Biological Control of the Banana Skipper, *Pelopidas thrax* (Linnaeus), (Lepidoptera: Hesperiidae) in Hawaii[1]

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The banana skipper, *Pelopidas thrax* (Linnaeus), (=*Erionota thrax*) was discovered in Hawaii in August 1973 (Davis and Kawamura 1975). Subsequent surveys indicated that the pest was confined to Hickam AFB and Fort Kamehameha. An eradication program was initiated and continued until infestations were discovered in other areas. By this time, sources for two promising parasite species were located, and a biological control program was initiated. Mass colonization and distribution of the parasites were carried out by the Entomology Branch of the Hawaii Department of Agriculture.

Three species of parasitic Hymenoptera were introduced. These were *Ooencyrtus erionotae* Ferriere (Encyrtidae), *Apanteles erionotae* Wilkinson (Braconidae), and *Scenocharops* sp. (Ichneumonidae).

The egg parasite, *O. erionotae*, was received in September 1973 from Guam and the initial release of this parasite was made on November 8, 1973 (Nakao et al. 1975).

The larval parasite, *A. erionotae*, was introduced from Thailand in December 1973 (Nakao and Funasaki 1976) and from Malaysia in July, 1974. The initial release was made in January 1974, and periodic releases followed from laboratory reared stock.

The third introduced parasite was *Scenocharops* sp., an ichneumonid parasite of skipper larvae (Nakao and Funasaki 1976). Attempts to mass rear this parasite were unsuccessful. However, a total of 35 adults from the original stock were released at Waiahole and Kaneohe, Oahu during November and December 1974. To our knowledge, this parasite did not become established.

In addition, four other species of parasitic Hymenoptera were occasionally reared out of field collected *P. thrax* eggs and pupae. These were: *Anastatus* sp. (Eupelmidae), *Trichogramma* sp. (Trichogrammatidae), *Ecthromorpha fuscator* Fabricius (Ichneumonidae), and *Brachymeria obscurata* (Walker) (Chalcididae). The first two species were reared from *P. thrax* eggs while the latter two were from larvae or pupae. *Anastatus* sp. had not previously been found in the State. Incidence of parasitism of *P. thrax* by these four parasites was low in comparison with that by *O. erionotae* and *A. erionotae*.

This paper reports on the life histories of *O. erionotae* and *A. erionotae* and the action of these parasites in controlling the banana skipper at one location in Hawaii.

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Materials and Methods

The life histories of *A. erionotae* and *O. erionotae* were determined during the mass rearing program. Laboratory temperature averaged 26.7°C. The parasites were reared in the following manner.

Apanteles erionotae. Ten second instar banana skipper larvae were exposed for oviposition to 10-20 *A. erionotae* adults in a gallon jar. Honey was provided for the wasps to feed on by streaking a few drops on the side of the jar. Fresh sections of banana leaf with midrib (15-17 cm length) were provided every 2-3 days for the caterpillars to feed on. After emergence and pupation of *A. erionotae* larvae, the host was discarded. The wasp cocoons were placed in a clean jar and held for adult emergence.

Ooencyrtus erionotae. Approximately 50 banana skipper eggs (0-1 day old) were placed in a gallon jar with 100 *O. erionotae* adults. The jar mouth was covered with cotton organdy. Food for the parasite adults was streaked on the upper surface of the jar with a camel's-hair brush. The food consisted of a mixture (6:3:1) of honey, soy hydrolysate, and water. Water was misted onto the sides of the jar daily to keep the humidity high. After the parasites oviposited, the skipper eggs were removed and placed into a clean jar.

Results and Discussion

Life History

Apanteles erionotae. Females oviposited in early instar larvae. The second instar larva was preferred. The parasite larvae developed within the caterpillar. During the period prior to emergence, the host larva continued to develop and did not exhibit any external symptoms due to parasitization. Sixteen to 24 days following oviposition, mature parasite larvae emerged through the integument of the host (Figure 1A) and pupated within silken cocoons on both sides of the host (figure 1B). The caterpillar usually died within a day. *Apanteles* adults emerged in 5-7 days. The life cycle was completed in 21-31 days. An average of 69 adults (range 18-150) was reared out of each parasitized larva.

Ooencyrtus erionotae. Parasite females readily oviposited (Figure 1C) in banana skipper eggs which were up to 3 days old. Oviposition in older skipper eggs occurred infrequently. The entire oviposition process was completed in 10 minutes. Each female usually oviposited at several different sites of the same skipper egg. Eggs were deposited singly and attached to the inside of the chorion. *O. erionotae* eggs hatched in 2 days.

