

## Short Note

### Induction of Host Plant Choice for Feeding and Oviposition in Diamondback Moth Larvae (*Plutella xylostella*)

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**How-Jing Lee and Yi-Chien Tseng (1993)** Induction of host plant choice for feeding and oviposition in Diamondback moth larvae (*Plutella xylostella*). *Bull. Inst. Zool., Academia Sinica* 32(2): 148-152. Last larval instar of Diamondback moth (DBM), *Plutella xylostella*, can be induced to prefer the same host plant species that the first three larval instars feed on. Although the DBM used in our experiments showed rather weak feeding induction response in a choice test, a significant preference for its familiar host plant was observed in a no-choice test. However, feeding preferences learned during DBM larval stages were not transferred to adult ovipositional preference. The significance of feeding induction and its effects on ovipositional choice are discussed.

**Key words:** Induction, Feeding, Oviposition, Diamondback moth, *Plutella xylostella*.

Feeding induction (Dethier 1982) is a common phenomenon in phytophagous insects (Jermy *et al.* 1968, Saxena and Schoonhoven 1982, de Boer and Hanson 1984). Food preference induction has also been reported in a variety of polyphagous and oligophagous species (Hsiao 1985). Although feeding preference can be altered by previous experience, the capacity for induction is rather species-specific, and is usually correlated with taxonomic distance between inducing plant pairs (de Boer and Hanson 1984).

Induction has some adaptive advantages in nature (Yamamoto 1974); since leaves and branches of different plants often intermingle in a natural habitat, larvae may come into contact with several plant species during normal feeding. Therefore, preference induction may restrict feeding to a single host species. Since it is metabolically costly to detoxify secondary plant chemicals (Schoonhoven and Meerman 1978, Brattsten 1979), an induction which confines larval feeding to one host species reduces the additional metabolic cost of adapting to the chemistry of a second host plant species.

The Diamondback moth (DBM), *Plutella xylostella*, is a serious pest affecting crucifers (Talekar *et al.* 1985). Its host plants are restricted to a limited number of cruciferous vegetables, and the economic damage it causes can be extensive. Although DBM (as well as *Manduca sexta*) are oligophagous insects, and although the latter can be induced to feed on non-host plants (de Boer and Hanson 1984), a preferred non-cruciferous plant species has yet to be documented for DBM. This study focuses on feeding induction among four host plants and the possibility of transferring feeding experience to ovipositional preference.

**Materials and Methods**—Diamondback moth larvae were collected from the field in areas outside of Taipei, Taiwan. These and all other experimental animals were kept in an environmental chamber under 23° C, L/D 12:12 h conditions. Larvae were fed fresh leaves of Ching-chiang Pai-tecei (CP) (*Brassica chinensis*). After pupation, leaves with attached cocoons were transferred to a 30X30X30 cm plastic container. Honey water was provided for emerging adult moths. Adults in the container were allowed to mate freely, and fresh

CP leaves were added daily as ovipositional substrates.

Four cruciferous plant species were chosen as larval food for the experiment: Cauliflower (CA) (*Brassica oleracea* var. *botrytis*), Rape (RP) (*Brassica campestris* var. *amplexicaulis*), Chinese kale (CK) (*Brassica oleracea* var. *acephala*) and Ching-chiang Pai-tecei (CP) (*Brassica chinensis*). Eggs laid by 1-day-old females were collected and equally distributed among 12-day-old seedlings of the four test plant species. Fresh 15-day-old seedlings were provided daily as food sources for the larvae throughout the experimental period. On the second day after molting, 10 second-instar larvae were selected from each of the four rearing groups for the preference experiment. Individual larvae were placed in the center of plastic petri dishes (8.5 cm in diameter) which were divided into eight equal sections. Each section contained a single leaf from one of the four test plant species. Two leaves of the same species were placed at opposite sides of each petri dish. During the 2h test period, actual feeding time was recorded as an index of feeding preference. For each larva tested, a feeding rank (1 to 4) was assigned to each plant species according to actual feeding time. The Feeding Indices shown in Fig. 1 are the cumulative feeding ranks among the four test plant species for 10 larvae from each reared plant group. A Kruskal-Wallis test (Sokal and Rohlf 1981) was employed to determine whether significant induction occurred in our experimental DBM larvae. The same experimental design was used to test the feeding preferences of 3rd and 4th instar larvae.

A no-choice experiment was conducted following the same design as the choice test, with the exception that only 4th instar larvae were tested. On the second day of their 4th instar, 40 larvae were selected from each of the four test plant species group and divided into four larval test groups. A single leaf from one of the four test plants (CK, CP, CA, RP) was placed in the center of an 8.5 cm diameter petri dish with a single 4th instar larva. During the subsequent 2h of observation, actual feeding time was recorded as an index of feeding preference. The collected data were analyzed using one-way ANOVA (Sokal and Rohlf 1981).

