

The *Brachiacantha* (Coleoptera: Coccinellidae) of Illinois

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ABSTRACT

The Illinois species of *Brachiacantha* are described and discussed. The Illinois fauna includes six species; *B. ursina*, *B. decempustulata*, *B. felina*, *B. quadripunctata*, *B. dentipes* and *B. indubitabilis*. A key to the identification of adults, descriptions and habitus photographs are provided for each species. State distribution maps are provided for the four *Brachiacantha* species for which numerous Illinois records were found. Also discussed is the species status of *B. rotunda* Gordon, which we here reduce to synonymy with *B. felina*. Malaise traps, sweep netting, yellow sticky traps and visual inspection of plant material were effective collecting procedures in deciduous forest habitats; U-V light traps and pitfall traps did not collect *Brachiacantha*. The larvae of only two species are known and both have been identified as myrmecophiles. The evolutionary basis of this *Brachiacantha*-ant relationship is discussed.

INTRODUCTION

The Coccinellidae (ladybird beetles) are well known members of the order Coleoptera. Fifty-seven genera and more than 475 species are currently recognized in the family Coccinellidae from America north of Mexico (Gordon 1985, Gordon and Vandenberg 1991). In temperate regions many of these beetles are considered beneficial as predators on pest insects. In tropical regions, some species are economically important plant feeders (Belicek 1976).

Beetles of the family Coccinellidae are round to elongate oval, and convex to weakly convex. Their colors are usually red, orange, or yellow, with black maculations, or black with red or yellow markings. Antennae are clavate, with 11 antennomeres, sometimes reduced to 10, 9, 8, or 7. The apical segments of the maxillary palpi are securiform, parallel sided, or conical. The elytra are either pubescent or glabrous, but not truncate or striate. The prosternal process distinctly separates the transverse front coxae. The abdomen has 5-7 visible sternites and a postcoxal line is nearly always present on the first abdominal sternite. The tarsal formula is 4-4-4 and often cryptotetramerous, or truly 3-3-3. Tibial spurs are either present or absent; tarsal claws are simple or toothed. Male genitalia consist of a curved, sclerotized aedeagus, with trilobed phallobase. Larvae are campodeiform, usually with numerous setae, and often colored in contrasting colors of black, brown, yellow, or orange.

Adult beetles of the genus *Brachiacantha* (from the Greek "brachys" meaning short and "akantha" meaning thorn) are rounded to elongate oval and strongly convex. Their color is black with variable patterns of yellow to orange spots, some of which may become confluent. The antennae have 11 antennomeres, with the insertions concealed ventrally. The eyes are narrowly emarginate by the expansion of the epistoma. The epipleura are strongly excavated for reception of the middle and hind femoral apices. The prothoracic tibiae are flanged or grooved and have distinct spines (Figs. 1 & 2). Tarsal claws have large, basal, quadrate lobes. The emarginate eyes and the spines on the prothoracic tibiae easily distinguish *Brachiacantha* from all other members of the Hyperaspini, particularly *Hyperaspis* species, which they closely resemble.

Brachiacantha is a New World genus with 50 species and subspecies currently recognized, ranging from Canada to Argentina. Twenty-six species and subspecies are recognized from America north of Mexico (Gordon 1985). Two North American species of the genus have been found to be myrmecophilous as larvae, in nests of ants of the genus *Lasius*, where they feed upon root aphids and root coccids (Smith 1886, Wheeler 1911). Adults are found on vegetation in deciduous forest habitats (Blatchley 1910, Maredia, et al. 1992).

The purposes of this research were to: (1) determine the *Brachiacantha* species occurring in Illinois, (2) provide descriptions and a key to those species, (3) record the distribution and seasonal occurrence of each species within the state, and (4) add to our knowledge of the biology of these species where possible.

METHODS

A total of 1810 specimens of *Brachiacantha*, 430 of which were from Illinois, were examined and identified. These specimens were collected in the context of this research, or borrowed from 18 institutions and private collections. Data from all specimens collected or examined from Illinois are cited in the "Systematic Account of the Species" with museum acronyms as follows: Brian Baldwin Collection, Little Rock, AR, (BBBC); Eastern Illinois University, Charleston, IL, (EIUC); Field Museum of Natural History, Chicago, IL, (FMNH); Florida State Collection of Arthropods, Gainesville, FL, (FSCA); Hastings College, Hastings, NE, (HCCA); Illinois Natural History Survey, Champaign, IL, (INHS); Illinois State University, Normal, IL, (ISUC); Louisiana State University, Baton Rouge, LA, (LSUC); P. E. Skelley Collection, Gainesville, FL, (PESC); Purdue University, West Lafayette, IN, (PURC); Southern Illinois University, Carbondale, IL, (SIUC); University of Arkansas, Fayetteville, AR, (UADE); University of Kentucky, Lexington, KY, (UKYC); University of Michigan, Ann Arbor, MI, (UMMZ); University of Missouri, Columbia, MO, (UMRM); University of Wisconsin, Madison, WI, (UWEM); Washington State University, Pullman, WA, (WSUC); Western Illinois University, Macomb, IL, (WIUC).

Several techniques were employed to collect additional *Brachiacantha* for this study. Malaise traps, as described by Townes (1972), provided a continuous collection method for flying insects. These traps were equipped with "wet" head type collecting jars containing 80% ethanol. Collecting jars were replaced weekly from early spring to early

winter. Malaise traps have been monitored and maintained in 10 different woodland sites in Illinois over the past decade by one of us (MAG) and two of his graduate students, J. W. Griffiths and R. S. Hanley.

Yellow sticky traps were also used to collect *Brachiacantha* adults. These traps were made of thin plastic, 6 by 12 inches, with a coating of "Tangle-trap." They were suspended by cotton string from tree branches, usually near the bank of a small stream at three different woodland sites in Clark, Coles and Hardin counties in Illinois. Specimens were removed from sticky traps in the field with forceps and placed in screw-top glass vials containing 80% ethanol. Cleaning the "Tangle-trap" material, usually polyisobutylene (PIB), from these specimens required a 24-48 hr bath in pure lemon extract, followed by a 24-48 hr bath in xylene.

