# The Moth *Choreutis emplecta*: Another New Pest of *Ficus microcarpa* In Southern California

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As if the common and valuable landscape tree and sometime hedge *Ficus microcarpa* (Chinese banyan, Indian laurel) does not have enough pests (Hodel 2017; Hodel et al. 2016, 2020), another new insect pest has recently been detected feeding and causing damage on its leaves (**Fig. 1**). In October, 2020, co-authors Robin Kim and Paul Webb, agricultural pest control advisers, found larvae and adults of a small moth damaging leaves of *F. microcarpa* in Newport Beach, Orange

**1.** Typical leaf damage caused by the moth *Choreutis emplecta* occurs on new growth of *Ficus microcarpa* and consists of tip and marginal notching, holes, and blackened tissue. (©2021 by D. R. Hodel).

County, about 55 km southeast of Los Angeles. They had actually noticed the characteristic damage a month earlier, in September, 2020 but were unable to associate it with a known pest. Kim sent samples of the moth to the California Department of Food and Agriculture (CDFA), which, with the help of molecular data, tentatively identified it as *Choreutis emplecta*, previously recorded from Australia (**Fig. 2**). Damage can be particularly severe, with up to about three-quarters of all shoot tips infested. Here we provide an overview of this pest, including its history, hosts, damage, description, biology and natural history, and management.

## History

Alfred Jefferis Turner (3 October 1861, in Canton, China – 29 December 1947, in Brisbane, Australia), an Australian pediatrician and noted amateur entomologist (Thearle 1990), first named and described this pest as *Simaethis emplecta*, basing it on a single specimen (apparently male) from Cairns, Queensland, Australia although he did not designate a type specimen (Turner 1942). Later, Heppner and Duckworth (1981) transferred it to the genus *Choreutis*, making it *C.*

**2.** *Choreutis emplecta*, here on a leaf of *Ficus microcarpa*, is a small but colorful and handsome moth. (©2021 by D. R. Hodel).

*emplecta*. After co-authors Kim and Webb detected *Choreutis emplecta* in October, 2020, several official CDFA collections of this pest were made in Orange County in November, including on *Ficus microcarpa* in Laguna Beach and in two nurseries, one on a *F. microcarpa* in Irvine and the other on *Rhaphiolepis indica* (Indian hawthorn) in Stanton (Beucke 2021).

However, based on numerous sightings and posted photographs (BugGuide 2021, iNaturalist 2021), *Choreutis emplecta* has been in Southern California from San Diego into Orange, Los Angeles, and Ventura counties since at least June, 2020, and mostly observed on plants other than *Ficus microcarpa* although damage to these other plants, if any, was minimal.

Considering its rather wide range (an area spanning about 300 km long and 50 km wide), an abundance of it primary host (*Ficus microcarpa*) within this range, and observations of the pest for over a year, *Choreutis emplecta* can be considered established in Southern California. Indeed, the North American Moth Photographers Group (2021) noted that it is now recognized within the North American fauna north of Mexico.

In November, 2020, CDFA tentatively identified this pest as *Choreutis emplecta*, one of the metalmark moths. This species is little known, and critical information about its biology, which would provide additional diagnostic and management tools, is lacking. Dr. Marc Epstein at CDFA, who made the tentative identification, notes that another species, *C. sexfasciella*, cannot be separated and might be conspecific (North American Moth Photographers Group 2021). If so, the name *C. sexfasciella* is older and would have priority, making *C. emplecta* a synonym. It is even possible that what has been tentatively identified as *C. emplecta* actually is a new, undescribed species. More, likely molecular, work is sorely needed to confirm the identity of this pest.

CDFA's pest ratings for *Choreutis emplecta* ranged from a "Q" to a "C" (Beucke 2021) but is likely to change again as more is known about this pest and especially if further work shows it to be another species or a new species.

Although *Choreutis emplecta* does not have a formal common name, the initial and most conspicuous damage symptom, leaf tip and margin notching and holes, suggests that the name Ficus leaf-notching or leaf-hole moth might be appropriate.

