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Biology of the mealy bug, *Rhizoecus amorphophalli* infesting tubers of major aroids

Sreerag, R. S*, Jayaprakas, C. A and Nishanth Kumar S

Central Tuber Crops Research Institute, Sreekariyam Thiruvananthapuram 695 017, Kerala, India.

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The present study was carried out to trace the life cycle of mealy bug, *Rhizoecus amorphophalli* on three different hosts including elephant foot yam, taro and tannia tubers. Investigation revealed that the mealy bug reproduces sexually and the adult female secretes an egg sac of white waxy substance in which eggs were laid. Female nymph moult normally, but male instar produces a cottony puparium around its body and form a pupal stage from which adult males emerge. On tubers of elephant foot yam, average fecundity and incubation period were 68.30±6.22 and 7.80±0.88 days respectively. But, it was significantly lesser for those on the taro and tannia tubers. Nevertheless irrespective of hosts, the percentage of hatching maintained uniformity. The total life cycle of bug which includes three instars and a pupal stage took 27.10 days for females and 22.40 days for males on tubers of elephant foot yam. The larval stages of mealy bug did not show prominent morphometric changes among the hosts used for life cycle study.

Key words: *Rhizoecus amorphophalli,* elephant foot yam, taro, tannia, mealy bug, biology, life cycle.

INTRODUCTION

Among the insect pest complex in agricultural ecosystem, mealy bugs (Hemiptera: Pseudococcidae) have ever been rated as a major pest, since they play a dual role as pest and vector in field crops. The genus *Rhizoecus* encompasses about 118 species of root mealy bugs (Ben-Dov, 1994) of potential pest status (Williams, 1996), and they enjoy cosmopolitan distribution (Williams and Willink, 1992) from all zoogeographical regions. During the last few decades, the mealy bug, *Rhizoecus amorphophalli* Betrem has emerged as a noxious pest infesting on stored tubers of elephant foot yam, taro and tannia (Palaniswami and Pillai, 1979; Rajamma et al., 2002, 2006). Corm or tuber is the storage organ and is used as seed material or vegetable after cooking (Kundu et al., 1998; Ravi et al., 2009). The tubers contain about 15 to 25% starch and fairly good amount of protein and minerals (Moorthy and Padmaja, 1991) with indisputable palatability, medical utility and therapeutic values (Suja et al., 2010). They play a vital role in food security and are the important staple or subsidiary food for a large population (Ramanandam et al., 2008; Quaye et al., 2009).

R.amorphophalli suck cell sap from the tubers, and the severely infested deformed tubers find no place in market, nor are accepted for cooking (Palaniswami, 1994). Mealy bug multiplication is rapid during summer

*Corresponding author. E-mail: sreerag6989rs@gmail.com

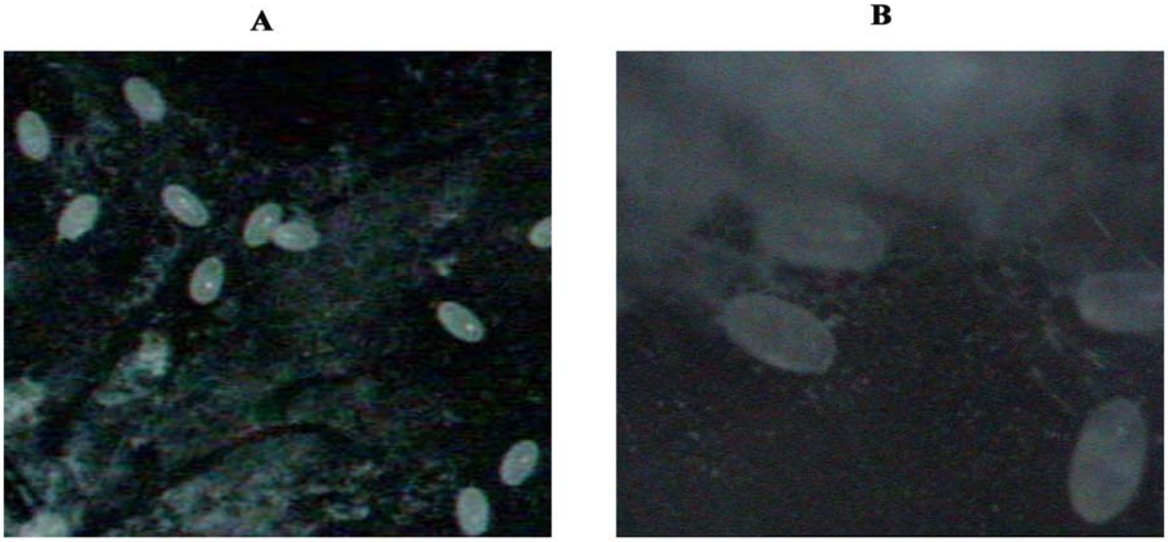

Figure 1. Colour change in *Rhizoecus amorphophalli* eggs from pale white (A) to light brown (B) before hatching.

