OnLine Journal of Biological Sciences 1 (8): 742-743, 2001
© Asian Network for Scientific Information 2001

Evidence of *Diadegma insulare* (Cresson), a Parasitoid of Diamondback Moth, *Plutella xylostella* L., Present in Various Habitats

[1]Idris, A. B. and [2]E. Grafius
[1]School of Environmental & Natural Resource Sciences, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia, [2]Department of Entomology, 243, Natural Science Building, Michigan State University, East Lansing MI 48824-1115, USA

Abstract: *Diadegma insulare* (Cresson), a parasitoid of diamondback moth (DBM), *Plutella xylostella* L., caught per sticky traps were used to indicate the presence of parasitoid in the habitats. The numbers of *D. insulare* caught were significantly different among habitats in 1993 and 1994. The parasitoid adults were caught in most habitats (crop or non-crop) except in the woodland's centers and weedy areas with > 90% *Agropyronrepen* (L.) or Asteraceae plus grasses as themajority of plants present. *D. insulare* is highly mobile and prefers to visit or stay longer in the habitats that have *Daucus carota* L. or wild *Brassica* species. These two weed species provided food sources or refuge for both parasitoid and its host (DBM). However, shelter of woodland edge with *D. carota* as the majority of plant presence attracted the highest numbers of *D. insulare*. Presence of *D. insulare* in most crop habitats especially in the field of tomato and corn suggests that these crops could be interplanted with cabbages that may enhance the role of *D. insulare* as a biocontrol agent of diamondback moth.

Key words: Habitat, *Plutella xylostella*, *Diadegma insulare*, biological control, crop diversity

Introduction

Habitat is the physical area encompassing the resources that support the existence of an individual insect population for a specific time, while habitat heterogeneity is the environment being composed of significantly different parts within a particular landscape (Gould & Stinner, 1984). Habitat can influence the population size and distribution of the pests and its parasitoids (Hawkins & Sheehan, 1994). Habitat preference and the potential of host community location within habitat are two of the nine steps necessary for successful parasitism (Vinson, 1985). He also suggested that the interactions between the host's habitat and the parasitoid are dependent on the active behaviour and physiological states of the parasitoid. Kareiva (1987) reported that specific dispersal behaviour of natural enemies is greatly influenced by the habitat's heterogeneity.

Landis and Hass (1992) indicates that microclimate of habitat, particularly in warm years, influence the movement and behavior of *Eriborus terebrans* (Gravenhost)(Hymenoptera: Ichneumonidae), a parasitoid of European corn borer, *Ostrinia nubilalis* (Hubner)(Lepidoptera: Pyralidae). Idris & Grafius (1995) found that *Diadegma insulare* (Cresson)(Hymenoptera: Ichneumonidae), the major larval parasitoid of diamondback moth (DBM), *Plutella xylostella* L., longevity and fecundity were influenced by wind flowers found in various habitats. The objectives of this study were to test hypotheses that (1) *D. insulare* is actually present in various habitats, and (2) its abundance is somewhat related to types of plants present in a particular habitat.

Materials and Methods

The study was conducted at the Michigan State University Research Farm, East Lansing, Michigan, during the summer of 1993 and 1994. The habitats used were woodland's edges and its center, apple orchard, weedy areas, alfalfa, tomato and corn field.

Forty white sticky traps (Pherocon™ 1C trap-bottom; Trece Inc., Salinas, CA) per habitat (4 replicates per habitat, 10 traps per replicate, and 10 m between traps) were used. Each trap was folded in half to make a two-sided trap with sticky side out. Traps were placed upright on a 40 cm stake in weedy areas, middle of alfalfa fields, within the canopy of tomato, *Brassica kaber* D.C. Wheeler, *Brassica nigra* L. Koch and *Raphanus raphanistrum* L., along the edge and center of woodlands, hung on an apple tree branches or corn leaves (50 m into the field). Trap height was varied with habitat but ranged from 40 to 80 cm above the ground except for apple tree. *D. insulare* trapped were recorded and removed every day between 1800 and 1900 h for a week. Numbers of *D. insulare* caught per trap per day in various habitats were analyzed using one-way ANOVA and means were separated using Turkey's test (Abacus Concept, 1991). Data were transformed using Log (1 + x) before analysis.

Results and Discussion

The numbers of *D. insulare* caught per trap per day were significantly different among habitats in both years (Fisher's Protected LSD, $P < 0.05$)(Table 1 & 2). *D. insulare* adults were caught in all crop and non-crop habitats except in the woodland center, weedy areas with Asteraceae plus grasses or > 90% *A. repens*. So, *D. insulare* was a mobile parasitoid within the heterogeneous habitats.

