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Biology and predatory potential of *Coccinella transversalis* (Fab.) on cabbage aphid, *Brevicoryne brassicae* (Linn.) under laboratory conditions at Raipur, Chhattisgarh

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Abstract
Biology and predatory potential of *C. transversalis* (Fab.) on *B. Brassicae* (Linn.) were carried out in Biocontrol laboratory during the year 2019-2020 at Department of Entomology, IGKV, Raipur. *Coccinella transversalis* passed through four instars, 1st, 2nd, 3rd and 4th instars, ranging from 2-4, 3-4, 3-4 and 4-6 days with an average duration of 3.00 ± 0.60, 3.20 ± 0.42, 3.40 ± 0.52 and 5.10 ± 0.57 days respectively. Grub period ranged from 12-18 days with mean of 15.00 ± 1.56 days. The prepupal and pupal period was of 1.30 ± 0.46 and 3.30 ± 0.48 days. Longevity of female ranged from 32-40 days and male ranged from 24-37 days. Results showed that the total consumption of aphids in grub stage of *C. transversalis* ranged from 75-83 with an average of 78.70 ± 2.79 per day and the total consumption of aphids during adult period was 48 to 50 aphids with an average of 48.60 ± 0.84 aphids/day. Total aphid consumption during the entire life ranged from 128-132 aphids /day with an average of 129.0 ± 1.32 aphids/day.

Keywords: coccinellid beetles, cabbage aphid, duration

Introduction
The cabbage aphid, *Brevicoryne brassicae* (Linn.), is one of the most important insect pests of the family Aphididae. They are grayish green with waxy covering that gives them grayish-white appearance, and have short siphunculi. Adults are present in both wingless and winged form. However, wingless females producing live young (nymphs) are the most common. It is one of the most serious sucking pests of *brassica* plants. The aphid infestation not only deteriorates the quality of the crop, but also decreases the yields. Direct injury results in loss of plant vigour and stunted growth and indirectly the honey dew excreted by the aphids and sooty mold hinder the growth of the plants. Predatory Coccinellidae play a major role in keeping these aphids under control. Among the different species of predatory Coccinellidae, *Coccinella transversalis* (Fab.) is one of the potential predators against aphids in cabbage ecosystem. The important features of *C. transversalis* includes its wide geographic distribution and host range, tolerance to certain pesticides, enhanced searching ability, voracious larval feeding capacity and easy rearing in laboratory.

Materials and Methods
Studies on the biology of *C. transversalis* on *B. brassicae* were conducted at Biocontrol laboratory, Department of Entomology IGKV, Raipur (CG) during year 2019-2021. Ten newly hatched grubs of *C. transversalis* were kept individually in petridishes. Cabbage aphids were provided as host for feeding and for completion of their life stages. Emerged adults were paired and kept in different glass chimneys for further detailed life stage studies. Ten such sets were maintained. Eggs laid by the female coccinellids on leaves and surrounding area of jars were collected after 2 to 3 days with the help of fine camel hair brush and kept in petridish to minimize cannibalism among newly emerged grubs. Aphids as food were provided daily in each individual petridish until pupation. Emerged adults were collected separately and transferred to glass chimneys for mating. Observations were recorded on the total number of instars, duration of each instar, grub period and pupal period. Longevity of male and female were also recorded. Similarly, pre-oviposition, oviposition and post oviposition period of females were also recorded. The time after emergence of adults from pupa and starting of oviposition was considered as pre-oviposition period.

The period of egg deposition was considered as oviposition period. Post oviposition of female was recorded from period between the days when the female ceased egg laying up to the death of the female beetle.

Studies on the predatory potential of grub and adult beetles of *C. transversalis* on *Brevicoryne brassicae*

Ten newly hatched grubs of *C. transversalis* were kept individualy in petridishes . The grubs were fed separately in petridish with cabbage aphids (*B. brassicae*) and the experiment was replicated 10 times. Counted numbers of aphids were provided daily in the morning hours *i.e.* 10, 15, 30 and 40 number of cabbage aphids for I, II, III, and IV instars grubs respectively. The number of aphids consumed was recorded daily and new aphids were provided as per their requirement. Instar wise feeding potential of grubs were recorded.

