Population Dynamics of *Macrotoma palmata* F. (Col.: Cerambycidae) on Casuarina Trees in Alexandria, Egypt

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ABSTRACT

Population dynamics of Acacia stem borer, *Macrotoma palmata* F. (Col., Cerambycidae) was performed on casuarina trees in Alexandria, Egypt during 2009 and 2010. Results showed that older trees were highly infested especially those on the east side of the garden, as well as no preferred part of tree - trunk for occupation by this insect. Emergence of adult - beetles begins from the 1st half of June to late September in 2009 and 2010. The maximum mean number of emerged beetles ranged between 17.5 – 19.5 beetles/ tree during the period from late July to early August under environmental conditions of 19.5 – 26.0 ^{o}C & 68.7 – 76.4% R. H. One peak of adult emergence was recorded per year in both seasons of study. The combined effect of day - maximum temp., day - minimum temp. and daily- mean relative humidity on the rate of beetles emergence were recorded. Repetition of infestation after two years later increased the infestation rate by 92.3%.

Key words: Population dynamics- *Macrotoma palmate* F. – Casuarina trees.

INTRODUCTION

Casuarina is a common and widely cultivated trees in several regions of Egypt.

Macrotoma palmata F. (Coleoptera : Cerambycidae) is considered the principle problem of casurina wood, which severely suffers from its infestation repetition. The larvae feed and burrow into the vital wooden tissues of trunk and main branches resulting in considerable destruction of infested trees.

Previous investigations on the biology, ecology and control of *M. palmata* were achieved by Willcocks (1922), Mostafa (1977), EL-Sebay (1984), Helal *et al* (1987), Tadros *et al* (1993) and (1996), and Shehata et al (2001).

Willcocks (1922), recorded that adults of *M. Palmata* emerge from the trunks of the host trees through elongate exit holes, 22mm lenght and 12.5 mm width, between late April and August. The eggs are usually laid in cracks in the bark of the trunks of healthy trees. Young larvae excavate small galleries that are getting wider gradually with the progress of larval development until they change into wide cavities. The total larval period lasts for 1 – 2 years or even more. Pupation takes place inside cells of coarse wooden fibers and saw-dust situated just under the bark.

Mostafa (1977) stated that the intervals of adult beetle activity extended from July to September on ficus trees in Alexandria. Tadros *et al* (1993), recorded the periods of adults emergence in apricot orchards in Alexandria and Giza. Shehata *et al* (2001) mentioned that the factors of age, site and part of tree greatly affected on the rate of beetle population. They also added that the adult emergence continued from June to September or October in orange orchards in Alexandria.

The present investigation on *M. palmata* includes the main following points:

1. Sites and directions of infestation.
2. Fluctuation of beetles population.
3. Progress of infestation
4. Effect of some environmental factors on the rate of beetles emergence.

These studies will provide better information on the insect activity leading to determine the perfect time to control this pest on casuarina trees.

MATERIALS AND METHODS

The present investigation deals with monitoring *M. Palmata* on casuarina trees at EL-Montaza gardens in Alexandria city during two subsequent years from January, 2009 to December, 2010.

Population fluctuation of *M. palmata* was studied based on the following technique:

Counting the population levels of the insect, the old exit beetle holes of selected trees were marked with red paint. Newly exit holes formed by recently emerged beetles were then counted, and the mean number of emerged beetles / tree was recorded.

1. Effect of some environmental factors on the population level of *M. palmata* during 2009:

1-1. Effect of age of tree:

Casuarina trees (*Casuarina equistifolia*) less than 10 years, 10 – 20 years and more than 20 years old were selected. Fifty randomized trees of each age were marked to determine the effect of tree age on its susceptibility for infestation.

1-2. Effect of part of tree:

About 20 randomizely infested casurina trees (about 25 years old) were checked. Each trunk of

tree was horizontally marked into 3 equal parts, i. e., the lower, the middle and the upper parts.

Adult - exit holes occurred on each part of trunk were counted to define the part of trunk which is chosen by the insect.

1-3. Effect of site and direction of tree:

Forty randomized trees (about 25 years old) were divided into 4 groups according to the cardinal directions (east, west, north and south). Ten trees of each direction were used to check the direction which harbored the highest infestation.

Another group of twenty heavily infested casaurina trees (about 25 years old) were chosen. The trunk of each tree was vertically marked into 4 parts according to the cardinal directions (east, west, north and south). Numbers of exit beetle holes were counted for each direction/ tree.

