The Bioscan 8(3): 795-799, 2013
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

DESCRIPTION AND POPULATION FLUCTUATION OF TEAK SKELETONIZER, *EUTECTONA MACHAERALIS* WALKER ON TEAK

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KEYWORDS
Description
measurement
population fluctuation
teak
E. machaeralis

Received on :
31.12.2012

Accepted on :
22.04.2012

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ABSTRACT
Studies on description, measurement and population fluctuation of teak skeletonizer, *Eutectona machaeralis* Walker revealed that the eggs of the pest were round in shape, greenish-white in colour and translucent. Diameter of the eggs was 0.27 + 0.04 mm. Average length and breadth of first, second, third, fourth and fifth instar larvae were 2.08 ± 0.23, 7.50 ± 1.11, 11.61 ± 1.68, 17.63 ± 1.81, 23.42 ± 1.06 and 0.26 ± 0.03, 0.97 ± 0.14, 1.30 ± 0.27, 1.72 ± 0.30, 2.14 ± 0.17, respectively. The corresponding values of head width were 0.21 ± 0.04, 0.80 ± 0.11, 1.11 + 0.18, 1.51 ± 0.29 and 1.66 ± 0.36 mm, respectively. Average length and breadth of pre-pupae was an 16.59 ± 2.73 and 2.85 ± 0.84 mm, respectively. Length and breadth of male pupae ranged from 10.00 to 13.00 and 2.20 to 3.20 mm, while in female, it ranged from 13.00 to 15.00 and 3.00 to 4.00 mm, respectively. Abdomen of female was wider than male, but it tapered posteriorly in both the sexes. Average length of female (from head to tip of abdomen) was 11.35 ± 0.97 mm, whereas, the breadth across the expanded wings was 23.11 ± 2.02 mm. The corresponding values for male was 10.14 ± 0.43 and 21.04 ± 1.09 mm, respectively. Activity of *E. machaeralis* commenced from the fifth week of May during 2006 and 2007 which reached to its peak in fourth week of July during 2006 and first week of August during 2007. Thereafter, it decreased up to first week of November during 2006 and 2007.

INTRODUCTION

Teak (*Tectona grandis* Linn.) is one of the most important hardwood commercial timber in tropics. In India, the major teak growing states are Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Karnataka, Kerala, Uttar Pradesh, Gujarat, Orrisa and Rajasthan (Tewari, 1992). The pests attacking teak are grouped into root and stem feeders, sap suckers, defoliators, tree borers, fruit borers and gall formers. There are two species of defoliators *i.e. Eutectona (=Pyrausta) machaeralis* Walker and *Hyblaea purea* Cramer. Among them, *E. machaeralis* is commonly known as teak skeletonizer. It caused 35.79 % loss in annual growth in teak nursery (Anonymous, 2001) and also caused 60.00 to 81.77 % loss in plantation (Nayak *et al*., 2002). Biology and population fluctuation of *E. machaeralis* on teak has been studied by few earlier workers (Stebbing 1908, Wu *et al.,* 1979, Patil and Thontadarya 1987, Alam *et al.,* 2002, Ali *et al.,* 2002) in past. No such attempt has been made in Gujarat. With this intension the present study was undertaken and results obtained are presented here.

MATERIALS AND METHODS

Present study on biology of *E. machaeralis* was carried out in laboratory of Department of Entomology, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during July – August 2007. The study was undertaken at an average maximum and minimum temperatures of 30.76 ± 1.20 and 29.40 ± 0.50 ^{0}C, respectively with an average relative humidity of 80.00 ± 5.63^{0}C %. Freshly laid eggs were observed under binocular microscope to study their colour and shape. In all, twenty five individuals of different life-stages were used for their measurement. Diameter of eggs was measured under microscope by using stage and occular micrometer. In order to know the number of larval instars, the newly hatched larvae were confined individually in plastic specimen tubes (Diameter: 3.5 cm, Height: 4.0 cm) with the help of camel hair brush. Larvae were provided fresh food everyday and observed daily in the morning for the change of instars till they attained last instar. The exuviae of head capsule left either on leaves of teak or inside the specimen tube was the indication for the change of instar. Larvae of each instar were observed under binocular research microscope for their colour, shape and size. The breadth of head capsule of all the instars and length and breadth of first and second instar were measured with the help of occular and stage micrometre, while length and breadth of the remaining instars were measured using millimetre scale. When full grown larvae ceased feeding and contracted with sluggish movement they were considered to be pre-pupal stage. Pre-pupae developed from larvae were kept individually in plastic specimen tube (3.5 cm x 4.0 cm) along with the infested leaves and allowed to pupate. Pupae removed from the cocoons were examined under binocular research microscope for their colour, shape and size. Pupae were sexed by examining the distance between the anal and genital slits and their size was measured using by millimetre scale. Newly emerged male and female adults were observed under binocular microscope after killing them in killing jar to study their colour as well as the morphological differences between male and female. The size of the adults with wing expanded was measured using millimetre scale.

