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Prey Preference of Four species of Forest Spiders to *Spodoptera litura* and *Plutella xylostella*

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ABSTRACT

The prey preference of *Heteropoda garciai*, *Olios mahabangkawitus*, *Ctenus floweri*, and *Pardosa apostoli* was examined on *Spodoptera litura* and *Plutella xylostella* in laboratory. These spiders showed a clear preference for *P. xylostella* compared to *S. litura*. However, there was no significant difference observed between the second and third instars larvae of *P. xylostella*. Similarly, the size of prey was not an important factor in the prey selection by *H. garciai*, *O. mahabangkawitus* in this study. *P. apostoli* showed higher preference on smaller sized *S. litura* larvae.

Keywords: Heteropoda garciai, *Olios mahabangkawitus*, *Ctenus floweri*, *Pardosa apostoli, Plutella xylostella*, *Spodoptera litura*, prey preference test

INTRODUCTION

The armyworm, *Spodoptera litura* (Fab.), is a polyphagous insect pest of many economically important crops (Cab International, 2002). In particular, this insect pest causes heavy yield loss in groundnut and soybean productions, depending on the infestation level and crop stage (Dhir *et al*., 1992; Dhaliwal & Koul, 2010). In Malaysia, this insect pest has become the main pest of *Musa sapienthum* L., *Citrullus vulgaris* L. and cucurbit vegetables (Badri *et al*., 2009). Meanwhile, diamondback moth (DBM), *Plutella xylostella* L. (Lepidotpera: Plutellidae), another serious insect pest in Malaysia, is a well-known insect pest of Brassica crops. It has caused 99% (1992) and 80% (1994) cabbage loss in Jiangsu if no spray was applied for DBM control (Zhao *et al*., 1996). Over dependent on chemical insecticides for *S. litura* and DBM control has resulted in pest resistance development to chemical insecticides. *S. litura* has been reported resistant to conventional chemical

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insecticides such as organochlorines, organophoshates, carbamates and synthetic pyrethroids (Kranthi *et al*., 2001; Shi *et al*., 2003), while DBM resistance to all classes of synthetic insecticides has been documented as well (Grzywacz *et al*., 2009). The annual cost of managing DBM worldwide is estimated to be about US$1 billion (Talekar & Shelton, 1993).

Formulations based on *Bacillus thuringiensis* (Bt) have been used as alternative means to control insect pests with pesticide resistance problem. Development of resistance to Bt products or Bt-crop has been documented in several insect pests. For example, *B. thuringiensis* resistance has been reported in *P. xylostella* and is strain-dependent (Kao & Cheng, 1994). *Spodoptera* species such as *Spodoptera exigua* (Hübner) (Lepidotpera: Noctuidae) has been reported to be resistant to *Bacillus thuringiensis* Cry1C (Moar *et al*., 1995), while *Spodoptera fruigiperda* (Lepidotpera: Noctuidae) has been shown to have low sensitivity to *B. thuringiensis* Cry1F (Storer *et al*., 2010). Other microbial insecticides such as baculoviruses and entomopathogenic fungi have been reported to pathogenic to *S. litura* (Sajap *et al*., 2000; Vijayavani *et al*., 2009) and also *P. xylostella* (Wang *et al*., 2009; Dezianian *et al*., 2010). However, it is crucial to note that these microbial agents have slow killing rate compared to Bt.

Spiders are unique arthropods which prey on living organism and not fussy about their prey. They are important natural enemies of many insect pests in the agricultural ecosystem (Maloney *et al*., 2003). Many studies have been conducted to study the potential use of spiders as a predator (Amalin *et al*., 2001; Larsson , 2007). Our research team conducted a preliminary assessment on local spiders in agricultural lands such as oil palm and rubber plantation, and tropical forests such as National Park, Sungai Dusun Wildlife Reserve, Fraser Hill Wildlife Reserve, Tasek Bera, Ayer Hitam Forest Reserve, Pangkor Island and Jerejak Island from 2008 to 2010. Based on the research findings, a rich spider fauna exists in Malaysia. Meanwhile, the current study was conducted to evaluate the efficiency of forest spiders as the predators of *S. litura* and *P. xylostella* under laboratory condition.

MATERIALS AND METHODS

Insects

The larvae of *P. xylostella* and *S. litura* were used as prey to evaluate the feeding activity and food preference of these spiders. They were obtained from MARDI, Serdang, and maintained in plastic aquariums under 12L:12D photoperiod, at 26±1°C and 60-70% relative humidity. The larvae were supplied with chemical- and disease-free cabbage plants while the adults were supplied with 10% honey-water solution.

Spiders

Sampling activity was carried out from the 1st to 4th of April 2011 in Pulau Tioman forest and also from 27th to 30th June 2011 at Penang National Park. All the spiders were brought back to the laboratory and maintained under laboratory condition. The adult spiders were identified to species level using available literature (Barrion & Litsinger, 1995; Richman *et al.*, 2006). A total of ten adults (mixture of males and females) of four spider species were used in the prey preference test.

