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MORPHOMATRIC STUDIES OF BLACKHEADED FIREWORM, *RHOPOBOTA NAEVANA* (HUBNER) (LEPIDOPTERA: TORTRICIDAE)

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ABSTRACT

Morphomatric studies and determination of larval instars are fundamental to both basic entomological research and its application, but these can be difficult, particularly when ecdysis is not readily observed as is the case with Rhopobota naevana (Hubner). So an attempt was made to determine the number of larval instars through the application of Dyar's law. For this purpose Rhopobota naevana (Hubner) was successfully reared in the laboratory at an ambient temperature (25±5^{o}C) and relative humidity (70±5%) and subjected to laboratory investigation on its sizes of developmental stages and geometric growth ratio of successive instars. The development from egg to adult was described and their respective sizes were measured. This was done under a dissecting Stereo zoom Olympus microscope containing ocular grids calibrated with a stage micrometer. The results emphasised that development took place through holometamorphosis and close proximity between the mean, observed and calculated widths of head capsule and increase in widths of head capsules of different larval instars categorised them into five well defined instars. The head capsule width recorded was 0.28 mm for the 1st instar (newly hatched larvae) and 1.60 mm for the 5th instar (taken to pupation). The mean geometric growth ratio of 1.54 using the head capsule width in successive larval instars as a parameter was obtained and it conformed well to Dyar's law.

Key words: *Blackheaded fireworm, Dyer's law, Kashmir, Larvae, Morphomatrics, Tortricid Moth.*

I.INTRODUCTION

Blackheaded fireworm (BHFW) is a major pest throughout North American cranberry growing regions. Historically, this species was chief among the damaging insects in Massachusetts. In second half of the 20th century, Blackheaded fireworm lost its key pest status in Massachusetts and was found only in high numbers in wild and unmanaged beds. Lately this pest showed a remarkable resurgence in Massachusetts where it became a serious problem for many growers [1]. In temperate region of Jammu and Kashmir, this moth became serious problem in apple orchards particularly on young plants, where larvae of this moth damage the terminals of current season twigs by skeletonising the leaves often so severely that areas of the apple orchards turn brown and appear burned top of trees [2]. The larvae wriggle vigorously when disturbed and use silk to construct protected feeding sites by webbing together terminal leaves [3]. For successful management of this pest, it is

desirable to know its number of larval instars and morphomatrics. To do this, study was made on larval instar determination and morphomatrics of Blackheaded fireworm, *Rhopobota naevana* which has not been studied earlier in detail as the available literature itself shows except some scattered reports.

II.MATERIAL AND METHODS

For the study of morphomatrics and larval instar determination of Blackheaded fireworm, *Rhopobota naevana*, (Hubner), it was successfully reared in the laboratory at an ambient temperature (25±5^{o}C) and relative humidity (70±5%) and observations on the larval instars with moultings, prepupal and pupal period and longevity of adult moth were recorded and subjected to laboratory investigation on its measurement of developmental stages and geometric growth ratio of successive instars. Dyar's law [4] has been found useful in determining the number of larval instars in insects which feed hidden within plant tissues. This law states that the head widths of the larvae follow a geometrical progression in successive instars. So, an attempt was made to determine number of larval instars in Blackheaded fireworm, *Rhopobota naevana* (Hubner) through the application of Dyar's law. The development from egg to adult was described and their respective sizes were measured. This was done under a dissecting Stereo zoom Olympus microscope containing ocular grids calibrated with a stage micrometer. The mean widths of head capsule in all larval instars were measured which yielded a mean consecutive geometric progression. The calculated or theoretical head capsule width was thus computed from the average mean geometric progression. The difference or the discrepancy between the observed and calculated or theoretical head capsule width was computed from pooled Chi-square value (χ^2) by using the Chi-square test.

III.RESULTS AND DISCUSSION

Results of this investigation revealed that female moth started fertile egg laying one day after mating, the diameter of egg ranged from 0.79-0.90 mm with an average of 0.84±0.05 mm (Table 1). These observations agreed with those of Sylvia and Averil [1], which reported average size of egg as 0.88 mm. The mean length of 1st, 2nd, 3rd, 4th and 5th instar larvae was 2.39±0.31, 4.42±0.60, 6.08±0.60, 7.90±0.62 and 9.16±0.38 mm respectively, while as mean width of 1st, 2nd, 3rd, 4th and 5th instar larvae was 0.97±0.12, 1.33±0.12, 1.94±0.24, 2.25±0.12 and 2.64±0.12 mm respectively (Table 1; Fig. 1). The mean head capsule width of 1st, 2nd, 3rd, 4th and 5th instar larvae was found as 0.28, 0.42, 0.65, 1.02 and 1.60 mm respectively (Table 2; Fig. 2). These observations are similar to those of Sylvia and Averill [1], which reported the length of fully grown larvae as 7-9 mm. Thus larval period completed through five distinct instars (Fig. 1). These observations are in confirmation with the work of Cockfield and Mahr [5] which reported five larval instars in *Rhopobota naevana*. The prepupa measured on an average as 7.44±0.63 mm in length and 2.78±0.19 mm in width. Further the mean length and width of male pupae was 6.00±0.60 mm and 3.00±0.12 mm, respectively while as that of female pupae was 6.48±0.48 mm and 3.43±0.30 mm, respectively (Table 1). These findings are in agreement with Sylvia and Averill (2005) which reported that mean length of pupae was 6-7 mm. The male moth is small with mean of 11.52±0.31 mm (Table 1) across the expanded wings and with mean head capsule width of 2.45 mm, while as the female moth is larger in size than male with a mean wingspan of 12.23±0.32 mm (Table 1) and mean head capsule width of 2.45 mm (Table 2), other characters are similar to male but lacking the patches of specialized

