

Cannibalism and Interspecific Predation in Ladybird Beetle *Coccinella Septempunctata* (L.) (Coleoptera: Coccinellidae) in Laboratory

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Abstract: The cannibalistic behaviour of various developmental stages of *Coccinella septempunctata* was investigated on scarcity of food and different degrees of hunger. There was 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 scarcity of food was not absolute reason for cannibalism. In both developmental stages (larvae and adult) kin recognition ability was also poorly proved. The fourth instar larvae were seemed 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. It is concluded that cannibalism increased the survivorship and shortened the developmental period.

Key words: *Coccinella septempunctata*, cannibalistic behaviour, kin recognition, interspecific predation, food supplements

INTRODUCTION

The cannibalism in coccinellids is mainly due to scarcity of aphid prey and predator starvation. The cannibalistic feeding appears as a mean of preserving their race in case of shortage of their natural diet (Dixon, 1959 and Brown, 1972). Usually the eggs and young coccinellid larvae are more vulnerable to cannibals as compared to older larvae and adults. (Agarwala and Dixon, 1992). The older larvae and adults pose a threat to eggs and younger larvae. The cannibalism rate may increase when their food is decreased (Polis, 1981; Cottrell and Yeagan, 1999) but some other species like *Hormonia axyridis* shows the cannibalistic behaviour even when the food is abundant (Wagner and Wise, 1996; Wagner *et al.*, 1999 and William *et al.*, 2000). The prey quality may have low food value so that predator may use the egg masses as to accumulate the valuable resource. The possibilities of eliminating toxic prey or low quality compounds of food source were seemed to be the strategies of cannibalistic behaviour of coccinellids and their ecological advantages are not quite clear. The discrimination for the selection between the predator's own kin and eggs of the non-sibling species indicates their recognition ability and degree of relatedness. The biased behaviour often assumed that the animal have the ability to recognise their kin and often to implicate the history of their selection (Gamboa *et al.*, 1991). However, the unbiased behaviour among kin and preferentially attack on sibling species is ambiguous. The indiscriminate

cannibalistic behaviour of *C. septempunctata* and its impact on mass rearing has not been studied.

The objective of the present study is to evaluate the cannibalistic behaviour of *Coccinella septempunctata* and its impact on the growth and survival of cannibals and to determine the capability of various stages of cannibals for their kin recognition and discrimination for non-sibling eggs and larvae.

MATERIALS AND METHODS

Four species of coccinellid beetles i.e. *Coccinella septempunctata*, *Adalia bipunctata*, *Adonia variegata* and *Menochilus sexmaculatus* were reared in Entomological Laboratory of Faculty of Agriculture, Rawalakot on frozen and live aphids (*M. persicae* Sulzer). Three experiments were performed to investigate the value of the cannibalism for the survival of the predator species and its impact on the mass rearing of coccinellids.

In 1st experiment, the impact of different factors such as predators gender, level of voracity and developmental stages on fecundity and longevity were also evaluated with their natural diet.

In second experiment, prey preferences was evaluated among the variables of egg cannibalism alone (Control) the eggs + larvae (T₁) eggs + aphids (T₂) and larvae + aphids (T₃). The percentage of eggs and larval cannibalism was recorded in the presence and absence of the aphid prey.

In third experiment kin recognition capability was evaluated. Six treatment of the combination (10 + 10 eggs/treatment) were compared with control treatment of *C. septempunctata*'s eggs offering alone. Before being placed in the experimental arena the test predators were starved for 12 h to homogenise their hunger level. The satiated level was attained when the predator refuse to take any more aphid prey. The stage specific development time and survivorship from hatch to adulthood of comparisons of the treatments were recorded from individual experimental arena. Each petri dish arena was considered as single replicate and each treatment was replicated thrice. The data were analysed using Analysis of Variance (ANOVA).

RESULTS

Cannibalism of eggs and larvae of their own progeny:

The rate of egg cannibalism was shown significantly higher by starved larvae and adults in the absence of aphid. The fourth instar larvae were seemed highly voracious and consumed the higher number of (32.5) eggs (Fig. 1). However, the female appeared to be more reluctant in consuming eggs as compared to the larvae and male counterparts. The satiated larvae and adults also consumed few numbers of their own eggs (Fig. 2). It was inversely related to the aphid abundance and the level of their hunger. In the presence of aphids and the eggs no larva was cannibalised by 4th instar larvae and female adults except the male adults which ate 1st instar larvae at the average rate of 4 (Fig. 2). The incidence of the egg cannibalism was dependent on the level of hunger and the availability of the number of egg batches.

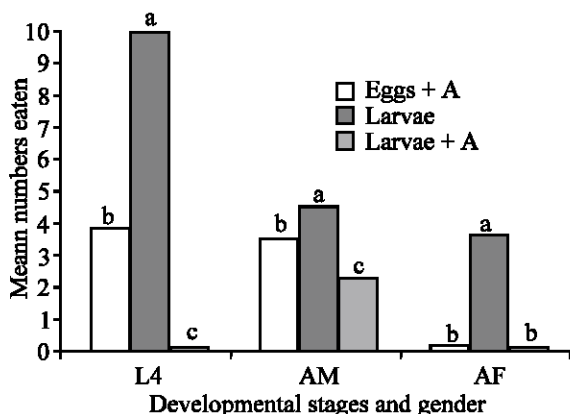


Fig. 1: Mean number of eggs and larvae eaten by 12 h food deprived Fourth instar larvae (L4), AM (Adult male), AF (Adult female) of *Coccinella septempunctata* (L.)

