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GENDER ASSOCIATED DIFFERENCES IN NUMBER OF LARVAL INSTARS IN *Opisina arenosella* (Walker)

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ABSTRACT : Prevailing confusion in the number of larval instars in *Opisina arenosella* led to the present investigation on its developmental biology with particular reference to the number and duration of larval instars, length, weight, head capsule width and the total amount of food consumed by the larvae. Results showed an interesting pattern where male larvae underwent seven instars while the females had eight developmental instars. All the other parameters recorded were influenced by the presence of the eighth instar in the females, which led to an increased larval duration, length, weight and amount of food consumed. The general implications of such gender associated differences have been briefly discussed.

Key Words : Black headed caterpillar, coconut, *Opisina arenosella*

INTRODUCTION

Opisina arenosella (Walker) (Lepidoptera : Oecophoridae), popularly known as the coconut black headed caterpillar, is a pest of coconut palms in peninsular and coastal India, Sri Lanka and Burma. The caterpillars, which cause economic losses, construct silken galleries on the undersurface of the coconut leaflets. From within the galleries they scrape and feed the lower epidermis of the leaflets. The affected leaflets turn brown and appear scorched from a distance. When population of this caterpillar reaches pest proportions, growth and yield of coconuts are drastically reduced and the affected palms take several years to recover. One hundred years of research on this species has led to notable advancements in managing its populations. However, several critical aspects of its life remain uncertain. For instance, the most primary information in the developmental biology of any insect species – the number of larval instars, remains controversial with respect to *O. arenosella*. Researchers have reported five (Rao *et al.*, 1948; Nirula *et al.*, 1952; Nirula, 1956; Lever, 1969; Mohamed *et al.*, 1982; and Parera *et al.*, 1988), six (Ramchandran, *et al.*, 1979), seven (Antony, 1962) and eight (Santhosh Babu and Prabhu, 1987) larval instars so far. Santhosh Babu and Prabhu (1987) opined that reports on the number of larval instars that had been published prior to their report were just casual laboratory observations, as the earlier reports did not carry experimental details. Results of their laboratory study show that larvae had eight instars. Later, Parera *et al.* (1988) observed that larvae

underwent five instars in natural conditions (infested coconut gardens) and speculated that laboratory reared larvae were perhaps stressed and hence were showing supernumerary (eight) instars. In their opinion, all the supernumerary instars (sixth, seventh and eighth) were not different from the fifth instar larvae. But, if their speculation holds good, i.e., if laboratory rearing indeed stressed larvae and led to supernumerary instars, a high degree of individual-to-individual variation in the number of instars would be expected. However, Santhosh Babu and Prabhu (1987) reported that all the test larvae consistently had eight instars and the co-efficient of variation within an instar did not exceed 15% for any of the instars (44 to 72 larvae were used in their study to obtain data for different instars). This put the speculation of stress-induced supernumerary instars in doubt. Also, there is no evidence, so far, to show that laboratory rearing stresses larvae of *O. arenosella*. As the issue on number of instars has not been addressed since 1988 the present investigation was taken up.

MATERIAL AND METHODS

Late instar larvae were collected from infested gardens and reared on coconut leaflets in the laboratory till they pupated. Laboratory studies were conducted during 2001 at the Department of Entomology, University of Agricultural Sciences, GKVK, Bangalore. Eggs were collected from moths that emerged from the pupae as per the descriptions in Ram Kumar *et al.*, (2001). From a number of neonates that hatched, sixty were individually reared on coconut leaflets in cylindrical plastic vials (5 x 1.5 cm) till pupation. The vials were placed in an incubator maintained at 25 ± 1°C for the entire period. The end of an instar was marked by the presence of the closed head capsule, whose width was measured and recorded for each larva at every instar. Leaflets were changed at the end of each instar. A piece of larval frass was stuck to the fresh leaflet and the larvae were carefully introduced into the frass. This ensured that larvae did not move around in the vial and that they quickly resorted to feeding. Pupae were sexed and placed individually in labeled vials till adult emergence. Data from individuals that could not complete the life cycle were discarded.

Daily observations on length and weight of individual larvae were taken until the larvae reached the pupal stage. Additionally, leaf area fed by each larva in every instar was found out by plotting the area fed on a graph sheet marked with 1 mm squares. The area fed by 1st instar larvae was extremely small and not easily detectable, hence ignored. The leaf area fed by larvae in 2-4 instars was marked on a graph sheet using camera lucida and the actual area was calculated later. The area fed by larvae in 5-8 instars was considerably large, hence directly marked on the graph sheet.

