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INTRASPECIFIC PREDATION (CANNIBALISM) IN TWO CO-OCCURRING COCCINELLID BEETLES (*COCCINELLA TRANSVERSALIS* AND *MENOCHILUS SEXMACULATUS*)

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ABSTRACT

Studies on intraspecific predation (cannibalism) in two co-occurring coccinellid beetles *Coccinella transversalis* and *Menochilus sexmaculatus* were undertaken in the Bio-control Laboratory, Department of Entomology, IGKV, Raipur, Chhattisgarh during the year 2019-20 and 2020-21. During the study, it has been found that egg predation was highest among female beetles, 4th instar larvae and 3rd instar larvae of *C. transversalis* (i.e. 25.00). Male beetles of *C. transversalis* showed slightly lower predation rates (i.e. 24.00). Intraspecific egg predation of *M. sexmaculatus* was maximum in the 4th instar larvae i.e. (24.89) followed by the female beetle i.e. (24.56), 3rd instar larvae (24.44) and the male beetle i.e. (20.33). Intraspecific larval predation was maximum for the 1st instar by both female and male beetle of both the species *M. sexmaculatus and C. transversalis* i.e. (5.00) and (4.89) and (5.00) and (5.00) respectively but more in case of *C. transversalis*. Larval predation by the larvae in both the species *M. sexmaculatus* and *C. transversalis* were maximum in the 3rd instar i.e. (3.55) and (3.44), respectively.
***Keywords*:** Intraspecific predation, *Coccinella transversalis*, *Menochilus sexmaculatus*.

Introduction

Ladybirds are generalist predators with diverse prey, including hemipterans, thysanopterans, mites, young holometabolous insects, and fungi. Based on their diet, they are categorized as aphidophagous, coccidophagous, acarophagous, or mycophagous. Aphidophagous species exhibit better growth when consuming aphids compared to non-aphid prey (Evans, 2008), suggesting they are evolutionarily adapted to exploit aphids efficiently. Ladybird species often coexist in shared habitats, leading to competition for limited prey resources like aphids, which are short-lived and patchily distributed (Muller and Godfray, 1999; Amarasekare, 2000). This competition can lead to starvation under resource-scarce conditions. Since these beetles feed on the insects like aphids (Dixon, 2000) and these aphids are short lived and living in patchy distribution, which may occasionally result in ladybirds starving in the field (Cottrell, 2007). Cannibalism enables larvae to optimally use the resources in a patch. In cannibalism, conspecific eggs, larvae, especially neonates and pupae are duly consumed (Dixon, 2000). Out of the various stages, eggs are most likely to be attacked by predators, as they are immobile and poorly defended (Felix and Soares, 2004; Michaud and Grant, 2004) and likely to be a high-quality food (Omkar *et al.*, 2006). Eggs, being immobile and poorly defended, are particularly susceptible to predation. They are considered high-quality food for predators, especially in resource-

limited environments. These mechanisms (cannibalism and intraguild predation) play crucial roles in resource regulation and the competitive dynamics of ladybird populations. Eggs are considered highly nutritious first food consumed by newly hatched instars of ladybirds. Apart from attacking aphids and other insect pests, they attack immature stages of other conspecific ladybirds, especially eggs and immature stages of conspecifics. Coccinellid predators which feed on the same aphid resource, used to engage in conspecific and hetero-specific predation of eggs and larvae (Yasuda and Ohnuma, 1999; Yasuda *et al.*, 2001).