## Hosts

The primary, reproductive host of *Choreutis emplecta* in Southern California appears to be *Ficus microcarpa* (**Figs. 3–4**) although we have also found it on *F. benjamina* (weeping fig) (**Fig. 8**). We have not detected it yet on species of *Ficus* with thick-textured leaves with hairy indument, which might offer some protection and resistance to the pest, such as *F. rubiginosa* (rusty-leaved fig) and *F. macrophylla* (Moreton Bay fig). Although about 50 documented observations of *C. emplecta* adults have been made in Southern California, most of these have been on non-*Ficus*

**3.** *Ficus microcarpa*, here in Newport Beach, is one of the most common landscape trees in Southern California and the primary host of *Choreutis emplecta*. (©2021 by D. R. Hodel).

**4.** *Ficus microcarpa*, here in Newport Beach, is often pruned into a hedge. (©2021 by D. R. Hodel).

plants that have mostly sustained no damage. Although we have seen *C. emplecta* and damaged leaves on *Rhaphiolepis indica*, we are unable to confirm that it caused the damage). Less than 5% of the observations (but nearly 100% of the damage) have been on *Ficus*, upon which the pest feeds and damages leaves and reproduces although this figure might be more apparent than real because searching large trees is not a practical, easy, or attractive endeavor. It is possible that other species of landscape *Ficus*, especially those with thinner, glabrous leaves, will eventually fall prey to *C. emplecta*.

## Damage and Signs

Larvae of *Choreutis emplecta* feed on and damage the new leaves of *Ficus microcarpa* and *F. benjamina*. New leaves are softer and more supple, making them more attractive to the pest (**Fig. 1**). Thus, damage is typically noticed on new leaves although as the leaves enlarge and mature, they will still show this old feeding damage.

Typically, damage shows as a notch at the apex or along the margin of the leaf (**Figs. 5–6**). Sometimes the feeding creates a hole within the leaf itself. In some instances, the larvae do not

**5.** Leaf damage from *Choreutis emplecta* on new growth of *Ficus microcarpa* includes notching and holes. Note the larva, frass, and webbing. (©2021 by D. R. Hodel).

**6.** Leaf damage from *Choreutis emplecta* on new growth of *Ficus microcarpa* includes notching and holes. Note the larva, frass, and webbing. (©2021 by D. R. Hodel).

**7.** Leaf tip and marginal necrosis and leaf deformation are common symptoms of *Choreutis emplecta* on *Ficus microcarpa*. (©2021 by D. R. Hodel).

**8.** *Choreutis emplecta* also can cause damage on *Ficus benjamina*. (©2021 by D. R. Hodel).

**9.** Larvae of *Choreutis emplecta* can deform leaves when they construct cocoons by using there webbing to pull leaf margins inwards. (©2021 by D. R. Hodel).

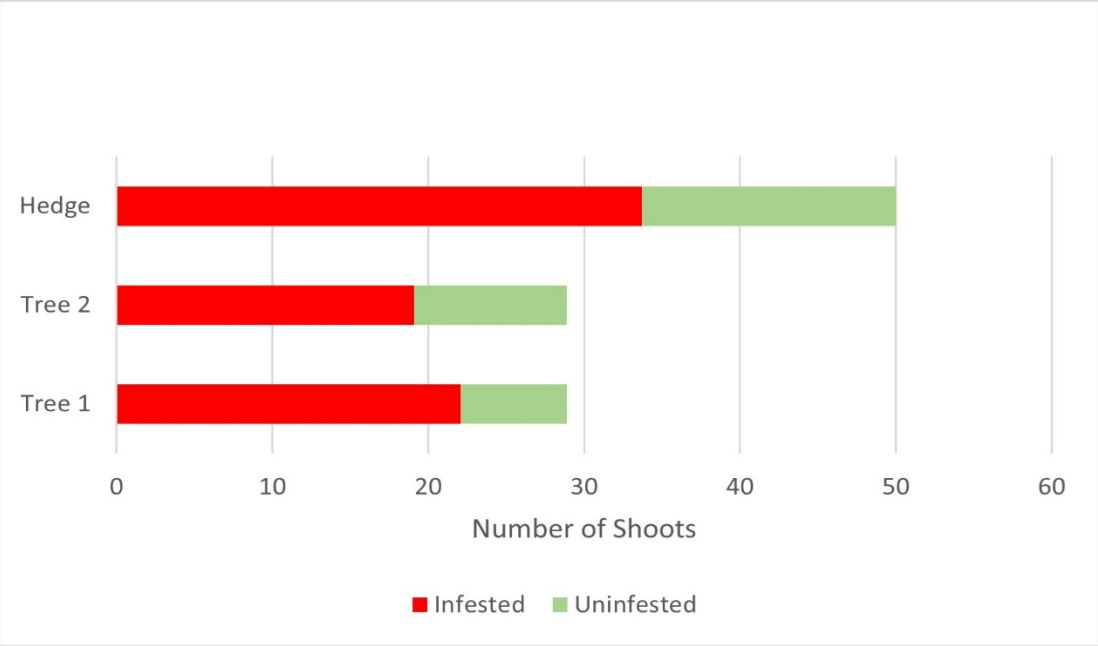
**10.** Frequent pruning of *Ficus microcarpa* hedges does not significantly increase infestation rates of *Choreutis emplecta*. (©2021 by D. R. Hodel).

