

## SCIENTIFIC NOTE

Parasitoids of *Sophonia* Leafhoppers in Southern China

Russell Messing<sup>1</sup>, Andrei Alyokhin<sup>2</sup>, Lin-nai Quan<sup>3</sup>, Chen Yiqun<sup>3</sup>, and Fang Xiongxi<sup>3</sup>

<sup>1</sup>Department of Plant and Environmental Protection Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii, Kauai Agricultural Research Center, 7370-A Kuamoo Rd., Kapaa, HI 96746, USA. <sup>2</sup>Present address: Department of Biological Sciences, University of Maine, Orono, ME 04469-5722, USA. <sup>3</sup>Biological Control Research Institute, Fujian Agriculture & Forestry University, Fuzhou 350002, Republic of China

**Abstract.** Leafhoppers and their parasitoids in Fuzhou, China, were sampled from 1998 to 2001 in order to find natural enemies with potential for biological control of *Sophonia rufofascia* in Hawaii. Eleven parasitoid species were found, of which *Chaetomyxar* sp. (Mymaridae) were the most abundant, accounting for 65.8% of total parasitism. Parasitism of leafhopper eggs in guava orchards averaged 61.9% from April to November, with peak parasitism in September of 91.4%.

The genus *Sophonia* (Cicadellidae: Nirvaninae: Nirvanini) contains 37 recognized species worldwide, 18 of which are known from China (Li & Chen 1999). The two-spotted leafhopper, *Sophonia rufofascia* (Kuoh & Kuoh), was originally described from southern China (Kuoh & Kuoh 1983), including Guizhou, Fujian, and Guangdong provinces, and also occurs in Taiwan, Pakistan and Japan (Li & Chen 1999). It was inadvertently introduced into Hawaii in the 1980's, where it causes damage to a wide variety of agricultural crops and endemic plants.

Five *Sophonia* species occur in Fujian province. *Sophonia pallida* (Melichar) and *Sophonia furcilinea* (Kuoh & Kuoh) are common on guava and *Acacia confusa*, respectively, while *S. orientalis* (Matsumura), *S. unicolor* (Kuoh & Kuoh), and *S. rufofascia* (Kuoh & Kuoh) are relatively rare. Neither *Sophonia* nor related Nirvanine leafhoppers are serious pests in southern China, perhaps due to the presence of effective, co-evolved natural enemies. Therefore it is a promising area to locate parasitoids for classical biological control of *Sophonia* in Hawaii, where the parasitoid guild is less robust (Alyokhin et al. 2001, Yang et al. *in press*). In order to explore this possibility, the population dynamics and natural enemies of *S. pallida* on guava and *S. furcilinea* on acacia were studied in Fuzhou from 1998 to 2001.

We used a sweep net at 7–10 day intervals to sample branches of 45 guava trees on the grounds of the Biocontrol Research Institute (BCRI) in Fuzhou, 45 guava trees in Dongshan; and 45 *Acacia confusa* trees in Fuzhou. For 10–15 sweeps per tree we collected and counted nymphs and adults of all *Sophonia* leafhoppers occurring on these plants. On each sample date, we also collected 400 guava leaves and 400 acacia leaves and brought them to the laboratory, where eggs of *Sophonia* were removed from leaf tissues and held for emergence of egg parasitoids.

We also caged *Sophonia* adults on shoots of guava or acacia in the field so they would oviposit into marked leaves. The adults were transferred to new shoots at 7 days intervals. Cages were then removed so that the cohorts of eggs could be exposed to naturally occurring parasitoids. We left egg cohorts in the field for 5, 10 or 15 days, then picked the leaves and brought them to the laboratory, where they were put into small plastic culture plates with moistened filter paper to maintain high humidity. After all parasitoids emerged we dissected remaining egg and recorded rates of parasitism for each leafhopper species.

### ***Sophonia pallida***

Previously recorded host plants of *S. pallida* in southern China include guava (*Psidium guajava*), soybean (*Glycine max*), ramie (*Boehmeria nivea*), mung bean (*Vigna radiata*), cowpea (*Vigna sinensis*), broad bean (*Vicia faba*), rice (*Oryza saliva*), sugarcane (*Saccharum officinarum*), camphor tree (*Cinnamomum camphora*), orange (*Citrus sinensis*) and *Cajanus cajan* (Li & Chen 1999). Our observations in Fuzhou province indicate that guava is the preferred host plant, with the highest *Sophonia* populations.

