

Assessment of growth of Lemon butterfly (*Papilio demoleus*) in Tando Muhammad Khan, lower Sindh, Pakistan

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ABSTRACT

Introduction: Lemon butterfly (*Papilio demoleus*) is one of the most destructive pests of citrus plants; while major pest of plant family Rutaceae in severe infestation the tree becomes weak. The aim of present research study is to determine the number of generations and their duration in Tando Muhammad Khan Lower Sindh Pakistan.

Materials and Methods: The freshly eggs and larvae were collected from citrus orchards and put them in plastic jars at the size of 9x9x9 inches. The research work started in 1999 with ten pairs of adults were released in cage and noted the development of eggs incubation period, larval duration, pre pupa, pupa and adult readings.

Results: In Tando Muhammad Khan, lower Sindh (Pakistan) *Papilio demoleus* generations were recorded overlapping 13 in a year, from 1999 duration minimum and maximum was 22.5-46.5 days at the temperature 37-17.5°C for 1-13 generations. In 2000, it was 22.5-46.5 days at the temperature 38-18.11°C for 1-13 generations, during 2001 it was 23.5-45 days at the temperature 37-17.81°C for 1-13 generations.

Conclusion: during study it is also noted the effect of temperature highly correlated with the duration of developmental stages.

Key words: *Papilio demoleus*, Generations, Citrus *aurantifolia*, Lower Sindh

INTRODUCTION

Lemon butterfly (*Papilio demoleus*) is one of the most destructive pest of citrus plants (Parson, 1990); it is a major pest of plant family Rutaceae (Fletcher, 1917) in severe infestation the tree becomes weak (Duport, 1913; Malik, 1973) reported the *P. demoleus* the citrus butterfly is black in color with broad irregular yellow discal band on the upper side of the hind wing which is broken into irregular spots and patches on forewing there are marginal anti terminal row of yellow spots on both the fore wings, whereas hind wings are devoid of tail and possess at tornal end red spot with black mark in male and red and blue in female (Roberts, 2001) there are five larval instars and they are the foliage feeder and pest is found all over the Pakistan.

Badawi (1981) in severe attack of this pest the plant completely defoliated (Lefroy, 1906; Wynter and Blyth, 1975) the *P. demoleus* is cosmopolitan pest and found in plains and lower hills of area (Garraway and Murphy, 2006). Pest also found in Jamaica (Homziak and Homziak, 2006) *P. demoleus* first time recorded in Puerto Rico (Sherwood and Myers 2008) reported *P. demoleus* is highly injurious pest of citrus plants of family Rutaceae the pest hibernates in cold weather as in pupal stage and life cycle from egg to emergence of adult duration prolonged respectively, the attack activity of pest on citrus plants becomes reduced in winter and high in temperate regions the duration of generation varies with season (Yadave and Rizvi, 1995) the pest infestation becomes very active during February to March; While scientist (Pipatwatanakul, 1979; Badawi, 1968; Winotai and Napompeth, 1981) also reported the pest life cycle, included incubation period, duration of larval, prepupation, pupa and Adult.

The aim of present research study is to determine the number of generations and their duration in Tando Muhammad Khan Lower Sindh Pakistan.

MATERIALS AND METHODS

The rearing of *Papilio demoleus* was done at Tando Muhammad Khan Sindh. The freshly eggs and larvae were collected from citrus orchards and put them in plastic jars at the sized of 9x9x9 inches. The research work started in 1999 with ten pair of adults were released in cage and noted the development of eggs incubation period, larval duration, pre pupa, pupa and adult readings.

