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Fruit Piercing Moths in Micronesia and their Natural Enemies

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Abstract—Four primary fruit piercing moths (Noctuidae) are currently found in Micronesia. They are *Othreis fullonia* (Marianas, Palau, Pohnpei and Kosrae), *Ercheia dubia* (Guam, Rota, Tinian and Saipan), *Pericyma cruegeri* (Guam, Rota and Palau) and *Platyja umminia* (Guam). All inflict moderate to severe damage on a variety of citrus and soft fruits at certain times of the year and, in this regard, *O. fullonia* is considered to be the most important species throughout the region. This species is native to Asia where the larvae feed on various vines (Menispermaceae) in contrast to the Pacific region where they feed almost exclusively on certain *Erythrina* spp. (Fabaceae). Although both groups of plants are unrelated taxonomically, they contain similarly structured tetracyclic erythrina-type alkaloids which, we believe, provide the chemical stimulus for host plant selection and thus play a key role in the successful shift from primary to secondary host species. The larval host plants of *P. cruegeri* are well known (*Delonix regia* and *Peltophorum pterocarpum*), whereas those of *E. dubia* and *P. umminia* remain to be determined.

Several natural enemies of *O. fullonia* are known and the microhymenopteran egg parasitoids, *Telenomus* sp., *Ooencyrtus* sp. (both density dependent) and *Trichogramma* sp. (density independent) rank among the most successful biological control agents. *Trichogramma* sp. also parasitize the eggs of *P. cruegeri* and the pupae of this species are attacked by two other parasitoids, *Exorista civiloides* and *Brachymeria* sp.

Introduction

Fruit piercing moths are distributed throughout the world: the genera *Othreis* in Africa, Asia, Australia, and throughout the Pacific; *Eudocima* in Australia and New Caledonia; *Pericyma, Ercheia* and *Platyja* in Asia and Micronesia; *Calpe* in Asia; *Calyptra* and *Oraesia* in Japan; *Gonodonta* in America and *Scolypteryx, Ophiusa* and *Dysgonia* in Europe. Adult moths are powerful flyers and are capable of sustained flight over considerable distances. They feed nocturnally, penetrating a variety of fruits, particularly the sweeter aromatic varieties, with their highly sclerotized, often heavily armored proboscis and suck the liberated cell sap. The larvae, in contrast to adults, feed on unrelated trees, shrubs and vines often located well away from the adult feeding grounds.

Although fruit piercing moths are currently a serious problem in the Commonwealth of the Northern Marianas, Guam and Kosrae, they are of minor importance in Pohnpei and Palau and of no importance in Chuuk, Yap and the Marshall Islands.

Materials and Methods

To assess the seasonal fluctuations of single eggs, egg masses and egg parasitoids of *O. fullonia* biweekly surveys have been conducted since March 1989. Eggs were collected from *Erythrina variegata* trees in six different locations on Guam as described by Denton et al. (1992). Larvae and pupae of *O. fullonia* were field collected and kept in the laboratory to observe emergence of parasitoids. In an effort to determine the larval host plants of *P. umminea* and *E. dubia*, unidentified noctuid caterpillars were çollected in periodic surveys in various habitats of Guam. Brief one to two day survey trips were made to different islands in Micronesia to record the occurrence of different species of fruit piercing moths and various egg parasitoids of *O. fullonia*.

Results and Discussion

(i) *Othreis fullonia* (Clerck) (Noctuidae)

The fruit piercing moth, *Othreis fullonia*, is distributed from Africa to Samoa and French Polynesia in the Pacific along the tropical and subtropical belt. Its biology, food preferences in Guam and its distribution and natural enemies in Micronesia were reported by Denton et al. (1991, 1992). It is considered to be one of the top ten invertebrate pests, causing widespread and serious damage in Guam and Saipan today.

In Australia, Asia and Africa the larvae feed on the foliage of several vine species of the family Menispermaceae. However, in the Pacific region, where this family is generally not well-represented, the larvae have successfully adapted to various *Erythrina* spp. of the Fabaceae family. According to Waterhouse & Norris (1987), the species of *Erythrina* most preferred by *O. fullonia* include *E. variegata, E. fusca, E. indica, E. lithosperma, E. tahitiensis, E. crista-galli* and *E. variegata orientalis*.