2. Fluctuations of *M. palmata* population:

Fifty infested casuarina trees of about 25 years old were randomly selected. Old beetle exit holes were painted. Starting from early January 2009 until late December 2010, half monthly inspections were carried out to count the newly exit beetle holes which were considered as the criteria for assessment of the beetles population fluctuation. After each count, the exit holes were painted to prevent count repetition.

The above experimental design was used to record; the first and last dates of beetles emergence as well as peaks of adult emergence during the two successive years of study.

"C- multipliers formula" described by fisher (1950) was used to explain the relation between temperature and relative humidity and their effects on the rate of adult emergence.

''F'' test (Snedecor and Cochran, 1961) was used to check the differences between adult population and each of age of tree, site and part of tree as well as direction of tree trunk.

RESULTS AND DISCUSSION

1. Effects of tree age, tree part, site and direction on population level of *M. palmata* on casuarina trees:

Effect of the age and the part as well as the site of tree on the population level of *M. palmata* are shown in Table (1).

1.1. Effect of age of tree:

Results declared that the age of casuarina tree greatly affected with the level of insect population.

Trees less than 10 years, 10 – 20 years and more than 20 years were infested by [0.70 (0-1) beetles/ tree], [2.70 (1-5) beetles/ tree] and [7.46 (2-13) beetles/ tree]; respectively. Thus, the older trees were more susceptible to insect infestation than younger ones.

1.2. Effect of part of tree:

Data shows also that the wooden horizontal parts of trunk tree (upper, middle and lower trunk) were exposed with variant level of *M. palmata* infestation.

The upper trunk harboured the highest population [2.35 (2-4) beetles/ tree] while the middle trunk was the lowest population [2.06 (1-5) beetles/ tree]; whereas, population occurred on the lower trunk was generally intermediate between upper trunk and middle trunk [2.28 (1-4) beetles/ tree].

1.3. Effect of site and direction of tree:

The selected area cultivated with casurina trees was divided into four locations according to the four cardinal directions (north, south, east and west). Results showed that, trees occurred at the eastern direction harboured the highest number of insects [10.40 (4-16) beetles/ tree] followed by trees at the northern direction [7.24 (3-11) beetles/ tree], then trees at the southern direction [2.82 (1-4) beetles/ tree] while the western direction was subjected the least number of insects [2.26 (1-3) beetles/ tree].

Table 1: Number of *M. Palmata* beetles emerged from *C. equistifolia* according to age and site of tree as well as part and direction of trunk in Alexandria during 2009.

Number of emerged beetles/tree				**F**	**P**	**L. S. D**	
Age of tree (years)							
less than 10	From 10 to 20	More than 20				0.05	0.01
0.70 (0-1) *	2.70 (1-5)	7.46 (2-13)		50.81	0.01	1.31	1.73
Part of tree trunk							
Upper	Middle	lower		**F**	**P**	**L. S. D**	
2.35 (2-4)	2.06 (1-5)	2.28 (1-4)		0.52	0.00	_	_
Site of tree							
North	South	East	West	**F**	**P**	**L. S. D**	
7.24 (3-11)	2.82 (1-4)	10.40 (4-16)	2.26 (1-3)	7.67	0.01	3.99	5.35
Direction of tree trunk							
North	South	East	West	**F**	**P**	**L. S. D**	
5.75 (3-7)	5.45 (3-7)	5.07 (3-8)	4.91 (2-7)	0.24	0.00	_	_

F = F value
P = Probability
L.S.D. = Least Significant Differences
* = The average number (the least number – the highest number)

On the other hand, trunk of casurina tree was vertically marked into four directions (north, south, east and west).

Data in the same Table indicated that the number of adults emerged descendigly being [5.75 (3-7), 5.45 (3-7), 5.07 (3-8) and 4.91 (2-7) beetles/ tree] at the directions of north, south, east and west, respectively.

Statistical analysis proved that the factors of age of tree as well as site of tree significantly affected on the population of *M. palmata*, while the factors of the part of tree and its direction resulted insignificant effects on population of adult beetles.

2. Population fluctuation of *M. palmata* beetles:

Population fluctuation of *M. palmata* was studied on casuarina trees (*C. equistifolia*) under prevailing environmental factors, in Alexandria governorate throughout two successive years, 2009 and 2010.

2.1. Seasonal abundance:

Data given in Table (2) and attendant figure (Fig. 1) indicated that, the adult beetles emerged from casuarina trees during 4 months (Jun. - Sep.) under mean environmental factors of 18.1- 24.4^{o}C and 63.0- 76.4% R.H. in 2009 and 2010.

