Journal of Biotechnology **18**(2): 265-272, 2020

THE FUNCTIONAL RESPONSE AND PREDATORY ABILITY OF THE REDUVIID *CORANUS FUSCIPENNIS* REUTER (HETEROPTERA: REDUVIIDAE) FED ON THE RICE MEAL MOTH *CORCYRA CEPHALONICA* (STAINTON)

Truong Xuan Lam[1,2,✉], Nguyen Thi Phuong Lien[1,2], Nguyen Quang Cuong[1]

[1]*Institute of Ecology and Biological Resources (IEBR), Vietnam Academy of Science and Technology*
[2]*Graduate University of Science and Technology (GUST), Vietnam Academy of Science and Technology*

✉To whom correspondence should be addressed. E-mail: txlam.iebr@gmail.com

Received: 03.4.2020
Accepted: 11.5.2020

SUMMARY

The reduviid *Coranus fuscipennis* Reuter (Heteroptera: Reduviidae) is an important predator for biological control the pests of vegetables in Vietnam. The functional response of the 2nd, 3rd, 4th, 5th nymphal instars and adult male and female of the predator *C. fuscipennis* to the larvae of rice meal moth *Corcyra cephalonica* (Stainton) (Lepidoptera: Pyralidae) was evaluated in laboratory conditions (temperature 30±2ºC; relative humidity 75±5%; and 14:10 h Light:Dark). The results show that the nymph and adult of *C. fuscipennis* responded to different densities of prey. They killed more number of prey at higher prey densities and less prey at lower prey densities that produced a curve linear type II functional response (Holling 1959). The maximum consumption was always found restricted when rearing the *C. fuscipennis* at high prey densities. The relationship between the predation rate of the *C. fuscipennis* and the prey densities was negative correlation (R is between 0.70 and 0.98), but between the number prey killed and the prey density is positive correlation. The searching time prey of the *C. fuscipennis* decreased when the prey densities increased that was confirmed by the negative correlation (R between 0.85 and 0.98). The reduviid *C. fuscipennis* bred by the *C. cephalonica* in laboratory and they can use for biological control some pests of vegetables (*P rapae*, *S. litura* and *P. xylostella*) in Vietnam.

Keywords: *Coranus fuscipennis*, predation, prey, density, function response.

INTRODUCTION

The functional response of a predator is one of the important key factors regulating population dynamics of predator and prey systems which describes the relationship between the consumption rate of an individual predator and prey density, and the variation in the number of prey consumed per unit time in relation to prey density (Mandour *et al.* 2006). The functional responsive curves can be used to infer basic mechanisms related to predator and prey, enhancing biological control (Houc & Strauss 1985).When the number of predators per unit time is plotted against the number of prey available per predator, any one of the following types of functional responses can occur: i) an increasing linear relationship (type I), ii) a decelerating curve relationship (type II) and iii) sigmoidal relationship (type III), and the functional response of most beneficial arthropods is either type II or type III (Holling, 1959, Luck, 1985).

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, Jalali, 1997; Liu *et al*., 2002). The rice meal moth *Corcyra cephalonica* Stainton (Lepidoptera: Pyralidae) is one of the most dangerous pests of stored rice and corn, and this species was mass rearing in laboratory to produce moth egg parasite *Trichogramma* spp. for biological control pest in Vietnam (Con, Chau 2001).

The reduviids are polyphagous species, and they are either known as predators of many dangerous pests in agricultural ecosystem. The reduviid *Coranus fuscipennis* Reuter is an important predator and its preys were recorded such *S. litura*, *P. xylostella, P. rapae*, *Anomis flava* (Fabricius), *Hedylepta indicate* (Fabricius), *Achaea janata* Linnaeus and *Ostrinia furnacalis* (Guenee) (Ambrose 2002; , 2003, Truong, 2016). Moreover, the reduviid *C. fuscipennis* can mass reared in laboratory by the rice meal moth *C. cephalonica* (Ambrose, 2002).

