Field Release of *Melittia oedipus* (Lepidoptera: Sesiidae) for Biological Control of Ivy Gourd, *Coccinia grandis* (Cucurbitaceae), in Hawaii

Environmental Assessment

July 1996

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I. Proposed Action--Description and Statement of Need

The Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) has received an application (Appendix 1) from the Hawaii State Department of Agriculture for a permit to release an exotic moth, *Melittia oedipus* Oberthur (Lepidoptera: Sesiidae), in Hawaii. Larvae of the moth bore in stems and roots of ivy gourd, *Coccinia grandis* (L.), a weedy vine in the family Cucurbitaceae.

M. oedipus was collected from Diani Beach, Kenya in 1992 and shipped to the quarantine laboratory of the Hawaii State Department of Agriculture in Honolulu. A quarantine colony was established, parasitic insects and mites were screened out, and host-specificity tests were conducted until 1996.

The moths will be released first into field cages near Waimanalo on the windward side of the island of Oahu. As populations build, about 500 adults moths per month will be collected from the cages and released at increasing distances from Waimanalo. New colonies will be started at Punchbowl in Honolulu and at various sites on the leeward coast of Oahu. Eventually, releases will be made on the Kona coast of the island of Hawaii. To supplement releases of adults, laboratory-reared eggs and larvae contained in pieces of ivy gourd stems will be attached to ivy gourd vines. Immature stages will be released first into field cages, then into the environment. Most free releases will be made during the favorable season for establishment, June through October.

The species identity of specimens collected in Kenya has been determined by Dr. Thomas D. Eichlin, California Department of Food and Agriculture. Voucher specimens have been deposited in the collection of the Hawaii Department of Agriculture, Honolulu, HI; the Bernice P. Bishop Museum, Honolulu, HI; and the U. S. National Museum in Washington, DC.

The pending application was submitted in accordance with the Federal Plant Pest Act (7 USC 150aa *et seq.*) and the Plant Quarantine Act (7 USC 151aa *et seq.*). This EA was prepared in compliance with the National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*) as described in implementing regulations adopted by the Council on Environmental Quality (40 CFR 1500-1509), by USDA (7 CFR 1b), and by APHIS (7 CFR 372).

The purpose of the proposed releases of *M. oedipus* is to reduce infestations of ivy gourd, a State-listed noxious weed. In lowland areas ivy gourd forms a dense canopy over trees and understory vegetation. The weed also covers fences, utility lines, and cultivated fields. Ivy gourd fruits serve as reservoirs for major fruit fly pests--the melon fly, *Bactrocera cucurbitae* (Coquillett), and the oriental fruit fly, *Bactrocera dorsalis* (Hendel). Important field crop pests such as melon aphid (*Aphis gossypii*), melon thrips (*Thrips palmi*), spider mites (*Tetranychus* spp.), and whiteflies utilize ivy gourd as an alternate host, as do certain disease agents such as powdery mildew fungus and cucumber mosaic virus.

II. Alternative to the Proposed Action

The "no-action" alternative to issuing a permit for the release of *M. oedipus* is to deny the permit. If the permit is denied, chemical and mechanical methods will continue to be used for the control of ivy gourd.

III. Environmental Impacts of the Proposed Action and Alternative

The intended environmental impact of the proposed action is a reduction in severity of infestations of ivy gourd with consequent recovery of forests and associated flora and fauna. It is also expected that economic costs and environmental contamination associated with chemical control of the weed will decline.

If a permit is not issued for the release of *M. oedipus*, applications of chemical herbicides will continue. Since herbicides cannot be applied in large amounts in Hawaii because of high risks to native plants and associated animals, herbicidal control is largely ineffective. Consequently, the denial of a permit to release *M. oedipus* implies damage to native plant and animal communities by invasions of ivy gourd.

The proposed introduction of an exotic, plant-feeding insect into Hawaii raises the question of environmental safety since *M. oedipus* conceivably might damage nontarget plants. Evidence for the host-specificity of *M. oedipus* comes from published literature on the family Sesiidae and the genus *Melittia*, collection records of *M. oedipus* in East Africa, and laboratory tests conducted on diverse

plant species in Hawaii.

Most species of Sesiidae are specific to a single plant genus or family (Brown & Mizell, 1993; Eichlin, 1995; Heppner, 1987). All known species of *Melittia* bore in the vines or underground tuberous roots of Cucurbitaceae (Eichlin, 1975; Eichlin & Duckworth, 1988; Englehardt, 1946). Reliable host-specificity information is available for the eight *Melittia* species indicated in Table 1. Seven of these attack hosts in a single genus, while only one (*M. gloriosa*) attacks hosts in two genera. The number of species attacked ranges from one to eight.

Table 1. No. genera and species of hosts utilized by eight species of *Melittia*.[1]

Melittia sp.	No. host genera	No. host species
M. calabaza	1	8
M. cucurbitaceae	1	8
M. eichlini	1	1
M. gloriosa	2	4
M. grandis	1	1
M. magnifica	1	1
M. oedipus	1	1
M. snowii	1	1

[1]Compiled from Eichlin & Duckworth (1988), Howe (1950), Howe & Rhodes (1973).

