LIFE TABLE PARAMETERS OF IMPORTANT

**COCCINELLID PREDATOR *Nephus regularis* (SICARD) ON THE MEALY BUG, *Phenacoccus madeirensis* (GREEN) (HEMIPTERA: PSEUDOCOCCIDAE)**

# ABSTRACT

The mealy bug Phenacoccus madeirensis (Green) (Hemiptera: Pseudococcidae) is an invasive exotic pest with an extensive host of more than 130 genera of host plants from 51 families P. madeirensis is considered one of the most economically significant pests of many fruits, fibre plants, food crops and vegetable crops etc. The damage is due to both nymphs and adult stage resulting withering and yellowing of leaves. The plant protection products are of limited effectiveness against mealy bugs because of their habit of hiding in crevices and the presence of waxy covering on its body. Several efforts were made to study the biology of the most abundant predator of the P. madeirensis in the Kolhapur district of Maharashtra. The present study was carried out during summer season (March- May 2019) in the laboratory of AGPM Department, Shivaji University, Kolhapur. The present study was conducted in an incubator under optimum constant laboratory conditions 27± ± 2ºC and 65± ± 5% R.H. The observed mean pre-oviposition period of the N. regularis was3was 3.4 ± 1.07 days, whereas the recorded oviposition period was32was 32.6 ± 2.59 days. The observed post oviposition period noticed about

20.4 ± 1.07 days. The average egg-laying was 92.7 ± 8.41 eggs/ female. The recorded mean incubation period was 5.2 ± 0.5 and the larval period lasts for about10about 10-13 days. The mean duration of pre-pupae and pupae was 1.5 ± 0.7 and 6.5 ± 0.8 days, respectively. The average longevity of male and female beetles noticed was 47.1 ± 1.7 and 58.4 ± 2.16 days respectively.

**Keywords:** *Phenacoccus madeirensis;* biological control; native predator *Nephus regularis;* biology.

# INTRODUCTION

The mealy bug Phenacoccus madeirensis (Green) (Hemiptera: Pseudococcidae) common widespread insect belonging to the family Pseudococcidae. The mealy bug P. madeirensis was first time described on Madeira Island and later it has spread to 58 countries in Southeast Asia, North Africa and the Mediterranean region. Mealy bugs are a small, oval and soft-bodied insect which is often covered with a white powdery wax coating. Mealy bugs are protected by waxy filaments and almost impossible to be penetrated by insecticidal spray so they attain as “Hard to kill pest” (Lower, 1968).[1]. Most of mealy bug species are white, pink, orange and yellow colour. Feeding by both nymphs and adults reduces plant vigour. The honeydew which is secreted by this pest causes the growth of black sooty mould disease which affects the photosynthesis rate of the plant. High infestation of the pest results in malformation of leaves and growing shoots. At severe infestation leaf fall, fruit loss or even death of infected plants is occurred (Franco et al., 2000).[2]. All females are mobile and crawlers show the greatest mobility for a suitable feeding site. Mealy bugs shelter in the crack and crevices of the bark to escape and re-establish their population quickly (Manjunath, 1985).[3]. For these reasons various chemical pesticides have been failed to control of mealy bug population.

In the distribution map, CABI enlisted 85 countries from many tropical and subtropical regions. *P. madeirensis* survives mainly in tropical and subtropical regions and successively reproduces in temperature between 15-35°C. In the last decade, the Madeira mealy bug has continued to spread in the Mediterranean region and other parts of the world, such as Southern Asia and Tropical Africa [4].

For the management of mealy bugs, bio-controls have proved an effective means of achieving insect control of the major pest of agricultural and horticultural crops. Biological control is considered the most effective sustainable solution for the mealy bug infestation because the parasites and predators are self-perpetuating, persist even when the mealy bug is at low population densities and they continue to attack the mealy bugs, keeping populations below Economic injury level, the population of mealy bug could rapidly grow when environmental conditions are suitable which results in the outbreak of pests in a very short time.

# MATERIALS AND METHODS

The biology of coccinellid predator *N. regularis* was studied on *P. madeirensis* at department of AGPM,

Shivaji University Kolhapur. Adult males and females of *N. regularis* were collected from the mealy bug infested shoots of ornamental, vegetables and fruit plants. Later collected samples were taken into the laboratory for initiation of primary culture and further mass multiplication. From the primary culture, eggs were collected and further biology was initiated under controlled condition like temperature 27 ± 20 C and 65

± 5% RH.

**Incubation, Developmental periods of immature stages Pre-oviposition, oviposition, fecundity and longevity of adults:** Each pair of newly emerged adult beetle was kept for oviposition in a separate glass beaker of the size (10×5 cm) by providing egg masses of *P. madeirensis*. After oviposition by adult female beetle, newly laid eggs were collected and kept separate in individual cavity blocks in size (2×2cm) along with the eggs of *P. madeirensis*. In Mealy bugs are a small, oval and soft-bodied insecttotal 10 replications of eggs were maintained and an incubation period was recorded. After hatching the eggs, the grubs of *N. regularis* were supplied daily with fresh eggs of the mealy bug until it pupates. Each cavity block was carefully observed thrice a day to know whether the larvae had moulted to record the duration of each instar period [5].