Studies on population fluctuation of *E. machaeralis* in relation to weather parameters was carried out at horticulture farm of B. A. College of Agriculture, Anand Agricultural University, Anand from May to December during 2006 and 2007. Eight years old five trees (Valsadi sag planted at 8 x 8 m) were selected randomly and kept free from insecticidal application. From each tree, 5 twigs were selected randomly for recording the observations of larval population at weekly interval starting from appearance of the pest. To determine the influence of various physical factors of environment in causing population fluctuation of *E. machaeralis*, the population data were correlated with different meteorological parameters and correlation coefficient values were worked out.

RESULTS AND DISCUSSION

Biology of *E. machaeralis*

Eggs

Freshly laid eggs of *E. machaeralis* were round in shaped, greenish-white in colour and translucent. Later on, it became brownish red in colour prior to hatching. Diametres of eggs ranged from 0.24 to 0.32 mm with an average of 0.27 + 0.04 mm (Table 1).

Larva

Newly hatched larvae emerged out by making a small hole in egg shell. Head wriggles out first followed by thorax and abdomen. It took about 2 to 3 minutes to come out from the egg shell. The caterpillar as it came out from the egg was delicate with cylindrical body but tapering at the posterior end. Newly hatched caterpillar was greenish white with conspicuous light brown head capsule. The integument was transparent and abdominal segments were clearly distinct. When larvae were viewed under microscope from the dorsal side, golden white delicate setae were visible on each thoracic and abdominal segment. Larvae were typically eruciform and possessed a pair of true legs on each thoracic segment and a pair of prolegs on third to sixth and tenth abdominal segment. Length and breadth of larvae and width of head capsule ranged from 1.84 to 2.56, 0.24 to 0.32 and 0.08 to 0.24 mm with an average of 2.08 $\pm$ 0.23, 0.26 $\pm$ 0.03 and 0.21 $\pm$ 0.04 mm, respectively (Table 1). Length of first instar larvae recorded in present study is more or less nearest to the report of Mishra and Singh (2004).

Second instar larvae were quite different from first instar. Its head capsule was light brown to greenish brown in colour. There were six (3 pairs) black spots on each segment which were more clearly visible when the larvae were viewed under microscope. Thoracic and abdominal setae were more distinct being larger and darker than it was in the first instar. First abdominal segment was broader than other abdominal segments, whereas meta-thoracic segment was broader than pro and meso-thoracic segments. Length, breadth and width of head capsule of second instar larvae ranged from 6.00 to 9.00, 0.70 to 1.10 and 0.60 to 1.00 mm with an average of 7.50 $\pm$ 1.11, 0.97 $\pm$ 0.14 and 0.80 $\pm$ 0.11 mm, respectively (Table 1). These observations are in accordance with the report of Mishra and Singh (2004).

Third instar larvae were distinguished from second instar by presence of more number of black dots on each body segment. The position of six spots on each segment also became clear in the third instar larvae. Larval body length, breadth and width of head capsule of third instar ranged from 9.00 to 14.00, 0.95 to 1.80 and 0.86 to 1.60 mm with an average of 11.61 $\pm$ 1.68, 1.30 $\pm$ 0.27 and 1.11 $\pm$ 0.18 mm, respectively (Table 1). The present results fall in the same line with the report of Patil and Thontadarya (1987) and Mishra and Singh (2004).