season and they spread all over the tubers with white powdery mealy substance and disfigure the tubers (Palaniswami and Tarafdar, 2008). Aroids are the main host of the pest, and its infestation is a major concern among the aroid farmers.

Generation of basic data regarding a pest is prerequisite for the formulation of a sound pest management strategy. Tracing the life stages of mealy bug needs careful attention (Blumberg and Van Driesche, 2001) as these are cryptic and favour a warm and humid sheltered site to escape from adverse environmental conditions (Mudavanhu et al., 2011). The present study aimed to study the life cycle of the mealy bug, *R. amorphophalli* that was reared on three different hosts.

MATERIALS AND METHODS

Maintenance of stock culture

The nucleus culture of *R. amorphophalli* was obtained from the pure culture maintained on the tubers of elephant foot yam at the Biopesticide laboratory of Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram and also from the mealy bug infested tubers of elephant foot yam, taro and tannia collected from the field of CTCRI at harvest. Mealy bugs from the infested tubers were brushed onto the uninfested tubers of elephant foot yam, taro and tannia using a camel hair brush, and the tubers were kept separately in wooden cages (60 × 60 × 60 cm) with a front door covered with muslin cloth and other three sides covered with wire mesh (1.18 mm). Decayed and damaged tubers were replaced with fresh tubers and the culture was replenished.

Biology of *R. amorphophalli* on elephant foot yam, taro and tannia

Uninfested, fresh, medium sized tubers of elephant foot yam (700-2000 g), taro (50-200 g) and tannia (100-250 g) were collected from the farm of CTCRI on which *R. amorphophalli* eggs isolated from the stock culture were introduced. On development, each stage of this insect was studied in detail with a stereo zoom binocular microscope (Leica M10, Leica Microsystems and Weltzar, Germany, magnification: 12-50 X). Adult females were observed regularly to record the details regarding egg sac formation. Females with the egg sac were isolated into Petri dishes and the eggs were counted after removing the mealy substance with a camel hair brush. Incubation period and hatching percentage were also noted and the average temperature (33.59°C) and humidity (65.16% R.h) during the study period was also recorded.

Measurements and images of egg and other stages of mealy bugs were taken using Stemi-2000C stereo microscope (Fisher Bioblock Scientific, France) in 50 X magnification using Lecia DMLB, AVT Horn camera with acquisition software: Axio vision (AC Rel.4.5) (Leica Microsystems and Weltzar, Germany).

RESULTS

Life cycle of *R. amorphophalli* on tubers of elephant foot yam

Ovoid, pale white eggs were laid in clusters inside the egg sac which turned into light brown on hatching (Figure 1). The average length and breadth of the egg was 187.80±8.70 and 102.50±4.30 μm respectively (Table 1).

After eclosion, the first instar larvae (crawlers) moved out of their cocoon (Figure 2) actively searching for suitable feeding site on the tubers. Crawlers were oval, semi-translucent with three pairs of legs and paired eyes, measuring 183.53±16.53 μm in length and 98.90±12.20 μm in width (Table 1). The antenna was 55.12±11.63 μm long; nine segmented with flagellate setae.

