NOTE

A Method for Rearing *Diadegma insulare* (Hymenoptera: Ichneumonidae) in the Greenhouse[1]

Jianxiang Xu[2] and A. M. Shelton

Department of Entomology, Cornell University, New York State Agricultural Experiment Station, Geneva, NY 14456 USA

J. Entomol. Sci. 36(2): 208-210 (April 2001)

Key Words Diamondback moth, *Plutella xylostella, Diadegma insulare*

The diamondback moth, *Plutella xylostella* (L.), is the most destructive insect of crucifer crops worldwide (Talekar and Shelton 1993, Annu. Rev. Entomol. 38: 275-301). With the development of widespread resistance in *P. xylostella* to nearly all classes of insecticides used against it, biological control agents, especially parasitoids, have attracted more attention. *Diadegma insulare* (Cresson) is the most important parasitoid of *P. xylostella* in North America and high rates of parasitism of *P. xylostella* caused by this parasitoid has been recorded in crucifer fields (e.g., Zhao et al. 1992, Great Lakes Entomol. 25: 253-258; Godin and Boivin 1998, Environ. Entomol. 27: 1157-1165). Nevertheless, in some years, *P. xylostella* may still not be adequately controlled by natural populations of parasitoids, and more research is needed to find ways to enhance the effects of *D. insulare.* Efficient rearing methods can facilitate research on *D. insulare* and increase its use in augmentative biological control for *P. xylostella.* However, other researchers have noted that *D. insulare* can be difficult to rear and often produces strongly male-biased sex ratios when in culture (Hu et al. 1998, Florida Entomol. 81: 526-534; Sieglaff et al. 1998, Florida Entomol. 81: 578-582). Herein, we report a simple method for rearing *D. insulare* on a laboratory colony of *P. xylostella* in a greenhouse. Using this method, we have maintained a colony of *D. insulare* in the greenhouse for over 9 months (13 generations) with an approximately 1:1 sex ratio.

Diadegma insulare pupae, collected from Celaya, Mexico on 20 May 1999, were taken to Geneva, NY, and placed in an environmental chamber at 27 ± 1°C, 35 ± 2% RH and a photoperiod of 16:8 (L:D) h. Once the wasps emerged, pairs of the wasps were transferred into clear plastic cylinder cages (12 cm diam × 15 cm tall) (8 to 10 pairs per cage) with 10% sugar solution as food and allowed to mate. A laboratory colony of *P. xylostella* (Shelton et al. 1993, J. Econ. Entomol. 86: 11-19) was used as host. A tray (24 × 34 × 6 cm) of 5- to 6-week-old oilseed rape (*Brassica napus* L.

[1]Received 22 June 2000; accepted for publication 31 July 2000.

[2]Current address: Department of Plant Protection, Yangzhou University, Yangzhou, P. R. China 225009.

subsp. *oleifera* cultivar "Dwarf Essex") seedlings was infested with 300 to 350 *P. xylostella* eggs on an aluminum foil oviposition strip (Shelton et al. 1991, J. Entomol. Sci. 26: 17-26) and placed into a wooden rearing cage (45 × 50 × 76 cm, with a glass top and screen-covered openings on three sides) in a greenhouse at 27 ± 5°C and a photoperiod of 14:10 (L:D) (natural lighting was supplemented with 32 W fluorescent lamps to achieve this photoperiod). The growing medium for the oilseed rape was Cornell Mix (Grace Sierra Horticultural Products Company, Milpitas, CA), and the plants were fertilized weekly (16:32:16, N:P:K) starting 3 wks after sowing. When the *P. xylostella* population reached second- to third-instar, and after the *D. insulare* had been allowed to mate in the cylinder cages for 24 h, six to eight pairs of mated *D. insulare* adults were transferred from the cylinder cage into the wooden cage with the *P. xylostella* larvae. A 10% sugar solution was provided as food for the wasps, and the wasps were left in the cage until they died.

When the wasps of the next generation emerged, pairs of *D. insulare* were collected, transferred into plastic cylinder cages in the environmental chamber and allowed to mate for 24 h, and then moved into the wooden cage in the greenhouse. Plants in the cages were colonized with second- to third-instar *P. xylostella* on rape seedlings, as described above. All materials (cages, plastic trays, etc.) were washed in a mild bleach and soap solution before each use.

Under our greenhouse conditions, it took 15 to 20 d for *D. insulare* to develop from egg to adult. The parasitism rate usually was >95% and the sex ratio (percent females) was 45 to 63% (Table 1). If the population of *D. insulare* needed to be enlarged within a short period, after 48 h exposure in the first cage, mated adults could be transferred into another wooden cage with another tray of rape seedlings colonized by second- to third-instar *P. xylostella.* In this way, 6 to 8 pairs of *D. insulare* adults could parasitize 3 to 4 cages of *P. xylostella* larvae with >85% parasitism.

Table 1. Number and sex ratio of *Diadegma insulare* produced in the greenhouse using a method in which a cohort of hosts at a specific age is parasitized

Generation	No. of *D. insulare**	Sex ratio (% female)
F_1	252	56.7
F_2	567	51.2
F_7	480	45.8
F_8	285	44.9
F_9	278	62.2
F_{10}	568	63.0
F_{11}	312	60.3
F_{12}	246	54.1
F_{13}	241	53.5

* The number of adult *D. insulare* produced in the next generation from 8 to 10 mated pairs of *D. insulare,* which were allowed to parasitize *P. xylostella* larvae.

Previous authors have noted that heavily male-biased sex ratios may be a problem when maintaining *D. insulare* in culture but, with this method, we have maintained the *D. insulare* colony easily and have not been bothered by the sex ratio problem. Also, because we used a healthy laboratory colony of *P. xylostella* as host, we did not have any disease problems in either the host or parasitoid culture.

We thank R. M. Bujanos (INIFAP, Mexico) for collecting the *D. insulare* pupae and M. A. Schmaedick, H. L. Collins and W. T. Wilsey (Department of Entomology, Cornell University/NYSAES) for their help.