make a hole entirely through the leaf but destroy layers of tissue, the remaining tissue turning dark brown or black. Leaf tip and marginal necrosis and leaf deformation are common (**Figs. 7–8**), mostly from feeding but also to some extent from the larvae constructing cocoons in which to pupate, a process whereby they pull adjacent leaves or margins of one leaf together to provider more protection for the cocoon and its pupa (**Fig. 9**).

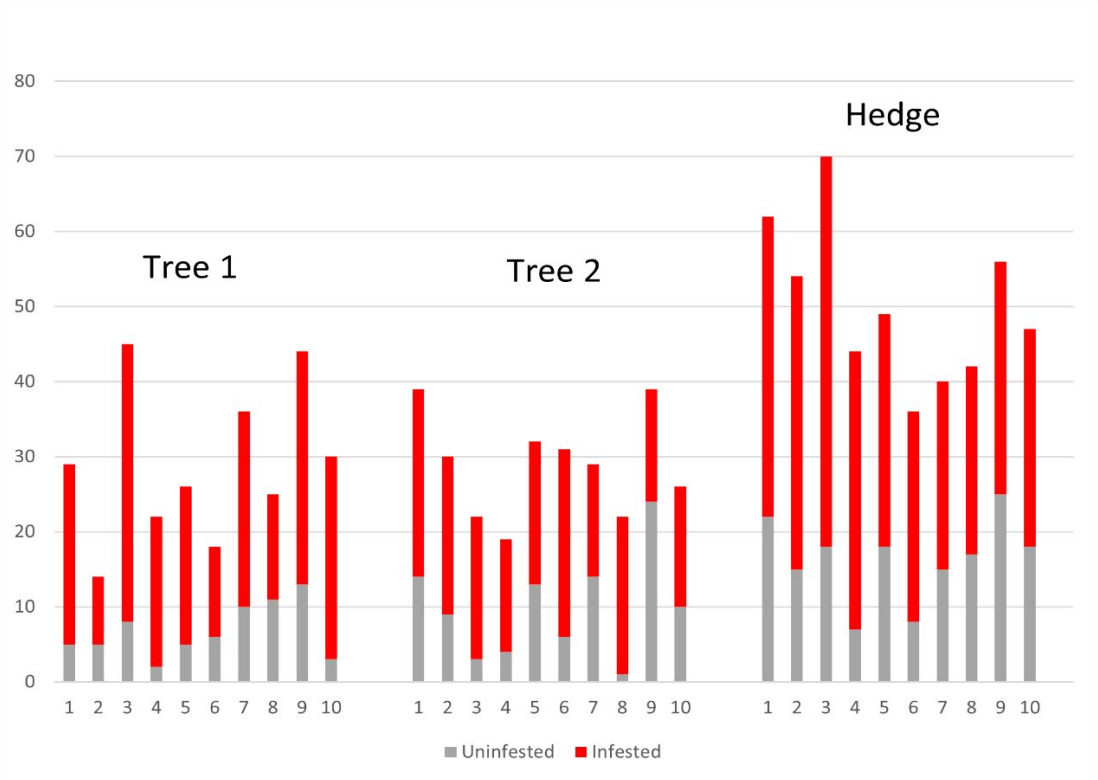
One would think that damage would be more extensive and severe on frequently pruned *Ficus* plants, such as those maintained as hedges and topiary artwork, or those subject to frequent size control (**Fig. 10**). The frequent pruning to maintain the formal shape and/or desired size typically causes abundant, new growth during the summer and fall, which would be highly attractive to the pest.

