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Occurrence and Food of Some Coccinellids (Coleoptera) in Ontario Peach Orchards[1]

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Abstract *Canad. Ent.* 96: 1149-1155 (1964)

Ten species of the larger, primarily aphidophagous, coccinellids were present in peach orchards of the Niagara Peninsula. *Adalia bipunctata* (L.) and *Coccinella trifasciata perplexa* Mulsant were the commonest. All were most numerous in the spring while the green peach aphid, *Myzus persicae* (Sulzer), was present but their population densities were low at all times, apparently because suitable prey was scarce. They were not attracted to dense populations of the European red mite, *Panonychus ulmi* (Koch), and were of no importance as predators of peach pests.

At least 7 species were bivoltine but the second generation was only partial.

Coccinellids were investigated during a study of predators in peach orchards of the Niagara Peninsula, particularly concerning their relations with phytophagous mites. A study of *Stethorus punctillum* Weise, an obligate predator of tetranychid mites, was published previously (Putman 1955), and Phillips (1963) discussed predation by *Hyperaspis proba proba* (Say) and *H. binotata* (Say) on *Pulvinaria vitis* (L.). This paper describes studies in peach orchards on the occurrence and food of the commoner, primarily aphidophagous coccinellids, the food habits of which were previously investigated in the laboratory (Putman 1957). Some field and laboratory observations on their life histories are also given.

The species concerned, and some revisions of names used in the previous paper, are:—*Coleomegilla maculata lengi* Timberlake, *Hippodamia tredecimpunctata tibialis* (Say), *H. parenthesis* (Say), *H. convergens* (Guérin-Méneville), *Adalia bipunctata* (L.), *Coccinella trifasciata perplexa* Mulsant, *C. transversoguttata richardsoni* Brown (*C. t. quinquenotata* Kirby and *C. t. nugatoria* Mulsant of Putman 1957), *C. novemnotata* Herbst, *Cycloneda munda* (Say) (*C. sanguinea* L. of Putman 1957), and *Anatis quindecimpunctata* (Olivier).

Occurrence on Peach Trees

Coccinellids, with other insects yielding to the same technique, were sampled each year from 1948 to 1954 and occasionally to 1960 in several plots of one or more orchards in the Niagara Peninsula. Most plots contained 100 or more trees. During the earlier years some plots received DDT or parathion in early July and later; others were left unsprayed. One branch on each tree was jarred with a stick or swept with a broad brush over a yard-square cotton sheet. Details and limitations of the method were given elsewhere (Putman 1955). Sampling was usually carried on weekly or biweekly from May to September, but was often interrupted by unsuitable weather and ripening of fruit. Larvae were also recorded from the samples of leaves taken for mite counts (Putman and Herne 1959).

The sampling method did not give an absolute measure of the numbers of the insects per tree or per unit area of orchard. Also, its efficiency gradually decreased during the season as growth of the fruit imparted greater inertia to the branches, and then suddenly increased after the fruit was harvested in late August

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or September, depending on the variety of peach. But the generally low density of the coccinellids was obvious, and approximate upper limits could be fixed by estimating the proportion of the tree from which the collecting tray intercepted the falling beetles, and in some plots by beating the branches repeatedly to ensure that all the beetles (and much of the fruit) were dislodged. The maximal density was probably not more than 25 beetles per mature tree. This was approached only a few times, during June, on trees with unusually dense populations of the green peach aphid, *Myzus persicae* (Sulzer). After *M. persicae* had left the trees in mid to late June, the density of adult coccinellids seldom reached five per tree and often averaged less than one, even in orchards that received no pesticides during the growing season. The small size and high variance of the samples did not justify a more detailed analysis of relations between population density and orchard environment.