Parasitized eggs were readily distinguished by the greyish color of the areas surrounding the oviposition sites. The larval period was completed in 6-7 days, and pupation occurred within the host egg. The adults emerged 8-10 days later by chewing holes through the chorion (Figure 1D). The total development period from oviposition to adult emergence was 16-19 days. An average of 5 parasites were reared out of each parasitized egg. There was a 2-day preoviposition period. Adults lived as long as 2 months.

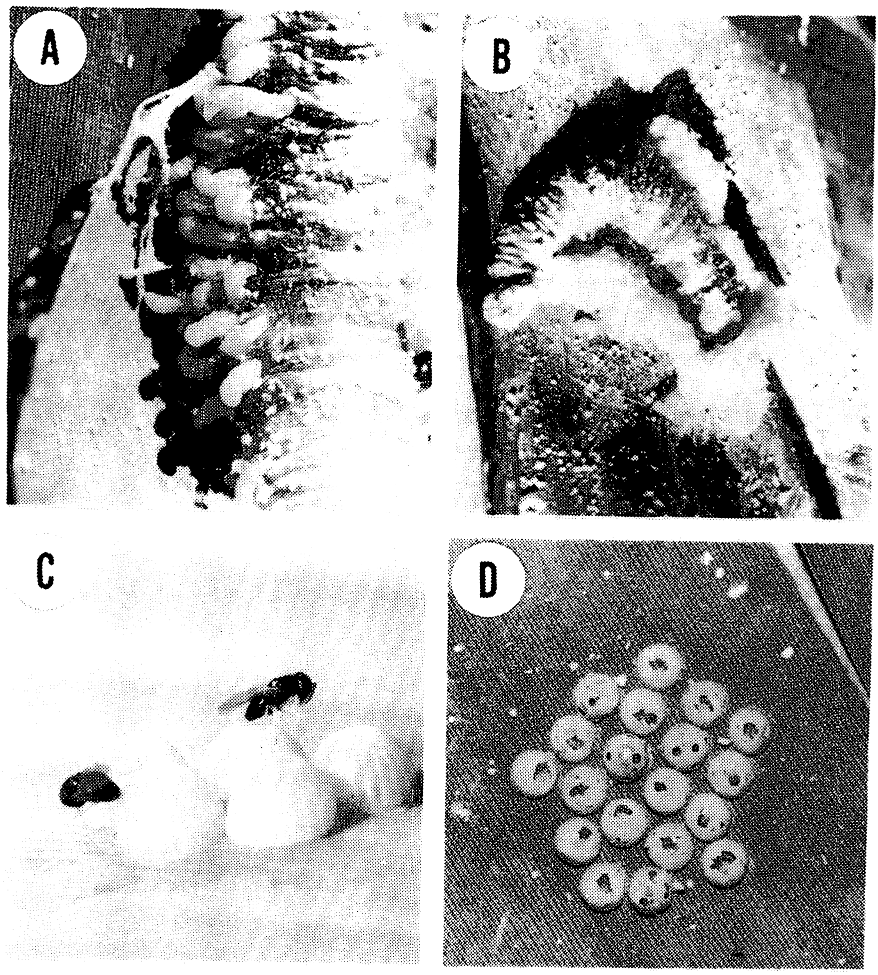

Fig. 1 A, *Apanteles erionotae* larvae emerging from *Pelopidas thrax* larva; B, *A. erionotae* cocoons; C, *Ooencyrtus erionotae* female ovipositing in *P. thrax* egg; D, *O. erionotae* adult emergence holes.

Field Evaluation

A total of 1165 *O. erionotae* and 1510 *A. erionotae* adults were released throughout a 10- acre banana farm at Waiahole, Oahu during September and October 1974. Evaluation surveys commenced in October 1974 and were terminated in July 1975. During this period, *P. thrax* egg clusters and 5th instar larvae were collected at random at monthly intervals. The relative size of the monthly sample decreased considerably after the 5th month of the study (Table 1). This was the result of a general decrease in banana skipper abundance. The egg clusters were held in jars. The rate of parasitism was determined after emergence of *O. erionotae* adults. Larval parasitism by *A. erionotae* was determined in the following manner. Each caterpillar was dissected longitudinally, in a dish partially filled with water and examined for the presence of *A. erionotae* larvae. In addition, corresponding monthly estimates of the proportion of banana plants and leaves infested with *P. thrax* larvae were made when egg and larval samples were collected.

