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Sibling Cannibalism in the First Instar Larvae of *Harmonia axyridis* PALLAS (Coleoptera, Coccinellidae)

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Synopsis The hatching of egg batches of a predacious coccinellid, *Harmonia axyridis*, was precisely observed and the effect of sibling cannibalism on the survival of the 1st instar larvae was experimentally examined. More than one fourth of the eggs were eaten by the larvae which hatched in advance from the same egg batches. The hatching in an egg batch lasted for several hours and the larvae ate not only infertile eggs but also fertile ones which would hatch later. The 1st instar larvae frequently failed to capture aphid when they encountered it. The life span of the 1st instar larvae which ate only one egg was twice as long as that of unfed larvae. Since egg batches were often deposited on leaves uninfested with aphids, it would be difficult for the 1st instar larvae to obtain aphids. It seems probable that the sibling cannibalism is effective for securing the survival of the 1st instar larvae.

Introduction

The majority of aphidophagous coccinellids deposit their eggs in batches. The distribution of the egg batches is concentrated on plants infested heavily with aphids (BANKS, 1956a; DIXON, 1959; WRATTEN, 1973). However, the close vicinity of prey colony is avoided for oviposition site and egg batches are often deposited on uninfested leaves (KAWAI, unpublished). The 1st instar larvae tend to stay on leaves on which they hatched (KAWAI, 1976) and the efficiency in capturing prey is very low even if they encounter their prey (DIXON, 1958, 1959; BROWN, 1972). Therefore, the 1st instar larvae will have great difficulty in obtaining aphids as their food.

The 1st instar larvae of most aphidophagous coccinellids which lay eggs in batches stay on their egg shell for a short time after hatching and they often attack unhatched eggs. This type of cannibalism is called sibling cannibalism (BROWN, 1972). In the present study, the author precisely observed the hatching of egg batches of *Harmonia axyridis* and discussed the significance of sibling cannibalism to the survival of the 1st instar larvae.

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Incidence of Cannibalism

Egg batches of *H. axyridis* were collected on cherry trees in Kyoto City in May and June of 1974. The egg batches were generally found on the underside of leaves. Each egg batch contained 6 to 62 eggs, with a mean of 27.7±10.8 for 114 batches. The 1st instar larvae stayed on their own egg shell for about half a day after hatching.

In order to examine the amount of cannibalism, 98 egg batches of *H. axyridis* were kept singly in a glass petri dish (4 cm in diameter) with a wet filter paper at the bottom. The laboratory was controlled at 25°C, 50–60% R.H. and 16L-8D. Counts were made on the number of eggs prior to the initiation of hatching and that of larvae after leaving their own egg shell and the hatchability was calculated (Table 1). In 7 out of 98 egg batches, no larvae hatched and they were excluded from the calculation. The hatchability of the total eggs was only 72.7±5.5%.

Table 1. Mortality of *Harmonia axyridis* in egg stage.

Hatchability with cannibalism	(a)	72.7±5.5(%)
Hatchability without cannibalism	(b)	84.8±7.7
Eggs from which no larvae were obtained	(c)=100−(a)	27.3
Infertile eggs	(d)=100−(b)	15.2
Fertile eggs eaten by larvae already hatched	(e)=(c)−(d)	12.1

(m±95% c.l.)