Observations on number of instars, duration of each instar, larval length, larval weight, head capsule measurement, and leaf area consumed during the larval period were grouped for males and females separately. Student's t-test was used to test the differences between male and female larvae for the above mentioned parameters, while Duncan's Multiple Range Test was employed to test the differences in larval durations across different instars within males and females.

RESULTS AND DISCUSSION

For the first time it was found that the number of larval instars varied between sexes in *O. arenosella* (Table 1). Males recorded seven (n=21), while females recorded eight larval instars (n=26). It is to be noted that duration of each comparable instar (1-7 instars) did not differ significantly between males and females. However, time taken to complete instars varied significantly within male and female larvae. In males, only the fifth instar was longer than others, while the first, fifth and eighth instars were longer in females. Total larval duration between males

Table 1. Growth and development of *Opisina arenosella* on coconut leaflets under laboratory conditions

Instar	Duration (days)			Larval length (mm)						Larval weight (mg)					
				1st Day of instar			Last day of instar			1st day of instar			Last day of instar		
	Male	Female	t-test	Male	Female	t-test	Male	Female	t-test	Male	Female	t-test	Male	Female	t-test
I	5.09[a]	5.11[bc]	NS (t=0.89)	1.49 (±0.07)	1.47 (± 0.08)	NS (t=0.71)	1.95 (±0.12)	1.91 (± 0.12)	NS (t=0.51)	#	#	-	#	#	-
II	4.85[a]	4.88[ab]	NS (t=0.81)	2.08 (± 0.14)	2.06 (± 0.12)	NS (t=0.46)	2.95 (±0.63)	2.76 (± 0.13)	NS (t=0.87)	#	#	-	#	#	-
III	4.71[a]	4.73[ab]	NS (t=0.93)	3.07 (± 0.18)	3.02 (± 0.13)	NS (t = 0.99)	3.97 (± 0.67)	3.84 (±0.31)	NS (t=-0.90)	0.20 (± 0.09)	0.19 (± 0.07)	NS (t = -0.51)	0.50 (±0.14)	0.47 (±0.15)	NS (t=-0.90)
IV	4.66[a]	4.73[ab]	NS (t=0.75)	4.05 (± 0.23)	4.01 (± 0.29)	NS (t=-0.14)	5.76 (±0.50)	5.81 (± 0.47)	NS (t=-0.814)	0.57 (± 0.14)	0.75 (± 1.07)	NS (t=0.87)	1.45 (± 0.44)	1.85 (± 0.42)	NS (t=-0.81)
V	5.71[b]	5.11[bc]	NS (t=0.005)	6.02 (± 0.37)	6.10 (± 0.36)	NS (t=-1.37)	8.47 (±1.04)	8.12 (± 0.69)	NS (t=0.73)	1.94 (± 0.59)	2.08 (± 0.38)	NS (t=-0.90)	5.78 (± 1.57)	5.29 (± 1.37)	NS (t=0.73)
VI	4.95[a]	4.42[a]	NS (t=0.03)	8.62 (± 0.75)	8.47 (± 0.61)	NS (t=0.73)	11.05 (±1.29)	10.78 (± 1.06)	NS (t=0.76)	6.24 (± 1.38)	5.91 (± 0.99)	NS (t=0.79)	13.84 (± 3.67)	11.88 (± 3.47)	NS (t=0.76)
VII	4.95[a]	4.73[ab]	NS (t=0.34)	11.66 (± 1.00)	11.05 (± 1.02)	NS (t=0.50)	15.14 (±2.01)	14.60 (± 0.79)	NS (t=1.16)	15.96 (± 3.34)	3.71 1(± 3.71)	* (t=2.15)	34.32 (± 8.39)	32.22 (± 7.06)	NS (t=1.16)
VIII	-	5.46[c]	-	-	14.93 (± 1.00)	-	-	18.57 (± 1.52)	-	-	34.54 (±7.57)	-	-	64.27 (±12.98)	-
Total	32.97	39.17 DMRT	** (t=-4.31)												

[5]RL Ratio of larval length of 1st day of instar between successive instars
NS: Non-significant, * Significant (p=0.05) ** Significant (p=0.01)
Larval weight less than 0.1 mg
Figures in parenthesis are values for standard deviation from the mean

Table 2. *Opisina arenosella* larval head capsule width during the larval development

Instar	Head capsule width (mm)			*RW	
	Male	Female	t-test	Male	Female
I	0.222 (±0.007)	0.226 (±0.009)	NS(t=-2.51)	-	-
II	0.310 (±0.010)	0.310 (±0.013)	NS(t=0.37)	1.40	1.37
III	0.417 (±0.015)	0.414 (±0.016)	NS(t=0.93)	1.35	1.35
IV	0.595 (±0.043)	0.598 (±0.040)	NS(t=-1.10)	1.43	1.44
V	0.811 (±0.04)	0.821 (±0.04)	NS(t=-0.07)	1.39	1.36
VI	1.175 (±0.09)	1.205 (±0.110)	NS(t=-0.88)	1.42	1.40
VII	1.453(±0.089)	1.475 (±0.091)	NS(t=-1.38)	1.26	1.31
VIII	-	1.868 (±0.073)	-	-	1.28

*RW-Ratio of head capsule width between successive instars

Figures in parenthesis are standard deviation from the mean

NS-Non Significant

(32.97 ± 1.83 days) and females (39.17 ± 2.25 days) also varied significantly. Female development was marked by a considerably longer eighth larval instar.

