BIOLOGICAL CONTROL OF IVY GOURD, *COCCINIA GRANDIS* (CUCURBITACEAE), IN HAWAI'I

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Abstract. Three insect biological control agents collected in Kenya have been introduced into Hawai'i to combat the exotic weed ivy gourd (*Coccinia grandis)*. The clearwing moth, *Melittia oedipus*, was released in 1996. The larvae of this moth bore into the mature vines and roots of ivy gourd. It is now established in Hawai'i. Two additional agents, which belong to a group known as the African melon weevils, were released in 1999. The first, *Acythopeus burkhartorum*, forms galls on young shoots. The second, *A. cocciniae*, mines ivy gourd leaves. Aspects of the project, including host range testing are discussed.

Key words: *Acythopeus burkhartorum, Acythopeus cocciniae*, *Coccinia grandis,* Cucurbitaceae, Curculionidae, *Melittia oedipus*, Sesiidae

INTRODUCTION

Ivy gourd, *Coccinia grandis* (L.) Voigt (Violales, Cucurbitaceae), is an aggressive vine that has become a serious weed in lowland areas of Hawai'i, particularly on the island of O'ahu and on the Kona coast of the island of Hawai'i. It is native to Africa and has been present in the Indo-Malayan region of Asia for many centuries (Burkhart 1993, Singh 1990). It is also naturalized in parts of Australia, the Caribbean, the southern United States and several Pacific islands (Linney 1986, Telford 1990). Ivy gourd was first collected on the slopes of Punchbowl, Honolulu, in 1968 and its presence in the state can probably be attributed to several independent introductions by immigrants from Southeast Asia where ivy gourd is used for food and medicinal purposes (Nagata 1988). Though probably still used to some extent by Southeast Asian immigrants, the general public in Hawai'i has not adopted it as a common food item.

Ivy gourd is a dioecious perennial herb with tuberous roots and thick stems, which can grow to several meters in length and up to 12 cm in diameter. These succulent stems allow ivy gourd to survive defoliation caused by occasional outbreaks of powdery mildew and by the recent drought experienced in Hawai'i. It has white flowers and small cucumber-like fruits which turn red when ripe, making them attractive to birds who distribute the seeds to new locations.

During the 1970's and 80's, ivy gourd spread rapidly and began to blanket trees and other vegetation. Unlike weeds which flourish at higher elevations and escape widespread notice, the rampant growth of ivy gourd in residential neighborhoods and agricultural areas prompted many complaints from the general public and the Outdoor Circle, a volunteer organization devoted to maintaining the natural beauty of Hawai'i. The heavy vines hanging from telephone and electrical wires became a problem for utility companies. In addition, ivy gourd fruits were found to be an excellent host of the melon fly, *Bactrocera cucurbitae* (Coquillet) – (Diptera, Tephritidae). There was particular interest at the time in reducing or eliminating fruit flies to facilitate the export of Hawaiian agricultural crops. Proliferation of ivy gourd increased the melon fly population. In response to the above, there was legislative interest in finding a way to

control ivy gourd, and the Hawai'i Department of Agriculture (HDOA) began work on the project.

EXPLORATION

The vines and tuberous roots of ivy gourd were unresponsive to widespread application of herbicides, and mechanical management was prohibitively expensive. Consequently, the decision was made to look for biological control agents. In 1990, exploration had been planned for Southeast Asia to look for natural enemies of the insect pests *Thrips palmi* Karny (Thysanoptera, Thripidae) and the banana aphid *Pentalonia nigronervosa* Coquerel (Homoptera, Aphidae). Ivy gourd was added to the list of target species based on literature that considered Asia to be part of its native range and on consultations with Asian scientists who believed effective control agents were present in the region. However, all of the insects and diseases collected during subsequent work in Thailand, Malaysia, and Indonesia were known to attack other cucurbits and therefore were not considered for use in Hawai'i.

