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Biology, morphology and seasonal population dynamics of mango leaf cutting weevil, *Deporaus marginatus* (Pascoe) (Coleoptera: Attelabidae)

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ABSTRACT

Detailed study revealed that the life cycle of *D. marginatus* from egg to adult stage lasted for 19.1 ± 2.17 days with nearby 55 days from egg to egg with 96.17 ± 3.07% hatchability. The grub passes through three instars in fallen cut leaves. Data on population dynamics revealed the fact that the seasonal population progression of *D. marginatus* was synchronized with initiation of new leaves in grafted young plants in nursery in the month of June to October.

Key words : Mango, leaf cutting weevil, biology, *Deporaus marginatus*, morphometrics.

INTRODUCTION

Deporaus marginatus (Pascoe) (*Eugnamptus marginatus* (Pascoe)) (Coleoptera: Attelabidae) is an economically important pest of mango, *Mangifera indica* L. (Anacardiaceae) in India (Butani, 1979; Rafiquzzaman *et al.*, 1999; Singh, 2014), Bangladesh (Uddin *et al.*, 2003; Uddin *et al.*, 2014), Sri Lanka (Hutson and Alwis, 1934) and Malaysia (Ahmad and Ho, 1970; Soh and Khoo, 1983; Tigvattnanont, 1988) which is commonly known as leaf cutting weevil. The pest considered as specific to mango (Butani, 1979) causes damage to new flushes of leaves by the adult insect.

Mango is native to South and Southeast Asia, or from where it has been distributed worldwide to become one of the most cultivated fruits in the tropics and subtropics (Pepenoe, 1964). Fruits of mango are one of preferred fruit having the characteristics of fabulous and delicious taste, flavor and sweet fragrance. India is the highest mango producer in the world. But large number of insect pest causes a considerable damage in mango tree and in the fruit. There are many insect and mites species (>260) have been recorded attack on foliage, inflorescence, buds, branches and on the trunk of mango (Nayar *et al.*, 1976; Pena *et al.*, 1998). Among the foliage feeders, the mango leaf cutting weevils, *D. marginatus* is also attacking on new and the young mango plant and hamper growth particularly in new grafts (Singh, 2014; Hill, 1983). Adult weevils after emergence feed on the epidermis of young leaves, turning the affected leaves brown, curly and crumpled. The gravid female excavates small cavities on either side of the mid ribs on lower surfaces of tender pinkish leaves which are then cut by the weevils near the base and clearly visible as a blade cut injury. Infested shoots are defoliated, loose vigor and ultimately become weak. When pest density is high, adults can cause serious damage by their feeding alone. Its damage to the autumn shoots in the orchard has a great impact on fruit setting and therefore on the yield. The attacks delays the growth of root stock and results in poor success of new grafts. Despite its economic importance, very few vague studies have been done especially on its biology (Tigvattnanont, 1988; Rafiquzzaman and Maiti, 1998a, 1998b; Rafiquzzaman *et al.*, 1999; Uddin *et al.*, 2014) and extent of damage causes by its (Uddin *et al.*, 2003; Singh, 2014). The present study is thus an attempt in this direction, and the biology of *D. marginatus* has been studied along with some morphometrics of the nymphs and adults leading to its redescription. In addition, damage by adult stage in nursery grafted plants has also been assessed.

MATERIALS AND METHODS

The experiments were carried out at ICAR RCER, Research Centre Plandu, Ranchi (23° 45′ N latitude, 85° 30′ E longitude, elevation 620 m

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AMSL) from year 2012-13 (Year I) to 2013-14 (Year II). One year old grafted mango plant grown in polythene bags were placed in nursery beds (size). Beds were prepared in open place according to standard packages of mango seedlings nursery raising and data on number of leaf per grafted plant, egg cavities per leaf and number of cut end leaves per plant were recorded for assessing the damage in natural conditions. Ten grafted plant in three replications were considered for data recoding once in week.

For studying the life cycle, freshly cut leaves with egg cavities (egg cavities n = 100) by *D. marginatus* were collected from mango nursery yards of ICAR Research Complex for Eastern Region, Research Centre, Ranchi, and kept individually in insect rearing cages (20 × 40 cm) at 25 ± 1°C, RH = 60 ± 5%, and light: dark phase, 16:8 hr with pulverized soil (5 cm deep). The neonates that emerge were transferred with a brush to rearing jars, supplied with fresh leaves and suitably sealed. The requisite amount of water was given as and when necessary to maintain the soil moisture properly. When these developed into adults, pair of males and females were placed in rearing jar for mating, provided with egg laying substrates *i.e.* leaves. These rearing cages and jars were disinfected periodically with Protasan DS® to enable healthy stock culture for the required experiments.

