

## Rediscoveries and Presumed Extinctions of Hawaiian Leaf-roller Moths (Lepidoptera: Tortricidae)

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**Abstract.** Three species of endemic Hawaiian leaf-roller moths were rediscovered after a 90-year gap in collection records. Twenty-one other species are presumed extinct, with no collection records from the past 50 years. Remarks concerning the type localities of four species (*Cydia chlorostola*, *C. gypsograpt*a, *C. parapteryx*, and *Pararrhaptica leucostichas*) described by Meyrick are given. A list of all described endemic Hawaiian Tortricidae is provided with corresponding years for when each species was last reliably seen or collected as well as the type locality (when known). For each species, we include a list of known or hypothesized host plants, which we hope will spur future rediscoveries and conservation efforts for this group which has, to date, been ignored in conservation planning.

**Key words.** Conservation, endangered species, endemic, insects, host plant

The Hawaiian Islands are commonly referred to as the “extinction capital of the world,” but literature supporting this claim is largely focused on the most well-studied and often charismatic taxa (Régnier et al. 2015, Paxton et al. 2018, Rønsted et al. 2022). In contrast, there are exceedingly few studies on extinction rates in the Hawaiian insect fauna. The first and only comprehensive attempt was undertaken in the 1980s (Gagné 1982, Gagné and Christensen 1985). With funding from the U.S. Fish and Wildlife Service, Wayne Gagné and colleagues assessed approximately 800 endemic arthropod species to determine their conservation status, including 22 species of *Omiodes* (Crambidae) and a handful of endemic macrolepidoptera. Haines et al. (2004) subsequently reported the rediscovery of five species of *Omiodes* on Hawai'i island considered extinct by Gagné (1982), offering hope that similar rediscoveries could be made. Understandably, these researchers could not include

all endemic Lepidoptera in their studies due to the sheer numbers of described species and the lack of data for the majority of them. Since then, taxonomic monographs have alluded to possible extinctions in a select few genera: *Scotorythra* (Heddle 2003), *Thyrocopa* (Medeiros 2009), *Cydia* (Oboyski 2011), and *Philodoria* (Kobayashi et al. 2021), but no order-wide assessment has been made to date.

Though we investigated only a small fraction of the approximately 6,000 described endemic arthropod species (Nishida 2002, Hembry et al. 2021), which includes 930 Lepidoptera (Nishida 2002; Austin and Rubinoff 2022), our assessment provides an important glimpse into the dire situation for many endemic insects.

As part of an ongoing effort to catalogue possible extinctions in endemic Hawaiian Lepidoptera, we visited museum collections, reviewed literature, and conducted field work throughout the state in order to build a comprehensive database of all

species, including the year each species was last reliably seen or collected. Dozens of “rediscoveries” of species have been documented to date (in prep.), but because of the paucity of existing literature and identified material in museum collections, it is often difficult to determine if species were actually “rediscovered” or are relatively common and have been simply overlooked and unidentified by entomologists until now. Towards that end, we present a snapshot of the Hawaiian Tortricidae, historically a diverse family with a disproportionate number of independent colonizations and subsequent radiations (Hembry et al. 2021), and which appears to be particularly hard-hit by extinctions in the past century.

There are 66 described endemic species of Hawaiian Tortricidae, along with dozens of undescribed species. Four authors are responsible for the named species: A.G. Butler (1844–1925), Lord Walsingham (1843–1919), E. Meyrick (1854–1938), and O.H. Swezey (1869–1959). Of these, only Swezey lived in Hawai‘i. Butler and Walsingham based their descriptions on material sent to London by R.C.L. Perkins (1866–1955). Meyrick used material collected by both Perkins and Swezey. No native Tortricidae have been described since 1946, although many introduced species have been reported or released since then (Davis 1959, 1962, Davis and Krauss 1966, Pogue 1988, Miller and Hodges 1995, Austin and Rubinoff 2022, 2023).

The Hawaiian Tortricidae are a diverse group of endemic insects, having independently colonized the Hawaiian Islands at least ten times (Zimmerman 1978, Hembry et al. 2021), but possibly more, making them the most successful colonists of any family of Hawaiian Lepidoptera, and exceeding virtually all other native terrestrial arthropod families (Zimmerman 1948). Most genera, including several undescribed ones, are highly host-specific,

utilizing a single family of native plants, feeding typically as leaf-tiers or -rollers on leaves, but some occur in fruits, stems, seeds, and bark. These specialized feeding habits (often on uncommon or rare plant species), coupled with their apparent vulnerability to introduced predators and parasitoids (naked larvae, only rarely internal feeders) seem to have made them exceptionally prone to extinction.

### Materials and Methods

The following museum collections were examined to establish the most recent year each species was collected: Bernice Pauahi Bishop Museum (BPBM), Hawai‘i Department of Agriculture (HDOA), and University of Hawai‘i Insect Museum (UHIM). For some species, only the holotype, housed in the Natural History Museum, London (NHMUK, formerly the British Museum of Natural History), is known. Identifications were made using original descriptions, supplemented by Zimmerman (1978). Genitalia dissections, when necessary, were prepared using standard techniques and slide-mounted, following Landry (2007). Label data are copied verbatim except for “USA: Hawaii,” collection-event specific codes, and museum accession/catalogue numbers, which are omitted. Slashes (/) separate data labels when multiple labels are present on the same specimen.

