

The Citrus Leafminer and Its Natural Enemies

Jesusa C. Legaspi

Citrus/Sugarcane Entomologist
Texas Agricultural Experiment Station

and

J. Victor French

Citrus Entomologist
Texas A&M- Kingsville Citrus Center
Weslaco, Texas

The Texas A&M University System

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Biology and Ecology of the Citrus Leafminer

The citrus leafminer (CLM), *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae), is a pest of citrus species and other Rutaceae in many parts of the world. CLM larvae form mines predominantly in leaves, but also in succulent stems and sometimes fruit. The larvae bore through the leaf epidermis, ingesting the sap and producing a chlorotic leaf patch. CLM may prevent young leaves from expanding, causing them to remain twisted and curled. After the CLM have finished feeding, other insects such as aphids and mealybugs often continue feeding on the damaged area.

CLM lifecycle. Total generation time for CLM ranges from 13 to 52 days, depending on temperature. The lifestages are: adult, eggs, larvae (four instars, including prepupa) and pupae.

The **adult** CLM is a small moth (Fig. 1) about 2 mm long with a wingspan of about 4 mm. Moths have silvery and white iridescent forewings with brown and white markings, and a distinct black spot on each wing tip. The adults copulate 14 to 24 hours after emergence and lay their eggs soon afterwards. A single female may lay about 50 eggs during her lifetime. The adults are most active from dusk to early morning; they spend the daytime mostly resting on the undersides of leaves. Adults feed on nectar and live from 2 to 12 days.

CLM **eggs** look like tiny droplets of water (Fig. 2) measuring only 0.3 x 0.2 mm. They are transparent when newly-laid, but become yellowish and opaque in 2 days. The eggs are laid singly on either surface of the leaf, but may also be laid on succulent stems. Newly-emerged leaflets, particularly along the midvein, are the preferred oviposition sites. Larvae emerge from the eggs after 2 to 10 days.

The **larvae** undergo four instars and total development time takes from 5 to 20 days.



Figure 1. Citrus leafminer adult, *Phyllocnistis citrella*.

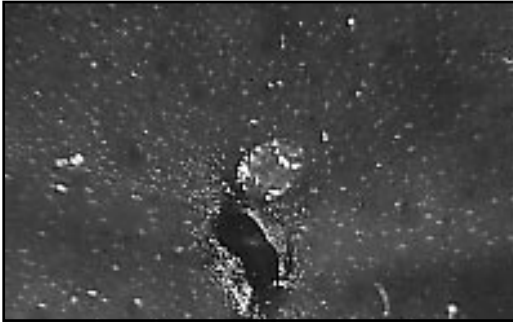


Figure 2. Transparent and ovoid-shaped egg of citrus leafminer.

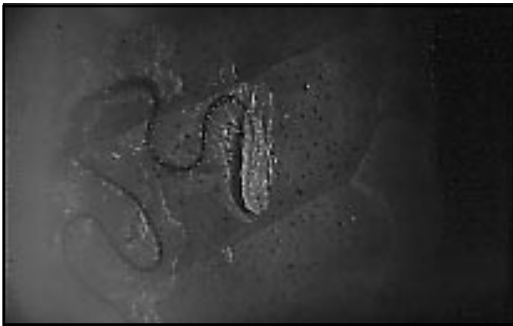


Figure 3. Young larva of citrus leafminer.



Figure 4. Pupa of citrus leafminer.

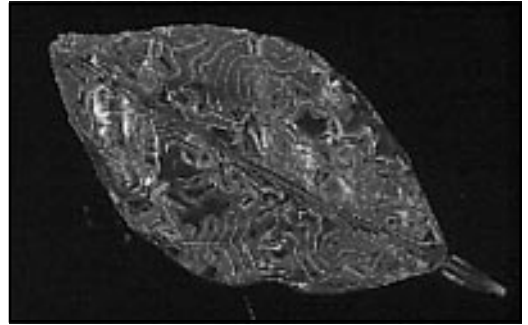


Figure 5. Serpentine patterns made by larvae of citrus leafminer.



Figure 6. Mines on grapefruit caused by citrus leafminer.



Figure 7. *Zagrammosoma multilineatum*, a native parasite of citrus leafminer in South Texas.

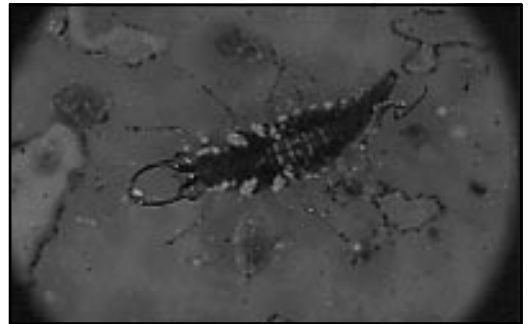


Figure 8. Green lacewing (*Chrysoperla rufilabris*), a predator of citrus leafminers.

First instar larvae begin feeding immediately, forming nearly invisible mines. The larvae are 1 to 2 mm long, light green and difficult to detect. During the course of larval development, the mines become more visible and larval excrement forms a central trail within the mine (Fig.3). When larval feeding is completed, the third instar usually forms a mine that is directed towards the leaf margin. There, it molts into the fourth instar or **prepupa**. The prepupa is pale and almost cylindrical, and while it no longer feeds, it remains quite active. It forms a silken cocoon within the mine. As the silk dries, the leaf curls over the pupal cell. The **pupal** stage (Fig. 4) takes 6 to 22 days. The pupa is yellowish-brown, turning darker with age. Just before adult emergence, the pupa uses a spine on its head to make an opening at the anterior of the chamber, and forces its body through.