Two years later, exploration for natural enemies of ivy gourd shifted to Africa, the center of diversity for the genus *Coccinia* (Singh 1990). New information suggested that *C. grandis* is native to north central East Africa and perhaps Arabia (C. Jeffrey, pers. comm. to R. Burkhart). It likely moved into Asia in trade centuries ago. The other 29 species of *Coccinia* are confined to tropical Africa (Singh 1990). A list of collection localities for ivy gourd was obtained from the Kew Herbarium, London.

During the summer of 1992, Burkhart, HDOA exploratory entomologist, collected over 30 species of insects and several pathogens of ivy gourd in Kenya and Tanzania. Other cucurbits were examined and preliminary host range tests were conducted on promising species. Based on these tests and field observations, five insect species and three pathogens were selected as potential biological control agents and sent to Hawai'i for further testing.

HOST RANGE TESTING

All cucurbits found in Hawai'i were included in host specificity tests on the eight potential biological control agents. These included commercially grown cucurbit crops, naturalized weedy cucurbits, and representative species of the endemic genus *Sicyos* as listed by Telford (1990). Additional test plants included species in the Order Violales, several plant species of economic importance, and key endemic species that are major components of native Hawaiian ecosystems. Plants other than cucurbits that contain cucurbitacins, secondary plant compounds characteristic of the family Cucurbitaceae (Metcalf and Rhodes 1990), were not tested, since none of the listed species are known to occur in Hawai'i.

Early attempts to identify candidate insects met with failure, a problem common to many biological control projects when agents are collected in parts of the world with poorly known faunas. Eichlin (1995) identified the sesiid moth just as host range testing was completed. The identity of the two weevils was delayed until a systematist willing to help was located. An initial misidentification incorrectly placed them in the wrong genus resulting in our selecting the wrong plants for host screening. Eventually, they were described by O'Brien and Pakaluk (1998), and with the names provided, it was possible to apply for release.

Further delays were due to the time required for input and approval from multiple state and federal agencies. The length of time required for the process is unpredictable and may vary due to changing procedures and problems within the approving agencies. In the case of this project, it contributed to a three-year gap between the release of the

first agent and the last. The possibility of delays due to this unpredictability should be considered during the planning stage of a project, as they may add greatly to the cost and can tie up personnel and quarantine space for long periods of time.

RELEASE PHASE

Three of the eight African insect species that underwent host range testing were found to be host specific and were released in Hawai'i. The biology of the three insects and release information is presented below.

***Melittia oedipus* Oberthür (Lepidoptera: Sesiidae).**
Larvae of this clearwing moth feed inside mature stems and tuberous roots of ivy gourd. Adults are diurnal, emerging in the morning and mating soon thereafter. Females lay eggs soon after mating is completed and are most active in full sunlight. Eggs are laid singly on all parts of the ivy gourd plant, from ground level to vines covering the tops of trees. Newly hatched larvae bore immediately into the stems and are exposed only briefly. Larval development and pupation all take place within the vine, and adults emerge in two to four months. Other females are attracted to sites with previous infestations, and larvae of different sizes are commonly found in close proximity. Repeated attacks cause vines to break and decay. Other insects attracted to the decaying vines, such as the banana moth, *Opogona sacchari* (Bojer) – (Lepidoptera, Pyralidae), appear to increase the damage. *Melittia oedipus* was first released on the slopes of Punchbowl, O'ahu, in August 1966. From that date to August 1999, approximately 21,600 adults and 16,000 larvae were released on O`ahu. The moth is now well established and vines have thinned out substantially.

***Acythopeus burkhartorum* O'Brien (Coleoptera: Curculionidae)**
This small black beetle is part of a group known as the African melon weevils. Adult females lay their eggs in meristematic tissue at the tips of young shoots. As the shoot elongates, galls form at the juncture of the stem with leaves and tendrils. When mature, the larva excises the proximal end of the gall, causing it to fall from the plant. The larva seals this cut end with plant fibers obtained from the gall lining. It then turns and excises the other end, forming a smooth cylinder, 10-13 mm in length. Pupation takes place within this protective case, and the adult emerges three to four months later. Burkhart (1993) surmised that the long pupal stage is probably an adaptation for the long dry season in East Africa when suitable host plants are lacking. The adult weevils feed on young ivy gourd leaves but cause only minimal damage. While this species is not capable of killing ivy gourd, the galls are an energy sink and may slow down growth of young vines. It was first released in August 1999 in Waimanalo on the island of Oahu and in December 1999 in Kailua-Kona on the island of Hawai'i.