Predatory potential of adult beetles of *C. transversalis* on *B. brassicae*.

Under this experiment feeding consumption of newly hatched adult beetles starved for 24 hours, both male and females, collected from stock culture were tested for their predatory potential. Each beetle was kept separately in petridishes and provided with cabbage aphid, *B. brassicae* daily till death of the beetles and the number of aphids consumed daily were cumulated. The experiment was replicated 10 times.

Results and Discussion

Pre-oviposition ranged from 3-4 days with a mean of 3.40 ± 0.48 days. The oviposition period of *C. transversalis* ranged from 12-16 days with mean duration of 13.40 ± 1.26 days. Post –oviposition period ranged from 4-6 days with mean of 4.60 ± 0.69 days. Maximum fecundity were recorded from 160-250 eggs with mean of 202.30 ± 27.32 eggs.

Female started laying eggs after 3.4 ± 0.48 days of emergence. A single female laid 202.30 ± 27.32 eggs. The freshly laid eggs of *C. transversalis* were spindle shaped and yellowish orange in colour. The eggs turned blackish in colour with maturity and became completely black before hatching. Eggs were laid by the female on the lower surface of the leaves near midrib also but rarely observed on stem or upper surface of leaves.

C. transversalis passed through four larval instars. The newly emerged larvae were dark grey in colour. The duration of the first instar larvae of *C. transversalis* ranged from 2-4 days with a mean of 3.00 ± 0.60 days. The duration of second instar larvae was of 3-4 days with a mean of 3.20 ± 0.42 days. The duration of third instar larvae ranged from 3-4 days with a mean duration of 3.40 ± 0.52 days and fourth instar larvae ranged from 4-6 days with an average duration of 5.10 ± 0.57 days. The total duration of grub period ranged from 12-18 days with an average duration of 15.00 ± 1.56 days. Similar descriptions were made by Lyla *et al.* (2008) [5], who also observed that the larval stage of *C. transversalis* lasted for 10.30 days when fed on *A. craccivora*. Chakraborty and Korat (2014) [2] noticed that the grub stage of first, second, third and fourth instar ranged from 3-6, 6-6, 4-6 and 7-9 days with an average duration of 4.73 ± 0.23, 3.93 ± 0.28, 5.13 ± 0.19 and 7.53 ± 0.22 days respectively which is an accordance with the present findings. Total grub period varied from 19-23 days with a mean duration of 21.33 ± 0.39 days, which is more or less similar to the present studies.

The prepupal and pupal period was of 1.30 ± 0.46 and 3.30 ± 0.48 days respectively. Similar findings were reported by the Shukla and Jadhav (2014) [6] The average biology of *C. transversalis* reared on *A. craccivora* in term of the egg, total larval, pupal and adult male and female periods was 2.70 ± 0.76, 12.90 ± 1.44, 2.62 ± 0.63, 31.58 ± 3.22 and 39.10 ± 3.37 days, respectively, whereas on *L. erysimi* were 2.70 ± 0.76, 12.68 ± 1.63, 2.62 ± 0.69 and 30.12 ± 4.49 and 33.88 ± 2.56 days, respectively, while on *M. persicae* were 2.70 ± 0.76, 12.98 ± 1.93, 2.52 ± 0.61 and 29.08 ± 4.25 and 37.12 ± 2.27 days, respectively. However, the results differ with the Debaraj and Singh (1990) [3] who studied on the biology of *C. transversalis* and found that the average duration of pre pupae were (2.62 days) and pupae were (8.6 days).

It was observed that female longevity was higher than the males and ranged from 32-40 days, while longevity of the males ranged from 24-37 days respectively. Present results are in conformity with the report of Debaraj and Singh (1990) [3] who also recorded that the adult longevity ranged from 38-45 days. However, Chakraborty and Korat (2014) [2] reported that male and female beetle survived for 21.13 ± 1.02 and 22.17 ± 1.27 days.

