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Laboratory study on biology of syrphid fly, *Ischiodon scutellaris* (Fabricius) on mustard aphid, *Lipaphis erysimi* Kaltenbach

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Abstract

The present investigation on biology of syrphid fly, *Ischiodon scutellaris* (Fabricius) on mustard aphid, *Lipaphis erysimi* Kaltenbach was carried out in the laboratory of Department of Entomology, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during Rabi, 2024-25. The results revealed that an average duration of egg, first, second, third instars and total larval period were 3.04 ± 0.49 , 2.48 ± 0.54 , 3.30 ± 0.50 , 3.68 ± 0.55 and 9.46 ± 0.73 days, respectively. An average hatching percentage was 72.00 ± 4.00 percent. The female measured with a mean of 8.17 ± 0.13 mm in length and 2.51 ± 0.02 mm in width. The length and width of male were 8.28 ± 0.11 mm and 2.54 ± 0.02 mm, respectively. The fecundity of a female was 34.45 ± 2.40 eggs. Total life span of adults of *I. scutellaris* in case of female was 38.85 ± 1.24 days and 37.94 ± 1.25 days in case of male. The observed sex ratio of *I. scutellaris* was 1:1.25 (M:F).

Keywords: Biology, syrphid fly, *Ischiodon scutellaris* (Fabricius), mustard aphid, *Lipaphis erysimi* Kaltenbach

Introduction

Aphids (Aphididae: Hemiptera) are soft bodied herbivorous insects, affecting plants directly or indirectly by feeding on its phloem sap. They are known for rapid colonization by parthenogenetic viviparity, short and telescoping generations and polymorphism (Singh and Ghosh, 2002) [19]. Their complex life cycles involve alternation of sexual and asexual generations and host switching (Ghosh and Singh, 2000) [9]. Aphids, also known as plant-lice or ant-cows are associated with about 50 crops in 19 different plant families (Blackman and Eastop, 2007) [5]. Approximately 4,702 aphid species were reported globally (Remaudiere and Remaudiere, 1997) [17], 1015 were reported in the Oriental region, and about 653 species in India, representing 208 genera (Agarwala and Ghosh, 1984) [1]. *Lipaphis erysimi* Kaltenbach is one of the important aphid species causing serious damage to cruciferous crop especially mustard, widely grown in North Gujarat. Mustard aphid feeds on rapeseed and mustard from the seedling to the maturity stage by making small to large colonies. Both nymphs and adults suck the cell sap of the different parts of the plant such as petioles, tender stems, leaves, pods and inflorescences (Kumar *et al.*, 2022) [10]. The affected plants show curling of leaves, stunted growth and withered flowers. Later on, the whole plant may wither and die (Das and Isman, 1986) [7]. Due to honey dew excreted by aphids, development of sooty molds occurs on the plant which

hinders the photosynthetic activity of plant ultimately resulting in to poor pod and seed formation. The aphid, *L. erysimi* causes up to 90 to 96 percent yield loss (Rana, 2005) [16], 31 percent seed weight loss and 5 to 6 percent oil loss (Pandey *et al.*, 2023) [14]. Indiscriminate and overuse of pesticides leads to several consequences viz., destruction of natural enemies and pollinators, environmental pollution, health hazards, pest resurgence and resistance development in insect-pests (Meena *et al.*, 2013) [11]. By affecting pollinators, soil microorganisms and pest control agents, pesticide use also threatens key ecosystem services (Pelsoi *et al.*, 2021) [15]. Hence, the threats associated with conventional insecticide have necessitated the need to find alternate economical and environmentally safe methods. Among bio-agents, syrphid flies (Syrphidae: Diptera) such as *Syrphus confrater* (Weid.), *Syrphus balteatus* (Deg.) and *Ischiodon scutellaris* (Fab.) are the important entomophagous predators upon many species of aphids (Singh and Singh, 2013) [18]. Larvae of syrphid fly play crucial role in regulating populations of several species of aphids such as *Lipaphis erysimi* (Kalt.), *Brevicoryne brassicae* (Linnaeus) and *Aphis craccivora* (Koch). Considering the importance of the biocontrol agent in sustainable pest management, an attempt has been made to study the biology of syrphid fly, *Ischiodon scutellaris* (Fab.) feeding on mustard aphid, *L. erysimi* under laboratory conditions.

