Adventive Thysanoptera Species in the Hawaiian Islands: New Records and Putative Host Associations

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Abstract. Fifteen adventive species of Thysanoptera, comprising eight Thripidae and seven Phlaeothripidae, are recorded for the first time from the Hawaiian Islands. Four of these are native Australian species, seven are native to south-eastern Asia, with one species known only from Costa Rica and one known from several sites around the Caribbean. New host and locality records are given for a further 15 species, and the situation is noted that some species established on the Hawaiian Islands are pests in other parts of the world but have failed to become problematic here.

Key words: Hawaii, new state records, thrips

The number of insect species recognized as being adventive to the Hawaiian Islands is large and continues to increase, although recent summary statistics about species establishment rates are not readily available. According to Beardsley (1962), over the 25-year period 1937–1961 approximately 400 adventive insect species were reported as new to the islands, with an average rate of establishment as high as 20 species per year (Beardsley 1979). In a Farm Bill Report to the United States Department of Agriculture (USDA), Howarth et al. (2013) indicated that the nursery trade and various cut flower and agricultural industries, in importing live plant material, is probably a major source of adventive and invasive phytophagous insects in Hawaii. These authors reported an estimate of 27 to 29 insect species arriving and establishing each year in Hawaii. Moreover, since the last revision of the Hawaiian Terrestrial Arthropod Checklist (Nishida 2002) over 330 arthropod species adventive to Hawaii have been recorded (Howarth et al. 2013). However, as noted by Beardsley (1962), discovery and reporting of many alien arthropods in Hawaii is associated with special projects and interests of local and visiting researchers, and are not indicative of true dates of arrival or establishment (Howarth et al. 2013).

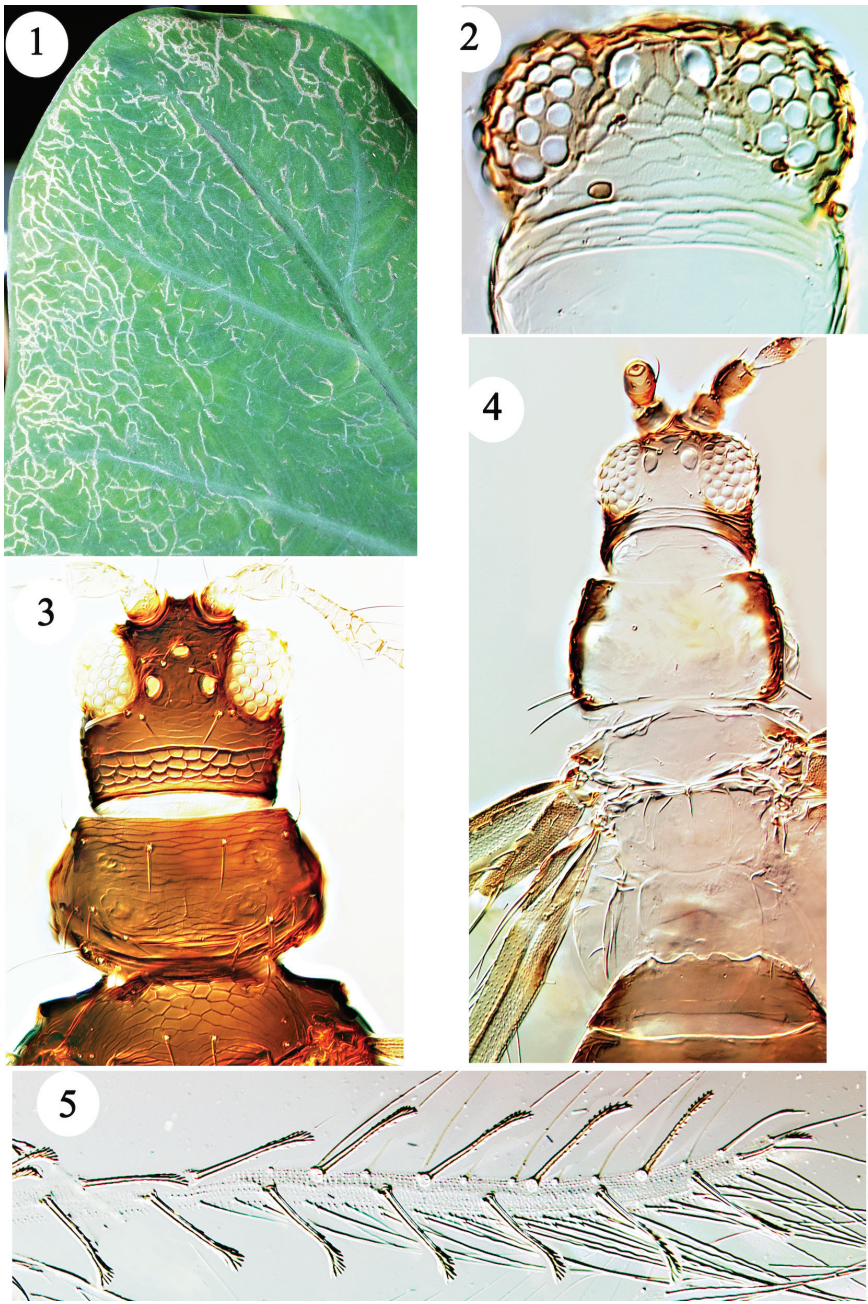
Incursions of exotic insects resulting in successful establishment are ongoing, because Hawaii is a major hub for tourism, trade, and military traffic (Messing et al. 2007). The result of this ongoing process is that the present-day insect fauna of Hawaii is dominated by introduced species, a situation that is facilitated by anthropogenic activities (Messing et al. 2007). Native and endemic Hawaiian insect species are restricted to small areas at higher elevations, although even these are often altered by non-native animals such