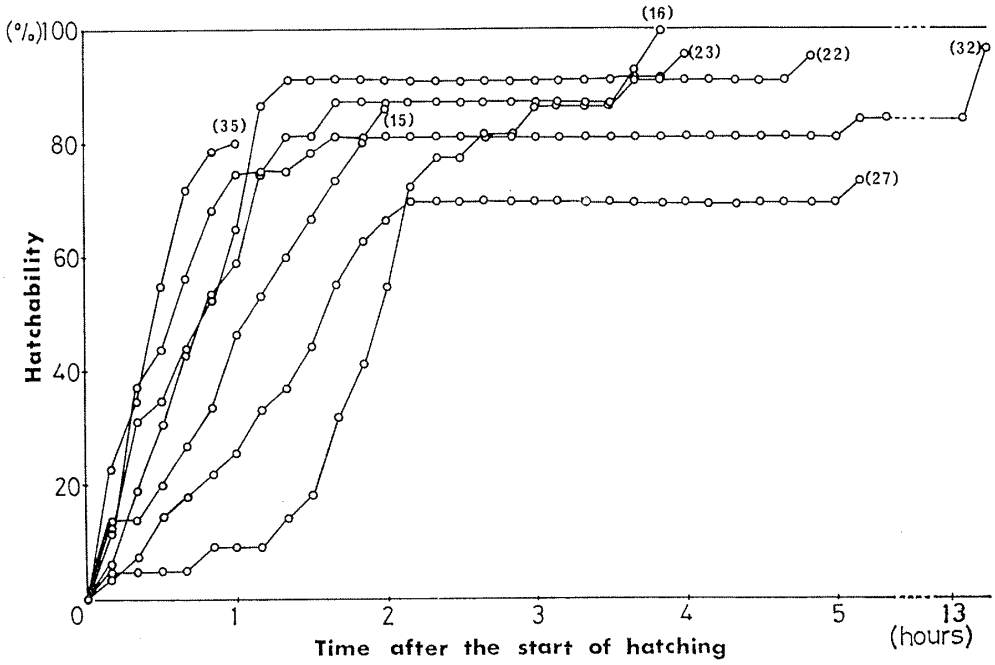

Fig. 1. Sequence of egg hatching.
The number of eggs in each egg batch is shown in parenthesis.

Since no eggs were left after hatching, the rest (27.3%) was thought to be eaten by the larvae which hatched out earlier.

Next, the sequence of hatching in an egg batch without cannibalism was observed precisely. In order to exclude the effect of sibling cannibalsim the 1st instar larvae were removed by forceps one by one soon after their hatching. The sequence of hatching is shown in Fig. 1. Most larvae hatched during the first one or two hours, though the hatching lasted for several hours. The hatchability out of 15 egg batches was 84.8±7.7% in this case (Table 1). The rest (15.2%) was unhatched and thought to be infertile.

The difference between these two hatchabilities (84.8% and 72.7%) was attributed to sibling cannibalism of larvae on fertile eggs which would hatch later. Since coccinellid larvae can perceive their prey only by a physical contact with them and the sibling cannibalism occurs before their dispersal from egg batches, the proportion of eggs eaten by the 1st instar larvae will not change according to the density of their prey in the neighborhood.

Effect of Sibling Cannibalism on Life Span

The influence of the amount of food consumed by the 1st instar larvae on their life span was examined. One, 2 or 3 eggs, or 1, 2 or 3 aphids (3rd instar larvae of *Myzus persicae*) were provided to the 1st instar larvae of *H. axyridis* just after hatching. They were kept singly without any food in a glass petri dish (4 cm in diameter) with a wet filter paper at the bottom until they died. The laboratory was controlled at 25°C, 50–60% R.H. and 16L-8D.

Most larvae ate their food completely but some were excluded from calculation when food was not completely eaten. Table 2 shows the life span of the 1st instar larvae and the proportion of the larvae which developed to the 2nd instar. Without eating any food they could survive only about 45 hours and could not develop into the 2nd instar. When only one egg or one aphid was provided their longevity became twice longer. When more eggs or more aphids were provided, the longevity

Table 2. Effect of the amount of food consumed by the 1st instar larvae on their life span.

Food provided	No. of repl.	Life span (hours)		Moulting (%)
		m±S.E.	Range	
No food	65	45.9±18.9	19— 88	0
1 egg	28	98.4±27.3	51—159	0
2 eggs	19	95.3±27.6	51—168	16
3 eggs	5	106.8±10.2	96—116	100
1 aphid	26	83.0±22.6	24—119	0
2 aphids	10	78.8±13.7	65—102	10
3 aphids	10	82.0± 8.1	65— 90	40

did not change, but the rate of survival increased and all the larvae moulted when 3 eggs were provided.