*S. pallida* completes 3–4 overlapping generations per year on guava. Each generation lasts 3–4 months, while egg duration during winter lasts 4–5 months (similar to the phenology of *S. rufofascia* in Hawaii (Duan & Messing 2000)). Eggs continue to develop and hatch during January–February, as guava trees are evergreen in Fuzhou. The nymphs of the 1<sup>st</sup> generation reach a peak during mid-April to early May, followed by a peak in adults in late April to May. The 2<sup>nd</sup> generation nymphs peak from mid-June to early July, with the second adult generation peaking in mid to late July. The population of nymphs and adults of the 2<sup>nd</sup> generation is very large, and overlaps with the 3<sup>rd</sup> generation. From mid-July to mid-October, populations of *S. pallida* steadily expand, with large numbers of eggs, nymphs and adults. The population peaks in mid to late October, when it is common for large numbers of nymphs and adults to transfer to, and feed on, sweet potato (*Ipomoea batatas*), peanut (*Arachis hypogaea*), soybean, and hyacinth bean (*Lablab purpureus*). *S. pallida* is sometimes more abundant on sweet potato during this period than on guava. Populations decline gradually after November, due to lower temperatures and loss of hosts, but a small peak in adults was also observed in early to mid December.

### ***Sophonia furcilinea***

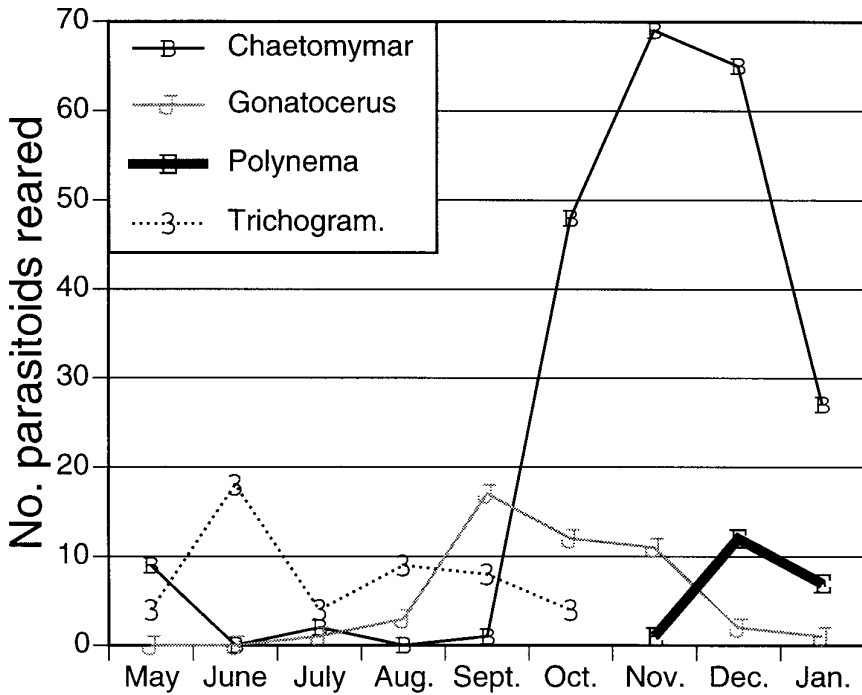
The highest populations of *S. furcilinea* in Fuzhou were observed on *Acacia confusa*. Other host plants include guava, sweet potato, peanut and hyacinth bean. *S. furcilinea* occurs on *A. confusa* throughout the year, with population trends similar to those of *S. pallida* on guava. Eggs in the evergreen leaves of *A. confusa* can develop and hatch normally during January and February, with a first peak in nymphal populations in early spring. The nymphs of the 2<sup>nd</sup> generation occur in early May and peak in mid to late May. In early June nymphs begin to decline, then increase again in July with another population peak in August. In September, nymphs decline to lower levels, with two smaller peaks in mid-October and early December. Adults of *S. furcilinea* were only seen at low levels, except during June–July.

### **Natural Enemies**

In three years of collections in Fuzhou we reared 11 species of parasitoids from *Sophonia* leafhoppers. The majority were egg-parasitoids, including *Chaetomyrmar bagicha* (Narayanan et al.); *Chaetomyrmar* sp. B; *Gonatocerus* spp. (2 spp.); *Himopolynema* (= *Polynema*) *angustalis* (MS) sp. nov; and *H. octosetarum* (MS), sp. nov. [Mymaridae]; *Hispidophila sophoniae* (MS) sp. nov; *Hispidophila* sp. B.; *Ufens rimatus* (Lin); and *Oligosita* sp. [Trichogrammatidae]; and *Centrodora* sp. [Aphelinidae]. In addition, there was a single nymphal parasitoid, an unidentified species in the Dryinidae. We also observed 3 predators feeding on *Sophonia* leafhoppers in the field: an ant (*Polyrhachis vicina* Roger), a spider and a coccinellid.