as goats and pigs, and the invasion by a diversity of weedy plants. The extent to which adventive insect species can potentially colonize this native flora is a major biodiversity concern. Examples are given below of species that are pests in some parts of the world, but when introduced to the Hawaiian Islands have failed to cause noticeable damage to crop plants or native vegetation. In this context we distinguish between "adventive" and "invasive" species. Adventive species are non-native, accidentally introduced, immigrants or are species whose populations were intentionally introduced (e.g., biological control agents) (Frank and McCoy 1995). In this context, we refer to accidentally introduced adventive thrips as those causing no economic or ecological harm to the ecosystem that has been infiltrated. In contrast, non-native populations that have become pestiferous after establishing are considered invasive species.

The insect Order Thysanoptera comprises just over 6000 species worldwide, with most of these species residing in tropical and subtropical areas. However, despite the fact that these insects, known as thrips, are small and potentially dispersive, there are only around 200 species recorded from the Hawaiian Islands. Moreover, of the 99 species of the suborder Terebrantia currently listed from these islands (Mound et al. 2016), no more than seven are considered to have evolved here, with the other 90 Terebrantia species having been accidentally introduced from other countries through human activities. At least two species are known to have been deliberately introduced as biocontrol agents: *Liothrips urichi* against the highly invasive forest weed, *Clidemia hirta* (Melastomataceae), and *Sericothrips staphylinus* against the noxious weed, gorse, *Ulex europaeus* (Fabaceae). During July 2016, in association with a short course on thrips identification and biology presented at the USDA Pacific Basin Agricultural Research Center (PBARC) in Hilo, samples of thrips were taken on three islands, Hawaii, Maui, and Oahu. As a result, 15 additional adventive thrips species were discovered, and information was gathered on the putative host associations of several other species. The purpose of this work is to present new information about these non-native thrips species. For the sake of brevity, full nomenclatural details of collected species are not given here, but are available for all thrips taxa at ThripsWiki 2017. Specimens will be deposited into the collections both at the Hawaii Department of Agriculture (HDOA) and CSIRO, Australian National Insect Collection, Canberra (ANIC), or as noted.

Newly Recorded Thripidae

***Biltothrips minutus* Bhatti.** This minute white insect with black forewings was abundant in the vicinity of Hilo, Hawaii, breeding on the leaves of both taro (*Colocasia esculenta* [Araceae]) and cassava (*Manihot esculenta* [Euphorbiaceae]). Feeding damage by this thrips on *C. esculenta* was unusual (Fig. 1), comprising small linear markings that resembled leafmines of minute Lepidoptera. Similar leaf damage in association with this thrips was also noted on cabbage (*Brassica oleracea* [Brassicaceae]), avocado (*Persea americana* [Lauraceae]), and blueberry (*Vaccinium* sp [Ericaceae]). This biparental species was described from West Bengal, India. Subsequently it was reported from Thailand, and from Malaysia (both sexes were collected from cassava [Ng et al. 2014]), and also the Society Islands (Hoddle et al. 2008, Ng and Mound 2015). In the key to Hawaiian Terebrantia (Mound et al. 2016) *B. minutus* will run to the genus *Scirtothrips*, because of the presence of closely spaced rows of microtrichia laterally on the tergites. However, in contrast



