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Bionomics and morphometrics of different developmental stages of Orchid blossom midge, *Contarinia maculipennis* Felt. in Perunchilambu, Tamil Nadu, India



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ABSTRACT

Orchids are infested by different insect pests as that of other flowering and ornamental plants. The production of orchids is mainly hampered by the blossom midge, *C. maculipennis*. Studies on the biology of blossom midge, *C. maculipennis* showed that the incubation period (1.67 ± 0.39 days), larval period (8.50 ± 0.89 days), pupal period (9.37 ± 0.70 days), adult longevity of female (3.0 ± 0.55 days) and male (1.57 ± 0.53 days) were minimum during March – April 2018. Morphometrics of different stages of blossom midge were observed. The egg measured was 0.26 ± 0.04 mm in length and 0.06 ± 0.01 mm in breadth. The larval length was found to be 1.69 ± 0.11 mm and 0.40 ± 0.05 mm breadth. The length and breadth of the pupa was 1.63 ± 0.06 mm and 0.31 ± 0.05 mm, respectively. The female adult measures 1.91 ± 0.12 mm in length and 0.38 ± 0.04 mm in breadth and the male adult was 1.62 ± 0.08 mm in length and 0.31 ± 0.02 mm in breadth. Thereby, the bionomics and morphometrics on the pest paves way to identify and to follow the pest management strategies in a clear cut way.

Keywords: Orchid midges, *C. maculipennis*, Bionomics, Morphometrics.

INTRODUCTION

Orchids are the most elegant and colorful flowers widely used as cut flowers and decorative flowers. Orchids are the most important flowering plants valued for cut flower production due to their long-lasting vase life and high price in the international market [3]. Among the orchids, *Dendrobium* spp. are the most popular tropical orchids widely used as cut flowers in the world [11] and occupies nearly 90 percent of the area under orchid cultivation due to the advancement in management practices and availability of plant materials [12]. *C. maculipennis* has been recorded as an important insect pest infesting the flower buds of *Jasminum sambac* Linn. in Andhra Pradesh [13] and *J. auriculatum* Vahl. in Tamil Nadu [1] for the first time. Further, it is primarily a pest of hibiscus and *dendrobium* orchids, tomato, jasmine, plumeria, egg plant, pepper, bitter melon and many vegetables and ornamentals [7]. [5] reported that the eggs are

laid by *C. maculipennis* inside the flower buds. The eggs are usually hatched within one to two days after egg laying. The larval development has completed within five to seven days and then pupates in the soil. Adults normally emerged 14 days after pupation. In Hawaii islands, *C. maculipennis* took 24 – 28 days to complete one generation.

Though *C. maculipennis* has been recorded as a major pest in other parts of the world, it is known to infest the *Dendrobium* plants very recently in Tamil Nadu, India [6]. The infestation may be due to importation of orchids from Thailand. Now, *C. maculipennis* has become a serious threat to orchid producers in the Indian subcontinent. It is essential to understand the basic aspects viz., bioecology and morphometrics of the midges is the need of the hour.

MATERIAL AND METHODS

Biology of blossom midge, C. maculipennis on orchids

Experiments on the biology of blossom midge, *C. maculipennis* on orchids were carried out under the shade net conditions at Rynco orchid farm, Thuckalay, Kanyakumari. All the parameters were recorded during Nov - Dec 2017, Jan - Feb 2018, and Mar - Apr 2018. The mean temperature and relative humidity were also recorded for the same period.

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Egg

Five untreated *Dendrobium* potted plants were placed inside the metal cage (60×60×60 cm) and ten pairs of *C. maculipennis* adults consisting of both sex at 1: 1 ratio were released in the cage. After egg laying, the unopened buds were cut open longitudinally and the number of eggs laid in each bud was observed. The eggs thus obtained were observed daily to record the incubation period. The incubation period was recorded in five replicates consisting of thirty eggs in each replication. The larvae that hatched from the eggs on the same day were used for biological studies.

Larva

The larvae were observed at every 12 hours interval to ascertain the growth and the developmental period was recorded. The observations were continued till pupation.

Pupa

The pupae were kept in glass bottles containing moist soil and the top rim of the glass bottles were covered with masculine cloth and observed for adult emergence at every six hours interval. Pupal period was recorded and the pupation percentage was worked out.

Adult longevity and fecundity

Freshly emerged adults were used for studying the adult longevity and fecundity. Freshly emerged adults were provided with diluted honey drops fortified with vitamin solution along with fresh flower buds as feed inside the glass bottles and observed at six hours intervals and their longevity was recorded. A pair of adults consisting of both the sexes were released into a glass bottle containing fresh *dendrobium* buds (20 buds in each glass bottle). Flower buds were changed at 24-hour intervals upto seven days. Total number of eggs laid by each female was recorded and fecundity was calculated accordingly.

