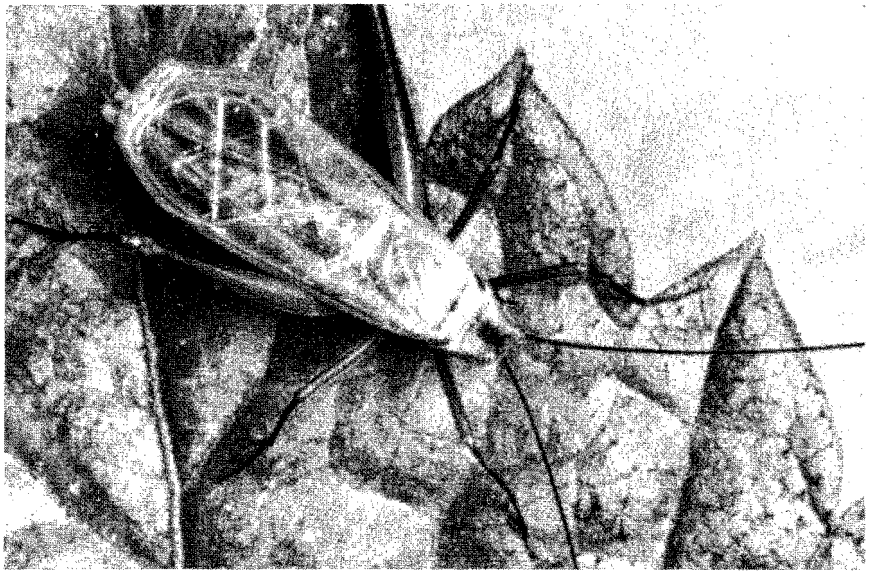
Vol. 25, No. 4 Winter 1992

THE GREAT LAKES ENTOMOLOGIST



PUBLISHED BY

THE MICHIGAN ENTOMOLOGICAL SOCIETY

ECOLOGICAL OBSERVATIONS ON PREDATORY COCCINELLIDAE (COLEOPTERA) IN SOUTHWESTERN MICHIGAN

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ABSTRACT

Ecological observations on habitat utilization by thirteen species of predatory Coccinellidae were made at a southern Michigan site during 1989 and 1990. Most of species were common during both years and used both agricultural and uncultivated habitats. *Coccinella septempunctata* and *Coleomegilla maculata*, were the most abundant in agricultural crops (alfalfa, maize, soybean and triticale), whereas *Adalia bipunctata* and *Cycloneda munda*, were the most abundant in deciduous and bushy habitats.

Biological control of insect pests is gaining increasing importance as issues such as environmental and health safety and long term sustainability become more and more critical. The importance of lady beetles as regulators of pests has been recognized since the late 19th century, when the cottony cushion scale outbreak in California, which threatened the citrus industry was controlled by the introduced vedalia beetle, *Rodolia cardinalis* Mulsant, (van den Bosch 1982).

There are over 400 species of Coccinellidae in North America with a wide range of life histories (Gordon 1985). The majority thrive in diverse habitats and are predators of soft-bodied insects (aphids, scale insects, mealybugs and others). Apart from feeding on Homoptera, some prey on early instars of Lepidoptera and Coleoptera (Hodek 1967). Some species are both pollenophagous and insectivorous. Both adults and larvae consume similar prey and can be found together when their prey is abundant. Lady beetles most often overwinter as adults in non-crop areas (field edges, old field-woodlot edges).

This paper presents ecological observations made on 13 species of Coccinellidae in southwestern Michigan during 1989 and 1990. Emphasis is placed on differences in habitat utilization by different species.

MATERIALS AND METHODS

Observations were made at Michigan State University's Kellogg Biological Station (KBS), Hickory Corners, Kalamazoo County, Michigan. A total of 880 ha are within the contiguous station holdings. Approximately 400 ha are devoted to agricultural research and production; 240 ha are in various stages of native succession, and the remaining 240 ha are in woodlots and plantation forests.

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Observations were made from May to October, 1989 and March to October, 1990 using yellow sticky traps, sweep net samples and visual counts. The habitats sampled represent the entire KBS area, including cereal crops (wheat *Triticum* sp., triticale X *Triticosecale*, and oat *Avena* sp.), field crops (maize *Zea mays*, soybean *Glycine max*), a forage crop (alfalfa, *Medicago sativa*), early succession, grasses, apple *Malus* sp. orchard, *Populus* plantations, deciduous trees, shrubs and bushes. The early succession was a abandoned crop field (after plowing in spring 1989) primarily consisting annual and biannual weeds. Alfalfa, early succession, deciduous and apple orchard habitats were sampled weekly during both years, and wheat, triticale, soybean, maize and *Populus* were sampled either of the two years depending on the availability of the habitat. Sample size in specific habitats depended on the number of patches available in the landscape.