Figures 1–5. Thrips new to Hawaii. 1. Leaf-damage on *Colocasia esculenta* by *Biltothrips minutus* (photo: S. Chun). 2. Head of *Indusiothrips seshadrii*. 3. Head and pronotum of *Monilothrips kempi*. 4. Head and thorax of *Trichromothrips priesneri*. 5. Forewing of *Coremothrips pallidus*.

to *Scirtothrips* species, *Biltothrips* species have the median pair of setae on the sixth to the eighth tergites as large as, and situated close to, the submedian setal pair, instead of being small and close together in the mid-line.

***Chirothrips manicatus* (Haliday).** The record from the Hawaiian Islands of this common grass thrips of temperate countries was considered doubtful by Mound et al. (2016), but an overlooked report by Krushelnycky et al. (2007) indicated that the species had been found at Haleakala National Park, Maui, during a survey between 2001 and 2004, and in July 2016 substantial populations were found on the upper slopes of Haleakala within the national park. As with other species of *Chirothrips*, this thrips breeds and pupates within the florets of grasses, and it is thus easily distributed in commercial grass seed. Moreover, it seems to be catholic in the range of Poaceae on which it can breed, and large populations have been studied from Australian native grass species in montane areas of Tasmania.

***Coremothrips pallidus* Hood.** In December 2016 Randy Hamasaki found larvae and adult females of this species feeding on the leaves of avocado at Laupahoehoe, Hawaii. Also in December 2016, a single female was taken from avocado foliage in Waimanalo, Oahu. This is a very small, pale species, but the adults are remarkable for having the major setae on the forewings (Fig. 5), head and pronotum exceptionally long with expanded fringed apices. Similar setae also occur on the dorsal surface of the larvae. This thrips was described from specimens taken from avocado on Trinidad, and is also reported from Panama, Puerto Rico, Guadeloupe and St. Vincent (Mound and Marullo 1996). However, a survey of thrips associated with avocado in several Neotropical countries (Hoddle et al. 2002) did not find this species.

***Indusiothrips seshadrii* Priesner.** Until now, this species was known only from the original specimens collected in southern India. It is identified here by means of the key that was provided by Wilson (1975) in describing the only other species in the genus. Both of them apparently live on ferns, and *I. nakaharai* has been found in large numbers on Polypodiaceae in Honshu, Japan (Okajima and Urushihara 1994). The two species are distinctive in having the head reticulate (Fig. 2), and all the major setae minute on the body and forewings, except for two pairs of remarkably long setae with broadly expanded apices on tergite IX. Both species are small and white in color, but *seshadrii* has uniformly dark forewings and a dark area on the anterior half of the head, whereas *nakaharai* is almost entirely yellow. One female of *seshadrii* was taken from an unidentified fern on the Mokuleia Trail, Oahu (in ANIC).

***Monilothrips kempi* Moulton.** Described from northern India, with one synonym from South Africa, this fern-living Panchaetothripine is also known from California (Wilson 1975), where it was collected recently in large numbers on the fern *Woodwardia fimbriata* [Blechnaceae]. On Hawaii, at Kipuka Ki, Hawaii Volcanoes National Park, it was found breeding on the fronds of the fern *Microlepia strigosa* [Dennstaedtiaceae] in association with a substantial population of the predatory ant-mimic, *Franklinothrips vespiformis*. There is only one species recognised in the genus *Monilothrips*, and *kempi* is a large dark brown species that is distinctive among Panchaetothripinae in lacking reticulate sculpture on the fore femora and much of the head. The posterior third of the head has a strongly reticulate transverse band (Fig. 3), and the meso- and metanota are also reticulate, the forewing bears two complete rows of veinal setae, the sense cones on antennal

segments III and IV are long and forked, and antennal segments II–IV are almost yellow.