The morphology studies were carried out with Leica MZ6 stereozoom microscopes. Images were taken with a Sony DSC H50 digital camera and measurements were taken in millimeter (mm) with standard deviation (SD) using a micrometer eyepiece.

RESULTS AND DISCUSSION

Biology : Adults started copulation within 45.0 ± 5.0 hrs after emergence from pupal stage. Adults remained in coitus position for nearly 1-2 hrs and during copulation male was observed above position like other coleopterans where male aedeagus extruded and the both median lobes placed in the female reproductive tract. Adults mated repeatedly before and after oviposition. Timing of first mating of *D. marginatus* may differ but position and mating behaviour were the same as were observed by other workers (Tigvattnanont, 1988; Camila *et al.*, 2013; Singh 2014), who further observed that the mating took place 5th and 7th day after emergence. Oviposition occurred 35.0 ± 4.92 h (n = 20) after mating. Female before oviposition moves to the whole surface of the tender leaf and the selection of the new leaf, the female moves to the central surface of the leaf and gave an initial 'C''shaped cut to accommodate an egg by inserting its snout. Eggs were laid in single along with midrib of leaves. The total number of egg cavities was found from 3.0 ± 1.08 to 7.0 ± 1.97 per leaf (Table 2). After the hatching, initially grub feeds inside narrow galleries in leaf through mines. Last instar grubs colour was dirty greenish with light pigments. The fully grown larva entered into the soil which came out by boring the mined leaf before entering into the pupa stage. High hatching percentage (96.17 ± 3.07%) of eggs and high survivability was observed at different stages of life of *D. marginatus* in laboratory conditions. The life span and percent succession in to next stage of all immature stages has been provided in (Table 1 and Fig. 1). The life cycle of the mango leaf cutting weevil from egg to adult lasted for 19.15 days and that of the total life period from egg to egg was ~55.0 days (Bhole and Dumbre 1989; Rafiquzzaman and Maiti, 1998; Uddin *et al.*, 2014). The mango leaf cutting weevil at adult stage lived longer than the egg and immature stages almost double the duration of egg adult.

Morphology : Eggs were cylindrical (mean 0.63 mm long and 0.25 mm in diameter). Freshly laid eggs were whitish and change to yellowish pink at maturity. Eggs generally do not possess any processes. Hatchability of 96.17 ± 3.07% was observed.

The newly hatched grubs come out from egg cavities in the midrib. The grub passes 3 instars in laboratory conditions without much general characteristics except for the size of the body and head capsules. First instar grubs with head yellow retracted in to prothorax, sub cylindrical flat and white in colour measuring about 1.81 mm in length and 0.86 mm in width. Antennae brown in colour, present on the either side of the mandibles. The final instar grubs with same shape of first instar remained inside the fallen dead and dried leaves which could be exposed by breaking the leaves. The morphometric parameters of different stages of grubs were measured and shown in (Table 1).

The newly formed pre pupa colour was shiny white and then it's became pale yellow to turned in to pupa. Pupae were soft with minute setae, head little longer than broad bearing 2 pairs of divergent setae. The length and width of pupae ranged from

Table 1. Observations on morphometric, immature and adult stages of *Deporaus marginatus*.

Stages	Length (mm)			Width (mm)			Snout Length (mm)			Duration (Days)	Emergence (%)
	Range		Mean	Range		Mean	Range		Mean		
	Min	Max		Min	Max		Min	Max			
Egg	0.50	0.70	0.63	0.22	0.30	0.25	-	-	-	2.00 ± 0.06	96.17 ± 3.07
Larva											
First Instar	1.5	1.97	1.81	0.66	0.97	0.86	-	-	-	1.08 ± 0.10	82.73 ± 6.80
Second Instar	1.95	3.3	2.90	1.02	1.41	1.19	-	-	-	1.26 ± 0.26	75.07 ± 7.90
Third Instar	4.60	5.16	4.93	1.79	2.04	1.92	-	-	-	3.85 ± 0.41	71.60 ± 8.10
Pre Pupa	4.89	5.4	5.15	1.5	1.7	1.56	-	-	-	3.93 ± 0.84	86.0 ± 5.24
Pupa	3.60	4.41	3.96	1.49	1.70	1.60	-	-	-	7.03 ± 1.09	
Adults											
Male	4.04	4.32	4.19	1.42	1.80	1.63	1.02	1.16	1.09	19.15 ± 2.17*	
Female	4.7	4.9	4.83	1.52	1.98	1.86	1.2	1.41	1.29		

* = duration from egg to adult stage

Table 2. Progression of egg cavities and defoliation in young grafted nursery plants due to *Deporaus marginatus*.