In 1993, *D. insulare* caught were significantly higher on traps placed along the woodland edges that had 50 - 70% *Daucus carota* L. than traps placed in other habitats (FPLSD, $P < 0.05$)(Table 1). *D. insulare* preferred to aggregate and spend longer time to search for food or hosts in habitat having higher percentage of *Daucus carota* L. than the other habitats. *D. carota* flowers provide an excellent nectar source for the *Diadegma insulare* (Idris & Grafius 1995). However, the availability of food sources seemed not the only factor that influences the presence of *D. insulare* in a particular habitat but the cooling factor provided by the woodland edges may attract more *D. insulare* adults to visit and stay longer than the hot condition offered by an open weedy areas. This was indicated by significantly high number of parasitoid caught along the woodland edges than in the weedy areas (both had 50 - 70% *D. carota*) (Table 1). Habitats with > 90% *Agropyron repens* (L.) or with > 50% Asteraceae plus grasses as the dominant weed present seems to be not attractive for *D. insulare* (zero catch), suggesting that these weeds are not the food sources of the parasitoid. Interestingly, *D. insulare* was also present in the Apple orchards and alfalfa fields even though these crops are not the host plant of main insect host, *P. xylostella* (Harcourt, 1963). The presence of *D. insulare* in these crop habitats is probably searching for its alternate hosts and/or food sources. *D. insulare* has no host other than DBM, but the closely related species of *D. insulare*, *D. semicalausm*, visiting flower of apple tree was observed in Indonesia (B.M. Shepard, Clemson University, USA – unpublished data).

In 1994, *D. insulare* were significantly higher in weedy areas than in the tomato, corn field or woodland's center (FPLSD, $P < 0.05$)(Table 2). Presence of 50 - 70% wild Brassicaceae (*B. nigra*, *R. raphanistrum* or *B. kaber*)

Table 1: Numbers of *D. insulare* caught in various habitats from 12 to 18 August 1993.

Habitats (treatments)			No. of *D. insulare* caught/trap/day (± S. E)[1]
Woodland edge	(WE):	> 50 – 70% *Daucus carota* L.	0.40 ± 0.16c
	WE:	Asteraceae (=compositae) + *Agropyron repens* (L.) Beauv	0.05 ± 0.28ab
	WE:	> 90% *A. repens*	0.15 ± 0.05b
	WE:	grasses (no *A. repens*) + shrubs	0.17 ± 0.07b
Apple Orchards			0.08 ± 0.05ab
Weedy areas	(WA):	> 50 – 70% *D. carota*	0.18 ± 0.05b
	WA:	> 50 – 80% Asteraceae	0.03 ± 0.03ab
	WA:	> 50% Asteraceae + grasses	0a
	WA:	> 90% *A. repens*	0a
Alfalfa fields			0.05 ± 0.03ab

[1]In column means with similar letter are not significantly different (Fisher's Protected LSD, P > 0.05)

Table 2. Numbers of *D. insulare* caught in various habitats from 14 to 20 August 1994.

Habitats (treatments)			No. of *D. insulare* caught/trap/day (± S. E.)[1]
Woodland Center			0a
Tomato fields			0.15 ± 0.05a
Corn fields			0.14 ± 0.08a
Weedy areas			
	(WA):	> 50 – 70% *Brassica nigra* (L.)	1.60 ± 0.19b
	WA:	> 50 – 70% *Raphanus raphanistrum* (L.)	1.50 ± 0.14b
	WA:	> 50 - 80% *Brassica kaber* (L.)	1.83 ± 0.17b

[1]In column means with similar letter are not significantly different (Fisher's Protected LSD, P > 0.05)

in weedy areas had attracted more *D. insulare* adults to visit these habitats than the other habitats. *B. kaber* and *B. nigra* were reported to provide excellent nectar sources for *D. insulare* (Idris, 1995). These wild brassicas may also harbor the alternate hosts of *D. insulare* although *R. raphanistrum* is not a good food sources for *D. insulare* (Idris & Grafius, 1995). There was no *D. insular* in the center of the woodland. Low light intensity in this habitat (< 80 $\mu Em^{-2} sec^{-1}$) might have not attracted *D. insulare* to get into the center of woodland. Idris & Grafius (1998) reported that light intensity below 500 $\mu Em^{-2} sec^{-1}$ ceased diurnal flight activity of *D. insulare*. *D. insulare* activities was light sensitive as opposed to most parasitoids which can be found more inside than the outside of the forests or woodlands (Noyes, 1989).