Several species are currently placed in incorrect genera or are members of undescribed genera; these species are written with their current genus in quotation marks. Manuscripts are currently being prepared to transfer these species to the correct genus and describe new genera as necessary. Host data were gathered from Zimmerman (1978), Oboyski (2011), and museum specimens. Hypothesized host plants are based on the known host plants of congeners or presumed congeners in the case of misplaced species. Evenhuis

(2007) was used to identify type localities based on the dates provided on Perkins' data labels; localities identified in such a way are written in brackets in Table 1.

The arbitrary date of 1972 was selected as the cut-off date for presuming a species extinct, representing 50 years since the last known specimen was collected. Though many species are reported from multiple islands (Zimmerman 1978), we only list the island containing the type locality as correct, as most species appear to be single-island endemics, with undescribed sister species on other islands. A few species (e.g., *Bactra straminea*, *Crocidosema blackburnii*, *Cryptophlebia illepida*) appear to occur on multiple islands, and it is unclear whether they represent endemic species or early introductions from unknown source regions.

## Results

### *Pararrhaptica leopardellus*

(Walsingham)

#### Rediscovery

This species was originally described from a single male collected in 1895 at Kahōluamanu, Kaua'i by R.C.L. Perkins. J.A. Kusche collected a male and female at the same locality in 1920, which KAA identified in BPBM. No other known specimens have been collected since. Here we report it from six specimens collected on the Nu'alolo Trail in Kōke'e State Park. Larvae are suspected to feed on *Myrsine lanaiensis* (Primulaceae), based on the abundance of typical *Pararrhaptica*-like feeding damage on leaves of *M. lanaiensis* in the immediate vicinity of the collecting locality of the most recent specimens.

*Material examined.* **Kaua'i:** 1♂, 2♀♀, Kōke'e State Park, Nu'alolo Trail; 22.1310, -159.6607; 1160 m; 22–23 iii 2022; K. A. Austin; LED bucket trap / DNA extractions KA0493, KA0494, KA0497 / KAA diss. #0738(♀), #0739(♀), #0742(♂) (UHIM). 3♂♂, same as previous except

22.1312, -159.6606; 1165m / DNA extractions KA0496, KA0498, KA0499 / KAA diss. #0741, #0743, #0744 (UHIM).

### *Spheterista oehoheana* (Swezey)

#### Rediscovery

This species was previously known only from the type series of five specimens (four males, one female) reared "from larvae and pupae found in dead twigs" of *Polyscias kavaiensis* (Araliaceae) at Halemanu, Kaua'i in 1932 (Swezey 1933). All specimens of the type series are in poor condition, with wings heavily rubbed and not spread. We report a single female from the Nu'alolo Trail. A few *Polyscias kavaiensis* were observed nearby, although no dead twigs were noticed.

*Spheterista oehoheana* is one of three species of Hawaiian Tortricidae to have been included in a USFWS Candidate Notice of Review (USFWS 1984), meaning it has been considered for possible protection under the Endangered Species Act. It was listed as a category 2 candidate species, meaning that "conclusive data on biological vulnerability and threat are not currently available" to support inclusion. The other two species included in the review, also category 2, *S. pterotropiana* and *S. reynoldsiana*, have been collected in recent years (although *S. reynoldsiana* may be extinct on O'ahu). All three species were removed from consideration in 1996 when the USFWS discontinued the use of category 2 (USFWS 1996).

*Material examined.* **Kaua'i:** 1♀, Kōke'e State Park, Nu'alolo Trail; 22.1310, -159.6607; 1160m; 22-23 iii 2022; K. A. Austin; LED bucket trap / DNA extraction KA0556 / KAA diss. #0787 (UHIM).

### *Spheterista tetraplasandra* (Swezey)

#### Rediscovery

This species was originally described from two males reared from fruits of "*Tetraplasandra*" [= *Polyscias*] (Araliaceae)

in 1918 from Kaumuahona<sup>1</sup> and Wailupe, O'ahu (Swezey 1920). A few additional specimens were collected in the following years, most recently a small series reared from "*Tetraplasandra*" [= *Polyscias*] at Pu'u Kaua, O'ahu in 1932. One specimen is known from Kaua'i, but this may represent a closely related undescribed species. We report three specimens from two separate locations in the central Ko'olau Mountains of O'ahu.

*Material examined:* **O'ahu:** 1♂, Honolulu Watershed For[est] Res[erve], nr. summit of Moanalua Ridge Trail along K[o'olau] S[ummit] T[rail]; 21.3945, -157.8243; 830m; larva coll[ected] 22 viii, pupa[ted] 24 viii, adult ecl[osed] 1 ix 2021; K. A. Austin, K. Faccenda / HOST: *Polyscias* (*Tetraplasandra*) *oahuensis* (Araliaceae), leaflet-tier / DNA extraction KA0297 / KAA diss. #0595 (UHIM). 2♂♂, 'Ewa For[est] Res[erve], Manana Ridge, inside fenced area; 21.4502, -157.8887; 575m; 24-25 xi 2021; K. A. Austin, K. Faccenda; LED bucket trap / DNA extractions KA0387, KA0388 / KAA diss. #0650, #0651 (UHIM).

