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The Success of Natural Enemies in Controlling Introduced Pests in American Samoa

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Abstract—Natural enemies keep most pest populations in American Samoa below economically important levels. When new pests (such as *Thrips palmi* and *Plutella xylostella*) arrive, they initially cause severe damage. However, within one to two years, natural enemies or perhaps other environmental conditions reduce pest populations. Nevertheless, in some cases, such as that of *Othreis fullonia*, additional biological controls are needed in order to keep a pest below the economic threshhold.

The success of natural enemies in American Samoa may be due to a number of factors: little insecticide usage, thus minimising adverse effects on natural enemies; mixed cropping systems (eg. interplanting with *Coleus blumei*); and the presence of the virgin rainforest, which may contain alternative hosts and suitable habitats for natural enemies.

Introduction

American Samoa is a group of tropical, mountainous islands of volcanic origin in the South Pacific (14°S), characterized by steep slopes and dense rainforest. It receives approximately 500 cm of rain a year. Staple crops include taro, (*Colocasia esculenta*), banana (*Musa* spp.), breadfruit (*Artocarpus communis*) and coconut (*Cocos nucifera*), usually planted in a mixed cropping system. Vegetables such as cucumber (*Cucumis sativus*), tomato (*Lycopersicon esculentum*), and Chinese cabbage (*Brassica* sp.) are becoming important as nutrient sources.

In 1981, with the establishment of a Land Grant Program at the American Samoa Community College, the first formal agricultural research program began. Entomological research began in 1984 and was advised by a board that included farmers, researchers, administrators, and extension agents. The development of management strategies for pests of staple and vegetable crops was a high priority and attention was thus focused on the identification of major pests and their natural enemies.

This paper reports on the pest and natural enemy complexes on various crops and offers an initial evaluation of the success of natural enemies in controlling long standing pests, such as *Spodoptera litura* (F.), *Aphis gossypii* Glover and *Tarophagus proserpina* (Kirkaldy), and recently introduced pests, such as *Thrips palmi* Karny, *Othreis fullonia* (Clerck) and *Plutella xylostella* (L.).

Materials and Methods

(i) Taro

An experiment was conducted from May to November 1991 to determine the effect of planting *Coleus blumei* ("Pate" in Samoa) on taro pests and their biological control agents. It had been reported by farmers (Vargo 1991) that planting this ornamental with taro would keep away the taro armyworm (*Spodoptera litura*) and the taro planthopper (*Tarophagus proserpina*).

Two plots (10 m by 9 m), were planted with taro at a 1 m × 1 m spacing. At the centre of each plot a circular area, (1.2 m in diameter) was designated to be either planted or not planted with 0.3 to 0.6 meter-high cuttings of *Coleus blumei* at a distance of about 0.45 m apart. The *C. blumei* was planted at the same time as the taro. Taro was planted throughout the non-*Coleus* field.

Each field was marked into 8 segments by ribbons radiating from the centre of the field. In order to determine if distance from *C. blumei* had any effect on pests or natural enemies, each segment was further subdivided into 3 sections, located at differing distances (1, 2, or 3 m) from the centre circle (of *C. blumei* or taro) and designated centre, middle and edge respectively. Every two weeks, data was collected from 72 plants to compare pest and natural enemy incidence at different distances from the centre of each field. Counts of the following were made on the inner 3 leaves of taro (3 youngest leaves): cluster caterpillar (*Spodoptera litura*) egg masses and larvae, hornworm (*Hippotion celerio* (L.)) eggs and larvae, spiders, dryinid wasps, syrphid larvae and ladybird beetles. Planthoppers, (*Tarophagus proserpina*) and their mirid egg predator, (*Crytorhinus fulvus* Knight) were counted on the first and third leaves and petioles. Aphids (*Aphis gossypii* Glover) were counted in a circular area (approximately 10 cm diameter) around the point where the petiole inserts into the leaf.

(ii) Cucumber

This study was conducted in 1990 to identify major cucumber pests and their biological controls. Nine varieties of cucumber obtained from the Known-You Seed Co., Taiwan, R.O.C. were transplanted in a randomized complete block design, with 3 replicates each containing 4 plants of each variety. The vines were trained to climb a 1.5 m trellis. The field was mulched with a thick layer of coconut fronds. Fruit was harvested 3 times a week between 23 March and 25 April 1990. During this period temperatures ranged from 21 to 30°C, averaging 25°C.