Therefore, this study was conducted to understand the functional response of nymphal instars and adult male and female of the reduviid *C. fuscipennis* to species *C. cephalonica* in order to provide the scientific basis for breeding of the reduviid *C. fuscipennis* by larvae of *C. cephalonica* for controlling the pests of vegetables in Vietnam.

MATERIALS AND METHODS

Materials maintenance

The adults (female and male) of *C. fuscipennis* were collected from Ea Kar District, Dak Lak Province (altitude: 450±7.85 m; latitude: 108º31′ E and 12º46′ N), Central Highlands of Vietnam. In the laboratory conditions (temperature 30±2ºC; relative humidity 75±5%; and 14:10 h Light:Dark) they were reared by prey (rice meal moth larvae *C. cephalonica*) in plastic containers (height =25, diameter =20 cm) to collect eggs. The eggs of *C. fuscipennis* were placed separately in plastic containers (height=15 cm, diameter=10 cm). The nymphs hatched from eggs were reared separately in plastic containers (heigh=20 cm, diameter=15 cm) using prey sources (*C. cephalonica)*. The adults of *C. fuscipennis* (developed from 5th nymphal instar) were reared in plastic containers (height=25, diameter =20 cm) also by the prey sources, after 24h adults were separated and sexed according to the size and genitals (male smaller than female in size). In each plastic containers the wet cotton swabs were changed periodically in order to prevent fungal growth, and 10% honey solution was also provided every day.

The 2nd, 3rd, 4th, 5th nymphal instars of the *C. fuscipennis* starved for 2h, and the female and male adult starved for 24h before being used. The prey *C. cephalonica* were introduced to in plastic containers (height =25, diameter =20 cm). After 15 minutes, each stages of the predator *C. fuscipennis* was entered in plastic containers at prey densities 2, 4, 6, 8, 10 and 12 individuals. The number of prey in plastic containers is always constant by replacing the dead prey individuals with the live ones. The observation time for the 2nd, 3rd nymphal instars of *C. fuscipennis* were 5 days, for the 4th, 5th nymphal instars, female adult and male adult were 6 days. Six replicates were maintained for each prey density. All killed and consumed preys were recorded at 24h intervals.

The study on predatory ability of instars and adult of the predator *C. fuscipennis* fed by the *C. cephalonica* was carried out in plastic containers (height= 30, diameter = 20 cm). The preys (*P. rapae*, *S. litura* and *P. xylostella)* was first introduced to cabbage plants in broad plastic cages (25 cm wide, 30 cm long, 35 cm high), and these species are maintained on cabbage plants in the experimental period. The 2nd, 3rd, 4th, 5thnymphal instar of the *C.*

fuscipennis starved for 2h, the female and male adult starved for 24h before being used. All killed and consumed preys were recorded at 24h intervals, the number of preys is always constant by replacing the dead prey individuals with the live ones. Three repetitions were maintained for each experiment. The body weight of the 2nd, 3rd, 4th, 5th nymphal instars, male and female adults were measured individually by the CP-Sartorius ED 224S analytical balance with a precision of 0.1 mg.

Data analyses

The linear type II equation of Holling (1959) was used for to find out the functional response of the predator to different prey density following parameters: $Y = a\ T_s\ x$ (1).

Where : x = prey density; Y = total number of prey killed in given period of time (T_t); T_s= time spent by the predator in searching prey; a = rate of discovery per unit of searching time $[(\frac{y}{x})/T_s]$. If we presume that each prey requires a constant amount of time 'b' for consumption then $T_s = T_t - by$ (2). Where: T_t = total time in days when prey was exposed to the predator; b = time spent handling each prey by the predator $(\frac{T_t}{k})$; k = the maximum prey consumption. The parameters (b), (k), and (a) were directly measured in the present study. The handling time (b) was estimated as the time spent for pursuing, subduing, feeding and digesting each prey. The maximum prey consumption was represented by the k value. Substituting 2 in 1: $Y = a\ (T_t - by)\ x$.

