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Feeding potential of anthocorid bug, *Blaptostethus pallescens* (Poppius) (Hemiptera: Anthocoridae) against eggs of pear psylla, *Cacopsylla pyricola* (Foerster) (Homoptera: Psyllidae) on pear in Kashmir

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Abstract
The anthocorid bug, *Blaptostethus pallescens* (Poppius) from ICAR-NBAIR, Bengaluru, India showed positive response against eggs of pear psylla, *Cacopsylla pyricola* (Foerster). Feeding potential of an individual bugof *B. pallescens* from 1st instar to adult was 3.4 to 9.4, 5.2 to 9.6 and 6.2 to 10.0 eggs on 1st 2nd and 3rd day respectively at 1:15 predator prey ratio/ day. Per cent host egg mortality caused by feeding during 3 day'stime, by 1st instar nymph to adult ranged 27.03 to 61.34. Data on rate of consumption among each stage of the predator was found statistically significant on 1st 2nd and 3rd day. Total egg consumption by 1st instar, 2nd instar, 3rd instar, 4th instar and adult was worked out as 11.19, 24.52, 27.36, 43.52 and 160.74 respectively. An individual bug in its life time of 35 days consumed 267.33 eggs of pear psylla. Total egg consumption was found strongly correlated with the stage of the predator (r= 0.925**; d.f.= 23). Regression equation between host stage vs. per day rate of egg consumption (Y = 3.38 + 1.14X) and host stage vs. host egg mortality was established as Y = 24.48 + 8.26X).

Keywords: *Blaptostethus pallescens*, eggs, feeding potential, pear, pear psylla, Kashmir

1. Introduction
Pear is the next important pome fruit after apple, in Kashmir. In India, Kashmir ranks first in pear production out of 10 states, sharing about 29.23% of total 322.24 thousand tonne [4]. In the erstwhile state of Jammu & Kashmir, pear is grown in an area of 13945 ha with a total productivity of 86034 metric tonne [5]. The fruit is though cultivated in all the three regions of the former state Jammu, Kashmir and Ladakh and in almost every district. District Budgam however tops both in acreage (1636 ha.) and production (17685 metric tonne) [5]. Pear production however is affected by the presence of a number of insect pests and diseases throughout world. Notable among insects are pear psylla, *Cacopsylla pyricola*, San Jose scale, *Quadraspidiotus perniciosus*, Codling moth, *Cydia pomonella*, Green peach aphid, *Myzus persicae*, spider mite, *Tetranychus urticae*, stink bugs, *Halyomorpha halys*, oblique banded leaf roller, *Choristoneura rosaceana*, European red mite, *Panonychus ulmi*, pear rust mite, *Epitrimerus pyri*, pear leaf blister mite, root borer, *Dorysthenes hugelii*, Thrips, *Taeniothrips* sp., *Eriophyes pyri* etc [6]. In Kashmir however, pear psylla, San Jose scale, Green peach aphid, spider mite, thrips, pear rust mite and pear leaf blister mite are of common occurrence. Out of these, pear psylla, *Cacopsylla pyricola* (Foerster) is considered an important pest of pear.
Of the two generations of pear psylla in Kashmir, the summer generation is observed during the month of late April which lays a number of eggs on twigs which hatch during 1st to 2ndweek of May depending upon the weather condition. The first instar and late instar nymphs live on the shoots, excreting a large amount of honeydew responsible for heavy damages to the plant. Fruit damage occurs by feeding of nymph on leaves causing production of honeydew which apart from reducing rate of photosynthesis [12, 13] also acts as substrate for sooty mold and black fungal growth. Mild impacts lead to fruit skin russeting, psylla shock and pear decline [9] while severe problems result in fruit drop. It is also known to vector plant pathogens Phytoplasmas which cause pear decline disease in Japan and Korea [14].

Pear psylla, although an important pest of Kashmir, but not much effort has been made in this direction as indicated by the documented literature [3, 16, 17, 21]. Discovery of a new species of pear psylla, *Cacopsylla bidens* [20] from Kashmir however indicates the need of further explorations and management aspect.In view of socio-environmental perspective, health risks and development of insecticide resistance in pear psylla [11], some eco-friendly approaches like use of plant origin compounds [24, 27], processed Kaolin [18] and use of natural enemies [15] have been suggested by many workers.