Prey Preference Test

Adult spiders were kept individually in plastic containers under laboratory condition and starved for three days before predation test was carried out to ensure that they would be adequately hungry to hunt. The predation test was conducted in clear plastic containers measuring 10 cm x 10 cm x 1.5 cm, with chemical- and disease-free cabbage leaves as food for larvae and wet tissue to provide moisture. The larvae were prepared in a similar manner for the no-choice and choice prey preference tests. The larvae with body length measured at 3 mm (early second instar *S. litura*; second instar *P. xylostella*) and 5 mm (late second instar *S. litura*; third instar *P. xylostella*) respectively were used in the predation test. All the experiments were conducted in laboratory at 12L:12D photoperiod, at 26 ±1°C and 60-70% relative humidity.

In the no-choice prey preference test, each spider was offered with one insect species of the same size larvae. Treatments were replicated 9 times and each replicate contained 10 larvae for each spider. The number of survival (larvae) was recorded daily. The same procedure was also used for the choice prey preference test, except that each spider was offered with two different insect species of the same size larvae (namely, five *P. xylostella* larvae and five *S. litura* larvae). All the data collected were analyzed using the analysis of variance (ANOVA), followed by means separation using Tukey test analysis ($P<0.05$).

RESULTS AND DISCUSSION

A total of 489 individual spiders were collected from Pulau Tioman forest and Penang National Park. Spiders such as *Heteropoda garciai*, *Olios mahabangkawitus*, *Ctenus floweri*, and *Pardosa apostoli* have been identified as the most abundance spider species in both the sampling sites (Fig.1 and Fig.2). In particular, *H. garciai* and *O. mahabangkawitus* are the Sparassidae spiders which can be mostly found on leaf litter. Meanwhile, *C. floweri* has a similar habitat, while *P. apostoli* (Lycosidae spider) can be found in sandy area. These spiders are ground hunting spiders. Other species of spiders were insufficient for prey preference test due to the low number of collections or they died during handling.

The results of the prey preference test under laboratory condition are shown in Tables 1 and 2. The preference of these spiders was towards *P. xylostella* larvae in the no-choice prey preference tests, except for *C. floweri*. Meanwhile, *H. garciai* and *O. Mahabangkawitus* preferred *P. xylostella* than *S. litura* and no significant difference was observed between the second and third instars larvae of *P. xylostella*. *C. floweri,* and *P. apostoli* preferred both the insect species. However, *P. apostoli* did not consume much on the 5 mm *S. litura* larvae. When two

Fig.1: Spiders used in the prey preference test; (A) Female *Heteropoda garciai* (Bar = 2mm), (B) Male *Olios mahabangkawitus* (Bar = 2mm), (C) Female *Ctenus floweri* (Bar = 2mm), and (D) Male *Pardosa apostoli* (Bar = 2mm)

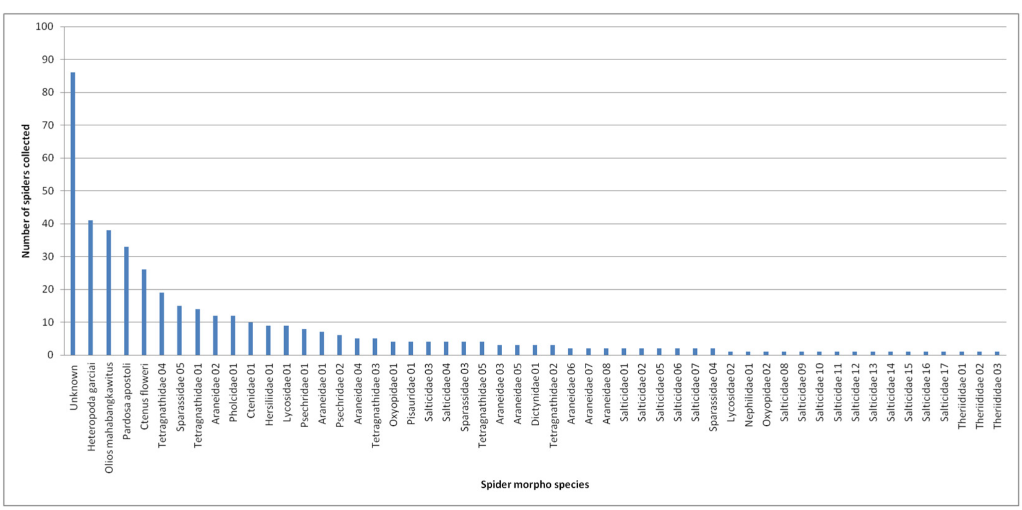

Fig.2: Total collection of spiders from two sampling sites (Pulau Tioman forest and Penang National Park)

TABLE 1
The mean number (± S.E.) of insect pest larvae consumed in 5 days by four species of spiders under no choice prey preference test

