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P Suyal
Department of Entomology, College of Agriculture
G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

RP Maurya
Department of Entomology, College of Agriculture
G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

D Chaudhary
Department of Entomology, College of Agriculture
G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

P Dobhal
Department of Entomology, College of Agriculture
G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

Corresponding Author:
P Suyal
Department of Entomology, College of Agriculture
G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand, India

Effect of live and freeze killed larvae of preffered hosts on the biological attributes of predatory bug, *E. furcellata*

P Suyal, RP Maurya, D Chaudhary and P Dobhal

Abstract
Pentatomid predatory bug, *Eocanthecona furcellata* is a potential predator which effectively controls different lepidopteran pests of various crop ecosystems. Hence, proper utilization of this predator in biological control of insect pests is the need of the hour. In this regard, experiment was conducted to study the suitability of freeze killed larvae of *Spodoptera litura* and *Corcyra cephalonica* for mass rearing of *E. furcellata* based on different biological attributes. The total adult period of predator on live larvae varied significantly with frozen larvae of both the prey. The maximum consumption rate of adult predatory bug was recorded on freeze killed larvae of *S. litura* while minimum consumption rate was observed on live larvae of *C. cephalonica*. The results revealed that *E. furcellata* can be successfully reared on the live and frozen larvae of both the prey in laboratory conditions. Therefore, live and freeze killed larvae of *S. litura* and *C. cephalonica* may be exploited for mass rearing of predatory bug in laboratory conditions.

Keywords: biological attributes, *Corcyra cephalonica*, *Eocanthecona furcellata*, freeze killed larvae, mass rearing, *Spodoptera litura*

Introduction
Eocanthecona furcellata (Wolff) (Hemipetra: Pentatomidae) has been considered as an important predator of several important lepidopteran pests in different crop ecosystem [18, 11, 10, 1, 13] and also from forest ecosystem [2]. In Uttarakhand, the predator has been found majorly predating on *Spodoptera litura*, *Maruca vitrata*, *Mythimna seprata*, *Clostera fulgurita*, *Cnaphalocrosis* sp. and many hairy caterpillars [8]. Host specificity and eco-friendly nature of *E. furcellata* encourages its use in insect pest management programme. For proper utilization of *E. furcellata* in IPM programme, it becomes imperative to mass produce this predatory bug in laboratory conditions. In any mass multiplication programme of biological control agents, easy availability and easy culturing of the host are the prime prerequisites. *Corcyra cephalonica* and *S. litura* has been found as preferred hosts for laboratory rearing of *E. furcellata* [8]. Owing to the voracious feeding of this predatory bug, it has been observed that the maintenance of continuous supply of host larvae is a major challenge in mass rearing programmes. Hence, storage and supply of the preferred larval stage becomes of utmost importance throughout the season. Supply of freeze killed larvae of preferred hosts might be an option for maintaining the predator culture in the laboratory. Reduviid bug, *Rhynocoris marginatus* was successfully reared on freeze killed larvae of *C. cephalonica* to maintain sufficient population of the host in the laboratory [12]. Keeping the above fact in mind, present investigation was carried out to observe the effect of the freeze killed larvae of the preferred host on the biology and predation efficiency of *E. furcellata* so that, freeze killed larvae could be utilized in mass rearing programmes during non-availability of host.

Material and Methods
Maintenance of host insects and predator culture
Present investigation was carried out at Biological Control Laboratory, G. B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, Uttarakhand (India) during 2019-20. The stock culture of *S. litura* was maintained on artificial diet which was prepared by mixing kabuli gram flour, methyl- para- hydroxyl benzoate, yeast powder and ascorbic acid in a mixer grinder and later Agar was added to the diet for the purpose of solidification [14].

The laboratory culture of *C. cephalonica* was also maintained in the laboratory [6].

The culture of predatory bug was maintained in plastic containers (20×20×15 cm) lined with blotting paper and moist cotton for maintaining the moisture. A ventilator hole with fine wire mesh was given in the lid of the rearing box. The culture of *E. furcellata* was maintained in the laboratory at temperature 27±2 °C, relative humidity 70±5% and photoperiod 12±1 hrs. Initial culture of the predatory bug, *E. furcellata* was collected from field and maintained in laboratory conditions [16]. Owing to the zoo- phytophagous nature of early instars of *E. furcellata*, chopped beans were provided to 1st instar nymphs and from 2nd instar onwards, larvae of *C. cephalonica* were provided for the maintenance of initial culture of *E. furcellata*.

