

# Release and Establishment of *Coccinella septempunctata*<sup>1</sup> in Oklahoma<sup>2</sup>

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## ABSTRACT

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From 1975-78, subcolonization releases were made of the originally Palearctic *Coccinella septempunctata* L. at 7 sites in 4 Oklahoma counties. Recoveries of *C. septempunctata* in Payne and Lincoln Counties are summarized for 1976-78 with no recoveries following releases in the other 2 counties. After introduction into Payne County, Oklahoma in 1975, the predator has survived 3 years and spread at least 5 km. Nine aphid species were found associated with recoveries of *C. septempunctata*. The three most common were *Acyrtosiphon pisum* (Harris), *Therioaphis maculata* (Buckton), and *Dactynotus ambrosiae* (Thomas).

*Coccinella septempunctata* L. is an aphidivorous coccinellid native to much of Asia, Europe, and North Africa. Hodek (1973) extensively reviewed a variety of work exemplifying the aphidophagy of *C. septempunctata*. Hodek has also been a primary contributor to the knowledge of dormancy, food relations, general biology, and ecology of this species. Hamalainen and co-workers (1975) described the fecundity and larval voracity; storage of adults reported by Hamalainen (1977a), and laboratory rearing by Hamalainen (1976). The insect's effectiveness against aphids of sweet peppers, chrysanthemums, and roses was discussed by Hamalainen (1977b). Ali and Azam (1977) attempted to curb dispersal of this beetle by starvation, spraying of sugar solution, and immobilization of the wings. Sundby (1968) discussed the effects of host aphids and artificial foods as well as the importance of hibernacula. Other biology and feeding behavior studies include Blackman (1965, 1967), Gurney and Hussey (1970), Aziz et al. (1969), Murdoch and Marks (1973), and Radke et al. (1977).

Introductions of *C. septempunctata* to the United States were begun with shipments from India to southern California in 1956 (Angalet, unpublished data). Shipments were followed by introductions from Europe to the Beneficial Insects Research Laboratory, Newark, DE, during 1958-73. Shands and co-workers (1972a, b) documented releases of *C. septempunctata* for aphid control in Maine; however, no evidence of establishment was found. Somewhat later, Angalet and Jacques (1975) reported the establishment of this predator on the east coast of the United States. Large numbers of beetles were found overwintering in aggregations centered in and around the Hackensack Meadowlands, Bergen County, of eastern New Jersey. Following this discovery, subcolonization efforts were initiated (1975) in Oklahoma. Most beetles that were released in Oklahoma were collected at the N J location by G. W. Angalet and the staff of BIRL. Subcolonization of established beneficials could be attempted without the completion of quarantine requirements. Therefore, establishment attempts of *C. septempunctata* were not dependent on mass rearing programs as were quarantined beneficials,

thus, possible genetic degradation caused by laboratory breeding was avoided (Mackauer 1976). It was our objective to take advantage of subcolonization and release large numbers of adult *C. septempunctata* in Oklahoma. The release and recovery of *C. septempunctata* are reported in this paper.

## Methods and Materials

Releases of the beetles were made in two ways depending on the time of year. First, diapausing adult *C. septempunctata* collected during the fall in the Meadowlands were released in "overwintering cages" of two types: 1) a large wooden frame cage (2.5 × 1.5 × 1.5 m) covered with screen wire and a plywood top, and 2) several small animal cages (28 × 28 cm with 1.2-cm screen wire mesh and a solid metal top). A variety of materials was placed in the cages in an attempt to provide a suitable microhabitat. Materials that were utilized for beetle overwintering inside cages included: pine clippings; artificial scotch pine; dried mullein, (*Verbascum thapsus* L. leaves); excelsior; styrofoam packing; and wood chips. In the spring, cages were opened to release beetles to adjacent vegetation infested with aphids. The smaller cages, buried in hedgerows, allowed emigration of the beetles to surrounding leaf litter during warmer temperatures (above 20°C). The release habitats were intentionally varied with alfalfa being the most frequent release crop (Table 1). A 2nd mode of release was to liberate spring and summer collected beetles directly into the habitat chosen for releasing beetles. Most releases were divided into groups in each field rather than being placed in one point depending on the number of beetles available for release and on the size of the field.

