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Biology of rice moth Corcyra cephalonica (Stainton) (Lepidoptera: Pyralidae) in laboratory condition

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ABSTRACT

Corcyra cephalonica (Stainton) is a storage insect of cereals used as factitious host for laboratory mass production of different parasitoids and predators. Various biocontrol agents are reared in *C. cephalonica* eggs; thus, biology of the insect needs to be well understood for successful mass production of bio-control agent. Considering the fact, biology of *C. cephalonica* was studied at 27±2°C temperature and 70 ±5% relative humidity in laboratory of National Entomology Research Center during 2024. Life cycle of rice moth consists of four stages: egg, larva, pupa and adult. Average egg duration of the insect was found 3.91 days. The larva passed through seven instars and average duration of each instar was found 4.98, 3.23, 3.52, 3.60, 4.93, 6.47, 10.20 days, respectively. Average pupal period was recorded 9.44 days. The mean adult longevity of male and female moths was recorded as 9.54 and 6.67 days, respectively. The pre-oviposition, oviposition and post-oviposition days of female moth was 1.09, 5.13 and 1.90 days, respectively with average fecundity of 468.3 eggs per female. The morphometric measurement showed that average length and breadth of egg was 0.57 mm and 0.37 mm. The mean length and breadth of larval instars were 1.35, 2.15, 3.50, 4.52, 6.38, 8.28, 15.50 mm and 0.21, 0.37, 0.46, 0.70, 0.92, 1.29 and 2.64 mm, respectively. Female pupae and adult moths were found larger than males. Average length of female and male pupae was 10.61 and 8.84 mm, respectively. Length and breadth of female moth was measured 10.61 and 2.23 mm whereas male moths were measured 8.84 and 1.97 mm, respectively. The width of head capsules of larval instars measured 0.22, 0.31, 0.43, 0.62, 0.81 and 0.04 mm, respectively.

Keywords: Biology, fecundity, host insect, instar, morphometric.

सारांश

अनाजको पुतलीको अण्डा प्रयोगशालामा धेरै प्रकारका मित्रजीव परजिवी तथा परभक्षी कीराहरु उत्पादनको लागि आश्रयदाताको रुपमा प्रयोग गरिन्छ । सफल रुपमा प्रयोगशालामा मित्रजीवहरु उत्पादन गर्न अनाजको पुतलीको जिवनी थाहा पाउन अत्यन्त जरुरी हुन्छ । त्यसैले राष्ट्रिय कीट विज्ञान अनुसन्धान केन्द्रको प्रयोगशालामा २७+२ डिग्री सेन्टिग्रेड तापक्रम तथा ७०+५ प्रतिशत सापेक्षिक आर्द्रतामा यस कीराको जिवनी सन् २०२४ मा अध्ययन गरिएको थियो । यस कीराको जिवनी अण्डा, लार्भा, प्यूपा र वयस्क पुतली हुँदै सम्पन्न हुने देखियो । यस कीराको अण्डा अवस्था सरदरमा ३.९१ दिन भएको पाइयो । यसको लार्भाको सातवटा अवस्था हुने देखियो भने उक्त अवस्थाहरुको अवधि क्रमशः ४.९८, ३.२३, ३.५२, ३.६०, ४.९३, ६.४७ तथा १०.२० दिन रहेको पाइयो । प्यूपा अवस्था ९.४४ दिन रहने देखियो भने वयस्क भाले र पोथी पुतली क्रमशः ९.५४ र ६.६७ दिन बाँच्ने देखियो । पोथी कीराले सरदरमा ४६३.३ वटा अण्डा पार्ने पाइयो । यस कीराको अण्डा ०.५७ मि.मि. लामो तथा ०.३७ मि.मि. चौडा पाइयो । यस कीराको लार्भा अवस्था क्रमशः १.३५, २.१५, ३.५०, ४.५२, ६.३८, ८.२५ र १५.२० मि.मि. लामो देखियो । यस कीराको प्यूपा र वयस्क अवस्थामा भाले भन्दा पोथी ठूलो भएको पाइयो । भाले प्यूपा ८.८४ मि.मि. र पोथी प्यूपा १०.६१ मि.मि. लामो भएको पाइयो । यस कीराको भाले वयस्क ८.८४ मि.मि. लामो, १.९७ मि.मि. चौडा तथा पोथी वयस्क १०.६१ मि.मि. लामो तथा २.२३ मि.मि. चौडा देखियो ।