The adult beetles didn't emerge during the period from early October to late May during the 2 years of study.

The least population of *M. palmata* (0.07 - 0.50 beetles/ tree) was recorded during late September (24.2 – 24.8 ^{o}C and 67. 0 - 68.2 % R.H.). The main period of adult emergence (1.50 - 19.47 beetles/ tree) occurred during late June and continued until late August (19.5- 26.4 ^{o}C and 63.0- 76.4% R. H.). Only one peak of adult emergence existed annually in late July (19.5 ^{o}C & 76.4% R. H.) and early August (26.0 ^{o}C & 68.7%) in 2010 and 2009, respectively. However, Mostafa (1977) found that *M. palmata* emerged from *Ficus nitida* during a period from July to September in Alexandria region. Tadros et al (1993) mentioned that this insect started to appear in apricot orchards during June until October in Alexandria and Giza. Shehata et al (2001) achieved that *M. palmata* started to emerge in orange orchards during a period from June to October, recording one peak of beetle emergence annually.

2.2. Progress of infestation:

The cumulative numbers of adult – exit holes of *M. palmata* beetles per casuarina tree during 2009 & 2010 are shown in Table (2) and attendant figure (Fig. 1).

Table 2: Population fluctuation and cumulative numbers of *M. palmata* beetles emerged from casuarina trees corresponding with hygrothermic weather factors (Temp. ^{o}C & RH%) in Alexandria during 2009 and 2010.

Year	Date	No. of emerged beetles/tree		Mean weather factors			
				Temp. ^{o}C			R.H. %
		Actual	Cumulative	max	mean	min	
2009	May i	0.00	0.00	24.2	19.0	13.5	63.7
	ii	0.00	0.00	28.5	27.6	12.8	67.3
	Jun. i	0.80	0.80	27.0	24.1	19.1	67.8
	ii	3.13	3.93	31.1	25.7	20.5	63.0
	Jul. i	3.60	7.53	30.1	25.8	21.5	69.7
	ii	8.08	15.61	30.4	26.4	22.3	68.0
	Aug. i	17.50	33.11	30.7	26.0	21.3	68.7
	ii	1.50	34.61	30.1	25.4	20.5	69.9
	Sep. i	0.80	35.41	29.7	25.3	19.5	67.5
	ii	0.50	35.91	29.5	24.8	18.7	67.0
	Oct. i	0.00	35.91	29.0	22.8	16.5	69.7
	ii	0.00	35.91	28.7	22.3	15.9	68.5
2010	May i	0.00	35.91	25.7	20.7	15.5	61.3
	ii	0.00	35.91	23.6	19.5	15.4	66.6
	Jun. i	0.47	36.38	24.2	18.1	14.4	69.1
	ii	0.47	36.85	24.5	20.1	15.6	70.3
	Jul. i	0.47	37.32	22.6	18.3	13.9	76.2
	ii	19.47	56.79	24.7	19.5	16.3	76.4
	Aug. i	9.73	66.52	24.8	20.7	16.6	74.6
	ii	2.20	68.72	24.9	20.6	16.4	71.5
	Sep. i	0.27	68.99	25.9	22.3	18.7	72.3
	ii	0.07	69.06	27.8	24.2	20.5	68.2
	Oct. i	0.00	69.06	27.6	24.3	21.1	67.8
	ii	0.00	69.06	27.2	22.4	17.6	67.7