Type of larvae	Spider species			
	Heteropoda garciai	*Olios mahabangkawitus*	*Ctenus floweri*	*Pardosa apostoli*
3 mm *P. xylostella*	$10.0^{a} \pm 0.0$	$9.7^{a} \pm 0.9$	$10.0^{a} \pm 0.0$	$10.0^{a} \pm 0.0$
5 mm *P. xylostella*	$10.0^{a} \pm 0.0$	$9.3^{a} \pm 1.6$	$10.0^{a} \pm 0.0$	$9.8^{a} \pm 0.4$
3 mm *S. litura*	$2.6^{b} \pm 1.4$	$2.8^{b} \pm 1.3$	$9.4^{a} \pm 1.6$	$7.7^{a} \pm 1.9$
5 mm *S. litura*	$2.4^{b} \pm 2.5$	$5.8^{b} \pm 1.8$	$7.6^{a} \pm 2.6$	$3.6^{b} \pm 3.4$

Means followed by the same letters within a column are not significantly different (P≤0.05) according to Tukey test analysis

TABLE 2
The mean number (± S.E.) of insect pest larvae consumed in 5 days by four species of spiders under the choice prey preference test

Size of larvae	Type of larvae	Spider species			
		Heteropoda garciai	*Olios mahabangkawitus*	*Ctenus floweri*	*Pardosa apostoli*
3 mm	5 *P. xylostella* +	$4.7^{a} \pm 0.5$	$4.7^{a} \pm 0.5$	$5.0^{a} \pm 0.0$	$5.0^{a} \pm 0.0$
	5 *S. litura*	$2.4^{b} \pm 1.4$	$2.2^{b} \pm 0.8$	$5.0^{a} \pm 0.0$	$4.9^{a} \pm 0.3$
5 mm	5 *P. xylostella* +	$4.8^{a} \pm 0.6$	$4.4^{a} \pm 1.6$	$5.0^{a} \pm 0.0$	$5.0^{a} \pm 0.0$
	5 *S. litura*	$2.0^{b} \pm 1.9$	$1.7^{b} \pm 0.9$	$5.0^{a} \pm 0.0$	$1.0^{b} \pm 0.8$

Means followed by the same letters within a column are not significantly different (P≤0.05) according to Tukey test analysis

different insect species of the same body length were provided as food sources in the choice prey preference test, *H. garciai* and *O. mahabangkawitus* still preferred *P. xylostella* than *S. litura*, while the maximum predation was observed with *C. floweri* on both the insect species. A similar trend of prey preference was also observed for *P. apostoli* in the choice and no-choice prey preference tests. Prey preference is evident in *H. garciai* and *O. Mahabangkawitus* as they consumed significantly more *P. xylostella* than *S. litura* under both the choice and no-choice conditions regardless of the prey size.

Therefore, the present study has shown that *C. floweri* has no significant preference between *S. litura* and *P. xylostella* but the maximum predation was observed on both the insect species. In particular, *C. floweri* used in this study was two times bigger in size compared to other tested spiders, resulting in a higher consumption rate of prey. In other words, the size of a predator is important for feeding capacity. Larsson (2007) reported that bigger Salticidae spiders consumed significantly more *P. xylostella* compared to those smaller Salticidae spiders.

The size difference between the prey and predator clearly affects the killing capacity because the predators usually attack prey that is smaller than themselves (*Cogni et al*., 2002). Miranda *et al.* (2011)

reported a clear trend for individual predators to have a higher mean killing rate on smaller sized prey (second instars) than larger sized prey (third instars). Ma *et al.* (2005) also reported a similar result of predator preferences towards smaller prey when *Nabis kinbergii* preyed on smaller *P. xylostella* at increasing rates while the number of prey consumed by *N. kinbergii* decreased as the body size of prey increased. This is also evident in *P. apostoli* predation on *S. litura* larvae. However, when preying on the same prey species, this feeding behaviour was not observed in *H. garciai* and *O. Mahabangkawitus*, which have similar body length with that of *P. apostoli.* This finding demonstrates that the prey size preferences will be affected when there is a prey species preference.

CONCLUSION

Four species of the spiders collected from Pulau Tioman forest and Penang National Park had demonstrated predation towards *P. xylostella* and *S. litura* larvae under laboratory conditions. The present study is an initial laboratory study undertaken to examine the preference of *Heteropoda garciai*, *Olios mahabangkawitus*, *Ctenus floweri*, and *Pardosa apostoli* under the most simplistic conditions. Nonetheless, the actual effect of predation on prey population is hard to measure without experimental field studies when environmental factors become complicated. The question on whether or not these spiders are effective predators of *S. litura* and *P. xylostella* in vegetable farms cannot be conclusively answered as yet. Thus, a further study is needed to evaluate the actual potential of the forest spider species as biological control agents for *S. litura* and *P. xylostella* in vegetable farms.

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