RESULTS

In Tando Muhammad Khan, lower Sindh (Pakistan) *Papilio demoleus* generations were recorded overlapping 13 in a year, from 1999 duration minimum and maximum was 22.5-46.5 days at the temperature 17.5-37°C (Table 1) for 1-13 generations. In 2000, it was 22.5-46.5 days at the temperature 18.11-38°C for 1-13 generations (Table 1), during 2001 it was 23.5-45 days at the temperature 17.81-37°C for 1-13 generations (Table 1). Duration of life stages of different generations are shown in (Figure 1) for 1999-2001 it shows during 1999-2001, 1st and 13th generation was prolonged in the month of December and January due to low temperature. The incubation period was 6 days in 1999 at the temperature 17.51°C in 2000; it was 7 days at the temperature 19°C while in 2001 it was 4.5 days at the temperature 19.11°C shows the correlation between temperature and duration of incubation period data highly explained by linear model as $R^2=91.4\%$ in 2000 (Figure 1), in 1999 total larval duration was 8 to 13.5 days at the temperature 17.5-33°C, in 2000 it was 8.5 days at the temperature 37-19.13°C, while in 2001 it range from 8.5 to 13.5 days at the temperature 17.81-37°C shows the correlation between temperature and larval duration period data highly explained by linear model $R^2=88.5\%$ in 2001 (Figure 2). The diapauses period of pupa in 1999 it was 6-20 days in 1-13 generations at the temperature 17.51-37.5°C. In 2000 it was 18-55 days at the temperature 18.11-38°C and in the year 2001, it was 6-20 days at the temperature 17.81-34.66°C (Table 4) shown the correlation between temperature

and pupal period data highly explained by linear model as $R^2=92.9\%$ in 1999 (Figure 3). During the research study period it was noted that from eggs to pupa all the stages are highly sensitive against the temperature. During 1999 the pupal duration range from 6 to 20 days at the temperature $17.51-34^\circ\text{C}$ in 2000 it was 6-15 days at the temperature $18.11-37^\circ\text{C}$ while in 2001 the pupal duration was found 20-6 days at the temperature $17.81-34^\circ\text{C}$. During the month of March-July the generation was short at the temperature 38°C while in the month of February the generations were long at the temperature 19.11°C . December to February growth rate was slow while during the rest of months growth rate was observed faster. Adult duration was 6.5 days in 1999; 6.7 days in 2000; while in 2001 it was 6.8 days.

Table 1: Generation wise total duration in days (egg to adult) of *P. demoleus* during 1999-2000.

Generation	Life stages	Days			Temperature $^\circ\text{C}$		
1 st	Egg	6.00	7.00	4.50	17.51	19.00	19.11
	Larva	13.50	14.50	13.50	17.50	19.13	17.00
	Pupa	20.00	18.00	20.00	17.51	18.11	17.81
	Adult	7.00	7.00	7.00			
	Total duration	46.50	46.50	45.00			
Generation							
2 nd	Egg	3.50	3.50	4.00	28.50	26.00	25.44
	Larva	11.00	13.00	12.00	28.00	30.45	28.66
	Pupa	10.00	7.00	7.50	31.50	31.33	32.61
	Adult	7.00	6.50	6.50			
	Total duration	31.50	30.00	30.00			
Generation							
3 rd	Egg	2.00	2.00	2.00	32.50	32.50	34.11
	Larva	10.00	10.00	10.50	32.00	33.50	33.61
	Pupa	7.00	6.50	6.50	32.15	32.35	34.11
	Adult	6.50	7.00	7.00			
	Total duration	25.50	25.00	26.00			
Generation							
4 th	Egg	2.00	2.00	2.00	31.50	33.50	34.61
	Larva	12.00	10.50	10.50	32.00	33.00	33.11
	Pupa	7.00	6.50	7.00	34.00	33.55	32.33
	Adult	6.00	6.00	7.00			
	Total duration	27.00	25.00	26.50			
Generation							
5 th	Egg	2.00	2.00	2.00	34.50	36.50	35.00
	Larva	9.50	10.00	9.00	34.00	36.00	35.11
	Pupa	6.00	6.00	6.00	34.50	36.13	34.66