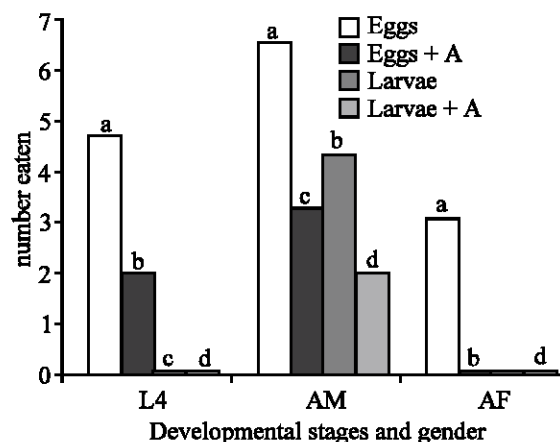


Fig. 2: Mean number of eggs and larvae eaten by full fed Fourth instar larvae (L4), of *Coccinella septempunctata* (L.) AM (Adult male), AF (Adult female)

To measure the life span and fertility of females, they were fed on various combinations of eggs and natural diet. The egg production was positively correlated with no of egg consumed. If less than 20 eggs were consumed no stimuli for further egg production was shown. The increasing rate of egg consumption also increased the average egg production. The average oviposition days also increased significantly (Table 1).

Table 1: The Effect of Egg Cannibalism and Aphid feeding on the Fecundity and Longevity of *C. septempunctata*.

Type of Food offered	Preoviposition period (Days Aver.)	Oviposition period (Days Aver.)	No. of Eggs laid/ female (Aver.)	Average Longevity	
				Male	Female
10	0c	0c	0c	12c	17c
15	0c	0c	0c	15c	21c
20	13.6a	31b	63.5b	26b	54b
25	10.5b	54a	84a	51a	75a
<i>Myzus persicae</i>					
10	10.8a	44c	614c	46c	52.5c
15	7.5b	67b	630c	49c	57.5c
20	6.5b	74b	712b	74b	81b
25	5.5b	105a	927a	103a	112a

P<0.005 Means derived the same letters in columns are not significantly different

Table 2: Average eggs eaten from the combination of sibling and non-sibling eggs during 12 h

Type of Eggs Offered	No. offered	No. Eaten				
		Cs	Av	Ab	Ms	Total
<i>C.septempunctata</i> alone	20	17a	-	-	-	17
<i>C.septempunctata</i> + <i>A. bipunctata</i>	10+10	9a	-	10a	-	19
<i>C.septempunctata</i> + <i>A. variegata</i>	10+10	5.5	10a	-	-	15.5
<i>C.septempunctata</i> + <i>M. sexmaculatus</i>	10+10	7a	-	-	8.5a	23
<i>A. variegata</i> + <i>M. sexmaculatus</i>	10+10	-	8.6a	-	8.8a	17.4
<i>A. bipunctata</i> + <i>A. variegata</i>	10+10	-	3.7b	10a	-	13.7
<i>M. sexmaculatus</i> + <i>A. bipunctata</i>	10+10	-	-	8a	8.6a	16.6

P<0.005

Kin recognition and Cannibalism: The kin recognition ability in adult *C. septempunctata* was proved very poor. The proportion of eggs consumption from the combination of four egg batches of different coccinellid species was not significantly different. Although the cannibalism was the due to scarcity of the food but there was no preference shown among the egg diversity of sibling and non sibling species. In all the treatment Adult *C. septempunctata* feed almost equal proportion from available numbers (Table 2). This behaviour indicated a negative response to biased-ness and there was no discrimination between different degrees of genetic relatedness.

DISCUSSION

Cannibalism is a widespread phenomenon found in many arthropods. It is generally considered that this behaviour is shown by coccinellids during the shortage of natural prey, but during the present study it was observed that the adult of *C. septempunctata* also cannibalise some percentage of its own eggs even in the presence of aphids prey. As there are apparently no penalties associated with eating conspecific eggs one would expect cannibalism to occur even aphid are very abundant (Agarawala and Dixon, 1992). There is a possibility of low-level cannibalism when aphids are abundant and it reflects the low relative frequency of encounters between adults and larvae and eggs. However, if the eggs are laid at too greater distance from the aphid colony, it would increase the further risk of newly hatched larval cannibal. To reduce the further risk ladybirds should synchronise the oviposition (Hemptinne *et al*, 1990; Hemptinne and Dixon, 1991) closer to the aphid colony so that the newly hatched larvae should not be victimised by elder larvae of its own species. The incidence of egg cannibalism depends upon the degree of eggs batches. There are evidences that of ladybird beetles do lay eggs slightly away from the aphid colonies (Dixon, 1959; Owasa, 1989) and eggs are more at risk if they are laid near the aphid colony (Owasa, 1989). On the positive side, cannibalism improves the chances of surviving the predator to ensure future availability of food when aphids are scarce.