Crawlers preferred to hide out in crevices or depressions of the tubers, and on settlement they produce mealy substance to waxy filaments over their body (Figure 3). The first instar lasted for 4-7 days with

Table 1. Morphometric measurements of different stages of *Rhizoecus amorphophalli.* reared on tubers of elephant foot yam

Stage	Length (µm)	Breadth (µm)	Length of antenna (µm)
Egg	187.80±8.70 (171.50-200.30)	102.50±4.30 (95.41-108.00)	NA
1st instar	183.53±16.53 (165.61-203.48)	98.90±12.20 (84.86-121.70)	55.12±11.63 (38.21-68.80)
2nd instar	270.90±34.74 (222.10-319.10)	124.74±14.85 (96.96-143.50)	77.42±10.29 (61.36-90.91)
3rd instar	429.47±31.47 (384.76-477.95)	193.26±10.60 (175.22-209.96)	79.10±13.82 (66.30-101.30)
Adult female	867.19±53.67 (792.11-939.54)	368.88±19.78 (325.94-399.31)	93.45±11.66 (81.61-123.30)
Adult male	336.75±13.52 (316.03-351.30)	NA	251.93±10.40 (241.20-267.75)

NA, Not applicable; values in parenthesis are range.

Figure 2. Crawlers of *Rhizoecus amoprhophalli* moving out of the mealy cocoon.

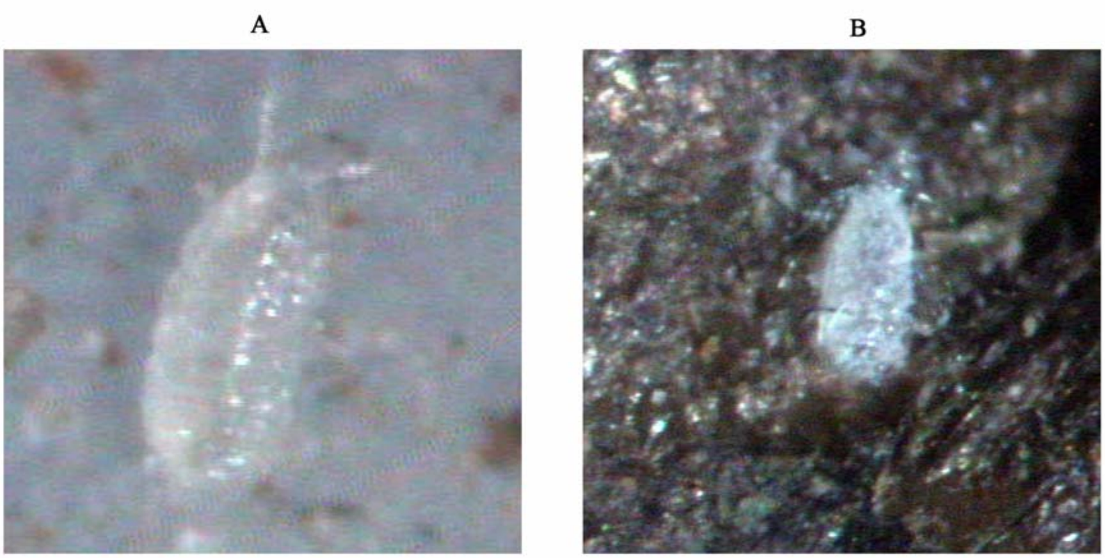

Figure 3. Freshly emerged, semi-translucent crawlers (A) cover themselves with mealy substance subsequently (B).

Table 2. Duration of different stages of *Rhizoecus amorphophalli.* reared on tubers of elephant foot yam

Parameter	Larval instar			Pupa	Adult	
	1st	2nd	3rd		Male	Female
Mean±SD	5.82±1.07	4.82±0.72	4.58±0.71	2.50±0.50	4.90±0.56	11.94±1.98
Range	4-7	4-6	4-6	2-3	4-6	9-15
N	17	17	17	10	10	17

SD, Standard deviation; N, number of observations.

an average duration of 5.82±1.07 days (Table 2). The 2nd instar larva was 270.90±34.74 µm long and 124.74±14.85 µm wide, and was semi-translucent with shining body. They are highly active and except in body size, they are morphologically similar to the first instar. Length of the antenna increased prominently to 77.42±10.29 µm. The second instar larva lasted for an average of 4.82±0.72 days and before undergoing next moulting, they settled either on the previous site or on another suitable site on the tuber and covered themselves with mealy filaments.

The third instar is relatively bigger, measuring 429.47±31.47 µm long, 193.26±10.60 µm wide; antenna 79.10±13.82 µm long, and were visible to naked eye. Morphologically, it resembles the previous instars, but is more agile in their movement. Duration of this instar was 4-6 days (Table 2), and the sex differentiation was obvious at the end of this stadium. Female moults normally, but male instar produces a cottony puparium around its body and form a pupal stage with protected mealy cocoon. Pupal stage lasted for an average of 2.50±0.50 days, and the male transformed to winged adult form.