Table 1: Biology of *C. transversalis* on cabbage aphid, *Brevicoryne brassicae*

Stage	Range (days)		Duration (mean ± SD)
	Minimum	Maximum	
Pre oviposition period	3.00	4.00	3.40 ± 0.48
Oviposition period	12.00	16.00	13.40 ± 1.26
Post oviposition period	4.00	6.00	4.60 ± 0.69
Fecundity	160.00	250.00	202.30 ± 27.32
Incubation period	2.00	3.00	2.50 ± 0.53
Grub stage			
Ist instar grub	2.00	4.00	3.00 ± 0.60
II nd instar grub	3.00	4.00	3.20 ± 0.42
IIIrd instar grub	3.00	4.00	3.40 ± 0.52
IVth instar grub	4.00	6.00	5.10 ± 0.57
Total grub period	12.00	18.00	15.00 ± 1.56
Pupal stage			
Prepupal period	1.00	2.00	1.30 ± 0.46
Pupal period	3.00	4.00	3.30 ± 0.48
Total pupal period	4.00	6.00	5.40 ± 0.54
Adult longevity			
Female	32.00	40.00	35.40 ± 2.50
Male	24.00	37.00	32.10 ± 4.14

Total duration of life cycle			
Female	66.00	89.00	76.70 ± 5.71
Male	58.00	80.00	68.60 ± 5.48