	Adult	6.50	6.50	7.00			
Total duration	24.00	24.50	24.00				
Generation							
6th	Egg	2.00	2.00	2.00	32.40	37.00	34.66
	Larva	8.00	9.00	9.50	33.00	37.11	35.00
	Pupa	7.00	6.00	6.50	33.13	37.00	35.00
	Adult	6.50	7.00	6.50			
Total duration		23.50	24.00	24.50			
Generation							
7th	Egg	1.50	1.50	2.00	37.50	38.11	36.00
	Larva	9.50	9.00	8.50	33.00	38.00	37.00
	Pupa	6.00	5.50	6.50	34.51	38.00	37.00
	Adult	7.00	6.50	6.50			
Total duration		24.00	22.50	23.50			
Generation							
8th	Egg	1.50	1.50	2.00	35.33	35.33	37.00
	Larva	9.00	8.50	9.50	35.00	37.00	36.00
	Pupa	6.50	6.50	6.50	35.35	36.00	36.11
	Adult	7.00	7.00	7.00			
Total duration		24.00	23.50	25.00			
Generation							
9th	Egg	2.00	2.00	2.00	35.35	37.00	36.00
	Larva	8.00	9.00	8.50	37.00	38.00	37.00
	Pupa	6.00	5.50	6.50	37.5	38.11	37.00
	Adult	6.50	7.00	7.00			
Total duration		22.50	23.50	29.00			
Generation							
10th	Egg	1.50	1.50	2.00	37.50	38.00	37.00
	Larva	9.50	9.50	9.50	33.00	35.11	36.50
	Pupa	6.50	6.00	6.50	33.50	35.00	37.00
	Adult	7.00	6.00	7.00			
Total duration		24.50	23.00	25.00			
Generation							
11th	Egg	2.00	2.00	2.00	33.50	35.00	36.00
	Larva	9.00	10.00	9.50	34.11	35.33	35.66
	Pupa	6.00	6.50	6.50	33.50	35.33	34.33
	Adult	6.00	7.00	6.50			
Total duration		23.00	25.50	24.50			
Generation							
12st	Egg	3.00	2.00	2.00	32.50	35.00	35.11
	Larva	9.00	9.00	10.00	33.33	34.11	33.66
	Pupa	7.00	6.00	7.00	32.11	36.50	33.61
	Adult	6.50	6.50	7.00			
Total duration		25.50	23.50	26.00			
Generation							
13st	Egg	3.50	3.50	4.00	29.50	33.50	33.11
	Larva	10.50	11.00	11.50	29.00	32.50	329.50
	Pupa	10.00	11.00	11.00	29.41	27.11	28.66
	Adult	5.50	7.00	7.00			