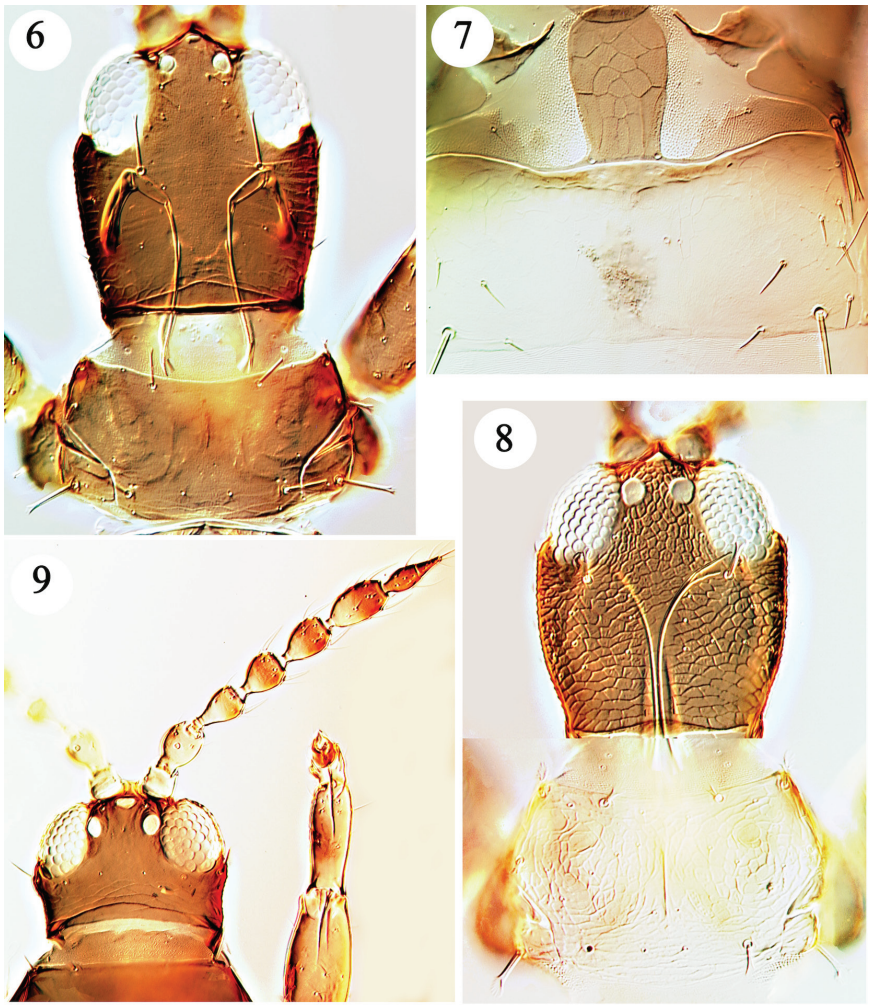
***Pseudanaphothrips achaetus* (Bagnall).** Both sexes of this highly polyphagous Australian flower thrips were found on Maui, Haleakala National Park, in the flowers of the native plant *Geranium cuneatum* [Geraniaceae] and the flowers of an introduced *Oenothera stricta* [Onagraceae]. It is distinguished from the other members of this predominantly Australian genus by the absence of any long setae on the pronotum. In the key to Thripinae genera in Mound et al. (2016) this species will run to *Anaphothrips*, but in contrast to members of that genus the forewing in *Pseudanaphothrips* species resembles that of species of *Frankliniella* in having both longitudinal veins with a complete row of setae.

***Thrips safrus* Mound and Masumoto.** This species was identified from the Hawaiian Islands as *Thrips imaginis* Bagnall (see Mound et al. 2016), based on specimens collected on *Leptecophylla tameiameiae* [Ericaceae] flowers at Haleakala National Park, Maui. Contrary to previous information, those specimens were not retained in 2003 by the Systematic Entomology Laboratory, USDA, Beltsville. They were returned to the collector, Paul Krushelnycky, through whose courtesy they have now been re-examined. In contrast to specimens of *imaginis*, the Australian plague thrips, the females collected from Maui lack discal setae on the abdominal pleurotergites. This condition is typical of *safrus*, a polyphagous species that is common in northern Australia (Mound and Masumoto 2005). The two species are otherwise closely similar in structure, and both are notable for the numerous (15–25) discal setae on the abdominal sternites. Three further females of *safrus* were taken on the Hawaiian Islands in July, 2016; one on Hawaii near Volcano from *Nestegis sandwicensis* [Oleaceae], one on Hawaii on Mauna Loa at 2050 m from flowers of *Vaccinium* sp. [Ericaceae], and a third on Maui at Waihee Ridge, from the flowers of an introduced *Acacia* sp. [Fabaceae].