Materials and Methods

Maintenance of stock culture

Adults of *M. sexmaculatus* and *C. transversalis* were collected from the cowpea field of the Horticultural Research Farm, College of Agriculture, IGKV, Raipur and reared in the Bio-control Laboratory and paired in plastic petri dishes (9.0cm diameter × 2.0cm height) under constant conditions (27±2ºC; 65±5% RH; 14L:10D) in B.O.D. Incubator. They were fed on *ad libitum* supply of aphids, *Aphis craccivora*. After laying of eggs, by all the adult female beetles, the beetles were separated and transferred into other petri-dishes. The hatched larvae/grubs were separated with the help of camel hair brush. Thereafter, newly hatched larvae/grubs of respective coccinellid beetles were supplied with counted number of aphids on their host leaves until pupation. Adult beetles thus emerged as new generation were taken forward for further studies. In this way, stock culture of respective coccinellid beetles were maintained. All experiments were performed in plastic petri dishes (2.0cm height × 9.0cm diameter).

Experimental Design

The number of eggs laid by *Menochilus sexmaculatus* were counted and 24 hours starved adult male and female beetles of *Menochilus sexmaculatus* were transferred to the petri-dishes containing 25eggs of *Menochilus sexmaculatus*, separately. Observations were recorded by counting the number of eggs fed by the adult beetle of *Menochilus sexmaculatus* after every 24 hours.

Similar experiments were conducted to study the egg predation by 1st, 2nd, 3rd and 4th instar grub stages of *M. sexmaculatus* and all the stages of *C. transversalis* and by the adult beetle of. This experiment was replicated three times.

Twenty four (24) hours starved adult beetles of *M. sexmaculatus* were used as predator and released into the petri-dishes having five of each 1st, 2nd, 3rd and 4th instar larvae/grub of *M. sexmaculatus* as prey and the experiment were replicated three times and carried out under laboratory conditions. Similar experiment was conducted in the case of *C. transversalis* adult on different larval instars of *C. transversalis.*

Observations were recorded by counting the number of larvae of *M. sexmaculatus* fed by the adult beetle of *M. sexmaculatus* and the number of larvae of *C. transversalis* fed by the adult beetle of *C. transversalis* respectively.

Results

Egg predation of *Menochilus sexmaculatus* by different growth stages of *M. sexmaculatus*

Egg predation of *M. sexmaculatus* significantly differed among all the stages of *M. sexmaculatus*. Among all the stages, 4th instar larva was found to be highly voracious towards the conspecific egg predation. Maximum egg predation *i.e.* (24.89) of *M. sexmaculatus* was observed by its 4th instar larvae followed by the female beetle (24.56), 3rd instar larvae (24.44), and male beetle (20.33) but 3rd, 4th instar and female beetle were found on par with each other. Next in the series was the 2rd instar larvae (2.89) and minimum predation was recorded in 1st instar larvae (1.00) number of egg predation. (Table 1 and Fig. 1).

Eggs predation of *C. transversalis* by different growth stages of *C. transversalis*

Egg predation of *C. transversalis* significantly differed among all the stages of *C. transversalis*. Among all the stages, female beetle consumed (25.00), 4th instar larvae (25.00), 3rd instar larvae (25.00) and eggs were found to be highly voracious towards the conspecific egg predation, followed by the male beetle (24.00) of *C. transversalis* but 3rd , 4th instar, female and male beetle were found on par with each other and minimum predation was observed in the 2rd instar larvae *i.e.* (12.50) and the 1st instar larvae recorded egg predation (10.00) of *C. transversalis* (Table 1 and Fig. 1).

Table 1: Eggs predation of *Menochilus sexmaculatus* by different growth stages of *Menochilus sexmaculatus* and eggs predation of *C. transversalis* by different growth stages of *C. transversalis*

Sl. No.	*M. sexmaculatus* stages	No of eggs *(M. sexmaculatus)* Given	Mean no of eggs *(M. sexmaculats)* fed	*C. transversalis* stages	No of eggs *(C. transversalis)* given	No of *(C. transversalis)* eggs fed
1	Female	25	24.56 (5.055)	Female	25	25.00 (5.099)
2	Male	25	20.33 (4.618)	Male	25	24.00 (5)
3	1st Instar	25	1.00 (1.402)	1st Instar	25	10.00 (3.255)
4	2nd Instar	25	2.89 (1.971)	2nd Instar	25	12.50 (3.644)
5	3rd Instar	25	24.44 (5.043)	3rd Instar	25	25.00 (5.099)
6	4th Instar	25	24.89 (5.088)	4th Instar	25	25.00 (5.099)
	C.D.@ 5%		0.175			0.710
	SE(m) +		0.056			0.228