Mated one-day-old female moths were selected from each of the four test groups and placed in 5.5x8.5 cm plastic cages containing seedlings from the four test plants; the seedlings were tied together with moist cotton at their base for use as ovipositional substrates. The number of eggs laid on these leaves within 24 hours was recorded. Our observed "Oviposition rate" was calculated as the number of eggs laid on each plant divided by the total number of eggs laid within 24 hours. Ovipositional preference was tested using one-way ANOVA (Sokal and Rohlf 1981).

**Results**—Second- and third- instar larvae did not actively seek and feed on their familiar host plants (Fig. 1); there was no apparent pattern of feeding preference for 2nd or 3rd instar larvae from the host plant choice

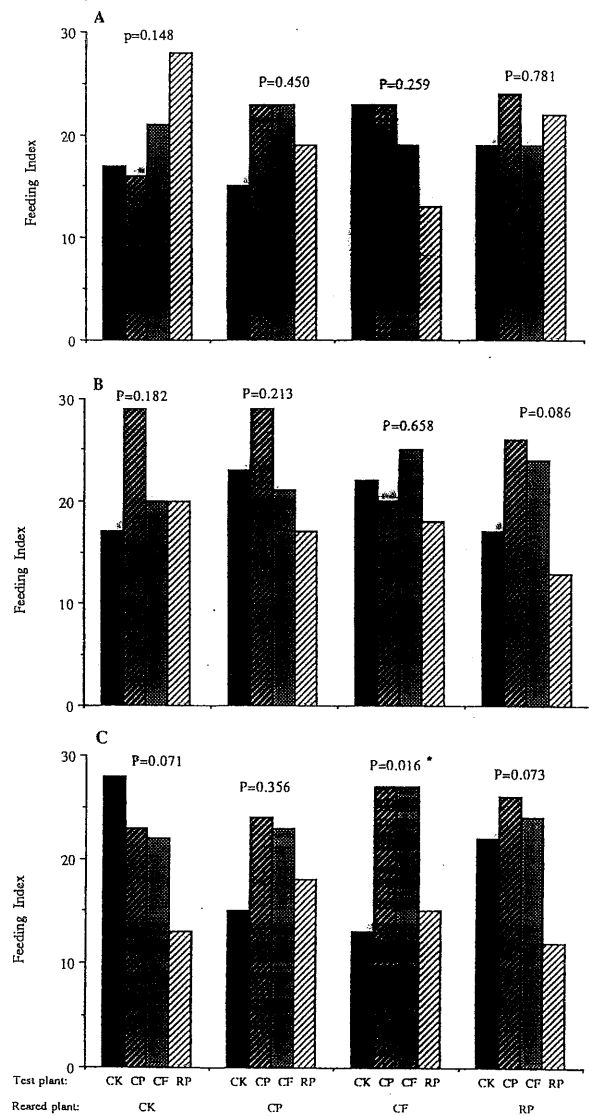


Fig. 1. Preference effect of feeding experience on food plant choice by 2nd (A), 3rd (B), or 4th (C) instar larvae of the Diamondback moth, *Plutella xylostella*. The four histograms for each reared plant are labelled as: CK (Chinese Kale), CP (Ching-chiang Pai-tecei), CF (Cauliflower), and RP (Rape). The Feeding Index is the cumulative feeding ranks among four test plant choice stations for ten larvae in each reared plant group.

test. Therefore, the feeding experience acquired during the 1st instar larval stage apparently did not affect 2nd or 3rd instar feeding preferences. Fourth instar larvae reared on CF showed a significant preference for CF or CP, but not for CK or RP (Fig. 1). Larvae from the other test groups showed no host plant preference. These results indicate that 4th instar larvae show some feeding preference for the plants they were initially reared on, although this preference was not obvious for all tested host plants.

Observed 4th instar larvae spent more time feeding when they were placed on leaves of a familiar plant species (Fig. 2). Even when test plants were within their normal host plant range, these 4th instar larvae spent significantly more time feeding on familiar host plants after only a few days of feeding. However, the 4th instar larvae spent about the same amount of time feeding on unfamiliar host plants.

Even when larvae were reared on a single plant species, in their adult stage they did not show a preference for the same plant species as an ovipositional substrate. We found no meaningful relationships between larval food plant sources and adult ovipositional preference; feeding preferences acquired during larval stages did not affect ovipositional preferences in adulthood.

**Discussion**—As an oligophagous insect, DBM larvae feed only on Cruciferae—a family of plants which is

unique in having a high concentration of sinigrin and other mustard oil glycosides (van Etten and Tookey 1979). DBM larvae can discriminate between host and non-host plants, since their larval feeding is stimulated by sinigrin and related glucosinolates (David and Gär-diner 1966). For tobacco hornworm (*Manduca sexta*) larvae, it has been shown that host plants are not preferred equally (Hanson 1983). Although our DBM larvae did not show a significant preference for any of the four host plants provided during their 2nd and 3rd instars (Fig. 1), the induced preference observed in 4th instar larvae (Figs. 1 and 2) convincingly showed host plant discrimination.