It is noteworthy that very few species of *Erythrina* are native to the Pacific region. Most of those found today are of Asiatic origin and were introduced by the early European settlers as shade trees for coffee, cacao, citrus and other plantations; as fence posts; as ornamentals; and more recently as windbreaks and as food (flowers) for fruit bats. Thus, *O. fullonia* presumably reached Australia and the Pacific Islands in the wake of its secondary host species between 150 and 200 years ago.

O. fullonia apparently evolved in Asia using native Menispermaceae plants for oviposition and as larval hosts. Today, the preferred genera of this family seem to be *Tinospora, Fawcettia, Triclisia, Cocculus, Pleogyne, Sarcopetalum, Carronia, Hypserpa, Legnephora,* and *Stephania.* (Banziger 1982, Sands & Schotz 1988). Interestingly, *Erythrina,* which is also a native of Asia, is not selected for oviposition by *O. fullonia* in this region. Similarly, in other areas of the world (e.g. Australia) where both Menispermaceae plants and *Erythrina* coexist, the former is selected as the larval host plant. When Menispermaceae do not occur or are rare in the Pacific *O. fullonia* will transfer to the secondary host plant species. In New Caledonia, for example, *O. fullonia* is thought to have originally fed on the vine, *Stephania forsteri,* until it became rare (possibly as a result of grazing pressure by the introduced insect) at which time feeding shifted to *Erythrina* (Cochereau 1977).

Precisely why two taxonomically unrelated groups are utilized by *O. fullonia* for oviposition remains a mystery, although attraction to a specific chemical or group of chemicals, common to all selected host plants, seems to be the most likely explanation. In this regard, Cochereau (1977) postulated that the occurrence of the alkaloid cocculobidine in *Cocculus trilobus* and *Erythrina* was responsible for the oviposition and larval feeding behavior of *Othreis.* Recently, however, Amar et al. (1991) identified over 90 closely related tetracyclic alkaloids in *Cocculus* and *Erythrina* which suggests that more than one chemical may be involved in providing the stimulus for oviposition. Amar et al. (1991) point out that these structurally similar tetracyclic alkaloids are confined exclusively to *Erythrina* spp. and representatives of the Menispermaceae, which indeed lends weight to the idea of *O. fullonia* homing in on host plants along specific chemical concentration gradients. It may be further speculated that *O. fullonia* is more strongly attracted to the tetracyclic erythrina-type alkaloids present in Menispermaceae plants than to those in *Erythrina* species. This could explain why the former are preferentially selected when representatives of both are present. Clearly, oviposition and feeding trials are warranted in order to understand the precise relationship between these intriguing plant alkaloids and host plant selection by *O. fullonia.*

(ii) *Pericyma cruegeri* (Butler) (Noctuidae)

Locally referred to as the flame-tree looper or poinciana looper, *Pericyma cruegeri* is distributed in southeast Asia, Papua New Guinea and northern Australia. In Micronesia, it was first observed on Guam in 1972 (Muniappan 1974) and more recently in Rota and Palau. As its common name implies, the larvae of this species feed on the foliage of flame-trees, specifically *Delonix regia* (Bojer) and *Peltophorum pterocarpum* (DC) Backer and cause severe defoliation during the rainy season. The adult moths are equipped with a highly chitinized, barbed proboscis which is capable of penetrating various fruits including tough skinned varieties of citrus and pomegranate. However, the extent to which this species inflicts damage to local fruits on Guam is highly seasonal; maximum damage is coincident with the sharp increase in population densities usually observed in

October. Economically, it is more important as a pest of poinciana trees than as a fruit piercing moth.

(iii) *Ercheia dubia* (Butl.) and *Platyja umminea* (Cram.) (Noctuidae)

In Micronesia, *E. dubia* occurs in Guam, Rota and Palau, whereas *P. umminea* has, so far, only been found in Guam. Both species are of Asian origin and are recent introductions to Micronesia, i.e., within the last 5 to 10 years. They have been observed in relatively large numbers at certain times of the year and, together, contribute significantly to the fruit piercing moth problems of the area. So far we have been unable to locate the larval host plants of these species.