Materials and Methods

Rearing technique

The study on biology of syrphid fly was carried out in the laboratory of Department of Entomology, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar during year 2024-25. The initial culture of syrphid fly, *Ischiodon scutellaris* (Fabricius) was raised by collecting large number of syrphid fly larvae (maggot) from heavily aphid infested mustard crop at Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar. The larvae were kept inside the Petri Plate (10 cm × 2 cm). The adult syrphid flies as they emerge were paired and introduced in wooden cages. Cotton wool soaked in five percent honey solution was placed on a Petri Plate to provide food for the adults in each cage. Mustard plants infested with aphid were placed inside the cage for oviposition by adult flies.

Egg

The freshly laid eggs (n = 50) were transferred in Petri Plate with the help of camel hair brush on aphid infested mustard leaves. Eggs were examined under stereoscopic binocular microscope for studying their colour, shape and size. For study of incubation period freshly laid eggs were observed daily till hatching. Hatching percentage was calculated from the number of eggs hatched out of total number of eggs kept under observation. The size of the eggs was measured under stereoscopic binocular microscope.

Larva (maggot)

To study the colour, shape, size and duration of different larval instars, the newly hatched larvae from eggs were observed under microscope daily. Moulting was confirmed by presence of exuviae as well as change in larval colour and size. The individual larval period and total larval period was calculated from the period of hatching to the formation of pupa. The size of larval instars was measured under stereoscopic binocular microscope.

Pre-pupa and Pupa

To record the pre-pupal period, the larva was observed from the time when it stopped feeding and became sluggish to the time when it formed pupa. Observations on pupae were taken for their colour, shape, size and pupal period. Time between formation of pupae to adult emergence was considered as pupal period.

Adult

The adults obtained from the rearing cage were collected and observed carefully to study their size, colour, appearance and sex differences. The adults emerged were used for further studies on pre-oviposition, oviposition and post-oviposition.

Pre-oviposition, oviposition and post-oviposition periods

The period between the emergence of adult female and commencement of the egg laying was considered as pre-oviposition period. Duration of egg laying was considered as oviposition period. Time period starting from completion of oviposition period till the death of the adult (female) was considered as post-oviposition period.

Fecundity

For the study of fecundity ten pairs of adults were placed in wooden cage. Aphid infested mustard plants were placed inside the cage for laying eggs. Cotton wool soaked in five percent honey solution was provided as a food for the adults. The number of eggs laid was counted and average fecundity was calculated.

Longevity

Longevity of the adults (male and female) was calculated by observing from the date of newly emerged adults from pupae to the death of the adults.

Total life span

The entire life span from egg laying to the death of both male and female adults of *I. scutellaris* was recorded.

Results and Discussion

Egg

The female syrphid fly, *I. scutellaris* laid eggs singly on or near the aphid colonies in scattered form. Freshly laid eggs were white in colour which turned yellowish white in colour on the next day (Plate 1). They were elongated oval in shape, microscopically sculptured with a lace-like pattern on the surface. The length of eggs varied from 0.76 to 0.86 mm with an average of 0.83 ± 0.03 mm, while the width varied from 0.25 to 0.36 mm with an average of 0.32 ± 0.01 mm (Table 2). The incubation period was ranged from 2 to 4 days with an average of 3.04 ± 0.49 days. The hatching percentage ranged from 70 to 80 percent with an average of 72.00 ± 4.00 percent (Table 1).

The findings regarding the biology of *I. scutellaris* were similar to the previous observations of Suja (2008) ^[20], who reported a mean incubation period of 2.90 days. Similarly, Baskaran *et al.* (2009) ^[2] and Chouhan (2011) ^[6] also recorded average incubation periods of 3.10 ± 0.11 and 3.02 ± 0.05 days, respectively, further supporting the present results. Chouhan (2011) ^[6] and Beeraganni (2016) ^[3, 4] reported average hatching rates of *I. scutellaris* eggs as 71.13 ± 1.10 and 74.29 percent, respectively, which are similar to the present findings.

Larva (maggot)

During the larval period, the larvae moulted two times and thus passed through three larval instars.

First instar

Newly hatched larva was transparent and colourless. The larva turned yellowish white to greenish in colour after taking first meal (Plate 2). It was tapered anterior which lacks an external head capsule and broader posteriorly. Internal organs were visible to some extent through the integument. Dorsal surface was covered with semi circular tubercular spines with indistinct segmentation owing to the presence of numerous transverse folds and wrinkles in the integument. The duration of the first instar larvae of *I. scutellaris* was 2 to 3 days with an average of 2.48 ± 0.54 days (Table 1). The length of first instar larvae ranged from 1.45 to 2.38 mm with an average of 1.62 ± 0.11 mm, while width varied from 0.40 to 0.62 mm with an average of 0.47 ± 0.03 mm (Table 2).