Fourth instar larvae were similar to third instar, but with additional longitudinal brown, yellow and green colour band on lateral sides. Body length, breadth and width of head capsule ranged from 15.00 to 20.00, 1.25 to 2.10 and 1.00 to 1.95 mm with an average of 17.63 $\pm$ 1.81, 1.72 $\pm$ 0.30 and 1.51 $\pm$ 0.29 mm, respectively (Table 1). Present observations on longitudinal band on larval body are in accordance with the report of Mishra and Singh (2004).

Fifth instar larvae were similar to fourth instar, but their colour changed from green to brown or purplish. There were four white or yellow coloured spots on each segment *i.e.* two on either side of the mid-dorsal line on the anterior half of the segment, whereas other two spots, each on either side of the mid-dorsal line on the posterior half of the segment. Thus, the four spots on each segment were arranged in a rectangular fashion on either side of mid-dorsal line. The golden white setae became inconspicuous with darker in colour at the base. The anal claspers or false legs became conspicuous, projecting and diverting in this instar.

Length, breadth and width of head capsule of fifth instar ranged from 22.00 to 25.00, 1.95 to 2.50 and 1.00 to 2.00 mm with an average of 23.42 $\pm$ 1.06, 2.14 $\pm$ 0.17 and 1.66 $\pm$ 0.36 mm, respectively (Table 1). Present observations of black dots on larvae is in confirmity with the observations of Mishra and Singh (2004). Similarly, the measurements of larvae recorded in present study are more or less similar to the reports of Roychoudhary (1999) and Mishra and Singh (2004).

Pre-pupa

Full grown larvae of teak skeletonizer became less active and ceased feeding, lost its normal mobility, spun transparent whitish cocoon, contracted length and breadth wise and became pre-pupae. The pre-pupae were light pale green in colour. It possessed hooks on the anal segment with which it got attached to the silken cocoon. Length and breadth of pre-pupae were 13.00 to 21.00 and 1.75 to 4.00 mm with an average of 16.59 $\pm$ 2.73 and 2.85 $\pm$ 0.84 mm, respectively (Table 1).

Pupa

In majority of the cases, *E. machaeralis* larvae found to pupate on lower side of green leaves especially on the basal half portion, whereas few larvae also pupated on the dead fallen leaves on the ground. More or less similar observations regarding site of pupation were recorded by Hole (1904), Stebbing (1908), Besson (1941), Mathur (1960), Patil and Thontadarya (1987) and Mishra and Singh (2004). Pupae were cylindrical in shape and adecticous obtect type. They were initially creamy in colour, gradually changed to creamy yellow and finally to reddish brown and hardened. In fully developed

Table 1 : Measurement (mm) of different life stages of *E. machaeralis*.

Stage		Parameters	Min.	Max.	Mean ± S. E.
Eggs		Diametres	0.24	0.32	0.27 ± 0.04
Larvae	I	Length	1.84	2.56	2.08 ± 0.23
		Breadth	0.24	0.32	0.26 ± 0.03
		Head capsule width	0.08	0.24	0.21 ± 0.04
	II	Length	6.00	9.00	7.50 ± 1.11
		Breadth	0.70	1.10	0.97 ± 0.14
		Head capsule width	0.60	1.00	0.80 ± 0.11
	III	Length	9.00	14.00	11.61 ± 1.68
		Breadth	0.95	1.80	1.30 ± 0.27
		Head capsule width	0.86	1.60	1.11 ± 0.18
	IV	Length	15.00	20.00	17.63 ± 1.81
		Breadth	1.25	2.10	1.72 ± 0.30
		Head capsule width	1.00	1.95	1.51 ± 0.29
	V	Length	22.00	25.00	23.42 ± 1.06
		Breadth	1.95	2.50	2.14 ± 0.17
		Head capsule width	1.00	2.00	1.66 ± 0.36
Pre-pupae		Length	13.00	21.00	16.59 ± 2.73
		Breadth	1.75	4.00	2.85 ± 0.84
Pupae	Male	Length	10.00	13.00	11.56 ± 1.11
		Breadth	2.20	3.20	2.74 ± 0.36
		Distance between genital pores	0.24	0.32	0.28 ± 0.04
	Female	Length	13.00	15.00	14.10 ± 0.64
		Breadth	3.00	4.00	3.49 ± 0.42
		Distance between genital pores	0.32	0.64	0.41 ± 0.09
Adults	Male	Length	10.00	11.00	10.14 ± 0.43
		Breadth (wing expanded)	19.00	24.00	21.04 ± 1.09
	Female	Length	10.00	13.00	11.35 ± 0.97
		Breadth (wing expanded)	20.00	25.00	23.11 ± 2.02

