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Biology and predatory ability of the reduviid *Sycanus falleni* Stal (Heteroptera: Reduviidae: Harpactorinae) fed on four different preys in laboratory conditions

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ABSTRACT

The reduviid *Sycanus falleni* Stal (Heteroptera: Reduviidae) is an important predatory insect in biological control pests in vegetable, soybean, corn and rice plants. It is omnivorous species and has a wide range of prey. The influence of fed on four different preys as *Pieris rapae* (Linnaeus), *Spodoptera litura* (Fabricius), *Plutela xylostella* (Linnaeus) and *Corcyra cephalonica* (Stainton) on biological parameters, ability to eat prey and body weight of the nymph and adult of *S. falleni* were evaluated in laboratory conditions (26 ± 2 °C, 75 ± 5% RH and light:dark 14:10 h) in Vietnam. The biological parameters of reduviid *S. falleni* reared on the laboratory were determined by observing the development stage of egg, development stage of nymph, pre-oviposition period, life cycle, longevity of adult, number of eggs laid, sex ratio. The nymph and adults of reduviid *S. falleni* consumption the number of *P. xylostella, P. rapae*, *S. litura* and *C. cephalonica* larvae were different, and an adult female consumed more than an adult male while the body weight of the I and V nymphal instars, male and female adults of reduviid *S. falleni* wasn't significantly different ($P < 0.01$).

Introduction

The cabbage white *Pieris rapae* (Linnaeus) (Lepidoptera: Pieridae), leafworm *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae) and diamond back moth *Plutela xylostella* (Linnaeus) (Lepidoptera: Plutellidae) are key pests and very dangerous to all cruciferous vegetable crops. These pests species are very difficult to control in the field because of genetic resistance to insecticides (Singh and Jalali, 1997; Liu et al., 2002; Beata, 2006), and the rice meal moth *Corcyra cephalonica* Stainton (Lepidoptera: Pyralidae) is one of the serious insect pests of stored rice and other cereal products (Jyoti et al., 2017).

The species of the assassin bugs belonging to the family Reduviidae (Heteroptera) is not only one of the most abundant groups but also showing significant economics and high scientific values. The family Reduviidae was documented with approximately 7000 species worldwide with from 29 subfamilies (Weirauch, 2008). They are present in all ecosystems and even near human places. Many species play important roles in the food chain of animals and plants, as well as the ecological balance. Many species are either known as predators of many dangerous pests and indicative role for forest habitats (Ambrose, 2002, 2003).

The species of genus *Sycanus* (Reduviidae: Harpactorinae) have high ability in controlling pests, and they are predacious reduviids that have a wide range of prey such as both the larvae and pupae of Lepidoptera, Coleoptera and Diptera (Sahayaraj and Balasubramanian, 2016). The predator *Sycanus versicolor* Dohrn of the genus *Sycanus* have been studied particularly on the biology, a voracious predator upon *Heliothis armigera* Hubner and *Earias insulana* Boisdual (Kumaraswami and Ambrose, 1992). The biology, behavior and biocontrol efficiency of *Sycanus reclinatus* Dohrn from Southern India were recorded by Vennison and Ambrose (1992). Some biological characters of *Sycanus sichuanensis* Hsiao were noted based on laboratory rearing and field observations (Hui et al., 2012). The suitability *Tenebrio molitor* Linnaeus and *C. cephalonica* larvae as food sources for the predator *Sycanus dichotomus* Stal was evaluated by examining the effects of different prey consumption on the predator's growth parameters and longevity (Siti and Norman, 2016). The biology, behaviour and predatory efficiency of *Sycanus galbanus* Distant were observed to be frequently predating on

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Helopeltis antonii Signoret, and reared under laboratory conditions by the larvae of greater wax moth *Galleria mellonella* Linnaeus (Nitin et al., 2017). The biology and predatory behaviour of III, IV and V nymphal instars and adults of *Sycanus collaris* (Fabricius) to the larvae of *C. cephalonica* and *S. litura* was observed in the laboratory (Rajan et al., 2017). The *Sycanus annulicornis* Dohrn reared by two preys species (*Crocidolomia pavonana* (Fabricius) and *T. molitor* was used to attack and kill the nettle cater pillar pest *Setothosea asigna* van Eecke in the laboratory (Abdul et al., 2018).