Sweep sampling of ground cover and lower tree foliage, using a 12 inch standard insect net, visual collection of specimens from foliage, pitfall trapping and U-V light trapping were also employed to collect adult *Brachiacantha* at many woodland locations in Illinois.

Collection of adult *Brachiacantha* was concentrated in deciduous forest habitats. Wooded habitats were selected as a result of previous collecting experience. Preliminary collecting studies were conducted from May to November of 1993, consisting of weekly "20 sweep samples" in each of three other distinct habitats. These habitats were: a commercial apple orchard located seven miles southeast of Charleston, Illinois, a grassy field located south of the boundary of Fox Ridge State Park in Coles County, and a prairie restoration area at the entrance to Fox Ridge State Park. These studies, although successful in collecting several genera of coccinellids, yielded no specimens of *Brachiacantha*. *Brachiacantha* were regularly taken in deciduous forests during the same period.

In examining adults in the laboratory, body lengths were measured with a dissecting microscope from the anterior margin of the pronotum to the apex of the elytra. Body widths were measured at the widest point between the lateral margins of the closed elytra.

The Illinois collection maps are based on locations taken from the labels of specimens examined in the course of this study.

RESULTS

Five *Brachiacantha* species collected in Illinois were examined and identified. Seen most commonly were *B. ursina*, *B. decempustulata*, *B. felina* and *B. q. quadripunctata*; more rarely collected was *B. dentipes*. A sixth species, *B. indubitabilis*, has been recorded for Illinois. Although no specimens of this species from Illinois were seen in this study, it has been included in the list of species because the lectotype for the species, designated by Gordon (1985), is an Illinois specimen in the LeConte collection.

Of the methods employed by us in this study to collect *Brachiacantha* adults, Malaise trapping proved to be the most successful with 94 specimens of three species collected; *B. decempustulata*, *B. felina* and *B. q. quadripunctata*. Sweep netting and visual

inspection of plant material (manual collecting) yielded 39 specimens of four species; *B. ursina*, *B. decempustulata*, *B. felina* and *B. q. quadripunctata*. Yellow sticky traps were effective in collecting 13 specimens of two species; *B. decempustulata* and *B. q. quadripunctata*. U-V light traps and pitfall traps were not successful in collecting specimens of *Brachiacantha*. Two species recorded for Illinois were not collected in the course of this study, *B. dentipes* and *B. indubitabilis*. Illinois specimens of *B. dentipes* were seen among museum specimens examined.

KEY TO THE *BRACHIACANTHA* SPECIES OF ILLINOIS

1. Prothoracic tibia with arcuate flange on outer margin (Fig. 1); male abdomen with 3rd sternite prominently bicuspid..... *B. dentipes*
 Prothoracic tibia not noticeably flanged, or if flanged, then flange not arcuate (Fig. 2); male abdomen with 3rd sternite lacking cusps.....2
2. Elytra black, with five yellow to yellow-orange spots on each elytron; spots may be partially confluent or confluent to the extent that each elytron is mostly yellow to yellow-orange3
 Elytra black, with less than five yellow spots on each elytron5
3. Form round *B. felina*
 Form oval to elongate-oval4
4. Less than 3.00 mm long; elytra black, with five small yellow spots on each elytron; elytra coarsely punctured, punctures separated by more than the diameter of a puncture..... *B. decempustulata*
 More than 3.00 mm long; elytra black, with five yellow to yellow-orange spots on each elytron, spots may be partially confluent or confluent to the extent that the elytron is mostly yellow to yellow-orange; elytra finely punctured, punctures separated by less than the diameter of a puncture *B. ursina*
5. Elytra black, with two yellow spots on each elytron, one basal and one apical; male with additional feeble humeral spot on each elytron.....
*B. quadripunctata quadripunctata*
 Elytra black, with 3 yellow spots on each elytron, two median, one apical*B. indubitabilis*

SYSTEMATIC ACCOUNT OF THE SPECIES

Genus *Brachiacantha* Dejean 1836

This genus differs from all other genera in the family Coccinellidae by the sum of the following characters: small size, 1.80 mm to 6.30 mm long; having emarginate eyes by the expansion of the epistoma; having small spines at the basal 2/5 of the prothoracic tibiae; two carinae may, or may not, be present on the prosternum, if carinae are present, they are slightly convergent apically; scutellum wider than long; epipleura nearly flat; postcoxal line on first abdominal sternite incomplete, of the *Scymnus* type. Male: frons mostly yellow; clypeus may be slightly darkened to dark brown; pronotum black, with broad yellow to orange anterolateral angles and a narrow to broad yellow to orange anterior margin, usually with an extension medially into apical margin of black area; metepisternum light yellow to yellow; seven abdominal sterna present. Female: head

yellow, except clypeus brown or black; pronotum black, except for broad yellow to orange anterolateral angles; six abdominal sterna present.

***Brachiacantha dentipes* (Fabricius)**

Diagnostic Description:

This species differs from other North American species of *Brachiacantha* by: having a yellow to orange apical spot and irregular median band on each elytron, varying in shape and width and sometimes separated into two large spots; and oblong to slightly oval body form. This species is easily the largest of the Illinois *Brachiacantha*. Overall length 4.75-6.30 mm; width 3.60-4.60 mm (Fig. 3). Male: pronotum black, with broadly yellow to orange anterolateral angles, narrow yellow to orange anterior margin with slight extension medially into apical margin of black area; third abdominal sternite with cusps separated by 1/2 the diameter of a cusp. Female: pronotum black, with only the anterolateral angles yellow to orange; abdominal sternites glabrous.