Table 2: Population fluctuation of *E. machaeralis* in teak.

Month and week		2006		2007			
		Met. Week	Av. no. of larvae/twig	Month and week		Met. Week	Av. no. of larvae/twig
May	V	22	0.04	May	V	22	0.08
June	I	23	0.08	June	I	23	0.28
	II	24	0.44		II	24	1.12
	III	25	1.68		III	25	2.16
	IV	26	0.60		IV	26	2.52
July	I	27	2.80	July	I	27	3.16
	II	28	6.48		II	28	2.84
	III	29	8.40		III	29	6.08
	IV	30	11.88		IV	30	5.92
Aug.	I	31	1.04	Aug.	I	31	6.96
	II	32	1.24		II	32	6.20
	III	33	2.60		III	33	4.80
	IV	34	8.72		IV	34	5.44
	V	35	7.20		V	35	4.84
Sept.	I	36	8.44	Sept.	I	36	4.72
	II	37	7.24		II	37	4.72
	III	38	6.40		III	38	4.96
	IV	39	5.36		IV	39	5.08
Oct.	I	40	3.32	Oct.	I	40	4.56
	II	41	4.56		II	41	4.72
	III	42	2.00		III	42	4.44
	IV	43	1.20		IV	43	4.76
	V	44	0.52		V	44	1.64
Nov.	I	45	0.28	Nov.	I	45	0.24
	II	46	0.00		II	46	0.00
	III	47	0.00		III	47	0.00
	IV	48	0.00		IV	48	0.00
Dec.	I	49	0.00	Dec.	I	49	0.00

pupae, segments and appendages were clearly visible with naked eyes. Under microscope, the spiracles on thoracic segments as well as hairs and spines on the abdominal segments of pupae were clearly visible. Pupae were surrounded by spinning a thick opaque shelter web in two criss – cross layers. The outer pupal shell was provided with 13 to 17 round holes almost at equidistance all around the edge. An emergence hole was also provided at one end. Before

Table 3: Correlation coefficient between weather parameters and *E. machaeralis* on teak.

Weather parameters	2006	2007
Bright Sunshine Hours (BSS)	-0.568**	-0.519**
Maximum Temperature (Max.T)	-0.400*	-0.350
Minimum Temperature (Min.T)	0.451*	0.355
Morning Relative Humidity (RH_1)	0.465*	0.722**
Evening Relative Humidity (RH_2)	0.548**	0.694**
Morning Vapour Pressure (VP_1)	0.506**	0.574**
Evening Vapour Pressure (VP_2)	0.536**	0.644**
Morning Vapour Pressure Deficit (VPD_1)	-0.343	-0.565**
Evening Vapour Pressure Deficit (VPD_2)	-0.534**	-0.681**
Wind Speed (WS)	0.248	0.190
Rainfall (RF)	0.224	0.305
Evaporation (EP)	-0.375*	-0.412*

pupation, a thin lining of fine silk was added as a third layer inside. The finished web measures about 17 x 23 mm and was constructed in 2 to 3 hours. Male pupae were pointed at the end of abdomen with wings ending on eighth abdominal segment, while female pupae were slightly blunt at abdominal end and wing ended on the tenth abdomen. Male and female pupae also differed from each other in respect to distance between anal and genital slits. The distance between anal and genital slit was less (0.28 + 0.04 mm) in males than females (0.41 + 0.09 mm). Length and breadth of male pupae ranged from 10.00 to 13.00 and 2.20 to 3.20 mm with an average of 11.56 ± 1.11 and 2.74 ± 0.36 mm, respectively. Corresponding values for female pupae were 13.00 to 15.00 and 3.00 to 4.00 mm with an average of 14.10 ± 0.64 and 3.49 ± 0.42 mm, respectively. It indicated that the female pupae were slightly longer than the male pupae (Table 1). Shape, colour and size of pupae revealed in present study are more or less similar with the observations recorded by Roychoudhary, (1999) and Mishra and Singh, (2004).