Insect counts were made twice a week on all varieties from 8 March to 16 April 1990. A leaf from the vine tip, midsection and base of 1 of the 4 plants of each variety in each block was examined and all insects and spiders seen on these leaves were counted.

(iii) Chinese cabbage

Chinese cabbage plots were examined at three sites on the Western side of Tutuila, at the villages of Leone, Mapusaga and Iliili. From each site samples of caterpillars were brought back to the laboratory and raised to adults for identification and to observe for parasitoid emergence.

(iv) Fruit-piercing moth

The fruit-piercing moth (FPM), *Othreis fullonia* is a serious pest on tomatoes, citrus, green pepper and star apple in American Samoa, often causing 80 to 100% crop loss. In 1989 a collaborative project was initiated with Dr R. Muniappan (University of Guam) and Dr D. Sands and W. Liebregts (CSIRO).

The first step was to document what natural enemies were present on the island. In 1989 and 1990 eggs, larvae and pupae of the pest were periodically collected from *Erythrina variegata* trees throughout Tutuila and held for emergence of moths or parasites.

From June to December, 1991 single eggs, egg masses, and larvae were collected from 7 sites covering both east and west sides of Tutuila. At each location, various combinations of 5 *Erythrina* varieties were examined for FPM stages for 10 minutes.

Leaves with single eggs, egg masses, or larvae were brought back to the laboratory and held until emergence of larvae or parasites (approximately 2–3 weeks).

This study also gathered information on the incidence of FPM eggs, larvae and parasitoids on each of the 5 varieties of *Erythrina* one of which, *E. subumbrans*, is regularly intercropped in taro fields. Farmers believe it enriches the soil and suppresses weeds (Vargo, 1991). If this species of *Erythrina* proved to be a major host of FPM larvae, planting it in proximity to vegetable or fruit gardens might be deleterious to these crops. Another species, *Erythrina variegata fastigata* is planted as a windbreak by many farmers.

Results

(i) Taro

At times the taro armyworm, *Spodoptera litura*, causes severe defoliation of taro. During this experiment, armyworm incidence and damage was low. More egg masses and larvae were found in the field without *Coleus blumei*, but the differences were not statistically significant. At the first reading, which was taken about 2 weeks after the taro and *C. blumei* were planted, the number of eggs and larvae were higher in the *C. blumei* field (Fig. 1). In subsequent readings, more larvae were found in the non-*Coleus blumei* field at all distances from the centre.

The data suggest that an egg or larval parasitoid or predator may be present. Whereas the number of egg masses is initially high, the number of larvae is low, especially in *C. blumei* plots. The natural enemies included *Apanteles* sp., *Euplectrus* sp. and *Chelonus* sp.. Predators included the cockroach, *Blattella germanica* (L.), ants and assorted spiders.