INTRODUCTION

Introduction of invasive pests in the country has become the threat to food security. With the introduction of pests, immediate management practice is conducted using different chemical pesticides. Indiscriminate use of pesticides has resulted in contamination of the environment with chemicals

causing ecosystem disruption and various health hazards to producers and consumers and even loss of beneficial natural enemies. Pesticides are well known for bio-magnification in food chain and its indiscriminate uses also develops resistance against it in insect pests. In order to reduce such problem, integrated pest management (IPM) was introduced with incorporation of different pest management techniques. Biological control is one of the important component of IPM which helps in reducing contamination of environment by chemical pesticides. This is the most efficient, sustainable and compatible to other methods of pest control. Biological control by augmentation, mainly by inundative release of natural enemies is generally successful in the pest management. Its efficacy mainly depends on their mass production and timely release. Mass production of predators and parasitoids depends on efficient production of host insects in the laboratory. The rice moth, *Corcyra cephalonica* Stainton (Lepidoptera, Pyralidae) is used as one of important factitious host in laboratory production of various parasitoids and predators (Manjunath 2023).

C. cephalonica is widely used as alternate host for economical production of natural enemies in the laboratory. Eggs are mainly used for the mass production of *Trichogramma* spps*, Chrysoperla carnea* etc whereas, larvae are used for laboratory production of *Bracon* hebetor (Say). *Corcyra cephalonica* Stainton is found as one of the best factitious hosts for mass production and 78 species of natural enemies: 60 parasitoids and 18 predators belonging to 35 genera in 18 families under 8 orders are produced worldwide (Manjunath 2023). *C. cephalonica* is mass produced as a host of several natural enemies in the laboratory (Lalitha and Chandish 2015). *C. cephalonica* eggs are the most suitable host and used to produce natural enemies such as *Trichogramma* for augmentative purpose of pest control (Adom et al 2021). *C. cephalonica* eggs are used as factitious host insect for the production of several natural enemies like *Trichogramma spp*. (Jalali et al 2007).

Trichogramma spp are an important egg parasitoids of lepidopteran insect pests. They are used as biocontrol agent because they kill the pest in early egg stage which prevents larval damage to crops (Goebel et al 2010). The release of *Trichogramma spp*. reduced the infestation level of the pest (Sattar et al 2016). The parasitism of *Trichogramma spp* on the eggs of *C. cephalonica* was recorded as 93.86 % (Begum et al 2013). Rice moth can be reared in all season so it is available for rearing *Trichogramma spp* It is necessary to study life cycle of *C. cephalonica* in laboratory for development of mass rearing technology of egg parasitoid *Trichogramma spp* A basic knowledge of life cycle like duration of different life stages including egg period, egg laying period and fecundity is helpful help in successful and efficient mass production of parasitoids in laboratory. So, this study was undertaken to study lie cycle and morphometrics of different development stages of *C. cephalonica* in National Entomology Research Center laboratory.

MATERIALS AND METHODS

Culture of *C. cephalonica*

The stock culture, of *C. cephalonica* was maintained on the crushed maize grain as source of food. 2.5 kg of roughly crushed maize grains was mixed with 3g yeast extract powder as protein supplement and 0.5g of Streptomycin Sulphate to prevent bacterial contamination in laboratory condition. The crushed maize grain was sterilized at 100ºC for one hour before mixing with the ingredients. Mixture of ingredients was kept in a ventilated plywood box with internal dimensions of 45 cm x 30 cm x 15 cm in length, width and height, respectively. In the box 0.5 ml of *C. cephalonica* eggs was introduced. Then the box was placed inside the mass rearing room where temperature and relative humidity was maintained at 27±2°C and 70 ±5%. The emerged moths were transferred into well ventilated breeding cage of 5 L capacity plastic bucket. The collected eggs were used for mass rearing of *Trichogramma chilonis* Ishii and for conducting experiments.

