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A Preliminary Study on the Flight Ability of the Sweetpotato Weevil, *Cylas formicarius* (FABRICIUS) (Coleoptera: Apionidae) Using a Flight Mill¹

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A new experimental project has just started in Okinawa Pref., Japan, to eradicate *Cylas formicarius* (FABRICIUS) and *Euscepes postfasciatus* (FAIRMAIRE), both of which are important pests of sweet potatoes, *Ipomoea batatas* (L.) LAM., by using sterile insect technique (SIT). Assessment of the dispersal ability of the target insect is one of the fundamental problems of the SIT program, but little information is available now on this subject. Therefore, methods for measurement of their dispersal ability must be developed as soon as possible. *E. postfasciatus* has no ability to fly (RAMAN and ALLEYNE, 1991). A simple flight mill system was assembled to confirm whether flight ability of *C. formicarius* could be measured by the flight mill method. This study also aimed to elucidate technical difficulties in handling small insects in the further expansion of the flight mill system.

MATERIALS AND METHODS

Adults of *C. formicarius* from one to four weeks after the exodus from sweetpotato tubers were used for the experiment. They were randomly chosen from a stock culture that had been maintained since April 1993 at room temperature conditions and supplied only with sweetpotato tubers. The original population of the stock culture was collected in sweetpotato

fields in the central part of Okinawa Island in September 1989 and then reared successfully at $25 \pm 1^\circ\text{C}$, 14L-10D on sweet potatoes (cultivar: Beniazuma).

A flight mill described by NAKAMORI and SIMIZU (1983) and MORIYA (1987) was modified to fit the specific conditions of *C. formicarius*. In principle, materials in this system were the same as those used by NAKAMORI and SIMIZU (1983). Length of the flight mill arm was 8 cm, and was determined by a pre-experimental test. Eight sets of flight mills shown in Fig. 1 were placed in a walk-in chamber at $27 \pm 2^\circ\text{C}$, 14L-10D. Each flight mill was confined in a plastic container (Fig. 1A) to prevent it from rotating irregularly by air flow in the chamber. An insect tested was tethered to the flight mill with chloroprene cement, Bond G17® (Fig. 1C). A set of photoelectric switches (OMRON OPE-S10D) in the container detected rotation of the flight mill, and the total number of revolutions was recorded by a magnetic counter (OMRON CSK6-YW) connected with the photoelectric switch through an amplifier (OMRON OPE-

Fig. 1. Schematic diagram of the flight mill system. A: container in which the flight mill is placed, B: piece of an insect pin, C: tethered insect, D: set of two magnets, E: axis made of an iron needle, F: rotor made of bamboo stick, G: set of photoelectric switches, light source and receiver, H: infra-red ray beam emitted by light source, I: amplifier, J: solid state relay, K: magnetic counter.

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VB) and a relay (OMRON G3A-210B). Measurement was usually started between 13:00 and 16:00 and finished after 24 h. All the individuals were measured only once.

RESULTS AND DISCUSSION

Since the weevil is relatively small in size, especially with its narrow pronotum width, some experimentation was necessary to find ways to tether the insect in its correct position with a minimum amount of glue. The tethered weevil could not fly if too much glue was applied, or it could detach during the period of measurement if the glue was inadequate. A prototype of a flight mill was 16 cm in length, but it was too big and/or heavy for the insects to rotate it by their flight. The flight mill length was therefore reduced to 8 cm.

Average flight distance calculated from the number of revolutions of the flight mill is shown in Table 1. It is quite evident that male weevils flew much longer than females. But these values, far less than 50 m on average, were very small compared with those of other insects. Melon flies, *Bactrocera cucurbitae*, could fly more than 2,000 m in the flight mill without a break (NAKAMORI and SIMIZU, 1983). I noted that the longest flight distance of 823 m recorded by the male adult weevil was fairly consistent with the values of 300–1,000 m obtained by the mark-and-recapture experiments in the field that used synthetic pheromone traps (JANSSON et al., 1991; YASUDA et al., 1992; MIYATAKE et al., unpubl.). This indicates that the result of this flight mill experiment gave a good estimation of the flight ability of the weevils in the field.