Foliar and fruit damage can be extensive when populations of CLM are high. Because the larvae generally do not cross existing mines, the later stages of feeding result in characteristically serpentine patterns (Fig. 5). Although mining usually occurs on leaves, it also can occur on fruit—particularly grapefruit (Fig. 6), greatly reducing the market value of produce.

Host range and geographic distribution. CLM attacks all citrus cultivars, many related species in the Rutaceae family, and also some ornamentals. Grapefruit, tangerine and pummelo are among the most susceptible hosts. However, CLM has also been reported on jasmine, mistletoe, some legumes, willow and anaqua, *Ehretia anacua* (Mier & Berland) Johnst.

The CLM is believed to have originated in India and southern China, where it is a major constraint to citrus production. In the last century it has spread to the Philippines, Japan, the Middle East, Australia and parts of Western Africa. The movement into North-

ern Africa, Central America and the United States is very recent. CLM was first reported in the U.S. in Florida in 1993. By late 1994, the invasion had spread to Alabama, Louisiana and Texas. CLM was first found in Texas orchards (eastern Hidalgo County) in late August of 1994; by late November, it had spread throughout the South Texas citrus growing area.

Controlling the Citrus Leafminer

Chemical control. Insecticidal control is difficult to achieve because the larvae are shielded within the mines by the leaf epidermis. The pupal stage is also protected by the rolled leaf margins. Moreover, the continuous use of pesticides induces resistance in CLM and is detrimental to its natural enemies. Foliar sprays may be applied to protect new flushes of growth when the leaves are most vulnerable to CLM damage. However, the best foliar insecticides confer only 2 to 3 weeks of leafminer control, and insecticides cannot be relied upon for effective control of heavy leafminer infestations. Petroleum oil sprays applied to flush leaves may inhibit egg laying, but must be repeated every 14 days during each flush cycle. Chemicals are being tested and utilized for short-term CLM control. Eclipse® (fenoxycarb) was registered in early 1995 for use on nursery and nonbearing citrus. Research is emphasizing the development of a long-term CLM management program using cultural and biological controls. For current insecticide and dosage recommendations, see the latest Citrus Pest Control Guide obtainable from the Texas A&M-Kingsville Citrus Center in Weslaco.

Cultural control. Cultural control of CLM includes protecting the young plants (from 1 to 3 years old) and nursery plants. In addition, it is important to limit flush growth when CLM population levels are high (usually during summer and autumn) and to pro-

mote flushing when populations are low. Flushing is limited by reducing fertilization and irrigation to the minimum required for normal plant growth. Mechanical hedging also should be delayed, if possible, until cooler winter temperatures prevail in order to limit regrowth. CLM infestations are lowest during the spring; the spring flush is promoted by fertilizing during the previous winter. These control methods may not be applicable in areas without pronounced seasons.

Natural enemies. The natural enemies of an insect fall into three general categories:

Parasites usually lay their eggs in or on the body of the host insect. The developing parasites feed on the host, eventually causing its death.

Several indigenous species that attack CLM larvae and pupae in south Texas appear promising. The most abundant species is the Eulophid *Zagrammosoma multilineatum* (Ashmead) (Fig. 7). Other Eulophid species are: *Closterocerus cinctipennis* Ashmead, *Closterocerus* sp., *Neochrysocharis* sp., *Horismenus* sp., and *Pnigalio* sp. One species from the Proctotrupoidea also was identified as a parasite of CLM.

In Thailand, a number of parasites have been found for CLM, mostly Chalcidoidea. Ten species of chalcidoid parasites have been reared from the CLM in Thailand, with *Ageniaspis* sp. probably being the most significant. Total parasitism ranged from 25.4 to 91.9 percent in a pummelo orchard from May to September 1990.

In the United States, native parasites in south Florida cause parasitism rates in excess of 50 percent in unsprayed citrus groves. Three of the most effective parasites in Asia (*Citrostichus phyllocnistoides*, *Cirrospilus quadristriatus* and *Ageniaspis citricola*) were introduced into Australia. The parasites *A. citricola* and *C. quadristriatus* were subsequently collected from Australia and released

into citrus groves in Florida in 1994. Preliminary surveys indicate that *A. citricola* had established in 3 of 12 release sites, causing up to 50 percent parasitism. No evidence was found to indicate that *C. quadristriatus* has established. *Ageniaspis citricola* (imported through Florida) was released in Texas A&M University-Kingsville Citrus Center orchards in early 1995, but has not been established.

Predators feed on the pest insect. In many predatory insects, only the immature stages feed on other insects. The adults often feed on nectar. Several predators are known to reduce population levels of CLM, although they may have to be used in large numbers and in conjunction with parasites. Among these predators are various spiders, flower bug, *Orius insidiosus*, ladybugs, fire ants and the lacewing, *Chrysoperla rufilabris* (Fig. 8). The lacewing, a common predator that feeds on a variety of insect pests, is sold as a commercial biological control agent.

Pathogens cause insect diseases. They may be bacteria, fungi or viruses. Many commercial bioinsecticides are formulated from pathogens. There are no known naturally-occurring pathogens of the citrus leafminer. When the larvae are inside the mines, they are protected from pathogens. The pupae are also afforded some degree of protection by the curled leaf margins.

Acknowledgments

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