The regression analysis was made to determine the relationship between the prey density and the number of prey consumed, searching time, attack ratio, handling and recovery time (Daniel, 1987). All statistical analyses were carried out at 1% level of significance ($P < 0.01$)

RESULTS AND DISCUSSION

The maximum prey consumption (k value) was always found restricted at high prey density (k=1.36, 2.13, 3.21, 4.35, 3.45 and 5.02 for the 2nd, 3rd, 4th, 5th nymphal instars, male and female adult of predator *C. fuscipennis* to larvae *C. cephalonica*, respectively). This was confirmed by the relationship between the prey density and the prey killed which is positive correlation (y= 0.547 + 0.071x, R= 0.970; y= 0.517 + 0.147x, R= 0.979; y= 0.950 + 0.209x, R= 0.920; y= 1.369 + 0.280x, R= 0.882; y= 1.401 + 0.193x, R= 0.857 and y= 2.166 + 0.258x, R= 0.864 for the 2nd, 3rd, 4th, 5th nymphal instars, adult males and females of predator *C. fuscipennis* to *C. cephalonica* larvae, respectively). However, the relationship between the predation rate and the prey density is negative correlation (y= 30.610 - 1.815x, R= -0.93; y= 36.019 -1.598x, R= -0.94; y= 54.429 -2.326x, R= -0.92; y= 73.241 - 2.964x, R= -0.77; y= 108.690 -5.988x, R= -0.77 and y= 70.120 -3.555x, R= -0.92 for the 2nd, 3rd, 4th, 5th nymphal instars, adult males and females of predator *C. fuscipennis* to *C. cephalonica* larvae, respectively) (Figs1, 2). The female predators were more vigorous in responding to the increasing prey density. This result is similar to the result of Ambrose *et al.* (2009), Manimuthu *et al.* (2011) and Jesu *et al.* (2011). The relationship between the predation rate of each stage of the predator *C. fuscipennis* and prey densities was negative correlation which indicates the increase in prey consumption at high prey densities might be due to the probability of contacts between the predators and preys increased which makes the number of prey surviving at low prey density always higher than at high prey densities. This results was similar to the observations of Propp (1982), Claver, Ambrose (2002), Ravichandran, Ambrose (2006), Manimuthu *et al.* (2011), Jesu *et al.* (2011).

The negative correlations were obtained between the searching time prey of the predator *C. fuscipennis* and all prey densities (y= 2.285 - 0.205x, R= -0.961; y= 3.047 - 0.276x, R= -0.982; y= 4.099 - 0.390x, R= -0.908; y= 4.109 - 0.386x, R= -0.882; y= 3.561 - 0.335x, R= -0.857 and y= 3.396 - 0.390x, R= -0.862 for the 2nd, 3rd, 4th, 5th nymphal instars, adult males and females of predator *C. fuscipennis* to *C. cephalonica* larvae, respectively).

This was also shows that the searching time prey of the 2nd, 3rd, 4th, 5th nymphal instars decreased from 2.94 to 1.38, and the attack rate of prey increased from 0.18 to 0.52. The adult females of predator *C. fuscipennis* searching time prey was shortest (b = 1.20), and attack rate of prey was highest (0.67). The handling time prey was depended on the size of the prey because the predator take a longer time to eat larger prey, so the successful attacks were more frequent on small prey and also reduced the risk of injury to the predator. This results was similar to studies on heteropteran predators as *Reduviolus americoferous* Carayon (Flinn *et al.* 1985), *Sinea confusa* Caudell (Cohen 2000), *Canthecona furcellata* (Wolff) (Cogni *et al.* 2003), *Zelus renardii* Kolenati and *A. pedestris* (Jesu *et al.,* 2011).

The body weight of the nymphal instars, adult males and females of the reduviid *C. fuscipennis* fed on the larvae of *C. cephalonica* shown in table 1. The results showed that the body weights from 1st nymphal instar to 5th nymphal instar increased from 12.16 mg to 103.46 mg and the body weight of adult female was biggest.

