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FOOD SEEKING AND SURVIVAL IN PREDACEOUS COCCINELLID LARVAE

ВЫЖИВАЕМОСТЬ ЛИЧИНОК ХИЩНЫХ КОКЦИНЕЛЛИД В ЗАВИСИМОСТИ ОТ ДОСТУПНОСТИ ПИЩИ

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Abstract

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Survival of *Adalia bipunctata* (L.) emerging from eggs laid some distance from prey locations, depended on the ability of the larvae to reach a prey location on a host plant. Distances between egg clusters and prey locations, when less than 63 cm in laboratory cages, had little effect on larval survival. Pathways used by a larva to prey was more important than distance. Larvae that had access to prey via pathways, reached prey as distant as 63 cm from eclosion sites.

Cannibalistic predation by these larvae on eggs increases their survival chances when prey are scarce.

Лабораторными экспериментами в Гуэлфском университете (Канада, провинция Онтарио) установлено, что выживаемость личинок **Adalia bipunctata L.,** отродившихся из яиц отложенных на некотором расстоянии от колонии тлей, зависит от способности личинок обнаружить источник пищи.

В лабораторных садках не было выявлено разницы в выживаемости личинок в зависимости от удалённости (в пределах 63 см) места откладки яиц от источника пищи.

Качество пути к источнику пищи значительно более важно, чем расстояние до него. Если личинки не встречают препятствий на своём пути к источнику пищи, они могут достигнуть его даже на значительном расстоянии.

Поедание отродившимися личинками кокцинеллид части свежеотложенных яиц увеличивает вероятность обнаружения и схватывания жертвы и тем самым способствует увеличению выжиавния личинок при наличии скудных источников пищи.

Introduction

Predatory coccinellids are important regulatory agents of aphids and other insect pests. They are predaceous in both the larval and adult stages. The eggs are laid on the trunks or stems and leaves of trees and plants at varying distances from prey. Smith (pers. commun.) reported that food is not the main factor in the choice of egg-laying locations by predatory coccinellids on corn and that their survival would be higher if first-instar larvae were provided with food.

Coccinellid larvae feed on eggs of their own and other coccinellid species in laboratory cages and in nature. This may lead to a decrease in numbers of adults. However, such feeding could increase the survival of cannibalistic larvae when prey are scarce. Opinions differ on the survival value of cannibalism of eggs in coccinellids (Banks 1957; Pienkowski 1965; Smith 1961).

It has been shown that boards and extracts of *Juniperus virginiana* L. stimulate oviposition of various species of coccinellids (Boldyrev *et al.* 1969). Use of these boards was considered a possible means of bringing first-instar larvae closer to food, would reduce mortality caused by starvation of these stages, and would give preliminary data on distances between predator and prey that affects predator survival. The relationship between survival of first-instar coccinellid larvae and distance between eggs and prey was determined and the results are described herein.

Materials and Methods

Two coccinellid species, *Adalia bipunctata* (L.) and *Cycloneda munda* (Say), were used in experiments on survival of newly-hatched larvae. Dried and powdered pea aphids, *Acyrthosiphon pisum* (Harr.), and live aphids of the same species were used as food in the tests. Broad bean, *Vicia faba* L., was the host plant used to rear the aphids.

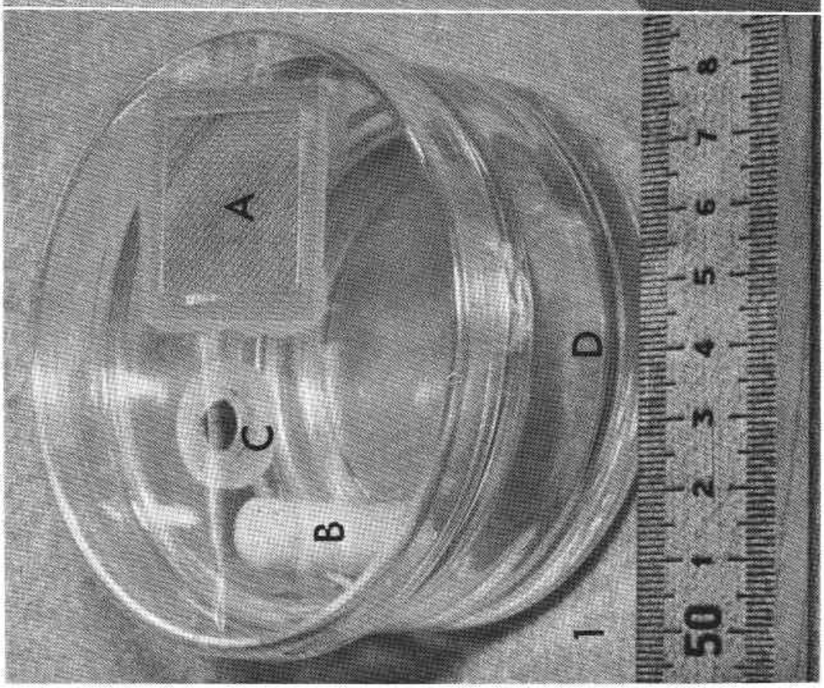
Petri dish cages (Fig. 1) each 9 cm in diameter and 1 cm deep, with a 2.5×3.7 cm screened window in the lid, were placed on 9-cm-diameter glass culture dishes containing 5% sugar solution. A cotton wick, which extended from the sugar solution through a tight-fitting hole in the floor of the petri dish, supplied the coccinellid in a petri dish. Dried food in a feeding container was placed in the centre of each petri dish.