scales on the hind wing and costal fold on fore wing. These findings are in agreement to those of Bradely *et al.* [6], Alford [7] and Sylvia and Averill [1]. Thus results in data further revealed that larvae of *Rhopobota naevana* underwent five larval instars and a pupal stage to reach adulthood. The mean widths of head capsule in 1st to 5th larval instars which were found as 0.28, 0.42, 0.65, 1.02 and 1.60 mm, respectively yielded a consecutive geometric progression during each stage ranged from 1.50-1.56 with an average of 1.54. Johri and Johri [8] applied Dyar's law in Indian predaceous earwig, *Labidura riparia* (Pallas) form *bengalensis* (Dohrn) and revealed five nymphal stages duration ranging from 49-73 days. The calculated or theoretical head capsule width was thus computed from the average mean geometric progression of 1.54. Using the Chi-square test, the computed pooled Chi-square value (x^2) was found to be 0.0011 with p-value > 0.01, thus insignificant difference was found between the observed and calculated or theoretical head capsule widths and hence geometric growth ratio of 1.54 confirmed Dyar's law (Table 2). No earlier reports were found on the growth ratio of *Rhopobota naevana* elsewhere to determine its development.

IV.CONCLUSION

The study clarified that development of Blackheaded fireworm, *Rhopobota naevana* (Hubner) from egg to adult took place through holometamorphosis and close proximity between the mean, observed and calculated widths of head capsule and increase in widths of head capsules of different larval instars categorised them into five well defined instars. Thus this study revealed that Blackheaded fireworm, *Rhopobota naevana* underwent egg stage, five larval instars, prepupal stage and a pupal stage to reach adulthood.

V.ACKNOWLEDGEMENT

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Table-1: Body sizes of egg, different larval instars, pupa and adult of Blackheaded fireworm, *Rhopobota naevana* (Hubner).

Stage of Development	Number of specimens (n)	Length (mm)		Width (mm)	
		Range	Mean ± SD	Range	Mean ± SD
Egg	20	0.79 - 0.90	0.84 ± 0.05	-	-
Larva:1st Instar	15	2.04 - 2.64	2.39 ± 0.31	0.84 - 1.08	0.97 ± 0.12
2nd Instar	15	3.84 - 5.04	4.42 ± 0.60	1.20 - 1.44	1.33 ± 0.12
3rd Instar	15	5.52 - 6.72	6.08 ± 0.60	1.68 - 2.16	1.94 ± 0.24
4th Instar	12	7.20 - 8.40	7.90 ± 0.62	2.16 - 2.40	2.25 ± 0.12
5th Instar	12	8.88 - 9.60	9.16 ± 0.38	2.52 - 2.76	2.64 ± 0.12
Pupa: Pre pupa	15	6.96 - 8.16	7.44 ± 0.63	2.64 - 3.00	2.78 ± 0.19
Male pupa	12	5.40 - 6.60	6.00 ± 0.60	2.88 - 3.12	3.00 ± 0.12
Female pupa	12	6.00 - 6.96	6.48 ± 0.48	3.12 - 3.72	3.43 ± 0.30
Adult: Male	10	11.28 - 11.88	11.52 ± 0.31 (w.sp.)	3.96 - 4.32	4.12 ± 0.18
Female	10	12.00 - 12.60	12.23 ± 0.32 (w.sp.)	4.44 - 4.80	4.59 ± 0.18

Table-2: Geometric growth ratio of Blackheaded fireworm, *Rhopobota naevana* (Hubner) larvae using head capsule width as a parameter.

Stage of Development	Number of Specimens (n)	Mean observed head capsule width (mm)	Geometric progression	Calculated head capsule width (mm)	X^2
Larva:					
1st Instar	10	0.28	0.42/0.28=1.50	0.28	
2nd	12	0.42	0.65/0.42=1.54	0.28x1.54=0.43	

Instar 3rd Instar 4th Instar 5th Instar Adult	14 15 15 12	0.65 1.02 1.60 2.45	1.02/0.65=1.56 1.60/1.02=1.56 2.45/1.60=1.53	0.43x1.54=0.66 0.66x1.54=1.01 1.01x1.54=1.55 1.55x1.54=2.38	0.0011
Total	78	6.42	Mean G. ratio=1.54	6.31	P>0.01

X^2 = Pearson's Chi- squared test (P = 1).