The total number of larvae collected by jarring and brushing was only about 1/9 of the number of adults collected. In an orchard with an unusual abundance of *M. persicae* in May and June 1951, leaf counts showed up to 156 coccinellid eggs and 79 larvae per hundred leaves, but the highly contagious distribution of these stages gave very wide confidence intervals to such values. For most of the season eggs and larvae were nearly absent. Sixty-four per cent of 96 larvae collected in 1953 and 1954 were in the first instar, 17 in the second, 11 in the third, and 8 in the fourth. Because pupae may be on either leaves or twigs, they could not be sampled by the methods used for other stages, but their obvious scarcity on the trees suggested that less than 1% of the larvae reached maturity.

Larvae and adults of several coccinellid species were often conspicuous, though not sampled quantitatively, in August and September on aphid-infested annuals that sprang up after orchard cultivation ceased in early July.

Among a total of 888 adults identified in all years, 45.5% were *A. bipunctata*, 21.6 *C. t. perplexa*, 11.8 *C. m. lengi*, 8.4 *C. t. richardsoni*, 4.2 *H. t. tibialis*, 2.9 *C. novemnotata*, 2.2 *H. convergens*, 1.4 *A. quindecimpunctata*, 1.3 *C. munda*, and 0.7 *H. parenthesis*. *A. bipunctata* and *C. t. perplexa* remained the first and second most prevalent species throughout the period but the relative abundance of the other species varied from year to year. During the earlier years larvae were not identified to species. In 1953 and later, larvae in the third and fourth instars were identified with a field key constructed from reared larvae, and some first- and second-instar larvae were reared to later instars for identification. Among 93 larvae, 69% were *A. bipunctata;* other species were *C. m. lengi*, *H. t. tibialis*, *H. convergens*, *C. munda*, and *A. quindecimpunctata*. It is noteworthy that no larvae of *C. t. perplexa*, which was the second most abundant species among the adults, nor of the other *Coccinella* spp. were found. All fourth-instar larvae were *A. bipunctata*.

The predominance of *A. bipunctata* on the trees reflects more its arboreal habit than a greater overall abundance in the district. Of the coccinellids collected from various habitats for the laboratory studies reported previously, more of *A. bipunctata* were on woody plants and more of the other species mentioned herein on herbaceous plants, though some of all species occurred in both habitats. Hodek, Stary and Stys (1962) likewise found *A. bipunctata* to be chiefly arboreal in Europe. This difference in habitat preference is reflected in the behaviour of the larvae. The stout, short-legged larvae of *Coccinella* spp. tend to curl up and drop when disturbed. The more slender, active larvae of *C. m. lengi* and *Hippodamia* spp. were not observed to behave in this way but they scramble about when disturbed and are easily dislodged. Species of these genera are more adapted to low-growing plants which the larvae can easily reascend. On the other hand, larvae of *A. bipunctata* cling tenaciously to leaves. As noted above the only mature larvae on the trees were of this species, though earlier instars of other species were also found.

Seasonal Life Histories

It is remarkable that the life histories of our common coccinellids have never been carefully studied in eastern North America. Most American work on the bionomics of coccinellids, reviewed by Hagen (1962), has been done in the Pacific states under very different climates. Although the life histories were not specifically studied, some information was obtained during the orchard work reported here, observations in other habitats, and the laboratory studies on food habits.

The overwintered adults became active in late April and early May, and some of most species survived till mid July or rarely early August. One female of *A. quindecimpunctata* captured in May laid its last egg on 14 August. Adults of the spring generation first appeared in late June or early July while some of the parent generation were still living. The presence of ovipositing females or of immature stages in late August or September gave proof of two generations in all the species mentioned previously except *C. munda* and *A. quindecimpunctata*, which were too scarce to yield conclusive evidence.

The second generation of all these bivoltine species, with the possible exception of *C. m. lengi*, was only partial. Females maturing in an insectary or captured in the field in early July either oviposited within a few days or not at all, even after one or two months. The latter individuals were found on dissection to have extensive fat deposits and undeveloped ovaries, conditions indicating diapause in adult coccinellids (Hodek and Cerkasov 1958, 1961; Putman 1955). Most of the coccinellids collected in the orchards after June and dissected for food study as described later were also in diapause. *C. m. lengi* was an exception; most females caught in July and August were ovipositing.