Life cycle of *C. cephalonica*

Laboratory experiment was conducted to find the duration of each stages of *C. cephalonica* in its life cycle at National Entomology Research Center during April 2024 to August 2024. The GPS co-ordinates of the location is N 27º39’03.74”, E 085º19’38.59” and the altitude is 1,308 m above mean sea level. Temperature of laboratory during experimental period was maintained at 27±2 º C whereas,

humidity was maintained at 70±5%. The experiment was conducted in completely randomize design with 30 replications. Male and female moths of *C. cephalonica* were identified by their labial palp: female moth has long and snout like labial palp while male moth possessed shorter and blunt labial palp (**Figure** 1). Adults were paired and kept in glass culture tubes of 100 cc capacity and allowed to lay eggs. Eggs laid on same day was collected and used for experiment. Diet for experiment was prepared from crushed maize with same procedure described in section of insect culture of *C. cephalonica*. The diet was kept in the petri-plates measuring 9 cm in diameter to study the life cycle of the insect. Eggs laid by paired insect collected and kept in test tube for hatching. After hatching, single larva was placed in each petri plate containing sufficient amount of diet using fine camel hair brush. Daily observation was recorded for molting of larva from each Petri plate. The head capsule was collected from each petri plate after molt and all operation was conducted under stereo microscope (Olympus SZ61). The newly emerged male and female adults were collected from petri plate and placed in glass tube (100 ml) measuring 19.5 cm long. The open top end of tube was covered with plug made up of cotton wrapped within muslin cloth.

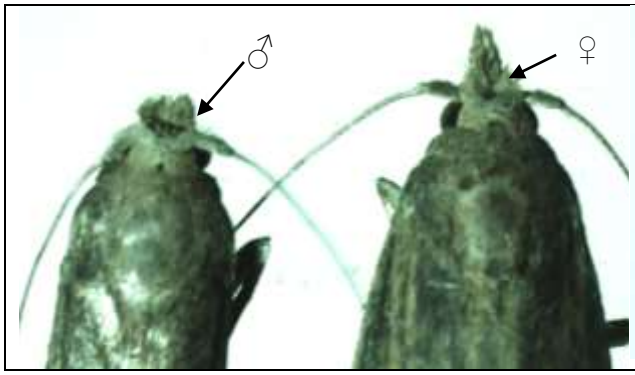

Figure 1. Male and female moths of *C. cephalonica* differentiated by labial palp

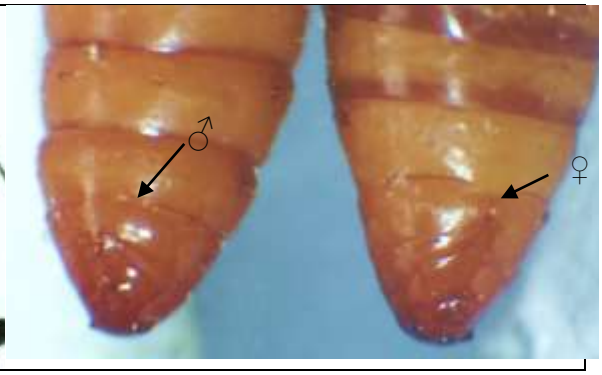

Figure *2.* Male and female pupae differentiated by presence of slit on 8th abdominal segment of female

The observations recorded on the life cycle study of *C. cephalonica* were egg period, larval period with different duration of each instar, pupal period, adult emergence and adult longevity of male and female moths. Larval instar was recorded by counting the number of head capsule during the larval stage. The number of days taken from egg hatching to pupation was recorded as larval period. The duration from the formation of pupa from larva inside the web until adult emergence was calculated as pupal period Adult longevity was calculated as duration after emergence from pupa till its death without feeding. Similarly, pre-oviposition, oviposition, and post-oviposition duration were also recorded. The fecundity of female moth was also observed and recorded. The length and breadth of egg, larva, pupa and adult were also measured. The egg length will be measured from the one end of pointed part to another end of the egg. The number of eggs laid per female was also measured. The male and female pupa was differentiated by observing slit on eighth abdominal segment: female pupa had slit on the eighth abdominal segment while it was absent in male pupa (**Figure** 2). Data recorded from observation were entered in Microsoft excel. Mean values, range and standard error of means were calculated using computer software GenStat Discovery edition.

RESULTS

Life cycle of *C. cephalonica*

Life cycle of *C. cephalonica* consisted of four development stages viz. egg, larva, pupa and adult (**Figure** 3). Eggs were laid singly. Freshly laid eggs were shiny, pearly white in colour with irregular sculptured surface when observed under microscope. Pear shaped eggs were gently rounded at one end and pointed at the terminal end.