*The following species are presumed extinct owing to the absence of records over the past 50 years:*

***Cydia chlorostola*** (Meyrick)

**Presumed extinct**

This species is known only from the female holotype, supposedly collected in 1909 by R.C.L. Perkins from Waialua, O'ahu (but see comments below). Meyrick (1932) suggested that it was introduced along with a hypothesized leguminous host, possibly from Asia. Zimmerman (1978) disagreed and considered it endemic. Oboyski (2011) agreed with Zimmerman and compared it to several *Canavalia*-feeding Hawaiian *Cydia*. It appears very similar to *C. parapteryx* (Meyrick), also only known from O'ahu.

***Cydia crassicornis*** (Walsingham)

**Presumed extinct**

This species is known only from two males collected by R.C.L. Perkins in 1892 at 4000 ft near Kona, Hawai'i island (Walsingham 1907). Although possibly a color form of the koa-feeding *C. walsinghamii* (Butler), Oboyski (2011) considered it distinct based on subtle differences in the male genitalia. Perkins' field notes for September 1892 indicates that he "collected ... by sifting dead leaves at the foot of a big koa tree" (Evenhuis 2007). The forewings are very similar to *C. conspicua* (Walsingham), but the absence of a "sex pouch" (Zimmerman 1978) on the ventral surface of the male hindwing readily separates it from that species.

***Cydia gypsograptia*** (Meyrick)

**Presumed extinct**

This species is known only from the male holotype supposedly collected by R.C.L. Perkins near Honolulu, O'ahu in 1908 (Meyrick 1932; but see comments below). Oboyski (2011) found it difficult to distinguish from *Canavalia*-feeding Hawaiian *Cydia*.

***Cydia obliqua*** (Walsingham)

**Presumed extinct**

This species is known from three female specimens collected at Hualālai (5000 ft) and Kona (4000 ft) on Hawai'i island by R.C.L. Perkins in 1892. Oboyski (2011) considered it possibly just an extreme color form of the widespread and polymorphic *C. plicatum* (Walsingham), but refrained from synonymizing it because of significant differences in the female genitalia. The collection date given for the two female types from Hualālai (5 viii 1892) corresponds to a journal entry in which Perkins wrote, "there were two Tortricids on Koa" (Evenhuis 2007).

***Eccoptocera osteomelesana* (Swezey)****Presumed extinct**

This species is the most recent native Hawaiian tortricid to be described (Swezey 1946). It has been reared from leaves of *Osteomeles anthyllidifolia* (Rosaceae) and is known from small series of specimens collected in Mānoa and Wailupe Valley on O'ahu and was most recently collected on the campus of UH Mānoa in 1969. However, it may have been introduced, as it more closely resembles some Pacific and Australian *Eccoptocera* than native Hawaiian ones. It is also notable that no other entomologist collected this species prior to F.X. Williams in 1929, despite it having been reared and collected in such heavily urbanized places. No specimens have been collected by us despite extensive searching near large patches of *Osteomeles* in the southern Ko'olau Mountains and extensive trapping in areas it might be expected.

***Nuritamburia phyllanthana* (Swezey)****Presumed extinct**

This species is known from the type series of seven specimens reared from *Phyllanthus distichus* (Phyllanthaceae) from Malamalama Ridge, O'ahu in 1916 and 1925 (Swezey 1940). No other specimens are known, and targeted collecting near *P. distichus* on O'ahu did not result in any specimens. The hostplant has not been encountered frequently by us, although Wagner et al. (1999) considered it "locally common in mesic forest, often on steep slopes or ridge tops, sometimes in dry shrubland" on Kaua'i, O'ahu, Moloka'i, Lāna'i, West Maui, and rarely on East Maui.

***Paraphasis perkinsi* (Walsingham)****Presumed extinct**

This enigmatic genus and species is known only from the male collected in 1894 from 3000–4000 ft elevation on

Kaua'i by R.C.L. Perkins. This area has been consistently surveyed by us and other entomologists over the past century. Walsingham (1907) originally described *Paraphasis* in Tineidae, but Zimmerman (1978) treated it as a tortricid. The illustration of the head in Zimmerman (1978) appears to show a basally scaled proboscis, a character only very rarely seen in Tortricidae (Diakonoff 1977). In addition, the wing venation and genitalia would be highly unusual for a tortricid. In the absence of a more compelling family placement, we consider it a tortricid for the purposes of this paper.