Hodek and Cerkasov (1961) found that diapause in selected strains of *Coccinella septempunctata* L. could be prevented or induced by manipulation of the photoperiod, temperature, and to some extent, the food supply. However, a large proportion of field-collected beetles entered diapause regardless of environmental conditions. They concluded that the Czechoslovakian population of this species was a mixture of a univoltine strain with a genetically fixed, obligate diapause and a potentially multivoltine strain with a facultative diapause induced by short photoperiod and low temperature. This hypothesis could be applied to the bivoltine species in Ontario, again with the possible exception of *C. m. lengi.*

Parasitism

The braconid *Perilitus coccinellae* (Schrank) emerged from a number of adults of *C. m. lengi* collected in the field. As the beetles were held captive for varying periods no reliable values for the extent of parasitism could be obtained. This parasite was not recovered from the other coccinellid hosts listed by Hudon (1959) and Smith (1960). I have records of *C. m. lengi* parasitized by *P. coccinellae* at Vineland Station dating back to 1930, considerably before those of Hudon (1959). The parasite was identified under the synonym *Euphorus sculptus* Cresson by a member, now unknown, of the former Entomological Branch, Department of Agriculture, Ottawa.

Food of Orchard-collected Coccinellids

Most coccinellids taken by jarring during the orchard surveys from 1953 to 1960 were examined for food content. In 1953 the guts were dissected from the beetles, teased apart in a drop of Hoyer's medium on a microscope slide and the contents scanned under a microscope. In later years the beetles were kept individually in small glass vials until they died. The accumulated frass pellets were put in a small drop of 10% sodium hydroxide on a slide until they softened and then dispersed with a needle in a drop of Hoyer's medium. The slide had to be examined within about half an hour, before obscuring crystals and bubbles formed.

Dissection of the beetles sometimes showed liquid food in the gut, which was not shown by frass examination, and it also gave some evidence of the physiological state of the beetles through the development of the gonads and fat body. However, the need to dissect them soon after capture limited the number that could be examined in this way. The vials containing frass could be set aside until winter.

Although all but very small forms were fragmented, aphids, scales, thrips, tetranychid mites, and some other groups were easily identified by the structure of their appendages. Less than 10 per cent of the insects could not be identified to order. The approximate number of aphids could be determined by counting rostra and tarsi, and numbers of tetranychid mites by the cheliceral plates. In the Tetranychidae, *Panonychus*, *Tetranychus*, and *Bryobia* could be differentiated by characters of tarsi and body setae.

Nearly all guts or frass, even when otherwise devoid of food, contained small quantities of detritus consisting of amorphous and crystalline material resistant to charring and hence apparently mineral matter from the soil; vegetable matter including fragments of bark and epidermis, trichomes, pollen grains and fungal spores; and sometimes animal matter such as lepidopterous scales and setae of the European red mite, *Panonychus ulmi* (Koch). A similar assortment of materials was found in swabs from peach leaves; hence that in the alimentary tracts was probably ingested incidentally when the beetles cleaned their legs by drawing them between their trophi. This well-known habit of many, perhaps most, insects (see, for example, Mote, Wilcox and Davis (1926)) is probably especially frequent among coccinellids, which often contact sticky honeydew. Captive coccinellids spend much time grooming themselves. It is not unlikely that many of the smaller mites, especially the peach silver mite, *Aculus cornutus* (Banks), found in the gut contents were obtained incidentally in this manner. The small amount of digestible material such as pollen and spores in the detritus may help sustain the beetles when prey is scarce.