Second instar

Freshly moulted second instar larva was greenish yellow in colour. A distinct yellowish longitudinal stripe was present at the mid-dorsal line extending throughout the body (Plate 3). Duration of second instar larvae ranged from 2 to 4 days with mean of 3.30 ± 0.50 days (Table 1). The length of second instar larva varied between 4.73 to 5.08 mm with an average of 4.90 ± 0.04 mm, while width varied from 0.64 to 0.89 mm with an average of 0.81 ± 0.03 mm (Table 2).

Third instar

The third instar larvae of *I. scutellaris* were green in colour with more prominent white streak along the mid dorsal surface compared to the second instar. Additionally, the transverse folds and wrinkles on the body segments became more distinct at this stage (Plate 4).

The data presented in Table 1 revealed that the duration of third instar larvae lasted for 2 to 4 days with an average of 3.68 ± 0.55 days. The length of third instar larva varied from 11.80 to 13.10 mm with an average of 12.48 ± 0.14 mm while, width varied from 1.96 to 2.48 mm with an average of 2.13 ± 0.06 mm (Table 2).

Total larval period

The data illustrated in Table 1 indicated that the total larval period of *I. scutellaris* varied from 7 to 12 days with an average of 9.46 ± 0.73 days. Chouhan (2011)^[6] observed that the total larval period of *I. scutellaris* varied from 8 to 12 days. This was further supported by Mishra *et al.* (2012)^[12] and Gelot (2014)^[8], who reported similar ranges with mean values of 9.52 ± 0.49 and 9.28 ± 0.54 days, respectively, thereby supporting the present findings.

Pre-pupa and pupa

The full grown larvae of *I. scutellaris* began to show slight decrease in movements and the body length got stretched and swelled up, prior to entering into pre-pupa (Plate 5). The pre-pupal period of *I. scutellaris* lasted for 1 to 2 days with an average of 1.28 ± 0.45 days (Table 1).

A freshly formed pupa was green in colour which turned greenish brown on next day. It was broad and round at the anterior end, while narrow at the posterior end. The fat streak was also present in pupa. The pupa is enclosed in a hardened, teardrop shaped or bulb-shaped case, which is the hardened skin of the last larval stage (Plate 6). Pupation took place usually on the leaf or in Petri Plate under laboratory condition. The duration of the pupal period of *I. scutellaris* varied from 7 to 11 days with a mean of 9.50 ± 0.64 days (Table 1). The average pupal length of *I. scutellaris* ranged from 5.84 to 6.05 mm with a mean of 5.91 ± 0.03 mm, while the width varied between 2.15 and 2.30 mm with a mean of 2.22 ± 0.02 mm (Table 2).

Chouhan (2011)^[6] and Gelot (2014)^[8] also reported pupal period averaging 9.80 ± 0.09 and 9.46 ± 0.64 days, respectively, which closely align with the present findings.

Adult

The adult syrphid fly, *I. scutellaris* emerged from the puparium by making a distinct split at the anterior end. The body was medium to slender. The head was hemispherical with a predominantly yellow face except at the base of the antennae. Both sexes possessed brown compound eyes and

aristate type antennae. The thorax was black in colour with a narrow yellow band at the sides of the thorax. Legs were covered with dense layer of hairs. The claws were deep at the tip. Wings were transparent. Abdomen was deep brown to shinning black in colour with yellow spots on the dorsal side. Ventral surface of each abdominal segment was orange coloured with short transverse black band at the posterior margin. Abdominal tip in ventral view was asymmetrical in male (Plate 7) and symmetrical in female (Plate 8). Adult females were easily distinguishable by their tapering abdomen extending into pointed ovipositor. They were also comparatively smaller in size than adult males. The terminal abdominal segments consisted of the aedeagus in males and ovipositor in females.

The length of the female syrphid flies ranged from 7.35 to 8.61 mm with an average of 8.17 ± 0.13 mm, while the width of females varied between 2.49 to 2.57 mm with an average of 2.51 ± 0.02 mm. The length of the males ranged from 7.59 to 8.64 mm with an average of 8.28 ± 0.12 mm, while the width of males varied between 2.53 to 2.59 mm with an average of 2.54 ± 0.02 mm (Table 2). Thus, female was smaller than the male.

Adult longevity

Both males and females of *I. scutellaris* survived for 14 to 17 days with mean of 14.69 ± 0.85 days in case of males and 15.85 ± 0.79 days for females (Table 1).