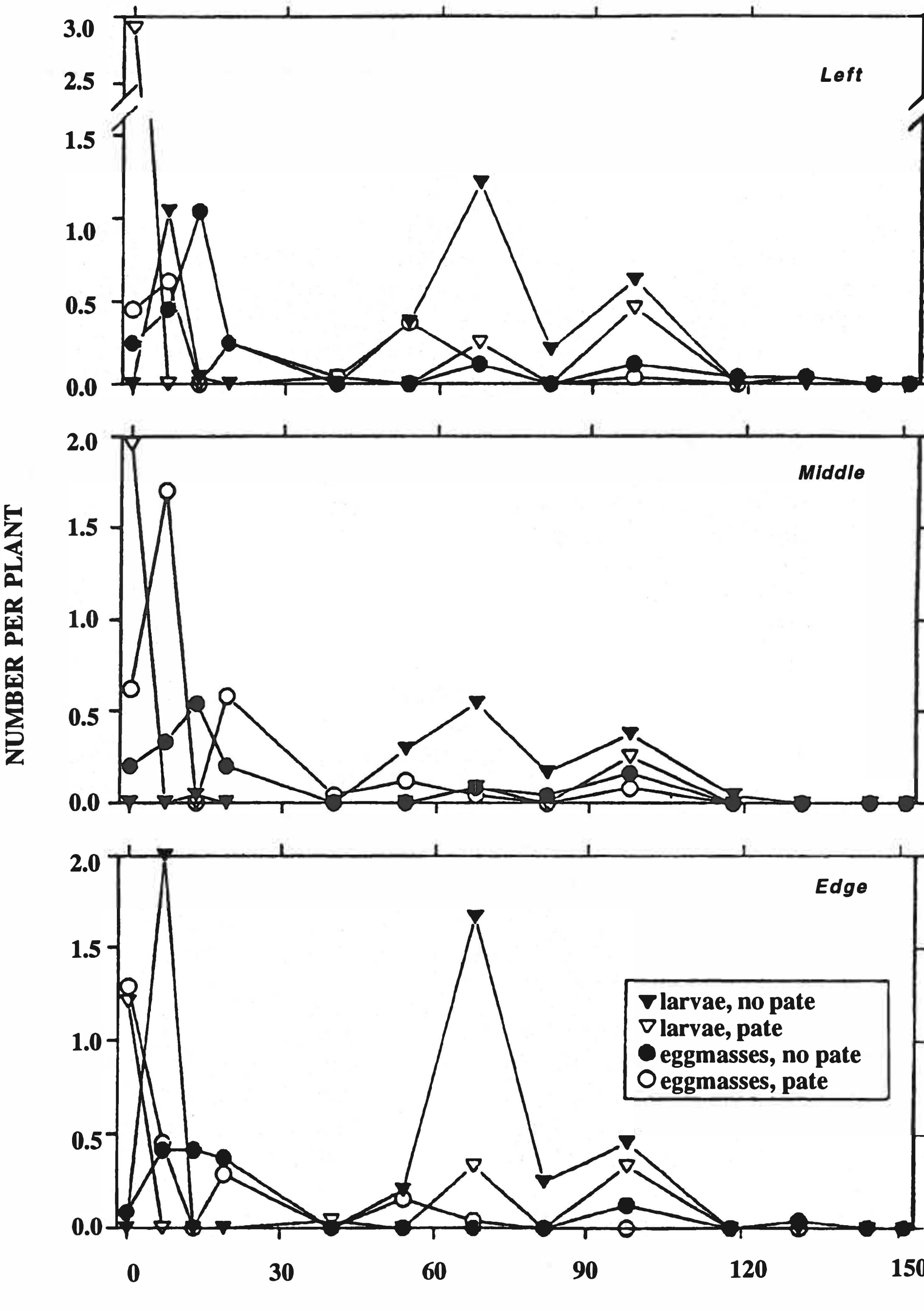

Figure 1. Average number of armyworm larvae and eggmasses found in the centre, middle and edge of taro fields, with or without pate (*Coleus blumei*). Counts based on 24 plants per section.

Another pest of taro is *Tarophagus proserpina*, the taro plant-hopper, whose populations can rise to hundreds per plant, although numbers remained relatively low throughout this experiment (Fig. 2). The mirid egg predator, *Crytorhinus fulvus,* was present throughout the experiment and its populations did not seem to be influenced by the presence of *Coleus blumei*. A comparison of planthopper nymphs in fields with or without *C. blumei* indicates that there were fewer in fields with the *C. blumei*. Adult dryinid wasps which parasitise planthoppers were also noted in small numbers.

The taro aphid, *Aphis gossypii*, was present initially in high numbers in the non-*Coleus* field, but abundance then dropped dramatically. Two predators, syrphid fly larvae and ladybird beetles, were present in both fields (Fig. 3).

The taro hornworm, *Hippotion celerio*, was initially present in high numbers and abundance peaked again twice. As with the armyworm, fewer hornworm larvae were found in *Coleus blumei* fields, but the difference was not significant. An egg parasitoid, *Ooencyrtus* sp., emerged from some hornworm eggs.

(ii) Cucumber

Aphis gossypii and *Thrips palmi* were the first pests to infest cucumbers. *T. palmi* can be a devastating pest but was present in low numbers and caused no noticeable damage throughout this experiment. The presence of an *Orius* sp. bug predator was noted. The population of *Aphis gossypii* varied throughout this trial, peaking on 23 March, 3 weeks after transplanting. Ten days later, the population of aphids had dramatically decreased (Fig. 4).

As the aphid population increased, so did the biological control complex (Fig. 4). The natural enemies observed were syrphid larvae, lacewing (*Chrysopa* sp.) adults and larvae, ladybird adults and larvae and several kinds of spiders.

The decline of aphids was followed by a decline in all predators (Fig. 4).

Other cucumber pests included *Leptoglossus gonagra* (F.) (= *L. australis*) and *Epilachna* sp., the latter occasionally being extremely destructive.