Distribution:

Found in eastern and midwestern North America, ranging in the north from New Hampshire to Ontario and Nebraska, in the south from Florida to Louisiana and northern New Mexico. We recorded a single specimen from Union County in southern Illinois. We also examined one museum specimen labeled only "IL." In addition, we have recorded museum specimens from seven locations in Missouri.

Seasonal Occurrence:

The Illinois specimen from Union County was collected 26 May 1972.

Remarks:

Brachiacantha dentipes was designated as the type-species for the genus by Crotch (1873). Because this species is uncommonly collected in Illinois, despite its large size, we suspect it has a more southerly distribution than Gordon (1985) suggests.

The immatures of this species have not been described.

Material Examined:

We examined 32 specimens of *B. dentipes*, two of which were from Illinois. **IL**, (1 INHS); **Union Co.**, Pine Hills, 26 May 1972 (1 SIUC).

***Brachiacantha ursina* (Fabricius)**

Diagnostic Description:

This species differs from other Illinois species of *Brachiacantha* by: having five yellow to yellow-orange spots on each elytron; a finely punctured elytral surface which gives it a slightly dull appearance; and elongate-oval body form. In some Midwestern specimens the elytral spots are partially to completely confluent, making the elytra mostly yellow to yellow-orange. Overall length 3.00-4.50 mm; width 2.10-3.20 mm (Fig. 4). Male: pronotum black, with anterolateral angles broadly yellow to yellow-orange, narrow yellow to yellow-orange anterior margin with the yellowish color extending medially into

the apical margin of black area. Female: pronotum black, with only the anterolateral angles yellow to yellow-orange.

Distribution:

Found in eastern and midwestern North America, ranging in the north from Newfoundland to Saskatchewan, in the south from South Carolina to Arkansas. Gordon (1985) reports a disjunct population in Louisiana. We recorded specimens from 29 Illinois counties ranging throughout the state (Fig. 9).

Seasonal Occurrence:

Adults have been collected in Illinois from 31 March through 12 October, with the greatest number of specimens collected in June.

Remarks:

Of the 134 adult specimens seen from Illinois, 26 (19.4%) are in the EIUC. Only eight of these 26 specimens (30.8%) have been collected since 1990 and all were manually collected. Although this species historically has been the most commonly collected in Illinois, it has not been collected in Malaise traps despite extensive Malaise trap collecting by one of us (MAG) and his graduate students in a variety of woodland habitats in the last decade. This is in contrast to three other *Brachiacantha* species which were frequently collected using this technique (Table 1).

Smith (1886) collected larvae of *B. ursina* in nests of ants of the genus *Lasius*. He reported that these larvae were not attacked by the ants even as they fed on the aphids domesticated by the ants. These larvae were described as being a "sordid whitish-yellow" and of similar form to other coccinellids. Smith also states that the larva "... excretes a waxy substance that exudes in long strings and gives the insect the appearance of being covered with cotton or hoar frost." Larvae of this species have not been collected since and a more complete and diagnostic description is needed.

Material Examined:

We examined 776 specimens of *B. ursina*, 134 of which were from Illinois. **IL**, (3 INHS); **N. IL**, (3 WSUC); **Adams Co.**, Quincy, 30 June 1951 (1 INHS), 1 July 1953 (1 INHS); **Bureau Co.**, Princeton, 2 July 1937 (2 INHS); **Carroll Co.**, Savanna, 15 June 1932 (1 INHS); Mt. Carroll, 15 June 1932 (1 INHS); **Champaign Co.**, 23 June 1926 (1 INHS); Cham., 4 June 1915 (1 INHS); Champaign, 30 May 192- (1 INHS); Urbana, 19 June 1940 (1 INHS), 28 June 1940 (1 INHS), 13 June 1941 (1 INHS); **Clark Co.**, Rocky Branch, Dolson, 25 June 1932 (1 INHS); **Coles Co.**, 16 June 1959 (1 EIUC), 14 June 1965 (1 EIUC), 17 June 1965 (1 EIUC), 27 June 1966 (1 EIUC), 15 June 1972 (1 UADE), 30 June 1985 (2 PESC); Charleston, July 1937 (2 EIUC), 7 June 1941 (2 INHS), 14 June 1962 (1 EIUC), 9 June 1965 (1 EIUC), 10 June 1966 (1 EIUC); Salisbury, 10 June 1934 (1 EIUC), 27 July 1935 (1 EIUC); **Cook Co.**, (4 FMNH); Skokie, 13 July 1953 (1 UMRM), 25 June 1955 (1 UMRM); **Cumberland Co.**, 2mi W. Toledo, 29 June 1993 (1 EIUC), 8 July 1993 (1 EIUC), 25 May 1996 (6 EIUC); **Du Page Co.**, Hinsdale, 10 June 1953 (4 INHS); **Hancock Co.**, A. L. Kibbe Life Sci. Sta., 25 June 1969 (1 WIUC), 6 July 1982 (1 WIUC); Hamilton, 6 July 1982 (1 WIUC); **Iroquois Co.**, Watseka, 4 June 1932 (1 INHS); **Jackson Co.**, Carbondale, 24 May 1961 (1 SIUC), 19 June 1963 (1 SIUC), 31 March 1964 (1 SIUC), 4 June 1979 (1 SIUC); Giant City, 27

