricao Forest, rd 120 km 17.9, 18°10'51"N 66°58'48"W, 22 Oct 2002, Gates, rd edge and shrubs, sweep [1♀, UC456205 (**D2808s**)]. **St. Lucia: W.I.:** Barre del Isle, 13°52'23"N 60°58'1"W, 2 Mar 2000, L. Masner, forest trail, ss [1♀, UC235964 **D0437s**)]. **Trinidad:** Gasparillo, 10°18'57"N 61°25'7"W, 5–15 Nov 1987, R. Borneo, grass/forest edge, malaise trap, ROM 870031 [1♀, ROME: UC364799 (**D2810s**)]. Maracas Falls, 190 m, 10°43'28"N 61°24'32"W, 16 Jul 2013, Heraty, forest, swp, H13-044 [2♀, UC412118 (**D3800s**), UC412119 (**D3801s**)]. Maracas Falls, 190 m, 10°43'28"N 61°24'32"W, 23 Jul 2013, Heraty&Baker, forest, YPT/PB bait, H13-073 [3♀, UC412127 (**D3809s**), UC412131 (**D3814s**), UC412132 (**D3810s**)].

Published online: 30 March 2021 ISSN (online) 2376-3191

Records of the Hawaii Biological Survey for 2020. Edited by Neal L. Evenhuis, N.L. *Bishop Museum Occasional Papers* 137: 19–20 (2021)

New Ant Records (Hymenoptera: Formicidae) from Maui and Molokaʻi

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The following contribution includes new island records of non-native ant species located on the islands of Maui and Molokaʻi. The voucher specimens were collected by Maui Invasive Species Committee (MISC) and Molokaʻi Invasive Species Committee (MoMISC) staff, determined by Forest Starr, and confirmed by Paul Krushelnycky. The vouchers are housed at the University of Hawaiʻi Insect Museum, Honolulu.

Hymenoptera: Formicidae

Pseudomyrmex gracilis (Fabricius) **New island records**

Previously known from Oʻahu (Nishida 2002) and Kahoʻolawe (Starr *et al*. 2004), this large ant with a painful sting was recently collected at a Hale o Lono on the south shore of Molokaʻi and in dry lowlands of both East and West Maui. This species was first collected on both islands during surveys for Little Fire Ants or LFA (*Wasmannia auropunctata*). The species does not usually come to peanut butter bait, rather they are generally observed crawling over the environment.

Material examined. **MAUI**: 1, Hanakaʻōʻō Beach Park, on concrete picnic bench, in coastal dry urban park setting with kiawe (*Prosopis pallida*) and coconut (*Cocos nucifera*), 10 ft [3 m], (20.899172, -156.441377), 17 Oct 2018, Coll. by M *Tudor-Long (181017-01)*; 1, Kanahā Beach Park, on vegetation, in windward coastal habitat with naupaka (*Scaevola taccada*) and akiaki (*Sporobolus virginicus*), 10 ft [3 m], (20.899172, -156.441377), 27 May 2020, Coll. by *M. Tudor-Long (200527-01)*; 1, Kanahā Beach Park, on boulder, 10 ft [3 m], (20.909262, -156.688351), 12 Jul 2020, Coll. by *M. Tudor-Long (200712-01)*; 1, Hanakaʻōʻō Beach Park, on person, 10 ft [3 m], (20.909911, -156.688468), 22 Jul 2020, Coll. by *F&K Starr (200722-01)*; 1, Lahainaluna High School, on vehicle, 460 ft [140 m], (20.890227, -156.662178), 23 Jul 2020, Coll. by *M. Tudor-Long* (*200723-01*). **MOLOKAʻI**: 2, Hale o Lono, crawling on kiawe tree, in habitat of kiawe (*Prosopis pallida*) and buffel grass (*Cenchrus ciliaris*), near ocean, on coral dirt road of concrete pier, 10 ft [3 m], (21.086945, -157.24875), 14 Oct 2019, Coll. by *MoMISC (Niles Soares & Kamalani Pali)* (*191014-01*).

Solenopsis abdita Thompson **New island record**

Previously known from the islands of Hawaiʻi and Oʻahu (Gruner *et al*. 2003) and Molokaʻi (Starr & Starr 2012), as *Solenopsis* sp. HI01, this small, yellow, translucent ant was recently determined through genetic work, to likely be a previously overlooked tramp ant species, *S. abdita* (Sharaf *et al*. 2020). This species readily recruits to peanut butter bait, often in large numbers, and is regularly collected across a wide range of sites during LFA surveys on Maui. All the specimens in the material examined were collected in vials with peanut butter baits.

Material examined. **MAUI**: 10, Happy Valley, 375 ft [114 m], (20.890493, -156.509872), 8 May 2020, Coll by *M. Tudor-Long* (*200508-01*); 10, Lahainaluna High School, 460 ft [140 m], (20.890227, -156.662178), 23 July 2020, Coll by *M. Tudor-Long* (*200723-01*); 5, 204 Akeke Pl., Lahaina, 100 ft [30 m], (20.892683, -156.681049), 24 July 2020, Coll by *M. Tudor-Long* (*200724-01*); 5, Kihana Nursery, Kīhei 15 ft [5 m], (20.736459, -156.453935), 13 Aug 2020, Coll by *J. Fleming* (*200813-01*); 10, Kapalua, 60 ft [18 m], (21.003001, -156.658631), 20 Aug 2020, Coll by *B. Black* (*200820-01*); 5, Maui Invasive Species Committee baseyard, Pi‘iholo, 2100 ft [640 m], (20.841175, -156.294034), 22 Sep 2020, Coll by *M. Tudor-Long* (*200922-01*).