(iii) Chinese cabbage

Earlier, inspections of farmers' plots indicated that all cabbages were severely infested (85–95% leaf destruction) by *Plutella xylostella*, the diamondback moth. About 5% of the cabbages were also infested with the cabbage looper (*Crocidolomia pavonana* (F.)). Surprisingly, during 1991 and 1992 farmers did not report either pest, nor were they present on the research station plots.

(iv) Fruit-piercing moth

Two hymenopteran parasitoids, *Ooencyrtus* sp. and *Trichogramma* sp., emerged from single eggs and egg masses of *Othreis fullonia*, the former being the more abundant. A higher proportion of moth larvae were produced from egg masses than from single eggs.

A comparison of parasitization rates showed great variation between sites at any time. Fewer egg were found on *Erythrina subumbrans*, the taro plantation variety, than on the other species of *Erythrina*.

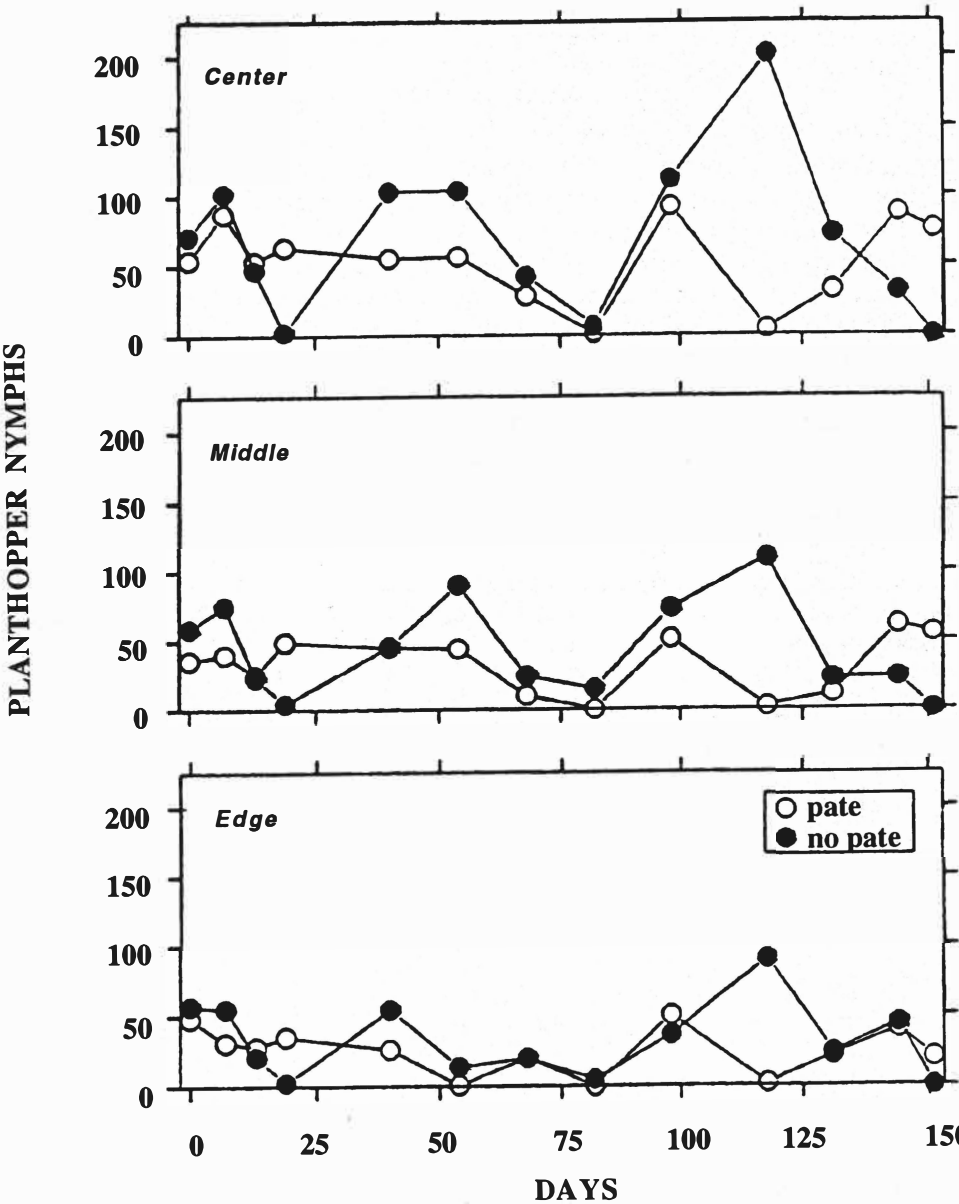

Figure 2. Total number of planthopper nymphs found in the centre, middle and edge of taro fields, with or without pate (*Coleus blumei*). Counts based on 24 plants per section.