The *Sycanus falleni* Stal (Reduviidae:Hacpartorinae) has been recorded from Cambodia, China, Myanmar and Vietnam. However, the biological and ecological characters of *S. falleni* have so far been little known. In Vietnam, the reduviid *S. falleni* is a common predator on trees in mountainous evergreen forest, lowland semi evergreen forest and agricultural ecosystems in Bac Kan, Cao Bang, Ha Tay, Ha Tinh, Hoa Binh, Ninh Binh, Son La, Vinh Phuc, Dak Lak, Kon Tum, Gia Lai, and Lam Dong province (Truong et al., 2015). The reduviid *S. falleni* has the potential for biological control of pest insects in coffee, cotton and vegetable plants as this species attacks many lepidopteran larvae such as *Anomis flava* Fabricius*, H. armigera*, *S. litura, P. rapae* and *P. xylostela* (Truong, 2016; Truong and Ha, 2017). Moreover, the reduviid predators were mass reared in laboratory by *C. cephalonica* (Ambrose, 2002).

Therefore, this study was conducted to understand biology, predatory ability and body weight of the reduviid *S. falleni* fed on four different preys (*P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica*) under laboratory conditions to provide the basis for using *S. falleni* as biological control agents on vegetable growing areas in Vietnam.

Materials and methods

Materials maintenance

The adults (female and male) of *S. falleni* were collected from Kbang District, Gia Lai province (altitude: 860 ± 7.85 m, latitude: $108^0 30'$ E and $14^0 28'$ N), Yen Chau District, Son La province (altitude: 460 ± 3.58 m, latitude: 104°26′ E and 21°13′ N) and Cuc Phuong, Ninh Binh province (altitude: 426 ± 3.15 m, latitude: 105°37′ E and 20°19′ N) in Vietnam. The adults of *S. falleni* were reared by the *P. rapae*, *S. litura, P. xylostela* and *C. cephalonica* larvae in the laboratory under optimal conditions (temperature: 26 ± 2 °C, relative humidity: 75 ± 5% and light:dark 14:10 h). The preys *P. rapae*, *S. litura* and *P. xylostela* larvae were bred on cabbage plants in broad plastic cages (25 cm wide, 30 cm long and 35 cm high) in laboratory as mentioned above. The prey *C. cephalonica* larvae have mass breeding by material (rice bran mixed corn flour) in the same plastic cages in laboratory. The population of *P. rapae*, *S. litura* and *P. xylostela* larvae were maintained on cabbage plants that cultivated in big pots (height = 50 cm, diameter = 50 cm).

