



## Biology of ginger rhizome fly, *Mimegralla* sp. nr *coeruleifrons* (Diptera: Micropezidae)

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**ABSTRACT:** A survey conducted in the ginger growing areas of Thrissur and Palakkad districts of Kerala, during 2013 and 2014, revealed the presence of three species of flies infesting both healthy as well as diseased ginger rhizomes. The predominant, most injurious one was identified as *Mimegralla* sp. nr *coeruleifrons* (Macquart) (Diptera: Micropezidae). The biology of the same was studied in the laboratory on diseased ginger rhizomes. The mean incubation period was 3.75 days, while the mean duration of first, second and third larval instars was 2.25, 3.15 and 6.70 days respectively. The mean pupal period lasted for 8.80 days. The longevity of adult male and female flies was 43.90 and 51.00 days respectively, and the sex ratio was 1:1. The morphometric observations of each life stage are also described, with a note on the taxonomy of the fly. © 2016 Association for Advancement of Entomology

**KEYWORDS:** rhizome maggot, *Mimegralla* sp., ginger rhizomes, biology

### INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) is one of the earliest cultivated oriental spices grown throughout India. Nearly 46 species of insects are recorded to damage ginger in India (Devasahayam and Koya, 2005), among which rhizome maggots are considered to be the most important. Yield reduction of up to 31 per cent has been reported in ginger due to maggot infestation (Ghorpade *et al.*, 1983), though it is often considered as a secondary pest, infesting diseased rhizomes (Devasahayam and Koya, 2005).

Several species of true flies *viz.*, *Calobata indica* Robineau-Desvoidy (Maxwell - Lefroy and Howlett, 1909), *Mimegralla coeruleifrons* Macq. [Micropezidae] (Khaire *et al.*, 1972), *Chalcidomyia*

*atricornis* Malloch, *Formosina flavipes* Malloch [Chloropidae] (Malloch, 1927), *Celyphus* sp. [Celyphidae] (Nair, 1975), *Eumerus albifrons* Walker (Sathiamma, 1979) and *E. pulcherrimus* Brunetti [Syrphidae] (CPCRI, 1986) infest ginger. Among these the biology of *M. coeruleifrons* have been studied by several workers (Ghorpade *et al.*, 1988; Koya, 1989; Sontakke, 2000). However, there is some uncertainty regarding the correct identity of *Mimegralla* sp. on ginger which remains to be resolved.

The present study was carried out with the objective of studying the biology of major species of rhizome maggot collected during survey conducted in 2013-14 in ginger growing areas of Thrissur and Palakkad districts of Kerala.

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## MATERIALS AND METHODS

A survey was conducted in the ginger growing areas of Thrissur and Palakkad districts of Kerala during 2013 - 2014 to document the rhizome flies infesting ginger. Healthy as well as diseased rhizomes infested with maggots were collected and brought to the laboratory, where they were reared to the adult stage. One thousand eight hundred and twenty three (1,823) maggots were collected from August to October, out of which 96 per cent belonged to one species which was identified as *Mimegralla* sp. nr *coeruleifrons* (Macquart) (Diptera : Micropezidae) by Dr K. Ghorpadé, one of the authors.

The life history of *Mimegralla* sp. nr *coeruleifrons*, was studied at the Dept. of Agricultural Entomology, College of Horticulture, Vellanikkara, Thrissur, Kerala. The study was conducted at a mean temperature of 28.7°C and mean relative humidity of 82 per cent. Rhizome maggots collected from ginger fields, along with the infested rhizome were placed in plastic containers covered with muslin cloth for emergence of adults. The newly emerged adults were collected and released into aluminium mesh cages of 75 × 30 × 30 cm size and provided with 10 per cent honey solution as food, as well as diseased ginger rhizome pieces in Petri dishes for oviposition. The eggs were collected at 24 h interval and were placed singly on a thin slice of ginger rhizome, each in a Petri dish lined with cotton. Twenty newly hatched maggots were reared individually on single pieces of ginger rhizome. The second instars were identified by the presence of a pair of red anal tubercles while third instar maggots were identified by the presence of black cephalic mouth hooks and a pair of anal tubercles. Pupae were placed in separate plastic containers until the adults emerged. Ten pairs of adult flies were released into aluminium cages @ one pair per cage for observing their adult longevity. The fecundity was recorded by releasing 10 pairs of adult flies into a single aluminium mesh cage and recording the total number of eggs laid. The results are presented in Table 1. Biometric observations of different life stages of *Mimegralla* sp. nr *coeruleifrons* were recorded using a Leica EZ4

HD stereo binocular microscope equipped with LAS image analysing software and are presented in Table 2.

## RESULTS AND DISCUSSION

**Egg** was small, white and the chorion was sculptured with parallel longitudinal stripes. The eggs were pointed at the anterior end but rounded at the posterior end. Eggs recorded a mean length of 0.74±0.02 mm and mean width of 0.20±0.03 mm, which was in close conformity with the mean length and width of 0.77 mm and 0.17 mm respectively, reported in case of *M. coeruleifrons* (Koya, 1989). The incubation period varied from 3.31 to 4.19 days, with an average of 3.75 ± 0.44 days.