TABLE 1. *Size of samples collected at random to determine rates of parasitism of* Pelopidas thrax *(Linnaeus).*[1]

Month	No. Egg Clusters	Total No. Eggs	No. Larvae
October	56	606	86
November	46	547	50
December	37	427	53
January	39	460	42
February	41	406	36
March	7	79	1
April	21	35	5
May	1	3	1
June	7	8	3
July	14	16	2

[1]Waiahole, Oahu. 1974-75

At the onset, banana skipper eggs, larvae, and pupae were present on all of the plants. Adults were abundant throughout the study area. Foliar damage by the larvae was widespread and severe (Figure 2). More than 80% of all banana plants and leaves were damaged.

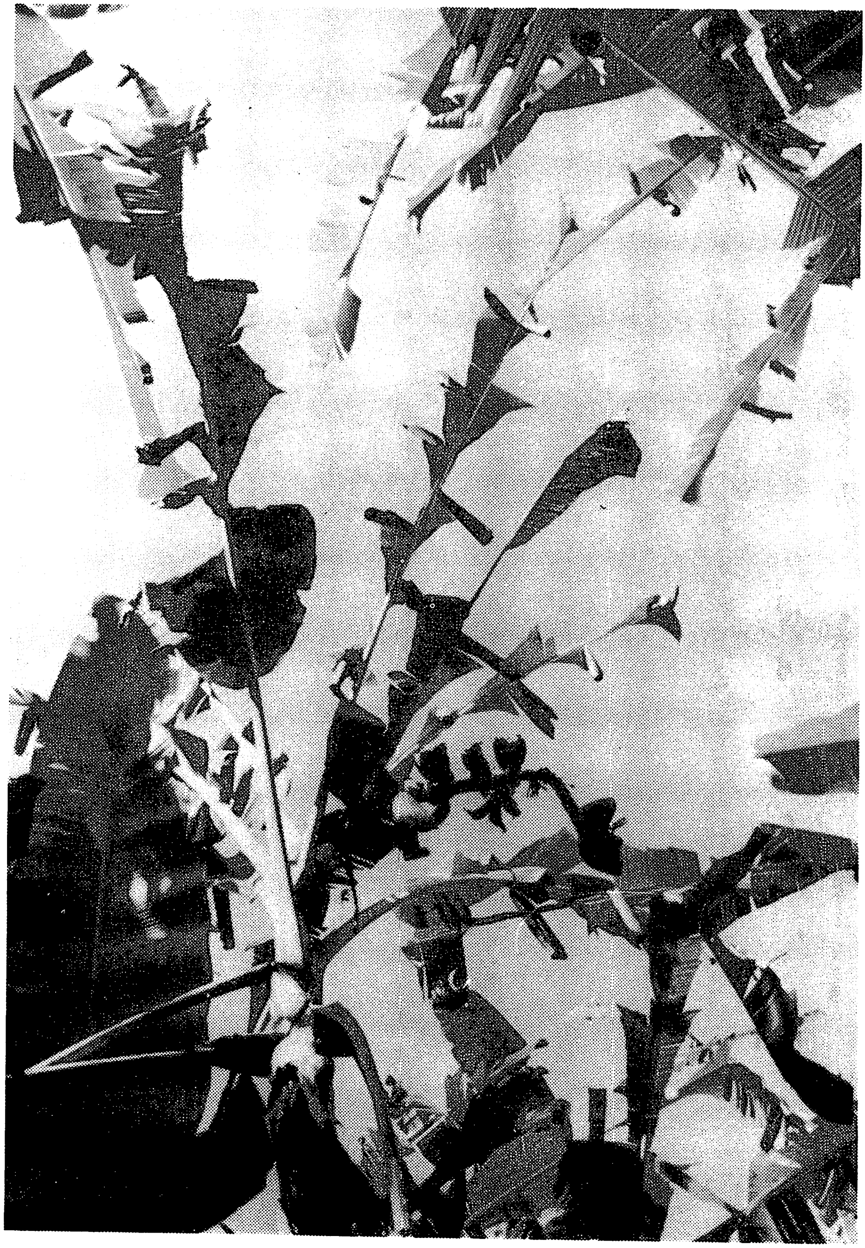

Fig. 2. *Pelopidas thrax* (Linnaeus). Typical damage to banana. Waiahole, Oahu. November 1974.

Following introduction of the parasites, the number of damaged plants and the severity of damaged leaves also decreased steadily (Figure 3A). A high degree of control of the banana skipper was achieved within 7 months of introduction of parasites into the area.