Experiment with live and freeze killed host larvae

The frozen larvae of both the hosts (*S. litura* and *C.cephalonica*) were obtained by placing them at -20ºC in deep freezer for 24hrs. Second instar nymphs of *E. furcellata* were placed in plastic rearing boxes (20×20×15 cm) lined with blotting paper and moist cotton. Owing to the sap feeding nature of the first instar nymph, predation efficiency of the bug was studied from the second instar. 10 nymphs per box were separated and were maintained on live and freeze killed larvae of both the hosts in separate rearing boxes. Daily 10 numbers of both forms of hosts were provided separately to the bugs to observe the predation rate of each instar (Fig 3). Observations on biological parameters (nymphal period, adult period, total life cycle, fecundity and incubation period) and predation rate of *E. furcellata* fed on live and frozen host were recorded. The data on predation efficiency of bug was recorded after 24 hours. For predation efficiency, number of larvae consumed every day were counted and recorded. The experiment was replicated thrice. The consumed larvae of each factitious host were replaced from the box and the boxes were cleaned daily to maintain the hygienic conditions.

The obtained data was subjected to statistical analysis which was carried out in SPSS (Statistical Package for Social Sciences, version 16). Data was subjected to analysis of Variance (ANOVA) [3]. The significance of results was verified with one way ANOVA and statistical significance of result were measured by using Duncan's multiple range post hoc test at $P < 0.05$.

Results and Discussion

Results on biology of *E. furcellata* on different forms *i.e* live and frozen larvae of *S. litura* and *C. cephalonica* are shown in Table 1. On live and frozen *S.litura* larvae, the predatory bug completed its life cycle on 37.75±0.13 and 36.23± 0.24 days, respectively. Whereas, it took 35.05 ±0.33 and 35.33 ±0.42 days on live and frozen larvae of *C. cephalonica*, respectively. Observations revealed that the predatory bug passed five nymphal instars on live and frozen *S. litura* with total nymphal period of 20.25 ± 0.22 and 19.75± 0.20 days, respectively. Similarly, on live and frozen *C.cephalonica* total nymphal period of *E. furcellata* was 17.46± 0.23and 19.08± 0.12days, respectively. The duration for first instar nymph did not showed much variation as they are non-predacious and fed on plant sap. However, the first instar nymphal period ranged from 2.66± 0.08 days to 3.3±0.12 days. Second instar onwards, nymphs started feeding on the given hosts. Second nymphal periods range between 2.5 ± 0.15 to 3.71± 0.15 days. Third and fourth nymphal periods ranged between 3.21 ± 0.08 to 4.23 ± 0.24 days and 4.46 ± 0.19 to 6.50± 0.34 days, respectively. For the fifth instar, maximum period (4.93±0.13 days) was recorded on frozen *C. cephalonica* larvae and minimum nymphal period (3.93± 0.10 days) was observed on live *C. cephalonica* larvae. The maximum cumulative nymphal period (20.25 days ± 0.22 days) of predator was observed on live larvae of *S. litura* which varied non-significantly with cumulative nymphal period (19.75 days ± 0.20 days) on frozen larvae of *S. litura*. Whereas, predator took minimum 17.46 ± 0.23 days on live larvae of *C. cephalonica* which varied significantly with cumulative nymphal period (19.08 days ± 0.12 days) on froze larvae of *C. cephalonica* to complete nymphal stage. The total adult period of predator on live larvae of *S. litura* (18.01±0.13 days) varied significantly with frozen larvae of *S. litura* (17.26 ± 0.16 days). Similarly, on live larvae of *C. cephalonica* total adult period of the predator (15.81 ± 0.26 days) varied significantly with frozen larvae of *C. cephalonica* (17.56 ± 0.34 days). The total shortest life span (35.05±0.33 days) of predator *E. furcellata* was recorded on live larvae of *C. cephalonica* which did not differ significantly with frozen larvae *C. cephalonica* (35.33±0.42 days). Number of eggs laid by the predator feeding on frozen larvae differ significantly with predator feeding on live larvae of both the insect. The lowest number of eggs were laid (36.16±1.35 eggs) on live larvae of *C. cephalonica* followed by frozen larvae of *C. cephalonica* (59.50±0.42 eggs). The highest egg laying was observed on live larvae *S. litura* with maximum egg laying of 67.83±0.65 eggs which varied significantly with frozen larvae *S. litura* (62.66±0.55 eggs) (Fig 1). Maximum incubation period of 8.33± 0.21 days was recorded on live larvae of *C. cephalonica* which varied significantly with frozen larvae *C. Cephalonica* in which minimum incubation period of 7.00±0.51 days was observed (Fig 1). Incubation period on live larvae *S. litura* (7.50±0.20 days) varied significantly with frozen larvae *S. litura* (7.33±0.49 days).