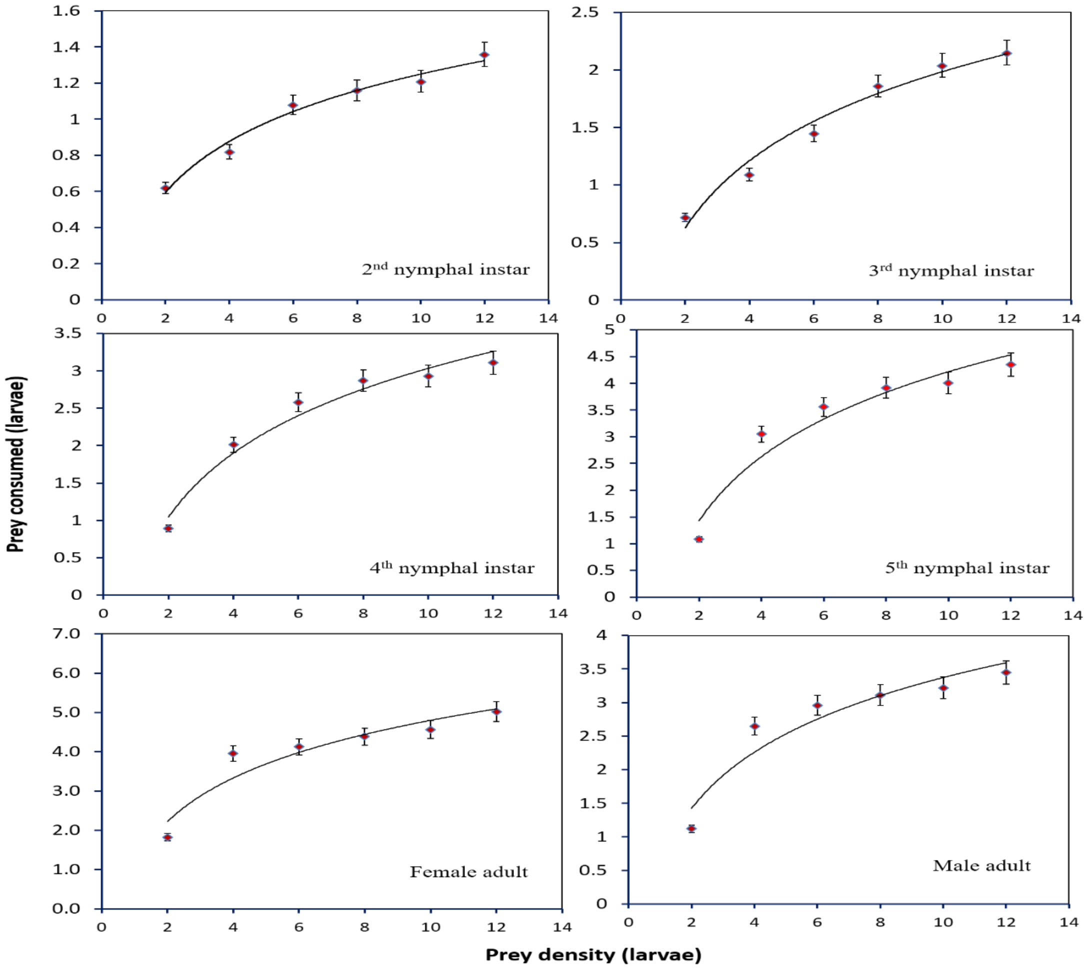

Figure 1. Functional response of predator *Coranus fuscipennis* Reuter to *Corcyra cephalonica* (Stainton) in the plastic containers. Points show mean number of prey eaten or killed by *C. fuscipennis* at different prey densities. The curves line shows the Hollings model for a type II functional response (Holling 1959). Error bars show standard errors.