Adult

Moths of both the sexes were found to be bright yellowish. Forewings were pale to ochreous yellow, distinct orange or pinkish transverse zig-zag lines, with an ochreous or reddish marginal line or band whereas, hindwings were yellowish white with serrated marginal line. Abdomen of female was wider than male, but it tapered posteriorly in both the sexes. The light yellow coloured antennae were filiform type and covered with hairs. The middle tibia in male was dilated and grooved with completely concealed dense tuft of fine grey scattered hairs. Abdomen in females was thick and bluish. Anterior six segments of abdomen were brown colour, whereas abdomen in males was pointed and tapering. Moths were nocturnal in habit. In field condition, the moths rested in shaded places during day time, specially under the dead leafy material on ground and grasses. Length of females (from head to tip of abdomen) was from 10.00 to 13.00 mm with an average of 11.35 ± 0.97 mm, whereas the breadth across the expanded wings was from 20.00 to 25.00 mm with an average of 23.11 ± 2.02 mm (Table 1). In case of males, length was from 10.00 to 11.00 mm with an average of 10.14 ± 0.43 mm whereas, the breadth was from 19.00 to 24.00 mm with an average of 21.04 ± 1.09 mm. The data indicated that length and breadth of females were relatively more than the males. These results are in accordance with the observations made by Wu *et al*. (1979), Patil and Thontadarya (1987) and Mishra and Singh (2004).

Population fluctuation

Larval population of *E. machaeralis* was found from fifth week of May to first week of November during the year 2006 and 2007 (Table 2). The pest first appeared (0.04 larva/twig, 0.08 larva/twig) on teak in fifth week of May. The population gradually increased and reached to a peak (1.68 larvae/twig) in third week of June during 2006 and 3.16 larvae/twig during first week of July during 2007. Thereafter, the population suddenly decreased in fourth week of June (0.60 larva/twig) in 2006 and second week of July (2.84 larvae/twig) during 2007. Again population gradually increased and reached to a peak (11.88 larvae/twig) during fourth week of July in 2006. Same trend was noticed in third week of July (6.08 larvae/twig) and reached to a peak of 6.96 larvae/twig in first week of August during 2007. Similar observations have been reported by Wu *et al*. (1979). The population of *E. machaeralis* again decreased up to third week of August in both the years. The pest activity remained steady up to second week of September (7.24 larvae/twig) during 2006 and fourth week of October (4.76 larvae/twig) during 2007. The population started decreasing (0.28 larva/twig, 0.24 larva/twig) from first week of November and disappeared from the field.

Data on correlation between weather parameters and larval population are presented in Table 2. Data indicated that evening relative humidity (r = 0.548**), morning vapour pressure (r = 0.506**) and evening vapour pressure (r =0.536**) showed significantly positive correlation during 2006. Similarly, minimum temperature (r = 0.451), morning relative humidity (r = 0.722), evening relative humidity (r = 0.694), morning vapour pressure (r = 0.574) and evening vapour pressure (r = 0.644) showed significantly positive correlation during 2007. These results are same line as reported by Ali *et al*. (2002) and Alam *et al*. (2002). They reported that minimum temperature, relative humidity and rainfall had significant positive correlation with *E. machaeralis*. Effect of wind speed and rainfall found to be non-significant during both the years.

Bright sunshine hours (r = -0.568) and evening vapour pressure (r = -0.534) showed significantly negative correlation while maximum temperature (r = -0.400) and evaporation (r = -0.375) exhibited significant negative correlation with larval population in 2006 and bright sunshine hours (r = -0.519), morning vapour pressure deficit (r = -0.565), evening vapour pressure deficit (r = -0.681) and evaporation (r = -0.412) showed significantly negative correlation during 2007 (Table 3).

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