The composition of the egg-parasitoid guild was different for the 2 *Sophonia* species. Among the 186 egg-parasitoids reared from *S. pallida*, there were 77 *Chaetomyrmar* sp. (41.4% of all parasitoids), 54 *Gonatocerus* spp. (29.0%), 20 *Polynema* spp. (10.8%), 34

**Figure 1.** Number of parasitoids reared from eggs of *Sophonia pallida* on guava, Fuzhou, China, 1999–2000.



Trichogrammatoids (18.3%) and one Aphelinid. Thus there was a relatively high degree of species evenness among parasitoids in the guild. In contrast, for the 151 egg parasitoids reared from *S. furcilinea*, 144 were *Chaetomyxar* sp. (95.4% of the guild). The other egg parasitoids, such as *Gonatocerus* spp., *Polynema* spp., aphelinids and trichogrammatoids were very rare. For both *Sophonia* species, *Chaetomyxar* spp. were the dominant parasitoids (accounting for 65.8% of the total observed parasitism), followed in abundance by *Gonatocerus* spp. and *Polynema* spp.

The parasitoids showed some evidence of phenological complementarity (Fig. 1). *Chaetomyxar* sp. occurred from May to January, with a peak in November. *Gonatocerus* spp. appeared from July to the following April, with a peak in September. *Polynema* spp. appeared mainly from November to January, with highest numbers in December. Trichogrammatoids occurred from May to October in low numbers. Aphelinids were reared from August to October, and Dryinids were found from July to September; both were uncommon.

The average rate of egg parasitism of *Sophonia* leafhoppers in Fuzhou increased progressively from spring to fall. Mean parasitism from April to June was 44.4%, from July to August increased to 58.2%, and from September to November was 75.8%. Total parasitism appeared closely correlated with the occurrence of *Chaetomyxar* sp., the dominant egg parasitoids.

The rate of egg parasitism was positively correlated with egg exposure time in two orchards. At the Research Institute in Fuzhou, mean parasitism in egg cohorts with a 5 d exposure (22.7%) was lower than in eggs exposed for 10 d (31.9%), but did not increase further after exposure for 15 days (30.3%). In Dongshan, eggs parasitism was exposed 45.4% for 5 d exposure, 66.2% for 10 d exposure, and 57.2% for 15 d exposure. Thus *Sophonia* eggs in the early and mid-embryonic stage are preferred by parasitoids over eggs in the later stage (>10 d old), and in order to maximize parasitoid collection for biological control sentinel eggs should be placed in the field for about 10 days.

### Acknowledgments

Leafhoppers were identified by Prof. Li Zi-zhong of Guizhou University and Prof. Cai Ping of Anhui Agricultural University. This work was supported by USDA-CSREES-T-STAR Grant No. 98-34135-6783. This is no. 4595 in the University of Hawaii, College of Tropical Agriculture and Human Resources journal series.

### Literature Cited

- Alyokhin, A. V., P. Yang, and R. H. Messing.** Distribution and parasitism of two-spotted leafhopper eggs (Homoptera: Cicadellidae) in Hawaii. *Annals Entomological Society America*, *in press*.
- Duan, J. J. and R. H. Messing.** 2000. Mating, oviposition, and development of *Sophonia rufofascia* (Homoptera: Cicadellidae) in Hawaii. *Annals Entomological Society America* 93: 554–558.
- Kuoh, C.-I. and J.-I. Kuoh.** 1983. New species of *Pseudonirvana* (Homoptera: Nirvanidae). *Acta Entomologica Sinica* 26: 316–325.
- Li, Zizhong and X. Chen.** 1999. Nirvaninae (Hom.: Cicadellidae) from China. Guizhou Science & Technology Publishing 28–40.
- Yang, P., D. Foote, A. V. Alyokhin, L. Lenz and R. H. Messing.** Distribution and abundance of mymarid parasitoids (Hymenoptera: Mymaridae) of the two-spotted leafhopper (Homoptera: Cicadellidae) in Hawaii. *Biological Control*, *in press*.