***Pararrhaptica capucina* (Walsingham)****Presumed extinct**

This species was described from two females: the holotype collected in 1893 at 4000 ft on Moloka'i and a questionably associated paratype collected in 1892 at 3000 ft near Kona, Hawai'i island (Walsingham 1907). The two specimens are likely not conspecific, as most *Pararrhaptica* appear to be single island endemics. Several other high islands host similar-looking *Pararrhaptica*, including *P. chlorippa* (Meyrick) on O'ahu (see below). However, in recent years on Moloka'i we have collected a species very similar to the type of *P. capucina* in genitalia but externally more closely resembling *P. longiplicatus* (Walsingham), described from Maui, suggesting that perhaps only one species is involved and that the holotype of *P. capucina* is just an unusual color form of a more widespread Maui Nui species.

***Pararrhaptica chlorippa* (Meyrick)****Presumed extinct**

This species was described from a single male specimen reared from *Myrsine lessertiana* (Primulaceae) by Swezey in 1911 from Mt. Olympus, O'ahu. Perkins collected a small series of what appear to be this species in 1901 and 1908 from

various locations in the Ko'olau Mountains. The associated females appear very similar to the holotype of *P. capucina* (Walsingham), known from Moloka'i. It appears likely that these two species were closely-related. A similar, undescribed species occurs on Kaua'i and is still extant.

***Pararrhaptica dermatopa*** (Meyrick)

**Presumed extinct**

This species was described from two males and a female reared from three different dates from *Myrsine lessertiana* (Primulaceae) by Swezey in 1911 on Mt. Olympus and Tantalus, O'ahu. Meyrick (1932) wrote that a second, larger female from Mt. Olympus "may be the same species," but we have not been able to locate this specimen.

***Pararrhaptica lysimachiae*** (Swezey)

**Presumed extinct**

This species is known only from the male holotype, supposedly reared from leaves of *Lysimachia hillebrandii* var. *venosa* [= *L. venosa*] (Primulaceae) by Swezey in 1932 on the "Kalalau Trail" at an elevation of 3800 ft. The collecting site may refer to the trail leading down from the Kalalau Lookout at Kōke'e State Park.

Zimmerman (1978) listed *Lysimachia glutinosa* as an additional host, but we are not sure of his justification, as we are only aware of the holotype for this species. Perhaps Zimmerman (1978) believed Swezey's initial plant identification was incorrect; *Lysimachia venosa* is an exceedingly rare species, known only from three specimens from the summit of Wai'ale'ale (Marr and Bohm 1997) until its rediscovery in 2012 (Wood 2013). On the other hand, *Lysimachia glutinosa* occurs somewhat commonly along the upper portion of the trail leading down from the Kalalau Lookout at Kōke'e State Park (KAA pers. obs.).

***Pararrhaptica lysimachiana*** (Swezey)

**Presumed extinct**

This species is known only from the female holotype, reared from leaves of *Lysimachia rotundifolia* [= *L. hillebrandii*] (Primulaceae) by Swezey at Pu'u Hāpapa on O'ahu in 1927. Collecting by KAA at the type locality did not result in any specimens, despite the host plant's presence in the immediate vicinity, and many island-wide surveys.

***Pararrhaptica punctiferanus***

(Walsingham)

**Presumed extinct**

This species was described from two specimens: the holotype male collected by Perkins in 1894 at 5000 ft on Haleakalā, Maui and a questionably associated female paratype, collected in the same year at 4000 ft elevation on Moloka'i. The female paratype likely represents an undescribed species, as most *Pararrhaptica* appear to be single island endemics. Like most other *Pararrhaptica*, it likely fed on *Myrsine* spp. (Primulaceae).

***Pararrhaptica subnenscens***

(Walsingham)

**Presumed extinct**

This species is known from a single female collected by Perkins in 1893 on Moloka'i (Walsingham 1907). No further locality data are given on the label, but the date (5 viii 1893) corresponds to a journal entry by Perkins from "near Waikolu" (Evenhuis 2007). We have collected in this general area and along the Hanalilolilo Trail but have not found this species. Like other *Pararrhaptica*, it likely fed on leaves and shoots of *Myrsine* spp. (Primulaceae).

***"Pararrhaptica" trochilidanus***

(Walsingham)

**Presumed extinct**

This species is known from three specimens: the holotype female and two



paratype males collected by Perkins at elevations of 3000–4000 ft on Molokaʻi. It appears closely related to “*P.*” *fuscoviridis* (Walsingham) from Lānaʻi and “*P.*” *lichenoides* (Walsingham) from Hawaiʻi island and likely fed on *Psychotria* spp. (Rubiaceae) or *Nestegis sandwicensis* (Oleaceae) like other members of this undescribed genus.

***Spheterista argentinotata***

(Walsingham)

**Presumed extinct**

This species is known from two females collected by Perkins in Olaʻa and Hilo, Hawaiʻi island in 1895 and 1896, respectively (Walsingham 1907). In the absence of known males, it is difficult to ascertain for certain whether it belongs to *Spheterista* or another genus. If *Spheterista*, it likely fed on leaves or fruit of *Cheirodendron* or *Polyscias* (Araliaceae).

**“*Spheterista*” *cassia*** (Swezey)

**Presumed extinct**

This species may have been introduced. It does not belong in *Spheterista* and more closely resembles some Australian tortricids, such as *Merophyas* Common, than any native Hawaiian species. It has been reared from leaves of *Senna gaudauchaudii* (Fabaceae), an indigenous species that also occurs in Australia and other islands in the Pacific. There are large series of this species in HDOA and BPBM, suggesting it was once common on several islands. It has not been collected since 1920; we have not encountered its host plant in the wild.