However, frequent pruning does not seem to increase infestation rates. In August 2021, we rated damage severity on two small street trees about five m tall (**Fig. 3**) and a hedge of about six m long and 1.5 m tall (**Fig. 4**) of *Ficus microcarpa* on Lido Isle in Newport Beach. For each of the two trees, we randomly selected the distal 40 cm of 10 branch tips (20 branch tips total). For the hedge, we selected ten 15 × 15-cm square sampling areas spaced 60 cm apart along a transect

**11.** Ten 15 × 15-cm square sampling areas spaced 60 cm apart along a transect on top of a *Ficus microcarpa* hedge were used to count shoot infestations. (©2021 by D. R. Hodel).




**12.** Quantity of *Choreutis emplecta* infested and uninfested shoots of *Ficus microcarpa* in three study areas, Newport Beach, California, August, 2021.



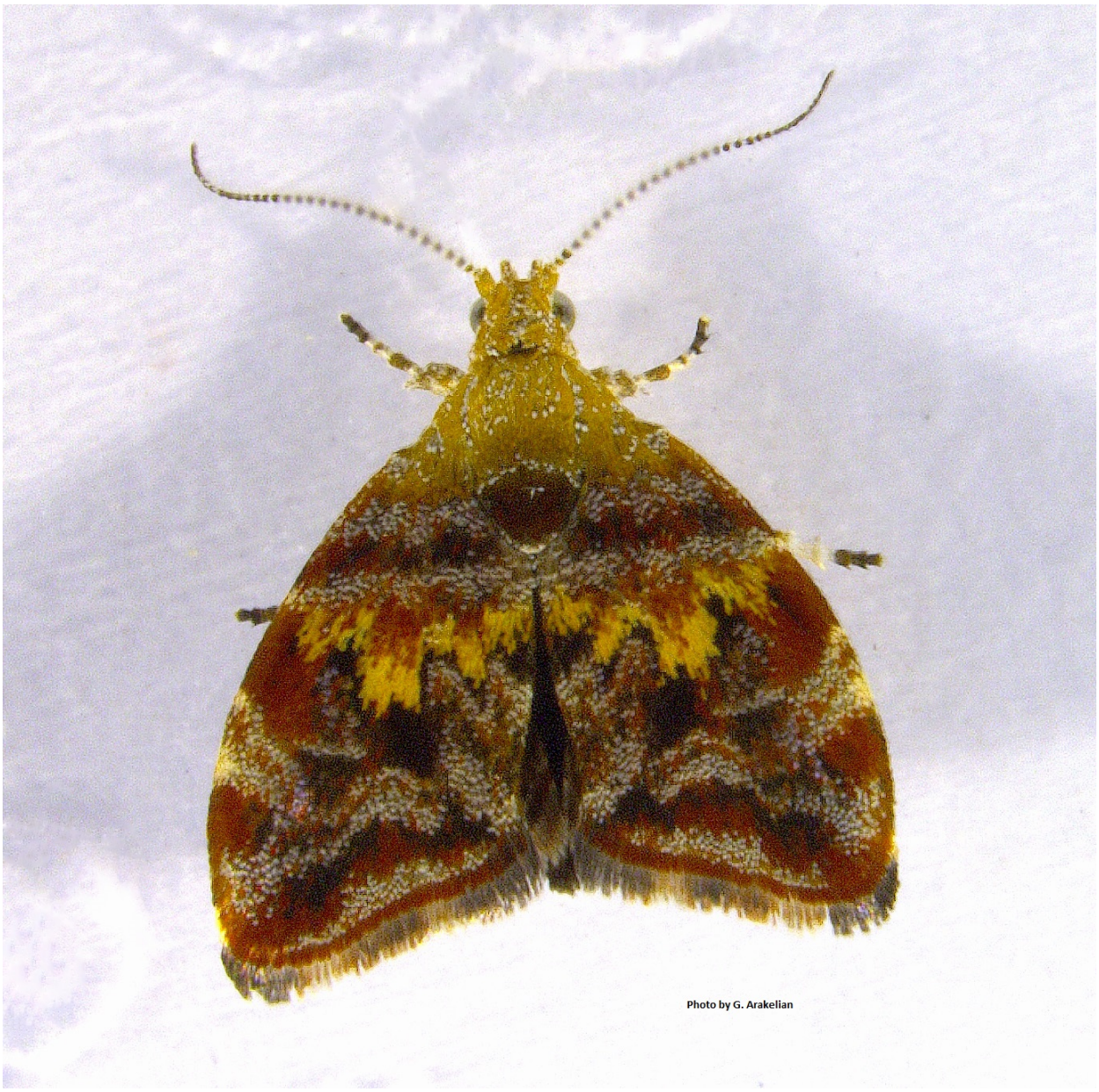

**13.** *Choreutis emplecta* infestation rates of *Ficus microcarpa* in three study areas, Newport Beach, California, August, 2021. STDV = 11.5%, 17.1%, and 9.1%, respectively.

on the top surface (**Fig. 11**). Within all sampled areas (20 on the two trees and 10 on the hedge) we counted the quantity of infested and non-infested shoots.