The adults of *S. falleni* (1 male and 1 female) that emerged in the laboratory were allowed to mate in plastic container (height = 25 cm, diameter = 20 cm), they were reared by four preys as *P. rapae*, *S. litura, P. xylostela* and *C. cephalonica,* separately. The plastic containers were carefully examined at regular intervals to record the number of eggs laid after successful copulation. Mated females were maintained individually in order to record the number of batches of eggs and number of eggs in each batch for each predator. The eggs of *S. falleni* were placed separately in plastic containers (height = 15 cm, diameter = 10 cm), and the biological parameters as development stage of egg (day), hatchability of eggs (%) were observed and compared. The nymphs hatched from eggs were reared in plastic containers (height = 20 cm, diameter = 15 cm), they were reared by sets of prey sources separately (*P. rapae*, *S. litura, P. xylostela* and *C. cephalonica)* for two generations and the biological parameters as development stage of nymph (day), survival rate of nymphal period (I-V) (%) of the predators were observed and compared. The adults of *S. falleni* (developed from V nymphal instar) were also reared in plastic containers (height = 25, diameter = 20 cm) by the four preys. After 24 h, adults were separated and sex were identified according to the body size (male smaller than female in size) and genitals. The biological parameters such as number of eggs laid (egg/female), pre-oviposition period of adult (day), male and female longevity (day) and sex ratio (male: female) of the predators were observed and compared. The cotton swabs were changed periodically in order to prevent fungal growth in plastic containers, and 10% honey solution was also provided in each plastic containers. Separate studies on consumption of four preys *P. rapae*, *S. litura, P. xylostela* and *C. cephalonica* by predator *S. falleni* in broad plastic containers (height = 30, diameter = 20 cm) were carried out. The I, II, III, IV and V nymphal instars and adults of *S. falleni* were first starved for 2 h. Each of the I, II, III nymphal instars of predator *S. falleni* were provided with 6 larvae individuals/day for each prey, the IV and V nymphal instars were provided with 10 larva individuals/day for each prey and the adults were provided with 14 larva individuals/day for each prey. The number of prey killed was recorded and then replaced with living larvae every 24 h. The daily consumption of all nymphal stages and adults of *S. falleni* over a period of 6 days was recorded, each based on 6 replicates. The body weight of the I, II, III, IV and V nymphal instars, male and female adults were measured after each molting, the newly molted nymphs and adults (molting from V nymphal instar) were weighed individually by the CP-Sartorius ED 224S analytical balance with a precision of 0.1 mg.

Data analyses

Development stage of egg and nymph, pre-oviposition period of adult, male and female longevity, number of eggs laid, body weight of *S. falleni* reared by different species of prey were compared using one-way analysis of variance (ANOVA), and total nymphal period, survival rate of nymphal period (I-V), life cycle, hatchability of eggs, sex ratio reared by different species of prey were compared using independent t-tests. The numbers of prey consumed by the nymphs and adults of *S. falleni* were also analyzed using one-way ANOVA and independent t-tests. All statistical analyses were carried out at 1% level of significance ($P < 0.01$).

Results

The influence of prey on the details of biological parameters of the reduviid *S. falleni* reared by four different preys (*P. rapae*, *S. litura*, *P. xylostela*, and *C. cephalonica*) were presented in the Table 1. The development of egg, I and II nymph instars of *S. falleni* as shown in Fig. 1. The results show that the different preys (*P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica*) had differently affected to the development stage of I and II nymphal instars ($F = 9.428$, $df = 47$), survival rate of nymphal period (from I to V) ($F = 5.866$, $df = 119$) and number of eggs laid ($F = 30.759$, $df = 23$) of the reduviid *S. falleni* reared in the laboratory, but not the egg development, hatching eggs, the development stage of III, IV and V nymphal instars, life cycle, male and female longevity. However, the longevity of reduviid *S. falleni* female was greater than the male when the adults reared by four different preys. The total development stage of nymph and life cycle of reduviid *S. falleni* reared by larvae of *C. cephalonica* were significantly greater than those reared by the larvae of *P. rapae*, *S. litura* and *P. xylostela*.

The daily consumption of different preys by nymphs and adults of *S. falleni* were summarized in Table 2 and the prey killed by the nymph and adult as shown in Fig. 2. The data shows that the I, II, III, IV and V nymphal instars, male and female adults of the reduviid *S. falleni* consumption the number of four different preys (*P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica* larvae, separately) were different, and the nymphs and adults of the reduviid *S. falleni* consumed more the number of larvae of *P. xylostela* than the larvae *P. rapae*, *S. litura* and *C. cephalonica*. However, no significant difference was recorded in the I

Table 1
Biological parameters of *Sycanus falleni* Stal reared by four different preys.

