

SOME BIOLOGICAL ACTIVITIES, FIELD OBSERVATIONS AND DETERMINATION OF DAMAGE OF EUCALYPTUS STEM BORER, *PHORACANTHA SEMIPUNCTATA* F.

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Abstract

Follow-up of biological activities of eucalyptus stem borer, *Phoracantha semipunctata* F. (Coleoptera:Cerambycidae) showed that pre-oviposition, oviposition, post-oviposition and incubation periods recorded 2.25 (1-5) , 6.45 (2-12) , 5.05 (2-10) and 9.3 (6-13) days, respectively. Durations of pre-pupa and pupa listed 9.5 (3-17) and 15.65 (12-19) days, respectively. The number of pupal chambers and emerged beetles / mother female were 22.8 (8-38) chambers and 19 (7-32) beetles, respectively. Adult hardness recorded 6.55 (4-9) days, the female lived 13.7 (4-25) days, while the male lived 11.25 (5-19) days. The female laid 42.7(12-81) eggs, the percentage of egg death was 21.8 % (6.1-37.5 %).

Field observations revealed that attack density represented by number of egg batches varied from 4 to 11 batches per eucalyptus log (45- 110cm.long).The number of eggs / batch was 24.48 (6-68) eggs. Hatching percentage (75.71%) differed from 50 % to 93.9 %. Larval density(428.03 larvae /m²) resulted 68.36 % death in number of hatching larvae, 280 full grown larvae (135.42 pupal chamber /m²), 217 emerged beetles (104.95 adult /m² & 22.5 % death in pupae) and 75.48 % reduction in the broods. Three periods of emergence were observed from stored infested logs during June 1999 to June 2000, the first was after 18 weeks during 3rd week of October to 2nd week of November (21.06 % emergence), the second occurred after 30 weeks during 3rd week of January to 3rd week of February (73.68% emergence) and the third was noticed after 48 weeks during 1st week of June (5.26 % emergence).

The estimated damage of lost wood volume average 263.08cm³ / maturity larva or pupal chamber and each one female can be destroyed about 5998.22 cm³ (average) from attacked wood by her brood.

INTRODUCTION

The eucalyptus stem borer, *Phoracantha semipunctata* F, is the commonest and most economically important insect pest that invades freshly and recently cut eucalyptus trees. Larvae bore in the cambium region under the bark making oval irregular winding tunnels that are tightly packed with their frass (larval feeding layer). As larvae ap-

proach maturity, each larva excavates a pupal chamber inside the wood (pupal layer) in which it transforms into pupa and adult afterward then emergence takes place. Due to numerous interconnected tunnels, the bark becomes loose and easily detach. The most damage of this pest is highly related to reduction in the wood yield of cut trees by larval feeding and pupation of full-grown larvae.

In Egypt, many researchers (Alfieri, 1976; Nour, 1963; El-Sebay, 1978; Batt, 1989; Okil, 1991; Haggag, 2000) reported that *P. semipunctata* infested eucalyptus trees. However, Nour, 1963 and Moussa, 1977 listed poplar and *Ficus nitida* as host of this insect.

The aim of the present work is to add some knowledge on the biological activities, new field contribution and precise information about the damage of attacked wood by estimating the volume of lost wood caused by this pest.

MATERIALS AND METHODS

During the 1st half of June 1999, seven freshly eucalyptus pieces (logs) recently infested by *P. semipunctata* were collected from wood piles, one week after felling, that were accumulated and stored on the sides of agricultural roads at Enshas district, Sharkyia Governorate. These pieces were transferred to PPRI, laboratory at Dokki, Giza and continuous observations was carried out to estimate the number of egg batches, number of eggs laid in each batch , hatching percentage and larval density. The logs were kept in wire screen wooden cages for one year and the adults emergence and activity periods were recorded. At the end of beetles emergence, the bark was removed and the total number of pupal chambers and exit holes were counted to estimate the percentage of adult emergence from pupae (adult availability).