**“*Spheterista*” *flavocincta***

(Walsingham)

**Presumed extinct**

This species was described from a single female collected by Perkins in 1892 near Kona, Hawaiʻi island at an elevation of 4000 ft. Walsingham (1907) described the male of this species as

*Capua trigonifer*, later synonymized by Zimmerman (1978). Records of this species on islands other than Hawaiʻi island are likely erroneous. *Capua santalata* Swezey, described from Oʻahu and currently considered a junior synonym of “*S.*” *flavocincta*, is still extant and probably deserves its species status restored. True “*S.*” *flavocincta* appears to be endemic to Hawaiʻi island and has not been collected since 1911. It probably fed on *Santalum* spp. (Santalaceae) like its close relatives.

***Spheterista pernitida*** (Walsingham)

**Presumed extinct**

This species is known from a single female collected at Olaʻa on Hawaiʻi island in 1896 by Perkins (Walsingham 1907). However, in the absence of males, it is difficult to determine whether it belongs to *Spheterista* or another genus. If *Spheterista*, it likely fed on leaves or fruit of *Cheirodendron* or *Polyscias* (Araliaceae). The male mentioned by Walsingham (1907) as being “closely allied to *pernitida*” is almost certainly not conspecific. The male genitalia closely resemble those of the Urticaceae-feeding “*Spheterista*” (“*S.*” *infaustana*, “*S.*” *urerana*).

**“*Spheterista*” *urerana*** (Swezey)

**Presumed extinct**

This species was described from a series of four specimens reared from twigs of “*Urera sandwicensis*” [= *U. glabra*] (Urticaceae) by Swezey in 1914 on Tantalus, Oʻahu (Swezey 1915). Zimmerman (1978) designated a lectotype and paralectotype and removed the latter from the cork mount. It does not appear he was able to locate the other two specimens in the series. We were unable to locate the paralectotype, though it is supposedly deposited in the BPBM. Females are unknown.

This species may be a synonym of “*S.*” *infaustana* (Walsingham), described from

Kaua'i. Alternatively, the type series could be an unusual color form of a widespread extant species on O'ahu closely related to "S." *infaustana* but provisionally considered undescribed by KAA. It is still common on parts of Tantalus where *Pipturus* and *Urera* grow.

**"*Spheterista*" *xanthogona***

(Walsingham)

**Presumed extinct**

This species is only known from two females, collected by Perkins in 1892 near Kona, Hawai'i island at 4000 ft elevation (Walsingham 1907). It appears to belong to the same *Santalum*-feeding group of "*Spheterista*" as "S." *flavocincta* (Walsingham), from Hawai'i island, and "S." *flavopicta* (Walsingham), from Kaua'i. Journal entries by Perkins around the collection dates of these two moths mention the abundance of *Santalum* (Santalaceae) in the area as well as *Acacia koa* (Fabaceae) and *Myoporum sandwicense* (Scrophulariaceae) (Evenhuis 2007), although the exact location is unclear.

**Additional comments**

For three species described by Meyrick in 1932 (i.e., *Cydia gypsograptæ*, *C. parapteryx*, and *Pararrhaptica leucostichas*), "Honolulu" is given as the type locality. *Cydia chlorostola*, also described by Meyrick in the same publication, was from "Waialua." These four species supposedly collected or reared by Perkins between 1906 and 1909 were almost certainly collected elsewhere in the archipelago.

By 1904, Perkins had started working for the Hawaiian Sugar Planters Association (HSPA) in Honolulu and stopped traveling to neighboring islands (Evenhuis 2007). However, his biocontrol partner, Albert Koebele, went to other islands and collected and brought back larvae for rearing by Perkins (Evenhuis, pers.

comm.). Specimens of these four species, now in the NHMUK, have different labels than Perkins' *Fauna Hawaiiensis* material collected in the 1890s, and the handwriting on them does not appear to be his. We believe Meyrick mistakenly interpreted these package's points of origin as the type locality; post offices existed in both Waialua and Honolulu at this time and were frequented by Perkins and colleagues (see Evenhuis 2007).

With the exception of *C. parapteryx*, all of these species were previously known only from the type series. Oboyski (2011) identified additional material from O'ahu as *C. parapteryx*, including additional HSPA reared material from "Honolulu" and various field stations as well as wild-caught and -reared specimens from the Wai'anae and Ko'olau Mountains from more specific localities. A species identical to the type series of *Pararrhaptica leucostichas* has been collected commonly on Hawai'i island in recent years, suggesting that the true type locality for it is not O'ahu. Similarly, a species closely resembling *C. gypsograptæ* was collected recently by the authors in Hawai'i Volcanoes National Park, but we hesitate to identify it confidently as such at present. *Cydia chlorostola* closely resembles some of the *Canavalia*-feeding *Cydia* species known from Hawai'i island, Maui, O'ahu, and Kaua'i and may be a synonym of one of them.