Biological parameter	Prey species			
	Pieris rapae (Linnaeus)	*Spodoptera litura* (Fabricius)	*Plutela xylostela* (Linnaeus)	*Corcyra cephalonica* (Stainton)
Development stage of egg (day) (n = 288)**	17.64 ± 2.01a	17.85 ± 2.20a	18.17 ± 2.26a	18.63 ± 2.54a
Min-max	15–21	15–21	13–20	15–22
Development stage of nymph (day) (n = 180)**				
I instar	5.38 ± 0.61b	6.17 ± 0.84b	6.64 ± 0.79b	7.48 ± 0.84a
Min-max	4–7	5–8	6–8	6–9
II instar	6.59 ± 0.82b	7.64 ± 0.95b	8.66 ± 1.22a	8.87 ± 1.02a
Min-max	5–8	6–9	7–10	7–10
III instar	8.75 ± 1.09b	9.82 ± 1.45ab	10.25 ± 1.11a	10.27 ± 1.11a
Min-max	6–10	8–12	8–12	8–12
IV instar	9.36 ± 1.27b	11.04 ± 1.28ab	11.75 ± 1.51a	12.53 ± 1.67a
Min-max	7–12	9–13	9–13	10–15
V instar	11.62 ± 1.73b	13.03 ± 1.36ab	13.59 ± 1.61a	14.46 ± 2.15a
Min-max	9–15	11–16	11–16	12–18
Total nymphal period (day)*	41.7 ± 2.44c	48.56 ± 2.93b	50.89 ± 2.69b	54.37 ± 3.06a
Survival rate of nymphal (I-V instar) (%)*	76.73 ± 9.45a	69.30 ± 8.20b	67.76 ± 7.84b	57.33 ± 7.50c
Pre-oviposition period of adult (day) (n = 36) **	10.54 ± 1.20b	11.42 ± 1.42ab	12.61 ± 1.57a	12.71 ± 1.73a
Min-max	9–13	9–14	9–14	10–15
Life cycle (day)*	69.88 ± 5.65c	77.83 ± 6.55b	81.67 ± 6.52b	85.71 ± 7.33a
Male longevity (day) (n = 36) **	40.87 ± 5.57a	36.27 ± 5.40b	41.88 ± 4.85a	38.71 ± 6.22ab
Min-max	32–50	26–45	33–52	27–48
Female longevity (day) (n = 36) **	59.97 ± 6.44a	51.31 ± 7.64bc	54.26 ± 6.28b	45.76 ± 7.36c
Min-max	49–68	39–64	45–65	40–57
Number of eggs laid (eggs/female) (n = 36) **	243.35 ± 33.15a	165.08 ± 24.57b	148.89 ± 17.23c	113.89 ± 18.31d
Min-max	106–290	96–202	85–181	65–142
Number of clusters/female	1–3	1–3	1–3	1–3
Number of eggs/cluster (eggs)	118.08 ± 10.32a	113.11 ± 15.86a	102.66 ± 10.72ab	87.75 ± 11.96b
Hatching eggs (%) (n = 288)*	84.58 ± 8.79a	78.85 ± 9.33ab	75.26 ± 9.50ab	70.96 ± 10.22b
Sex ratio (male:female) *	1: 1.4a	1 : 1.1b	1 : 1.3a	1 : 1.2ab

Means ± SD. Different letters within a row indicate significant differences (P < 0.01). *Data was analyzed using independent t-tests. **Data was analyzed using one-way ANOVA

nymphal instar consumption of larvae of *P. rapae*, *S. litura* and *C. cephalonica* (F = 0.887, df = 77), the II nymphal instar consumption of larvae of *P. rapae* and *C. cephalonica* (F = 1.634, df = 47), the III nymphal instar consumption of larvae of *P. rapae*, *P. xylostela* and *C. cephalonica* (F = 1,352, df = 65), the V nymphal instar consumption of larvae of *P. rapae* and *S. litura* (F = 1.091, df = 53), male adult