Previous studies on the biology of *E. furcellata* on *S. litura* and *C. cephalonica* reported that the total nymphal period was observed to be 24.33 days with a total period of life cycle of around 31.33 days on *C. cephalonica* [16]. The total nymphal period of *E. furcellata* on *S. litura* was reported to be 16.78 days [7]. A similar study was conducted to observe the effect of live and freeze killed larvae of *G. mellonella* and *E. kuhniella* on another predatory bug, *A. spinidens* and recorded that the predatory bug, *A. spinidens* were able to pass through its nymphal stages in five stages [9]. The biology of *E. furcellata* is also studied on freeze killed larvae of mulberry silkworm and it was eported that the predatory bug completed its nymphal development in 32 days [5]. Highest average number of eggs per bath among the females of *Rhynocoris marginatus* fed with live larvae of *C. cephalonica* [12].

Results presented in Table 2 on predation efficiency of *E. furcellata* on different factitious hosts indicated that the first instar larvae were non predacious and second instar onward the predation efficiency of *E. furcellata* increases with an increasing rate upto fifth instar for all the given hosts. Data on per cent predation by nymphs of *E. furcellata* varied significantly between live and frozen larvae of both the hosts. Whereas, in adults percent predation between the frozen larvae of *S. litura* and *C. cephalonica* varied non-significantly and per cent predation between live larvae of both was differed significantly. Maximum adult predation (87.63±0.75%) was observed on live larvae of *S. litura* followed by (76.79±0.90) frozen *C. cephalonica*. Maximum total mean predation 78.78% was observed on live larvae of *S. litura* followed by 69.03% on frozen larvae of *S.litura*. While, minimum total mean predation 54.81% was observed in live larvae of *C. cephalonica* (Fig 2). Results revealed that the mean predation between the live and frozen larvae of *S.litura* varied significantly of *E. furcellata*. It was observed that mean per cent predation on frozen larvae of both the pests was at par and did not vary significantly.

Previous work has reported that the 1st nymphal instar of predatory bugs do not feed on hosts [15, 16, 4]. Another scientist reported that the consumption rates of 2nd nymphal instar, 3rd nymphal instar, 4th nymphal instar, 5th nymphal instar of female predatory bug, *E. furcellata* were 7.6, 19.3, 57.3 larvae [17]. Also, the consumption rate of adult predatory bug is comparatively less than the nymphal instars [4].

Table 1: Effect of live and freeze killed larvae of preferred hosts on biological parameters of *E. furcellata*.

Treatment	Development Period (in days)*										
	Nymphal stages					Total nymphal period	Adult period	Total Life Period	Eggs laid	Eggs hatched	Incubation period
	1st	2nd	3rd	4th	5th						
S. litura live larvae	3.3±0.12c	3.71±0.15c	4.23±0.24b	4.61±0.9a	4.38±0.13b	20.25±0.22c	18.01±0.13c	37.75±0.13c	67.83±0.65d	63.83±0.79c	7.5±0.2ab
S. litura frozen larvae	3.05±0.04b	2.5±0.15a	3.55±0.25a	6.5±0.34c	4.15±0.08ab	19.75±0.20c	17.26±0.16b	36.23±0.24b	62.66±0.55b	61.66±0.65c	7.33±0.49ab
C. cephalonica live larvae	2.71±0.07a	3.01±0.01b	3.21±0.08a	4.46±0.19a	3.93±0.10a	17.46±0.23a	15.81±0.26a	35.05± 0.33a	36.16±1.35a	32.5±1.727a	8.33±0.21b
C.cephalonica frozen larvae	2.66±0.08a	2.83±0.09b	3.45±0.105a	5.2±0.15b	4.93±0.13c	19.08±0.12b	17.56±0.34bc	35.33±0.42a	59.50±0.42b	54.66±1.11b	7±0.51a