Wherever possible, a systematic recovery system was attempted. This included dividing fields (less than 10 ha) into 5 sections according to direction. Twenty standardized sweeps with 38 cm diam net were taken in each section (NE, NW, SE, SW, and Central). Additional sweeps were taken proportionally for fields larger than 10 ha. "Walking counts" (visual counts/given linear distance, usually ca. 35 m) were made in habitats where sweeps could and could not be made. In addition, general visual searches were made in areas where *C. septempunctata* might be found.

When recoveries occurred, host plant and host aphid collections were made. Unknown host plants were determined by Dr. Ronald Tyrl, Dept. of Botany, O.S.U., Stillwater, OK. Aphid determinations were made by Dr. Manya Stoetzel, USDA-SEA-IIBII, Beltsville, MD.

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Table 1.—Releases of *Coccinella septempunctata* in Oklahoma 1975–78.

Release site	Date	County	Habitat <sup>a</sup>	No. released	Intended host aphid
Perkins, OK (PER)	5-Aug.-75	Payne	Sor.; Var.	1,125	<i>Schizaphis graminum</i> (Rondani)
Perkins, OK (PER)	12-Aug.-75	Payne	Sor.;	725	<i>S. graminum</i>
W. of Stillwater, OK (FGH)	12-Aug.-75	Payne	Var.	245	<i>Dactynotus ambrosiae</i> (Thomas)
Perkins, OK (PER)	18-Aug.-75	Payne	Var.	870	<i>S. graminum</i>
Stillwater, OK (Campus)	18-Aug.-75	Payne	Var.	291	<i>Myzocallis kahawaluokalani</i> Kirkaldy
Idabel, OK	19-Aug.-75	McCurtain	<i>Pinus</i> sp.	582	<i>Cinera</i> sp.
Burneyville, OK	20-Aug.-75	Love	<i>Caryae</i> sp.	883	<i>Monellia</i> sp.
Perkins, OK (PER)	15-Mar.-76	Payne	Var., Peas	15,997	<i>Acyrtosiphon pisum</i> (Harris)
Lake Carl Blackwell (LCB)	30-Oct.-77	Payne	Peas, Wheat	13,000	<i>A. pisum</i> & <i>S. graminum</i>
Fowler, OK (FOW)	4-Apr.-78	Lincoln	Alf.	6,500	<i>A. pisum</i>
Fowler, OK (FOW)	18-Apr.-78	Lincoln	Alf.	6,279	<i>A. pisum</i>

<sup>a</sup> Sor = Sorghum (*Sorghum bicolor* (L.)), Alf = Alfalfa (*Medicago sativa* (L.)), Var = Variety of crops (more than 3), Peas = Austrian Winter Peas.

## Results and Discussion

### Releases

In 1975, a total of 4721 adult *C. septempunctata* was released in 3 counties at 5 different sites (8% died in shipment, Table 1). These beetles were collected during late summer and presumably were not in diapause but were no longer ovipositing. Generally, the beetles dispersed fairly rapidly and a few were found several days following each release. Three hundred seventy of the 1125 beetles released near Perkins, OK. (PER) on Aug. 5, 1975, were found dead within a 3-m radius of the release point 24 h after release. A search of the area following release gave no evidence of progeny.

Two releases were made Aug. 12, 1975; 725 adults were released in sorghum infested with greenbugs, *Schizaphis graminum* (Rond.) on the Oklahoma Agricultural Experiment Station near Perkins, OK (ca. 0.5 km from the Aug. 5 release site); and 245 adults were released near the Forestry greenhouse (FGH) on *Ambrosia* sp. infested with *Dactynotus ambrosiae* (Thomas). Both releases of Aug. 12 failed to produce progeny. However, beetles released at FGH remained and fed near the release site for at least one week. The relatively rapid dispersal was probably due to lack of sufficient cover at the Perkins release sites. No progeny were recovered following 3 other releases during Aug. 1975 that were

made at 3 different locations. Failure of *C. septempunctata* to produce progeny in 1975 was possibly due to the exhibition of univoltinism (Angalet, unpublished data), and thus, the adults, when released, were physiologically beyond reproduction.