Natural Enemies

Denton et al. (1991) reported that the micro-hymentopteran egg parasitoids, *Telenomus* spp. *Ooencyrtus* spp. and *Trichogramma* spp. were the major natural enemies of *O. fullonia* in Micronesia, although the relative importance of each varied significantly between islands. For example, in Guam, Rota, Tinian and Saipan, *Telenomus* sp. was generally the dominant egg parasitoid, closely followed by *Ooencyrtus* sp. In contrast, *Trichogramma* sp. was relatively ineffective on these islands. In Pohnpei and Kosrae, however, the reverse was true with *Trichogramma* sp. playing the most important role in controlling *O. fullonia* populations.

One contributing reason for the apparent ineffectiveness of *Trichogramma* sp. in Guam and the Northern Mariana islands could be that its foraging ability is relatively low and it does not generally extend into the mid and upper levels of mature *Erythrina* trees. The fact that it is more commonly recovered from *O. fullonia* eggs laid on young trees of less than 3m supports this hypothesis. Also, the eggs collected in Pohnpei and Kosrae were from lower levels, as most of the *Erythrina* trees sampled were short.

Bi-weekly field collections of *O. fullonia* eggs, conducted over a two year period in Guam, indicate that populations of *Telenomus* sp. and *Ooencyrtus* sp. are density dependent, (Figs. 1–4). Populations of both wasps increase with increased host availability during the wetter months of the year. *Telenomus* sp. has values of $r = 0.88$ and $r = 0.97$ for single eggs and eggs in egg masses respectively. Similar relationships for *Ooencyrtus* sp. are $r = 0.91$ and $r = 0.81$. *Trichogramma* sp., on the other hand is density independent (Figs. 5 & 6) and tends to be more common during the dry season. There is no relationship between *Trichogramma* sp. parasitization of either single eggs or eggs in egg masses. The r values are 0.03 and 0.45, respectively.

All three wasps, together with other minor parasitoids and predators, collectively destroyed over 95% of the total number of eggs collected. Although this cannot be directly equated against the total number of eggs laid we feel sure that it accounts for a substantial portion of destruction of eggs. Nevertheless, the

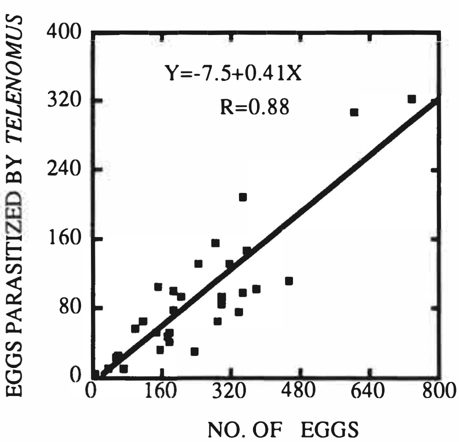

Figure 1. Relationship between number of single eggs of *O. fullonia* in the field and parasitization by *Telenomus* sp. on Guam.

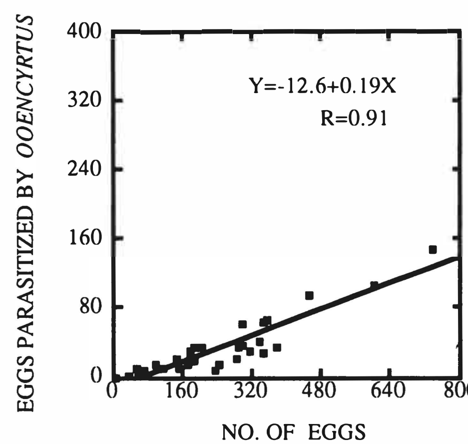

Figure 2. Relationship between number of single eggs of *O. fullonia* in the field and parasitization by *Ooencyrtus* sp. on Guam.