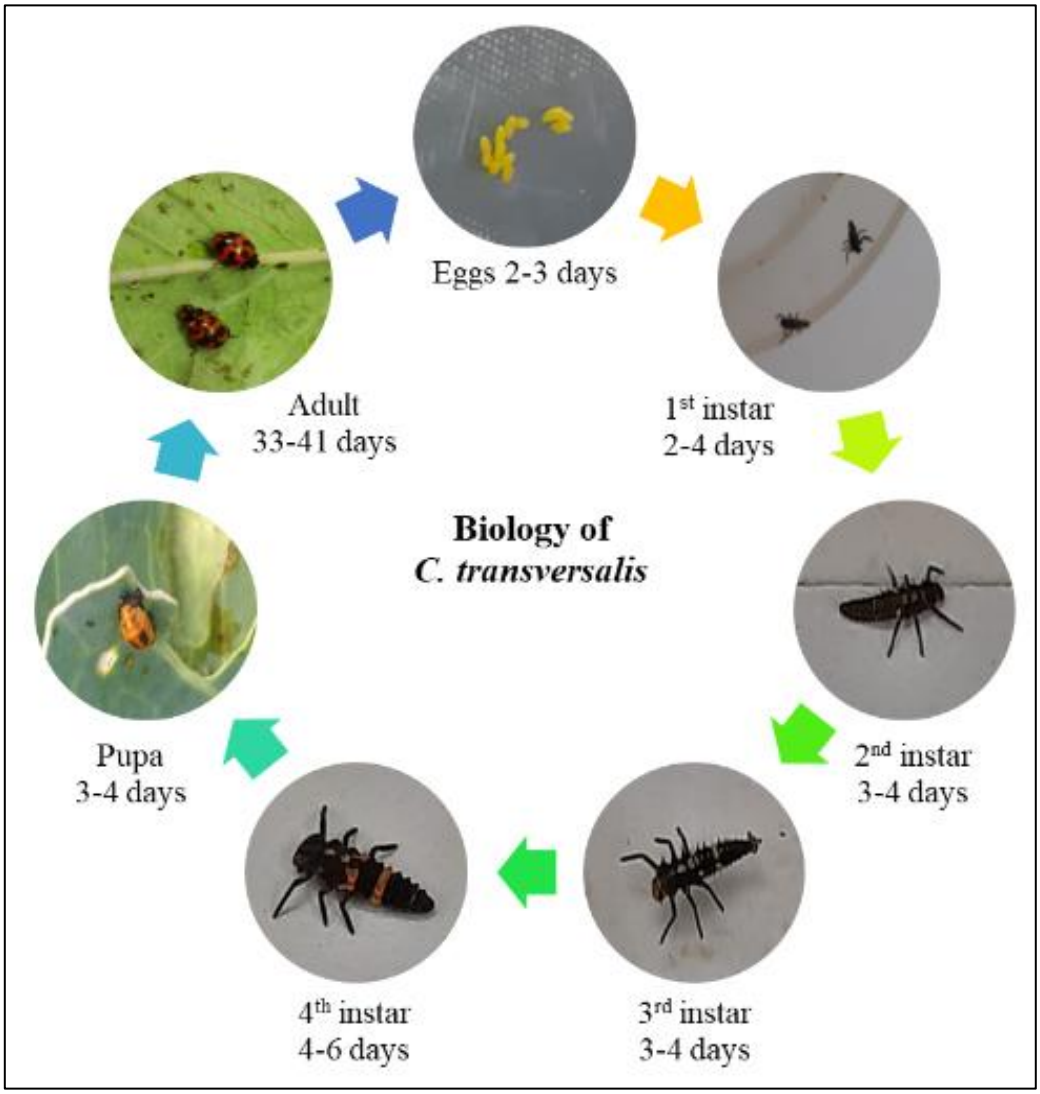

Fig 1: Biology of *C. transversalis* on cabbage aphid, *Brevicoryne brassicae*

Predatory potential of *C. transversalis* on cabbage aphid, *B. brassicae*

The predatory potential of grub and adult were examined separately by providing aphids daily and counting of the total number of aphids consumed by each larval (grub) instars and adult within 24 hours of conducted experiment under laboratory conditions. The data given in table revealed that the feeding capacity of grub *C. transversalis* increased gradually from the first instar to fourth instar. First instars consumed 4-6 aphids/day with an average of 5.10 ± 0.74 aphids/day. Second instars consumed 11-13 aphids with average of 12.20 ± 0.79 aphids/day. Third instar consumed 20-24 aphids with an average of 22.70 ± 1.33 aphids/day. Fourth instar consumed 38-40 aphids with an average of 38.80 ± 0.79 aphid/day.

Results showed that the total consumption in grub stage of *C. transversalis* ranged from 75-83 with an average of 78.70 ± 2.79 per day and the total consumption of aphids during adult period was 48 to 50 aphids with an average of 48.60 ± 0.84 aphids/day. Total consumption during the entire life ranged from 128-132 aphids per day with average of 129.0 ± 1.32 aphids/day. Borah and Dutta (2010) [1] observed that the fourth instar grub of *C. transversalis* devoured 65.67 apterous of *L. erysimi* in 24 hours and the overall consumption during the entire fourth instar was 252.90 apterous adults which is higher than the present results.

Jadhav and Shukla (2015) [4] studied the feeding potential of *C. transversalis* on aphid, *A .craccivora* Koch., *L. erysimi* (Kalt) and *M. persicae* sulzer under laboratory conditions. It was observed that total number of aphids (*A. craccivora*) devoured by the larvae during first, second, third and fourth instars were 7-18, 8-13, 34-47 and 50-79 aphid per larvae. The predatory capacity during the entire larval duration varied from 102-141 aphids. On *L. erysimi* the consumption by first, second, third and fourth instar was 10-38, 12-39, 70-113 and 52-198 aphids per larvae. Total consumption during entire larval period varied from 149-359 aphids per larvae on *M. persicae* during its first, second, third and fourth instar consumption were 9-24, 17-28, 60-110 and 95-161 aphids per larvae. The predatory capacity during entire larval duration varied from 181-291 aphids per larvae.

Wagle *et al.* (2006) [7] observed that *C. transversalis* on average devoured 38.8 *B. brassicae* per day with the feeding range of 25-50 aphids per day. This findings are in conformity with the present results.