i: The 1st half of month
ii: The 2nd half of month

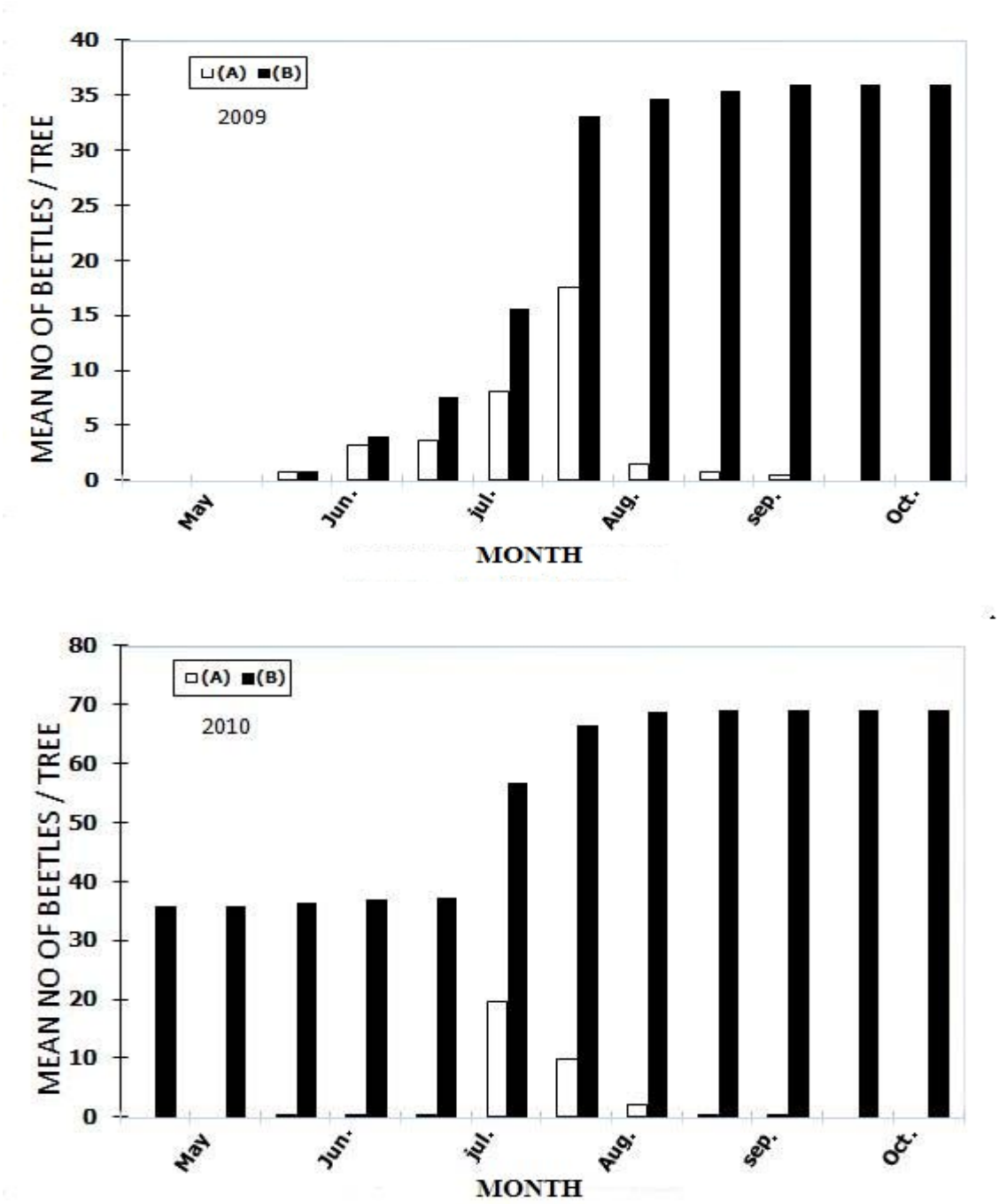

Fig 1:Actual (A) and cumulative (B) mean numbers of *M. palmata* emerged from casuarina trees in Alexandria region during 2009-2010.

During the seasonal activity period of adults emergence, the cumulative mean number of adults emerging were 35.91 and 69.06 beetles/tree in 2009 and 2010, respectively. So, repetition of infestation year after year increased the adult population level by 92.3%. This great increase in the rate of *M. palmata* infestation is considered as a dangerous parameter of this pest on its hosts of wood trees that needs rapid and effective management to reduce the population of this insect in casuarina plantations.

2.3. Effect of environmental factors:

Table (3) shows the simple correlation (r), simple regression (b), partial regression (p. reg.), analysis of variance (F) and the percentage of explained variance (E. V.) of the effect of day-maximum temperature (DMxT), day- minimum temperature (DMnT) and daily-mean relative humidity (DMRH) on the rate of *M. palmata* beetles emergence throughout 2009 and 2010.

Table 3: Simple correlation (r), simple regression (b), partial regression (p. reg.), analysis of variance (F) and percentage of explained variance (E.V.) of day- maximum temperature (DMxT), day-minimum temperature (DMnT) and daily- mean relative humidity (DMRH) affecting the rate of *M. palmata* adult beetles emerged from casuarina trees, in Alexandria during 2009 and 2010.

Year	Weather factor	r	b	p. reg.	F	E.V.%
2009	DMxT	+0.457	+0.17	+0.10	0.67	31.0
	DMnT	+0.547	+0.33	+0.80		
	DMRH	+0.191	+0.08	-0.03		
2010	DMxT	+0.649*	+0.32	+1.42*	4.10	73.2
	DMnT	-0.094	+0.04	+2.61		
	DMRH	+0.587*	+0.43	+0.18		

* significant

2.3.1. Effect of DMxT:

The direct effect (r) values of DMxT on beetle emergence was positive and insignificant in 2009, and it was positive and significant in 2010.

