SOME FACTORS INFLUENCING THE REPRODUCTION AND LONGEVITY OF *COCCINELLA SEPTEMPUNCTATA* LINNAEUS [*COLEOPTERA : COCCINELLIDAE*]

BY

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Introduction

The effectiveness of predatory Coccinellids as mortality agents of aphid depends on many factors. The theoretical number of aphids consumed by larvae and imagines during one summer has been reported earlier, together with other characteristics of the larvae (SUNDBY, 1966).

At our latitude *C. septempunctata* is univoltine with a long-lasting oviposition period. Aphids have several generations a year, and may already reach a high population level in June and July. During these months, Coccinellid larvae are most numerous, while highest population density of Coccinellid adults is usually noted in August and September.

The inability of predatory Coccinellids to survive when prey is scarce is reported to be a limiting factor for their effectiveness (SMITH, 1965). The synchronization between the development of predator and prey, the fecundity of Coccinellids in relation to the type of food eaten, and the efficiency of Coccinellids as predators at our latitude are central problems. The effect of aphids and artificial food on the longevity, reproduction and survival of adults of *C. septempunctata* is reported in this paper. The importance of hibernating places is also described.

Material and methods

The methods used are the same as reported previously (SUNDBY, 1966). The Coccinellid beetles used originated partly from the field, partly from laboratory cultures. The adults were kept in glass jars,

one pair in each, and the food consumption recorded every day. The amount of food offered was more abundant than the amount consumed. The eggs produced were removed three times a day. The artificial food consisted of liver, hydrolyzate of yeast, casein and honey. The aphid used was *Myzus persicae* (SULZER). The work was carried out at 21.0 ± 1 °C and at about 50 % r.h. Artificial light was used though natural light was admitted through the windows of the room. Other methods are described where applicable.

General feeding habits and egg production

Adults of *C. septempunctata* are aphid consumers. After hibernation they start feeding as soon as aphids are available in the spring. The amount of food eaten decreases after two to three weeks (fig. 1) and remains nearly constant throughout the rest of the summer. Oviposition starts about a week after feeding, and may last 3 months; an average of 7-800 eggs are laid.

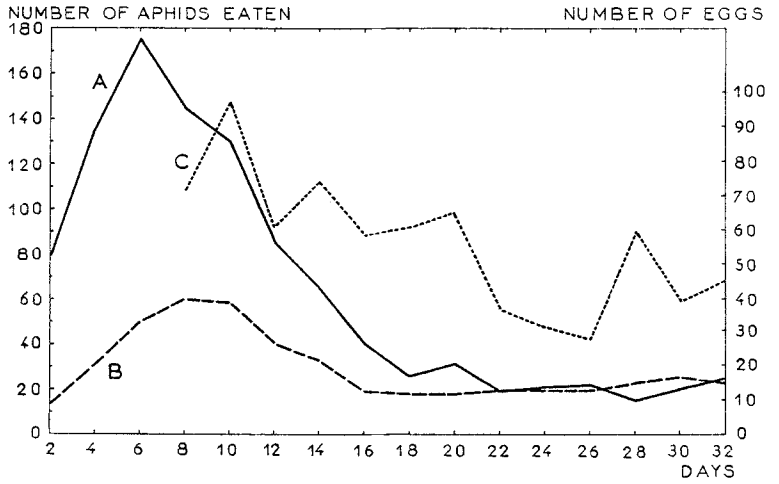

FIG. 1, Relationship between the food intake, age, and fecundity of adults of *C. septempunctata* (30 replicates).

A : Number of aphids eaten by egg producing imagines the first weeks after hibernation.

B : Number of aphids eaten by newly emerged imagines.

C : Number of eggs produced by hibernated females.

Food is necessary for the egg production. There is no egg production by this species if it doesn't feed on aphids. In spite of high food consumption, newly emerged females usually do not oviposit until the following year. Dissection shows the fat bodies develop

well, but there are no eggs in the ovaries. These beetles enter a kind of diapause early in the summer, but their feeding activity continues.

The longevity of *C. septempunctata* seems to be one to 1 1/2 years. The progeny produced during the summer will hibernate in the adult stage, produce their eggs the following summer, and die. This has been observed for most of the specimens. It has also happened, however, that imagines have hibernated twice. This has been previously reported for one simple female (SUNDBY, 1966) and observed later for several females. The fecundity of those females which hibernated twice, was lower during the first summer than that noted for females hibernating only once and therefore laying their eggs during one season. The fecundity of the female was, however, similar for all cases considered.

Effect of artificial food

In addition to aphids and other small insects and mites, the Coccinellid beetles are known to feed on insects eggs, honeydew, pollen of different plants, and fungis (PUTMAN, 1964). They are also known to feed on artificial food. According to SMITH (1965) desiccated liver is the best non-prey food supplement for the reproduction of some Coccinellid beetles. Liver was used in the present experiment too, but in addition to other ingredients.

The imagines used hibernated partly in the field, partly in the laboratory. One pair was kept in each glass jar, and food offered as shown in table 1. Females were fed for months on artificial food only and did'nt produce any egg. Dissections showed that their fat bodies developed well. All other diet combinations resulted in egg production as shown in table 1. According to SMITH (1965) synthetic food does not promote egg production in species of the genus *Coccinella*. The present investigation confirms it. However, the diet may possibly increase the number of eggs when aphids are available in unlimited numbers.