Table 2: Feeding potential of *C. transversalis* on cabbage aphid *B. brassicae*

Stage	Consumption of aphids/day		Total consumption of aphids on entire life	
	Range	Mean±SD	Range	Mean±SD
Grub stage				
Ist instar grub	4-6	5.10 ± 0.74	12-18	15.20 ± 1.69
IInd instar grub	11-13	12.20 ± 0.79	36-44	39.30 ± 2.36
IIIrd instar grub	20-24	22.70 ± 1.33	68-100	84.20 ± 11.43
IVth instar grub	38-40	38.80 ± 0.79	158-185	169.60 ± 9.02
Total consumption by grubs	75-83	78.70 ± 2.79	278-326	302.70 ± 18.96
Total consumption per day by adults	48-50	48.60 ± 0.84	2368-2442	2406.70 ± 25.34
Total consumption during the entire life	128-132	129.00 ± 1.32	2680-2752	2714.00 ± 22.87

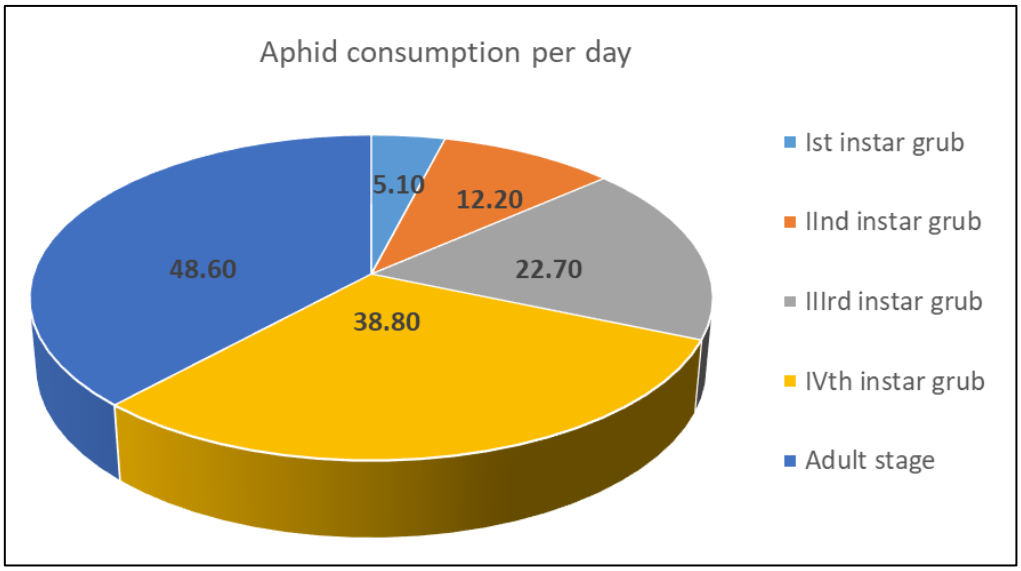

Fig 2: Feeding potential of *C. transversalis* on cabbage aphid *B. brassicae*

Total entire life time consumption of aphids

It was observed that, in the duration of 2-4 days, the first instar of *C. transversalis* consumed a total of 12-18 aphids with average of 15.20 ± 1.69 aphids, meanwhile the second, third and fourth instar consumed 36-44, 68-100, 158-185 with a mean of 39.30 ± 2.36, 84.20 ± 11.43, 169.60 ± 9.02 aphids respectively. Total consumption in grub stage was recorded to be 278-326 aphids with an average of 302.70 ± 18.96 aphids in 12-18 days of grub period. Total consumption of aphids during adult period of 48-52 days ranged from 2368 to 2442 with an average consumption of 2406.70 ± 25.34 aphids. Total feeding capacity of *C. transversalis* in its entire (total) life period of 60-66 day ranged from 2680-2752 aphids with an average consumption of 2714.10 ± 22.87 aphids. Similar findings were reported from Borah and Dutta (2010) [1] that the first instar larvae of *C. transversalis* was lesser voracious than older instars. The voracity (number of aphids consumed/24 hours) of *C. transversalis* increased in succeeding instars, which is in match with the present findings.

Conclusion

In conclusion, It was observed that, four instars/ larval period was, 3.00 ± 0.60, 3.20 ± 0.42, 3.40 ± 0.52 and 5.10 ± 0.57 days. Grub period and The prepupal and pupal period was of 15.00 ± 1.56 days and 1.30 ± 0.46 and 3.30 ± 0.48 days. Total consumption during the entire life was 129.0 ± 1.32 aphids/day. Total feeding capacity of *C. transversalis* in its entire (total) life period was 2714.10 ± 22.87 aphids.

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