Association of some natural enemies such as coccinellid beetles, *Chrysoperla* sp., anthocorid bugs and some parasitoids with pear psylla have been reported from Turkey [12]. *Deraeocoris brevis*, a mirid bug was reported to consume about 400 eggs and nymphs of pear psylla in its entire life time [12]. Interaction between *Harmonia axyridis* (Pallas) and *Cacopsylla chinensis* (Yang & Li) was reported in China [25]. Occurrence of anthocorid bugs along with pear psylla is also reported from California [6]. Attraction of anthocorids more to orchards with high density of pear *Psylla* is documented [10]. However use of anthocorids in India against the said pest has not been studied so far.

In view of natural association of anthocorid bugs with pear psylla as mentioned above, the predatory potential of *B. pallescens* was therefore evaluated in laboratory against eggs of pear psylla, *C. pyricola* for its future exploitation in field against the management of pest.

2. Materials and Methods

The present work was conducted in the Biological Control laboratory of the Division of Entomology of Sher-e-Kashmir University of Agricultural Sciences and Technology, Kashmir, (Jammu & Kashmir), during 2018. Twigs of pear with fresh eggs of pear psylla, *C. pyricola* were collected from the high density orchards of University campus of Shalimar, Srinagar (34° 4' 18.3" N 74° 48' 15.552" E) during the month of May- June and brought to lab for its evaluation against anthocorid bug, *B. pallescens*. Culture of anthocorid bugs from NBAIR, Bangalore, India was maintained on eggs of *Corcyra cephalonica* as per standard procedure [8]. A single newly hatched nymph of B. *pallescens* was isolated from the nucleus culture and transferred in a glass test tube (150 x 40 mm) containing 15 eggs of *C. pyricola* on a 7-8 cm. long twig of pear. Prior to exposure of eggs to the anthocorid bugs, each twig was waxed at both ends in order to retain moisture and help eggs to survive till hatching. After every 24 h the twig was replaced with fresh supply of 15 eggs until death of an adult. The old twigs with eggs, were transferred each day in new glass test tube for observation on egg hatching. Number of eggs that failed to hatch from each sample was considered as consumed by the bug. Rate of consumption by the first instar on daily basis, every three days as well as total consumption during its instar period was duly recorded. Rate of consumption from 2nd to fourth instar grubs was recorded in similar way. Rate of consumption by adult bug was determined by supplying 15 eggs daily till the death of the predator. Each experiment was replicated five times and conducted in BOD maintained at 27±1ºC, 65±5 % relative humidity and 14: 10 (L:D).

2.1 Consumption rate/day: Consumption of eggs by the predator was indicated by failure of egg hatch. Actual rate of consumption per day by 1st instar nymph to adult was determined by subtracting number of unhatched eggs in untreated control from total prey consumed during a period of three days and dividing the mean value of the replicates by 3.

2.2 Consumption rate/ 3day: Similarly,rate ofconsumption during first three days was subtracted from the number of unhatched eggs in untreated control and averaged for the five replicates. Data on consumption rate/ 3 day was considered important for the purpose of statistical comparison in view of varying developmental period of each instar.

2.3 Prey Consumption during stage: Stage wise prey consumption by 1st instar to adult bug was determined by multiplying period of days in a stadia by per day rate of consumption.

2.4 Total Feeding potential: Total number of eggs consumed by the predator in its life time, from first instar nymph till death of an adult bug indicated total feeding potential of the *B. pallescens.*

Per cent host egg mortality: Per cent mortality of host eggs of each sample was determined by dividing number of unhatched eggs from total number of eggs offered, and multiplied by 100. Correct mortality was determined by using Abbott's formula [1]: T-C/100-C X100 (where T= % mortality in treated condition; C= % mortality in untreated control condition).In untreated control condition, an average of 8.0 % mortality of eggs of pear psylla was recorded which was used to obtain corrected mortality of the host.