Male undergoes a radical change during its life cycle, the wingless nymphs transforms to a winged adult of size ranging from 316.03 to 351.30 µm with a pair of transparent, delicate wings of expansion of 223.12±9.30 µm. Antenna is 11 segmented with an average length of 251.93±10.40 µm, and its head, thorax and antenna had a tinge of red colour.

Adult female does not undergo complete metamorphosis and it morphologically resembles other instars. Body is oval, whitish, wingless and sparsely covered with white mealy substance. Morphometry varies from the previous instars and the length and width of adult are 867.19±53.67 µm and 368.88±19.78 µm, respectively (Table 1). Antenna six segmented and its length increased considerably (93.45±11.66 µm) from the previous instars. Unlike the other instars, they are mostly sedentary and strongly fasten to its host. Proceeding mating, adult female secretes an Ovi-sac of white waxy substance (Figure 4) in about 7-14 h, and egg laying started 3-7 h after this process (Table 3). Eggs are laid in a bead shaped pattern (Figure 5), but later these are found in a disarrayed and scattered manner under mealy covering. Oviposition, that happened only once in her life time, completes in about 3-8 h with a maximum fecundity of 79 eggs (average of 68.30±6.22), and the females were not able to survive more than 4 ho after egg laying (Table 3). Under laboratory conditions (temp.: 32.22-35.10°C, humidity: 55-65% R.h.), all the eggs hatched out in about 6-9 days of incubation (Table 4).

Life cycle of *Rhizoecus amorphophalli* on tubers of taro and tannia

Fecundity of *R. amorphophalli* on tannia was significantly lower than those on the EFY and taro, whereas it was significantly higher on EFY (Table 4). Although there was a notable variation among the lower limit of fecundity for mealy bugs on the three hosts (range: 50-58), this was not reflected in the upper limit.

Incubation period also varied significantly ($p \leq 0.05$) according to their hosts. Average incubation period of *R. amorphophalli* on tannia (8.30±0.62) varied significantly than other hosts, nevertheless irrespective of hosts; the percentage of hatching maintained a uniformity that ranged from 80-100% (Table 4).

Unlike instars developed on EFY, and the crawlers on other two hosts settled down immediately after hatching. However, distinct from the host of EFY, the first instar on transforming to second instar (Table 5) did not wander or change their feeding site. Presence of pupal stage was noted in male nymphs after the third instar, irrespective of the hosts, from which adult males emerged.

Instars and females prefer to colonise in the crevices or lesions as in the case of EFY, but in tannia and taro, they prefer to congregate on the junction between mother corms and cormels. The larval stages of mealy bug did not show prominent morphometric changes among the hosts used for life cycle study (Tables 6 and 7). The length and breadth of the different stages of mealy bugs ranged from 165.28 to 945.36 µm and 81.87-409.25 µm, respectively.

DISCUSSION

As is in *R. amorphophalli*, the eggs of mealy bugs, in general, are smooth, semi-translucent and oblong, but there would be a difference in color according to species. The egg of *Phenacoccus solenopsis* Tinsley is oblong