Total life cycle

The total period for the completion of the life cycle was worked out based on the duration of egg, larval, pupal and adult periods.

Sex ratio

Sex ratio was observed by counting the number of adult blossom midges that emerged from the pupae of maintained culture and differentiated into sexes based on the morphological characters.

Morphometrics of orchid blossom midge

The morphometric analysis for each developmental stage of blossom midges was examined and measured using the image analyzer (LEICA® M205 A, Germany) available at the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore.

Statistical Analysis

The experimental data on the biology of orchid blossom midge, *C. maculipennis* was analyzed statistically and the morphometric data were analysed using SPSS statistical package (SPSS version 16.0).

RESULTS AND DISCUSSION**Biology of blossom midge, *C. maculipennis* on orchids**

The eggs are laid in masses by the female midges into the tips of 3 to 5-day-old young flower buds. Freshly laid eggs are oval in shape, transparent to creamy white in color. The incubation

period varied from 1.45 to 2.05 days. It was minimum during Mar - Apr 2018 (1.45 ± 0.44 days) with the mean temperature and relative humidity of 32.30 °C and 77.41 percent, respectively. The maximum incubation period was observed during Nov - Dec 2017 (2.05 ± 0.28 days) with the mean temperature and relative humidity of 25.90 °C and 68.32 percent, respectively (Table 1). The newly hatched larvae were creamy white in color and later instars turned into yellowish orange. The first, second, and third instar larvae were almost similar to each other, except for difference in size and to some extent in color. The third instar larvae were larger than the previous instars. The fully grown larvae were capable of curling their body, flipping themselves into several centimeters and pupating in the soil. Three instars were observed during the growth of *C. maculipennis* larvae. The duration of the first, second, and third instars of blossom midge on orchids during different months was recorded.

The duration of the first instar larvae ranged from 1.50 to 1.85 days. The minimum duration was observed during Mar - Apr 2018 (1.50 ± 0.47 days) with a mean temperature of 32.30 °C and relative humidity of 77.41 percent. The maximum period was observed during Nov - Dec 2017 (1.85 ± 0.34 days) with a mean temperature of 25.90 °C and relative humidity of 68.32 percent (Table 2). The duration of the second instar larvae ranged from 2.30 to 3.30 days. The duration was minimum during Mar - Apr 2018 (2.30 ± 0.48 days) with a mean temperature of 32.30 °C and relative humidity of 77.41 percent. The maximum duration was observed during Nov - Dec 2017 (3.30 ± 0.48 days) with a mean temperature of 25.90 °C and relative humidity of 68.32 percent (Table 2). The duration of third instar larvae was ranged from 3.60 to 4.70 days. The duration was minimum during Mar - Apr 2018 (3.60 ± 0.52 days) with a mean temperature of 32.30 °C and relative humidity of 77.41 percent. The maximum period was observed during Nov - Dec 2017 (4.70 ± 0.67 days) with a mean temperature of 25.90 °C and relative humidity of 68.32 percent (Table 2). The total larval period ranged from 7.40 to 9.85 days. The larval duration was minimum during Mar - Apr 2018 (7.40 ± 0.94 days) with a temperature of 32.30 °C and relative humidity of 77.41 percent. The larval period was maximum during Nov - Dec 2017 (9.85 ± 0.94 days) with a temperature of 25.90 °C and relative humidity of 68.32 percent. Studies on the biology of blossom midge, *C. maculipennis* on orchids indicated that female adult midge laid transparent to creamy white color eggs in masses which hatched into creamy white to yellowish orange color larvae and larval period ranged from 7 to 10 days. The present findings were in agreement with [7].

The adult midges are tiny, soft-bodied, yellowish brown in color, and weak fliers. Males and females are easily distinguished by the presence of an ovipositor. Females with long ovipositors on the swollen abdomen which are usually larger than males. Both sexes have relatively large, multifaceted eyes. Wings are distinctly sub-hyaline and highly colored in adult females than males. A single pair of spotted wings is present and about two times as long as their body. Halteres are pale yellowish in color and very distinct. Legs are long and slender. Though the adult midges are short-lived, female midge longevity ranged from 2.70 to 3.40 days. The minimum longevity was observed during Mar - Apr 2018 (2.70 ± 0.48 days) with a mean temperature of 32.30 °C and relative humidity of 77.41 percent. The longevity was maximum during Nov - Dec 2017 (3.40 ± 0.52 days) with a mean temperature of 25.90 °C and relative humidity of 68.32 percent. The longevity of male adult midge ranged from 1.40 to