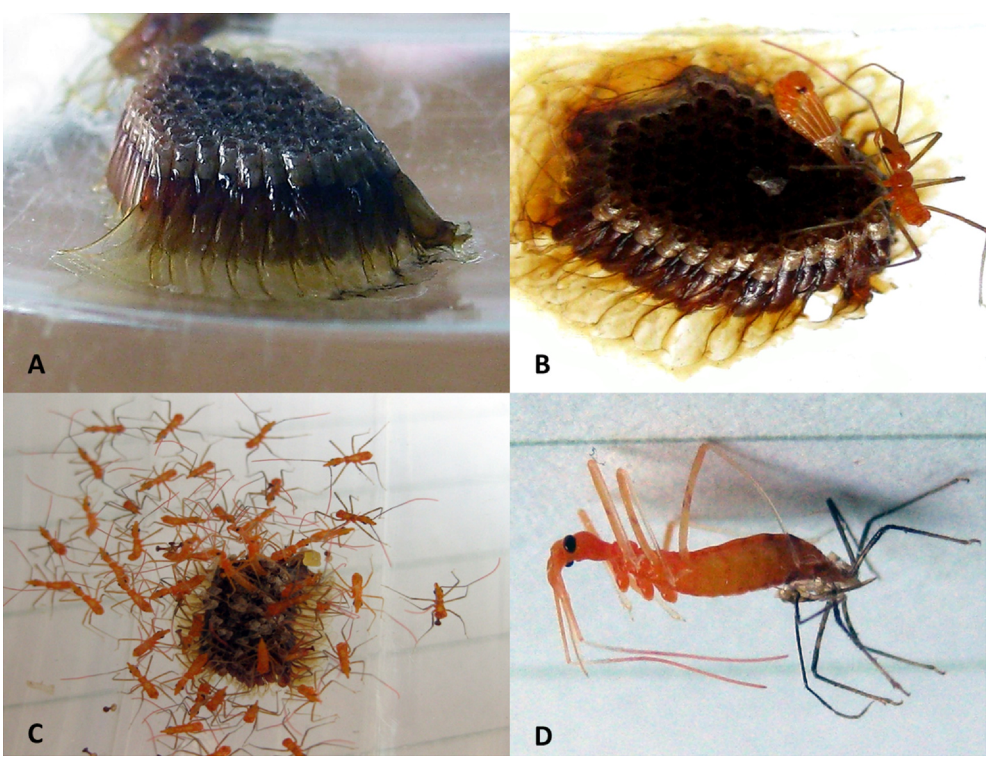

Fig. 1. The development of egg and I, II nymph instars of the reduviid *Sycanus falleni* Stal A. The eggs per cluster; B, C. I nymphal instar hatching from eggs; D. II nymphal instar molting from I nymphal instar (Photogrpahs by Truong X.L.).

Table 2
The number of larvae (larvae/24 h) of *Pieris rapae* (Linnaeus), Spodoptera litura (Fabricius), *Plutela xylostela* (Linnaeus) and *Corcyra cephalonica* (Stainton) consumed by the reduviid *Sycanus falleni* Stal.

Development stages	The prey killed (larvae/24 h)			
	P. rapae	*S. litura*	*P. xylostela*	*C. cephalonica*
Nymphs (n = 280)				
I instars	1.11 ± 0.12b	1.03 ± 0.12b	1.63 ± 0.19a	1.18 ± 0.11b
II instars	2.04 ± 0.26b	1.30 ± 0.16c	2.35 ± 0.29a	2.05 ± 0.26b
III instars	3.26 ± 0.41a	2.16 ± 0.31b	3.63 ± 0.51a	2.96 ± 0.41a
IV instars	4.10 ± 0.56bc	3.17 ± 0.51c	5.72 ± 0.78a	4.79 ± 0.70b
V instars	5.01 ± 0.86c	5.24 ± 0.88c	7.76 ± 0.26a	6.87 ± 1.16b
Adult (n = 48)				
Male	4.81 ± 0.52c	4.86 ± 0.91c	6.84 ± 1.22a	5.75 ± 0.86b
Female	6.49 ± 0.97b	6.99 ± 1.04b	10.37 ± 1.84a	9.55 ± 1.72a

Means ± SD, analyzed using one-way ANOVA. Different letters within a row indicate significant differences (P < 0.01).

consumption of larvae of *P. rapae* and *S. litura* (F = 0.018, df = 11) and the female adults consumption of larvae of *P. rapae* and *S. litura* (F = 0.921, df = 11).