Yellow sticky traps: Adult coccinellids were sampled weekly using double sided yellow sticky traps (22.5 cm x 14.0 cm, unbaited Pherocon, Zoecon, Palo Alto, CA) that were changed every two weeks. Varying numbers of traps were set up in all habitats depending on the size of the habitat patch (5 traps/ha).

Sweep samples: Adults and larvae were collected weekly from different habitats using a standard sweep net (37.5 cm diameter). Samples were collected from alfalfa, wheat, triticale, soybean, succession and grassy habitats. Fifty sweeps were made in each habitat each week. Each sample was put in a paper bag, labelled and brought to the laboratory where number of coccinellid larvae and adults were recorded.

Visual observations: Observations of adults were made in *Populus* and maize. This consisted of individual plant examinations or counts of insects in a given time. During 1989, in the *Populus* plantation (4-months old trees), an outbreak of brown aphids *Chaitophorus* sp., occurred in late July. Weekly visual examination of *Populus* trees (minimum of 50 trees sampled) from 8 to 30 August documented coccinellid adults and aphid incidence. During 1990, coccinellid adult counts were made weekly in maize fields for 2 min from 6 July to 30 August.

OBSERVATIONS

Thirteen species of coccinellids were observed during the two year survey. Of these 13 species, *Coccinella septempunctata* L., *Coleomegilla maculata lengi* Timberlake, *Adalia bipunctata* (L.), *Hippodamia convergens* Guérin-Meneville, *Hippodamia parenthesis* (Say), *Cycloneda munda* (Say), *Chilocorous stigma* (Say) and *Brachiacantha ursina* (Fab.) were commonly observed, and *Coccinella trifaciata perplexa* Mulsant, *Hyperaspis undulata* (Say), *Coccinella novemnotata* Herbst, *Hippodamia tredecimpunctata tibialis* (Say) and *Anatis labiculata* (Say) were occasionally observed. The mean number of adults of eight commonly observed coccinellid species in different habitats is shown in the Table 1. The relative abundance of these eight species in different habitats is expressed in percentages (Table 2).

Coccinella septempunctata is a Palearctic species which has recently been established in several regions of the United States (Angalet et al. 1979, Obrycki et al. 1987, Schaefer et al. 1987). In recent years this species has become established in Michigan (USDA 1990). It was introduced for control of several aphids. It is widely distributed in Eurasia and preys upon several aphid species in a variety of agroecosystems (Hodek 1973, Honek 1985).

Coccinella septempunctata was one of the most abundant coccinellids in agricultural crops during both years (Tables 1 & 2). It used wheat, triticale, oat, alfalfa, maize, soybean, *Populus*, horse weed *Conyza canadensis*, walnut

Table 1.—Mean number of adult Coccinellidae for varying time period in different habitats.

Species	Alfalfa[a] 1989 (N = 238) Mean ± SEM	Alfalfa[a] 1990 (N = 158) Mean ± SEM	Wheat[b] 1989 (N = 8) Mean ± SEM	Triticale[c] 1990 (N = 120) Mean ± SEM	Soybean[d] 1990 (N = 120) Mean ± SEM	Maize[e] 1990 (N = 99) Mean ± SEM
C. septempunctata	0.45 ± 0.05	0.91 ± 0.16	5.63 ± 0.31	0.35 ± 0.15	0.18 ± 0.04	0.36 ± 0.08
C. maculata	0.66 ± 0.06	0.74 ± 0.11	2.63 ± 0.39	0.85 ± 0.20	0.13 ± 0.04	1.34 ± 0.15
A. bipunctata	0.03 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
H. parenthesis	0.03 ± 0.01	0.06 ± 0.02	0.63 ± 0.06	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
H. convergens	0.19 ± 0.03	0.02 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
C. munda	0.42 ± 0.05	0.02 ± 0.01	0.00 ± 0.00	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00
C. stigma	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
B. ursina	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

[a]Mean based on 50 sweeps collected weekly from 17 alfalfa fields in 1989 (5 July to October 18) and from 8 alfalfa fields in 1990 (24 April to 16 October).
[b]Mean based on 50 sweeps collected weekly from 2 fields from 21 June to 26 July.
[c]Mean based on 50 sweeps collected weekly from 1 field from 24 April to 16 October.
[d]Mean based on 50 sweeps collected weekly from 12 fields from 12 June to 30 August.
[e]Mean based on 2 minute observations made weekly in each of 12 fields from 6 July to 30 August.