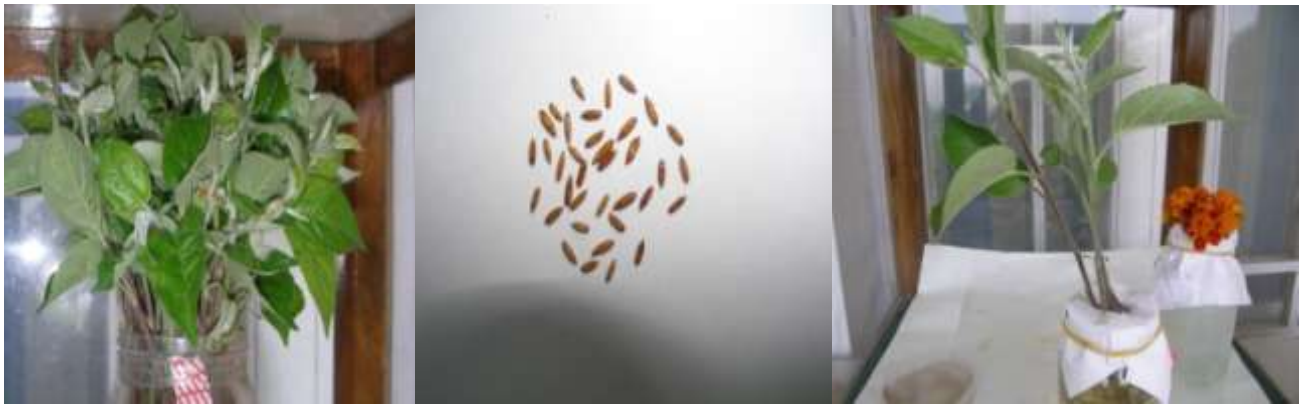

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Fig- 1: A. Culture inside cage, B. Pupae obtained from culture, C. Rearing inside cage, D. Freshly laid eggs, E. 1ST instar larvae, F. 2nd instar larvae, G. 3rd instar larvae, H. 4th instar larvae, I. 5th instar larvae, J. Prepupa, K. Pupa, L. Adult moth.

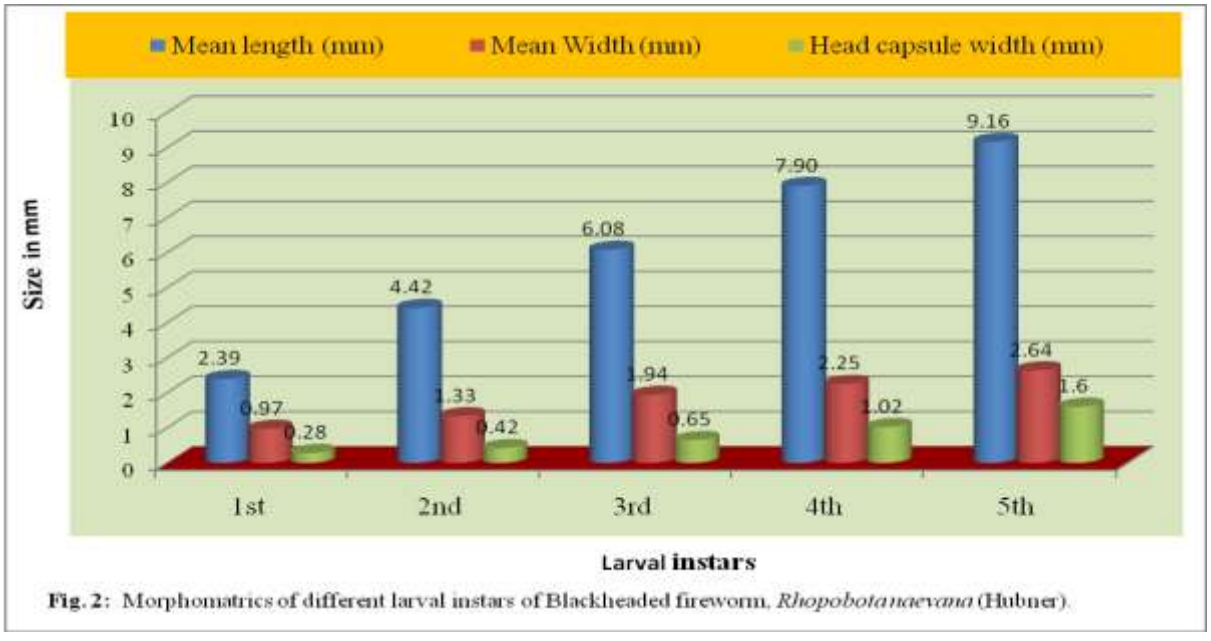

Fig. 2: Morphometrics of different larval instars of Blackheaded fireworm, *Rhopobota naevana* (Hubner).