### First instar larva

The maggot, on emergence, was tiny, apodous, translucent and colourless with a cylindrical body that lacked distinct segmentation. The body was narrow at the anterior end and widened towards the posterior end. The duration of the first instar ranged from 1.81 to 2.69 days, with an average of 2.25 ± 0.44 days. The larva measured 0.63 ± 0.05 mm in length and 0.16 ± 0.01 mm in width.

### Second instar larva

The second instar larva had white, cylindrical, tapering body with twelve visible segments. A pair of reddish brown spiracles at the blunt end of last abdominal segment as well as two semicircular flaps or oral lobes anterior to the mouth orifice on the first body segment were characteristic of the instar. Spinulose areas, which helped in locomotion, occupied the anterior part on the ventral side of each abdominal segment. The duration of the second instar larvae ranged from 2.79 to 3.51 days, with an average of 3.15 ± 0.36 days. On an average, the second instar larva measured 4.20 ± 0.08 mm in length and 0.90 ± 0.08 mm in width at the broadest part.

### Third instar larva

The fully grown third instar larvae were creamy white and similar in appearance to the second instar

**Table 1. Biology of ginger rhizome fly, *Mimegralla* sp. nr *coeruleifrons***

Sl. No.	Parameters	Duration * in days	Range (days) (Mean $\pm$ SD)
1	Incubation period	3.75 $\pm$ 0.44	3.31 – 4.19
2	First instar larva	2.25 $\pm$ 0.44	1.81 - 2.69
3	Second instar larva	3.15 $\pm$ 0.36	2.79 – 3.51
4	Third instar larva	6.70 $\pm$ 0.73	5.97 – 7.43
5	Pupa	8.80 $\pm$ 1.85	6.95 – 10.65
6	Adult male	43.90 $\pm$ 18.77	25.13 – 62.67
7	Adult female	51.00 $\pm$ 20.79	30.21 – 72.00
8	Fecundity (eggs )	55.40 $\pm$ 17.64	38.00 – 73.00

\* Mean of 20 observations

**Table 2. Measurement of different stages of *Mimegralla* sp. nr *coeruleifrons***

Sl. No.	Stage	Mean length* in mm (Mean $\pm$ SD)	Range (mm)	Mean width* in mm (Mean $\pm$ SD)	Range (mm)
1	Egg	0.74 $\pm$ 0.02	0.72 - 0.76	0.20 $\pm$ 0.03	0.017 - 0.23
2	First instar larva	0.63 $\pm$ 0.05	0.58 - 0.68	0.16 $\pm$ 0.01	0.15 - 0.17
3	Second instar larva	4.20 $\pm$ 0.08	4.12 – 4.28	0.90 $\pm$ 0.08	0.82 - 0.98
4	Third instar larva	8.11 $\pm$ 0.06	8.05 - 8.17	1.68 $\pm$ 0.04	1.64 - 1.72
5	Pupa	6.53 $\pm$ 0.62	5.91 - 7.15	1.65 $\pm$ 0.20	1.45 - 1.85
6	Adult female	13.56 $\pm$ 1.10	12.50 - 14.66	2.18 $\pm$ 0.77	1.41 - 3.00
7	Adult male	11.27 $\pm$ 1.40	9.87 - 12.67	1.30 $\pm$ 0.33	0.95 - 1.63

\* Mean of 20 observations

maggot. However, the cephalic mouth hooks as well as the pair of spiracles on the last abdominal segment were thicker, darker and bigger. Spinulose areas on ventral surface of each abdominal segment were fleshy, blunt and directed backwards. A pair of dark brown to black, fan-shaped spiracles was present on the first thoracic segment. The duration of larval period ranged from 5.97 to 7.43 days on an average of  $6.70 \pm 0.73$  days. The third instar larva measured  $8.11 \pm 0.06$  mm in mean length and  $1.68 \pm 0.04$  mm in mean width.

### Pupa

The full-grown larvae pupated in the larval tunnels in ginger rhizomes. The puparium was dark brown

and elongated, with posterior spiracles similar to those of larvae, though more sclerotized. The colour of puparia changed gradually from brown to black towards emergence time. The adult emerged by rupturing the puparium along a circular suture near the thoracic segments, detaching the anterior part while the posterior end of pupae usually remained loosely attached to its body. The pupal period ranged from 7.0 to 10.65 days with an average of  $8.80 \pm 1.85$  days. The mean length and width of puparium was  $6.53 \pm 0.62$  and  $1.65 \pm 0.20$  mm respectively.

### Adults

The adult flies were large and slender with elongate stilt like legs. The antenna was short with a sub-

basal arista. The abdomen, thorax and legs were brownish black. The tarsi of fore legs were white. The wings were transparent with well defined cross-bands. Males were smaller than females, and could be identified by the presence of conspicuous, prong like digitate claspers at the tip of abdomen. The last abdominal segments of female were modified into a short ovipositor. The males lived for an average of  $43.90 \pm 18.77$  days and the females for an average of  $51.00 \pm 20.79$  days. The adult male fly measured  $11.27 \pm 1.40$  mm in mean length and  $1.30 \pm 0.33$  mm in mean width. The adult female fly measured  $13.56 \pm 1.10$  mm in mean length and  $2.18 \pm 0.77$  mm in mean width.