Ivy gourd is the only known host of *M. oedipus* in the insect's native home, East Africa.

HOST-SPECIFICITY TESTS OF *MELITTIA OEDIPUS*

Species tested

Nineteen species of Cucurbitaceae including all 14 cultivated and naturalized species in Hawaii, four native species of *Sicyos*, and ivy gourd were subjected to oviposition and larval feeding tests in the quarantine insectary of the Hawaii

Department of Agriculture (Table 2).

Table 2. Species of Cucurbitaceae used in host-specificity tests

Tribe	Species
Benincaseae	*Benincasa hispida* (wax gourd), *Citrullus lanatus* (watermelon), *Coccinia grandis* (ivy gourd), *Lagenaria siceraria* (bottle gourd, ipu), *Luffa acutangula* (seequa), *L. aegyptiaca* (sponge gourd).
Cucurbiteae	*Cucurbita maxima* (hubbard squash), *C. moschata* (butternut squash), *C. pepo* (summer crookneck, pumpkin, zucchini).
Joliffieae	*Momordica charantia* (bitter melon).
Melothrieae	*Cucumis dipsaceus* (wild cucumber), *C. melo* (oriental pickling melon, honeydew melon, and cantaloupe), *C. sativus* (cucumber).
Sicyeae	*Sechium edule* (chayote), *Sicyos erostratus*, *S. hispidis*, *S. pachycarpus*, *S. waimanaloensis*.
Trichosantheae	*Trichosanthes anguina* (snake gourd).

Additionally, 18 species in other families were tested, including taxonomically unrelated crop plants that grow adjacent to ivy gourd, plants morphologically similar to ivy gourd, and several endemic Hawaiian species (marked with asterisk) that are placed with Cucurbitaceae in the order Violales. Oviposition choice tests: Apocynaceae, Aristolochiaceae, Begoniaceae, Caricaceae (*Carica papaya*), Convolvulaceae, Passifloraceae (*Passiflora edulis*), Turneraceae (*Turnera ulmifolia*), and Violaceae (*Viola* sp.). Larval feeding tests: Apiaceae, Brassicaceae, Fabaceae, Flacourtiaceae (**Xylosma hawaiiense*), Solanaceae, and Violaceae (**Isodendrion laurifolium*, **Viola chamissoniana*).

Experimental design

Oviposition, choice tests: In each test, one potted ivy gourd plant and one test plant were confined with 25 female adults and at least 25 male adults of *M.*

oedipus. Cucumbers were tested five times in small (91 cm x 46 cm x 64 cm) cages and five times in large (1.83 m^3) cages to determined the effects of cage size on ovipositional behavior; tests of all other cucurbits were replicated five times in small cages. Choice tests of plants in other families were replicated from one to four times. **Oviposition, no-choice tests:** One potted ivy gourd plant and one potted cucumber plant were each confined in separate cages with five female and eight male adult moths. Tests were replicated nine times. **Larval feeding tests:** All eggs deposited on plants during oviposition tests were left in place, and additional eggs were transferred as necessary from ivy gourd to test plants to bring the total number of eggs/replication up to 30. Eggs were also transferred from ivy gourd to cut or potted plants of the above-listed non-cucurbit species that had not been subjected to oviposition tests.

Results

Results of all tests are summarized in Table 3.

Table 3. Results of host specificity tests: No. of eggs (as % of total) on different plant species and cage surfaces, amounts of larval feeding, and extent of larval development.

Type of test	Ivy gourd	cucumber	Other cucurbits	Other plant families	Cage
Oviposition, choice	87.4%	0.2 %[1]	--	--	12.4%
	88.8%	0.03%[2]	--	--	11.2%[3]
	82.7%	--	0.5%	--	16.8%
	84.5%	--	--	0.4%	15.1%
Oviposition, no-choice	--	4.5%	--	--	95.5%
	84.9%	--	--	--	15.1%
Larval feeding	Heavy	Light-to-moderate	None-to-light[4]	None	--
Larval development	Generally complete	Generally incomplete[5]	None or incomplete	None	--

[1] Percentage of eggs deposited on cucumber in small cage (0.3m^3).

[2]Percentage of eggs deposited on cucumber in large cage (1.8m^3).
[3]Line figures round to slightly more than 100%.
[4]Light feeding: *Cucumis melo* only. Very light feeding: *Benincasa*, *Cucurbita*, *Sechium*, and *Sicyos* only.
[5]2% of larvae completed development.