On Nov. 7, 1975, 27,000 adult *C. septempunctata* were placed in 2 wooden frame cages (2.5×1.5×2.5 m) filled with overwintering materials. Winter mortality totaled 11,003 (ca. 41%) and on Mar. 15, 1976 the surviving 15,997 adults were released into a 2-ha field of Austrian winter peas surrounded by a variety of other crops including wheat, peaches, and apples. Dispersal of the beetles following this release was much slower since cover and an abundance of aphids were present. An F<sub>1</sub> generation was recovered during the following weeks until vegetation was removed in preparation for summer crop planting.

On Oct. 30, 1977, 13,000 beetles were released (1000/cage) from the "small animal cages" placed along the hedgerows adjacent to both Austrian winter peas (ca. 0.5 ha) and winter wheat (ca. 25 ha) located near Lake Carl Blackwell (LCB). Many beetles emigrated from the cages to nearby leaf litter and grasses when temperatures were above 20°C.

In Apr. 1978, two releases were made in an alfalfa field near Fowler, OK (Lincoln County). The beetles were collected at the Hackensack Meadowlands, NJ dur-

Table 2.—Recoveries of *Coccinella septempunctata* in Payne County, OK, 1976.

Date	Location <sup>a</sup>	No. recorded <sup>b</sup>	Habitat <sup>c</sup>	Aphid(s) present	Distance from nearest release <sup>a</sup>
30 Apr.	LCB	1 pupa	Wheat	None	13.3 Km (FGH)
5 June	FGH	2	Hedgerow	None	— (FGH)
5 June	W Stw	2	Vetch	<i>Acyrtosiphon pisum</i> (Harris)	0.83 Km (FGH)
15 June	W Stw	1	Alfalfa	<i>A. pisum</i>	2.5 Km (FGH)
27 Aug.	FGH	2	Hedgerow	None	— (FGH)
3 Sep.	FGH	1	<i>Ambrosia</i> sp.	None	— (FGH)
17 Sep.	FGH	1	<i>Helianthus</i> sp.	None	— (FGH)
19 Nov.	FGH		Inside greenhouse	None	— (FGH)
Total		11			

<sup>a</sup> FGH = Forestry Greenhouse Area; LCB = Lake Carl Blackwell; PER = Perkins; CC = "Cow Creek Area", W Stw = West of Stillwater, Ok. (but not at other sites); VT = "VoTech Area."

<sup>b</sup> All *C. septempunctata* recovered were adults unless otherwise noted.

<sup>c</sup> Wheat = *Triticum aestivum* L.; Vetch = *Vicia* sp.; Alfalfa = *Medicago sativa* L.

Table 3.—Recoveries of *Coccinella septempunctata* in Payne County, OK, 1977.

Date	Location <sup>a</sup>	No. recorded <sup>b</sup>	Habitat <sup>c</sup>	Aphid(s) present	Distance from nearest release <sup>a</sup>
12 Mar.	VT	>50 All stgs.	Wheat	<i>Rhopalosiphum padi</i> (L.)	2 Km (FGH)
9 Apr.	FGH	>25	Hedgerow, vetch	<i>Acyrtosiphon pisum</i> (Harris)	— (FGH)
20 Apr.	CC	1	Alfalfa	<i>A. pisum</i>	2 Km (FGH)
3 May	W Stw	1	Vetch	<i>A. pisum</i>	4 Km (FGH)
7 May	CC	1	<i>Convolvulus arvensis</i>	None	2 Km (FGH)
24 May	FGH	7	Vetch, clover	<i>A. pisum</i>	— (FGH)
2 June	FGH	5	Vetch, clover	<i>A. pisum</i> <i>Therioaphis maculata</i> (Buckton)	— (FGH)
5 Oct.	FGH	1	Hedgerow	None	— (FGH)
26 Oct.	FGH	1	Bare ground	None	— (FGH)
22 Nov.	PER	1	Wheat	<i>R. padi</i> ; <i>Schizaphis graminum</i> (Rond.)	— (PER)
Total		>92			

<sup>a</sup> FGH = Forestry Greenhouse Area; LCB = Lake Carl Blackwell; PER = Perkins; CC = "Cow Creek Area"; W Stw = West of Stillwater, OK (but not at other sites); VT = "Vo Tech Area."  
<sup>b</sup> All *C. septempunctata* recovered were adults unless otherwise noted.  
<sup>c</sup> Wheat = *Triticum aestivum* L.; Vetch = *Vicia* sp.; Clover = *Trifolium* sp.

ing Mar. 1978, and were presumably initiating diapause termination when released. The 1st release on Apr. 5 involved 6,500 adults and the release made on Apr. 12 included 6279 adults.