***Trichromothrips priesneri* (Bhatti).** Two females of this species, previously known only from India, were collected on Maui, on the wetlands behind Waihee Beach amongst dodder and Cyperaceae (deposited in ANIC). These females were identified from the description given by Bhatti (2000) in a key to the species of the genus. These specimens agree well with that description, except that they have the basal half of antennal segments III and IV more extensively yellow. *T. priesneri* is remarkable for its color, even in the field. The abdomen and forewings are dark brown, but the pterothorax is white, the pronotum is white with brown lateral margins (Fig. 4), and the head is white medially but brown at the anterior and posterolaterally. The only other member of this genus with a similar dark brown abdomen is *T. elegans* from Japan, but that has a uniformly dark head and a smaller pale area medially on the pronotum (Masumoto and Okajima 2005).

Newly Recorded Phlaeothripidae

***Adraneothrips alajuela* Mound and Marullo.** Previously known only from Costa Rica, four females were taken on Hawaii in July, 2016; two from a dead branch of *Metrosideros polymorpha* [Myrtaceae] at Tom's Trail, 30 km southwest of Hilo, one from dead branches of *Metrosideros polymorpha* at the Volcano Research Station, and one from a dead branch in a garden at Volcano. Generally medium brown in color (Fig. 6), this species has abdominal segment II yellow with its anterior margin weakly shaded, and tergites VI and VII lighter brown. The compound eyes are prolonged ventrally, and the pelta has very small lateral wings and bears a



Figures 6–9. Thrips new to Hawaii. 6. Head and pronotum of *Adraneothrips alajuela*. 7. Abdominal tergites 1 and 2 of *A. alajuela*. 8. Head and pronotum of *Azaleothrips siamensis*. 9. Head and antenna of *Sophiothrips annulatus*.

pair of campaniform sensilla (Fig. 7).

***Adraneothrips russatus* (Haga).** Described from Japan, but known from southern China and northeastern Australia (Dang et al. 2013), several females of this species were taken from dead branches in July 2016 on the Mokuleia Trail, Oahu (deposited in ANIC). Strikingly bicolored, with a brown head, pale pronotum, and banded tergites, this species is unusual in lacking duplicated cilia on the forewing.

***Azaleothrips siamensis* Okajima.** Identified here from the original description and key to species (Okajima and Masumoto 2014), this thrips was found on dead branches in considerable numbers on Hawaii. It was collected in July 2016 from recently felled trees at USDA PBARC in Hilo, in lower Puna, and also in the forest at Kipuka Ki, Hawaii Volcanoes National

Park. These specimens have the color, chaetotaxy, and sculpture character states of *siamensis* (Fig. 8), although the mouth cone appears to be rather shorter in not extending across the mesosternum.

***Cartomothrips neboissi* Mound and Walker.** A substantial breeding population of this Australian species was found on Hawaii, on the slopes of Mauna Loa just above the tree line at about 2200 m. The adults and first instar larvae were taken from *Metrosideros polymorpha* [Myrtaceae], where they were living within old seed capsules. The trees at this altitude were sparsely distributed and were no more than 6 ft in height. This thrips is common in southeastern Australia, living in the seed capsules of *Kunzea ericoides* [Myrtaceae], and is also recorded from New Zealand, North Island (Mound and Walker 2012).

***Plectrothrips* sp.** A single female of this genus was taken on Hawaii from dead wood at Kipuka Ki, Hawaii Volcanoes National Park, and one male and one female of the same species were taken on Oahu from dead branches on the Mokuleia Trail (deposited in ANIC). The species cannot at present be identified, because all three specimens are de-alate. However, it appears to share all the available character states with *orientalis* Okajima from Malaysia (Okajima 1981).