May 1975 (6 SIUC); Murphysboro, 27 May 1965 (1 SIUC); SIU campus, 27 June 1974 (1 SIUC), 10 Sept 1974 (1 SIUC), 5 June 1975 (1 SIUC), 16 June 1975 (3 SIUC), 25 June 1975 (1 SIUC); **Jo Daviess Co.**, Galena, 30 June 1932 (4 INHS); Apple River Canyon St. Pk., 27 June 1940 (2 INHS); **Johnson Co.**, Grantsburg, 20 June 1940 (2 INHS); **Kane Co.**, Elgin, 16 June 1934 (1 INHS); Elgin, Prairie Hill, 2 Aug 1945 (1 INHS); **Lake Co.**, Beach, 26 June 1927 (1 FMNH); Lake Forest, 4 July 1952 (1 UMRM); Waukegan, 10 June 1933 (1 INHS); **Lawrence Co.**, Lawrenceville, June 1935 (1 EIUC); **Macon Co.**, 12 June 1983 (1 PESC), 10 June 1984 (3 EIUC); Decatur, 12 June 1935 (1 INHS); **McDonough Co.**, Fandon, 12 June 1979 (1 WIUC); Macomb, July 1957 (1 WIUC), 19 April 1968 (1 WIUC), 27 June 1982 (1 WIUC); **McLean Co.**, Bloomington, June 1963 (1 ISUC); Normal, 27 June 1883 (2 INHS); **Piatt Co.**, Monticello, 28 June 1932 (1 INHS); **Putnam Co.**, 12 June 1932 (2 INHS), 4 July 1932 (1 INHS); 1.5mi S. Putnam, 27 June 1984 (1 INHS); **Shelby Co.**, 24 June 1984 (2 EIUC); Shelbyville, Lakewood Rd., 8 Sept 1936 (1 EIUC); **Union Co.**, Cobden, 28 April 1884 (13 INHS); Pine Hills, 12 Oct 1974 (1 SIUC); Giant City St. Pk., 23 June 1963 (1 SIUC); **Vermilion Co.**, Forest Glen Preserve, 28-29 July 1975 (1 BBBC), 16 July 1976 (1 BBBC); **Wabash Co.**, Mt. Carmel, 6 June 1941 (4 INHS); **Williamson Co.**, Cartersville, 30 May 1961 (1 SIUC); **Winnebago Co.**, New Milford, 2 July 1936 (2 INHS); **Woodford Co.**, Spring Bay region, 21 June 1942 (1 INHS).

***Brachiacantha decempustulata* (Melsheimer)**

Diagnostic Description:

This species differs from all other North American species of *Brachiacantha* by: having five light yellow to yellow spots on each elytron; a sparsely punctured elytral surface, with the punctures separated by the diameter of a puncture or more; and oval, slightly elongate body form. Overall length 1.80-2.80 mm; width 1.30-2.00 mm (Fig. 5). Male: pronotum black, with anterolateral angles broadly yellow and narrow yellow anterior margin with yellow extending medially into the apical margin of black area. Female: pronotum black, with anterolateral angles yellow; pronotum occasionally with very narrow, pale yellow margin without extension into the black area.

Distribution:

Found in eastern and midwestern North America, ranging in the north from New Brunswick and Nova Scotia to North Dakota, in the south from Florida to Louisiana. We recorded specimens from 12 Illinois counties scattered throughout the state (Fig. 10). This species is probably much more widespread throughout the state but is not commonly collected because of its small size and infrequent collection by conventional means (see Remarks).

Seasonal Occurrence:

Adults have been collected in Illinois from 15 May through 7-14 September, with the greatest number of specimens taken in July (Table 2).

Remarks:

Of the 92 adult specimens seen from Illinois, 61 (66.3%) are in the EIUC. Of those 61 specimens, 54 (88.5%) have been collected since 1990. Malaise trapping yielded 41 specimens (75.9%), yellow sticky traps yielded 10 specimens (18.5%) and manual

collecting yielded only three 3 specimens (5.6%) (Table 1). More extensive Malaise trapping in forested areas throughout the state would probably add substantially to the Illinois county records.

The immatures of this species have not been described.

Material Examined:

We examined 181 specimens of *B. decempustulata*, 92 of which were from Illinois. **IL**, (1 INHS); **Clark Co.**, 5mi S.E. Casey, 21 Aug 1994 (1 EIUC); Rocky Branch, 8-20 Aug 1987 (2 EIUC), 16-21 July 1989 (1 EIUC), 11-18 June 1990 (1 EIUC), 18-25 June 1990 (1 EIUC), 15 July-4 Aug 1990 (1 EIUC), 7-14 Sept 1990 (1 EIUC), 13-24 June 1991 (1 EIUC), 30 June-7 July 1991 (1 EIUC), 7-14 July 1991 (1 EIUC), 14-21 July 1991 (1 EIUC), 30 July-8 Aug 1991 (1 EIUC), 8-19 Aug 1991 (1 EIUC), 9-27 Aug 1993 (1 EIUC), 9 July 1994 (1 EIUC), 8-12 July 1994 (3 EIUC), 15-29 July 1994 (1 EIUC); **Coles Co.**, 14 June 1965 (1 EIUC); Fox Ridge St. Pk., 13-20 July 1992 (1 EIUC), 17-24 July 1993 (1 EIUC), 8 Aug 1993 (1 EIUC), 24 July-1 Aug 1994 (3 EIUC), 1-7 Aug 1994 (2 EIUC), 21-28 Aug 1994 (1 EIUC); **Cook Co.**, Palos Park, 15 July 1908 (7 FMNH), 26 Aug 1910 (8 UMMZ), 25 Aug 1912 (1 UMMZ), 19 June 1916 (1 UMMZ); **Cumberland Co.**, Roslyn, 7 July 1950 (1 INHS); woods 8mi W. Toledo, 3 July 1932 (4 EIUC), 15 July 1932 (1 EIUC); **Edgar Co.**, 4mi S.S.E.. Kansas, 10-17 July 1994 (1 EIUC), 28 Jul-4 Aug 2000 (1 EIUC), 25 Aug-1 Sept 2000 (1 EIUC); **Jackson Co.**, 7mi W. Carbondale, 19-26 June 1993 (1 EIUC), 26 June-3 July 1993 (1 EIUC), 3-11 July 1993 (4 EIUC), 1-8 Aug 1993 (3 EIUC), 8-15 Aug 1993 (2 EIUC), 28 Aug-5 Sept 1993 (1 EIUC); Fountain Bluff, 15 May 1932 (1 INHS); **Jo Daviess Co.**, Apple River Canyon St. Pk., 27 June 1940 (4 INHS); **Peoria Co.**, Peoria, Detwailer Pk., 25 Aug 1960 (1 INHS); **Piatt Co.**, Monticello, 1 Aug 1908 (1 INHS); **Union Co.**, Pine Hills, 3 July 1972 (1 SIUC), 5 July 1974 (1 SIUC); **Vermilion Co.**, Danville, 16 July 1930 (1 INHS); **Wabash Co.**, 3mi S.E. Allendale, 8-18 July 1993 (2 EIUC); Beall Woods Nat. Pres., 26 July-3 Aug 1995 (4 EIUC), 3-10 Aug 1995 (1 EIUC), 17-24 Aug 1995 (1 EIUC), 20-27 June 1996 (1 EIUC), 17-25 July 1996 (1 EIUC), 30 Aug-6 Sept 1996 (1 EIUC), 6-13 Sept 1996 (1 EIUC), 2-10 July 1997 (1 EIUC).