Figure in parentheses indicate square root transformed values

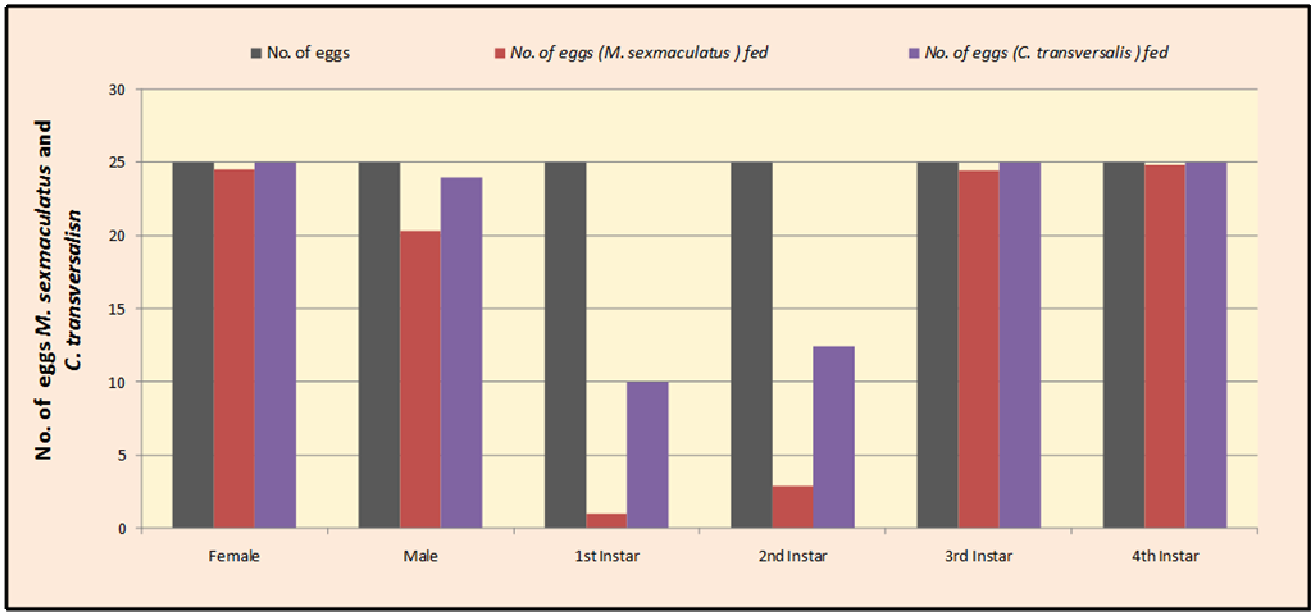

Fig. 1: Eggs predation of *Menochilus sexmaculatus* by different growth stages of *Menochilus sexmaculatus* and eggs predation of *C. transversalis* by different growth stages of *C. transversalis*

Larval predation of *Menochilus sexmaculatus* by female beetle of *M. sexmaculatus*

Larvae predation of *Menochilus sexmaculatus* by female beetle of *Menochilus sexmaculatus* differ significantly as the larger one always predated on the smaller one and predation by the larger species occurs in the immature stages according to Agarwala and Saha (1986).

Larval predation by the female beetle of *Menochilus sexmaculatus* ranges from 2.22 to 5.00 mean number of larvae per beetle. Female beetle predated maximally on the 1st instar larvae (5.00) followed by the 2nd instar (4.22), 3rd instar (4.22) and 4th instar (2.22).