***Pygothrips* sp.** One female, possibly related to *mikrommatos* Moulton from Fiji, was taken on Hawaii from dead branches at USDA PBARC, Hilo (deposited in ANIC).

***Sophiothrips annulatus* Okajima.** Four female and two male apterae, also two female macropterae and one female hemimacroptera, were taken on Maui in July 2016, from dead branches at Iao Valley, and on the trail to Waihee Ridge. In contrast to two paratype female apterae of *annulatus* that have been studied, these specimens have the femora and tibiae more extensively yellow, and the antennae are slightly longer (Fig. 9). The pelta of the apterae varies amongst the six available specimens, from rectangular with small lateral wings to almost as rounded as on the paratypes from Okinawa (Okajima 1994).

Notes on Recent Host-association and Locality Records

***Anisopilothrips venustulus* (Priesner).** The specimens of this Panchaetothripinae species on which the record from Hawaii was based (Mound et al. 2016) were taken from leaves of *Alyxia stellata* [Apocynaceae] at Keeau, Hawaii, in May 2010 (in Hawaii Department of Agriculture Collection, Honolulu). Considerable populations of this thrips were found in July 2016 causing leaf damage on *Alyxia stellata* at Kipuka Puaulu, Hawaii Volcanoes National Park, Hawaii. The species is otherwise known from Taiwan, Japan, Australia, Fiji, and Florida, but with little reliable host plant information. This appears to be a new host association for this species.

***Dichromothrips smithii* (Zimmermann).** As previously reported by Hawaii Department of Agriculture (2009) and Hollingsworth et al. (2012), substantial populations of this thrips were found on the bamboo orchid, *Arundina graminifolia*, that grows extensively along the roadsides in lower Puna. This thripid occurs widely in southeast Asia, and is a pest of *Vanilla* [Orchidaceae] in India.

***Dolichothrips franae* Mound and Okajima.** This impressive large species of Phlaeothripinae has previously been known only from the islands of Oahu and Kauai (Mound and Okajima 2015), where it was taken in good numbers from the flowers of *Macaranga tanarius* [Euphorbiaceae], with a few specimens also recorded from *Hibiscus tiliaceus* [Malvaceae] (Mound and Matsunaga

2017). However, on Hawaii, at Waikolola Dry Forest Reserve, a substantial breeding population was found amongst the apical leaves of *Hibiscus brackenridgei* [Malvaceae]. A similar pair of contrasting host associations involving these two unrelated plant genera has been recorded for *Dolichothrips reuteri* (Karny) in Australia, and possibly reflects some physical or chemical similarity in the apical tissues of these unrelated plants. This is the first report of *D. franae* for the island of Hawaii.

***Frankliniella insularis* (Franklin).** This Central and South American species is likely to be widely established on the Hawaiian Islands, although currently recorded only from Hawaii island. In July 2016 on Hawaii, it was abundant on *Hibiscus* flowers in lower Puna, and also on *Jacaranda* flowers at Puu Waawaa Forest Reserve. At the later site it was also taken from the flowers of the endangered endemic plant *Kokia drynarioides* [Malvaceae].

***Frankliniella occidentalis* (Pergande).** This ubiquitous, worldwide pest, the western flower thrips, was collected widely on Hawaii. Large populations were found on Mauna Kea in the flowers of the native plant species, *Sophora chrysophylla* [Fabaceae], and *Chenopodium oahuense* [Amaranthaceae], as well as in the flowers of the introduced plant species, *Senecio madagascariensis* and *Achillea millefolium* [Asteraceae]. These infestations of native plants may have been facilitated by the extent to which the vegetation at that site was degraded and dominated by non-native plants that are hosts for this pest thrips. In contrast, within healthy native forest at Kipuka Puaulu, Hawaii Volcanoes National Park, *F. occidentalis* was found only in the flowers of *Ipomoea indica* [Convolvulaceae] and was not collected from the flowers of any endemic plant species. Moreover, on the extensive areas of native plants that grow on Maui within the upper slopes of Mt. Haleakala, only two females of *occidentalis* were taken, whereas on the lower slopes where there are many non-native plants this thrips was common.

***Frankliniella schultzei* (Trybom).** The tomato thrips has been recorded from several of the Hawaiian Islands, but it was found in July 2016 only in low numbers and in dry areas, including Waikoloa Dry Forest Reserve, and Puu Waawaa Forest Reserve. Only the pale form of this species was found.