***Brachiacantha felina* (Fabricius)**

Diagnostic Description:

This species differs from other Illinois species of *Brachiacantha* by: having five large yellow spots on each elytron; coarsely punctured elytral surface, with the punctures separated by the diameter of a puncture or less; and round body form. Overall length 2.20-4.00 mm; width 1.65-3.00 mm (Fig. 6). Male: pronotum black, with anterolateral angles broadly yellow and narrow yellow anterior margin with yellow extending medially into the apical margin of black area. Female: pronotum black with anterolateral angles yellow; pronotum occasionally with narrow, pale yellow anterior margin without extension into black area.

Distribution:

Found in eastern and midwestern United States, ranging in the north from Massachusetts to Minnesota, in the south from North Carolina to Oklahoma. We recorded specimens from 28 Illinois counties ranging throughout the state (Fig. 11).

Seasonal Occurrence:

Adults have been collected in Illinois from 1 April through 15-29 November, with the greatest number of specimens taken in May. There is also an increase in the number of specimens collected during September and October (Table 2).

Remarks:

Of the 109 adult specimens seen from Illinois, 37 (33.9%) are in the EIUC. Twenty-seven of those 37 specimens (73.0%) have been collected since 1990. Of these 27 specimens, 15 (55.6%) were Malaise trapped and 12 (44.4%) were manually collected (Table 1). Seven specimens originally placed as *B. rotunda* are included here (see Discussion for explanation of this synonymy).

The immatures of this species have not been described.

Material Examined:

We examined 561 specimens of *B. felina*, 109 of which were from Illinois. **IL**, (1 FMNH), (3 INHS); **N. IL**, (1 WSUC), (3 WSUC); **S. IL**, 7-6-1890 (1 UMRM); **Adams Co.**, Quincy, 30 June 1951 (1 INHS); **Alexander Co.**, Olive Branch, 29 Sept 1909 (2 FMNH), 30 Sept 1909 (1 FMNH); **Champaign Co.**, Champaign, 1 April 1957 (1 INHS), 13 July 1975 (1 INHS); **Clark Co.**, Marshall, 18 May 1941 (1 EIUC); Rocky Branch, 15-29 Nov 1992 (1 EIUC); **Coles Co.**, 10 Oct 1966 (1 EIUC), 15 June 1972 (1 UADE), 12 Oct 1985 (1 EIUC); Charleston, 2 Oct 1951 (1 EIUC); Diona, 12 June 1935 (1 EIUC); Fox Ridge St. Pk., 13 May 1944 (1 EIUC), 5-12 Oct 1992 (1 EIUC); Salisbury, 28 April 1933 (1 EIUC), 28 April 1935 (1 EIUC); **Cook Co.**, Chicago, July (1 UWEM); Palos Park, 3 May 1907 (3 FMNH), 26 Aug 1910 (2 UMMZ), 14 May 1911 (1 FMNH), 28 May 1922 (2 UMMZ); Riverside, 6/10.1915 (1 UMMZ), 13 June 1916 (1 UMMZ); Willow Springs, 14 Sept 1906 (1 FMNH), 14 July 1912 (1 FMNH); **Cumberland Co.**, 2mi W. Toledo, 29 Sept-6 Oct 1991 (2 EIUC), 26 Oct-3 Nov 1991 (1 EIUC), 2 May 1993 (1 EIUC), 23 May 1993 (1 EIUC), 25 May 1996 (1 EIUC); woods 8mi W. Toledo, 3 July 1932 (1 EIUC); **Du Page Co.**, 19 May 1990 (1 EIUC); Green Valley F. P., 19-26 April 1996 (1 EIUC), 17-24 May 1996 (2 EIUC); **Edgar Co.**, 4mi S.S.E. Kansas, 17 April 1994 (2 EIUC), 24 April 1994 (3 EIUC), 29 May-5 June 1994 (1 EIUC), 25 Sept-2 Oct 1994 (1 EIUC), 2-9 Oct 1994 (2 EIUC), 9-16 Oct 1994 (1 EIUC), 16 Oct 1994 (1 EIUC), 16-30 Oct 1994 (1 EIUC), 29 Sept-6 Oct 2000 (1 EIUC); **Effingham Co.**, Atamont, 5 May 1943 (1 INHS), Funkhauser, 21 May 1950 (3 INHS); **Hancock Co.**, A. L. Kibbe Life Sci. Sta., 19 May 1980 (1 WIUC), 3 June 1980 (1 WIUC); **Hardin Co.**, Elizabethtown, 27-31 May 1931 (1 INHS), 27-31 May 1932 (2 INHS); near Tower Rock Rec. Area, 26 June 1994 (1 EIUC); **Jackson Co.**, Carbondale, 2 May 1958 (1 SIUC), 23 May 1962 (1 SIUC); De Soto, 5-10-1957 (1 SIUC); **Jo Daviess Co.**, Apple River Canyon St. Pk., 23 Aug 1939 (1 INHS); **Johnson Co.**, Grantsburg, 20 June 1940 (1 INHS); Ozark, 18 May 1932 (1 INHS); Vienna, 18 May 1932 (1 INHS); **Kane Co.**, Elburn, 19 May 1944 (1 INHS); **La Salle Co.**, Starved Rock, 8-10-1924 (1 FMNH); **Macon Co.**, 1 May 1980 (1 PESC); **Mason Co.**, Havana, 31 May 1933 (1 INHS); **McHenry Co.**, Algonquin, (3 INHS); McHenry, 25 June 1898 (1 WSUC); **Ogle Co.**, Castle Rock, Grand Detour, 2 July 1932 (1 INHS); **Peoria Co.**, Peoria, Bradley Park, 17 July 1942 (1 INHS); **Piatt Co.**, Monticello, 22 Sept 1934 (1 INHS), 12 May 1947 (1 INHS); **Pope Co.**, Eddyville, 16 May 1947 (1 INHS); Herod, 18 April 1944 (2 INHS); Lusk Creek, 12 Oct