In each cage five newly-hatched coccinellid larvae were placed. Various instars of living aphids were placed in these cages twice a day, at 10.00 a.m. and at 4.00 p.m., at a rate of five aphids per larvae per placement.

Larger cages, 90 cm long, 61 cm wide, and 61 cm high, were used in experiments on survival of coccinellid larvae at different distances from prey locations. Bases of these cages were ¼-in. plywood drilled to allow pots of various sizes and containing bean plants infested with pea aphids to be tightly placed and extended through into trays for subterranean watering.

Fifteen newly-hatched *A. bipunctata* larvae were placed in the centre of a board of *J. virginiana* that was 33.0 cm long, 6.4 cm wide, and 0.9 cm thick and attached to a plastic base at one end by two 15.0×7.0 mm screws. Two boards were placed in vertical positions on the cage floor, 2.5 and 61.0 cm distant from the rim of the pot containing the host plant and its aphid population. In all experiments both boards were placed in the test cages though larvae were placed on only one of them in each test.

To assess the role of pathways from hatching sites to prey locations, 15 newly-hatched *A. bipunctata* larvae were placed in each of two cages on boards



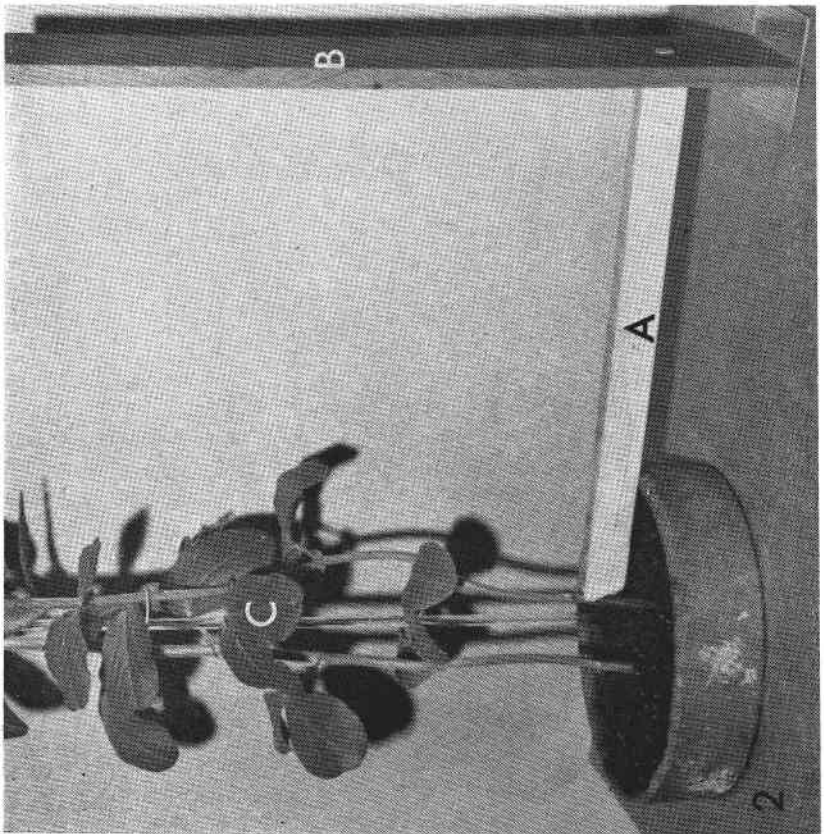


Fig. 1. Petri dish cages with ventilating screen (A), wick (B), and food container (C) dishes (D) and used to determine effects of diet on predaceous coccinellid survival.

Fig. 2. Pathway arrangement (A) from coccinellid egg hatching site (B) to prey host plant (C).

of *J. virginiana* located 25.5 cm from the rim of the pot. A straight pathway consisting of pine wood 1.5 cm thick, 2.0 cm wide, and 28.0 cm long led from the board to the host plant in one cage (Fig. 2) while no pathway was provided in the second cage. In a third cage, 15 control larvae were placed directly on the host plant. Prey densities were similar in all three cages.