1.90 days. The minimum longevity was observed during Jan - Feb 2018 and Mar - Apr 2018 (1.40 ± 0.52) with a mean temperature of 32.30°C and relative humidity of 77.41 percent. The maximum longevity was observed during Nov - Dec 2017 (1.90 ± 0.57 days) with a mean temperature of 25.90°C and relative humidity of 68.32 percent (Table 4). Usually, the adult activity was noticed from 6:00 hrs to 7:30 hrs and 17:00 to 20:00 hrs throughout the study period. Foraging activity was noticed from 18:00 hrs and the midges which fed on the guttation produced by orchid leaves and stem. The total life span of *C. maculipennis* varied from 21.70 to 27.60 days. The minimum period was observed during Mar - Apr 2018 (21.70 ± 3.3 days) with a mean temperature of 32.30°C and relative humidity of 77.41 percent. The life span was maximum during Nov - Dec 2017 (27.60 ± 4.0 days) with the mean temperature of 25.90°C and relative humidity of 68.32 percent (Table 5). The percent pupation of blossom midge *C. maculipennis* on orchids ranged from 72.08 to 92.53 with a mean of 84.29 ± 5.93 . The percent adult emergence of blossom midge, *C. maculipennis* on orchids ranged from 89.02 to 96.78 with a mean of 92.80 ± 2.58 . The mean number of eggs laid by a single female ranged from 7 to 13 with a mean of 8.73 ± 0.80 . Female to male ratio of orchid blossom midge, *C. maculipennis* was recorded as 2.12: 1. Egg hatchability of *C. maculipennis* ranged from 85.71 to 87.50 percent with a mean of 86.79 ± 0.98 (Table 6). The pupa was initially yellowish orange in color and later turn into brown and pupated in the soil and the duration varied from 8 to 12 days. The findings are in confirmatory with [2], [9], [10]. Adult midges are tiny in size; females are slightly larger than the males with multifaceted eyes and survived for 4 to 5 days which is in accordance with the findings of [4]. This difference in developmental duration may be due to seasonal variation and host plant influence. The total life span of blossom midge, *C. maculipennis* on orchids varied from 21 to 28 days which is in line with the findings of [7], who reported that the total life cycle was completed in 21 to 28 days. The fecundity of orchid blossom

midge was ranged from 7 to 13 eggs which were laid in masses which is following the findings of [2] and [8] who reported that the fecundity of *C. maculipennis* on jasmine ranged from 10 to 14 eggs.

Morphometrics of different stages of blossom midge, *C. maculipennis* on orchids

The different life stages of blossom midge, *C. maculipennis* viz., eggs, different larval instars, pupae, and adults were measured using an image analyzer (LEICA® M 205A, Germany) and measurements were recorded accurately.

The length of eggs ranged from 0.23 to 0.29 with a mean of 0.26 ± 0.04 mm and 0.04 to 0.08 mm in breadth with a mean of 0.06 ± 0.01 mm. The length of first, second, and third instar larvae ranged from 0.52 to 0.81 mm, 0.21 to 1.47 mm, and 1.53 to 1.88 mm with a mean of 0.64 ± 0.09 mm, 1.32 ± 0.08 mm, and 1.69 ± 0.11 mm, respectively. Whereas, the breadth ranged from 0.10 to 0.15 mm, 0.22 to 0.35 mm, and 0.31 to 0.48 mm with a mean of 0.13 ± 0.02 mm, 0.29 ± 0.04 mm, and 0.40 ± 0.05 mm, respectively. The pupal length ranged from 1.29 to 1.46 mm with a mean of 1.36 ± 0.06 mm. Whereas, the breadth ranged from 0.24 to 0.39 mm with a mean of 0.31 ± 0.05 mm (Table 7). The body length of male adult midge ranged from 1.48 to 1.73 mm with a mean of 1.62 ± 0.08 mm and breadth ranged from 0.27 to 0.35 mm with a mean of 0.31 ± 0.02 mm. The length of female adult midge ranged from 1.75 to 2.12 mm with a mean of 1.91 ± 0.12 mm. Whereas, the breadth ranged from 0.32 to 0.43 mm with a mean of 0.38 ± 0.04 mm. The mean length and breadth of eggs were 0.26 mm and 0.06 mm, respectively. The mean length and breadth of larvae were 1.53 mm and 0.40 mm, respectively. The mean length and breadth of pupae were 1.36 mm and 0.31 mm, respectively. The male adult was 1.62 mm in length and 0.31 mm in breadth, while the female adult measured was 1.91 mm in length and 0.38 mm in breadth. Similar measurements of various life stages of *C. maculipennis* were recorded by [8].