Table 1.—Continued.

Species	Early succession[f] 1989 (N = 9) Mean ± SEM	Early succession[f] 1990 (N = 84) Mean ± SEM	Deciduous[g] 1989 (N = 104) Mean ± SEM	Deciduous[g] 1990 (N = 194) Mean ± SEM	Apple orchard[h] 1990 (N = 1116) Mean ± SEM	Apple orchard[h] 1990 (N = 1840) Mean ± SEM	*Populus*[i] 1989 (N = 660) Mean ± SEM
C. septempunctata	0.22 ± 0.03	1.04 ± 0.20	0.12 ± 0.05	0.03 ± 0.01	0.09 ± 0.01	0.13 ± 0.01	0.07 ± 0.01
C. maculata	1.44 ± 0.10	0.08 ± 0.04	0.05 ± 0.02	0.08 ± 0.02	0.03 ± 0.01	0.13 ± 0.01	0.04 ± 0.01
A. bipunctata	0.00 ± 0.00	0.03 ± 0.02	0.08 ± 0.03	0.25 ± 0.06	0.14 ± 0.01	0.47 ± 0.04	0.31 ± 0.03
H. parenthesis	0.00 ± 0.00	0.08 ± 0.04	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00	0.01 ± 0.01	0.00 ± 0.00
H. convergens	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.14 ± 0.02
C. munda	0.00 ± 0.00	0.18 ± 0.05	2.62 ± 0.81	0.32 ± 0.13	0.23 ± 0.02	0.00 ± 0.00	0.02 ± 0.01
C. stigma	0.00 ± 0.00	0.00 ± 0.00	0.09 ± 0.03	0.28 ± 0.07	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
B. ursina	0.00 ± 0.00	0.00 ± 0.00	0.13 ± 0.05	0.09 ± 0.02	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

[f]Mean based on 50 sweeps collected weekly in 1989 (21 June to 30 August) and in 1990 (30 May to 30 August).
[g]Mean based on weekly yellow sticky trap catch in 1989 (5 July to 18 October) and in 1990 (15 March to 16 October).
[h]Mean based on weekly yellow sticky trap catch in 1989 (14 June to 7 August) and in 1990 (3 May to 13 September).
[i]Mean per tree based on visual observations made on 50–100 trees in 1989 (8–30 August).

Table 2. — Relative abundance (%) of adults of different species of Coccinellidae in different habitats at KBS.

Species	Alfalfa		Wheat	Triticale	Soybean	Maize	Succession		Deciduous		Apple Orchard		*Populus*
	1989	1990	1989	1990	1990	1990	1989	1990	1989	1990	1989	1990	1989
C. septempunctata	25	52	63	29	56	21	13	74	4	3	18	18	12
C. maculata	37	42	30	71	41	79	87	6	2	8	6	18	7
A. bipunctata	2	0	0	0	0	0	0	2	3	24	29	63	53
H. parenthesis	2	3	7	0	0	0	0	6	0	1	0	1	0
H. convergens	11	1	0	0	0	0	0	0	0	0	0	0	24
C. munda	23	1	0	0	3	0	0	12	84	30	47	0	3
C. stigma	0	0	0	0	0	0	0	0	3	26	0	0	0
B. ursina	0	0	0	0	0	0	0	0	4	8	0	0	0

Juglans nigra, apple orchard, early succession and grassy habitats. It was observed in almost every habitat during both years. Habitat preference of *C. septempunctata* depended upon availability of prey and disturbance (alfalfa cutting and wheat harvesting). During 1989, adults were abundant in wheat and alfalfa in May and June. Both larvae and adults were present in these habitats in June. The preference changed to walnut in mid-July and to *Populus* in late July when aphids built up there. During 1990 adults were abundant in alfalfa and triticale in May and June. Both larvae and adults were present in these habitats in June. The preference changed to succession habitats when aphids built up on horse weed in mid-July. The abundant food supply on horse weed stimulated oviposition and induced a second generation. Both annual and perennial habitats were important in supporting this predator. During the two years of observations *C. septempunctata* used aphid species *Acyrthosiphon pisum* (Harris) and *Therioaphis maculata* (Buckton) in alfalfa, *Chaitophorus* sp. in *Populus*, *Trioxys pallidas* (Haliday) in walnut, *Uroleucon* sp. in horse weed, *Rhopalosiphum maidis* (Fitch) in maize and *Macrosiphum avenae* (Fab.) in wheat as a food source. Our observations indicate that there are one to two generations per year depending upon food supply and weather.