Larval predation of *M. sexmaculatus* by male beetle of *Menochilus sexmaculatus*

Larval predation of *Menochilus sexmaculatus* by male beetle of *Menochilus sexmaculatus* differed significantly and ranged from 1.56 to 4.89 mean number of larvae per beetle. Male beetle predated mainly on the 1st instar larvae (4.89) followed by the 2nd instar (4.00), 3rd instar (3.67) and minimum predation was observed in the 4th instar larvae (1.56) (Table 2 and Fig. 2).

Larval predation of *C. transversalis* by female beetle of *C. transversalis*

Larval predation of *C. transversalis* by the female beetle of *C. transversalis* differed significantly as the larger one always predated on the smaller one and

predation by the larger species occurs in the immature stages these are in connection with the Vanrijn *et al.* (2005) who reported that in ladybeetles, intraguild predation and intraspecific predation seem to be determined largely by size differences of the interacting larvae, thereby giving an overall advantage to the larger species. And larval predation ranged from 3.78 to 5.00 mean number of larvae per beetle. Male beetle predated mainly on the 1st instar *i.e.* (5.00) mean number of larvae per beetle followed by 2nd instar (4.33), 3rd instar (4.89) and minimum predation was observed in the 4th instar (3.78) larvae.

Table 2: Larval predation of *Menochilus sexmaculatus* by female and male beetle of *M. sexmaculatus*

S. No.	*M. sexmaculatus* female	No of larvae (*M. sexmaculatus*) given (5)	Mean no of larvae *(M. sex maculatus)* Fed	*M. sexmaculatus* male	No of larvae (*M. sexmaculatus*) given (5)	Mean no of larvae *(M. sexma culatus)* fed
1	*M. sexmaculatus* female	1st Instar	5.00 (2.449)	*M. sexmaculatus* male	1st Instar	4.89 (2.427)
2	*M. sexmaculatus* female	2nd Instar	4.22 (2.284)	*M. sexmaculatus* male	2nd Instar	4.00 (2.235)
3	*M. sexmaculatus* female	3rd Instar	4.22 (2.284)	*M. sexmaculatus* male	3rd Instar	3.67 (2.159)
4	*M. sexmaculatus* female	4th Instar	2.22 (1.794)	*M. sexmaculatus* male	4th Instar	1.56 (1.598)
	C.D. @ 5%		0.076			0.124
	SE(m) +		0.023			0.038