# RESULTS AND DISCUSSION

The detailed observation on the various developmental times for egg, larva, pre-pupa and pupa of the coccinellid predators; *N. regularis* was recorded and presented in Table 1 whereas duration of Pre-oviposition, oviposition and post-oviposition period is described in Table 2.

**Egg:** The eggs of *N. regularis* found were larger, with the waxy covering of pest colony and characteristically stacked over each other. The eggs were light yellowish in colour, smooth, ablong, laid singly or in the group of three which was measured about 0.4 × 0.2mm in size.

**Grub:**The grubs of *N. regularis* underwent moulting three times with four instars in their life cycle. The grub of *N. regularis* developed a white wax coating and wax filaments on their body within 24 hr of its hatching. That external appearance often mimics the mealy bug which reduces the interference of mealy bug-tending ants on predation. The newly emerged sluggish larva measures about 0.8× 0.2mm. The second instar was relatively active as compared to the first instar. The duration of first, second, third and fourth instars ranged in between 2.1 ± 0.5, 3.4 ± 0.6,

2.9 ± 0.4 and 2.7 ± 0.8 days respectively. The 3rd and 4th instar is referred to as late instar grub. These grubs were robust and completely covered with the white

waxy strand. The total larval period of *N. regularis* was 11.1 ± 2.3 days. The measurement of the second, third and fourth instars were in between

1.2 × 0.5mm, 2.3 ×0.6mm and 3.4 × 0.8 mm

respectively. The early instar grub preferred to feed on egg and first instar of mealy bug while late instar grub fed on all the stages of mealy bugs. The early instar had 90% survivability while the late instar had 92% survivability under laboratory conditions. The duration of each larval instar was given in Table 1.

**Pre-pupae:** After the feeding ceased, fully grown grubs of *N. regularis* became sluggish and started congregating for pupation. In the pre-pupae stage, the body is shortened and remains inside the last instar cuticle under which pupation occurs. The caudal end was attached with the substrate in which they kept. Duration of the pre-pupal stage lasted for 1.5 ± 0.7 days. Pre-pupae of *N. regularis* measured about 2.1 ×

0.7 mm.

**A**

**B**

**C**

**D**

**E**

## Fig. 1. Life stages of *N. regularis* A) eggs B) Grub C) Pupa D) adult female &male E) copulation Table 1. Biological and Biometrical parameters of different stages of *N. regularis*

**Table 2. Duration of pre-oviposition, oviposition and post-oviposition period (Days) including fecundity**

|  |  |  |  |
| --- | --- | --- | --- |
| **Stages** | **Duration/longevity ( days)** | **Length (mm)** | **Breadth (mm)** |
| Egg | 5.2 ± 0.5 | 0.4 ± 0.1 | 0.2 ± 0.1 |
|  | **Grub** |  |  |
| Ist Instar | 2.1 ± 0.5 | 0.8 ± 0.11 | 0.2 ± 0.11 |
| IIndInstar | 3.1 ± 0.6 | 1.2 ± 0.15 | 0.5 ± 0.12 |
| IIIrd Instar | 3.5 ± 0.4 | 2.3 ± 0.17 | 0.6 ± 0.1 |
| IVth Instar | 3.9 ± 0.8 | 3.4 ± 0.8 | 0.8 ± 0.12 |
| Pre-Pupa | 1.5 ± 0.7 | 2.1 ± 0.7 | 0.7 ± 0.1 |
| Pupa | 6.5 ± 0.8 | 1.8 ± 0.1 | 1.1± 0.1 |
|  | **Adult** |  |  |
| Male | 47.1 ± 1.7 | 1.2 ± 0.1 | 1.0 ± 0.1 |
| Female | 58.4 ± 2.16 | 1.4 ± 0.1 | 1.1 ± 0.1 |

|  |  |
| --- | --- |
| **Parameters** | **Period (days)** |
| Pre-oviposition period | 3.4 ± 1.07 |
| Mating period | 32.6 ± 2.59 |
| Coitus Range | 16.4 ± 1.4 minutes |
| Fecundity | 92.7 ± 8.41 |
| Post-oviposition period | 20.4 ± 1.07 |

**Pupae:** The pupae are yellowish and measured about

1.8×1.1mm in size*.* The *N. regularis* pupation took place inside the last larval skin. The average pupae period lasted for 6.5 ± 0.8 days. The observed survivability of the pupae stage was 92%.

**Adults:** Freshly emerged adults were lighter in colour and later they turned to darken with reddish-brown colour due to its chitinisation. Females were slightly larger than males and measured about 1.7×1.1 mm while males measured about 1.5 × 1.0 mm. Adult beetle attack on all stages of mealy bugs. The adults of *N. regularis* by chewing completely devoured bio- stages of the mealy bugs.

