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Dispersal of Three Species of Coccinellids in Corn Fields[1]

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To determine the dispersal of coccinellids in corn fields, two methods were used: sticky traps were placed at different elevations to catch the beetles in flight, and a sucrose solution was sprayed on the upper or lower portions of plants to concentrate beetles.

The results show that the distribution on the plants is closely related to the manner of dispersal of the species, the *Hippodamia* species fly at a greater height than *C. maculata*, and *H. convergens* and *H. 13-punctata* are, respectively, about 15 and 9 times as mobile as *C. maculata*. The results generally support the idea that entomophagous coccinellids are more nomadic than their phytophagous relatives.

An earlier article by Ewert and Chiang (1966) reported that the three common species of coccinellids exhibited a vertical stratification in their distribution in crop fields. *Hippodamia convergens* Guerin-Meneville and *H. 13-punctata* L. are normally found at higher levels on the plants than is *Coleomegilla maculata* De Geer. The differential distribution was shown to be the result of differences in tactic reactions to light, humidity, and gravity, and in food preference. Information on food preference and survival of larvae indicated that *C. maculata*, which feeds on plant material readily, is the most omnivorous of the three species. A further question that arose was whether the differential reactions and the consequent differential distribution have any significance in the dispersal of the insects.

Only a few studies have been reported on the movement of coccinellids in the field. Davidson (1924) released marked individuals of *H. convergens* in an alfalfa field, and traced an extensive dispersal over a short period. Few individuals lingered in the area of release, and one individual was recovered as far as 12 km. away. Iwao *et al.* (1963), on the other hand, found very restricted movements among *Epilachna 28-maculata* Motschousky. Beetles tended to remain for one to two weeks within the 13–45 m.^{2} plots where they had been released. It is perhaps noteworthy that the less nomadic species is phytophagous. Marriner (1939) was

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impressed by the fact that *Adalia 2-punctata* and *Coccinella 7-punctata* fly at different elevations. The former flies close to objects as if to avoid wind currents, whereas the latter flies higher. The high altitudes reached by *H. convergens* during their annual migratory flight are discussed by Hagen (1962). Thus, the dispersal of different coccinellids follow different patterns, both in distance and in elevation.

In the present study, two methods were used. Sticky traps were placed at different elevations to catch beetles in flight. A sucrose solution was sprayed on the upper or lower portions of plants to concentrate beetles.

Statistical treatment of data involved the Student–Newman–Keuls' test of means. Readers are referred to Steel and Torrie (1960) for details on this statistical method.

Sticky Trap Study

From mid-July to mid-September, 1962, flying coccinellids were collected at heights of 0.9, 1.8, 2.7 and 3.6 meters. The trapping sites were the curved sides of four drums attached to a vertical pole at the four levels. The drums were 30 cm. long and 15 cm. in diameter, and were coated with a non-attracting sticky substance. Beetles that chanced to come in contact with the coated surface would stick to it. The apparatus was designed by Howe *et al.* (1963).

The pole was set up next to a corn field on the St. Paul campus of the University of Minnesota. Each week the drums were examined, beetles counted and removed, and a fresh sticky surface prepared. The total numbers of beetles caught at the four heights are given in Table I.

C. maculata were captured least frequently, although they occupied the immediate general areas in the greatest abundance. *H. convergens* were captured disproportionately often. Catch decreased with height. The two *Hippodamia* species landed at all heights, whereas *C. maculata* appeared only on the lowest.

In Wisconsin, Fluke (1929) mentions capturing *H. 13-punctata* on tanglefoot screens at a height of 29 feet but does not mention capturing *H. convergens* or *C. maculata*. The latter was often the most abundant in relation to his study as a whole (Fluke 1925).

These results suggest that *H. 13-punctata* and *H. convergens* move about more frequently and throughout a greater height than *C. maculata*.

Sucrose Spray Study

Entomophagous coccinellids readily eat sugar in high concentrations. Sugar is a component of several materials of biological origin including nectar (Rockwood 1952; Nishida 1958) and honeydew (Zoebelein 1956). Augustine *et al.* (1964) consider sucrose an attractant of the phytophagous coccinellid, *Epilachna varivestis*, which prefers bean leaves of high sugar content. The sucrose as applied in the present study was sprayed onto plants to simulate deposits of aphid

TABLE I
Number of beetles captured on sticky trap drums placed at four heights above the ground

Species	Height (meters) of drum above the ground			
	0.9	1.8	2.7	3.6
H. convergens	35	2	2	1
H. 13-punctata	19	0	1	1
C. maculata	11	0	0	0

honeydew in which sucrose is usually present (Auclair 1963). Since sucrose is non-volatile, it presumably did not have an olfactory effect on flying coccinellids. Thus, it is not likely that it attracted beetles from any great distance. However, beetles do eat the sugar and stay near it when they happen to come across the deposit. Therefore, in time, there would be a concentration of beetles on the sprayed plants. Since there was no distant attraction, the number concentrated would reflect the number of beetles moving about within the normal range of their dispersal.

