A Teflon®-walled mating table for assessing pheromone-based mating disruption

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ABSTRACT

A Teflon®-walled mating table to assess pheromone-based mating disruption of lepidoptera was constructed and field-tested using the eyespotted bud moth, *Spilonota ocellana* (Denis and Schiffermüller) (Lepidoptera: Tortricidae), in an apple orchard in the Okanagan Valley of British Columbia. Sentinel females were placed individually on mating tables on eight different nights during July 1996. The percentage of mated females ranged from 20-100%, with an average of 55.8% (n = 47). One female died and only three escaped. Females of the obliquebanded leafroller, *Choristoneura rosaceana* (Harris), also mated when placed on the tables in the field, suggesting that the table may have potential for use with many species, particularly those that are too small to be tethered.

Key words: mating table, pheromone-based mating disruption, sentinel female, *Spilonota ocellana*, *Choristoneura rosaceana*

INTRODUCTION

Several methods have been used to assess pheromone-based mating disruption of lepidoptera (Roelofs and Novak 1981, Rothschild 1981, Lingren *et al.* 1981), including mating cages (Fitzpatrick and Troubridge 1993), tethered sentinel or decoy virgin females that mate with wild or released males (Alford and Silk 1983, Cardé *et al.* 1977, Suckling and Shaw 1992, Rothschild 1981), and clipped-wing sentinel females placed on mating tables (Brooks *et al.* 1979, Lingren *et al.* 1981, Flint and Merkle 1983; 1984a; b, Niwa *et al.* 1988, Jenkins *et al.* 1990, Shaver and Brown 1993). During our study on pheromone-based mating disruption of eyespotted bud moth (ESBM), *Spilonota ocellana* (Denis and Schiffermüller) (Lepidoptera: Tortricidae), we focused on the use of mating tables to assess the mating status of sentinel females. This insect is a pest of apples and cherries in the Okanagan Valley of British Columbia and other fruit-growing areas in the northern hemisphere (Weires and Riedl 1991). Tethering is difficult with this small moth (length = 8 mm) and entry into a trap may interfere with mating. Escape of clipped-wing females from mating tables can be impeded by application of metal strips (Snow *et al.* 1976, Shaver and Brown 1993), talcum powder (Snow *et al.* 1976, Niwa *et al.* 1988) or petroleum jelly (Curtis *et al.* 1985) to the inner rim of the mating station. However, none of these techniques was effective for ESBM. We report the design and field-testing of a Teflon®-walled mating table for assessing the mating success of virgin sentinel female ESBM in apple orchards. The suitability of this table for the obliquebanded leafroller (OBLR), *Choristoneura rosaceana* (Harris) (Lepidoptera: Tortricidae), was also examined as part of our effort to control this pest with pheromone.

MATERIALS AND METHODS

Mating table design. Each mating table (Fig. 1) was designed to hold an individual sentinel female but more could be accommodated. A roof (14 x 17 cm) and base (18.5 x 9 cm) with a 2.5 cm high rim were cut from tops of wing traps (Phero Tech Inc., Delta, B.C.). A 28 cm length of Teflon® insect barrier tape (Consep®, Inc., Bend OR) was formed into a cylinder (8 cm diam. x 5 cm high) with the Teflon® side in. The ends were secured by duct tape, and a cylinder was glued to the base of each table using a glue gun. Backing on the barrier tape was not removed. Two circular drainage holes (1 cm diam.) were punched in the base outside the cylinder of Teflon® tape. Two 40-cm long pieces of stiff wire (1.5 mm diam.) attached the base to the roof, and were twisted together above the roof for attachment to a tree branch. To prevent horizontal movement in the wind, the base of each table was secured to surrounding branches using string or wire.