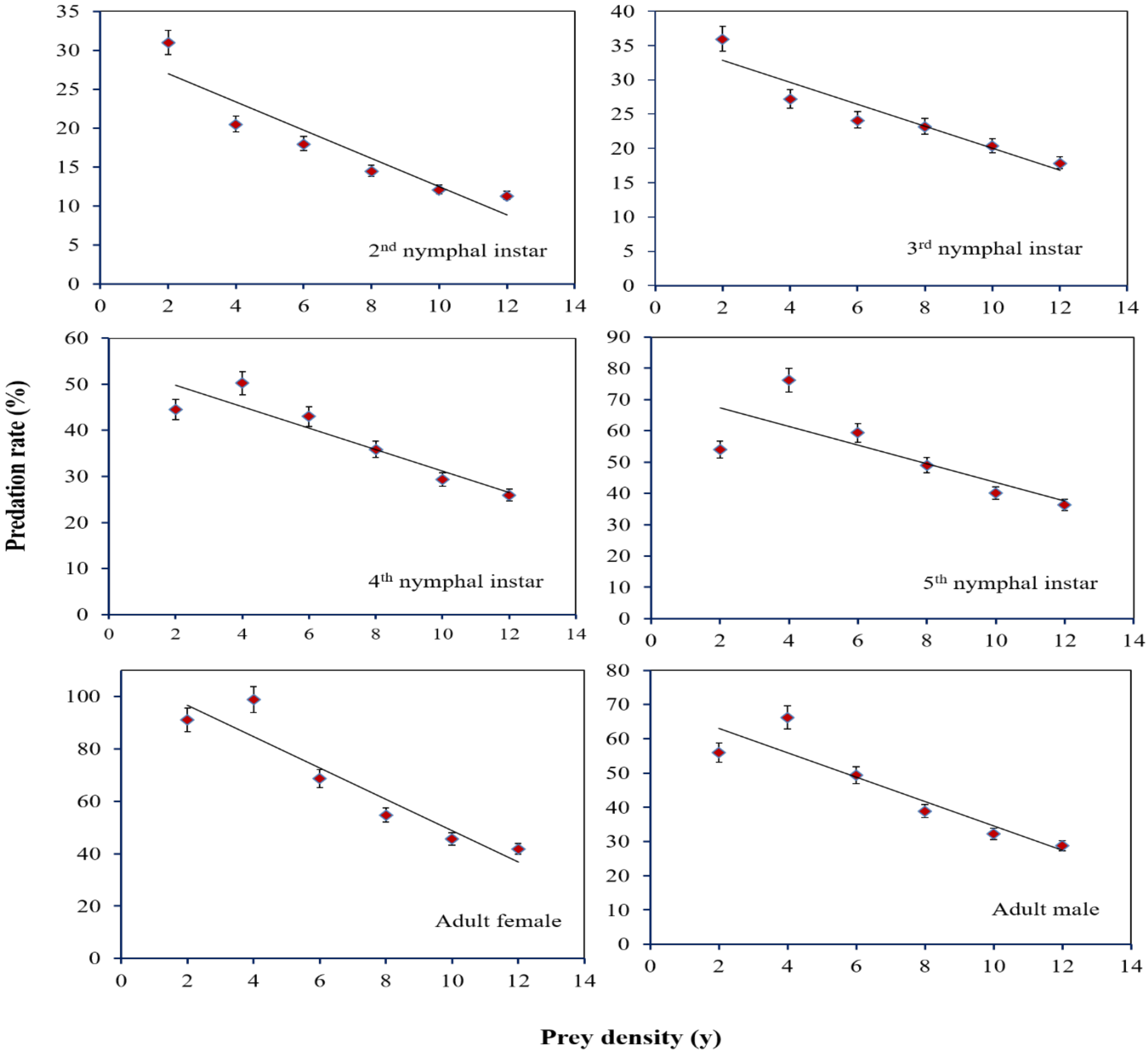

Figure 2. The predation rate of predator *Coranus fuscipennis* Reuter to *Corcyra cephalonica* (Stainton) in the plastic containers. Points show the predation rate (%) of by *C. fuscipennis* Reuter at at different prey densities. Error bars show standard errors.