Another infested cuttings were placed in wire screen cages (each, 60 x 60 x 90 cm.) and examined daily until the emergence of beetles. Twenty couples of emerged beetles were confined in 20 cages provided with fresh eucalyptus cuttings (each 50cm.long and 15cm.diameter) to determine the ovipositional periods, number of eggs laid, adult longevity and incubation period. Hatching larvae left to bred in attacked cuttings and continuous observations were made until the emergence of beetles, the bark was removed and the pupal chambers were counted. To estimate the duration of

pre-pupa, pupa and adult hardness, 20 full grown larvae were extracted from their pupal chambers and each one was put in a Petri-dish. Daily inspection was made to observe the different transformation and calculate the durations of different stages.

Determination of wood volume losses: Wood volume losses (devastated wood) by *P. semipunctata* damages resulting from larval feeding and proceeding pupal chambers were estimated according to the following equation:

$$V = B - A$$

Where, V=volume of lost wood

B = size of wood pieces before infestation (length of wood pieces x its sectorial area)

A = size of wood pieces after remove the consumed layer due to larval feeding and lost wood by pupal chambers (depth of pupal chambers) = length of wood pieces x remanent sectorial area.

The volume of destroyed wood of each pupal chamber = total volume of lost wood ÷ total number of pupal chambers.

$$\text{Percentage of lost wood volume} = \frac{\text{volume of destroyed wood}}{\text{Total volume of wood pieces}} \times 100$$

The volume of destroyed wood of each mother female = number of pupal chambers / female x volume of lost wood / pupal chamber (maturity larva).

RESULTS AND DISCUSSION

A. Biological activities of eucalyptus stem borer, *P. semipunctata*:

Data in Table 1 show certain biological activities of eucalyptus stem borer under mean laboratory conditions.

a. Ovipositional periods: Under mean laboratory conditions of 30.8°C and 62.5 % R.H., the pre-oviposition, oviposition and post-oviposition periods recorded 2.25 ± 1.13 (range, 1-5) , 6.45 ± 2.92 (range, 2-12) and 5.05 ± 2.85 (range, 2-10) days, respectively.

Table 1. Certain biological activities of eucalyptus stem borer, *P. semipunctata* under mean laboratory conditions.

Periods	Duration (in days)		Lab. cond.	
	Range	Av. \pm S.E.	Temp.°C	R.H.%
Ovipositional periods				
Pre-oviposition	1-5	2.25 \pm 1.13	30.8	62.5
Oviposition	2-12	6.45 \pm 2.92	30.8	62.5
Post-oviposition	2-10	5.05 \pm 2.85	30.8	62.5
Incubation period	6-13	9.30 \pm 2.23	31.2	61.8
Pre-pupa	7-13	9.50 \pm 1.72	27.6	60.2
Pupa	12-19	15.65 \pm 2.10	29.8	59.9
Adult hardness	4-9	6.55 \pm 1.53	31.6	62.4
Adult longevity				
Female	4-25	13.70 \pm 5.73	31.2	63.3
Male	5-19	11.25 \pm 4.36	31.2	63.3
No. of eggs laid /female	12-81	42.7 \pm 20.4	30.8	62.5

Helal and El-Sebay (1980a) reported 2-4 days for the pre-oviposition period and the female continued to lay eggs for 1 to 5 days with an average of 3.7 ± 0.2 days, whereas the post-oviposition period ranged 2 - 7 days with an average of 4 ± 0.3 days.

The fertilized female laid 12-81 eggs, with an average of 42.7 ± 20.4 eggs. The percentage of eggs death ranged between 6.1 to 37.5 % with an average of 21.8 %.

Chararas *et al.* (1971) and Helal and El-Sebay (1980a) recorded an average of 180 and 10-41 eggs per female of *P. semipunctata*, respectively.

b. Incubation period: The incubation period of *P. semipunctata* eggs listed 6-13 days with a mean of 9.3 ± 2.23 days under mean laboratory conditions of 31.2°C and 61.8 % R.H.

El-Sebay 1978 found that incubation period was influenced by temperature as the shortest period was 4.3 days at 35°C (with 97.6% hatchability), while the longest was 8.9 days at 20°C (with 80% hatchability). Powell 1982 mentioned that the incubation period of *P. semipunctata* eggs in the insectary was 9-14 days.

c. Adult longevity: The adult stand stilled for hardness for 4-9 days with an average period about 6.55 ± 1.53 days, under mean laboratory conditions of 31.6°C and 62.4 % R.H.