### Oviposition

The female flies became receptive to mating by the 10<sup>th</sup> day after emergence and oviposition occurred 2 to 3 days after mating. The females were normally observed to oviposit on diseased rhizomes. However, laying eggs on the tissue paper placed beneath the rhizome was also common. Eggs were laid singly and occasionally in batches of 4 to 7. The female flies recorded a pre oviposition period of 13 days and an average oviposition period of 3 days.

### Fecundity

Mated female flies laid 38 to 73 eggs with an average of  $55.40 \pm 17.64$  eggs during the oviposition period which varied from 1 to 3 days.

### Sex ratio

The sex ratio of female and male flies was 1:1.

The results of the present study on the duration of development as well as body measurements of different stages of the rhizome maggot, were broadly in agreement with previous reports on the biology of *M. coeruleifrons*.

For instance, the morphometric values recorded in case of egg, at a mean length of  $0.74 \pm 0.02$  mm and mean width of  $0.20 \pm 0.03$  mm, was in close conformity with the mean length and width of 0.77 mm and 0.17 mm respectively, reported by Koya (1989) as well as with the mean length and width

of 0.81 mm and 0.22 mm respectively, reported by Ghorpade *et al.* (1988).

Similarly, the size of the first instar larva ( $0.63 \pm 0.05$  mm long and  $0.16 \pm 0.01$  mm wide), were identical to the mean length of 0.63 mm and mean width of 0.15 mm, reported by Ghorpade *et al.* (1988). The morphometric observations of the second instar larva were also in conformity with the dimensions of  $4.5 \times 1.0$  mm reported by the above authors.

The measurements of  $8.11 \pm 0.06$  mm and  $1.68 \pm 0.04$  mm for mean length and width in case of third instar larva were marginally lower than the mean length of 9.6 mm and mean width of 1.7 mm reported by Ghorpade *et al.* (1988) and mean length of 10 mm reported by Koya (1989) for *M. coeruleifrons*.

The morphometric measurements of pupa (mean length and width of  $6.53 \pm 0.62$  and  $1.65 \pm 0.20$  mm respectively) again were more or less similar to the dimensions of  $8.0 \times 1.7$  mm reported by Ghorpade *et al.* (1988).

The morphometric data of the adult flies were also in agreement with the findings of Ghorpade *et al.* (1988) who reported that the length of females and males varied from 13 to 16 mm and 12 to 14 mm respectively.

It can be seen that the morphometric observations of the different stages were similar to those recorded in previous studies. However, there were variations in the duration of development of different stages. Thus, the mean incubation period of  $3.75 \pm 0.44$  days in the present study was greater than the 2.5 days reported by Sontakke (2000) while the mean duration of 2.25 days in case of the first instar larva was considerably shorter than the duration of 5 to 7 days recorded by Ghorpade *et al.* (1988). Similarly, the mean duration of 3.15 days for third instar larva is at variance with the findings of Ghorpade *et al.* (1988), who recorded mean duration of 2.0 days only for *M. coeruleifrons*. The same study had also observed the average duration of third instar larva to be 4.7 days, as against 6.70 days in the present study.

The pupal period ranged from 7.0 to 10.65 days with an average of  $8.80 \pm 1.85$  days. This was in agreement with the findings of Koya (1989) who recorded a mean duration of 8 to 11 days.

The male and female flies had an average life span of  $43.90 \pm 18.77$  and  $51.00 \pm 20.79$  days respectively. These observations do not agree with findings of earlier studies. For instance, Ghorpade *et al.* (1988) had recorded the average longevity of male and female flies on ginger as 8.8 and 10.6 days respectively. Kotikal and Kulkarni (2000) also had reported the longevity of males and females as  $10.50 \pm 3.35$  and  $17.20 \pm 2.66$  days respectively. Sontakke (2000) reported average longevity of *M. coeruleifrons* adults as ranging from 13.8 to 20.4 days.

Considerable variation was also observed with respect to fecundity. Mean fecundity of 130 eggs, reported by Ghorpade *et al.* (1988) was higher than the mean value of  $55.40 \pm 17.64$  eggs that was recorded in the present study.

The findings of the study conformed to earlier reports both in terms of oviposition period as well as sex ratio. Both pre oviposition as well as oviposition period (13 and 3 respectively) recorded in the present study were identical to the values recorded by Ghorpade *et al.* (1988). Similarly the sex ratio of 1:1 was similar to earlier reports by Koya (1989) as well as by Ghorpade *et al.* (1988).

The variations in the duration of development could be due to variations in the ambient conditions under which the experiments were carried out, though the differences in terms of longevity and fecundity are too pronounced for such an explanation. The possibility of the rhizome larva under study being a new species near *Mimegrella coeruleifrons* also can not be ruled out. The genus *Mimegralla* Rondani of the family Micropezidae is currently under taxonomic revision (K. Ghorpadé, 2014: personal communication), requiring more detailed

investigations of this poorly known genus and its species.

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