In some previous studies, the eggs of *A. bipunctata* were much less frequently eaten by the larvae and adult of other species of ladybirds as compared to their own species. Similarly, the larvae of adult of *A. bipunctata* were reluctant to eat the eggs of *C. septempunctata* (Agarawala and Dixon and 1992). On the contrary, in the present study *C. septempunctata* had shown no discrimination in consuming the eggs when exposed to a mixed diet of egg batches taken from four different coccinellid species.

Despite of variation in quality of diet, it was concluded that some coccinellid beetles defend themselves with bitter tasting volatile pyrazine and quinolones (Mueller *et al.*, 1984; Rothschild, *et.al.*, 1984). The dietary mixing has sometimes been found to increase predator growth and survival (Toft and wise, 1999). In present study the intake of small number of the eggs in the presence of even surplus aphids indicates that the adult *C. septempunctata* might some time need to supplement their diet or it may be the natural selection. The dietary value of eggs only makes less contribution in terms of predator's longevity. In *C. septempunctata*, kin recognition abilities of larvae and adult were found least. No particular preference for opposite kin was shown. However, it was unclear that why heterospecific selection of eggs were preferred. Such behaviour might be the function of better balance of nutrients, necessary for growth and body maintenances.

Generally the cannibalism occurs in coccinellids only because of scarcity of the natural diet but in the presence of aphid prey, egg cannibalism was also seen common. In the present study a poor kin recognition capability of *C. septempunctata* was also observed. The indiscriminate egg cannibalism between sibling and non sibling species was also found. The cannibalistic behaviour is a barrier in mass rearing of coccinellids.

REFERENCES

- Agarawala, B.K. and A.F.G. Dixon, 1992. Laboratory study of cannibalism and interspecific predation in ladybirds, *Ecological Entomol.*, 17: 303-309.
- Agrawala, B.K. and A.F.G. Dixon, 1993. Kin recognition: egg and larval cannibalism in *Adalasia bipunctata* (Coleoptera: Coccinellidae) *European J. Entomol.*, 90: 45-50.
- Brown, H.D., 1972. The behaviour of newly hatched coccinellid larvae (Coleoptera: Coccinellidae) *J. entomol. soc. of South Africa*, 35: 149-157.
- Cottrell, T.E. and K.V. Yeargan, 1999. Interbuild predation between the introduced lady beetle *Harmonia axyridis* (Coleoptera :Coccinellidae) and native lady beetle *Coleomegilla maculata* (Coleoptera: Coccinellidae) *J. Kansas Entomol. Soc.*, 71: 159-163.
- Dixon, A.F.G., 1959. An experimental study of the searching behaviour of predatory Coccinellid beetle *Adalia decempunctata* (Coleoptera: Coccinellidae) *J. Animal Ecology*, 28: 259-281.
- Gambao, G.J., K.A. Berven, R.A. Schemidt, T.G. Fishwild and K.M. Jankens, 1991. Kin Recognition by larval wood frogs (*Rana sylvatica*). The effect of diet and prior exposure to conspecifics, *Oecologia*. (Berl.) 86: 319-324.

- Hemptinne, J.L. and A.F.G Dixon, 1991. Why lady bird have generally been so ineffective in biological control proceedings IV International symposium, Ecology of Aphidophaga, SPB Academic Publishing, The Hague, pp: 149-157.
- Mueller, R.H., M.E. Thompson and R.M. Dipardo, 1984. Stereo- and regioselective total Synthesis of the the dynamics of intraspecific predation. Annual Review of Ecological Systems, pp: 225-251.
- Owasa, N., 1989. Sibling and non sibling cannibalism in the ladybird beetle *Harmonia axyridis*: fitness consequences for mother and offsprings. Res. Population Ecology, 31: 153-160.
- Polis, G.A., 1981. The evolutionary and dynamics of interspecific predation: Annual review of Ecological systems, 12: 225-251.
- Toft, S. and D.H. Wise, 1999. Growth, development and survival of generalist predator fed on single- and mixed species diets of different quality. *Oncologia*, 119: 191-197.
- Wanger, J.D. and D.H. Wise, 1996, Cannibalism regulates densities of young wolf spiders: Evidence from field and Laboratory experiments. *Ecology*, 77: 639-652.
- Wanger, J.D. and M.D. Glover, J.B. Mosely and A.J. Moore, 1999. Hatchability and fitness Consequences of Cannibalism in Larvae of the ladybird beetle *Harmonia axyridis* Evolution, *Ecological Res.*, 1: 375-388.
- William, E.S., S.B. Joseph, R.F. Preziosi and A.J. Moore, 2000. Nutritional Benefits and cannibalism for ladybeetle *Harmonia axyridis* (Coleoptera: Coccinellidae) When prey quality is poor. *Environ. Entomol.*, 29: 1173-1179.