The female beetle lived 4 - 25 days with an average of 13.7 ± 5.73 days, while the male beetle lived 5 - 19 days with an average of 11.25 ± 4.36 days under mean laboratory conditions of 31.3°C and 63.3 % R.H.

Helal and El-Sebay (1980a) mentioned that the longevity of mated female of *P. semipunctata* ranged 3-14 days (average, 8.9 ± 0.2 days), while that of unmated ones lived 3-12 days (average, 6.2 ± 0.2 days), whereas mated males lived 1-13 days (average 7.1 days) and unmated ones lived 2-12 days (average, 7.7 days).

d. Pupal duration: The pre-pupa lasted 3-17 days with an average duration of 9.5 ± 1.72 days, under mean laboratory conditions of 27.6°C and 60.2 % R.H.

Under mean laboratory conditions of 29.8°C and 59.9 % R.H., the pupa elapsed 12 -19 days with an average duration of 15.65 ± 2.10 days.

El-Sebay (1978) found that the temperature negatively affected the pupal duration as the longest period was 51 days at 20°C and the shortest was 10.4 days at 35°C

e. Number of pupal chambers and emerged beetles/female: The average number of pupal chambers/mother female recorded 22.8 ± 10.1 chambers (ranged, 8 - 38 chambers), while the average number of emerged beetles was 19 ± 8.3 beetles/female (ranged 7 - 32 beetles).

B. Field observations on attack density, laid eggs, hatchability, larval density and adult availability: Tables 2 and 3 showed the following information which were obtained from infested eucalyptus logs collected from the field during June 1999:

a. Density of attack and eggs laid : Daily field observation revealed that the attack of beetles and oviposition occurred nightly on the newly cut logs during June for about 30 days. Powell 1982 indicated that eggs were not found beyond day 42. This is a little longer than period of the 2-3 weeks recorded in Zambia (Loyttyniemi, 1975; Langstrom, 1976), but considerably shorter than the three months recorded during winter in Israel (Bytinski-Salz and Neumark, 1952).

Density of attack is represented by the number of egg batches laid by the female on fresh eucalyptus logs and accumulated in nature during June 1999 (average Temp. 29.6°C and 59% R.H.). The number of egg batches varied from 4 to 11 batches on different logs (about 45-110 cm. long). The total number of eggs laid in 48 batches reached 1169 eggs and the number of deposited eggs/batch ranged between 6 and 68 eggs (average, 24.48 ± 4.5 eggs/batch). The eggs density on exposed area of collected logs was 565.4 eggs/m².

The total number of hatching eggs recorded 885 eggs (range, 61-262 eggs/log) showing hatching percentage of 75.71% (range, 50 - 93.9 %.).

b. larval density and adult availability: Total number of hatching eggs in each eucalyptus log is an indicator to larval density of each on cm. long of infested wood. The larval crowd led to intensity competition (on food and space) and high percentage of larval death. The larvae reached full grown construct pupal chambers and the exit holes occurred after adult emergence .

Table 2. Hatchability, larval density, adult availability and reduction in broods of *P. semipunctata* on eucalyptus logs collected from the field during June 1999.