Total duration		29.50	32.50	33.50			

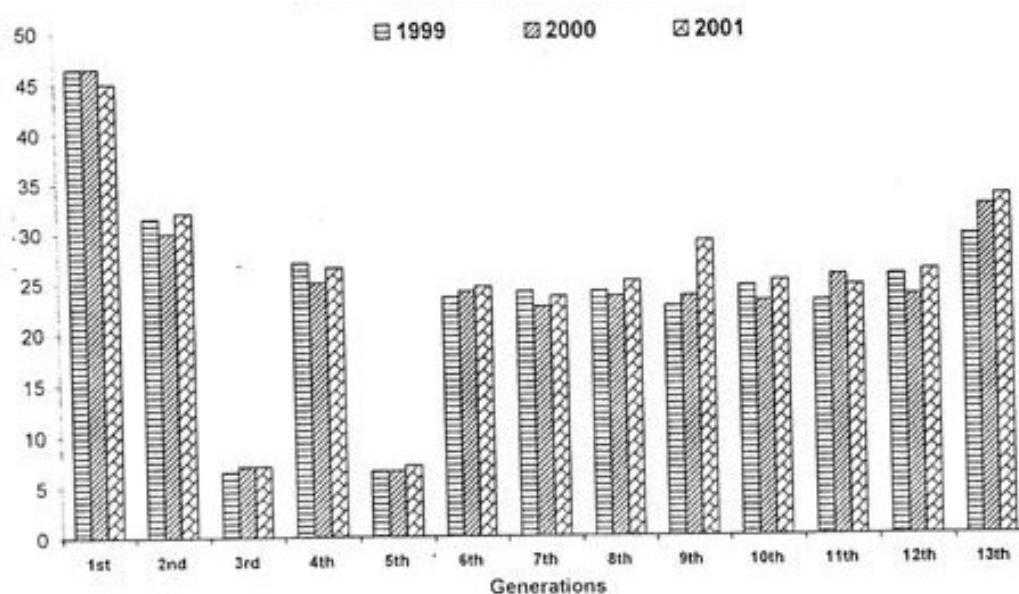


Figure 1: Histogram showing the generation wise total duration in days (egg to adult) of *P. demoleus* during 1999-2001.

Table 2: Duration (days) of incubation period ‘Y’ of *P. demoleus* with temperature ‘X’ analyzed fitting regression models for different periods (1999-2001).

Time period	Regression model equation	R ²	F-value	P-value
1999	Y=8.82-0.207X	86.7%	65.43	0.001
2000	Y=10.3-237X	85%	56.67	0.001
2001	Y=9.86-0.223X	91.4%	105.22	0.001

Table 3: Duration (days) of each larval instar for 3 years (1999-2001) the data analyzed fitting regression models Y= duration on X= average temperature of *P. demoleus*.

Time period	Regression model equation	R ²	F-value	P-value
1999	Y=18.6-0.275X	73.2%	30.06	0.001
2000	Y=21.2-323X	84.8%	61.45	0.001
2001	Y=18.4-0.251X	88.5%	84.8	0.001

Table 4: Total pupal period (days) 'Y' of *P. demoleus* 'Y' with temperature 'X' analyzed fitting regression models for different periods (1999-2001).

Time period	Regression model equation	R ²	F-value	P-value
1999	Y=32.8-0.767X	92.9%	157.58	0.001
2000	Y=27.6-0.603X	91.8%	135.18	0.001
2001	Y=31.3-0.701X	91.7%	133.02	0.001

DISCUSSION

Lefory (1906) reported that *P. demoleus* has extremely ecological tolerance and pests are found to be active throughout the year and have several generations. In present study similar results were observe pest *P. demoleus* was found throughout the year and had 13 generations in a year. Khan and Ayyar (1940) reported that duration of generations vary with the temperature. Abu-Yaman (1973) reported a number of generations in a closely related species of *P. demoleus* in Saudia Arabia. In the present study, the results are more of less same as reported by Khan and Ayyar (1940) as well as Abu-Yaman (1973).

Atwal (1976) reported that the duration of generations from egg to egg should be estimated by adding the pre-ovi-position period to the sum of the duration of eggs, larvae and pupal period. During the present study the pre-ovi-position period was observed and all the biological parameters were performed successfully. The duration of generations was found to be different and 13 generations were recorded in a year. In the present study, findings about the generations differ from the findings of Rafi *et al.* (1989) as he reported 8-9 generations of *P. demoleus* in barani area. Number and duration of generations were highly related to average temperature. The difference in both results may be due to change of temperature, locality and environment. Wynter and Blyth (1975) reported that the pest *P. demoleus* is found in large

number during and after the monsoon and flies in all the seasons except when and where the winter found very cold Rafi et al., (1989) reported that *P. demoleus* found throughout the year in Pakistan. During the present research study it was found that the pest found throughout the year, only in winter pupa hibernate which shows similarity with Wynter and Blyth (1975) and Rafi et al., (1989).

Conclusion: During this research noted that this species was recorded throughout the year, only in winter pupa hibernate; it is also noted the effect of temperature highly correlated with the duration of developmental stages.

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Availability of data: I have included all data in the manuscript that were collected during the field survey.

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