ACKNOWLEDGEMENTS

We thank MISC for funding the LFA project, Paul Krushelnycky for confirmation of the specimens, University of Hawai‘i Insect Museum for archival of the specimens, and the Bishop Museum staff for helping make these records possible.

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Published online: 10 July 2021 ISSN (online) 2376-3191

Records of the Hawaii Biological Survey for 2020. Edited by Neal L.
Evenhuis, N.L. *Bishop Museum Occasional Papers* 137: 21–23 (2021)

New synonymies in Hawaiian Diptera (Insecta)[1]

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The following new synonymies in Diptera occurring in the Hawaiian Islands are given below based on examination of specimens and unpublished records.

Anthomyiidae

***Fucellia aestuum* Aldrich** **New synonymy**

Fucellia aestuum Aldrich, 1918: 178.
Fucellia boninensis Snyder, 1965: 204, **n. syn**.

A recent review of a dataset of Anthomyiidae by one of us (VM) in *Systema Dipterorum* (Evenhuis & Pape 2021) noted this synonymy, which is based on an unpublished manuscript by the late Graham Griffiths revising *Fucellia*. Snyder (1965) originally described *Fucellia boninensis* from the Bonin Islands, but it has since been found to also occur in China (Hebei), Japan, the Korean Peninsula, the Ogasawara Islands, the Ryukyus, and the Hawaiian Islands (the last where it is known from Maui and Midway) (Hardy 1981; Dely-Draskovits 1993; Suwa 1999; Nishida 2002; Han *et al*. 2014; Xue & Du 2020). Aldrich (1918) described *F. aestuum* from Washington state and it has since been found to occur also in nearby British Columbia, Canada. In describing *F. boninensis*, Snyder (1965) alluded to the close relationship between *F. boninensis* and *F. aestuum*. The study of specimens by Griffiths (*in litt*.) found the two to be conspecific, hence its synonymy is formalized here. — **Verner Michelsen and Neal L. Evenhuis**

Dolichopodidae

***Campsicnemus* Haliday**

Re-examination of type material in Bishop Museum and/or comparison with homotypic specimens has discovered the following synonymies listed below.

***Campsicnemus albitarsis* Hardy & Kohn** **New synonymy**

Campsicnemus albitarsis Hardy & Kohn, 1964: 42.
Campsicnemus uniseta Hardy & Kohn, 1964: 163, **n. syn.**

Hardy & Kohn (1964) described *Campsicnemus albitarsis* based on a male from Waikamoi, above Kula Pipeline, on Maui. *Campsicnemus uniseta* was described by them (1964: 163) based on a holotype male also from Waikamoi on Maui. Although the illustrations of the midlegs of two species in Hardy & Kohn (1964) differ slightly, direct examination of the two holotypes in Bishop Museum showed no differences in the midleg modifications, thus the new synonymy here.

***Campsicnemus camptoplax* Hardy & Kohn** **New synonymy**

Campsicnemus camptoplax Hardy & Kohn, 1964: 53.
Campsicnemus makawao Evenhuis, 2007: 18, **n. syn**.

Hardy & Kohn (1964) described *Campsicnemus camptoplax* based on a holotype male from Waikamoi, Maui. Evenhuis (2011) described *C. makawao* based on a holotype male

1. Contribution No. 2001-006 to the Hawaii Biological Survey.

from the Makawao Forest Reserve on Maui (which is near Waikamoi). A direct examination of the holotypes of both species in Bishop Museum showed no differences between the two, thus the new synonymy here.

***Campsicnemus labilis* Hardy & Kohn** **New synonymy**

Campsicnemus labilis Hardy & Kohn, 1964: 109.
Campsicnemus bennetti Evenhuis, 2011: 15, **n. syn**.

Hardy & Kohn (1964) described *Campsicnemus labilis* based on a holotype male from Kula Pipeline above Waikamoi. Evenhuis (2011) described *C. bennetti* based on a holotype male from the Makawao Forest Reserve on East Maui, near Waikamoi. Direct comparison of the two holotypes in Bishop Museum showed no differences, thus the new synonymy here.

***Campsicnemus ornatus* Van Duzee** **New synonymies**

Campsicnemus ornatus Van Duzee, 1933: 323.
Campsicnemus furax Parent, 1940: 228, **n. syn**.
Campsicnemus scintillatus Evenhuis, 2012: 14, **n. syn**.

Van Duzee (1933) described *Campsicnemus ornatus* based on a holotype male from an unknown island in the Hawaiian Islands. He stated (Van Duzee 1933: 324) that the original labels with several specimens had become detached and disassociated from them. Hardy & Kohn (1964: 131) restricted the type locality to "Oahu" stating that this was a "common species on foliage, usually in the sun in the Mt. Tantalus region, Koolau Range, Oahu". Parent (1940) described *C. furax* based on a holotype male from Mt. Ka'ala in the Wai'anae Range on O'ahu. Evenhuis (2012) described *C. scintillatus* based on a holotype male from Poamoho Trail in the Ko'olau mountains on O'ahu. Re-examination of type material in Bishop Museum of *C. ornatus* and *C. scintillans* with the description and illustrations of *C. furax* showed all three to be conspecific, thus the new synonymies here. *Campsicnemus ornatus* has been commonly collected by me at a seep in a road cut on the way up to Mt. Ka'ala and is easily characterized by the metallic green thorax that reflects in the sunshine. It was initially thought that the Ka'ala and Ko'olau populations represented different species, thus *C. scintillans* was described as new. Direct comparison of a number of specimens showed that *C. ornatus* Van Duzee is much more widespread than previously believed.

Acknowledgments

Dan Bickel kindly reviewed and suggested improvements to the manuscript.

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