*Values are of mean of three replicates ±S.E. Significant difference at $p<0.05$ were calculated by one way ANOVA. Values followed by the same letter within a column are not significantly different and different letters with in column are significantly different (Duncan's multiple range post hoc test)

Table 2: Effect of live and freeze killed larvae of preferred hosts on predatory efficiency of *E. furcellata*.

Treatment	Predation efficiency (%)							
	Nymphal stages					Mean Predation	Adult predation	Mean Predation
	1st	2nd	3rd	4th	5th			
S. litura live larvae	No feeding	42.2±0.78c	74.53±2.28c	79.26±1.50c	83.8±0.75c	69.94d	87.63±0.75c	78.78c
S. litura frozen larvae	No feeding	36.2±0.69b	66.41±0.32b	69±2.08b	74.43±2.7b	61.51c	76.56±2.45b	69.03b
C. cephalonica live larvae	No feeding	39.2±1.30a	60.07±2.51a	60.36±1.30a	56.06±1.35a	53.92a	55.76±2.07a	54.81a
C.cephalonica frozen larvae	No feeding	34.16±1.27a	59.02±1.73a	63.63±1.08a	70.6±1.451b	56.85b	76.79±0.90b	66.82b

*Values are of mean of three replicates ±S.E. Significant difference at $p<0.05$ were calculated by One way ANOVA. Values followed by the same letter within a column are not significantly different and different letters with in column are significantly different (Duncan's multiple range post hoc test)

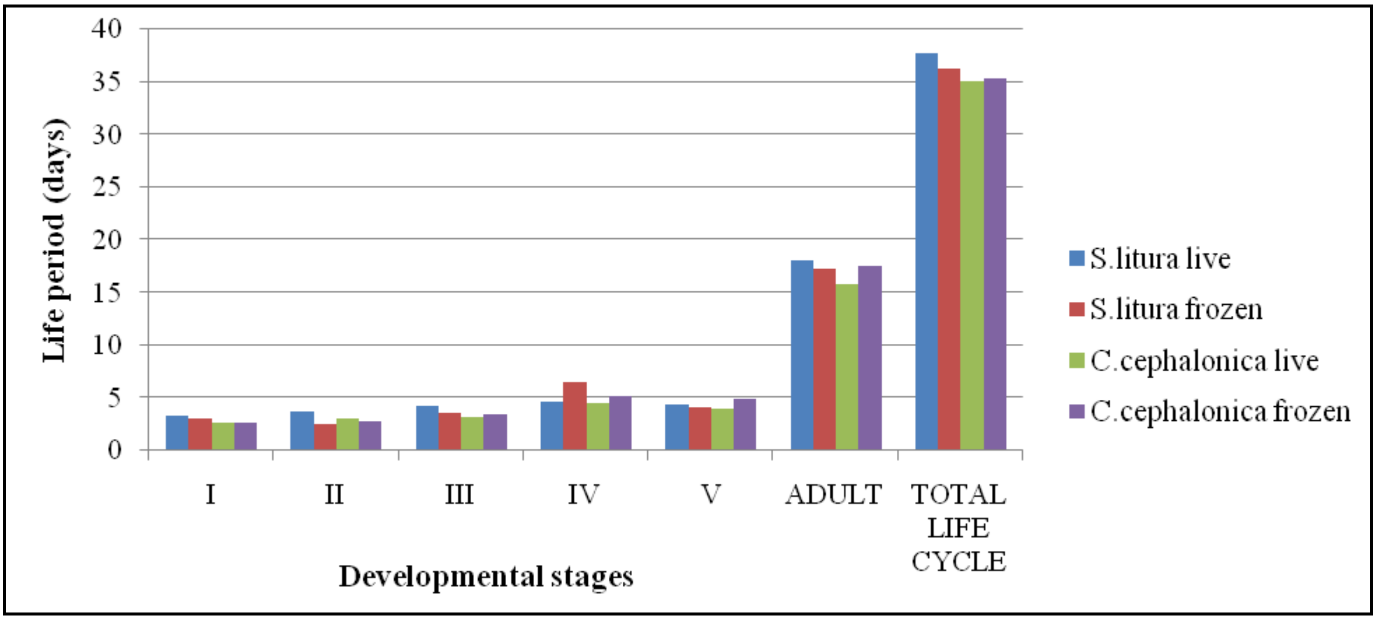

Fig 1: Effect of live and freeze killed larvae of preferred hosts on biological parameters of *E. furcellata*