Log no	Logs measure.		No. of Egg batches	No. of Eggs /batch	Total No. of eggs laid	Hatchability (%)	Total no. of hatching eggs	Percentage of hatching	No. of pupal chambers	No. of exit holes	adult emergence (%)	Reduction in broods (%)
	Length cm.	Exposed area (cm ²)										
1	60	4148.57	7	22.86 ± 14.37 (6 - 48)	160	17.86 ± 12.57 (4 - 40)	125	78.13 (62.5 - 93.9)	42	36	85.71	71.2
2	45	2828.57	6	28.5 ± 14.90 (13 - 59)	171	24.67 ± 13.73 (10 - 53)	148	86.55 (76.9 - 89.8)	38	34	89.47	77.03
3	55	3284.29	6	26 ± 20.33 (8 - 68)	156	21.17 ± 17.85 (5 - 58)	127	81.41 (62.5 - 85.3)	24	20	83.33	84.25
4	60	2310	10	15.8 ± 6.16 (9 - 29)	158	9.4 ± 3.26 (5 - 15)	94	59.49 (50 - 78.6)	54	45	83.33	52.13
5	53	1465.83	4	26.75 ± 4.82 (20 - 33)	107	17. ± 3.54 (14 - 23)	68	63.55 (55.17 - 75)	10	8	80	88.24
6	57	2490.09	4	21.25 ± 9.42 (10 - 36)	85	15.25 ± 7.46 (5 - 26)	61	71.76 (50 - 77.87)	51	37	72.55	39.34
7	110	4148.57	11	30.18 ± 11.22 (16 - 48)	332	23.8 ± 9.06 (9 - 38)	262	78.9 (65.8 - 84.4)	61	37	60.66	85.88
T	440	20675.92	48	24.48 ± 4.5 (6 - 68) *	1169	18.45 ± 4.92 (4 - 58) *	885	75.71 (50 - 93.9) *	280	217	77.5 (60.66-89.47) *	75.48 (39.34-88.24) *

T = Total * = average

Data showed that the total number of hatching eggs was 885 eggs on 20675.92 cm² (440 cm long) of eucalyptus logs with 0.0428 larvae of each cm² (428.03 larvae /m², range 244.79 -631.54 larvae/m²). Larvae reached full grown (pupal chamber) were 280 larvae (range, 10 – 61 chambers / log) meaning 68.36 % larval death (range, 16.39 –85.29 %). The density of pupal chambers recorded 135.42/m² (68.22-233.77 pupal chambers/m²). The total number of emerged adults (exit holes) were 217 adults (range, 8-45 exit holes for log) showed 22.5 (range, 10.53-39.34)% pupal death. The total percentage of adult emergence recorded 77.5 (range, 60.66-89.4) %. The mean density of emerging adults was 104.95 beetles /m² and indicated a reduction in the broods by 75.48 (range, 39.34-88.24) %.

$$= \left(\frac{\text{No. of hatching larvae} - \text{No. of emerged beetles}}{\text{No. of hatching larvae}} \times 100 \right)$$

Statistical analysis (Fisher 1950) clearly reveal that highly significant positive correlation ($r = 0.97$) was found between larval density/m² and the number of dead larvae, also positive significant correlation ($r=0.72$) showed between egg density/m² and number of eggs which fail to hatch. On the other hand, there was insignificant correlation ($r = 0.48$) between pupal chamber density and number of pupae that fail to complete metamorphosis.

C. Broods and emergence of beetles from stored infested eucalyptus logs during one year: Date in Table 4 showed that the emergence of beetles from infested eucalyptus logs which were stored for one year beginning June 1999 took place on 3 periods, the first emergence detected after 18 weeks (short brood) during the 3rd week of October to 2nd week of November (mean Temp 22.3°C and 61.1% R.H.) at 21.06 % emergence, the second observed after 30 weeks (middle brood) during the period from the 3rd week of January to the 3rd week of February (mean Temp 17.55°C and 63.5% R.H.) at 73.68 % emergence, while the third emergence was noticed after 48 weeks (long brood) during the 1st week of June (mean Temp 29.04°C and 55.6% R.H.) at 5.26 % emergence .

Helal and El-Sebay (1980b) reported that *P. semipunctata* has two adult broods. The first started from the 1st week of April to the 4th week of March and continued up to the end of June. The second began the 3rd week of August and continued until the 2nd half of December.

Table 3. Density/m² and death percentage of different stages of *P. semipunctata*

Log no.	Density /m ²							Death (%)			
	eggs	Larvae	pupae	adults	eggs	larvae	pupae	Adults	larvae	pupae	Adults
1	385.68	310.31	101.24	86.78	21.87	66.4	14.29	-	66.4	14.29	-
2	604.55	523.23	134.34	120.2	13.45	74.32	10.53	-	74.32	10.53	-
3	474.99	386.69	73.08	60.9	18.59	81.1	16.67	-	81.1	16.67	-
4	683.98	406.93	233.77	194.81	40.51	42.55	16.67	-	42.55	16.67	-
5	729.96	463.9	68.22	54.58	36.45	85.29	20	-	85.29	20	-
6	341.35	244.97	204.81	148.59	28.24	16.39	27.45	-	16.39	27.45	-
7	800.28	631.54	147.04	89.19	21.11	76.72	39.34	-	76.72	39.34	-
General mean	565.39	428.03	135.42	104.95	24.29	68.36	22.5	-	68.36	22.5	-

Table 4. Broods and emergence of *P. semipunctata* beetles from stored infested eucalyptus loges during one year beginning June 1999.