For DBM larvae, induced feeding preference within the host plant range is initially expressed during the last larval instar (Figs. 1 and 2). Our results indicate that the time required to establish induction is at least ten days—well into the last instar. This finding suggests two notions: first, ten days are required for reinforcing feeding preference for a host plant species. Hsiao (1985) reported that the time required for induction varies according to species; he also noted that, for most species, an induced preference usually develops after rearing on a particular host for one or more instar. Second, the last larval instar is the only period in which DBM can show an induced preference, since the degree to which preferences for specific resources may be modified by experience is age-dependent (Jaenike 1988).

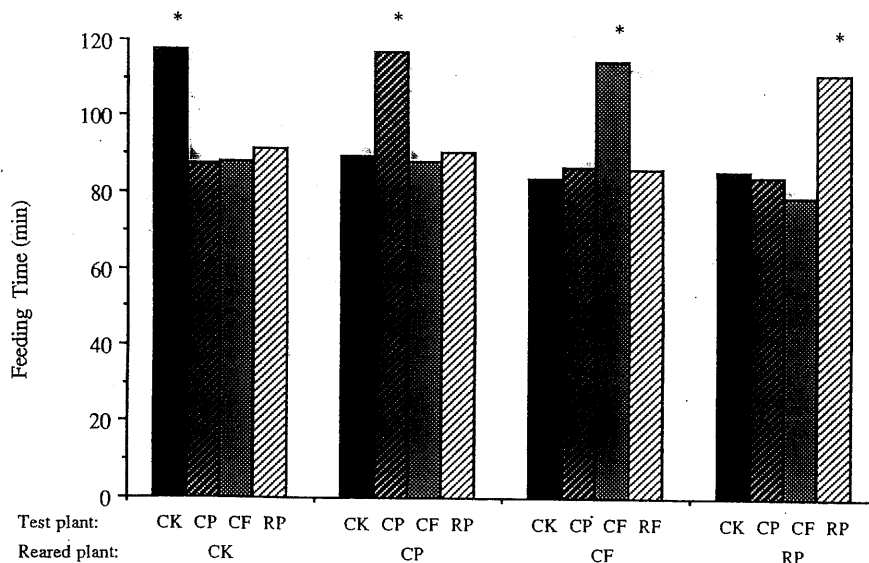


Fig. 2. Preference effect of feeding experience on no-choice test by 4th instar larvae of the Diamondback moth, *Plutella xylostella*. Feeding time on a particular plant is the actual feeding time within two hours of observation. The four histograms for each reared plant are labelled as: CK (Chinese Kale), CP (Ching-chiang Pai-tecei), CF (Cauliflower), and RP (Rape) ( $n = 10$  for each reared plant group).

\*indicates a significant difference in feeding among the four reared plant groups ( $p < 0.01$ ).

Induction is not completely universal; a lack of induction has been reported in *Pieris rapae* and *P. napi* (Chew 1980). Although this result may be attributed to the chemical similarity of plant pairs or a possibility that the plants may be more difficult to discriminate between during a choice test, a capacity for induction should be the manifestation of innately guided learning—that is learning by instinct (Gould and Marler 1987). Hsiao (1985) also concluded that induction could only occur within the insect's natural host range. Even in the polyphagous insect *Spodoptera frugiperda*, feeding preferences are relatively rigid, and innate feeding preferences override experience in a choice situation (Raffa 1987). Although de Boer and Hanson (1984) observed strong feeding induction in *M. sexta* for a non-host plant, observed DBM larvae did not feed on non-cruciferous plants. The weak induction preference of DBM larvae for four test host plants (Fig. 1) might be attributed to lower flexibility in the learning capacity for food choice, or a lower adaptive value of preference induction in their ecological environment.

Induction is a learned behavior (Dethier 1986) which has adaptive value for larval survival. By restricting feeding to a few plants, energy expenditure can be minimized and the potential hazard of ingesting toxins can be abated (Schoonhoven and Meerman 1978, Brattsten 1979, Hsiao 1985). However, larval feeding experience does not affect DBM host plant choice during oviposition; although the Hopkins Host Selection Principle (Hopkins 1917) suggests that larval experience may influence ovipositional choice, our results clearly refute this hypothesis.

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## 小菜蛾幼蟲對寄主植物取食及產卵之引導作用

李 後 晶      曾 憶 倩

小菜蛾末齡幼蟲可以被引導去偏好，它從一齡幼蟲就開始取食的寄主植物種類。雖然小菜蛾在選擇試驗中，表現出不是很明顯的取食引導，但是在無選擇試驗中，則對熟悉的寄主植物有顯著地偏好。然而在幼蟲期所學習到的取食偏好性並沒有移轉至成蟲對產卵寄主的偏好。