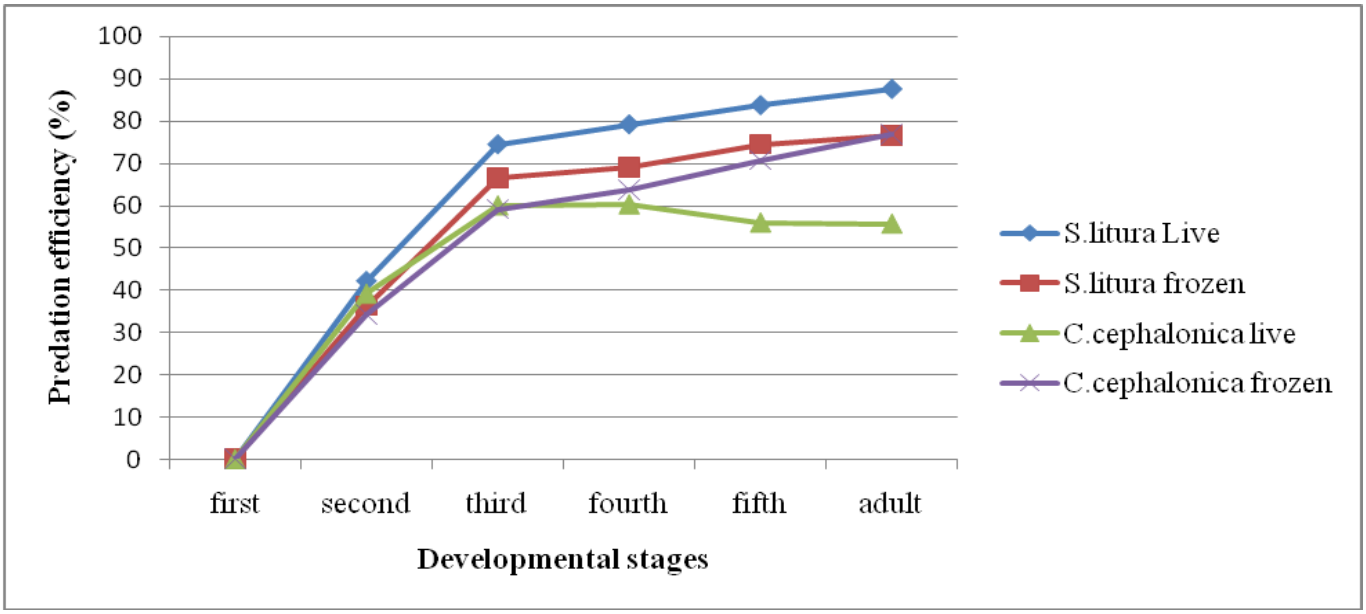

Fig 2: Effect of live and freeze killed larvae of preferred hosts on predatory efficiency of *E. furcellata*

Fig 3: *Eocanthecona furcellata* feeding on live and freeze killed larvae of different factitious host

Conclusion

The present work reflects that the predatory bug was able to complete its life cycle successfully on different factitious hosts viz., live and freeze killed larvae of *S. litura* and *C. cephalonica*. Therefore, to ensure the proper availability of the prey round the year, the frozen larvae of *S. litura* and *C. cephalonica* may be effectively used for feeding the predator when there is non-availability of host in the fields during non-cropping season. Thus the predatory bug, *E. furcellata* could be mass reared in laboratory conditions by exploiting live and freeze killed larvae of *S. litura* and *C. cephalonica*.