Brood	Number of weeks before emergence	Period of emergence	Percentage of emergence	Lab. Cond. (mean)	
				Temp. °C	R.H. (%)
First	18	3rd week of Oct.1999 to 2nd week of Nov.1999	21.06 %	22.3	61.1
Second	30	3rd week of Jan. 2000 to 3rd week of Feb. 2000	73.68 %	17.55	63.5
Third	48	1st week of Jun.2000	5.26 %	29.04	55.6

In Zambia Loyttyniemi (1983) mentioned that beetles of *P. semipunctata* were active and laid eggs all the year round. Flight and emergence occurred even during the cold season and chilling nights. The peak flight and attacking intensity were in the warm season (late July to September), the second peak was in November.

D. Determination of lost wood volume by eucalyptus stem borer, *P. semipunctata*: Data representing in Table 5 showed the volume of destroyed wood of infested logs by *P. semipunctata*. When total volume of wood pieces before infestation was 83958.87 cm³, the remanent volume of wood after infestation reached 10296.4 cm³, so the volume of lost wood recorded 73662.47 cm³ representing 87.74 % size of intact logs, this devastated wood referred to larval feeding layer which recorded 20221.49 cm³ (the range of feeding layer thick 0.3 to 1.14 cm, with an average of 0.99 ± 0.28cm) and pupal layer that recorded 53440.98 cm³ (the range of depth of pupal chamber 3.2 to 6.7 cm, with an average of 4.63cm).

Lost wood by brood of *P. semipunctata* was made by 280 maturity larvae (number of pupal chambers), it means that the total volume of lost wood recorded 263.08 cm³ /maturity larva (/pupal chamber).

Pre-mentioned study on the biology indicated that the average number of maturity larvae or pupal chambers resulted from the breeding hatching larvae of one female was 22.8 maturity larvae (range 8-38 pupal chamber), this result give conclusion that each one female can be destroyed about 5998.22 cm³ (range 2104.64-9997.04 cm³) from attacked wood by her brood.

Table 5. Determination the volume of lost wood by eucalyptus stem borer, *P. semipunctata* F.

Pieces No.	Measurements of wood logs										Volume of lost wood (cm ³)				Pupal chambers		Percentage of lost wood volume (%)	Lost wood volume /maturity larvae (or pupal chamber) cm ³
	Length (cm)	Diameter (cm)	Exposed area (cm ²)	Total		Remanent		TV.-RV.	F. L.	P. L.	Number	Mean depth						
				Sectorial Area (cm ²)	Volume (cm ³)	Sectorial Area (cm ²)	Volume (cm ³)											
1	60	22	4148.57	380.29	22817.4	88.28	5296.8	17520.6	4410	13110.6	42	4.58 3.8 - 5.3	76.79	417.16				
2	45	20	2828.57	314.29	14143.05	52.83	2377.35	11765.7	2839.5	8926.2	38	4.84 (3.7 - 5.5)	83.19	309.62				
3	55	19	3284.29	238.64	15600.2	43.03	2366.65	13233.55	3519.45	9714.1	24	4.66 (4 - 5.2)	84.83	551.4				
4	60	12.25	2310	117.91	7074.6	0.5544	33.26	7041.34	2360.31	4681.03	54	4.58 (3.2 - 6.7)	99.53	130.4				
5	53	8.8	1465.83	60.85	3225.05	0.0154	0.8162	3224.23	424.98	2799.25	10	4.03 (3.4 - 6.4)	99.97	322.42				
6	57	13.9	2490.09	151.81	8653.17	0.1964	11.2	8641.97	2522.45	6119.52	51	5.6 (4.4 - 6.5)	99.87	169.45				
7	110	12	4148.57	113.14	12445.4	1.912	210.32	12235.08	4144.8	8090.28	61	4.12 (3.8 - 5.6)	98.31	200.58				
T	440	-	20675.92	-	83958.87	-	10296.4	73662.47	20221.49	53440.98	280	4.63 (3.2 - 6.7)	87.74 (76.79-99.97)	263.08 (130.40 - 200.58)				