Beeraganni (2016)^[3, 4] recorded an average longevity of 14.03 ± 1.03 days for males and 16.03 ± 0.83 days for females and Gelot (2014)^[8] reported the mean lifespan of female *X. scutellare* as 38.60 ± 1.22 days and males as 37.63 ± 1.12 days. Thus, the present findings are in close agreement with those of earlier researchers.

Pre-oviposition, oviposition and post-oviposition period

The average pre-oviposition, oviposition and post-oviposition period of female *I. scutellaris* was 3.50 ± 0.59 days, 8.30 ± 0.56 days and 2.60 ± 0.92 days, respectively (Table 2). Palial (2023)^[13] observed that the average pre-oviposition, oviposition and post-oviposition periods of *I. scutellaris* were 3.33, 8.11 and 2.22 days, respectively when reared on *Brevicoryne brassicae* (L.).

Fecundity

The number of eggs laid by an individual female of *I. scutellaris* in laboratory conditions ranged from 24 to 35 eggs with an average of 34.45 ± 2.40 eggs (Table 1). Palial (2023)^[13] noticed that the fecundity (eggs/female) was recorded as 34.22 eggs for *I. scutellaris* reared on *B. brassicae* which is in close conformity with the present findings.

Total life span

The entire life span from egg laying to the death of adults in *I. scutellaris* varied from 36 to 41 days in case of females and 35 to 40 days in case of males with an average of 38.85 ± 1.24 and 37.94 ± 1.25 days, respectively (Table 1).

Sex ratio

The data presented in Table 1 revealed that the sex ratio of *I. scutellaris* was worked out as 1:1.25 which indicated that female population was high as compared to males.

Table 1: Duration of different stages of *I. scutellaris* on mustard aphid, *L. erysimi*

Life stages	Duration in day(s)		
	Min.	Max.	Mean ± SD
Egg			
Incubation period	2.00	4.00	3.04±0.49
Hatching (%)	70.00	80.00	72.00±4.00
Larva (maggot)			
I instar	2.00	3.00	2.48±0.54
II instar	2.00	4.00	3.30±0.50
III instar	2.00	4.00	3.68±0.55
Total larval period	7.00	12.00	9.46±0.73
Pupa			
Pre-pupal period	1.00	2.00	1.28±0.45
Pupal period	7.00	11.00	9.50±0.64
Adult (Female)			
Pre-oviposition period	2.00	4.00	3.50±0.59
Oviposition period	8.00	10.00	8.30±0.56
Post-oviposition period	1.00	4.00	2.60±0.92
Longevity			
Female	14.00	17.00	15.85±0.79
Male	14.00	17.00	14.69±0.85
Total life span			
Female	36.00	41.00	38.85±1.24
Male	35.00	40.00	37.94±1.25
Fecundity (No. of eggs laid/female)	24	35	34.45±2.40
Sex ratio (M:F)	1:1.25		
SD = Standard deviation			

Table 2: Morphometrics of different life stages of *I. scutellaris*

Stage(s)	Length (mm)		Width (mm)	
	Range	Mean $\pm$ SD	Range	Mean $\pm$ SD
Egg	0.76-0.86	0.83 $\pm$ 0.03	0.25-0.36	0.32 $\pm$ 0.01
Larva (maggot)				
I instar	1.45-2.38	1.62 $\pm$ 0.11	0.40-0.62	0.47 $\pm$ 0.03
II instar	4.73-5.08	4.90 $\pm$ 0.04	0.64-0.89	0.81 $\pm$ 0.03
III instar	11.80-13.10	12.48 $\pm$ 0.14	1.96-2.48	2.13 $\pm$ 0.06
Pupa	5.84-6.05	5.91 $\pm$ 0.03	2.15-2.30	2.22 $\pm$ 0.02
Adult				
Female	7.35-8.61	8.17 $\pm$ 0.13	2.49-2.57	2.51 $\pm$ 0.02
Male	7.59-8.64	8.28 $\pm$ 0.12	2.53-2.59	2.54 $\pm$ 0.02

**Plate 1:** Egg of syrphid fly on mustard aphid**Plate 2:** First instar maggot**Plate 3:** Second instar maggot**Plate 4:** Third instar maggot**Plate 5:** Pre-pupa**Plate 6:** Puparium



Plate 7: Male syrphid fly



Plate 8: Female syrphid fly

Conclusion

The female syrphid fly, *Ischiodon scutellaris*, undergoes three larval instars during its development. The average lifespan of the female was recorded as 38.85 ± 1.24 days, compared to 37.94 ± 1.25 days for the male.

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