About half of the adult beetles had no solids in their guts apart from detritus. Among those dissected a few had liquid contents, probably honeydew or nectar from peach leaf glands. All the species fed on honeydew in captivity but it is available in peach orchards only in May and June before *M. persicae* leaves the trees, except where infestations of lecaniine scales occur. Leaf nectar is available till late July or early August on mature trees and still later on young, vigorous ones (Putman 1963). Adults of *C. m. lengi*, the three species of *Hippodamia*, *A. bipunctata*, and the three species of *Coccinella* were often seen feeding on the nectar, especially in midsummer.

Aphids were the commonest prey in terms of mass among those coccinellid species examined in appreciable numbers (Table I). This confirms the previous conclusion from field observation and the laboratory study that all the species treated in this paper, except possibly *C. m. lengi*, are primarily aphidophagous (Putman 1957). Several species of aphids were represented. Though most prevalent in beetles collected in May and June, some were eaten throughout the summer. Most of those eaten after *M. persicae* emigrated must have been

TABLE I
Numbers of adult coccinellids containing particular food items

Species	No. of beetles	Aphids	Coccoids	*P. ulmi*	Other arthropods	Pollen	Spores
C. M. lengi	79	19(4)[1]		13(99)	16	10	21
H. t. tibialis	18	4(4)		1(4)	4		
H. parenthesis	4					1	
H. convergens	18	2(2)		4(88)	1		
A. bipunctata	216	65(11)	13(3)	51(67)	35	1	1
C. tri. perplexa	73	19(4)	2(1)	11(92)	10		1
C. tra. richardsoni	66	19(13)	1(1)	4(5)	8	1	3
C. novemnotata	24	5(5)	1(1)	1(1)			
C. munda	9	2(3)		1(1)		1	

[1]Numbers in parentheses are the greatest number of the prey found in one beetle.

obtained elsewhere, probably from the weedy ground cover. This suggests that the coccinellids on the trees were transients.

Although the values in Table I suggest rather heavy predation on *P. ulmi*, this was not really so. Only a few beetles had eaten large numbers of the mite; for example, those *A. bipunctata* that had eaten mites contained an average of only 12. The mass of an aphid averages more than ten times that of a mite; hence the coccinellids had consumed a greater mass of aphids than of mites though mites were at least a hundred times more abundant than aphids on most trees during most of the season. These results agree with laboratory studies showing that *P. ulmi* is not suitable prey for most of these species of coccinellids (Putman 1957). The few coccinellids containing many mites were from plots with high mite densities, but the density of the mites had no apparent effect on that of the coccinellids.

Some plots had rather high densities of the brown mite, *Bryobia arborea* Morgan and Anderson, yet only six beetles had eaten it. The two-spotted spider mite, *Tetranychus urticae* Koch, and the four-spotted spider mite, *T. canadensis* (McGregor), were scarce in most of the plots and none were found in most species of coccinellids. In May 1953, *C. m. lengi* found feeding on colonies of *T. canadensis* on shoots from the trunks and lower branches of peach trees each contained as many as 40 of this mite. *A. bipunctata* and other species on the trees were not seen to feed on the mite nor did they contain any. Most beetles collected after June contained small numbers of *Aculus cornutus*, probably accidentally ingested during grooming. There was no evidence of active predation on this minute mite.

Very few of the coccoids *Pulvinaria vitis* (L.) and *Lecanium* spp. were eaten (Table I) though some plots were heavily infested. Other arthropods recognized in guts or frass in very small numbers were thrips, small nematocerous Diptera, a lepidopterous larva, a spider, coccinellid larvae (including *Stethorus punctillum*) and phytoseiid mites. Occasional beetles contained fragments of membrane that appeared to be chorion of insect eggs.

Guts of ten *C. m. lengi* contained large amounts of pollen, which were much greater than those picked up with detritus, and sometimes comprised the exclusive contents. The pollen appeared to be usually that of dandelion, *Taraxacum officinale* Weber. Some beetles of this species collected from dandelion flowers had guts distended with this pollen. One beetle each of four other species contained significant amounts of pollen (Table I).