These four species appear to be the only Hawaiian species of Lepidoptera described by Meyrick in such a manner. However, other authors may have made the same mistake. For example, *Agrotis diplosticta* (Hampson) was similarly described from "Waialua," despite all other collections of this species being from the mountains of O'ahu and Kaua'i. As far as we are aware, all other Meyrick species were based on *Fauna Hawaiiensis* material overlooked by Walsingham (1907) or



sent to London by Swezey and included data labels. We suggest treating the type locality of these four species as unknown, as well as similar occurrences. It would be useful to attempt to find HSPA rearing records to find out where these specimens may have been collected before being shipped to London.

### Discussion

The rediscovery of the three species reported here are cause for hope that future rediscoveries can be made, although there is limited cause for optimism given the apparent extinction of 21 other species, representing nearly a third of the native Hawaiian tortricid fauna. Several of the species we found in recent years likely are on the verge of becoming critically endangered. As native Hawaiian plants disappear, the available habitat and hosts for the moths also recede. Given the unabated onslaught of invasive species, it is only a matter of time before more moth species are lost forever. This will have cascading effects on native ecosystems across the state as tortricids represent one of the most significant native herbivore groups in Hawai'i and a major source of food for native forest birds (Banko et al. 2022) and bats (Pinzari et al. 2019). Genera such as *Eccoptocera* and *Spheterista* can still be abundant in pristine wet forest and indicate the importance of tortricid moths in native ecosystems. Such species might serve as useful indicators of overall forest health.

Without rapid intervention, many rare species will soon blink out of existence – without much notice or fanfare – as the disappearance of the aforementioned 21 species indicates. A critical first step may be federal listing for the most vulnerable, but still extant, species in order to allocate resources to better understand their current ranges, life histories, and most significant threats, as these are all virtually

unknown for the majority of native moth species. For native moths in general, the most critical component of their conservation is likely the protection and restoration of their host plants and habitat.

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#### Footnote

<sup>1</sup>This place name, now out of use, refers to “the ridge leading up to Kōnāhuanui, forming the east side of Nuʻuanu Valley, and in particular the portion on the east side of Lulumahu Stream” (Magnacca 2013).

**Table 1.** List of Hawaiian Tortricidae with corresponding years for which each species was last seen and known (without question mark) or hypothesized (with question mark) host plants. Comments in brackets regarding type localities are based on Perkins' field notes transcribed by Evenhuis (2007). †presumed extinct (has not been collected in 50+ years) \*see comments in text regarding the type locality for this species.

Species	Last collected	Source	Host(s)	Type locality (island)	Type locality
<i>Bactra straminea</i> (Butler 1881)	2022	UHIM	<i>Bolboschoenus</i> , <i>Carex</i> , <i>Machaerina</i>	O'ahu	"salt marshes near Honolulu"
<i>Crociosema blackburnii</i> (Butler 1881)	2022	UHIM	<i>Abutilon</i> , <i>Sida</i>	Maui	Makawao
<i>Crociosema leprarum</i> (Walsingham 1907)	2022	UHIM	<i>Sesuvium</i>	Molokai	sea level
<i>Crociosema marcidellum</i> (Walsingham 1907)	2022	UHIM	<i>Abutilon</i> , <i>Hibiscus</i>	O'ahu	Wai'anae Mountains [exact location unclear]
<i>Cryptophlebia illepidia</i> (Butler 1882)	2022	UHIM	polyphagous	O'ahu	["in the neighborhood of Honolulu", see comments in Zimmerman 1978]
<i>Cydia chlorostola</i> † (Meyrick 1932)	1909	NHMUK	<i>Canavalia?</i>	O'ahu*	Waialua*
<i>Cydia conspiciua</i> (Walsingham 1907)	2022	UHIM	<i>Acacia koa</i>	Maui	Haleakalā, 5000 ft
<i>Cydia crassicornis</i> † (Walsingham 1907)	1892	NHMUK	<i>Acacia koa?</i>	Hawaii	Kona [vicinity of Pulehua?], above 4000 ft
<i>Cydia falsifalcellum</i> (Walsingham 1907)	2005	Oboyski 2011	<i>Canavalia</i> , <i>Vicia</i>	Hawaii	Ola'a, 2000 ft
<i>Cydia gypsograptia</i> † (Meyrick 1932)	1908	NHMUK	<i>Canavalia?</i>	O'ahu*	Honolulu*
<i>Cydia latifemoris</i> (Walsingham 1907)	2022	UHIM	<i>Sophora chrysophylla</i>	Maui	Haleakalā crater