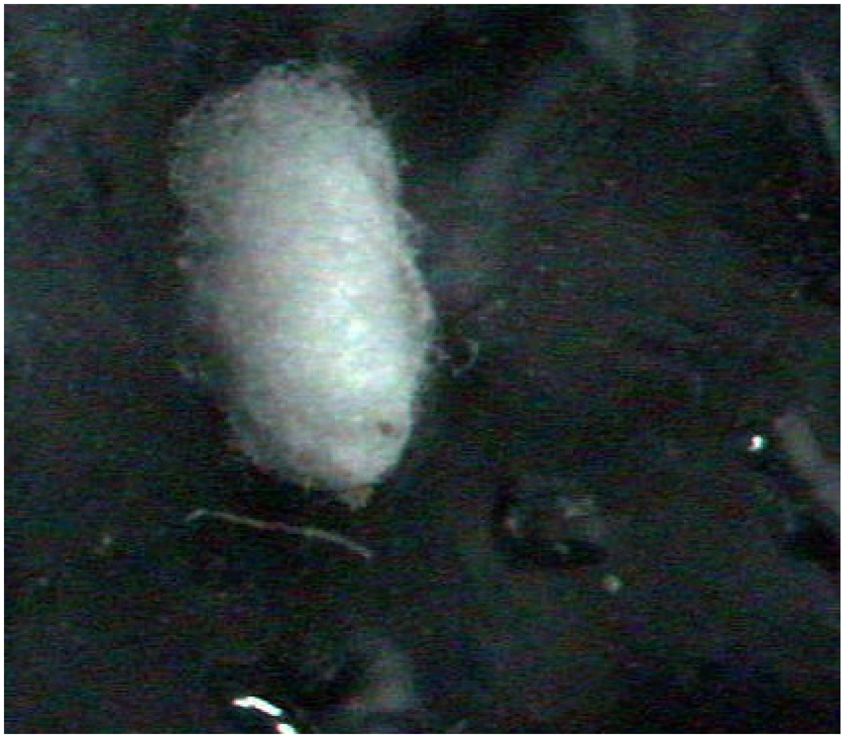

Figure 4. Ovisac produced by adult females of *Rhizoecus amoprhophalli.*

Table 3. Duration of egg sac formation, egg laying and longevity of adult female after oviposition.

Parameter	Duration for the completion of egg sac (h)	Time gap between egg sac formation and egg laying (h)	Duration for completion of egg laying (h)	Longevity of the female after egg laying (h)
Mean±SD	10.20±1.60	5.10±0.90	6.03±1.54	2.03±1.24
Range	7-14	3-7	3-8	0-4
N	30	30	30	30

SD, Standard deviation; N, number of observations.

with tapering ends and light creamy yellow (Nikam et al., 2010); in apple mealy bug, *Phenacoccus aceris* Signoret it is oval and lemon yellow (Beers 2007), but oval to cylindrical with round end and light yellow as in *Ferrisia virgata* Cockerell (Savaliya et al., 2008). Just before hatching of *R. amorphophalli* eggs, its color changed from pale white to light brown. Williams (1996) also reported a similar observation on eggs of *Maconellicoccus hirsutus* Green which changed from orange to pink before hatching.

There can be a possibility of morphological variations in eggs of the same cluster laid by a single species. Atodaria (1998) noticed the morphological variation of eggs in the same group laid by *F. virgata.* The eggs of *R. amorphophalli* are 0.18 mm long and 0.10 mm wide, whereas, Nikam et al. (2010) reported that the *P. solenopsis* eggs were 0.37 mm and 0.19 mm in length and breadth, respectively. Kriegler (1954) reported that the eggs of *Planococcus ficus* Signoret were 0.41 mm in length and 0.21 mm in breadth. Savaliya et al. (2008) observed that the eggs of *F. virgata* were 0.34 mm in length and 0.16 mm in breadth. Therefore, comparatively *R. amorphophalli* eggs are smaller in size.

The egg sac of *R. amorphophalli* carries both eggs and newly emerged crawlers; subsequently the crawlers dispersed off as has been reported by Charles et al. (2009), in pasture mealy bug, *Balanococcus poae* Maskell. The neonates squirms out of the eggs are active and move around their host till finding a suitable site for settling. Mani (1989) observed that the nymphs of *M. hirsutus* walk for a considerable distance in search of a suitable feeding location on their host plants. Hara et al. (2001) also reported similar observation in root mealy bug, *Rhizoecus hibisci* Kawai and Takagi. The present

Figure 5. Eggs of *Rhizoecus amoprhophalli* laid in bead shaped manner.

Table 4. Biological parameters of *Rhizoecus amorphophalli* on different hosts.

Host	Eggs numbers/female	Incubation period (days)	Hatching percentage (%)
EFY	68.30±6.22a (58-79)	7.80±0.88a (6-9)	98.00±4.20a (90-100)
Taro	65.10±6.92ab (53-79)	8.13±0.68ab (7-9)	93.00±8.20a (80-100)
Tannia	64.63±6.17b (50-78)	8.30±0.62b (7-9)	90.00±8.16a (80-100)

Means with the same letter in the same column are statistically not significant by DMRT (p≤0.05); Values given in bracket indicates the range.

Table 5. Duration of different stages of *Rhizoecus amorphophalli* on different hosts.