The predatory ability of the reduviid *C. fuscipennis* rearing on the rice meal moth *C. cephalonica* to some pests of vegetables (*P. rapae*, *S. litura* and *P. xylostella)* was recorded in table 2. The data shows that the 1stnymphal instar did not consume the pests. The 2nd, 3rd, 4th, 5th nymphal instars and adult consumed the larvae *P. xylostella* more than the *P. rapae* and *S. litura*. The number of pests (*P. rapae*, *S. litura* and *P. xylostella)* were consumed by female adult more than male adult. The number of larvae *P. xylostella* killed by female adult was highest. The number of *P. rapae*, *S. litura* and *P. xylostella* were killed by5th nymphal instars more than the2nd, 3rd and 4th nymphal instars. The body weight of the 1st, 2nd, 3rd, 4th, 5th nymphal instars, male and female adults of the reduviid *C. fuscipennis* reared by the larvae of *C. cephalonica* were smaller than the reduviid *S. dichotomus* with the prey the larvae of *C. cephalonica*, of the reduviid *S. collaris* with the prey larvae *C. cephalonica* and *S. litura* (Siti, Norman 2016, Rajan*et al.* 2017).

Table 1. Body weight (mean ± SD) of *Coranus fuscipennis* Reuter fed on the larvae of *Corcyra cephalonica* (Stainton). Temperature: 30±2ºC, relative humidity: 75±5% and Light:Dark 14:10 h.

Development stages	Body weight (mg)
1st nymphal instar (n=72)	12.16 ± 1.85
2nd nymphal instar (n=72)	17.57 ± 3.14
3rd nymphal instar (n=72)	26.28 ± 4.81
4th nymphal instar (n=62)	55.23 ± 10.75
5th nymphal instar (n=62)	103.46 ± 21.88
Adult male (n=48)	144.39 ± 30.53
Adult female (n=48)	160.04 ± 33.84

Table 2. The number (mean ± SD) of *Spodoptera litura* Fabricius, *Pieris rapae* (Linnaeus) and *Plutella xylostella* (Linnaeus) were killed by the predator *Coranus fuscipennis* Reuter. Temperature: 30±2ºC, relative humidity: 75±5% and Light:Dark 14:10 h.

Development stages	**The pests of vegetables killed (larvae/24h)**		
	S. litura	***P. rapae***	***P. xylostella***
1st nymphal instar	-	-	
2nd nymphal instar	0.85 ± 0.18 a	1.08 ± 0.28 ab	1.98 ± 0.80 b
3rd nymphal instar	1.25 ± 0.35 a	1.90 ± 0.64 b	2.28 ± 1.10 c
4th nymphal instar	1.64 ± 0.35 a	2.56 ± 0.72 b	3.46 ± 1.26 c
5th nymphal instar	2.31 ± 0.67 a	2.81 ± 0.81 ab	4.62 ± 1.50 b
Male adult	2.06 ± 0.56 a	2.65 ± 0.61 ab	3.91 ± 1.26 b
Female adult	2.69 ± 0.56 a	3.21 ± 0.67 b	5.42 ± 2.19 c

Means followed by the same letter in row are not significantly different based on a oneway ANOVA (P<0.01)

CONCLUSION

The nymph and adult of *C. fuscipennis* killed more prey (the larvae of *C. cephalonica)* at higher prey densities and less prey at lower prey densities that produced a curve linear type II functional response (Holling 1959). The relationship between the predation rate of the *C. fuscipennis* and the prey densities was negative correlation (R= 0.70 - 0.98), and between the prey density and the prey killed is positive correlation. The body weights from 1st nymphal instar to 5th nymphal instar of *C. fuscipennis* fed on the larvae of *C. cephalonica* increased (12.16 - 103.46 mg). The number of the pests of vegetables (*P. rapae*, *S. litura* and *P. xylostella)* were killed by 5th nymphal instars of *C. fuscipennis* more than the 2nd, 3rd and 4th nymphal instars.

Acknowledgments: *This research was funded by Vietnam National Foundation for Science and Technology Development (NAFOSTED) under grant number 106-NN.06-2015.35 to Truong Xuan Lam.*

REFERENCES

Ambrose, DP (2002) Assassin bugs (Heteroptera: Reduviidae) in integrated pest management programme: Success and Strategis. In: Strategies in Integrated Pest Management:Current Trends and Future Prospects, (eds.) Ignacimuthu, S. and Sen, A." Phoenix Publishing House Pvt. Ltd., New Delhi, India: 73–85.

Ambrose D (2003) Biological potential of assassin bugs (Hemiptera: Reduviidae). *J Exp Zool India* 6(1): 1–44.