The influence of prey on body weight of the reduviid *S. falleni* reared by the larvae of *P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica* under laboratory conditions at each developmental stage shown in Table 3. The results show that the body weight of the I and V nymphal instars, male and female adults of the reduviid *S. falleni* reared by the larvae of *P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica* were not significantly different (F = 4.938, df = 59), except on the body weight of the V nymphal instar reared by the larvae of *P. rapae* (218.47 ± 31.92 mg), but the body weights of the II, III and IV nymphal instars reared by the larvae of *P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica* were significant difference (F = 50.541, df = 53). The II, III and IV nymphal instars of reduviid *S. falleni* reared by the larvae of *P. rapae* had the body weights which was significantly greater than when reared by the larvae of *S. litura*, *P. xylostela* and C. *cephalonica*. The increase in body weights from I nymphal instar to V nymphal instar of reduviid *S. falleni* reared by the larvae of *P. rapae* (22.42 to 218.47 mg) was significantly faster than those reared by the larvae of *S. litura*, *P. xylostela* and *C. cephalonica* (21.55 to 182.02, 20.31 to 176.23 and 20.16 to 162.26 mg, respectively) (F = 147.627, df = 27).

Discussion

The nutrient composition of each species prey not only affects the development of predatory insects, but also their survival and reproduction (Huang et al., 2013; Bong et al., 2014; Lv et al., 2016). Egg development and hatching eggs of reduviid *S. falleni* weren't significantly different when reared by four different preys (*P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica*), which agree with previous studies of reduviid *S. collaris* reared by two different preys (*S. litura* and *C. cephalonica*) (Rajan et al., 2017), but different from the study of Abdul et al. (2018), in which the egg development and hatching eggs of reduviid *S. annulicornis* was significantly different when reared by two different preys (*T. molitor* and *C. pavonana*). The different species of preys (*P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica*) had differently affected to the development period of I and II nymphal instars of the reduviid *S. falleni*, which were similar to the reduviid *S. annulicornis* reared by different preys (*T. molitor* and *C. pavonana*) (Abdul et al., 2018). The development period of IV and V nymphal instars of reduviid *S. falleni* reared by the larvae of *C. cephalonica* weren't significantly