Simple regression (b) values indicated that an increase of 1 ^{o}C in DMxT increased the rate of adult emergence by 0.17- 0.32 beetles/ tree during 2009-2010.

The true effect (p. reg.) of the DMxT on the rate of adult emergence was insignificant in 2009 but it was significant in 2010.

2. 3. 2. Effect of DMnT:

The direct effect of (r) of DMnT on beetle emergence was positive and insignificant during 2009 but it was negative and insignificant in 2010.

Simple regression values showed that an increase of 1 ^{o}C in DMnT affected the population by 0.04- 0.33 beetles/ tree during 2009 and 2010.

Partial regression indicated that the real effect of DMnT on beetle emergence was insignificant in 2009 and 2010.

2. 3. 3. Effect of DMRH :

The direct effect of (r) of DMRH on beetle emergence was positive and insignificant in 2009; also it was positive but significant in 2010.

Simple regression coefficients showed that an increase of 1% R.H. raised the insect population by 0.08 and 0.43 beetles/ tree in 2009 and 2010, respectively. The true effect (p. reg.) of DMRH was insignificant during 2009 and 2010.

2. 3. 4. The combined effect of DMxT, DMnT and DMRH:

The analysis of variance (F) for the combined effect of three weather factors (DMxT, DMnT and DMRH) together on the rate of adult emergence was insignificant in 2009 and 2010.

However, the percentages of explained variance (E.V.), for the three weather factors together on the rate of beetles emergence varied from 31.0- 73.2% from casuarina trees during 2009 and 2010, respectively.

In conclusion, older casuarina trees are more susceptible to *M. Palmata* infestation. The higher infestations were usually found in the upper part of the tree trunk, compared to the middle and lower ones. The trees cultivated in the east is usually more infested than those in the north and south, while the least infested were trees cultivated in the west. Whereas, the northern side of each tree was the most, compared with other sides of the same tree.

Beetles started to emerge during a period from June to September. One peak of adult emergence was occurred in July or August in casuarina plantation. The combined effect of temperature and humidity on the emergence of adult insects was found to be insignificant.

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الملخص العربى

دراسات على تعداد حفار ساق السنط فى زراعات اشجار الكازوارنيا بمنطقة الاسكندرية

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يشمل البحث على بعض الدراسات الخاصه بديناميكية تعداد حفار ساق السنط (رتبة غمدية الأجنحـة– عائلـة سيرامبيسدى) على أشجار الكازوارينا بمنطقة الاسكندرية خلال عامى ٢٠٠٩ – ٢٠١٠.

أظهرت النتائج أن مستوى الاصابة يرتبط معنويا بعمر الأشجار وموقعها فى الحديقة حيـث تبـين أن أعـداد الحشرات الخارجة من الأشجار كبيرة العمر يفوق مثيلتها الأصغر عمرا؛ وأن خروج الحشرات الكاملة من الأشجار التى تقع ناحية الشرق يزيد عن مثياتها من الأشجار التى تقع فى اتجاهات الغرب والشمال والجنوب من الحديقة.

وجد أيضا أن الأجزاء المختلفة من جذع الشجرة (العلوى – الوسطى– السفلى) لم يكن لها تأثيرا معنويا علـى مستوى تعداد الجذع.

وجد كذلك أن خروج الخنافس يستمر خلال الفترة من أوائل يونيه وحتى أواخر سبتمبر؛ وأن أعلى قمة خـروج للحشرات (١٧.٥ - ١٩.٥ خنفساء/ الشجرة) سجلت أواخر يوليو أو أوائـل أغسـطس عنـد (١٩.٥ – ٢٦.٥ ^{o}م، ٦٨.٧ – ٧٦.٤ % رطوبة نسبية) خلال عامى الدراسة.

أظهرت نتائج تكرارالاصابة عام بعد عام ارتفاعا بمقدار ٩٢.٣%؛ وهذا يوضح مدى خطورة هذا الحفار على عوائله من أشجار الكازوارينا.

بينت نتائج التحليل الاحصائى عدم وجود علاقة معنوية مباشرة بين التأثير المشترك لعوامل الحراره العظمـى والصغرى والرطوبة النسبية ومعدل خروج الحشرات الكامله فى زراعات الكازوارينا.