3. Statistical analysis

Minitab 11.12 (Minitab LLC) was used to analyze the data for ANOVA. Corrected mortality was transformed to arc sin for statistical analysis. One way ANOVA was determined to compare the transformed data for its statistical significance. Coefficient of correlation and Regression values were determined from untransformed data. Regression model Y= a+bx was established for average consumption and % rate of prey consumption at given predator: prey ratio.

4. Results and Discussion

An individual bug of *Blaptostethus pallescens* from 1st instar to adult was found to consume an average of 3.4± 0.54 to 9.4±0.54, 5.2±0.83 to 9.6±1.14 and 6.2±0.83 to 10.0±1.00 eggs of pear psylla on 1st 2nd and 3rd day respectively at 1:15 predator prey ratio/ day. Data on rate of consumption when compared for nymphal instars to adult through one way ANOVA for 1st day (F= 77.38**; d.f.= 4(16); p= < 0.001), 2nd day (F= 27.85**; d.f.= 4(16); p= < 0.001) and 3rd day (F= 17.02**; d.f.= 4(16); p= < 0.001) was found statistically significant. Total egg consumption in 3 day period by newly hatched nymph to adult of the bug ranged 11.2 ±1.30 to 25.4 ± 0.54, which corresponded to host egg mortality of 27.03 to 61.34 % (Table 1). One way ANOVA for total prey consumption (F= 393.65**; d.f.= 4(16); p= < 0.001) and % host egg mortality (F= 348.27**; d.f.= 4(16); p= < 0.001) was found statistically significant. Per day consumption of host eggs by 1st instar nymph to adult was worked out as 3.73 to 8.46. Total prey egg consumption during the period of a stage from 1st instar to adult was 11.19 to 160.74. An individual bug in its life time of 35 days consumed 267.33 eggs of pear psylla (Table 2). Total prey egg consumption was found strongly correlated with the stage of the predator (r= 0.925**; d.f.= 23). Regression equation between host stage vs. per day

rate of egg consumption (Y = 3.38 + 1.14X;R^2 = 0.85, where Y= prey egg consumption and X= stage of host and R^2= Coefficient of determination) (Fig. 1) and host stage vs. host egg mortality was established as Y = 24.48 + 8.26X, R^2 = 0.85; where Y= % host egg mortality and X= stage of host and R^2= Coefficient of determination (Fig.2).

Gradual increase in rate of consumption from 1st day to 3rd day and also from 1st instar to adult was due to increase in food requirement by the bug for growth and development. Similar observation has also been made by earlier workers [22]. Difference in rate of consumption of eggs of spider mite, *Tetranychus urticae* and European red mite, *Panonychus ulmi* by nymphs and adult of anthocorid bug, *B. pallescens* has also been documented [2]. Increased rate of consumption on eggs of *Corcyra cephalonica* and nymphs of *Aphis gossypii* by adults of *B. pallescens* as compared to nymphs has also been reported [7], although similar work documented higher potential feeding by nymphs as compared to adults on nymphs of two spotted spider mite on okra. Adults of *Orius minutus* have also been reported to consume more eggs of *Tetranychus viennensis* Zacher than nymphs [26]. Increase in feeding potential from 1st instar to adult of *B. pallescens* on red spider mite, *Oligonychus coffeae* in tea [23] is also documented.

Host egg mortality in present case was due to insertion of proboscis inside egg for sucking up ooplasm by the predator, which rendered eggs unhatchable resulting into egg mortality. Rise in host egg mortality from 27.03 to 61.34 % during a period of three days was related to increased rate of consumption by 1st instar nymph to adult. An increase in correlated % host mortality with advancing age of predatory bug gets support from past workers [2, 7, 23, 26]. Present findings on biological parameters of *B. pallescens* also gets support from the documented work [18] who made almost similar observations on immature and adult stages of *B. pallescens* when fed on eggs of *Corcyra cephalonica*. Since biological studies of this predator against pear psylla has not been done so far hence no more corroborative evidences can be cited.

Table 1: Consumption rate of eggs of pear psylla, *Cacopsylla pyricola* by different stages of anthocorid bug, *Blaptostethus pallescens* in Kashmir during 2019.