Figure in parentheses indicate square root transformed values

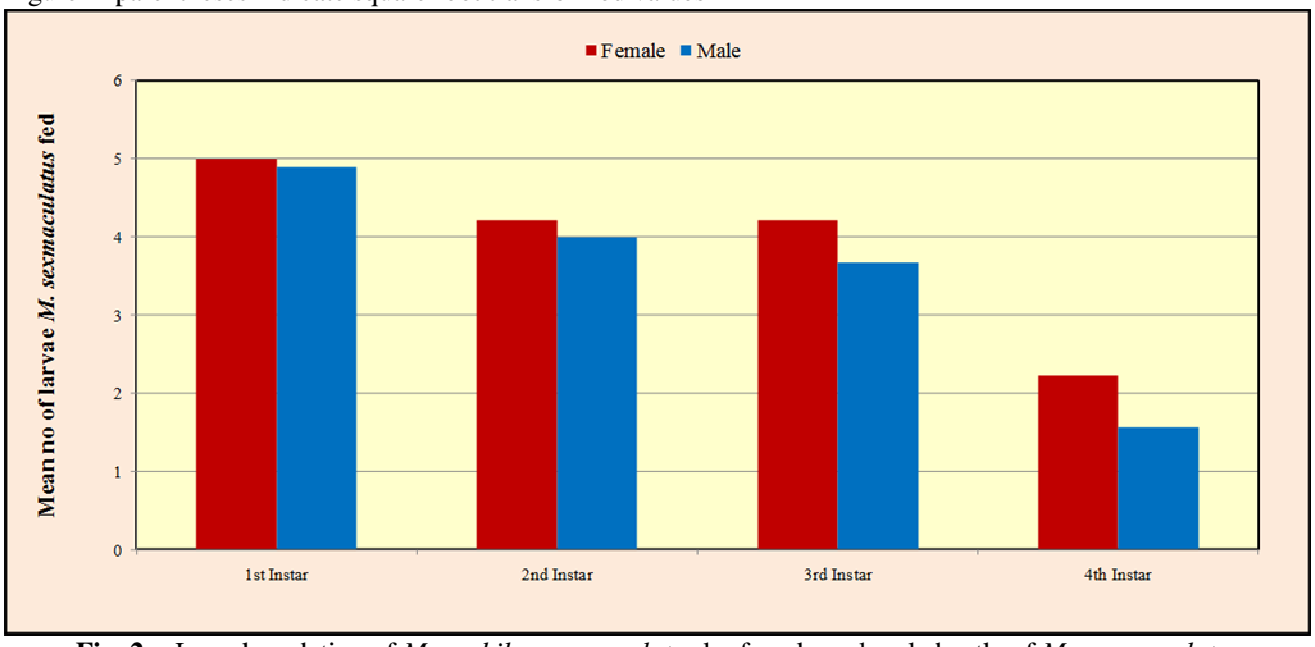

Fig. 2: Larval predation of *Menochilus sexmaculatus* by female and male beetle of *M. sexmaculatus*

Larval predation of *C. transversalis* by male beetle of *C. transversalis*

Larval predation of *C. transversalis* by the male beetle of *C. transversalis* differed significantly as the larger one always predated on the smaller one and predation by the larger species has occurred in the immature stages.

Number of predations ranged from 2.78 to 5.00 mean number of larvae per beetle. Male beetle predated mostly on the 1st instar (5.00) followed by the 2nd instar (4.11), 3rd instar (3.78) mean number of larvae per beetle and minimum predation was observed in the 4th instar (2.78) larvae (Table 3 and Fig. 3).

The results are in alignment with the findings of Khan *et al.* (2003) who also found an

indiscriminate egg cannibalism among the larvae and adults of their own and on the eggs of other species, *i.e. Menochilus sexmaculatus*, *Adalia bipunctata, Adonia variegata*. The 4th instar larvae seemed to be more voracious while feeding on eggs as well on the 1st instar larvae as compared to other three instars. The increasing numbers of egg consumption by adults was also related to their egg production and total number of oviposition days.

Table 3: Larval predation of *C. transversalis* by female and male beetle of *C. transversalis*

Sl. No.	*C. transversalis* female	No of larvae (*C. trans versalis* female) given (5)	Mean no of larvae (*C. transversalis* female) fed	*C. trans versalis* male	No of larvae (*C. transversalis* female) given (5)	Mean no of larvae (*C. transversalis* female) fed
1.	*C. transversalis* female	1st Instar	5.00 (2.449)	*C. transversalis* male	1st Instar	5.00 (2.449)
2.	*C. transversalis* female	2nd Instar	4.33 (2.306)	*C. transversalis* male	2nd Instar	4.11 (2.26)
3.	*C. transversalis* female	3rd Instar	4.89 (2.427)	*C. transversalis* male	3rd Instar	3.78 (2.186)
4.	*C. transversalis* female	4th Instar	3.78 (2.185)	*C. transversalis* male	4th Instar	2.78 (1.944)
	C.D.@5%		0.135			0.074
	SE(m) +		0.041			0.022