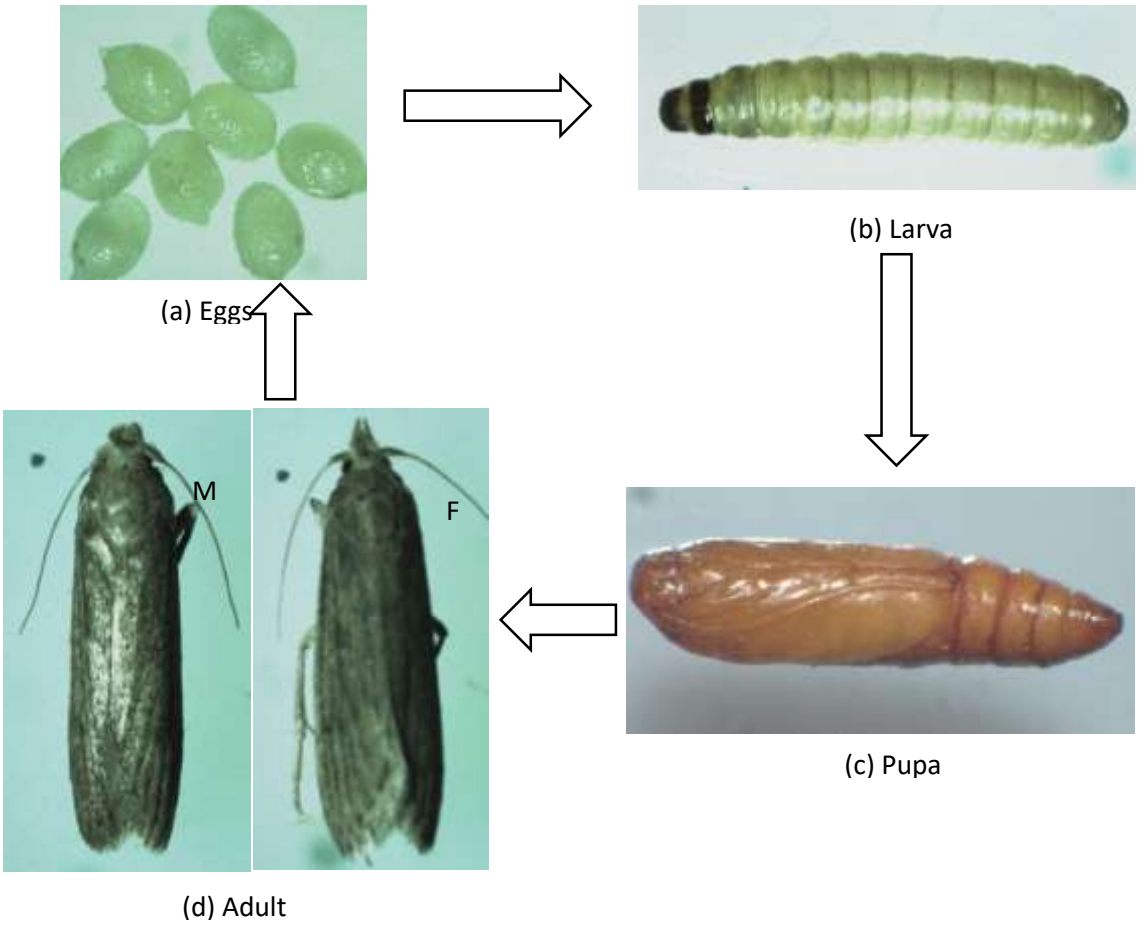

Figure 3. Different development stages of *C. cephalonica* (a) Eggs (b) Larva (c) Pupa (d) Adult (female, male)

Incubation period of egg was recorded as 3.91 days which ranged 3-5 days. Average larval duration was recorded 36.93±1.624 days. Larvae of *C. cephalonica* molted six times and passed through seven instars before pupation (**Figure** 4). Seventh instar cast exuviae attached with head capsule inside the web before formations of pupa. First instar larva with prominent head was white in color except head and prothoracic tergite which was light brown. Larvae possessed three pairs of true legs on thoracic segments and five pairs of well-developed prologs on abdominal segments of 3-6 and 10. Cuticular setae were present on the abdominal segments of the body which arise from a small patch of cuticle surrounded by a dark ringe. The mean duration of first instar larva was recorded 4.98 days. The second and third instars resembled with first instar larvae except size. The second and third instar larval duration was recorded 3.22 days and 3.52 days, respectively. The fourth, fifth and sixth instars were similar in external appearance but differed in size and shape. The color of the larvae were creamy off-white with brown color head. The prothoracic tergite was dark brown in color. With each molt larva seemed to become larger and fed more voraciously. The mean duration of fourth, fifth and sixth larval instars were 3.60, 4.93 and 6.47 days, respectively. The full grown seventh instar was uniform in shape, creamy off-white with dark brown head and the biggest instar in size. The mean larval period of seventh instar was 10.20 days (**Table** 1).