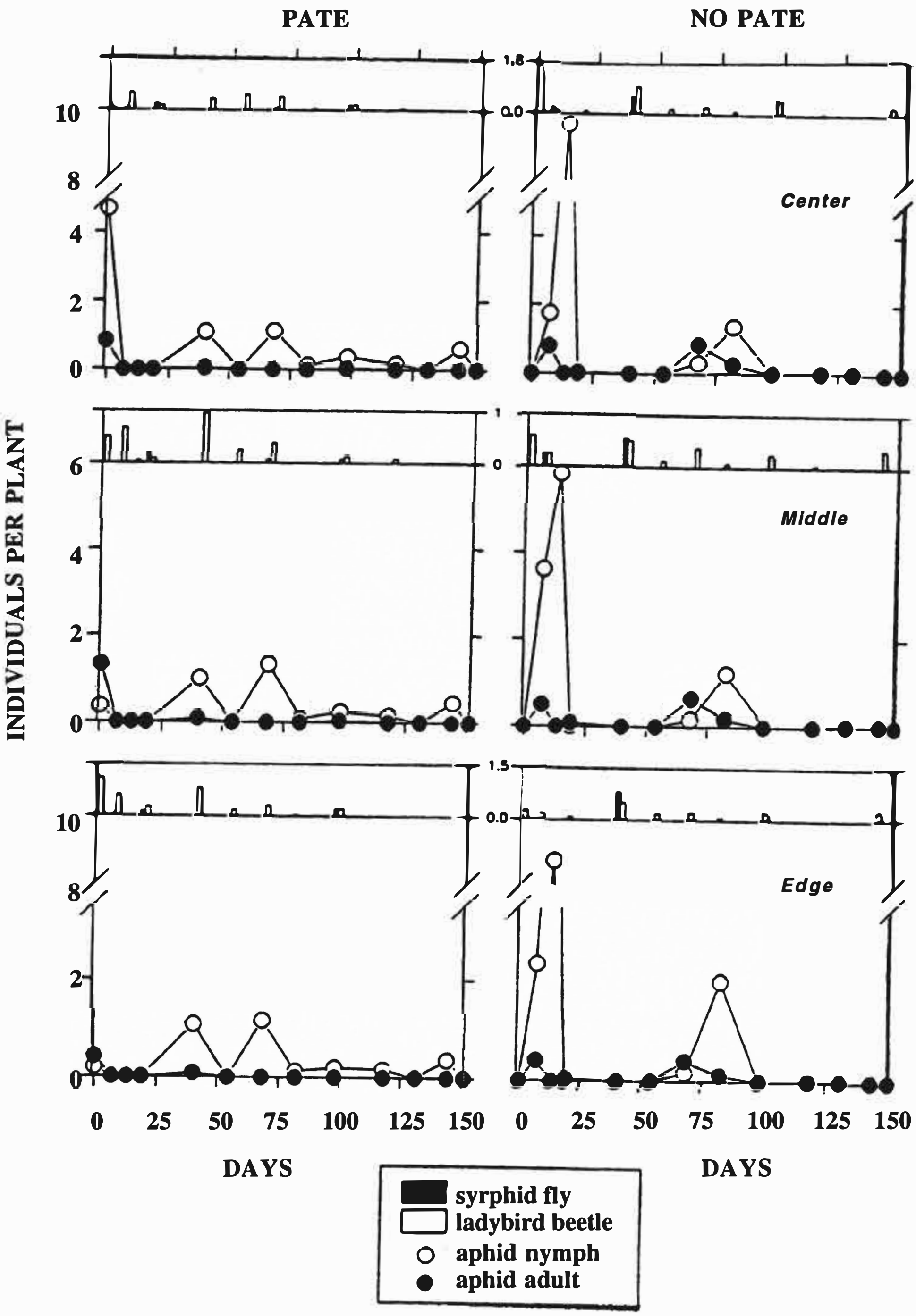

Figure 3. The populations of aphid nymphs, adults and two predators found in the centre, middle and edge of taro fields, with or without pate (*Coleus blumei*). Counts based on 24 plants per section.