Ambrose DP, Rajan SX, Jebasingh NK, Krishnan SS (2009) Biology, behaviour and functional response of *Sphedanolestes variabilis* Distant (Insecta: Hemiptera: Reduviidae: Harpactorinae), a potential predator of lepidopteran pests. *Entomol Croat* 13(2): 33–44.

Claver MA, Ramasubbu G, Ravichandran B, Ambrose DP (2002) Searching behaviour, functional response of *Rhynocoris longifrons* (Stål) (Heteroptera:Reduviidaae), a key predator of a pod sucking bug, *Clavigralla gibbosa*. *Entomol* 27(4): 339–346.

Cogni R, FreitasAV, Amaral FilhoBF (2003) Influence of prey size on predation success by *Zelus longipes* L. (Heteroptera, Reduviidae). *J Appl Entomol* 126: 74–78.

Cohen AC (2000) How carnivorous bugs feed. In:Heteroptera of Economic Importance, (eds.) Schaefer, C.W. and Panizzi, A.R., CRC Press, Boca Raton: 563–570.

Con VQ, Chau NN (2001) Development of biological control as key compoment for ecologically sustainable agricultural in Vietnam, High – Tech for Sustainable Agricultural. Proceeding of the APEC Symposium on Advances Technology for Sustainable Agricultural: 85–95.

Flinn PW, Hower AA, Taylor RA (1985) Preference of *Reduviolus americoferous* (Hemiptera:Nabidae) for potato leaf hopper nymphs and pea aphids. *Can Ent* 117(12): 1503–1508.

Propp GD (1982) Functional response of Nabis americoferus to two of its prey *Spodoptrea exigua* and *Lygus hesperus*. Environ. *Entomol* 11: 670–674.

Holling CS (1959) Some characteristics of simple types of predation and parasitism. *Can Ent* 91(7): 385–398.

Houc MA, Strauss RE (1985) The comparative study of functional responses: Experimental design and statistical interpretation. *Can Ent* 117(5): 617–629.

Liu TX, Stansly PA (2002) Functional response and plant preference of *Nephaspis oculatus* (Coleoptera: Coccinellidae) preying on *Bemisia argentifolii* (Bemiar) (Homoptera: Aleyrodidae) in the laboratory. *Entomol Sin* 9 1J9: 16–23.

Liu SS, Chen FZ, Zalucki MP (2002) Development and survival of the diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae), at constant and alternating temperatures. *Environ Entomol* 31: 1–12.

Luck RF (1985) Principles of arthropod predation. In: Ecological Entomology. *Ecol Entomol*, New York: 497–530.

Mandour NS, Basha NA, Liu TX (2006) Functional response of the ladybird, *Cydonia vicina* nilotica to cowpea aphid, *Aphis craccivora* in the laboratory. *Insect Sci* 13: 49–54.

Manimuthu M, Jesu RS, Micheal RJ, Ganesh KA and Ambrose PM (2011) Functional response of assassin bug, *Acanthaspispedestris*Stål to rice meal moth larva, *Corcyra cephalonica* (Stainton) and termite, *Odontotermesobesus* Rambur. Entomology Research Unit, St. Xavier's College, Palayamkottai, India: 302–308.

Jesu Rajan S, Micheal Raja J, Sivarama Krishnan S, Rajan K, Ambrose DP (2011) Biology of assassin bug, *Acanthaspis pedestris* Atal (Hemiptera:Reduviidae) on two prey species, *Corcyra cephalonica* (Stainton) (Lepidoptera: Pyralidae) and *Odontotermes obesus* Rambur (Isoptera: Termitidae). Entomology Research Unit, St Xavier's College Palayamkottai India: 130–133.

Ravichandran B, Ambrose DP (2006) Functional response of a reduviid predator *Acanthaspis pedestris* Stål (Hemiptera: Reduviidae) on three lepidopteran insect pests. *Entomol* 31(3): 1–9.