Cucumber was the only nontarget species which supported complete larval development of any test larvae. In general, feeding on cucumber was only light-to-moderate, and most of the larvae died in early instars. In oviposition choice tests conducted in large cages, cucumber was unsuitable as an oviposition substrate. In no-choice tests, cucumbers in small cages received only 4.5% of the deposited eggs versus 84.9% on ivy gourd (amount of oviposition on non-host plants generally decreases as cage size increases). Nevertheless, since individual cucumber vines might be killed by larval feeding, it is reasonable to ask whether or not *M. oedipus* larvae might, under intense population pressure, transfer from ivy gourd to cucumbers. Some caterpillars (*e.g.*, *Spodoptera* spp.) disperse over long distances. Three pieces of evidence relate to the possible danger of dispersal: (1) Howe (1949) found that larvae of the squash vine borer, *Melittia cucurbitae*, did not disperse from one hill of squash to another. (2) Exploratory work in East Africa revealed no incidents of attacks on cultivated or wild cucurbits by *M. oedipus*. This evidence is particularly compelling since ivy gourd frequently grows near vegetable crops in that region. (3) In the United States, cucumber and other cucurbits generally are subjected to heavy pesticide treatments for the control of aphids, whiteflies, fruit flies, thrips, leaf miners, and spider mites. Treatments for these pests would be expected to limit any incidental damage by *M. oedipus*.

Feeding on the cucurbits *Benincasa*, *Cucurbita*, *Sechium*, and *Sicyos* was very light, and no larvae developed further than the second instar. Furthermore, oviposition was as low on plants in these genera as it was on plants in other tested genera. Laboratory tests therefore support field data indicating that *M. oedipus* is monophagous. A full account of host specificity tests, a complete list of references, and other information concerning *M. oedipus* are provided by Chun (1996).

Field observations and test results indicate that release of *M. oedipus* poses no risk to threatened and endangered species of plants in Hawaii. No species of Cucurbitaceae are federally listed as threatened or endangered. One cucurbit, *Sicyos alba*, has been proposed for listing. Both *S. alba* and ivy gourd occur on the island of Hawaii, but *S. alba* is restricted to wet forests at elevations of 1,000 m to 1,600 m on the windward slopes of Mauna Kea, Mauna Loa, and Kilauea, whereas ivy gourd occurs only at low elevations (sea level to ca. 245 m) on the Kona Coast. Average temperatures at higher elevations in wet forests are too low for populations

of *M. oedipus* to survive. Activity of the moth slows at temperatures under 30°C. and is halted below 25°C. Average maximum annual temperatures in the wet forest are much lower. For example, at Univ. Hawaii Volcano Experiment Station, 1,200 m elevation, temperatures do not exceed 20°C. Thus, the temperature requirements of *M. oedipus* are expected to exclude the species from the habitat of *S. alba*. The host-specificity tests already discussed provide additional evidence that *M. oedipus* poses no threat to *S. alba*.

Six native, nonendangered species of *Sicyos* occur in the relatively warm areas of Hawaii into which *M. oedipus* is expected to spread. Although all available evidence indicates that these species are highly unlikely to be attacked by *M. oedipus,* the small risk of serious damage to *Sicyos* species could be mitigated by (1) identifying *Sicyos* populations located nearest the initial insect release sites, (2) monitoring the plants at least monthly for at least one year, and (3) if necessary, eradicating *M. oedipus* by treating release sites and entire neighboring stands of *Sicyos* with a biological pesticide such as *Bacillus thuringiensis*.

The biological characteristics of *M. oedipus* preclude any direct impacts on human health.

It seems unlikely that *M. oedipus* would enter the continental United States from Hawaii since the insect does not attack crop plants and therefore would not be transported on them.

In summary, all available evidence indicates that *M. oedipus* is safe to introduce into Hawaii. Both field observations and laboratory tests strongly suggest that *M. oedipus* is monophagous. Release of this insect is the preferred alternative to no release with consequent continuing destruction of Hawaiian forests.

V. References

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VI. List of Preparators, Consultants, and Reviewers

This environmental assessment was prepared by (listed alphabetically) **Ronald D. Hennessey**, USDA--APHIS, Riverdale, MD, and **Pat Conant**, Hawaii Department of Agriculture, Honolulu, HI. It was based largely on a release petition submitted to the Hawaii Department of Agriculture by **M. E. Chun**. The following people and agencies in Hawaii were consulted during the preparation of that petition:

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Hawaii Dept. Agriculture, Advisory Subcommittee on Entomology: **Vincent Chang**, Hawaiian Sugar Planters' Assoc., Honolulu; **Arnold H. Hara**, Ph.D., Dept. Entomology, Univ. Hawaii, Hilo; **Francis Howarth**, Ph.D., Dept. Entomology, Bernice P. Bishop Museum, Honolulu; **Scott Miller**, Ph.D., Dept. Entomology, Bernice P. Bishop Museum, Honolulu; **Wallace C. Mitchell**, Ph.D., Dept. Entomology, Univ. Hawaii at Manoa, Honolulu; **Kenneth Teramoto**, Hawaii Dept. Agric., Honolulu.

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VII. Appendix

Appendix 1. Application for permit to release *Melittia oedipus* in Hawaii.