For this work, a portion of a planting of field corn, variety Minhybrid 507, on the St. Paul Campus was used. At the time of observation the plants were about one week after pollen shedding stage. The plot consisted of four east–west oriented rows divided into eight randomized blocks with three cells each. Each of the three cells was given a different treatment. The treatments were (1) untouched plants serving as control, (2) plants with the tassels and a few upper leaves sprayed with nearly saturated sucrose solution, and (3) plants with the leaves below 120 cm. sprayed with the same solution. The plants whose upper parts were sprayed required only a third as much sucrose solution to reach near drip point as those with the lower parts sprayed. In the former treatment the dripping of a small amount of solution from upper parts to lower parts could not be avoided. Prior to spraying only low densities of Coccinellidae were known to occur within the experimental plot or in the immediate neighborhood.

Blocks 1–4 were sprayed on 20 August 1963, and checked for beetle abundance on 21 August. On 23 and 24 August, 0.37 inches of rain fell, which presumably removed all the sugar from the plants. The beetle population was checked on the next day. On the same day, beetle populations in blocks 5–8 were also checked; spray was applied later that day. Beetle populations were again checked on the next day (26 August).

The abundance of beetles on the different days is summarized in Table II. Each number in this table is based on one check for each cell. The Student–Newman–Keuls' test of means was applied at the 0.05 and the 0.01 levels of significance to the mean number of beetles in each cell for periods when the sucrose solution was present in the plot (Table III). The raw data used in this test are the same as those given in the upper half of Table II with the exception

TABLE II

Number of beetles observed on plants during checks when the sucrose was present or not present

	H. convergens	*H. 13-punctata*	*C. maculata*
Sucrose present (21 August in blocks 1–4, and 26 August in blocks 5–8)			
Control cells	32	3	6
Upper parts sprayed	289	13	18
Lower parts sprayed	150	10	25
Plot total	471	26	49
Sucrose removed by rain (25 August in blocks 1–8)			
Control cells	8	1	17
Upper parts sprayed	11	0	22
Lower parts sprayed	12	2	16
Plot total	31	3	55

TABLE III

Statistical treatment (Student–Newman–Keuls' test of means) of the numbers of beetles observed on plants during checks when sucrose was present. A solid line beneath two means indicates that the means are not significantly different from each other at the 0.01 level; dotted lines, 0.05 level

Species	Mean number of beetles per cell		
	Control cell	Lower parts sprayed	Upper parts sprayed
H. convergens	2.9	14.5	31.5
H. 13-punctata	0.44	1.38	1.81
	Control cell	Upper parts sprayed	Lower parts sprayed
C. maculata	0.88	2.80	3.60

that the means for *H. 13-punctata* and *C. maculata* were determined from two counts per cell per check date rather than just one count.

The following facts are noted from the results:

1. More beetles were present in the spray treatment cells than in the control cells. This relation was true for all three species (significant at 0.01 level for *H. convergens* and *C. maculata*, and at 0.05 level for *H. 13-punctata*).

2. Comparing the concentration of beetles on plants sprayed on the two different parts: the spray on upper parts overwhelmingly favored *H. convergens* (significant at 0.01 level) but no significant differences (even at 0.05 level) were evident in the cases of *H. 13-punctata* and *C. maculata.*

3. When the area of all the blocks (i.e. plot total) was considered, there were 31 *H. convergens* beetles when spray was not present. The population increased to 471 when spray was present. This means that sucrose concentrated about 15 times as many beetles as would have been expected in the area. Since sucrose merely retained those beetles that chanced onto the sprayed plants rather than actually attracting them, it may be inferred that beetles in an area at least 15 times as large as the observation plot must have dispersed freely. Similarly, *H. 13-punctata* beetles in an area nine times (26:3) as large moved around freely. In contrast, the results of *C. maculata* suggest that the dispersal was very limited (49:55). By merely assuming that beetles of this species moved from the control plants to the sprayed plants within the experimental plot, it is possible to account for the increased population on the sprayed plants. On the basis of the above analysis, it may be said that the mobility of *H. convergens*, *H. 13-punctata*, and *C. maculata* under the particular conditions showed roughly a ratio of 15:9:1.

Conclusion

The collection of beetles on the sticky traps suggests that *H. convergens* and *H. 13-punctata* move about more extensively than *C. maculata.* This contention is further substantiated by changes in the populations of beetles in the sucrose spray study. It was also shown that the distribution of beetles on plants is closely related to the manner of their dispersal. The populations of both species of *Hippodamia* increased throughout the study plot where sucrose solution was present, whereas the population of *C. maculata* scarcely changed. Under the con-

ditions of the present study, entomophagous *H. convergens* and *H. 13-punctata* are, respectively, about 15 and 9 times as mobile as omnivorous *C. maculata*. The results generally support the idea that entomophagous coccinellids are more nomadic than their phytophagous relatives. The adaptive significance of this difference is not difficult to see in light of the ephemeral and sporadic occurrence of most aphid populations sought by the former.

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Note on the Occurrence of *Anacampsis populella* (Clerck) (Lepidoptera: Gelechiidae) in Canada[1]

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In August, 1963, silver poplar trees in St. John's West, Newfoundland, were severely attacked by small leaf-rolling caterpillars. Larvae were taken from a poplar tree during mid-August, 1963, and reared in the laboratory. Moths that emerged were identified as of *Anacampsis populella* Clerck by Dr. T. N. Freeman, Entomology Research Institute, Canada Department of Agriculture, Ottawa, who also noted (in litt.) that this was apparently the first record of the species in Canada. Dr. K. Sattler (in litt.), Munich, Germany, confirmed the identification

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