Rajan SJ, Suneetha N, Sathish R (2017) Biology and predatory behavior of an assassin bug, *Sycanuscollaris* (Fabricius) on rice meal moth, Corcyra cephalonica (Stainton) and leaf armyworm, Spodopteralitura (Fabricius). Agric. Update, 12 (Techsear-5): 1181–1186.

Singh SE, Arbogast RT (2008) Predatory response of *Xylocoris flavipes* to bruchid pests of stored food legumes. *Entomol Exp Appl* 126: 107–114.

Siti NA, Norman K (2016) Growth and longevity of the insect predator, *Sycanusdichotomus* Stal. fed on live insect larvae. *J Oil Palm Res* 28 (4): 471– 478.

Truong XL (2016) The species diversity of assassin bugs (Heteroptera: Reduviidae) and their preys in Central highlands of Vietnam. Biological Forum – An International Journa, 8(2): 247–252.

PHẢN ỨNG CHỨC NĂNG VÀ KHẢ NĂNG ĂN MỒI CỦA LOÀI BỌ XÍT BẮT MỒI *Coranus fuscipennis* Reuter (HETEROPTERA: REDUVIIDAE) ĐỐI VỚI LOÀI NGÀI GẠO *Corcyra cephalonica* (Stainton)

Trương Xuân Lam[1,2] , Nguyễn Thị Phương Liên[1,2], Nguyễn Quang Cường[1]

[1]Viện Sinh thái và Tài nguyên sinh vật, Viện Hàn lâm Khoa học và Công nghệ Việt Nam
[2]Học viện Khoa học và Công nghệ, Viện Hàn lâm Khoa học và Công nghệ Việt Nam

TÓM TẮT

Loài bọ xít *Coranus fuscipennis* Reuter (Heteroptera: Reduviidae) là một loài bắt mồi quan trọng trên sinh quần rau ở Việt Nam. Phản ứng chức năng của các thiếu trùng tuổi 2, 3, 4, 5 và trưởng thành của loài bắt mồi *C. fuscipennis* đối với ấu trùng ngài gạo *Corcyra cephalonica* (Stainton) (Lepidoptera: Pyralidae) được xác định trong điều kiện phòng thí nghiệm (nhiệt độ 30±2ºC; độ ẩm 75±5%; và 14:10 h sáng:tối). Kết quả cho thấy, các tuổi thiếu trùng và con trưởng thành đực và cái của loài bắt mồi *C. fuscipennis* có phản ứng với các mật độ con mồi khác nhau và giết chết nhiều con mồi ở mật độ con mồi cao. Phản ứng chức năng này thể hiện phản ứng chức năng loại II (Holling, 1959). Mức tiêu thụ con mồi cao nhất luôn bị giới hạn khi nuôi loài bắt mồi *C. fuscipennis*. Mối quan hệ giữa khả năng ăn mồi của thiếu trùng tuổi 2, 3, 4 và 5, trưởng thành cái và đực của loài bọ xít bắt mồi *C. fuscipennis* với các mật độ con mồi khác nhau luôn thể hiện là mối tương quan nghịch (R= 0,70- 0,98), trong khi mối quan hệ giữa mật độ con mồi với số lượng con mồi bị giết bởi bọ xít bắt mồi *C. fuscipennis* thể hiện mối tương quan thuận. Khi mật độ con mồi tăng lên, thời gian tìm kiếm con mồi của các tuổi thiếu trùng và trưởng thành của loài bắt mồi *C. fuscipennis* giảm thể hiện mối tương quan nghịch (R=0,85-0,98). Loài bọ xít bắt mồi *C. fuscipennis* được nuôi bởi ngài gạo *C. cephalonica* có khả năng tiêu thụ tốt các loài gây hại trên rau như sâu xanh bướm trắng *P. rapae*, sâu khoang *S. litura* và sâu tơ *P. xylostella* và có thể sử dụng bọ xít bắt mồi *C. fuscipennis* được nuôi bởi ngài gạo *C. cephalonica* để kiểm soát sâu hại trên rau ở Việt Nam.

Từ khóa: Bọ xít bắt mồi, con mồi, mật độ, phản ứng chức năng, *Coranus fuscipennis*.