As kionobiont parasitoid *D. insulare* may have a restricted host range in a simple habitats within the landscape (Askew & Shaw, 1986, Sheehan, 1986). Therefore, it has to be actively mobile in the heterogeneous habitats that provide its alternate hosts or food sources. In addition, they also need shelter during hot day as indicated by the high numbers of *D. insulare* caught along the woodland edge (Table 1).

The numbers of *D. insulare* caught were relatively higher in tomato and corn field than in the alfalfa field or apple orchard (Table 1 & 2). This suggests that these crops could be interplanted with cabbage in DBM management program. The percent parasitism of DBM larvae by *Cotesia plutellae* (Kurdjumov) was not affected by the tomato-cabbage interplanting (Bach & Tabashnik,1990). As a result of interplanting, they reported a significant reduction in the percentage of damage by DBM larvae on cabbages.

There is a great potential for manipulation of cabbage field planting system which could includes the wild *Brassicas* or other crops that favour *D. insulare* activity. On the other hand the presence of nectar producing plants or *Brassica* plants in heterogeneous habitats should not be totally eliminated for the benefit of *D. insulare*. By doing so, the role of *D. insulare* in checking DBM infestation on cabbage crops could be optimized.

Acknowledgments

We thank B. Bishop, J. Kells and W. Pett for their valuable assistance. This research was supported by the Michigan Agriculture Experiment Station and Michigan Vegetable Growers Council.

References

Abacus Concept, 1991. Super ANOVA. Abacus Concept Inc. Berkeley, CA, USA.

Askew, R. R. and M. R. Shaw, 1986. Parasitoid communities; their structure and development, pp 225-264. In Waage, J. and D. Greathead (eds.). Insect Parasitoids. Academic Press, London.

Bach, C. E. and B. E. Tabashnik,, 1990. Effects of nohost plant neighbors on population densities and parasitism rates of the diamondback moth (Lepidoptera: Plutellidae). Environ. Entomol., 19; 987-994.

Gould, F. and R. E. Stinner, 1984. Insects in heterogeneous habitats, pp. 427-450. In Huffaker, C. B. and R. L. Rabb (eds.). Ecol. Entomol. John Wiley & Son., New York.

Hawkins, B. A. and W. Sheehan, 1994. Parasitoid community ecology. Oxford University Press. 516 pp.

Harcourt, D. G., 1963. Major mortality factors in population dynamics of the diamondback moth, *Plutella maculipennis* (Curt,((Lepidoptera: Plutellidae). Can. Entomol. Soc. Mem., 32: 55 –66.

Idris, A B., 1995. Ecology and behaviour of *Diadegma insulare* (Cresson), a biological control agent of diamondback moth, *Plutella xylostella* (L.). Ph.D dissertation. Michigan State Univ. Pp: 205

Idris, A. B. and E. Grafius, 1995. Wind flowers as nectar sources for *Diadegma insulare* (Hymenoptera: Ichneumonidae), a parasitoid of diamondback moth (Lepidoptera: Yponomeutidae). Environ. Entomol., 24: 1726-1735.

Idris, A. B. and E. Grafius, 1998. Diurnal flight activity of *Diadegma insulare* (Cresson) (Hymenoptera: Ichneumonidae), a parasitoid of diamondback moth, (Lepidoptera: Plutellidae), in the field. Environ. Entomol., 27: 406-414.

Kareiva, P., 1987. Habitat fragmentation and stability of predator-prey interactions. Nature, 326: 388-390.

Landis, D. A. and M. J. Hass, 1992. Influence of landscape structure on abundance and within-field distribution of European corn borer (Lepidoptera: Pyralidae) larval parasitoid in Michigan. Environ. Entomol., 21: 409-416.

Noyes, J. S., 1989. The diversity of Hymenoptera in the Tropics with special reference to Parasitica in Sulawesi. Ecol. Entomol., 14: 197-207.

Sheehan, W., 1986. Response by specialist and generalist natural enemies to agroecosystem diversification: A selective review. Environ. Entomol., 15: 456-461.

Vinson, S. B., 1985. The behaviour of parasitoid, pp. 417-457. In Kerkut, G. A. & L. I. Gilbert (eds.0 Comprehensive Insect Physiology Biochemistry and Pharmacology, Vol. 9, Behavior. Pergaman Press, New York.