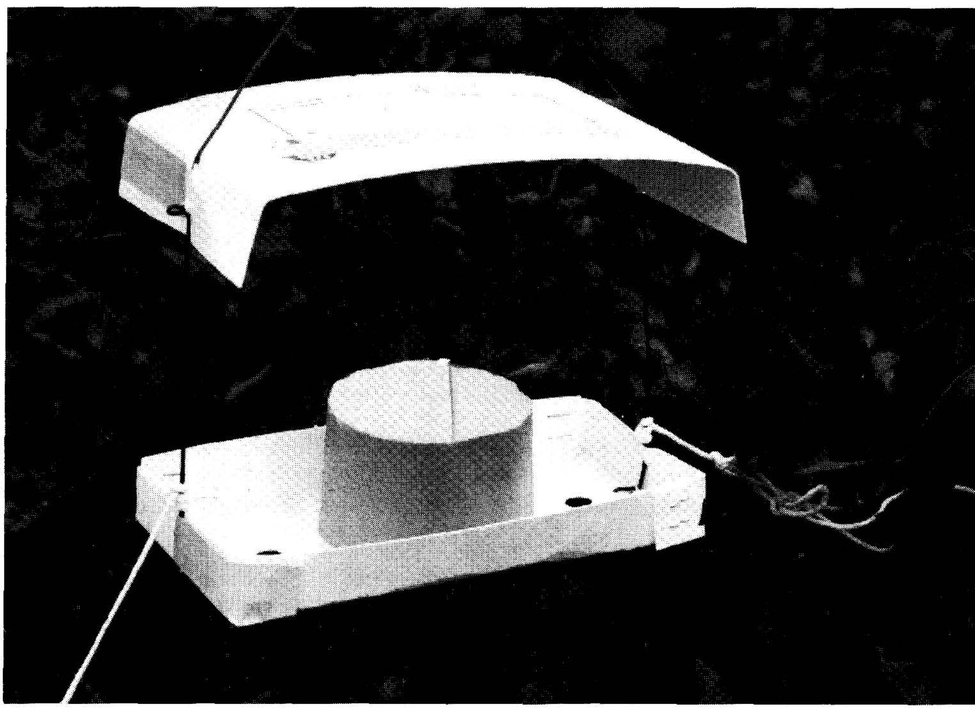

Figure 1. Mating table hanging in an orchard. Inner cylinder is 5 cm high.

Sentinel females. In May 1996, ESBM larvae were collected from an unsprayed apple orchard at the Pacific Agri-Food Research Centre (PARC) in Summerland, B.C. Larvae were reared on a diet of apple leaves in 59.1 ml plastic cups (two larvae per cup) in the laboratory at 20°C (± 0.5°C) and a light regime of 16:8 (L:D). Female pupae were isolated individually in 150 ml clear plastic cups and adults were provided with water. One- to 4-d-old females were used in field trials. Sentinel female OBLR were obtained from a laboratory colony reared on a pinto bean-based artificial diet at 24°C (± 0.5°C) and a light regime of 16:8 (L:D). Female pupae and adults were treated as described for ESBM.

One third of one forewing of each moth was removed using fine scissors to prevent flight. Moths were chilled at 0°C (± 0.5°C) for 30 min before and during wing clipping, and transported to the field in refrigerated containers.

Field trials. Trials were run in July 1995 and 1996 in three unsprayed blocks of semi-dwarf apple trees at the PARC entomology orchard in Summerland. Mating tables were hung about 2 m above ground. Clipped-wing females were placed on tables shortly before dusk, removed by 09:00 PDT the following day, and dissected in the laboratory to check for the presence of spermatophores in the bursa copulatrix. One moth was placed on each table. Three to eight female ESBM were placed on mating tables on eight different nights in July 1996 for a total of 47 insects, and five OBLR females were tested on 24 July 1995.

Hourly air temperatures in the orchard were recorded using a DP-212 Datapod (Omnidata International, Logan, UT) housed in a standard Stevenson screen. The average hourly temperature at dusk (18:00 to 22:00 PDT) was calculated for each trial.

RESULTS AND DISCUSSION

Each of the five OBLR females placed on mating tables was mated and none escaped. The mean hourly air temperature at dusk during the trial was 22.6°C. Mating of ESBM over the eight nights in July 1996 ranged from 20 to 100%, and there was no clear relationship between dusk temperature and their mating success (Table 1). Catches of male ESBM in pheromone-baited traps in an adjacent unsprayed orchard (H.L. McBrien, unpublished data) showed that 10, 50, and 90% of total trap catch during the 1996 flight occurred on 29 June, 15 July, and 1 August, respectively. Thus, low population densities of wild male ESBM during the last week of the field trials probably contributed to the low percentage of mated sentinel females. The proportion of mated sentinel females may be improved by placing host vegetation on tables to provide shelter and a perch for calling (Snow *et al.* 1976, Brooks *et al.* 1979, Flint and Merkle 1983; 1984a; b, Niwa *et al.* 1988, Jenkins *et al.* 1990, Shaver and Brown 1993). This was not done here because contact of materials with the surface of Teflon® tape decreases its effectiveness.

Table 1.