Figure 2 shows frequency distribution of the flight distance of the weevils. It was noted that nearly 50% of males and 95% of females tested never flew at all. Although no definite conclusions can yet be made later, two possibilities can be pointed out. First, there would be two groups, non-fliers and fliers in male adults. Secondly, females might disperse mainly not by flying but by crawling on the ground. Since no simple effective method was actually available to investigate field populations of *C. formicarius* except for using traps with sex pheromone (and these only attract males) (HEATH et al., 1986; PROSHOLD et al., 1986), problems arise from differences between dispersal abilities of males and females not only in flying but also in walking (MORIYA, 1994).

In the present study, the system was so simple that only the total accumulated flight distance during the testing period was obtained. But the results of this

Table 1. Flight distance of *Cylas formicarius* measured by the flight mill

	Male	Female
No. observed	108	116
Average flight distance (m) ^a	40.8	0.2
Standard error	11.6	0.1
Maximum flight distance (m)	823.0	17.5

^a $p < 0.001$ between the sexes (*U*-test).

Fig. 2. Frequency distribution of flight distances (m) of *Cylas formicarius*. Outer ring: males ($n=108$), inner ring: females ($n=116$). Numerals in the chart indicate percentages in each interval.

experiment proved that the flight ability of *C. formicarius* could be evaluated by using the flight mill system. Therefore the system must be improved, by the introduction of computer-interfaced devices, to be able to automatically measure various parameters of the flight ability. This includes flight time, flight speed, duration of longest flight distance, and day periodicity of flight frequency.

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Screening Plants Resistant to Green Peach Aphid, *Myzus persicae* (SULZER) (Homoptera: Aphididae)¹

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In tobacco culture, green peach aphid, *Myzus persicae* (SULZER), is an important vector of potato virus Y necrotic strain (PVY-T), and sometimes seriously damages tobacco plants. It is polyphagous, and attacks ca. 100 plant species in Japan (HIGUCHI and MIYAZAKI, 1969). Since this virus is nonpersistent (both the acquisition feeding and inoculation feeding periods are shorter than in persistent viruses) and easily transmitted by aphid probing, it is difficult to prevent primary infection of the virus with insecticides. Development of resistance to insecticides in aphids poses another difficulty.

Various bio-active substances, not only attractants but also antifeedants, repellents etc., exist in plant chemicals. For instance, (–)-warburganal from *Warburgia ugandensis*, and (–)-polygodial from *Polygonum hydropiper* are antifeedants against aphids. The latter decreased acquisition of PVY and beet yellows virus (BYV) in the laboratory (GRIFFITHS et al., 1989). SHAYYA et al. (1991) reported the insecticidal activities of some essential oils in aromatic plants. In agriculture, interplanting of odorous plants, for example garlic, leek and basil, is said to deter migration and reproduction of insect pests.

Plant chemicals interfere with aphids ecology in many ways. As a whole, this interference defines the identity of the non-host against certain aphids. It therefore seems logical to seek bio-actives among non-host plants. Non-host plants of *M. persicae* have been rather poorly examined so far from this point of view. In this paper we appraised the value of plant as non-hosts by comparing the settling and reproduction of *M. persicae* on 34 aromatic plants.

MATERIALS AND METHODS

Insects and plants. Aphids used for experiments were from a stock culture of *M. persicae* (SULZER) maintained on *Nicotiana tabacum* at 20°C in the greenhouse. Potted test plants were grown at 25°C in the greenhouse. Well-developed plants were used for experiments.

Experiment 1. Reproduction of adult alatae. A small open vial confining 50 adult alatae was placed and left in a breeding cage (35 × 35 × 50 cm) for the alatae to settle and feed on a potted test plant at 20°C in the greenhouse. Numbers of all surviving aphids on each plant were counted as the reproductive index on each plant species 15 d after the release.

Experiment 2. Settling and reproduction of adult apterae. Ten adult apterae were transferred from the stock culture with a writing brush onto the leaves of each potted test plant of 28 plant species that were chosen by experiment 1. Numbers of the aphids settling on the plant were counted every day during the first 5 d and 15 d after the release.

Experiment 3. Feeding behavior. Feeding behavior of aphids on the potted plants of species that were selected on the basis of results of experiments 1 and 2 was measured with EMIF (electronic measurement of insect feeding behavior). Electrically conductive paint (Dotite, Fujikura Kasei Co., Japan) was used for attaching a fine gold wire to the aphid dorsum, after removing the wings with dissecting scissors. The

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