Trees 1 and 2, each with 289 shoots in the sampled areas, had a mean infestation rate of 76% and 66%, respectively (STDV = 11.5% and 17.1%, respectively) while the hedge had 500 shoots in the sampled areas and a mean infestation rate of 68% (STDV = 9.1%) (**Figs. 12–13)**. The infestation rates between the trees and the hedge were more or less the same. Furthermore, because hedges are typically pruned frequently and periodically, damaged leaves are removed, reducing overall visible damage.

Nonetheless, like many of the numerous pests that infest leaves of *Ficus microcarpa*, damage is not too noticeable, if at all, when viewed from a distance (about 10 m or more) and is really only visible when viewed at closer range.

**14.** Larvae of *Choreutis emplecta* construct cocoons of fine, silken webbing, pulling the leaf margins inward for more protection for the pupa. Note the abundant frass and leaf damage. (©2021 by G. Arakelian).




**15.** Adults of *Choreutis emplecta* are handsome but small, about 10–11 mm long, and triangular shaped when resting. (©2021 by G. Arakelian).

Signs include fine silken webbing stretching across leaf blades and impregnated with tiny but typically abundant frass and silken cocoons with pupae inside (**Fig. 14**). One to as many as three green larvae and cocoons can be found on one leaf.

## Description

The description is from Turner (1942) and our field observations. Adults are handsome but small, about 10–11 mm long and triangular shaped when resting (**Fig. 15**). The head and thorax are


**16.** The light green larvae of Choreutis emplecta are about 15 mm long and 2 mm in diameter. (©2021 by G. Arakelian).

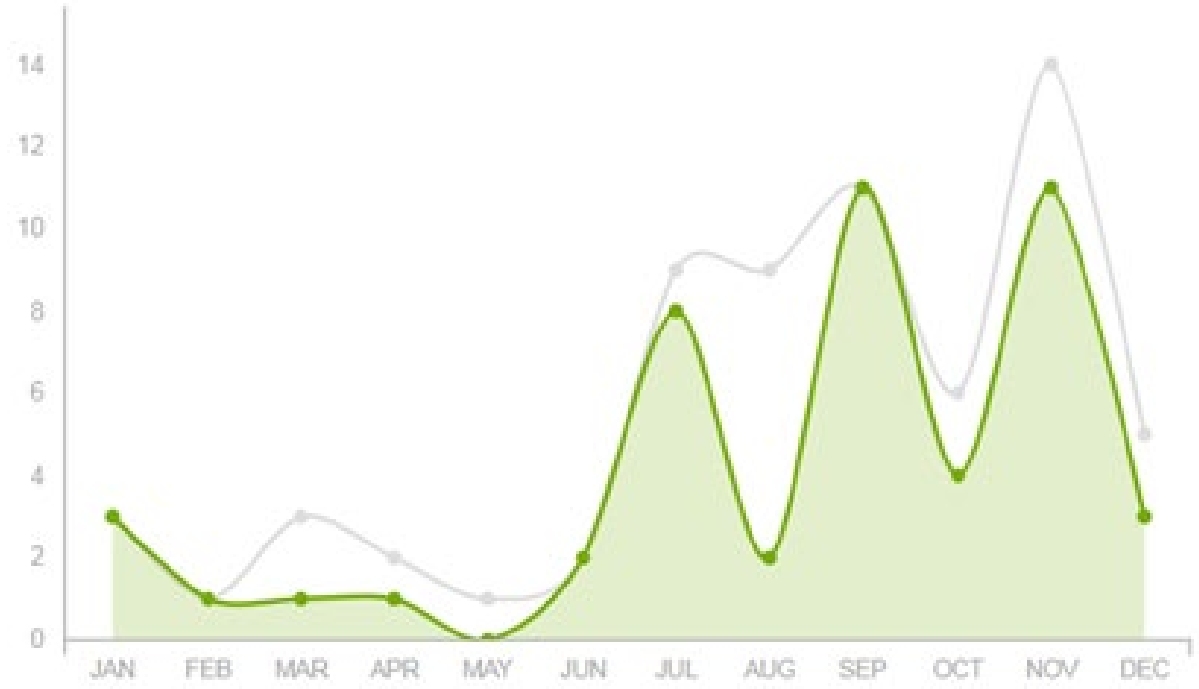
yellowish to reddish gray sprinkled with white. The two palpi are pale yellowish to reddish gray. Antennae are 4–5 mm long, black, with white rings, and with males, at least, having bunches of cilia. The abdomen is brownish gray. Legs are also brownish gray and with white rings while the middle and posterior tarsi are broadly white in their middle portions. Forewings are broadly triangular with a rounded apex and are tawny brown and attractively and intricately mottled with dark brownish gray, pale yellowish to reddish gray, and sprinkled or dotted with white bands or lines. The basal part of the wings is marked with a conspicuous, straight, whitish, transverse line or band with a second, less conspicuous, smaller one just proximal that is marked in the center with a large, dark brown spot. Wing margins are conspicuously fringed with whitish-gray cilia with tawny brown bases. Hindwings are brownish gray with slight whitish sprinkles or dots. The light green larvae are about 15 mm long and 2 mm in diameter (**Fig. 16**).