Std. Met. Week	Year I				Year II			
	Number of cavities/leaf (average of 10 leaves)	Percent leaves with egg cavities on plant	Percent defoliation (from total number of fully opened leaves)	Rainfall (mm)	Number of cavities/leaf (average of 10 leaves)	Percent leaves with egg cavities on plant	Percent defoliation (from total number of fully opened leaves)	Rainfall (mm)
24	3.0 ± 1.08	6.67 ± 0.97	5.55 ± 0.87	89.00	4.0 ± 1.12	6.98 ± 0.65	5.80 ± 0.48	17
25	4.0 ± 1.67	10.0 ± 2.13	8.55 ± 0.98	42.00	5.0 ± 1.67	7.0 ± 0.79	6.20 ± 0.59	0
26	3.0 ± 2.05	17.0 ± 2.69	13.00 ± 1.23	10.00	6.0 ± 2.07	15.0 ± 1.35	9.80 ± 0.85	44
27	4.0 ± 0.97	35.0 ± 3.41	25.05 ± 2.14	65.00	4.0 ± 1.32	22.0 ± 1.87	18.30 ± 1.23	21
28	4.0 ± 1.67	45.0 ± 4.86	32.50 ± 3.24	41.40	4.0 ± 2.14	39.0 ± 2.85	31.27 ± 2.57	97
29	5.0 ± 2.24	60.15 ± 5.67	65.00 ± 5.28	71.00	5.0 ± 2.97	40.0 ± 3.61	35.26 ± 2.97	67
30	6.0 ± 2.10	75.67 ± 6.98	60.00 ± 5.98	58.00	6.0 ± 2.45	46.15 ± 3.67	40.12 ± 3.67	0
31	7.0 ± 1.97	70.33 ± 6.24	70.00 ± 6.58	92.00	7.0 ± 3.09	55.67 ± 4.15	42.35 ± 4.28	5
32	6.0 ± 2.04	70.55 ± 5.98	60.00 ± 6.01	173.00	6.0 ± 2.57	60.33 ± 5.15	53.67 ± 5.18	153
33	6.0 ± 2.67	66.6 ± 5.68	55.55 ± 5.18	43.00	5.0 ± 2.47	66.67 ± 6.05	57.86 ± 4.67	33
34	5.0 ± 1.67	62.5 ± 4.25	50.00 ± 4.17	144.00	4.0 ± 1.31	70.00 ± 6.34	67.01 ± 5.37	20
35	6.0 ± 2.50	75.0 ± 7.10	62.50 ± 5.67	89.00	3.0 ± 1.24	70.00 ± 7.08	68.15 ± 5.67	21
36	7.0 ± 3.35	85.71 ± 7.68	57.14 ± 4.98	111.00	5.0 ± 1.39	66.67 ± 5.97	60.12 ± 4.98	36
37	6.0 ± 2.97	62.50 ± 4.68	50.00 ± 4.12	2.00	6.0 ± 2.58	70.00 ± 6.38	57.14 ± 5.09	36
38	5.0 ± 1.55	55.55 ± 4.12	48.55 ± 3.68	67.00	4.0 ± 1.39	62.50 ± 5.27	45.25 ± 3.67	13
39	5.0 ± 1.87	57.14 ± 5.10	40.15.14 ± 3.97	29.00	3.0 ± 1.18	57.14 ± 5.16	35.67 ± 2.98	142

3.60 mm to 4.41 mm and 1.49 mm to 1.70 mm and with mean range of 5.15 mm and 1.60 mm, respectively (Table 1).