Host	Instar			Pupa	Adult	
	1st	2nd	3rd		Female	Male
EFY	5.82±1.07	4.82±0.72	4.58±0.71	2.50±0.50	11.94±1.98	4.90±0.56
Taro	5.40±0.91	5.40±0.73	5.43±1.12	2.50±0.52	14.06±1.70	4.90±0.56
Tannia	4.93±0.70	4.13±0.83	5.53±0.91	2.50±0.52	11.00±1.41	5.10±0.31

Table 6. Morphometric measurements of different stages of *Rhizoecus amorphophalli* on taro.

Stage	Length (µm)	Breadth (µm)	Length of antenna (µm)
Egg	183.82± 7.15 (174.43-193.14)	99.34±5.08 (92.03-105.83)	NA
1st instar	184.79±15.85 (165.28-205.22)	99.78±13.63 (85.36-130.00)	54.72±13.50 (36.60-72.20)
2nd instar	272.80±33.24 (230.10-319.50)	130.61±15.06 (99.99-150.66)	78.76±10.85 (63.66-95.41)
3rd instar	430.36±30.17 (380.25-470.23)	196.51±12.18 (180.30-218.66)	78.40±12.40 (67.32-101.20)
Female	866.00±55.00 (785.33-935.21)	374.87±21.13 (329.66-409.25)	98.92±14.37 (80.21-132.20)
Male	330.86±14.00 (312.80-349.60)	NA	255.70±10.29 (245.30-267.30)

NA, Not applicable; values in parenthesis indicate range.

Table 7. Morphometric measurements of different stage of *Rhizoecus amorphophalli* on tannia.

Stage	Length (µm)	Breadth (µm)	Length of antenna (µm)
Egg	183.40±6.32 (172.6-194.10)	96.99±4.41 (90.40-103.20)	NA
1st instar	181.86±20.49 (155.68-208.69)	100.46±14.52 (81.87-128.66)	57.59±10.10 (42.50-69.22)
2nd instar	268.20±30.37 (219.50-311.80)	129.17±15.01 (103.20-148.61)	78.74±9.65 (62.20-90.45)
3rd instar	431.10±36.86 (389.57-481.26)	194.55±8.41 (180.23-208.66)	77.40±14.50 (62.30-105.23)
Female	857.92±57.90 (775.46-945.36)	370.66±26.45 (324.13-405.23)	96.76±12.45 (82.33-129.20)
Male	341.47±12.52 (322.90-359.65)	NA	257.00±10.63 (243.52-272.50)

NA , Not applicable; values in parenthesis indicate range.

study revealed that crawlers of *R. amorphophalli* were highly active for searching their feeding sites, and on finding a suitable location they settled for feeding and molting.

Immediately after molting, the instars of *R. amorphophalli* were devoid of mealy substance and look semi translucent, like the neonate instars of *Rastrococcus invadens* William as reported by Akintola and Ande (2006). But on settlement, powdery mealy substance was seen all over the body and finally, a white mealy filamentous structure covered the entire body of *R. amorphophalli*. In case of *P. solenopsis*, the white waxy powder appears on dorsal as well as lateral sides of the body after moulting which gradually becomes dense (Nikam et al., 2010). Savaliya et al. (2008) observed the change in body colour of fresh nymphs of *F. virgata* from pale white to white within 2 days after moulting due to the deposition of mealy substance. Change in nymphal colour during its development is a regular phenomenon. The instars of ground mealy bug, *Rhizoecus falcifer* secrete small amount of waxy substance, causing bluish appearance to the soil. Waxy filaments of *R. amorphophalli* facilitate the nymphs for a firm grip onto its host; however these shed along with its moulted skin. Addis et al. (2008) reported a similar observation in enset root mealy bug, *Cataenococcus ensete.*

Minor infestations by most mealy bugs are overlooked as they tend to wedge into crevices on the host plant. The crawlers of *R. amorphophalli* mostly tend to hide inside the crevices or depressions on the tubers and hence their infestation during the early phase is often unnoticed. As the intensity of infestation increases the tuber gets covered with multiple layers of mealy bug colonies blanketed with white mealy substance. Since most mealy bug species prefer cryptic habitat, tracing their life cycle with accurate instars culminate in a difficult task. Hara et al. (2001) opined that preference of crawlers of *Rhizoecus hibisci* Kawai and Takagi. to dark, hidden places found difficulty in tracking its life cycle and behavior. Morales et al. (1988) observed that the instars of sooty beech scale, *Ultracoelostoma assimile* Maskell settle in crevices on the bark, begin feeding and their body become enveloped in a fluffy, white, waxy covering.