## Biology and Natural History

Little is known about the biology and natural history of *Choreutis emplecta*. Taxonomically, it is in the order Lepidoptera, superfamily *Choreutoidea*, family *Choreutidae* (metalmark moths), subfamily *Choreutinae*, and genus *Choreutis*.

The tropical nature of *Choreutis emplecta* is reflected in its behavior in Southern California. According to iNaturalist (2021) and our field observations, *C. emplecta* adults increase dramatically in the summer and fall before precipitously falling in December. iNaturalist (2021) shows that three rapid spikes, one each in July, September, and November, occur during the summer and fall surge, which correspond somewhat to our field observations where sometimes adults are present and sometimes only larvae are present, with apparently little overlap in life stages (**Fig. 17**). These observations correspond with a significant increase in shoot growth and leaf production during this period for the host *Ficus microcarpa* in Southern California (Hodel et al. 2020). While old damage is visible from January through June, adults and larvae are typically absent during this period, and are mostly present from June until December.

Female moths deposit eggs on soft, pliable, new emerging leaves and newly hatched larvae begin feeding immediately. The eggs are likely deposited at or near the buds or tips of newly emerging leaves because we have found small, very early larval instars in newly expanding leaf buds and




**17.** Quantity and seasonality of sightings of Choreutis emplecta. From iNaturalist (2021).

leaves. The time from egg deposition to larva is unknown.