Coleomegilla maculata lengi is a native coccinellid widely distributed east of the Rocky Mountains (Gordon 1985). It is polyphagous (Hodek 1973), feeding on aphids and other prey (certain Lepidoptera eggs and larvae) (Conrad 1959, Warren and Tadic 1967, Groden 1989), and pollen from a variety of plants (Putman 1964).

Coleomegilla maculata lengi was also one of the most abundant coccinellids in agricultural crops during 1989 and 1990 (Tables 1 & 2). It was associated with many habitats including wheat, triticale, oat, maize, alfalfa and dandelion *Taraxacum officinalis*, with low numbers in *Populus*, horse weed and early succession. During May and early June, it was abundant on dandelion in alfalfa. Dandelion pollen rather than insect prey appeared to be the primary reason for high numbers. During late June and mid-July adults and larvae were seen mainly in wheat; adults moved to maize in mid-July when maize started flowering. Both adults and larvae were seen in maize. In late August adults moved to alfalfa fields. Alfalfa at this time had a high number of aphids, primarily pea aphids *Acyrthosiphon pisum* (Harris). Both larvae and adults were seen in alfalfa. *Coleomegilla maculata lengi* started moving out of alfalfa fields after mid-September, even though aphids were still present in high numbers. At this time high numbers were observed on the edges of alfalfa fields in habitats that included weeds, grasses, shrubs, bushes and deciduous trees. This may represent movement toward overwintering sites.

Hippodamia convergens is by far the most abundant and widespread

species of *Hippodamia* in North America (Gordon 1985). It is mainly aphidophagous and seems to be mainly associated with alfalfa. In 1989, this species appeared late in the season (mid-August to mid-September). It was abundant in 1989, but during 1990 was observed in very low numbers. During 1989, it responded to late season brown aphid build-up and both larvae and adults were found in high numbers in young *Populus* plantations.

Adalia bipunctata is a widespread polymorphic species generally found in tree habitats (Hodek 1973). It is specially beneficial in orchards and groves where it is the most important coccinellid predator (Smith 1958, Putman 1964, Hodek 1973). We observed *A. bipunctata* adults in selected deciduous habitats with low numbers in alfalfa, early succession and maize. *Adalia bipunctata* was one of the most abundant species in managed deciduous habitats such as apple orchard and *Populus* (Tables 1 & 2). In 1989, both adults and larvae were found in high numbers in young *Populus* plantations where there was brown aphid build-up in August. During 1990 high numbers were found in apple orchard in early June. As many as 21 adults were trapped on a single yellow sticky trap in June.

Cycloneda munda is a widespread coccinellid in the eastern United States and primarily feeds on aphids (Gordon 1985). It was also one of the most abundant coccinellids in deciduous habitats although it also occurred in horse weed, alfalfa, maize and *Populus*. During 1989, it was found there until mid-August. As many as 67 adults were trapped on a single yellow sticky panel in bushy habitat over a week period in early August. After mid-August there was a sharp decline in their numbers in deciduous habitats which coincided with their first appearance in alfalfa fields. In late August 1989, adults were observed feeding on brown aphids on *Populus*. During 1990, this species responded to aphid (*Uroleucon* sp.), build-up in horse weed in late July and was found in high numbers. It was also seen in low numbers on maize during late August in both years.

Hippodamia parenthesis is a widespread nearctic aphidophagous coccinellid (Gordon 1985) found in a variety of grassy habitats and agroecosystems. We mainly observed this species in grassy and successional habitats, with low numbers in alfalfa and wheat. During August 1990, a high concentration of *H. parenthesis* larvae and adults were found in a grassy habitat mainly composed of *Agropyron repens*, *Andropogon virginicus*, *Bromus inermis* and *Phleum pratense*. As many as 15 adults were found in 50 sweeps. It also responded to aphid (*Uroleucon* sp.) build-up in horse weed in late July, 1990, and was in high numbers in horse weed during the time of aphid infestations.