***Hercinothrips bicinctus* (Bagnall).** Although first listed for the Hawaiian Islands in 1998, from Oahu (Mound et al. 2016), this species was found commonly in July 2016 at various sites on Hawaii and Oahu (see also Kumashiro et al. 2002). Large populations were present on the leaves of recently planted specimens of the rare endemic plant *Clermontia lindseyana* [Campanulaceae] near Kipuka Puaulu, Hawaii Volcanoes National Park, and this is the first report of this host plant association. In contrast, only a few specimens of *Hercinothrips femoralis* were found, and these were on the leaves of taro in association with populations of *Biltothrips minutus* at Hilo (deposited in ANIC).

***Pezothrips kellyanus* (Bagnall).** Known as Kelly's citrus thrips, this species is considered a pest of citrus crops in South Australia, New Zealand, and southern Europe. It is not recorded from citrus in the Hawaiian Islands, but both sexes were collected in small numbers at various sites on Hawaii, Maui, and Oahu, mainly from white flowers of species in the genera *Aleurites* [Euphorbiaceae], *Gardenia* [Rubiaceae], *Myoporum* [Scrophulariaceae] and *Sida* [Malvaceae]. Specimens of this thrips are also available in the Hawaii Department of Agriculture collection from loquat (*Eriobotrya japonica*) [Rosaceae], *Persea americana* [Lauraceae], and *Myoporum sandwicense*.

First recorded in 2006 on the Hawaiian Islands, collected at Kula, Maui, records also show that this species was identified from the same area as far back as 2000 (Hawaii Department of Agriculture 2007). Krushelnycky et al. (2007), reported collections of this species at Haleakala National Park, Maui on *Leptocophylla tameiameiae* and *Vaccinium reticulatum* (all of these specimens were collected simply by beating these plants, so may not be definitive host-association data), and in pitfall traps. Although not specified, these collections were in 2003 (Krushelnycky 2017, review comments, 22 July).

***Pseudanaphothrips araucariae* Mound and Palmer.** Described from Australia, but also known from Hawaii and Oahu where it was collected from the male cones of the Norfolk Island Pine, *Araucaria heterophylla* [Araucariaceae], a single female of this species was taken from flowers of *Dodonaea viscosa* [Sapindaceae] in July 2016 on Maui on the lower slopes of Mt. Haleakala. This is the first report of this species from Maui.

***Sciothrips cardamomi* (Ramakrishna).** The cardamom thrips was found widely on both Hawaii and Oahu. This thrips occurred in large numbers, breeding within the apical rolled leaves and leaf axils of *Hedychium gardnerianum* [Zingiberaceae]. A few adults were also found in a similar situation on *Hedychium coronarium* on Oahu, confirming a new island record of this species

***Scirtothrips citri* (Moulton).** This Californian pest species was recorded from collections on mango and lime foliage at Kihei, Maui, in November 1994. There appear to be no more recent collections, and it remains unclear if this polyphagous species is established on the Hawaiian Islands.

***Scirtothrips dorsalis* Hood.** This Asian species is well established in Florida, as well as other localities around the Caribbean, and is a significant pest of ornamental and horticultural crops (Kumar et al. 2012). *S. dorsalis* was first detected on Oahu in 1987, then on Maui in 1988. On Hawaii, in July 2016, it was found in large numbers on the leaves of *Mimosa pudica* [Fabaceae] growing on the sea cliffs in lower Puna, and in 2009 was found heavily infesting *Myoporum sandwicense* [Scrophulariaceae] foliage at Waikoloa. *S. dorsalis* continues to be another pest of the native *M. sandwicense* that is already under threat from *Klambothrips myopori*.

***Scirtothrips inermis* Priesner.** Previously recorded from Maui (Nishida 2002; Mound et al. 2016), a single female of this species was taken in July 2016 from an unidentified plant in Hawaii Volcanoes National Park, Hawaii.