Numbers of female *Spilonota ocellana* deployed, recovered, mated, escaped, and dead in Teflon®-walled mating tables hung in apple orchards. Mean hourly air temperatures (T) at dusk (18:00-22:00 PDT) during July 1996, Summerland, B.C.

Date	T (°C)	Females tested	Recovered alive	Number mated	% mated	Number escaped	Number dead
4 July	16.6	6	6	2	30	0	0
9 July	20.8	3	3	3	100	0	0
16 July	21.9	6	5	4	80	0	1
17 July	11.6	6	5	5	100	1	0
22 July	21.2	5	5	3	60	0	0
25 July	23.2	5	4	2	50	1	0
26 July	23.3	5	5	1	20	0	0
31 July	20.4	11	10	4	40	1	0
Total		47	43	24	55.8	3	1

One female ESBM died during the field trials (Table 1). When removed, it had no signs of attack by a predator, and may have died because of injury during handling. On one occasion, a spider was found attacking a female ESBM, but dissection to check for spermatophores was still possible. If the spider had crawled into the Teflon® cylinder, this might have been prevented by having a Teflon® surface on the outside of the cylinder, as well as on the inside. Only three ESBM females escaped during the trials (Table 1). These were probably either blown out by the wind, or they crawled up the seam in the cylinder of Teflon® barrier tape, although inspection of the tables determined the latter to be unlikely.

The range in the percentage of female ESBM mated each night during our study (Table 1) is comparable to that obtained for pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae) (Flint and Merkle 1983; 1984a; b) and tomato pinworm, *Keiferia lycopersicella* (Walsingham) (Lepidoptera: Gelechiidae) (Jenkins *et al.* 1990) on mating tables in nontreated control plots during studies on pheromone-based mating disruption. The overall recovery of female ESBM from our study was 91.5% (Table 1). This falls within the range reported for other studies, which varied from 52% (Flint and Merkle 1983; 1984b) to almost complete recovery (Niwa *et al.* 1988, Shaver and Brown 1993).

If the Teflon®-walled mating tables are handled so that the surface of the tape is not damaged and the duration of exposure to field conditions, particularly rain, is kept to a minimum, they can be used several times. The base and roof of the tables last longer than the insect barrier tape, but the latter can be quickly replaced if necessary. Mating tables made of materials such as ice cream cartons attached to stakes (Lingren *et al.* 1981) or plywood and galvanized flashing (Shaver and Brown 1993) may be easier to handle and probably last longer under field conditions. However, clipped-wing ESBM crawled out of tables made from these materials. Teflon®-walled mating tables do not require the addition of substances such as talcum powder (Snow *et al.* 1976, Niwa *et al.* 1988) or petroleum jelly (Curtis *et al.* 1985), making them easy to handle.

Tethering a sentinel female to a branch using thread looped over the forewing or glued to the insect's body is a technique which is successful with OBLR and other species of lepidoptera (Cardé *et al.* 1977, Alford and Silk 1983, Suckling and Shaw 1992, Deland 1992, Delisle 1995). Losses of tethered females due to escape or predation are highly variable and depend on the site and environmental conditions. For example, losses of tethered female fruittree leafroller, *Archips argyrospilus* (Walker) (Lepidoptera: Tortricidae) was 6% (n = 281) in conventional apple orchards (Deland 1992) and 60% (n = 45) in the unsprayed apple orchard at PARC (H.L. McBrien, unpublished data). The use of the Teflon®-walled mating table may be preferred because of the low numbers of insects lost from escape or predation (Table 1) and a savings in labour during tethering, which limits the numbers of insects that can be set up at any one time.

This study shows that males of at least two species of lepidoptera enter the Teflon®-walled mating table and mate with sentinel females. It would be of interest to know what proportion of male moths approaching the table actually enter, and how this compares with mating cages (Fitzpatrick and Troubridge 1993). The Teflon®-walled mating table is probably suitable for many other species of lepidoptera, and possibly for insects in other orders.

ACKNOWLEDGEMENTS

We thank J. Schick and T. Hansford for technical assistance, M.G.T. Gardiner for photography, J.H. Borden and M.L. Evenden for advice and review of the manuscript, and the following for financial support: Science Council of British Columbia, Agriculture and Agri-Food Canada, British Columbia Fruit Growers' Association, Similkameen Okanagan Organic

Producers' Association, and Phero Tech Inc. This paper is contribution No. 983 of the Agriculture and Agri-Food Canada, Pacific Agri-Food Research Centre, Summerland.

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