Choice of Food by the First Instar Larvae

Food preference of the 1st instar larvae was examined between aphids and eggs of their own species. Ten eggs and ten 3rd instar aphids (*Myzus persicae*) were kept together in a glass petri dish (4 cm in diameter), into which one newly emerged larva or 1-day-old one was introduced. Table 3 shows the average number of food consumed for 17 replicates. The 1st instar larvae consumed more of their own eggs than aphids. This tendency was more obvious during the first 24 hours. The process in which the 1st instar larvae searched for aphids and eggs was observed (Table 4). Ten eggs and 10 aphids were put together into a petri dish as mentioned

Table 3. Preference of the 1st instar larvae between aphid and egg. (m±S.E.)

Hours after hatching	No. of individuals eaten	
	Aphids	Eggs
0–24	0.71±0.85	2.06±1.39
24–48	1.54±0.88	3.54±1.90

Table 4. Process of food selection of the 1st instar larvae between aphid and egg.

Experiment	I		II		III	
Food	Egg	Aphid (1st instar larva)	Egg	Aphid (3rd instar larva)	Egg	Aphid (apterous adult)
No. of contacts	7	6	6	5	9	4
No. of food eaten	6	3	6	2	8	0
Successful catch (%)	86	50	100	40	89	0

above and one 1st instar larvae which hatched 24 hours before was kept in it. The movement of the larva was observed until the larva contacted with an egg or an aphid. Number of contacts with aphid was almost equal to that with egg. When a larva contacted with aphids, they frequently escaped from its attack by means of walking. Consequently, the 1st instar larvae consumed more eggs than aphids. When adult aphids were provided, they often escaped from coccinellid attack before contact. Therefore, it seems difficult for the 1st instar larvae to capture aphid even if prey is abundant.

Discussion

The present study showed that more than one fourth of eggs of *H. axyridis* were eaten by the larvae which hatched earlier from the same egg batch. Several papers reported sibling cannibalism of predacious coccinellids (BANKS, 1956 b; DIXON, 1959; KADDOU, 1960; PIENKOWSKI, 1965; BROWN, 1972). BANKS (1956 b) stated that sibling cannibalism would have a survival value for individual larvae when prey density is low by prolonging the life span of the 1st instar larvae and increasing the chance of finding prey. PIENKOWSKI (1965) and BROWN (1972) claimed that sibling cannibalism did not noticeably increase the searching capacity since larvae that had fed on an egg were inactive and did not crawl about in search for aphids.

Though egg batches of *H. axyridis* are concentrated in an area where prey density is high, the close vicinity of prey colony is avoided for the oviposition (KAWAI, unpublished). Egg batches were frequently observed on uninfested leaves of heavily infested plants. Since the 1st instar larvae tend to stay on leaves on which they hatched (KAWAI, 1976), they have little chance to encounter their prey. Moreover, it is rather difficult for them to capture an aphid even if they encounter it (Table 4), whereas they easily eat eggs. The larvae that ate only one egg can survive about two days longer than the unfed larvae (Table 2) and hence the former may have a higher possibility to reach aphid-infested leaves.

Most aphidophagous coccinellids eat only aphid. Older larvae and adults can eat sufficient amount of aphids because they can successfully concentrate on heavily infested leaves. However, the 1st instar larvae have difficulty in capturing aphids and may suffer from a higher mortality. The females of some species of coccinellids belonging to Symninae, Chilocorinae and Noviivi lay their eggs singly (SASAJI, 1971). These species lay their eggs mostly among their prey colony. This oviposition habit ensures the first food supply for the newly hatched larvae. However, most aphidophagous coccinellids which lay their eggs in batches do not necessarily deposit eggs near prey colony. Therefore, sibling cannibalism may be effective for increasing larval survival even if prey density is very high by providing the first food to the 1st instar larvae.

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