***Scirtothrips perseae* Nakahara.** The avocado thrips is a pest in California, damaging the leaves and young fruit of *Persea americana* [Lauraceae], although it has a wide distribution on these trees southwards through Mexico to Guatemala (Mound and Hoddle 2016). It appears to have become established in Maui since 2006, but was first confirmed from Hawaii in 2016 where it remains localized at Kamuela. At present, there is limited information on its pest status on the islands. According to Mach Fukada (pers. comm. 2017), avocado thrips seems to be limited on Maui by the environment. In lowland areas populations seem to crash during high temperatures, and severe damage to avocado trees is generally not apparent below 2000 feet elevation. The females from the sample on Hawaii have the transverse dark markings on the tergites rather paler than on specimens from California, but are otherwise identical in structure with females from those pest populations.

***Thrips maculicollis* Hood.** As indicated in Mound et al. (2016) this species seems to be well established on Hawaii island, although no specimens have been

seen from any of the other islands. It was found at several sites on Hawaii in the flowers of *Fagraea berteriana* [Gentianaceae] that are commonly used in the production of lei.

Discussion

The major purpose of the thrips sampling carried out in July 2016 was to obtain good series of the endemic species in the genera *Neurisothrips* and *Hoplothrips*. Species-level taxonomy in those two genera is currently unsatisfactory, with type material of several named species being in very poor condition, but with some apparently undescribed species present in museum collections. Because of this objective, field work was primarily within areas of natural vegetation, leading to a collection of more than 50 Thysanoptera species in the four weeks that field surveys were conducted. Investigations into the range of Thysanoptera species on cultivated plants are clearly needed, and several Thripidae species are known to cause problems to horticulturalists in the Hawaiian Islands. For example, *Heliothrips haemorrhoidalis* and *Selenothrips rubrocinctus* are both responsible for leaf damage on tree crops, whereas *Thrips nigropilosus* can be severe on hydroponic lettuce crops, and *Thrips parvispinus* on the leaves and fruits of papaya. However, the relationships of thrips species to cultivated plants, and to the extensive areas of non-native plants will require separate studies by locally based entomologists in collaboration with the horticultural industry.

It is curious that several adventive species recorded from these recent surveys have not reached pest status in Hawaii, even though they are problematic elsewhere (e.g., *S. perseae* on avocados; *Pezothrips kellyanus* on citrus). Notable exceptions are the invasive *Thrips palmi* and *F. occidentalis* that are known to be pests of vegetable crops both through direct feeding damage and through virus transmission (Rosenheim et al. 1990). Similarly, the two widespread leaf-feeding *Chaetanaphothrips* species (*orchidii* and *signipennis*) are both damaging to various aroid plants including cultivated *Anthurium*, while feeding damage by *C. signipennis* can lead to banana fruits being unmarketable (Hara et al. 2002)

One exceptional adventive pest in recent years has been *Klambothrips myopori*. This species originated in Tasmania, but is established and seriously damaging to *Myoporum* spp. in California (Cameron and Mound 2014). On Hawaii island, this thrips has killed a large percentage of native *Myoporum sandwicense* in natural forests, as well as killed the prostrate variety of this species that is used for landscaping at lower elevations. Landscapers have had to replace this native species with other non-native dry tolerant species in landscaping on this island.

One problem with records of pest species may lie in extensive dependency on insecticides, leading to a situation where a pest is not reported until it exhibits pesticide resistance. However, there are several factors that could limit the negative impacts of adventive thrips in Hawaii, including suboptimal conditions both of temperature, environmental conditions, and host plants (Morse and Hoddle 2006), and biotic resistance in the form of competition from other thrips species (Funderburk et al. 2016), or even population suppression by resident guilds of natural enemies (Funderburk et al., 2000). One example of the latter appears to be the leaf damage to *Ficus* in landscapes and urban areas that is caused by *Gynaikothrips*; this seems to be under partial control by anthocorid bugs such as *Montandoniola confusa*. Investigation into mechanisms suppressing populations of adventive thrips in Hawaii may provide useful insights into factors influencing the invasion

ecology of these tiny insects, and for the development of ecologically-based management plans for economically damaging species.

Acknowledgments

The visits to and studies on Hawaii in 2016 by three of the authors (MSH, LAM, and AW) were facilitated by many people, including Rob Hollingsworth, Fran Calvert, Karl Magnacca, Michael Sthreshley, Stacey Chun, Robert Curtis, Linda Pratt, Paul Krushelnycky, Randy Hamasaki, and Dick Tsuda. Figure 1 was kindly provided by Stacey Chun. We are grateful to all of them for their input to these studies.

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