Figure 4. Different instar of larva

Figure 5. Pupa inside the web

Seventh instar formed the web in the food grain and remained inside it and transformed into pre-pupal stage, where the larva stopped feeding and became less active. Then spined a closely woven, very tough and double layered cocoon, its inner layer was white silken cocoon in color while outer layer was of maize grit (**Figure** 6). Inside the cocoon, it developed into light brown pupa and later changed into dark brown pupa. The pupa was obtect type and gradually tapering towards the abdomen. The mean pupal period was 9.44 days. Mean pre-oviposition, oviposition and post-oviposition period of female was recorded 1.09, 5.13, 1.91 days respectively. Adult longevity was recorded in the range of 3-21 days irrespective of gender. The average number of eggs per female during its life cycle was recorded as 468.3±23.97 (**Table** 1).

Table 1. Duration of different life stages of *C. cephalonica* in laboratory condition

Developmental stage	Mean (days)*	Range (days)
Egg Period	3.91±0.104	3-5
1st instar	4.98 ± 0.113	3-6
2nd instar	3.23 ± 0.124	2-5
3rd instar	3.52 ± 0.143	2-5
4th instar	3.60 ± 0.363	2-8
5th instar	4.93±0.330	3-7
6th instar	6.47±0.274	5-8
7th instar	10.20±0.277	8-14
Total larval period	36.93±1.624	25-63
Pupal period	9.44±0.252	8-12
Total development period	46.37±1.98	36-80
Pre-oviposition	1.09±0.164	1-2
Oviposition	5.13±0.291	3-8
Post-oviposition	1.91±0.164	1-4
Male longevity	9.54±0.948	3-21
Female longevity	6.67±0.524	3-15
No of eggs/ female	468.3±23.97	375-628

*Values presented as Mean ± SEM (Standard Error of Mean)

Morphometric measurement

Eggs measured 0.57 mm in length and 0.37 mm in breadth. The length and breadth increased with growth of larva. Immediately hatched larva was measured with an average 1.35 mm length and 0.21 mm breadth. While full grown larva measured 15.5 mm length and 2.64 mm breadth. Significant difference was noticed between the male and female pupae with regard to pupal size. Female pupae were larger in size as compared to male pupae, average length of female pupae and male pupae recorded 9.09 mm and 8.2 mm respectively. Adult female moth was also larger than the male moth (**Table** 2).

Table 2. Morphometric of different stage of *C. cephalonica* in laboratory condition

Stages	Length (mm)		Breadth (mm)	
	Average	Range	Average	Range
Egg	**0.57 ± 0.008**	**0.49-0.65**	**0.37 ± 0.006**	**0.32-.42**
1st Instar larva	1.35 ± 0.029	1.21-1.51	0.21 ± 0.005	0.18-0.24
2nd Instar larva	2.15 ± 0.0405	2.00-2.33	0.37 ± 0.017	0.33-0.44
3rd Instar larva	3.50 ±0.198	2.90-4.15	0.46 ± 0.025	0.40-0.58
4th Instar larva	4.52 ± 0.078	4.18-4.78	0.70 ±0.0159	0.62-0.76
5th Instar larva	6.38 ± 0.154	6.12-6.72	0.92 ± 0.0167	0.89-0.96
6th instar larva	8.28 ± 0.322	6.87-8.96	1.30 ± 0.046	1.13-1.44
7th instar larva	15.5 ± 0.269	14-17	2.64 ± 0.042	2.50-2.87
Pupa male	8.26 ± 0.283	7.12-9.97	2.52 ± 0.062	2.19-2.82
Pupa female	9.09 ± 0.458	7.82-11.06	2.67 ± 0.114	2.24-2.98
Adult male	8.84 ± 0.218	7.82-9.97	1.969 ± 0.044	1.73-2.14
Adult Female	10.61 ± 0.156	9.955-11.51	2.233 ± 0.057	2.011-2.520
Male antenna	6.033 ± 0.101	5.79-6.83		
Female antenna	6.784 ± 0.060	6.63-6.95		

*Values presented as Mean ± SEM (Standard Error of Mean)

Head Capsule of *C. cephalonica*

Larval stage of *C. cephalonica*, passed through seven instars thus consisting of six molts. Its width of head capsule increased after each molt and color changed progressively from light to dark brown. Average width of head capsule of different molts were measured by stereoscope (Olympus SZ61) are given in **Table** 3.