1967 (1 SIUC); **Pulaski Co.**, Mounds, 28 May 1957 (1 SIUC), 30 July 1957 (1 SIUC); Pulaski, 31 May 1909 (1 INHS); **Putnam Co.**, 5 June 1932 (1 INHS), 24 June 1932 (1 INHS); **Union Co.**, Giant City St. Pk., 5 June 1931 (1 EIUC), 5-7-1971 (1 SIUC); Pine Hills, 10-8-1955 (1 SIUC), 11 Sept 1966 (1 SIUC), 25 May 1973 (1 SIUC), 7 May 1975 (1 SIUC), 6 May 1977 (1 SIUC); **Vermilion Co.**, 12 Sept 1993 (1 EIUC).

***Brachiacantha quadripunctata quadripunctata* (Melsheimer)**

Diagnostic Description:

This species differs from all other North American species of *Brachiacantha* by: having two yellow spots, one apical and one basal, on each elytron; a coarsely punctured elytral surface with punctures separated by the diameter of a puncture or less; and round body form. Overall length 2.50-4.40 mm; width 2.00-3.40 mm (Fig. 7). Male: pronotum black, with anterolateral angles broadly yellow and wide yellow anterior margin with the yellow extending medially into the apical margin of black area; an additional humeral spot often confluent with basal spot on each elytron. Female: pronotum black, with only the anterolateral angles yellow.

Distribution:

Found in eastern and midwestern United States, ranging in the north from Massachusetts to Wisconsin, in the south from Virginia to Arkansas and Kansas. We recorded specimens from 18 Illinois counties ranging throughout the state (Fig. 12).

Seasonal Occurrence:

Adults have been collected in Illinois from 9 April through 13 November, with the greatest number of specimens captured in May and June. There is also a small increase in the number of specimens collected in October (Table 2).

Remarks:

Of the 93 specimens seen from Illinois, 59 (63.4%) are in the EIUC. Of those 59 specimens, 57 (96.6%) have been collected since 1990. Of these 57 specimens, Malaise trapping yielded 38 specimens (66.7%), conventional manual collecting yielded 16 specimens (28.1%), and yellow sticky traps yielded only three specimens (5.3%) (Table 1).

Wheeler (1911) collected ten larvae of this species from nests of the ant *Lasius umbratus* var. *aphidicola* in the vicinity of Great Blue Hill near Boston, Massachusetts. He described these larvae as moving slowly or resting among the root-coccids and root-aphids abundant in these ants' nests. The larvae were covered by waxy tufts and measured overall about 10 mm in length. The body was 6-7 mm long with a whitish or pinkish-yellow color. They were further described as having short, feeble legs, a smaller head, and a more obese body than common coccinellid larvae. Larvae of this species have not been collected since that time and a more complete and diagnostic description is needed.

Blatchley (1910), reported that *B. q. quadripunctata* adults "... occur especially on maple trees infested with plant lice."

Material Examined:

We examined 174 specimens of *B. q. quadripunctata*, 93 of which were from Illinois. **IL**, (4 FMNH), (5 INHS); **N. IL**, (1 WSUC); **S. IL**, 14 June 1896 (1 UMRM); **Clark Co.**, 5mi S.E. Casey, 19 May 1994 (1 EIUC), 7 Oct 1995 (2 EIUC); Rocky Branch, 1-7 Sept 1988 (1 EIUC), 15 June 1989 (1 EIUC), 14-21 May 1990 (1 EIUC), 4-11 June 1990 (1 EIUC), 12-19 May 1991 (3 EIUC), 19-27 May 1991 (4 EIUC), 27 May-2 June 1991 (1 EIUC), 2-13 June 1991 (5 EIUC), 24-30 June 1991 (1 EIUC), 14-21 July 1991 (1 EIUC), 21-30 July 1991 (1 EIUC), 10 May 1992 (1 EIUC), 1-8 May 1993 (2 EIUC), 8-16 May 1993 (1 EIUC), 7 May 1995 (2 EIUC), 1 June 1996 (1 EIUC); **Coles Co.**, 16 June 1972 (1 UADE); Burgner Acres, 30 June 1997 (7 EIUC); Charleston, EIU campus, 21 Feb 1995 (1 EIUC); Fox Ridge St. Pk., 8-15 June 1992 (3 EIUC), 17-24 April 1993 (1 EIUC), 22-29 May 1993 (1 EIUC), 17-24 July 1994 (2 EIUC); **Cook Co.**, Edgebrook, 24 Apr 1911 (1 UMMZ); Willow Spgs., 28 June 1903 (1 FMNH); **Cumberland Co.**, 2mi W. Toledo, 2-8 July 1991 (1 EIUC); **Edgar Co.**, 4mi S.S.E. Kansas, 2-9 Oct 1994 (1 EIUC), 16-30 Oct 1994 (1 EIUC), 13 Nov 1994 (1 EIUC); 21-29 Apr 1999 (1 EIUC), 30 June-7 July 2000 (2 EIUC), 6-13 Oct 2000 (1 EIUC); **Hardin Co.**, Tower Rock Rec. Area, 25-26 June 1994 (1 EIUC); **Jackson Co.**, Carbondale, 5-8- 1957 (1 SIUC), 12 May 1958 (1 SIUC), 7-10-1958 (1 SIUC), 13 May 1962 (1 SIUC), 10 June 1962 (1 SIUC); 7mi W. Carbondale, 12-19 June 1993 (2 EIUC), 19-26 June 1993 (1 EIUC); Little Grand Canyon, 9 April 1978 (1 SIUC); Midland Hills, 13 May 1972 (1 SIUC); **Jo Daviess Co.**, Apple River Canyon St. Pk., 27 June 1940 (1 INHS); **Macon Co.**, N.W. side Decatur, 11 May 1987 (1 PESC); **McDonough Co.**, Macomb, 24 May 1972 (1 WIUC); **McHenry Co.**, Algonquin, (1 INHS); **Putnam Co.**, 4 July 1932 (1 INHS); **Saline Co.**, Eldorado, 23 June 1960 (1 SIUC); **St. Clair Co.**, Kahokia, 8-6-1903 (1 UMRM); **Union Co.**, Pine Hills, 6 July 1972 (1 SIUC), 3 May 1987 (1 PESC); **Vermilion Co.**, Forest Glenn Preserve, 5mi S.E. Westville, 14-15 April 1977 (1 INHS), 19-20 April 1977 (1 INHS); **Wabash Co.**, 3mi S.E. Allendale, 25 Apr-2 May 1993 (1 EIUC); Beall Woods Nat. Pres., 16-23 May 1996 (1 EIUC), 23-30 May 1996 (1 EIUC); **Woodford Co.**, Kappa, 15 June 1931 (1 INHS).

***Brachiacantha indubitabilis* Crotch**Diagnostic Description:

This species differs from all other North American species of *Brachiacantha* by: having three yellow spots, two median and one apical, on each elytron; long, slender spines on prothoracic tibiae; and oval body form. Overall length 2.50-3.20 mm; width 1.80-2.60 mm (Fig. 8). Male: pronotum black, with anterolateral angles broadly yellow, and wide yellow anterior margin with yellow prominently extending medially into apical margin of black area. Female: pronotum black with only anterolateral angles yellow.

Distribution:

Found in eastern and midwestern United States, ranging in the north from New Hampshire to Minnesota, in the south from North Carolina to Tennessee. We saw no specimens of this species from Illinois. Although Gordon (1985), shows *B. indubitabilis* occurring in the northern 4/5 of the state, the only Illinois record is the lectotype in the LeConte Collection, which bears no collection data other than Illinois. In addition we have recorded three museum specimens from Indiana.

Remarks:

The immatures of this species have not been described.

Material Examined:

We examined ten specimens of *B. indubitabilis*, none of which were from Illinois.

DISCUSSION

Twenty-six *Brachiacantha* species and subspecies were recognized as occurring in America north of Mexico by Gordon (1985). We are reducing the number of *Brachiacantha* species and subspecies to 25 by placing *B. rotunda* in synonymy with *B. felina* (see later discussion). Questions of synonymy and species status may further change this number when this genus is more fully studied nationally.

The focus of this study is the six *Brachiacantha* species with ranges which include Illinois. These species are *B. dentipes*, *B. ursina*, *B. decempustulata*, *B. felina*, *B. q. quadripunctata* and *B. indubitabilis*.

Adults of four of the six *Brachiacantha* species known to occur in Illinois were collected by the authors during this study. These species are *B. ursina*, *B. decempustulata*, *B. felina*, and *B. q. quadripunctata*. Specimens of *B. dentipes* and *B. indubitabilis* were not collected. Only two specimens of *B. dentipes* from Illinois were seen among the museum specimens examined. No specimens of *B. indubitabilis* from Illinois are known other than the lectotype designated by Gordon (1985) in the LeConte Collection.

In our Illinois collecting Malaise trapping was the most successful technique to collect *Brachiacantha* species. Of 146 adult *Brachiacantha* of all species collected by us in Illinois since 1990, 94 (64.4%) were collected in Malaise traps (Table 1). Malaise traps are light-weight interception traps that are useful for obtaining insects for faunal surveys, relative abundance studies and several other types of studies (Powell, et al. 1996). Adult specimens of three species of *Brachiacantha* were collected by Malaise trapping. *Brachiacantha decempustulata*, *B. felina* and *B. q. quadripunctata* were most commonly collected by this method (Table 1). Malaise traps offer an effective, continuously operating technique for collecting arthropods. However, they do not trap all species of some taxonomic groups equally well (Goodrich 1997). We note that *B. ursina* was never taken in a Malaise trap during the course of this study, although this is the most common Illinois species of *Brachiacantha*, when all insect collections we examined are considered. The location of Malaise traps may have affected collecting *B. ursina* by this method. Malaise traps used in our Illinois collecting were located in interior forest habitats. *Brachiacantha ursina* may have a different microhabitat preference (see later comments).

Manual collecting (sweep netting and visual inspection of plant material) was the second most successful collecting method for Illinois adult *Brachiacantha*. Of a total of 146 *Brachiacantha* of all species taken in Illinois since 1990, 39 (26.7%) were manually collected. Manual collecting was the only collecting method which yielded specimens of all four *Brachiacantha* species collected in Illinois by us since 1990 (Table 1). This procedure was the only method by which we collected *B. ursina*; producing all eight

specimens taken by us in Illinois since 1990, all collected from the same Cumberland County location. This is despite extensive collecting, using several collecting methods, in many other Illinois locations.