T. = total, T.V. = total volume of wood, R.V. = Remanent volume of wood, F.L = feeding layer, P.L = pupal layer

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بعض النشاطات البيولوجية والملاحظات الحقلية وتقدير الضرر لحفار ساق الكافور

Phoracantha semipunctata F.

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معهد بحوث وقاية النباتات - مركز البحوث الزراعية - الدقى - الجيزة - مصر

أوضح النشاط البيولوجى لحفار ساق الكافور أن فترات ما قبل وضع البيض، ووضع البيض، وما بعد وضع البيض، وحضانة البيض سجلت ١-٥ و ٢-١٢ و ٢-١٠ و ٦-١٢ يوماً، على الترتيب. بلغت فترة ما قبل العذراء، والعذراء ٣-٧ و ٢-١٢ و ١٩-١٢ يوماً، على التوالي. وصل متوسط عدد غرف التعذير والخنافس الخارجة للأنثى الأم ٢٢,٨ غرفة تعذير، ١٩ حشرة كاملة على التوالي. بلغت فترة تصلب الحشرة الكاملة ٤-٩ يوماً. تعيش الأنثى ٤-٢٥ يوماً بينما يعيش الذكر ٥-١٩ يوماً و تضع الأنثى ١٢-٨١ بيضة كما تصل نسبة موت البيض ١,٦% - ٥,٢٧% بمتوسط ٨,٢١%.

أوضحت الملاحظات الحقلية أن كثافة الهجوم ممثلة بعدد لطم البيض التى اختلفت من ٤ الى ١١ لطة على قطع كافور تراوح طولها ما بين ٤٥ و ١١٠ سم. ويتراوح عدد البيض لكل لطة ما بين ٦ و ٦٨ بيضة، واختلفت نسبة الفقس من ٥٠ - ٩٣,٩% (بمتوسط ٧١,٧١%). كانت الكثافة اليرقية ٤٢٨,٠٢ يرقة/م^٢ بمعدل ٦٨,٣٦ موت فى عدد اليرقات الفاقسة، ووصل عدد اليرقات التامة النمو ٢٨. يرقة (١٣٥,٤٢ غرفة تعذير)/م^٢ وعدد الخنافس الخارجة ٢١٧ حشرة (١٠٤,٩٥ حشرة/م^٢ ٢٢,٥/موت فى العذراء ونسبة انخفاض فى الحضنة تقدر بحوالى ٧٥,٤٨%).

كانت هناك ثلاث فترات لخروج الحشرة من قطع الكافور المخزنة لمدة عام ابتداء من يونيو ١٩٩٩ حتى يونيو ٢٠٠٠. ظهرت الفترة الأولى بعد حوالى ١٨ أسبوع، خلال الأسبوع الثالث من أكتوبر الى الأسبوع الثانى من نوفمبر (٢١,٠٦ خروج)، بينما حدثت الفترة الثانية بعد حوالى ٣٠ أسبوع، خلال الأسبوع الثالث من يناير الى الأسبوع الثالث من فبراير (٧٣,٦٨ خروج) فى حين ظهرت الفترة الثالثة بعد ٤٨ أسبوع خلال الأسبوع الأول من يونيو (٥,٢٦ خروج).

أوضح ضرر هذه الحشرة مقدراً بحجم الخشب التالف نتيجة التغذية اليرقية ووجود غرف التعذير أن متوسط الحجم التالف لكل يرقة تامة النمو أو غرفة تعذير كان ٢٦٣,٠٨ سم^٣ وكذلك استنتج أن كل أنثى يمكن أن تحطم فى المتوسط حوالى ٥٩٩٨,٢٢ سم^٣ من الخشب المهاجم بواسطة حضنتها.