TABLE 1

Egg production of *C. septempunctata* fed on different diets (ten replicates)

DAILY DIET	OVIPOSITION PERIOD IN DAYS	AVERAGE NUMBER OF EGGS PER ♀	HATCHING PER CENT
Artificial	0	0	0 %
Artificial + 5 aphids	1	2.2 ± 0.9	0 %
Artificial + 10 aphids	22 ± 9.3	39 ± 11.2	15.1 %
Honey and aphids	60 ± 8.8	939 ± 201.2	46.4 %

If aphids are available as food, egg production will continue for several months as mentioned. If the diet is changed to artificial food, no eggs are laid. Whether in this case eggs are retained and absorbed, as reported for some parasitic hymenoptera (FLANDERS, 1942), is unknown. The females fed on artificial food will again start oviposition after about a week when aphids are available.

Number of eggs — Place of hibernation

The imagines have hibernated, as mentioned, partly in the field, partly in the laboratory. During summertime, however, the living conditions have been the same. The number of eggs laid by these two groups of adults is shown in table 2. The hatching per cent of eggs produced by females which hibernated in the field was higher (21 to 62,6) than the per cent of eggs produced by females kept in the laboratory during the winter (2 to 55). Similar results were obtained for females fed on aphids, as well as for females fed on artificial food supplement with 10 aphids a day, but these data were not included in the table. For females with two reproduction seasons the hatching per cent of the eggs is different for each of the two years. In the present experiment it was 31.9 in the first and 24 in the second reproduction period for adults overwintered in the laboratory, and 26.6 in the first and 67.9 in the second summer, for adults overwintered in the field.

TABLE 2

Egg production of *C. septempunctata* after different hibernating conditions (ten replicates)

FOOD	MAXIMUM NUMBER OF EGGS PER ♀	AVERAGE NUMBER OF EGGS PER ♀	HATCHING PER CENT	HIBERNATION
Honey and aphids	2175	1054 ± 203	62.1 %	Field
Honey and aphids	869	515 ± 137.5	8.2 %	Laboratory

According to HODEK & CERKASOV (1960) part of the females are fertilized before hibernation, but the males renew their sexual activity in the spring. In the present experiment beetles were observed to copulate several times during the oviposition period. There are many differences observed for the various hibernation places of the present material, but temperature seems to play the most important role. The material in the field was placed on the ground where the temperature may reach several degrees centigrades below zero during the fall; during the wintertime, however, the temperature stays at about zero most of the time. In the laboratory the temperature has been about

20 °C and the beetles have been active throughout the whole winter. They were fed with artificial food. It is unknown, whether or not the fertility of the egg or of the sperm or of both is reduced. The difference of activity is most likely to be responsible for the results mentioned.

Discussion

The efficiency of the Coccinellid beetles in the field partly depends on their aphid eating capacity. During springtime the population of *Coccinella* is rather small and is composed of hibernated imagines. Their aphid eating capacity (fig. 1) is high during the first 2 to 3 weeks, then rather low for the rest of the summer. The hibernated females produce eggs, and the larvae need aphids during 2-3 weeks for their development. Eggs are produced for several months, which means that active larvae are present in the field during most of the summer. The first generation imagines consume the highest amount of food during the first two weeks after emergence, but due to the long egg production period of the hibernated females, new specimens of emerged adults are added to the population in July, August and, probably, at the beginning of September. According to this, the aphid eating capacity of the Coccinellid population will increase during the whole summer. The population density will depend on the amount of food available. If the available aphid population decreases, the females discontinue their egg production. The lack of aphids will, however, not affect the adults, as they are able to survive on other kinds of food. According to laboratory tests they should be able to survive also when food is scarce. If aphids increase again in number, oviposition is resumed after one week. If they migrate and are able to find new places with aphids, their chance of continuous oviposition ought to improve.

Results indicate that *C. septempunctata* is well adapted to changes in the prey population under field conditions, and that the release of *Coccinella* to check the aphid populations ought to take place early in the season.

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ZUSAMMENFASSUNG

Coccinella septempunctata hat in Norwegen eine Generation pro Jahr. Die überwinterten Imagines haben in den ersten Wochen einen hohen Nahrungsbedarf (fig. 1). Das Ablegen der Eier erstreckt sich über mehrere Monate und man kann Larven fast über den ganzen Sommer finden. Die neu geschlüpften Käfer benötigen Nahrung, jedoch nimmt der Nahrungsbedarf nach den ersten Wochen ab. Der gesamte Nahrungsbedarf einer Population steigt während der gesamten Saison an.

Die Käfer können mit künstlichen Nahrungsstoffen gefüttert werden; sie leben mehrere Monate, doch legen sie dann keine Eier ab. Gibt man ihnen jedoch in einem solchen zustand Blattläuse zu fressen, so beginnt die Eiproduktion nach etwa einer Woche wieder.

Weibchen, welche im Felde überwinterten, übertrafen die Laboratoriumstiere sowohl bezüglich der Eizahl als auch der Schlüpfprozente.

Es wird die Schlussfolgerung gezogen, dass *C. septempunctata* geeignet ist, die Fluktuation der Blattlauspopulationen im Felde zu regulieren. Das Ausschlüpfen der Käfer sollte, damit die Blattlauspopulation klein gehalten werden kann, am besten zu einem frühen Zeitpunkt der Saison geschehen.

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