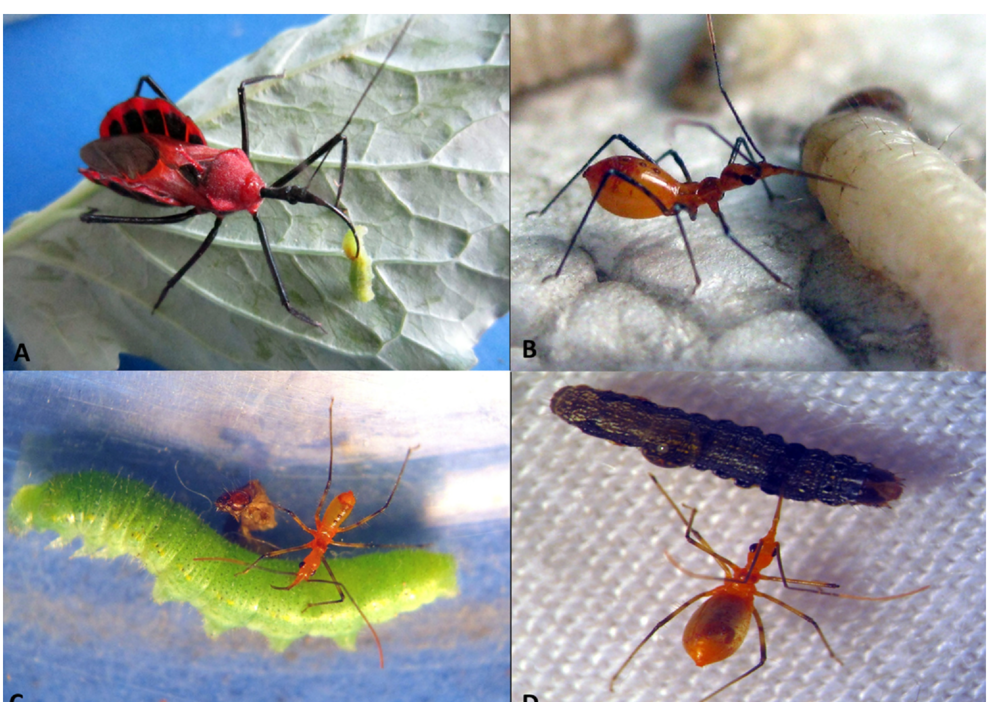

Fig. 2. The prey killed by the nymph and adult of the reduviid *Sycanus falleni* Stal A. The diamond back moth *Plutela xylostela* killed by adult; B. The rice meal moth *Corcyra cephalonica* Stainton killed by III nymph instar; C. The cabbage white *Pieris rapae* (Linnaeus) killed by III nymph instar; D. The leafworm *Spodoptera litura* (Fabricius) killed by II nymph instar (Photogrpahs by Truong X.L.)

Table 3
Body weight (mg) of *Sycanus falleni* Stal reared by four different preys.

Development stages	Prey species			
	Pieris rapae (Linnaeus)	*Spodoptera litura* (Fabricius)	*Plutela xylostela* (Linnaeus)	*Corcyra cephalonica* (Stainton)
Nymph (n = 120)				
I instar	22.42 ± 2.55a	21.55 ± 2.46a	20.31 ± 2.30a	20.16 ± 2.30a
II instar	40.01 ± 4.98a	33.54 ± 4.18b	28.58 ± 3.56c	27.84 ± 3.47c
III instar	96.33 ± 12.01a	78.20 ± 9.75b	59.29 ± 7.39c	40.87 ± 5.09d
IV instar	133.12 ± 18.14a	122.47 ± 16.69b	120.87 ± 16.69b	84.87 ± 11.56c
V instar	218.47 ± 31.92a	182.02 ± 27.10b	176.23 ± 26.23b	162.26 ± 24.15b
Adult (n = 48)				
Male	242.40 ± 36.09a	229.66 ± 34.19a	233.99 ± 34.83a	226.46 ± 33.71a
Female	271.96 ± 40.48a	261.42 ± 38.92a	252.85 ± 37.64a	251.01 ± 37.37a

Mean ± SD. Different letters within a row indicate significant differences. ANOVA – analysis of variance.

different, which was similar to the development period of IV and V nymphal instars of reduviid *S. dichotomus* reared by the larvae of *C. cephalonica* (Zulkefli et al., 2004). However, this result was different from the study of Rajan et al. (2017), in which the development periods of I, II, III, IV and V nymphal instars of reduviid *S. collaris* reared by the larvae of *C. cephalonica* were different.

The development period of nymph of reduviid *S. falleni* reared by *P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica* were shorter than some species of genus *Sycanus* as the reduviid *S. versicolor* reared by the larvae of *H. armigera* and *E. insulana*, the reduviid *S. dichotomus* reared by the larvae of *T. molitor, C. cephalonica* and *P. xylostella*, the reduviid *S. annulicornis* reared by the larvae of *T. molitor* and *C. pavonana*, the reduviid *S. galbanus* reared by larvae of *G. mellonella* (Kumaraswami and Ambrose, 1992; Siti and Norman, 2016; Zulkefli et al., 2004; Nitin et al., 2017).

The longevity of adult predatory insects may be significantly affected by the their prey (Srikumar et al., 2014). In the present study, the female longevity was longer than male when they were reared by four different preys which was a common feature of most reduviids (Ambrose et al., 1990; 2007;; Saharayayaj, 2002; Srikumar et al., 2014; Shanker et al., 2016; Nitin et al., 2017). However, the males living longer than females was also reported for the reduviid Sycanus aurantiacus Ishikawa et Okajima reared by the coleopteran T. molitor (Yuliadhi et al., 2015), for reduviid *S. annulicornis* reared by *C. pavonana* (Abdul et al., 2018).