To assess the effects of varying the age of first-instar larvae of *A. bipunctata* on egg cannibalism 20 eggs were placed on a board of *J. virginiana* situated 63.5 cm from the host plant. Cannibalism and survival of larvae were determined in this cage and compared with a second cage where 10 eggs were placed on a board of *J. virginiana* as in the first cage and 3 days later another 10 eggs were placed within 2.5 cm of the first.

Results

A. bipunctata and *C. munda* differed in response to various food regimens that were provided during larval development. Of 20 first-instar larvae of each species started on each regimen the following numbers of *A. bipunctata* and *C. munda* (in parentheses) reached the pupal stage: live aphids, 18 (19); dry powdered aphids, 6 (7); dry aphids during the first 3 days then live aphids, 14 (10); and live aphids up to the third-instar larva then dry aphids, 18 (no test).

Only 2 of 15 *A. bipunctata* larvae that were started 2.5 cm from a host plant with aphids reached the fourth instar. Of those that were started 61.0 cm from the plant only one reached the fourth instar. All other larvae in both cages died as a result of starvation and desiccation. None was observed being preyed upon by other larvae.

Provision of a pathway 28 cm long for first-instar larvae of *A. bipunctata* between the site occupied by these larvae and the host plant increased the rate of larval survival. Larvae reaching the fourth instar in three tests, each with 15 larvae were: with pathway 8, no pathway 2, and with larvae on host plant, 10.

Varying the age of a group of 20 first-instar larvae of *A. bipunctata* caused an increase in egg cannibalism and survival. Two of 20 larvae of the same age reached the fourth instar. However, with age differences, the older larvae were egg cannibalists and this increased fourth-instar survival rates to 5.0/20. In the mixed-age group, 10 eggs were eaten by older larvae. Cannibalism of larvae by other larvae was not observed. Larvae died as a result of desiccation and starvation.

Discussion

Survival of *C. munda* and *A. bipunctata* was higher when larvae were fed on living pea aphids than when they were fed on dried food. Cannibalism was observed only in second- and third-instar larvae and not in the first and fourth instars. Substitution of living aphids with dried food did not initiate cannibalism in fourth-instar larvae. Cannibalism was higher in larvae fed on dried food during the first 3 days of their development, and it was the highest in larvae fed only on dried food.

Experiments on the survival of *A. bipunctata* larvae at different distances between hatching sites and prey location and with different pathways or routes to food prey, showed that the survival of larvae was very low irrespective of distance if larvae had any obstacles on the route to the prey location. Observations on the searching behaviour of predatory coccinellid larvae in experimental cages showed that prey were usually captured by chance. This is similar to findings reported by Dixon (1959) and by Smith (1966). Coccinellid larvae failed to locate prey if they did not touch it. Visual stimuli such as prey movement, colour, shape, and size and olfactory stimuli are of little or no importance in coccinellids locating and capturing aphid prey. Even when larvae emerged from egg clusters located as close as 2.5 cm from the rim of the pot containing host plants infested with a high prey population, most failed to locate the prey. During the first 2 days after hatching, larvae were observed crawling randomly in the cage and mainly on the floor of the cage. Sometimes they were observed ascending the rim of the pot and crawling around it, but they often failed to overcome the short (about 3 cm) soil surface distance between this rim and the host plant.

When larvae had straight board pathways 28 cm from where egg clusters were located to a host plant supporting aphid prey, four times more larvae survived (eight larvae) as compared with those larvae having no pathways. This was similar to survival rates in other experiments where 15 emerged and 10 survived from egg clusters situated on a host plant.

Young larvae in these experiments did not eat their contemporaries. All larvae that failed to locate and capture prey died of starvation or desiccation. The most vulnerable period of larval life is from eclosion to the capture of their first prey. If newly-emerged larvae located other coccinellid egg clusters they would probably feed on them.

Apparently the feeding of coccinellid larvae on eggs of the same or other species is conducive to survival during the most vulnerable period of their life and increases a larva's chance of eventually locating and capturing its food prey. Hence such phenomena as coccinellid larvae predation on eggs must not be considered as a negative factor in survival of adequate numbers in nature.

On the basis of the previously described experiments it is possible to make inferences dealing with the possibility of practical usage of the oviposition attraction in *Juniperus* boards (Boldyrev *et al.*, in prep.). These boards should be situated in positions such as to provide the easiest route or pathway for young larvae to reach the host plant and food prey. This may increase the survival of the coccinellid larvae and decrease egg predation. Further studies of these problems in the laboratory and under field conditions are needed.

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