Previous reports on mealy bugs point out that they have small eyes and three pairs of legs and the current study reveals these are true in the case of *R. amorphophalli* also. Mealy bugs are different in size, and morphometry reveals that *R. amorphophalli* is medium sized compared to many other mealy bugs. Their first instars was 0.18 mm in length and 0.09 mm in width with antennae 0.06 mm as against *R. invadens* where these were 2.20, 1.23 and 0.02 mm, respectively (Akintola and Ande 2009).

Nikam et al. (2010) opined that the second instar of *P. solenopsis* is similar to its first instar in general appearance, except in an increase body size and antennae. Daane et al. (2012) stated that instars of most vine mealy bugs resemble their previous instar except an increase in size and amount of wax secretion. Addis et al. (2008) also reported that the nymphs and adult females of enset root mealy bugs are similar in body shape but the former is smaller in body size. Usually mandible size is considered as the key for the identification of instars, however Akintola and Ande (2006) focussed the variation in appendages to identify the instars in *Rastrococcus* sp. Charles et al. (2009) recommended that the body size of *Balanococcus poae* provided a better indication of different instars, but again, failed to discriminate clearly between the nymph and adult stages. Morphometric measurements including total body length, breadth and antennae length of different stages of *R. amorphophalli* in the present study showed marked difference among the instars, which can be used for the differentiation among instars; however identification of instars from a population of mealy bugs is quiet confusing.

Larval stages of *R. amorphophalli* consist of three distinctive instars and there was an additional pupal stage for male; whereas female instar moulted directly into adult females. Generally in mealy bugs no morphological difference between male and female could be seen at immature stages, but it is visible at the adult stage (Ben-Dov 1994; Wakgari and Giliomee, 2005). Akintola and Ande (2008) noted three nymphal stages in *P. solenopsis,* and sex could be differentiated at the 3rd stage (Nikam et al., 2010). Number of instars may vary with species. *Rhizoecus hibisci* undergoes four instars in female and five in the male including two pupal stages (Hara et al., 2001). The difference in number of instars was also reported from other species like *M. hirsutus* (Ghose 1972; Mani 1986), *F. virgata* (Savaliya et al., 2008) and papaya mealy bug, *P. margniatus* (Mishra 2011).

Normally mealy bugs complete its life cycle in about 1-2 months. Present study revealed that larval duration of *R. amorphophalli* was higher (27.10 days) for females than the males (22.40 days), similar to the reported data of 18.12±1.30 and 17.31±1.63, respectively. But certain species of mealy bug takes longer larval period for male than its female. Boavida and Neuenschwander (1995) observed the life period of mango mealy bug as 28 to 31 days for males as against 25 to 27 days for female, and in *P. solenopsis* these were 18.70±0.90 (male) and 13.20±1.80 (female) days respectively (Vennila et al., 2010). Savaliya et al. (2008) observed that the male and female adults of *F. virgata* lived for 25.10 and 23.10 days, respectively.

The adult males of *R. amorphophalli*, on rupturing the cocoon, emerge out and after sometime they fly out. Such phenomenon was also observed in other mealy bug like spherical mealy bug, *Nipaecoccus viridis* Maskell (Saha and Ghosh, 2001) and *M. hirsutus* (Tewari et al., 1994; Katke, 2008). *R. amorphophalli* male has 11 segmented antennae with red tinge on their anterior part, and its length is longer in male than in female. Whereas, in male cotton mealy bugs 10 segmented antennae was reported by Nikam et al. (2010) which are longer than females. Male of mealy bugs live for a shorter period and in *R. amorphophalli* longevity of adult male lasts for 4-6 days. Nikam et al. (2010) reported that *P. solenopsis* male lived only for 7 to 10 days.

In contrast to the males, female mealy bugs shows no morphological variation from the instars (Savaliya et al., 2008; Katke and Balikai, 2009), and the same was observed in the mealy bug, *R. amorphophalli.* The females of *R. amorphophalli* are creamy white, oval, with a body size of 0.86 mm long and 0.36 mm in breadth. The six segmented antennae with flagellate setae observed were corroborated with the findings of Williams (1985). Hara et al. (2001) reported that females of *R. hibisci* are creamy, white, elongate, oval, 1.20–2.40 mm long with short, with well developed legs and antennae, whereas in coffee root mealy bug, it is snow-white, elongate, oval and shape varying from 2.00 to 2.50 mm in length. Addis et al. (2008) observed that instars of *C. ensete* are mobile whilst adult females are slow moving and do so only when disturbed; similar feature was observed in *R. amorphophalli* also.