Species	Last collected	Source	Host(s)	Type locality (island)	Type locality
<i>Cydia montanum</i> (Walsingham 1907)	2022	UHIM	Acacia koa	Hawai'i	Kīlauea
<i>Cydia obliqua</i> † (Walsingham 1907)	1892	NHMUK	<i>Sophora chrysohylla</i> ? Acacia koa?	Hawai'i	Hualālai, 5000 ft
<i>Cydia parapteryx</i> (Meyrick 1932)	2022	UHIM	<i>Canavalia, Strongyloдон</i>	O'ahu*	Honolulu*
<i>Cydia plicatum</i> (Walsingham 1907)	2022	UHIM	<i>Sophora chrysohylla</i>	Hawai'i	Kona [Kānahāha], 4000 ft
<i>Cydia rufipennis</i> (Butler 1881)	2022	UHIM	Acacia koa	O'ahu	["mountains of O'ahu", see comments in Zimmerman 1978]
<i>Cydia storella</i> (Walsingham 1907)	1988	UHIM	Fabaceae?	Maui	Haleakalā, 5000 ft
<i>Cydia walsinghamii</i> (Butler 1882)	2022	UHIM	Acacia koa	O'ahu	["in the neighborhood of Honolulu", see comments in Zimmerman 1978]
<i>Ecoptocera foetorivorans</i> (Butler 1881)	2022	UHIM	<i>Metrosideros</i>	O'ahu	"Mountains of O'ahu"
<i>Ecoptocera osteomelesana</i> † (Swezey 1946)	1969	UHIM	<i>Osteomeles anthyllidi- folia</i>	O'ahu	Woodlawn, Mānoa Valley
<i>Macraesthetica rubiginis</i> (Walsingham 1907)	2022	UHIM	Unknown	O'ahu	Wai'ānae Mountains, [> 1300 ft]
<i>Manitua fulvosericea</i> (Walsingham 1907)	2022	UHIM	<i>Xylosma, Flueggea</i>	Molokai	[gulch SE of Makakupa'ia], 3500 ft
<i>Nuritamburia chlorocalla</i> (Walsingham 1907)	2022	UHIM	<i>Perrottetia</i>	Hawai'i	Ola'a

Species	Last collected	Source	Host(s)	Type locality (island)	Type locality
<i>Nuritamburia metallurgica</i> (Walsingham 1907)	2022	UHIM	<i>Perrottetia</i> , <i>Xylosma</i> , <i>Myrsine</i>	Molokai	3000 ft
<i>Nuritamburia phyllanthana</i> † (Swezey 1940)	1925	HDOA	<i>Phyllanthus distichus</i>	O'ahu	Malamalama Ridge
" <i>Nuritamburia</i> " <i>semicinereana</i> (Swezey 1913)	2022	UHIM	Unknown	Hawaii	Kilauea
<i>Nuritamburia thoracina</i> (Walsingham 1907)	2022	UHIM	<i>Perrottetia</i>	Kauai	Kahōluamanu, 4000 ft
" <i>Panaphelix</i> " <i>asteliana</i> Swezey 1932	2007	UHIM	<i>Astelia menziesiana</i>	O'ahu	Ka'ala
<i>Panaphelix marmorata</i> Walsingham 1907	2022	UHIM	Unknown	Maui	Haleakalā [exact location unclear, but above Perkins' usual camp], 6000 ft
<i>Paraphasis perkinsi</i> † Walsingham 1907	1894	NHMUK	Unknown	Kauai	Mts, [vicinity of Kahōluamanu?], 3000–4000 ft
<i>Pararrhaptica capucina</i> † (Walsingham 1907)	1893	NHMUK	<i>Myrsine</i> ?	Molokai	[exact location unclear, but above Perkins' camp at Makakupa'ia, perhaps near the "boggy plateau" he references elsewhere in his journal], 4000 ft
<i>Pararrhaptica chlorippa</i> † (Meyrick 1928)	1935	BPBM	<i>Myrsine lessertiana</i>	O'ahu	Mt. Olympus
<i>Pararrhaptica dermatopa</i> † (Meyrick 1928)	1928	BPBM	<i>Myrsine lessertiana</i>	O'ahu	Mt. Tantalus
<i>Pararrhaptica faleriana</i> (Walsingham 1907)	2022	UHIM	<i>Myrsine</i> ?	Molokai	[exact location unclear, gulch above Makakupa'ia], 4000 ft
<i>Pararrhaptica fuscocinereus</i> (Swezey 1913)	2000	UHIM	<i>Myrsine</i> ?	Hawaii	Kilauea