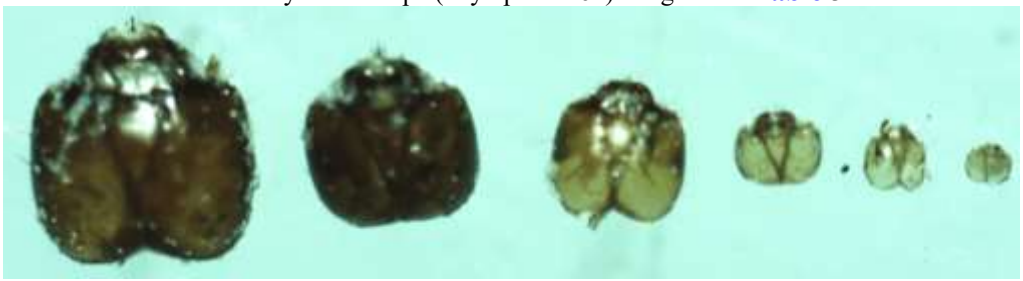

Figure 6. Head capsule of different larval instars of *C. cephalonica*

Table 3. Average head capsule width of various larval instars of *C. cephalonica*

Larval molts	Width (mm)*	Range (mm)
1st Instar	0.22 ± 0.001	0.200-0.222
2nd Instar	0.31 ± 0.002	0.289-0.333
3rd Instar	0.43 ± 0.005	0.400-0.489
4th Instar	0.62 ± 0.007	0.556-0.667
5th Instar	0.81 ± 0.0142	0.711-0.867
6th instar	1.04 ± 0.0286	0.978-1.200

*Values presented as Mean ± SEM (Standard Error of Mean)

DISCUSSION

The mean incubation period of *C. cephalonica* on crushed maize grain ranged between 3-5 days at 27±2 ºC temperature and 70±5% relative humidity. Similar egg period of 3-5 days was reported by Singh (2022) and Ramanaji et al (2020) on broken maize grain and groundnut, respectively. Devi et al (2013) and Jagadish et al (2010) recorded longer incubation period of 4-7 days on rice grains and foxtail millet grains, respectively. Average larval period lasted for 36.93 days on present study which was quite similar to larval period of 28-36 days reported by Jagadish et al (2010). Similarly, Menge et al (2018) recorded larval period of 41.10 days while studying life cycle of *C. cephalonica* on groundnut: difference with present study could be found in medium of rearing insect. Average pupal period was recorded 9.44 days in our present study which was similar to finding of Sowjanya et al (2018), Devi et al (2013) and Jagadish et al (2010). Total development period lasted for 50.28 days on crushed maize in present study. Similar findings of 41-59 day was reported by Jagadish et al (2010) and Sowjanya et al (2018). The mean adult longevity of female and male moths ranged between 3 to 21 days and 3 to 15 days, respectively. Similar results of female longevity were reported by Devi et al (2013) and Ramanaji et al (2020). But the male longevity was found longer as compared to previous workers. Pre-oviposition, oviposition and post-oviposition period recorded in present study was 1.09, 5.13 and 1.91 days respectively. Similar findings of pre-oviposition, oviposition and post-oviposition period of 1-2, 4-8 and 1-3 days, respectively were recorded by Jagadish et al (2010) and Ramanaji et al (2020).

Average length of egg was 0.57 mm which was longer compared to previous finding (0.39 mm) of Ramanaji et al (2020). The size differed as it was measured from the tip of the elongated part. But the breadth of egg was found similar. Length of different larval instar was comparatively larger in present study compared to Ramanaji et al (2020). The reason behind it might be due to the difference in the diet of the insect reared. Similarly, the sizes of pupae and adult moths were recorded larger in present study. Female pupae were larger in size compared to male pupae and adult female moth were also larger in size compared to adult male moth. Similar observation was also reported by Ramanaji et al (2020). *C. cephalonica* passed through seven larval instars with six molting. Average width of head capsules of different larval molts are given in **Table** 3. Osman et al (1984) also documented similar trend of increase in the width size of head capsule. Devi et al (2023) also concluded higher fecundity was observed in maize compared to rice and wheat diet. Maximum egg laying capacity was observed in maize based diet than sorghum, rice and wheat.

CONCLUSION

From the present study, it can be summarized that *C. cephalonic*a has an average incubation period 3.91 days and larval period 36.93 days with total development period of 46.37 days with a range of 36-80 days. The female moth laid 468.3 eggs during 5.13 days of oviposition period in laboratory conditions of 27±2 ºC temperature and 70±5% of relative humidity.

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