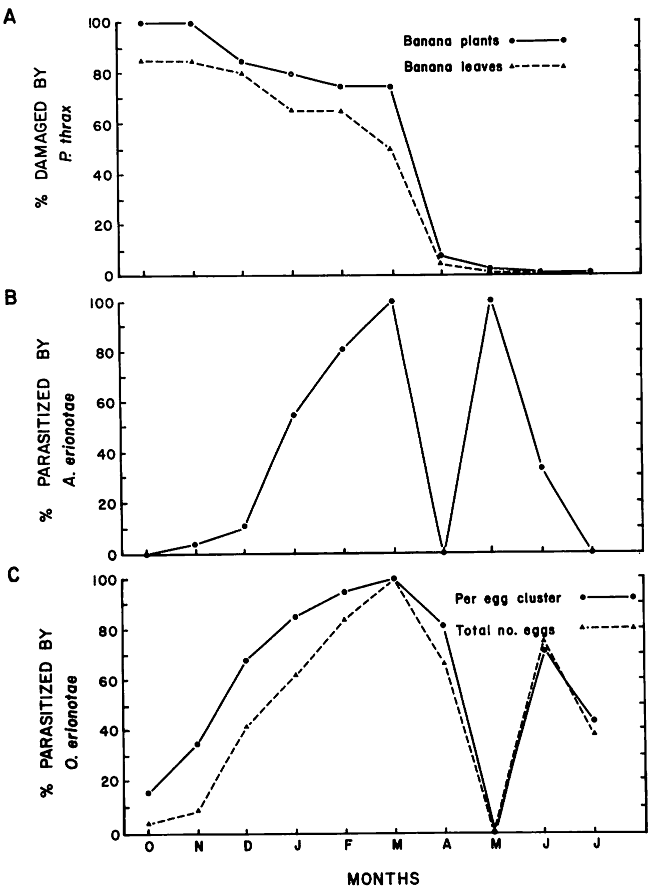

Fig. 3. Control of *Pelopidas thrax* (Linnaeus) at Waiahole, Oahu by *Apanteles erionotae* and *Ooencyrtus erionotae*. A, Estimated *P. thrax* damage; B, *A. erionotae* parasitism rate; C, *O. erionotae* parasitism rate.

Comparison of the results of egg larval parasitism and the monthly estimates of damage caused by the pest strongly indicated that the parasites were responsible for controlling *P. thrax* in the study area (Figure 3B, C). A significant inverse correlation was found in comparing % damaged leaves vs. % parasitized larvae (r = -0.98), and % damaged leaves vs. % parasitized eggs (r = -0.97) for the results from the first 6 months. Strong inverse correlations also existed between % damaged trees and % parasitism of eggs and larvae during the same period. Furthermore, overall damage estimates decreased greatly after maximum parasitization of eggs and larvae occurred and remained at a low level throughout the remaining months of the study. No large increase in *P. thrax* damage was detected by periodic surveys of the study site during the following year.

It is highly probable that a high degree of control would have also been achieved if only 1 of the 2 parasite species was introduced at the study site. According to the results, each parasite species was able to almost totally parasitize the respective host-stage throughout the area. Although typically cyclic rates of parasitism ensued after maximum parasitism was reached, no large increases in damage occurred.

Summary

Although *Pelopidas thrax* was a serious threat to the local banana industry, the establishment of *A. erionotae* and *O. erionotae* greatly reduced the importance of the pest. These natural enemies of the banana skipper were credited with providing a high degree of control in all areas of Hawaii. The parasites were effective in controlling widespread, heavy infestations and were also effective in preventing serious damage from developing in situations of low host density where banana skipper infestations had just begun to be noticed. As a result there were many localities in the State where severe damage to banana was prevented through timely releases of parasites. We believe that this control of *P. thrax* by two natural enemies constitutes another example of successful biological control of an introduced pest in Hawaii.

Acknowledgements

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References Cited

Davis, C.J. and K. Kawamura. 1975. Notes and exhibitions. Proc. Hawaii Entomol. Soc. 22 (1):21.

Nakao, H.K., G.Y. Funasaki, and C.J. Davis. 1975. Introductions for biological control in Hawaii, 1973. Proc. Hawaii. Entomol. Soc. 22 (1): 109-112.

Nakao, H.K. and G.Y. Funasaki. 1976. Introduction for biological control in Hawaii, 1974. Proc. Hawaii Entomol. Soc. 22 (2):329-331.