Figure in parentheses indicate square root transformed values

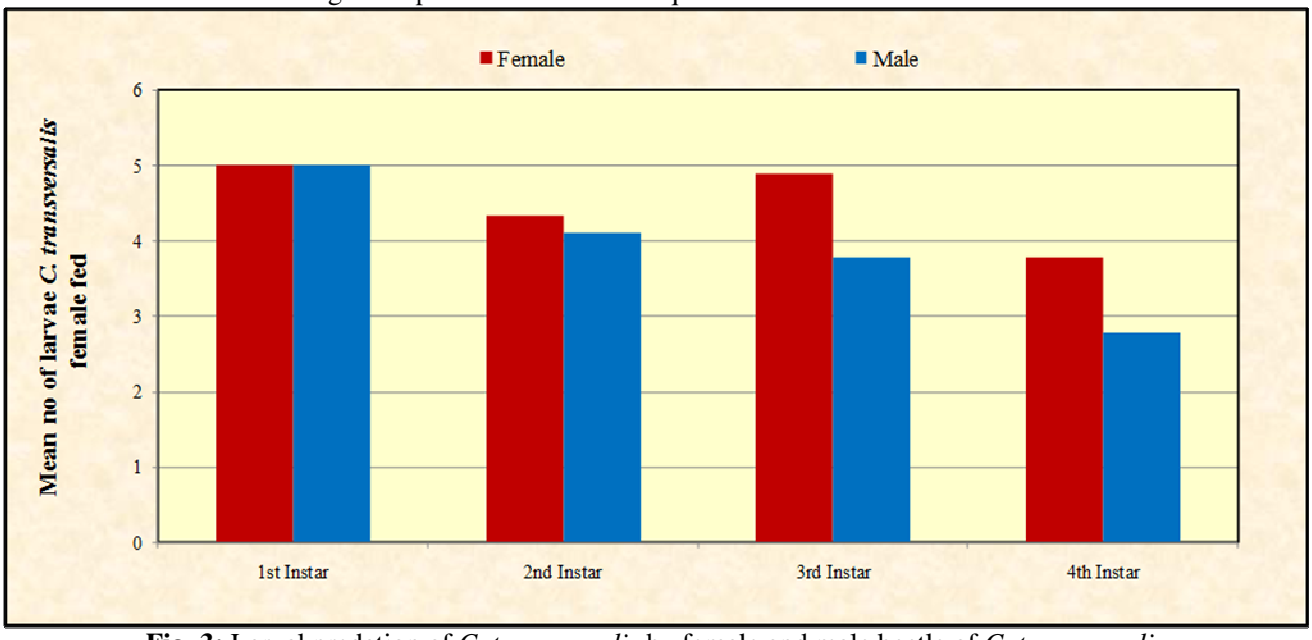

Fig. 3: Larval predation of *C. transversalis* by female and male beetle of *C. transversalis*

Discussion

Khan and Yoldas (2018) studied the cannibalistic behavior of various developmental stages of *Coccinella septempunctata* L. in the presence and absence of the natural food, *Acyrthosiphon pisum.* In both, *i.e.* presence and absence of aphids, the eggs and 1st and 2nd instars of *C. septempunctata* were cannibalized by the adults, and the level was inversely related to the availability of aphids. The same was also true for cannibalism of eggs by larvae and within the larval stages, with older larvae consuming significantly higher numbers of eggs and younger larvae in the absence of aphids. The adults and 4th instar larvae also consumed considerably higher number of eggs, even in the presence of aphids. Within the same stage/age of larvae, the level of cannibalism increased with each larval stage from minimum among1st instars and maximum among 4th instars. The study showed that a

low density or scarcity of prey was the main cause of cannibalism in *C. septempunctata*.

Maurice *et al.* (2012) found that the size disparity was the major factor for cannibalism among different larval combinations of two species of aphidophagous ladybird beetles namely, *Cheilomenes sexmaculata* and *Coccinella transversalis.* The results clearly discriminate that the degree of cannibalism augments when larvae of uneven size are kept together and the younger instars are at greater jeopardy in comparison to the older instars.

Conclusion

Intraspecific egg predation by all the growth stages and larval predation by adult beetle were more in case of *C. transversalis.* However larval- larval predation was more in case of *M. sexmaculatus*.

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