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References

1. Agnihotri M, Pillai AK, Ruhila A. Seasonal abundance of predatory stink bug in Pigeon pea. Annals of Plant Protection Sciences 2012;20:464-509.
2. Aland SR, Mamlayya AB, Kohli YJ, Bharmal DL, Bhawane GP. Studies on the heteropteran (Insecta: Heteroptera) fauna of Amba Reserved Forest, Western Ghats, Maharashtra. The Bioscan 2010;5(3):461-463.
3. Arkkelin D. Using SPSS to understand research and data analysis 2014.
4. Bhatnagar VK, Maurya RP, Brijwal L, Dobhal P, Suyal P, Singh NK. Study on variability among predatory stink bug, *Eocanthecona furcellata* (Wolff.) (Hemiptera: Pentatomidae) population thriving in different agroecosystems of north- western Himalayas, India. Journal of Entomology and Zoological Studies

2019;7(3):726-736.
5. Kimura H, Noguchi Y. Rearing of *Eocanthecona furcellata* (Wolff.) on the frozen larvae of silkworms, *Bombyx mori*. Bulletin of the Horticultural Institute, Ibaraki Agricultural Center (Japan) 2001
6. Kumar S, Maurya RP, Khan MA. Compartive performance of different rearing container on biology attributes of *Corcyra cephalonica*. Annals of Plant Protection Sciences 2005;13(2):465-466.
7. Kumar S, Mumtaz R, Maurya RP, Ahmad T, Singh SV, Khan MA. Life cycle of predatory bug, *Canthecona furcellata* on *Corcyra cephalonica*. Annals of Plant Protection Sciences 2007;15(1):124-126.
8. Maurya RP, Tiwari S. Relationship of predatory bug, *Eocanthecona furcellata* with lepidopteran insect pests infesting different genotypes of pigeonpea. In: Proceeding of 3rd Asia National Meet of Entomologist. October 7-8, ICAR-Indian Institute of Horticultural Research, Hesaraghatta, Bengaluru, Karnataka 2016, 57.
9. Mohaghegh J, Amir- Maafi M. Reproduction of the predatory stinkbug *Andrallus spinidens* (F.) (Heteroptera: Pentatomidae) on live and frozen prey. Applied Entomology and Zoology. 2007;42(1):15-20.
10. Nebapure SM, Agnihotri M. *Canthecona furcellata*: A predator of *Maruca vitrata*. Annals of Plant Protection Sciences 2011;19(2):477-478.
11. Nyunt KT. Impact of planting dates on the population of cotton pests and natural enemies in Myanmar. Thesis, M.Sc. Georg-August University, Goettingen, Germany. 2001, 99.
12. Sahyaraj K, Jeyslekshmi T. Mass rearing of *Rhynocoris marginatus* Fab. On live and frozen larvae of *Corcyra cephalonica* (Stainton). Entomological Croatian 2002;6(1, 2):35-49.
13. Sharma AK, Bisem S, Bisem UK. Comparative analysis on activity of major predatory and insect pest species of paddy in two distinct (forming-ecological) locations through light trap. The Ecoscan. 2015;9(1, 2):81-84.
14. Shorey HH, Hale RL. Mass-rearing of the larvae of nine noctuid species on a simple artificial medium. Journal of economic Entomology 1965;58(3):522-524.
15. Singh KJ, Singh OP. Biology of a pentatomid predator, *Andrallus spinidens* (Fab.) on *Rivula* sp., a pest of soybean in Madhya Pradesh. Journal of Insect Science. 1989;2(2):134-138.
16. Tiwari S, Maurya RP, Pandey AK. Effect of different insect hosts on biology and predation efficiency of *Eocanthecona furcellata* Wolff (Hemiptera: Pentatomidae). The Bioscan 2017;12(1):193-197.
17. Tuan SJ, Yeh CC, Atlihan R, Chi H. Linking life table and predation rate for biological control: A comparative study of *Eocanthecona furcellata* (Hemiptera: Pentatomidae) fed on *Spodoptera litura* (Lepidoptera: Noctuidae) and *Plutella xylostella* (Lepidoptera: Plutellidae). Journal of Economic Entomology 2016;109(1):13-24.
18. Yi NN, Win Kyi. Biological control of cotton bollworm and chickpea pod borer, Helicoverpa armigera using predator *Eocanthecona furcellata* and parasitoid *Campoletis chlorideae*. *In* : Proceeding of the annual research conference, April 3-5, 2000, Yangon, Myanmar 2000, 58-74.