Stages of predator	Predator: prey ratio/ day	1st day	2nd day	3rd day	Total prey consumption/ 3 day (After Abbott's method)	% Host egg mortality (After Abbott's method)
1st instar	1: 15	3.4±0.54^a	5.2±0.83^a	6.2±0.83^a	11.2±1.30^a	27.03 (31.30)^a
2nd instar	1: 15	5.2±0.83^b	7.4±0.54^b	9.4±0.54^b	18.4±1.14^b	44.44 (41.80)^b
3rd instar	1: 15	7.4±0.54^c	9.4±0.54^c	9.6±0.54^b	22.8±0.44^c	55.07 (47.91)^c
4th instar	1: 15	9.2±0.83^d	9.4±0.54^c	9.2±0.83^b	24.2±0.44^c	58.45 (49.86)^d
Adult	1: 15	9.4±0.54^c	9.6±1.14^c	10.0±1.00^b	25.4±0.54^{cd}	61.34 (51.55)^e
C.D. (0.01)		1.07	1.31	1.35	1.65	1.61
CV (%)		35.37	22.81	17.60	26.16	26.13

Each figure in column represents mean of five replications; values in parentheses are a sin transformation; ± Standard Deviation of mean; Different alphabetical superscripts in each column indicate values statistically significant

Table 2: Rate of prey egg consumption during developmental stages of *B. pallescens*

Stages of predator	Duration of a stage (in days)	Consumption rate/ day	Prey Consumption during stage	Life time consumption by an individual
1st instar	3.0	3.73	11.19	267.33
2nd instar	4.0	6.13	24.52	
3rd instar	3.6	7.6	27.36	
4th instar	5.4	8.06	43.52	
Adult	19.0	8.46	160.74	

Each figure in column represents mean of five replications

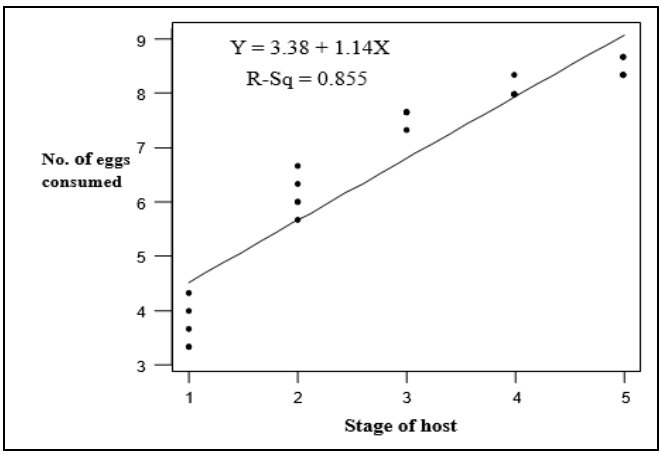

Fig 1: Regression Plot between host stage vs. per day rate of consumption

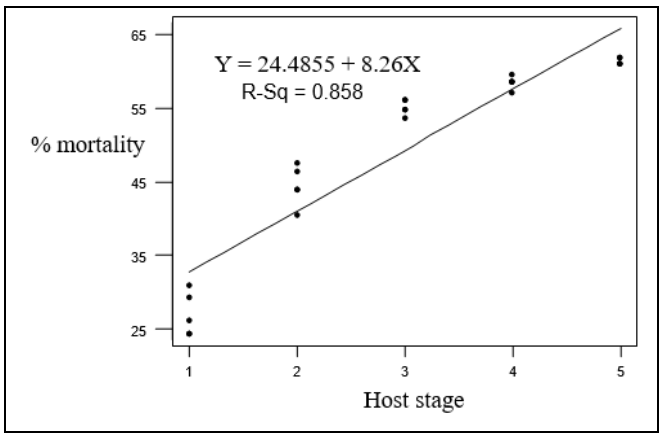

Fig 2: Regression Plot between host stage vs. % host egg mortality

5. Conclusion

In view of potential role of anthocorid bug, *B. pallescens* against eggs of pear psylla, *C. pyricola* as per laboratory evaluation, there seems to be a big scope of exploitation of the predator in field condition against the pest infesting pear in Kashmir, after its evaluation in field. If successful, the predator can be exploited as biocontrol component against pear psylla, as the mass production of anthocorid bug is both easy and economical.

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