The eggs of *R. amorphophalli* were laid in white, loose, waxy, elongate egg sac which easily disintegrates when disturbed. Such an egg sac was reported from *R. hibisci* (Hara et al., 2001), *R. invadens* (Akintola and Ande, 2009), *P. solenopsis* (Vennila et al., 2010), *B. poae* (Charles et al., 2009) and most vine yard mealy bugs (Daane et al., 2012). Female of *P. marginatus* also secretes an egg sac of white wax filaments from the ventral margin of its abdomen which entirely covers its body (Galanihe et al., 2010). The root mealy bug, *Rhizoecus pritchardi* McKenzie produces slender waxy filaments that form a sort of netting over their females in which eggs were laid.

Even though, the information pertaining to egg sac attached to female are known, literature keeps silent on the time taken for its formation. Present study reveals that *R. amorphophalli* took a maximum of 7-14 h for the complete formation of the egg sac and further 10-15 h for the completion of egg laying. However, 4 h after egg lying, female died, and similar observations were made by Rao and Srinivasan (1987) and Addis (2005), who observed the longevity of female *M. hirsutus* and *C. ensete* was only few hours after egg laying.

R. amorphophalli reproduces sexually and lays over 60 eggs. As has been reported in *R. hibisci* by Hara et al. (2001), the fecundity of *R. amorphophalli* is relatively low with longer incubation period. The fecundity of citrus ground mealy bug, *Rhizoecus kondonis* is 135 eggs and incubation is 8-10 days (Yoshida and Kubota, 1962), whereas, in papaya mealy bug it is 316 eggs with average incubation period 4.8 days (Mishra, 2011). In the case of *M. hirsutus*, the fecundity may go up to 600 (150-600) and incubation varies from 6 to 9 days (Mani, 1989). Although high fecundity (334) was reported in *P. solenopsis* (Vennila et al., 2010), the incubation period was lasting only for 35-60 minutes (Nikam et al., 2010). Savaliya et al. (2008) also recorded a short incubation period (28 minutes) in *F. virgata*. Although the fecundity of *R. amorphophalli* is relatively low with longer incubation period, the least embryonic mortality supports their fast multiplication. Katke (2008) and Sahito et al. (2012) reported 90.50-95.60%, hatching of eggs in *M. hirsutus.*

Host plant species as well as the feed had an important impact on the development of mealy bugs (Calatayud et al., 2003; Correa and Arquivos, 2008). Even though life table analysis of *R. amorphophalli* on elephant foot yam, taro and tannia had similarity in life history and morphological features, there were few exceptions too. Mealy bugs reared on EFY tubers showed higher fecundity with less incubation period. Such variation in biological parameters was previously reported by many workers. Satpute et al. (2011) observed that the fecundity was high when the *P. solenopsis* was fed on Hibiscus than on cotton and sprouted potato. Abbas et al. (2010) also recorded such differences especially on the fecundity of *P. solenopsis* as it varied according to the host-plant species. Johnson and Giliomee (2011) recorded less fecundity in oleander mealy bug, *Paracoccus burnerae* Brain that was reared in citrus compared to the butternut and sprouted potato and highest fecundity in spouted potato.

Host on which the mealy bug completes its life cycle is a limiting factor in the duration of larval period also. Satpute et al. (2011) reported the total developmental period of *P. solenopsis* female nymphs was 22.50, 26.00 and 23.50 days on cotton, hibiscus and sprouted potato respectively. Johnson and Giliomee (2011) also made similar observations and found that the total developmental period of *P. burnerae* on sprouting potatoes was shorter than on citrus (35.90 days) and potato (25.80 days). Stages of the foliage, nutritional status and chemical composition of leaves and seedlings are the factors attributed by these authors which are responsible for variation in larval development. Although most tuber crops are the rich sources of starch, there are diversified difference in other nutrients among the species (Bradbury, 1988), which might have played pivotal role in the variation of biological parameters and larval stages when the mealy bug was reared on different hosts.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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