Large numbers of fungal spores were found in 21 *C. m. lengi* but in only 5 of other species (Table I). Most spores were of *Alternaria* sp., apparently the "sooty mould" growing on the honeydew of aphids and scale insects. It is not known whether the beetles deliberately fed upon the fungus or whether they ate it incidentally while feeding on honeydew. One *C. m. lengi* contained large numbers of spores of the brown rot fungus, *Monilinia fructicola* (Wint.) Honey, probably acquired from decaying fruit.

Of 28 larvae of *A. bipunctata* examined, mostly in the second instar, 2 contained aphids; 12, *P. ulmi;* 2, *B. arborea;* and 1, a coccinellid larva. As coccinellid larvae, especially in the first two instars, may extract the body fluids but reject the exoskeletons of prey (Kaddou 1960), gut or frass examination cannot reveal all of their prey.

Most of the species examined appeared to utilize the same food items in similar proportions. *C. m. lengi* stands apart by its wider range of food. In the orchard it fed to a greater extent on *Tetranychus* spp. and on pollen and fungal spores, and in the laboratory it alone fed freely on *P. ulmi* and the eggs of the oriental fruit moth, *Grapholitha molesta* (Busck) (Putman 1957). Bartholomai (1954), Szumkowski (1955), and Harrison (1960), among others, reported this or other races of *C. maculata* to prey extensively on eggs and larvae of various Lepidoptera. Smith (1961) found that this was the only species, of three tested, whose larvae completed development on various pollens.

Some correlation between seasonal changes in food habits and changes in the population density of prey was shown by the greater proportion of aphids in beetles collected in May and June while *M. persicae* was present, and of *P. ulmi* later in the season when this mite had become abundant. Also, among 63 *A. bipunctata* captured from early May to 30 June, 41% had empty guts, while of 156 captured from 1 July to late September, 62% were empty. The greater proportion of unfed beetles during the latter part of the season may have resulted both from the scarcity of preferred prey and from the greater proportion of diapausing beetles in the population.

Conclusions

Though other factors may be involved, lack of prey can account for the low density of coccinellids on peach trees. The density of the most suitable prey, *M. persicae*, varies greatly from year to year and it is usually dispersed in small colonies over the trees. After late June the only possible prey ever present in numbers are *P. ulmi* and lecaniine scales, but these species are unsuitable for most coccinellids. *P. ulmi* is more acceptable to *C. m. lengi*, but though the mite is sometimes very abundant numerically its biomass per unit area is probably too small to support growth or oviposition of this coccinellid.

Most of the few coccinellids on the trees after early July are in diapause, when their nutritional requirements are lower and can possibly be satisfied by leaf nectar, detritus, and the few prey they chance to encounter.

It is obvious that coccinellids are of no importance as predators of insect or mite pests of peach in this district.

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The Caudal Appendage of Final-Instar Larvae of Some Porizontinae (Hymenoptera: Ichneumonidae)

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Abstract

Presence of a caudal appendage or tail in the last larval instar of three genera of the Porizontinae (Hymenoptera: Ichneumonidae) is reported. The structure is described and illustrated and it is suggested that it may be responsible for the jumping of cocoons known to occur in some of the species considered and not known in species that lack the tail.

An unusual structure, a caudal appendage or tail that arises from the tip of the last abdominal segment, was observed in the final-instar larvae of members of the Porizontinae (Hymenoptera: Ichneumonidae). It was found in the nine species of *Phobocampe* examined: *certa* (Vier.), *clisiocampae* (Weed), *crassiuscula* (Grav.), *disparis* (Vier.), *elyi* (Vier.), *geometrae* (Ashm.), n. sp. near *geometrae*, *pallipes* (Prov.), and *Phobocampe* n. sp.; in the two species of *Nepiera*: *marginata* (Prov.) and *oblonga* (Vier.); and in *Campoplex phthorimaeae* (Cush.).