Larval length and weight measured on the first day and last day of each instar did not differ between males and females except for the larval weight on the first day of the 7th instar. Both length and weight increased exponentially.

Head capsule width did not differ significantly between males and females in each instar (Table 2). The ratio of head capsule width between successive instars showed a decline from 1.40 to 1.26 and 1.37 to 1.28 for males and females, respectively. The ratios followed Dyar's law (Dyar, 1890), which predicted that such ratios would be close to 1.40 and weaken towards the end of the developmental period.

The total leaf area fed by male (877.79 ± 80.26 mm^2) and female (2020.14±110.35 mm^2) larvae differed significantly (t-test; $p<0.01$). The leaf area consumed till the 7th instar was similar between males and females. During their additional instar females fed an average leaf area of 1203.73 ± 95.68 mm^2, which was higher than the total area fed before the 8th instar. There was a positive relation between larval duration and total leaf area fed (Fig. 1).

Number of larval instars varied between sexes of *O. arenosella*. Males recorded seven larval instars whereas females recorded eight larval instars. This appears to be one of the few tropical lepidopterans where gender associated differences in number of larval instars have been detected. All the previous studies have failed to look for variation in the number of instars between sexes in *O. arenosella*.

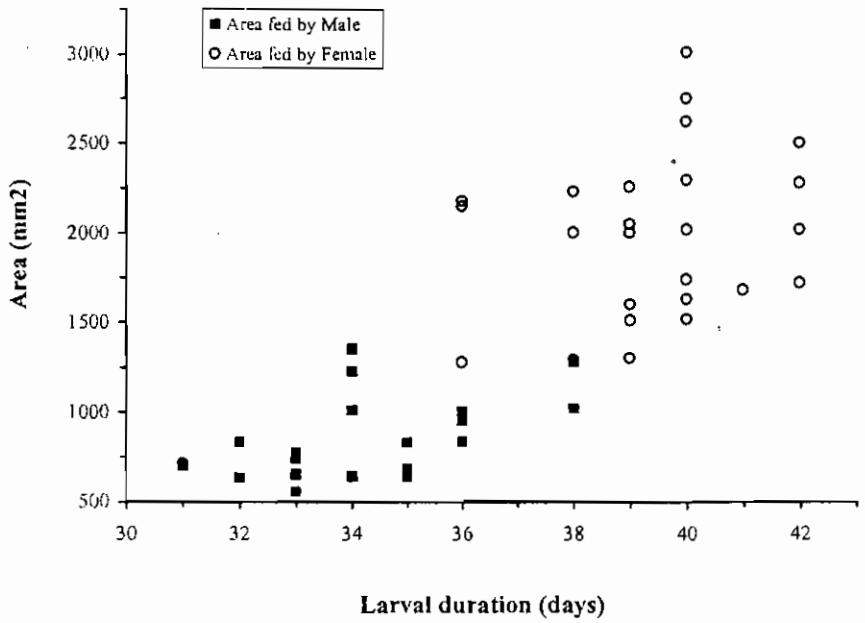

Fig.1 : Area fed by male and female during the larval development

It has been noticed on several counts – duration of instars, larval length, larval weight and head capsule width that males and females do not differ from first through seventh instars. All differences between sexes are explained by the presence of an eighth instar in females. There are several repercussions of having an eighth instar in female larvae. The food consumed during the eighth instar is greater than the food consumed in all the seven instars combined, giving rise to a peculiar situation where female larvae inflict more damage than their male counterparts. Such a situation has rarely being mentioned in literature. As the females live longer and feed a greater quantity of food, they are, as expected, longer and heavier than the males. This explains why female moths are always bigger than males.

As males and females have consistently recorded seven and eight instars, respectively, there is no reason to uphold the claims of Perera *et al.*, (1988) who believed that laboratory rearing stressed the larvae and led to supernumerary instars. As the authors have not described the methodology adopted in their field study, comparison with the results obtained in the present investigation has been difficult.

Although gender associated differences in number of instars throws up interesting evolutionary questions, surprisingly, not much has been associated with it in the literature.

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