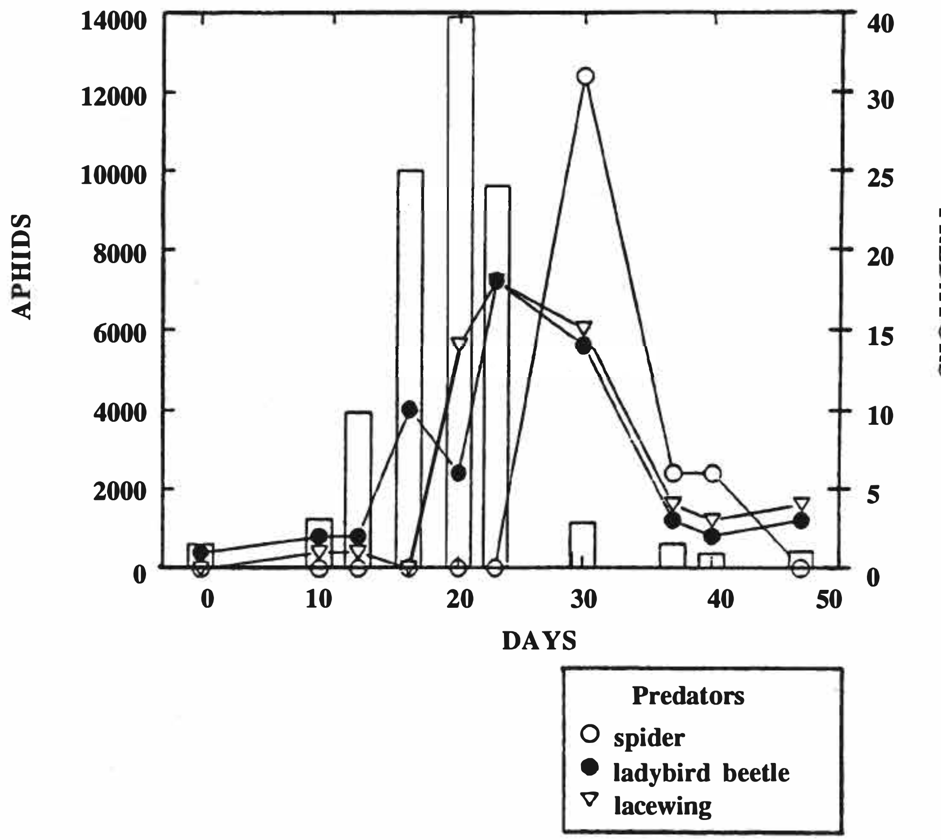

Figure 4. Populations of aphids and three predators on cucumber.

Discussion

A wide variety of natural controls exist in American Samoa for insect pests of the major crops, although occasional outbreaks may occur following hurricanes or after indiscriminate pesticide usage. Severe armyworm outbreaks occurred 1–4 months after two recent hurricanes in American Samoa, due presumably to the balance between the biological controls and the armyworms being disrupted. Armyworm outbreaks often occur in taro in newly-cleared plantations in the rainforest, but farmers report that subsequent plantings are rarely affected. It is not known whether natural enemies move in from the surrounding virgin forest. Although insecticide use is minimal in American Samoa (Vargo 1991), plant-hopper outbreaks have occurred after a taro plantation was sprayed for army-worms. Presumably, numbers of the planthopper egg predator, *Crytorhinus fulvus*, were significantly reduced by the insecticide, allowing a resurgence of the pest.

In considering the rapid decline in the population of *Plutella xylostella*, it may be that an equilibrium has been achieved between it and some natural enemy(ies). Should this be true, identification of these enemies could prove valuable to other diamondback moth biocontrol projects.

Populations of *Aphyis gossypii* on both taro and cucumber were reduced and held in check by a complex of predators.

The natural enemies of *Othreis fullonia* do not appear to provide adequate control of the moth. Because of the low economic threshhold of the fruit piercing moth, (one moth can damage a large number of fruits per night), it would be desirable to incorporate additional natural enemies into the existing biological control complex.

References

Vargo, A. M. 1991. The rapid rural appraisal of taro agriculture in American Samoa. *In* A. M. Vargo & L. Ferentinos (eds), A Rapid Rural Appraisal of Taro Agriculture in American Samoa, Hawaii and Micronesia, pp. 5–14. Agricultural Development in the American Pacific, Univ. of Hawaii.