Brachiacantha ursina, *Hyperaspis undulata*, *Chilocorous stigma* and *Anatis labiculata* were mainly found in deciduous habitats, and were not observed in crop fields. The *Hippodamia tredecimpunctata tibialis*, *Coccinella trifaciata perplexa* and *Coccinella novemnotata* were observed occasionally in low numbers in succession areas.

The two-year survey indicated that *C.septempunctata* and *Coleomegilla maculata lengi* seem to be generalized predators but tended to prefer agricultural crop plants and were the most abundant coccinellids in agricultural crops. *Adalia bipunctata* and *Cycloneda munda* were the most abundant species in deciduous and bushy habitats, however; *A. bipunctata* preferred managed deciduous habitats (apple orchard, *Populus*), whereas *C. munda* preferred the unmanaged deciduous and bushy habitats, but switched to field crops when the prey was available. *Hippodamia convergens* preferred alfalfa and *H. parenthesis* preferred the grassy habitats. *Chilocorous stigma* and *Brachiacantha ursina* preferred unmanaged deciduous habitats and were not observed in field crops.

Coccinella septempunctata has recently become established in Michigan and observations show that it has become one of the dominant species in

agricultural crops. Long term ecological observations are needed to see if the patterns of habitat utilization by different species are changing over time. If *C. septempunctata* becomes increasingly dominant, then further studies will be required to investigate any negative effects it may have on the native coccinellids, specifically on *Coleomegilla maculata lengi*, a dominant species in agricultural crops.

ACKNOWLEDGMENTS

This research was made possible with funding from the National Science Foundation (BSR89-06618) and the National Science Foundation LTER Program in Agricultural Ecology at Michigan State University (BSR87-02332). Aspects of this study were also partially supported by a grant from Rackham Foundation. Aphid species were identified by the Systematic Entomology Laboratory (Manya B. Stoetzel), ARS USDA, Beltsville, Maryland 20705.

LITERATURE CITED

Angalet, G. W., J. M. Tropp and A. N. Eggert. 1979. *Coccinella septempunctata* in the United States: recolonization and notes on its ecology. Environ. Entomol. 8:896-901.

Conrad, M. S. 1959. The spotted lady beetle, *Coleomegilla maculata* (De Geer), as a predator of European corn borer eggs. J. Econ. Entomol. 52:843-847.

Gordon, R. D. 1985. The Coccinellidae (Coleoptera) of America North of Mexico. J. New York Entomol. Soc. 93:1-912.

Groden, E. 1989. Natural mortality of the Colorado potato beetle, *Leptinotarsa decemlineata* (Say). Ph.D. Thesis, Michigan State University, East Lansing, Michigan. 221 pp.

Hodek, I. 1967. Bionomics and ecology of predaceous coccinellidae. Ann. Rev. of Entomol. 12:79-104.

_____. 1973. Biology of Coccinellidae. Junk, The Hague; Academia, Prague. 260 pp.

Honek, A. 1985. Habitat preferences of aphidophagous Coccinellids (Coleoptera). Entomophaga 30:253-264.

Obrycki, J. J., W. C. Bailey, C. R. Stoltenow, B. Puttler and C. R. Carlson. 1987. Recovery of the seven-spotted lady beetle, *Coccinella septempunctata* (Coleoptera: Coccinellidae), in Iowa and Missouri. J. Kansas Entomol. Soc. 60:584-588.

Putman, W. L. 1964. Occurrence and food of some coccinellids (Coleoptera) in Ontario peach orchards. Can. Entomol. 96:1149-1155.

Schaefer, P. W., R. J. Dysart and H. B. Specht. 1987. North American distribution of *Coccinella septempunctata* and its mass appearance in coastal Delaware. Environ. Entomol. 16:368-373.

Smith, B. C. 1958. Notes on relative abundance and variation in elytral patterns of some common coccinellids in the Belleville district (Coleoptera: Coccinellidae). Rpt. Entomol. Soc. Ontario 888:59-60.

USDA. 1990. Annual Report, USDA APHIS-PPQ, Biological control laboratory, Niles, Michigan.

Van den Bosch, R., P. S. Messenger and A. P. Gutierrez. 1982. An Introduction to Biological Control. Plenum Press, New York, 247 pp.

Warren, L. O. and M. Tadic. 1967. Biological observations on *Coleomegilla maculata* and its role as a predator on the fall webworm. J. Econ. Entomol. 60:1492-1496.