Table 1. Incubation period of blossom midge, *C. maculipennis* on orchids

Months	Incubation period* (days) Mean±SD	Temperature (°C)	Relative Humidity (%)
Nov - Dec 2017	2.05 ± 0.28	25.90	68.32
Jan - Feb 2018	1.50 ± 0.47	27.39	71.60
Mar - Apr 2018	1.45 ± 0.44	32.30	77.41

*Mean of 5 replications

Table 2. Larval period of blossom midge, *C. maculipennis* on orchids

Months	Larval period* (days) Mean±SD				Temperature (°C)	Relative Humidity (%)
	1 st instar	2 nd instar	3 rd instar	Total larval period		
Nov - Dec 2017	1.85 ± 0.34	3.30 ± 0.48	4.70 ± 0.67	9.85 ± 0.94	25.90	68.32
Jan - Feb 2018	1.75 ± 0.42	2.40 ± 0.52	4.10 ± 0.57	8.25 ± 0.79	27.39	71.60
Mar - Apr 2018	1.50 ± 0.47	2.30 ± 0.48	3.60 ± 0.52	7.40 ± 0.94	32.30	77.41

*Mean of 5 replications

Table 3. Pupal period of blossom midge, *C. maculipennis* on orchids

Months	Pupal period* (days) Mean±SD	Temperature (°C)	Relative Humidity (%)
Nov - Dec 2017	10.40 ± 0.84	25.90	68.32
Jan - Feb 2018	9.00 ± 0.82	27.39	71.60
Mar - Apr 2018	8.70 ± 1.25	32.30	77.41

*Mean of 5 replications

Table 4. Adult longevity of blossom midge, *C. maculipennis* on orchids

Months	Adult period* (days) Mean±SD		Temperature (°C)	Relative Humidity (%)
	Female	Male		
Nov - Dec 2017	3.40 ± 0.52	1.90 ± 0.57	25.90	68.32
Jan - Feb 2018	3.00 ± 0.67	1.40 ± 0.52	27.39	71.60
Mar - Apr 2018	2.70 ± 0.48	1.40 ± 0.52	32.30	77.41

*Mean of 5 replications

Table 5. Total life span of blossom midge, *C. maculipennis* on orchids

Months	Total life span (days) Mean±SD	Temperature (°C)	Relative Humidity (%)
Nov - Dec 2017	27.60 ± 4.0	25.90	68.32
Jan - Feb 2018	23.15 ± 3.5	27.39	71.60
Mar - Apr 2018	21.70 ± 3.3	32.30	77.41

*Mean of 5 replications

Table 6. Percent pupation, adult emergence, fecundity, sex ratio, and egg hatchability of blossom midge *C. maculipennis* on orchids

Parameters	Mean ±SD	Range
Pupation (%)	84.29 ± 5.93	72.08 - 92.53
Adult emergence (%)	92.80 ± 2.58	89.02 - 96.78
Fecundity (nos.)	8.73 ± 0.80	7 - 13
Sex ratio (♀ : ♂)	2.12 : 1	-
Egg hatchability (%)	86.79 ± 0.98	85.71 - 87.50

*Mean of 5 replications

Table 7. Morphometrics of different developmental stages of blossom midge *C. maculipennis* on orchids

Developmental stages	Length (mm)		Breadth (mm)	
	Mean ± SD	Range	Mean ± SD	Range
Egg	0.26 ± 0.04	0.23 - 0.29	0.06 ± 0.01	0.04 - 0.08
Larva				
I instar	0.64 ± 0.09	0.52 - 0.81	0.13 ± 0.02	0.10 - 0.15
II instar	1.32 ± 0.08	0.21 - 1.47	0.29 ± 0.04	0.22 - 0.35
III instar	1.69 ± 0.11	1.53 - 1.88	0.40 ± 0.05	0.31 - 0.48
Pupa	1.36 ± 0.06	1.29 - 1.46	0.31 ± 0.05	0.24 - 0.39

Adult				
Male	1.62 ± 0.08	1.48 – 1.73	0.31 ± 0.02	0.27 – 0.35
Female	1.91 ± 0.12	1.75 – 2.12	0.38 ± 0.04	0.32 – 0.43

CONCLUSION

C. maculipennis completed its life cycle in 21.45 ± 3.60 days with egg, larva, pupal period, and adult longevity of 1.67 ± 0.39, 8.50 ± 0.89, 9.37 ± 0.70, 1.57 ± 0.53 (male) and 3.0 ± 0.55 (female) days, respectively with a fecundity of 8.73 ± 0.80 eggs per female. Morphometrics of different stages of blossom midge were observed. The egg measured was 0.26 ± 0.04 mm in length and 0.06 ± 0.01 mm in breadth. The larval length was found to be 1.69 ± 0.11 mm and 0.40 ± 0.05 mm breadth. The length and breadth of the pupa were 1.63 ± 0.06 mm and 0.31 ± 0.05 mm, respectively. The female adult measures 1.91 ± 0.12 mm in length and 0.38 ± 0.04 mm in breadth and the male adult was 1.62 ± 0.08 mm in length and 0.31 ± 0.02 mm in breadth. Morphometrics of different life stages of blossom midge were measured and difference was noticed between both sexes of adult body length and breadth serves to distinguish the sex differences clearly.

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