***Acythopeus cocciniae* O'Brien (Coleoptera: Curculionidae).**
This weevil is similar in appearance to *A. burkhartorum* but is smaller, being only 2 to 2.5 mm in length, versus 5 to 6 mm for *A. burkhartorum*. *A. cocciniae* develops as a leafminer in ivy gourd leaves. Developmental time is approximately 33 days from oviposition to adult emergence. The adults also feed on the leaves. Combined damage from larval and adult feeding can be quite severe. *Acythopeus cocciniae* was first released on O'ahu in November 1999 and in Kona one month later. It has been recovered at all release sites on both islands.

BIOTIC INTERFERENCE

One of the concerns with any potential biological control agent is the likelihood that natural enemies will attack the agent itself. In the case of *Melittia oedipus*, there was concern that a moth might not be effective, as lepidopterans in Hawai'i are often heavily attacked by parasitoids. However, a reference to sesiid pest species in North America noted that they are not well controlled by natural enemies (Solomon 1995). In particular, there was no mention of attack by *Trichogramma* spp., egg parasitoids that have been a limiting factor for many Lepidoptera in Hawai'i. This may be due to the unusually thick chorion of sesiid eggs. In Africa, parasitism of specimens collected by Burkhart was light and only a few specimens of a large braconid, *Hyrtanommatium crassum* Enderlein (Hymenoptera, Braconidae), emerged from several pupae (Burkhart 1993). Neither this species nor any congeners occur in Hawai'i and, so far, none of the field-collected larvae, or pupae has shown any signs of attack by parasitoids. However, in 2001, a few male eupelmids (*Eupelmus* sp. – Hymenoptera, Eupelmidae) were reared from field-collected eggs.

Ants were anticipated predators of immature stages of the moth. Some field-collected eggs show signs of predation, and it is probable that ants kill neonate larvae as they emerge from the egg. However, once larvae bore into the stem, they are relatively well protected, as entrance holes are blocked by frass.

A factor not considered prior to release was the high rat population present in the Hawaiian Islands. Since the laboratory rearing of *M. oedipus* is labor intensive and HDOA personnel and laboratory space are limited, initially it was thought that larval releases would be the most efficient means of getting large numbers of moths into the field. Concentrated numbers were placed in close proximity to increase the probability of emerging adults finding mates. This technique was effective at first. However, rats soon discovered this new food source and tore open vines to extract the larvae. The moth, however, became established, but the high rate of predation impeded a rapid population buildup. We therefore switched to releasing adults instead of larvae since female moths can scatter eggs over a wide area and the rats find a lower percentage of the immatures.

It is still too early to determine how detrimental natural enemies will be to populations of the two *Acythopeus* weevils. In Kenya, both weevils were commonly found early in the wet season in May. However, by the beginning of the dry season in September 40-50% of the leafminers, and almost 100% of the gall-formers, were parasitized (Burkhart 1993). A eurytomid (*Eurytoma* sp. - Hymenoptera, Eurytomidae) and a eupelmid (*Neanastatus* sp. prob. *rufatus* Ferriere – Hymenoptera, Eupelmidae) were collected from parasitized galls. Neither of these two parasitoid species occurs in Hawai'i. However, *Eupelmus cushmani* (Crawford) (Hymenoptera, Eupelmidae), has been reared from *A. coccinae* on both O'ahu and Hawai'i, and birds appear to be opening *A. burkhartorum* galls. In addition, there is a likelihood that the melon fly will oviposit in these galls (M. Ramadan, pers. comm.).

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