The ability to lay eggs of reduviid *S. falleni* reared by four different preys was similar as reduviids S. dichotomus, *S. galbanus*, *S. annulicornis* and *S. collaris* (Zulkefli et al., 2004; Nitin et al., 2017; Abdul et al., 2018; Rajan et al., 2017). The number eggs/cluster of reduviid *S. falleni* reared by *P. xylostela* and *C. cephalonica* was smaller than the reduviid S. dichotomus reared by larvae of *P. xylostela* and *C. cephalonica* (Zulkefli et al., 2004), the reduviid *S. annulicornis* reared by larvae of *C. pavonana* (Abdul et al., 2018). However this result was greater the reduviids S. aurantiacus and *S. sichuanensis* reared by larvae of *T. molitor* (Yuliadhi et al., 2015; Hui et al., 2012). The total number of eggs laid of reduviid *S. falleni* reared by *P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica* was greater than the reduviid *S. galbanus* reared by larvae of *G. mellonella* (Nitin et al., 2017), the reduviid *S. annulicornis* reared by larvae of *T. molitor* and *C. pavonana* (Abdul et al., 2018), and was lower than the reduviid *S. collaris* reared by larvae *C. cephalonica* and *S. litura* (Rajan et al., 2017).

The females of the reduviid *S. falleni* consumed more the number of larvae of *P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica* than the males which was presumably to meet their reproductive needs for eggs production. This result was similar to previous studies on another species of family Reduviidae such as Rhynocoris marginatus (Fabricius) (Sahayaraj et al., 2016), *Coranus fuscipennis* Reuter (Truong, 2016) and *S. annulicornis* (Abdul et al., 2018). The nymphs and adults of the reduviid *S. falleni* consumption of the number of larvae of *P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica* was similar to the III, IV and V nymphal instars and female adults of the reduviid *S. annulicornis* consumption of larvae of *T. molitor* and *C. pavonana*. However, this result was diffirent with the I and II nymphal instars and male adults of the reduviid *S. annulicornis* consumption of larvae of *T. molitor* and *C. pavonana* (Abdul et al., 2018).

The body weight of the I and II nymphal instars of the reduviid *S. falleni* reared by the larvae of *P. xylostela* and *C. cephalonica* were similar to the I and II nymphal instars of the reduviid *S. annulicornis* reared by the larvae of *T. molitor* and *C. pavonana* (Abdul et al., 2018), and this result was different with the I and II nymphal instars of the reduviid *S. dichotomus* reared by the larvae of *C. cephalonica* and *P. xylostella*. The body weight of the III nymphal instar of the reduviid *S. falleni* reared by the larvae of *P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica* was similar to the III nymphal instar of the reduviid *S. annulicornis* reared by the larvae of *C. pavonana* (Abdul et al., 2018), of the III nymphal instar of the reduviid *S. dichotomus* reared by the larvae of *T. molitor* and *C. cephalonica* (Siti and Norman, 2016). The body weight of IV nymphal instar of the reduviid *S. falleni* reared by larvae of *S. litura* and *P. xylostela* was different with the IV nymphal instar of the reduviid *S. dichotomus* reared by the larvae of *T. molitor* and *C. cephalonica* (Siti and Norman, 2016). The body weight of male and female adults of the reduviid *S. falleni* reared by the larvae of *P. rapae*, *S. litura*, *P. xylostela* and *C. cephalonica* were similar to the reduviid *S. dichotomus* reared by the larvae of *C. cephalonica*, *P. xylostella* and *T. molitor* (Zulkefli et al., 2004; Siti and Norman, 2016), but were different the reduviid *S. annulicornis* reared by the larvae of *T. molitor* and *C. pavonana* (Abdul et al., 2018).

Conclusions

The influence of fed on four different preys as *P. rapae*, *S. litura, P. xylostella* and *C. cephalonica* on biological parameters, ability to eat prey and body weight of the nymph and adult of reduviid *S. falleni* indicate that the nymphal instars and adults of *S. falleni* can be easily mass rearing in laboratory by the rice meal moth *C. cephalonica* for integrated insect pests management (*P. rapae*, *S. litura* and *P. xylostella)* on the vegetable crops in Vietnam.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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