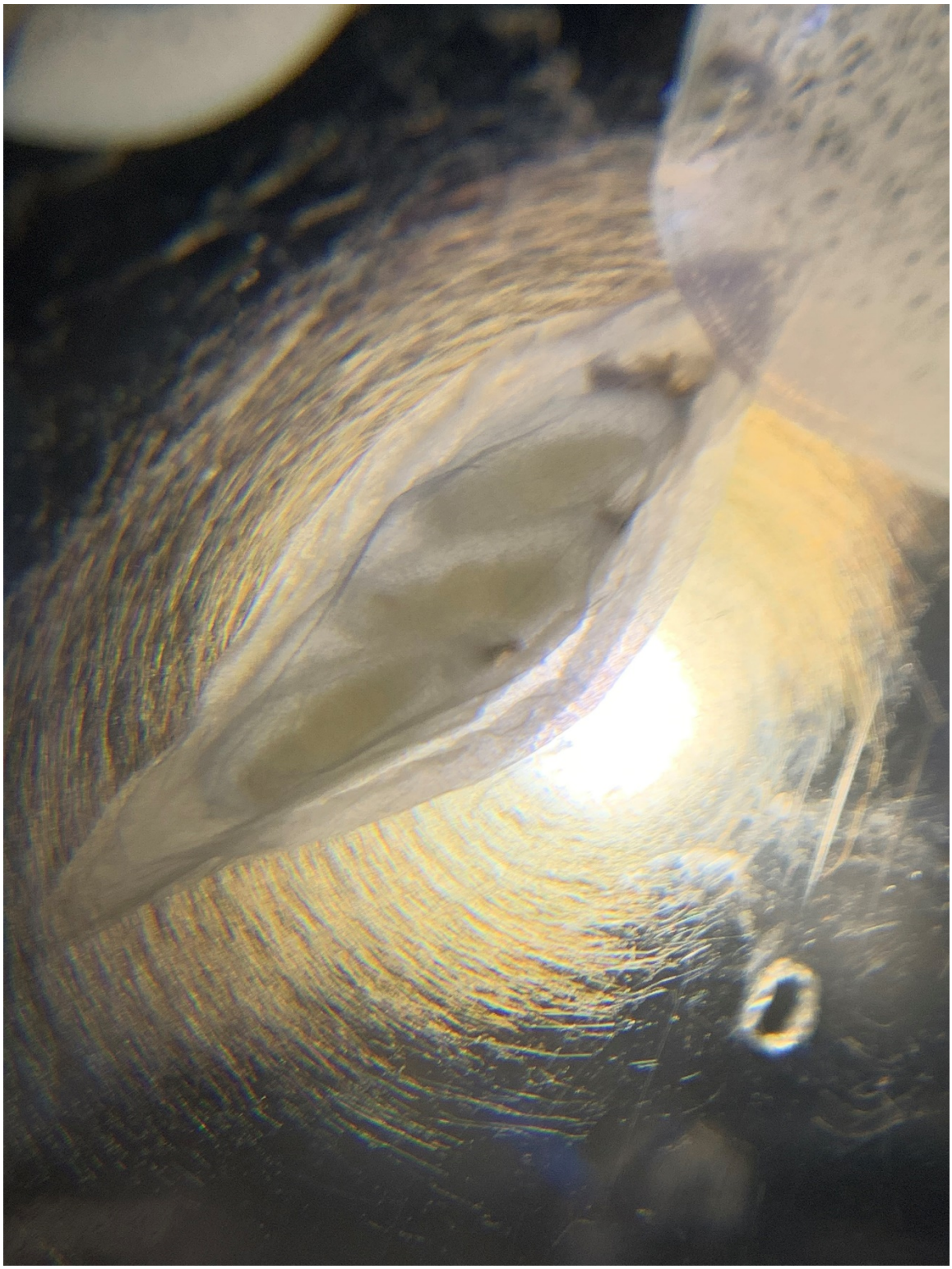
In general, larvae of *Choreutis* species feed on adaxial (upper) leaf surfaces and spin silken coverings and/or tie leaf margins together to form protective shelters (Gielis and Bippus 2016, Michigan State University 2020), which we observed with *C. emplecta* on *Ficus microcarpa*. We observed larvae descend 30 to 50 cm on silken threads and then ascend.

Larvae of *Choreutis emplecta* construct silken cocoons in which to pupate, typically on the adaxial leaf blade surface although the silken threads and those of the cocoon attachments themselves tend to pull the outer, opposing leaf margins up and slightly inward, offering additional protection for the cocoon (**Fig. 14**).

We reared larvae in zip-lock bags with holes and fresh leaves of *Ficus microcarpa* for food and shelter. The zip-lock bags with larvae were kept at about 21 C. After two days, larvae begin to construct cocoons. Eight days later adults emerged; thus, pupation takes about a week depending upon the temperature. Larvae constructed cocoons on leaves of other species that were placed in the bag but which they do not typically damage, including *Liquidambar styraciflua* (sweet gum) and *Melaleuca* sp. (paperbark), as well as on the sides of the plastic zip-lock bags themselves.

Cocoons and pupae seem fewer than would be anticipated considering the extent of the damage and quantity of larvae present in severe infestations. It could be that birds or insect predators are able to pick off larvae before they are protected and pupating in their cocoons. Indeed, we observed two parasitoid wasps attacking larvae of *Choreutis emplecta*. We saw one wasp attaching itself to larvae on a hedge and, while rearing *C. emplecta*, we observed wasps emerging from pupae inside cocoons. In one instance three wasps emerged from one pupa (**Fig. 18**). We performed DNA sequencing of both wasps at the Richard Stouthamer Laboratory at the University of California, Riverside using the nuclear ribosomal gene 28S. Adult moths and alcohol-preserved larvae and adult parasitoid wasps were deposited in the University of California Riverside Entomological Museum

DNA sequencing data showed that one wasp is in the Bethylidae family, which CDFA had suggested earlier, while the other is in the Ichneumonidae family, which Serguei Triapitsyn and Doug Yanega of the University of California Riverside Entomological Museum suggested. No good match was already present in the public service databases for the Bethylid wasp, and the closest match was with the genus *Goniozus* although further work is needed for better resolution and confirmation of its identity. The Ichneumonid wasp matched to the genus *Diadegma*. DNA accession numbers, University of California Riverside Entomological Museum voucher numbers, and GenBank accession numbers for the two parasitoid wasps are listed in **Table 1**.