**Copulation:** Male exhibited copulation behaviour by its approach, examination and copulatory attempt. Some females show multiple mating on the same day. Male and female mating occurred after 3-5 days of their emergence. Males generally recognize females through their size and body shape. Sometimes rejection was shown by females due to recently mated or about to oviposit. Generally, mating occurred 6-8 times during the whole life cycle. The copulation of *N. regularis* lasted for an average of 16.4 ± 1.4 minutes.

**Oviposition and Fecundity:** The female started egg- laying after 2-3 days of copulation. Females generally laid eggs singly or in the group inside the mealy bug colony during the late evening. Egg-laying continued up to 7 weeks and during the entire oviposition period, the average mean fecundity was 92.7 ± 8.41 eggs at laboratory conditions. The pre-oviposition, oviposition and post oviposition periods were

3.4 ± 1.07, 32.6 ± 2.59 and 20.4 ± 1.07

respectively.

**Adult longevity:** The longevity of females was greater than males, where female was 58.4 ± 2.16days while male was 47.1 ± 1.7 days. Both male and female longevity ranged from 45-49 days and 58-62 days respectively.

The seasonal activity and distribution of *N. regularis*, a predator on the mealy bug in India was studied by Rawat and Modi [6]. They found that the egg hatching period of the *N. regularis* was 6.3±0.3 to 8.9±0.9 days with the size 0.44 × 0.20mm while, the average larval period was 8.9 ± 1.1 days. They recorded the pupation period of *N. regularis* was 4-11 days along with the adult male and female longevity 43.6 and 42.8 days respectively. However in present study observed values of egg, grub, pupal period was 5.2 ± 0.5, 11.1 ±

2.3 and 6.5 ± 0.8 days respectively. Tranfaglia and Viggianni [7] reported that the development of *N. regularis* from egg to adult was completed in 25.4 ±

0.40 days and the development time from hatching to adult of *N. includens* was 25.9 days with a mean number of eggs laid 150.9/ female at 25 - 270C. However, in present study it is observed that development of *N. regularis* from egg stage to adult stage completed within 23.7 ± 0.7 days. Life table parameters of predators *Nephus includes* (Boheman) and *Nephus bisignatus* (Kirsch) was studied by Kontodimas [8] on *Planococcus citri* in Agricultural University of Athens, Greece. They found that both species were most fecund at 250C i.e. 162.8/ female in

*N. includes* and 96.9/female respectively, where in current study the observed fecundity of *N. regularis* was 92.7 ± 8.41 eggs/females which is quite similar to

*N. includes* species. Chakraborty *et al*. [9] also reported the Coccinellid *Nephus sp* as a potential predator of *M. hirsutus* mealy bug*.*

# CONCLUSION

In the present study the biology of *N. regularis* is from egg to adult is first time studied on *P. madeirensis* mealy bug in the department of AGPM Shivaji University, Kolhapur. From the results of this experiment, we can conclude that *N. regularis* is superior and effective bio-control agent against *P. madeirensis*. The observed values and biology will be helpful to control this invasive pest to reduce the pest infestation on various ornamental, vegetable and fruit plants of Kolhapur region. This study will also be useful to adopt further IPM (Integrated Pest Management) strategy.

# COMPETING INTERESTS

Authors have declared that no competing interests exist.

# REFERENCES

1. Lower HF. Hard to kill pests of fruit crops, Journal of Agriculture (South Australia). 1968;72:75-77.
2. Franco JC. Borges da saliva, possos de Carvalho J. Cochonilhas-algodao (Hemiptera: Pseudococcidae) associadasaoscitrinosem Portugal. ISA Press, Lisboa.Control in Citrus Fruit Crops IOBC/wprs Bulletin. 2000;38:117- 123
3. Manjunath TM. *Maconellicoccus hirsutus* on grapevine. FAO Plant Protection Bulletin. 1985a;38:74.
4. Williams DJ. Mealy bugs of Southern Asia, pp. 896. The Natural History Museum, London. 2004;1:( V1-896P).
5. Chandrababu A, Gautam RD, Garg AK. Biology of ladybird beetle, *Brumoides suturalis* (Fabricius) on aphid and mealy bugs. Annals of Plant Protection Sciences. 1999;7:13-18.
6. Rawat RR, Modi BN. Studies on *Nephus regularis* (Coleoptera: Coccinellidae) as a

predator of the striped mealy bug in Madhya Pradesh (India). Annals of the Entomological Society of America. 1969;62(5):953

-956.

1. Tranfaglia A, Viggianni G. Biological data on *Scymnus includens* (Col.,Coccinellidae). Bolletinodel Laboratoriadi Entomologia Agraria FlippoSilvestri Portici (RAE (A). 1973,1975, 63 Abstr. 1267).
2. Kontodimas DC. Life table parameters of the pseudococcid predators *Nephus includens* and *Nephus bisignatus* (Coleoptera: Coccinelidae) Eur. J. Entomol. 2007;104:407–415.
3. Chakraborty MV, Santhakumar SK, Sen. Studies on the feeding potential of a coccinellid predator *Nephus sp* on pink mealy bug *Maconellicoccus hirsutus* (Green). 1999;39(2): 193-207.