Recoveries

Numbers of recovered beetles listed in Tables 2–4 show only the numbers of beetles collected. A ">" indicates more beetles were observed at the collection site than actually were collected.

Table 2 lists recoveries of *C. septempunctata* in Payne County for 1976. The 1st recovery, a pupa found Apr.

30, 1976, near LCB, was taken to the laboratory and reared for determination. This recovery was made ca. 13 km from the nearest release site (FGH). Ten other specimens were recovered west of Stillwater, OK near the FGH during 1976.

In 1977, 92 total beetles were recovered (Table 3). All recoveries, except one beetle found near the Perkins release site, were made within 4 km of the FGH release site.

In 1978, 139 *C. septempunctata* were recovered at 9 different locations in Payne County (Table 4). The recoveries at the "Forestry greenhouse" "Cow Creek",

Table 4.—Recoveries of *Coccinella septempunctata* in Payne County, OK, 1978.

Date	Location <sup>a</sup>	No. recorded <sup>b</sup>	Habitat <sup>c</sup>	Aphid(s) present	Distance from nearest release <sup>a</sup>
15 May	CC	ca. 50 All stgs.	<i>Ambrosia</i> sp.	<i>Dactynotus ambrosiae</i> (Thomas)	— (FGH)
19 May	FGH	1	VET; CLO	<i>Acyrtosiphon pisum</i> (Harris)	— (FGH)
19 May	E. of LCB	19	ALF	<i>A. pisum</i>	2.5 Km (LCB)
19 May	LCB	16	WHE; PEA	<i>A. pisum</i>	— (LCB)
24 May	CC	14	VAR		1.5 Km (FGH)
25 May	CC	13	ALF; CLO; JOH	<i>A. pisum</i> <i>Rhopalosiphum maidis</i> (Fitch)	1 Km (FGH)
25 May	VT	1	ALF	<i>A. pisum</i>	2 Km (FGH)
30 May	W Stw	2	CTW		0.5 Km (FGH)
8 June	W Stw	8	VET	<i>A. pisum</i> <i>Therioaphis maculata</i> (Buckton)	4 Km (FGH)
8 June	LCB	5	PEA	<i>A. pisum</i>	— (LCB)
8 June	W Stw	4	VET	<i>A. pisum</i>	7 Km (FGH)
8 July	PER	1	SOR	<i>R. maidis</i>	— (PER)
27 July	FGH	2	<i>Ambrosia</i> sp.	<i>D. ambrosiae</i>	— (FGH)
3 Oct.	CC	1	fence	None	1 Km (FGH)
9 Oct.	CC	1	grass	None	1 Km (FGH)
1 Nov.	CC	1	grass	None	0.5 Km (FGH)
Total		139			

<sup>a</sup> FGH = Forestry Greenhouse Area; LCB = Lake Carl Blackwell; PER = Perkins; CC = "Cow Creek Area"; W Stw = West of Stillwater, OK (but not at other sites); VT = "VoTech Area."  
<sup>b</sup> All *C. septempunctata* recovered were adults unless otherwise noted.  
<sup>c</sup> VET = Vetch (*Vicia* sp.); CLO = Clover (*Trifolium* sp.); ALF = Alfalfa (*Medicago sativa* L.); WHE = Wheat (*Triticum aestivum* L.); PEA = Austrian Winter Peas (*Pisum* sp.); SOR = Sorghum (*Sorghum bicolor* L.); JOH = Johnsongrass (*Sorghum halepense*); CTW = Cottonwood (*Populus deltoides* Marsh); VAR = Variety of Crops.

"Vo-tech" areas and "west of Stillwater" were probably offspring from the beetles released at FGH in 1975 since none were later released at that site. These recoveries indicate that *C. septempunctata* has survived for 3 years west of Stillwater, OK. Populations appeared to be most concentrated in the FGH area.