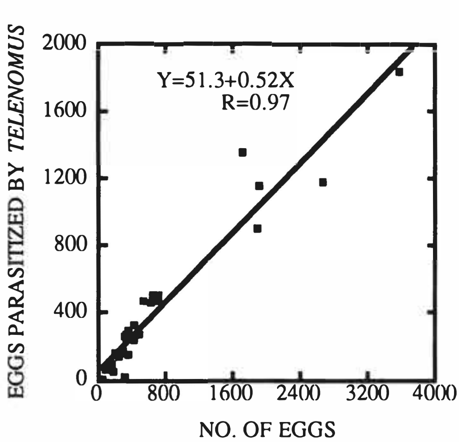

Figure 3. Relationship between number of eggs in egg masses of *O. fullonia* and parasitization by *Telenomus* sp. on Guam.

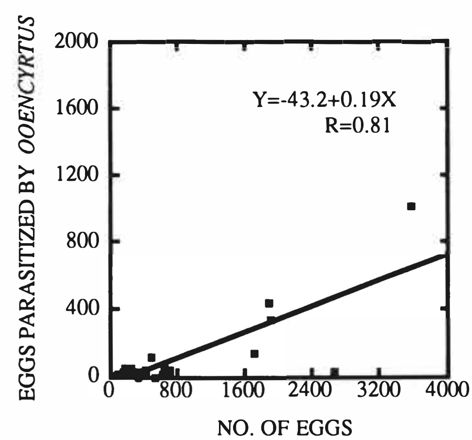

Figure 4. Relationship between number of eggs in egg masses of *O. fullonia* and parasitization by *Ooencyrtus* sp. on Guam.

numbers of viable eggs from which larvae hatch to produce adult moths remain sufficient to include *O. fullonia* among Guam's ten most important insect pests.

Recently, we discovered two pupal parasitoids of *O. fullonia* in Guam. A small eulophid wasp was identified by the British Museum as *Trichospilus diatraeae* Cherian and Margabandhu. The second is a *Brachymeria* sp. Unfortunately, neither are specific to *O. fullonia* and readily attack a variety of other lepidopteran pupae. To further suppress the population of *O. fullonia* in Guam, the introduction of an effective species of *Ooencyrtus* from Papua New Guinea

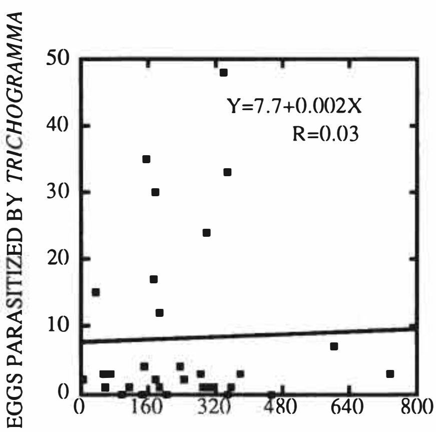

Figure 5. Relationship between number of single eggs of *O. fullonia* and parasitization by *Trichogramma* sp. on Guam.

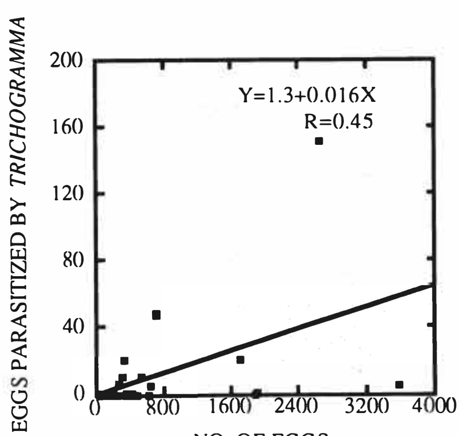

Figure 6. Relationship between number of eggs in egg masses of *O. fullonia* and parasitization by *Trichogramma* sp. on Guam.

via Australia is being actively considered. There are no major parasites that attack *P. cruegeri* on Guam. Egg parasitoids (*Trichogramma* sp.), pupal parasitoids (*Exorista civiloides* (Bar.) and *Brachymeria* sp.) and predators such as praying mantids, muddauber wasps, spiders, and predatory bugs cause very little impact on the population. With financial assistance from the Government of Guam and the cooperation of the International Institute of Biological Control, exploration and screening of some of the effective natural enemies of *P. cruegeri* in Malaysia is being pursued for eventual introduction to Guam. No natural enemies of *P. umminea* and *E. dubia* thus far have been recorded on Guam.

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