Sexual dimorphism was observed in case of emerged adults where as male weevils were slightly smaller than the female measuring 4.19 mm in length and 1.63 mm in width as compared to length of the females with 4.83 mm and 1.86 mm width. Adults elytra suture and lateral margins brownish in colour with reddish orange prothorax and femora and dark

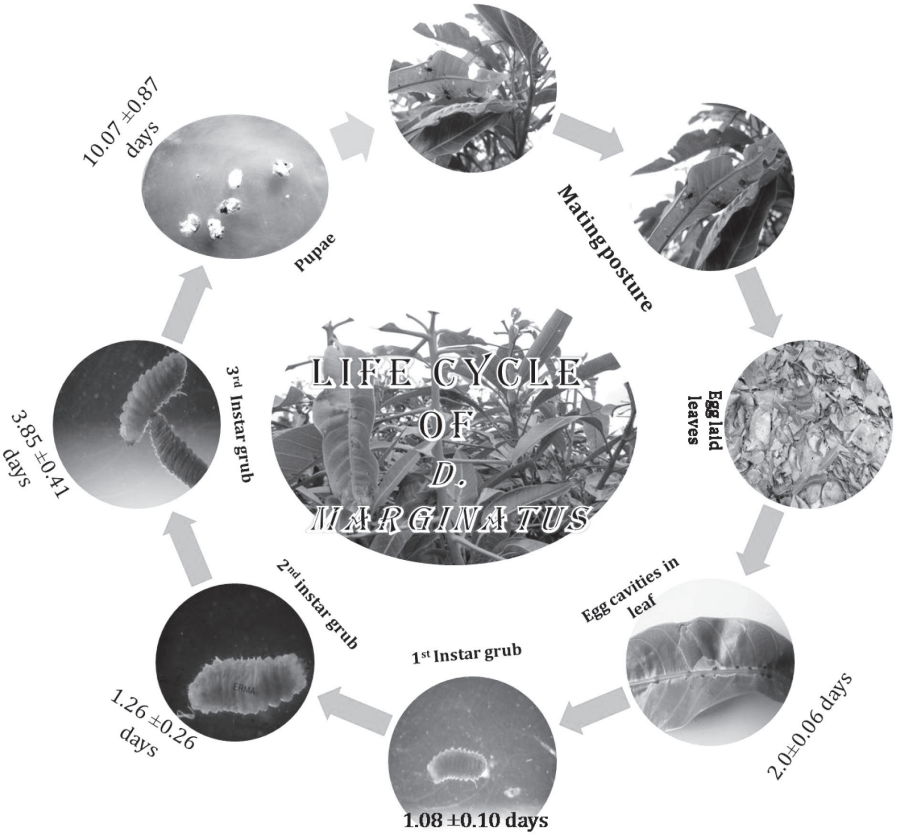

Fig. 1. Schematic diagram of life cycle of *D. marginatus*

brown to black anterior part of the snout, vertex, tibiae and tarsi. Elytra look reddish brown in color with dark longitudinal stripes not reaching the abdominal segment. Length of snout was measured 1.29 mm in female and 1.09 mm in male weevil. Geniculate type of densely hairy antennae inserted well below in the middle of snout with last slenderical segment and distinct club. The eyes look large, black and highly protuberant. Targus 3 segmented, protarsus with 1 pair of pulvillae and a medium embodies (Bhole and Dumbre 1989; Uddin *et al.*, 2014).

Seasonal progression of egg cavities and defoliation of newly grafted nursery plants : The activity of *D. marginatus* was recorded in the form of egg laid in the cavities and defoliation of leaves after egg laid and data presented in the (Table 2). The data reveals that weevil activity was found to start in the month of June in both years at the starting peak of rainy season in Jharkhand state of India (Singh, 2014). The number of egg cavities was recorded on an average from 3.0 to 7.0 egg cavities per leaf depending upon availability of leaves and weather conditions. The number of egg cavities varies in different environmental conditions. Singh (2014) have reported 2 to 14 egg cavities per leaf at Bhubaneswar (Odisha) conditions. High number of egg cavities and maximum percent leaves with egg cavities was found when less number of leaves was available on grafted plants. Even though maximum number of rainy days (data not presented) along with high rainfall (Table 2) were also concerned to high number of egg cavities per leaf and maximum percent leaves with egg cavities. Although population counting of *D. marginatus* was not recorded but high number of egg cavities along with high level of damage in terms of percent leaf defoliation are the indicators of high population level from 29 to 38 standard meteorological weeks in mango nurseries. Maximum defoliation to grafted plants was recorded as ~70 percent in both the recorded year (Uddin *et al.*, 2003). *D. marginatus* activity was found in relation with high humidity (rainy days) and high temperature. So during winter and early summer months (Before rain), period could be considered as hibernation (Rafiquzzaman

et al., 1999). The place of presence of adult/ pupa during hibernation period was also not understood properly during study.

Study revealed that development of pest was synchronized with initiation of new leaves in grafted young plants and the pest was more prevalent from June to October during period of study.

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