Recovery of a single adult was made near the PER release site. This, when combined with the single adult recovered in 1977, make annual recoveries for 2 consecutive years after the last release and 3 consecutive years since the initial release at that location. Thus, establishment at LCB seems likely but not conclusive. Beetles recovered at LCB in 1978 were probably the progeny of those released Oct. 30, 1977, however, the pupa found on Apr. 30, 1976 may indicate establishment had already been accomplished by spread of those released at FGH site. Confirmation of establishment at LCB will be more definite if specimens are recovered in 1979.

Recoveries made near Fowler, OK, Lincoln Co., following a release in April 1978 indicate an  $F_1$  generation was produced. Peak recoveries of *C. septempunctata* were made on May 22 and June 1. Immatures were recovered as early as May 1. Beetles were recovered on several occasions during the remainder of the season including July 21 (13 specimens), Aug. 4 (1 specimen), and Aug. 11 (6 specimens). No beetles were recovered after Aug. 11. Only a few aphids could be found at this time. Establishment of *C. septempunctata* at Fowler is not certain until future recoveries are made.

Criteria for judging establishment of new introductions of natural enemies as temporary or permanent are not well defined. DeBach and Bartlett (1964) state that 3 years must elapse in order to conclusively claim establishment. In Payne Co., OK., *C. septempunctata* satisfies this criterion. Interestingly, the most successful establishment site is west of Stillwater (FGH), where only 245 *C. septempunctata* were released.

#### Aphids Present

Nine species of aphids were found on vegetation associated with recoveries of *C. septempunctata* during 1976-78. Several other aphid specimens were collected on host plants different than those in Table 5 but identifications could not be made since no alate forms were found. Generally, *Acyrtosiphon pisum* (Harris), *Therioaphis maculata* (Buckton), and *Dactynotus ambrosiae* (Thomas) were the most abundant aphid species in confirmed areas of establishment.

The importance of *C. septempunctata* in limiting populations of the greenbug is discussed by Sisidko and Skylar (1974). Though several releases were made in areas containing greenbugs, no *C. septempunctata* were observed feeding on them in the field. Previous laboratory observations have shown that recovered *C. septempunctata* will feed on greenbug (Cartwright, unpublished data) indicating that it is at least an acceptable prey of *C. septempunctata*. Differences in food habits of *C. septempunctata* reported by different authors might be explained by the existence of different strains of *C. septempunctata*.

In summary, *C. septempunctata* has shown the ability to survive at least 3 years near release areas. Intra-field dispersal may be rapid as Ali and Azam (1977) found *C.*

Table 5.—Aphid species present with recoveries of *C. septempunctata* in OK, 1976-78.

Aphid spp.	Host plant
<i>Acyrtosiphon pisum</i> (Harris)	<i>Vicia</i> sp.; <i>Medicago sativa</i> L.
<i>Rhopalosiphum padi</i> (L.)	Wheat ( <i>Triticum aestivum</i> L.)
<i>Rhopalosiphum maidis</i> (Fitch)	<i>Sorghum bicolor</i> L.; <i>Sorghum halepense</i> L.
<i>Schizaphis graminum</i> (Rondani)	<i>S. bicolor</i> ; <i>T. aestivum</i> , Sorghum, wheat
<i>Macrosiphum euphorbiae</i> (Thomas)	<i>Chenopodium album</i>
<i>Dactynotus rudbeckiae</i> (Fitch)	<i>Rudbeckia amplexicaulis</i>
<i>Therioaphis riehi</i> (Boerner)	<i>M. sativa</i>
<i>Therioaphis maculata</i> (Buckton)	<i>M. sativa</i>
<i>Dactynotus ambrosiae</i> (Thompson)	<i>Ambrosia</i> sp.

*septempunctata* to be a strong flier. Observations during this study and those by Angalet (unpublished data) indicate that the spread by this species to new areas was very gradual. This contrasts with the rapid dispersal of collected *Hippodamia convergens* (G.-M.) that aggregate in the Sierra Nevada Mountains (DeBach and Hagen, 1964). Due to its non-dispersive nature, *C. septempunctata* may play an important role in biological control of aphids in Oklahoma and other newly subcolonized areas. Additional research would determine the impact of its introduction on aphid pests in Oklahoma.

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