Species	Last collected	Source	Host(s)	Type locality (island)	Type locality
<i>Pararrhaptica</i> "fuscoviridis" (Walsingham 1907)	1981	BPBM	<i>Psychotria?</i> <i>Nestegis?</i>	Lāna'i	[near Waipa'a], 2000 ft
<i>Pararrhaptica leopardellus</i> (Walsingham 1907)	2022	UHIM	<i>Myrsine lanaiensis?</i>	Kauai	Kahōluamanu, 4000 ft
<i>Pararrhaptica leucostichas</i> (Meyrick 1932)	2022	UHIM	<i>Myrsine lessertiana</i>	O'ahu*	Honolulu*
" <i>Pararrhaptica</i> " <i>lichenoides</i> (Walsingham 1907)	2001	UHIM	<i>Psychotria</i> , <i>Nestegis?</i>	Hawai'i	Kīlauea
<i>Pararrhaptica longiplicatus</i> (Walsingham 1907)	2022	UHIM	<i>Myrsine</i>	Maui	Haleakalā, 5000 ft
<i>Pararrhaptica lysimachiae</i> † (Swezey 1933)	1932	BPBM	<i>Lysimachia</i>	Kauai	Kalalau Trail, 3800 ft
<i>Pararrhaptica lysimachiana</i> † (Swezey 1946)	1927	BPBM	<i>Lysimachia</i>	O'ahu	Pu'u Hāpapa
<i>Pararrhaptica notocosma</i> (Meyrick 1928)	2012	UHIM	<i>Myrsine lessertiana</i>	O'ahu	Mt. Olympus
<i>Pararrhaptica perkinsana</i> Walsingham 1907	2012	UHIM	<i>Myrsine?</i>	Maui	Haleakalā, 5000 ft
<i>Pararrhaptica punctiferanus</i> † (Walsingham 1907)	1894	UHIM	<i>Myrsine?</i>	Maui	Haleakalā, 5000 ft
<i>Pararrhaptica pycnomias</i> (Meyrick 1928)	2012	UHIM	<i>Myrsine lessertiana</i>	O'ahu	Wailupe
<i>Pararrhaptica sublichenoides</i> (Swezey 1913)	2022	UHIM	<i>Myrsine lessertiana</i>	Hawai'i	Kīlauea

Species	Last collected	Source	Host(s)	Type locality (island)	Type locality
<i>Pararrhaptica subsensescens</i> † (Walsingham 1907)	1894	NHMUK	<i>Myrsine</i> ?	Molokai	["near Waikolu"]
" <i>Pararrhaptica</i> " <i>trochilidanus</i> † (Walsingham 1907)	1893	NHMUK	<i>Psychotria</i> ? <i>Nestegis</i> ?	Molokai	[gulch SE of Makakupa'ia], 3500 ft
<i>Spheterista argentinotata</i> † (Walsingham 1907)	1896	NHMUK	<i>Cheirodendron</i> ? <i>Polyscias</i> ?	Hawaii	Ola'a
" <i>Spheterista</i> " <i>cassia</i> † (Swezey 1912)	1920	BPBM	<i>Senna gaudichaudii</i>	O'ahu	Ka'ena Pt.
" <i>Spheterista</i> " <i>flavocincta</i> † (Walsingham 1907)	1911	HDOA	<i>Santalum</i> ?	Hawaii	Kona [vicinity of Pulehua?], 4000 ft
" <i>Spheterista</i> " <i>flavopicta</i> (Walsingham 1907)	2022	UHIM	<i>Santalum</i>	Kauai	Mts, [vicinity of Kahōluamanu?], 3000–4000 ft
<i>Spheterista fulva</i> (Walsingham 1907)	1979	BPBM	<i>Polyscias</i> ?	Kauai	Mts, [vicinity of Kahōluamanu?], 3000–4000 ft
<i>Spheterista glaucoviridana</i> (Walsingham 1907)	2009	UHIM	<i>Cheirodendron</i> ? <i>Polyscias</i> ?	Kauai	Kahōluamanu, 4000 ft
" <i>Spheterista</i> " <i>infaustana</i> (Walsingham 1907)	2022	UHIM	<i>Pipturus</i>	Kauai	Mts, [vicinity of Kahōluamanu?], 3000–4000 ft
<i>Spheterista ochreocuprea</i> (Walsingham 1907)	2022	UHIM	<i>Polyscias</i> ?	Kauai	Mts, [vicinity of Kahōluamanu?], 3000–4000 ft
<i>Spheterista oheoheana</i> (Swezey 1933)	2022	UHIM	<i>Polyscias</i>	Kauai	Halemanu
<i>Spheterista permitida</i> † (Walsingham 1907)	1896	NHMUK	<i>Cheirodendron</i> ? <i>Polyscias</i> ?	Hawaii	Ola'a

Species	Last collected	Source	Host(s)	Type locality (island)	Type locality
<i>Spheterista pleonectes</i> (Walsingham 1907)	2022	UHIM	<i>Cheirodendron</i>	Hawai'i	Kilauea
<i>Spheterista pterotropiana</i> (Swezey 1933)	2022	UHIM	<i>Polyscias kavaiensis</i>	Kaua'i	Halemanu
<i>Spheterista reynoldsiana</i> (Swezey 1920)	2009	UHIM	<i>Polyscias sandwicensis</i>	O'ahu	Wailupe
<i>Spheterista tetraplasandra</i> (Swezey 1920)	2022	UHIM	<i>Polyscias oahuensis</i>	O'ahu	"Kaumuahona" (see Magnacca 2013)
" <i>Spheterista</i> " <i>urerana</i> † (Swezey 1915)	1914	BPBM	<i>Urera glabra</i>	O'ahu	Mt. Tantalus
<i>Spheterista variabilis</i> (Walsingham 1907)	2022	UHIM	<i>Cheirodendron?</i>	Moloka'i	Kahanui
" <i>Spheterista</i> " <i>xanthogona</i> † (Walsingham 1907)	1892	NHMUK	<i>Santalum?</i>	Hawai'i	Kona [vicinity of Pulehua?], 4000–5000 ft