**18.** One cocoon of *Choreutis emplecta* backlit to show the pupa parasitized with three wasp larvae. (©2021 by R. Y. Kim).

**Table 1. Specimen Data for Two Parasitoid Wasps of *Choreutis emplecta*.**

**2x Bethylidae wasps (*Goniozus*?)**

Emerged from *Choreutis emplecta* pupa, collected by Robin Y. Kim on *Ficus microcarpa* hedge at 126 Via Lorca, Newport Beach, CA on August 20, 2021.

| | | GenBank Accession Numbers | | |
|---|---|---|---|---|
| DNA # | Museum voucher | COI | 28S | ITS2 |
| PR21-486 | UCRC_ENT 541256 | OK340528 | OK350675 | OK350677 |
| PR21-487 | UCRC_ENT 541257 | OK340529 | OK350676 | OK350678 |

**1x Ichneumonidae wasp (*Diadegma* sp.) (matches BOLD:ACN7003)**

Emerged from *Choreutis emplecta* pupa, collected by Robin Kim on *Ficus microcarpa* hedge at 126 Via Lorca, Newport Beach, CA on September 6, 2021. Emerged in lab September 20, 2021.

| | | GenBank Accession Numbers | | |
|---|---|---|---|---|
| DNA # | Museum voucher | COI | 28S | ITS2 |
| PR21-549 | UCRC_ENT 528704 | OK561853 | OK564655 | - |

Perhaps larvae of *Choreutis emplecta* might not always construct cocoons and pupate on the leaves; that they can descend for 50 cm on long, slender, filament-like, silken threads suggests pupation could occur well below the foliage canopy or even in leaf litter on the ground.

## Management

Unfortunately, little is known about the management of *Choreutis emplecta*. Action is unnecessary if damage is slight or insignificant. Furthermore, because damage is only evident when viewed at close range, in some instances, for example on trees or hedges lacking close-viewing opportunities, treatment might be unnecessary, even in especially severe cases. Thus, treatments might be unjustified and unwarranted in some cases.

The spectrum of natural enemies of *Choreutis emplecta* has not been studied although we have found lacewings on infested plants and documented wasps of the Bethylidae and Ichneumonidae families parasitizing larvae of *C. emplecta*.

Management strategies include vigilant scouting, followed by judicious and immediate removal, bagging, and disposal of shoot tips with infested leaves, which could be combined with foliar treatment with a Bt (*Bacillus thuringiensis*) insecticide. Such treatment with Bt has been effective, with a single application controlling larval populations. However, Bt has short residual activity and rain easily washes it off, so repeat applications at 5- to 14-day intervals might be necessary.

Other materials like contact insecticides, including pyrethrins (botanical), azadirachtin (organic/insect growth regulator), and bifenthrin (synthetic), applied as a foliar spray or systemics, like acephate (synthetic), applied to the root zone might provide longer residual or prophylactic control of pest populations. Weigh the damage that pesticides can do to the environment, including to beneficials and other non-target and desirable wildlife, against the perceived outcome of their use.

Hosing down infested shoot tips with a strong stream of water to dislodge larvae might help to reduce infestation severity but the ability of larvae to pupate on a variety of surfaces (plastic zip-lock bags) and perhaps adjacent non-primary host plants (for example *Liquidambar styraciflua*) might compromise this strategy somewhat.

Frequent, periodic pruning might be effective by constantly removing infested leaves. Such regularly pruned specimens frequently have been observed with less damage from other pests like the leaf gall wasp and Indian laurel thrips. However, pruning could stimulate new growth that is susceptible to attack. Similarly, excessive fertilizer and water could also stimulate new growth that could invite attacks.

Although we are unsure, larvae might be able to pupate in the fallen leaf litter below trees and hedges. If so, collecting, bagging, and disposing of leaf litter might help to reduce pest populations.

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