Two species, *B. decempustulata* and *B. q. quadripunctata*, were collected on yellow sticky traps (Table 1). These traps were used during July and August of 1994 only, which may have biased their effectiveness. Two of the most common species, *B. ursina* and *B. felina*, are most often collected during May and June and could have been missed by the timing of this method. *Brachiacantha ursina* has been collected in Michigan using this collecting method (Maredia, et al. 1992).

Cleaning the sticky material, usually polyisobutylene (PIB), from specimens in the laboratory proved to be a problem. Following techniques tested by Miller, et al. (1993), we also found citrus oil (Durkee lemon extract) to be a relatively effective removal agent, usually removing the PIB within a 24 to 48 hour immersion period. Some heavily coated specimens required a final immersion in xylene, up to 48 hours, to remove the majority of the PIB. Even after these two treatments some PIB remained on some specimens, but this did not interfere with identifications.

Pitfall traps are commonly used to sample ground-dwelling arthropods and usually provide reliable data for presence/absence studies (Powell, et al. 1996). U-V light traps collect light attracted nocturnal insects of many species and often in great numbers. Neither of these collecting methods yielded adult specimens of *Brachiacantha*, although these collecting strategies were extensively pursued in wooded habitats in this and related studies.

In our Illinois collecting we were not able to associate adult *Brachiacantha* species with any specific host plants or insects. The only published plant references and insect hosts for adult *Brachiacantha* are from Blatchley (1910). He reported *B. ursina* as occurring on common milkweed, but gives no further account of what the insect was doing there. He also reported *B. q. quadripunctata* as occurring on maple trees infested with plant lice (aphids). We did see a single specimen of *B. ursina* from Missouri labeled "aphids on canadian thistle." Data from the museum specimens examined included some references to various forest trees and shrubs. Two species, *B. ursina* and *B. felina*, are also reported from various grasses and legumes. This supports our hypothesis that *Brachiacantha* are forest species, but also suggests that the latter two species may be edge species. Additional support for this speculation comes from examination of a large number of specimens from Missouri. We examined 165 specimens of *B. felina* collected by Malaise trap between 17 May and 14 August 1968 at Tucker Prairie, Callaway County, Missouri.

The only known *Brachiacantha* species for which larval descriptions exist, *B. ursina* and *B. q. quadripunctata*, were both found in ant nests (Smith 1886, Wheeler 1911). Mann (1911) also describes what may be *Brachiacantha* larvae in an ant nest. The *Brachiacantha* larvae collected and described from ant nests, *B. ursina* and *B. q. quadripunctata*, were both found in nests of the ant genus *Lasius*. The larvae reported by Mann (1911) were found in a nest of the ant genus *Formica*. Species of both of these ant genera are represented in the Illinois fauna (DuBois and LaBerge 1988) and may have species of *Brachiacantha* associated with them. Because the larvae of these

Brachiacantha species were found in ant nests they are considered myrmecophilous. Myrmecophiles are organisms which must spend at least part of their life cycle with ant colonies (Nichols 1989). Other *Brachiacantha* species may also eventually be found to be myrmecophiles as larvae. This relationship is recognized for other Coccinellidae (Chapin 1966, MacKay 1983) and many other Coleoptera (Schwarz 1890, Mann 1911, Borror, et al. 1981, MacKay 1983). These relationships are reported with many different species of ants (Smith 1886, Schwarz 1890, Mann 1911, MacKay 1983).

The nature of *Brachiacantha*-ant associations is not well understood. The evolutionary basis is probably similar to that suggested for other insect species, that is selection for enemy free space (Way 1963, Atsatt 1981, Cushman and Whitman 1989), access to food (Fielder and Maschwitz 1989, Paulson and Akre 1994) and/or shelter from adverse conditions (Way 1963). In return the ants may receive additional food (Fielder and Maschwitz 1989, Way 1963) by feeding on the waxy secretion covering the *Brachiacantha* larva's body, as suggested by Smith (1886). This relationship is probably mediated by the *Brachiacantha* larva's ability to use the chemical and mechanical language of the host ant (Hölldobler 1971).

In his comprehensive treatment of the North American Coccinellidae, Gordon (1985) describes the new species *B. rotunda* and distinguishes it from *B. ursina*. We can easily separate this form from *B. ursina*, but cannot distinguish it from *B. felina*, except on the basis of size. Gordon (pers. comm.) acknowledges this difficulty. In examining 230 Illinois and Missouri specimens, we found that the size range from the smallest *B. felina* to the largest *B. rotunda* was continuous and the specimens were otherwise morphologically indistinguishable. To further illustrate, we examined a series of three female specimens from Palos Park, Cook County, Illinois with identical collection data which span the size range from *B. felina* through *B. rotunda*. We have also identified series of specimens spanning this size range from two other Illinois sites and three sites in Missouri. We have therefore placed *B. rotunda* into synonymy with *B. felina*.

Considerable research remains to be done to more fully understand the biology of the species of *Brachiacantha* including more complete descriptions of immatures of all *Brachiacantha* species, investigation of the myrmecophilous relationships of the *Brachiacantha* species and determination of the prey species fed upon by larval and adult *Brachiacantha*.

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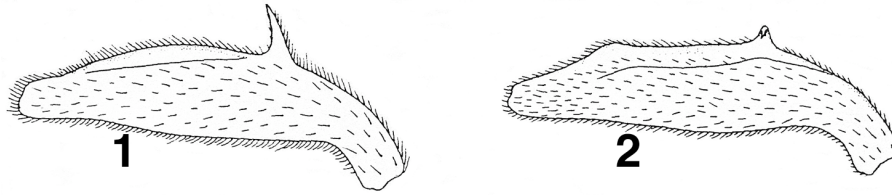
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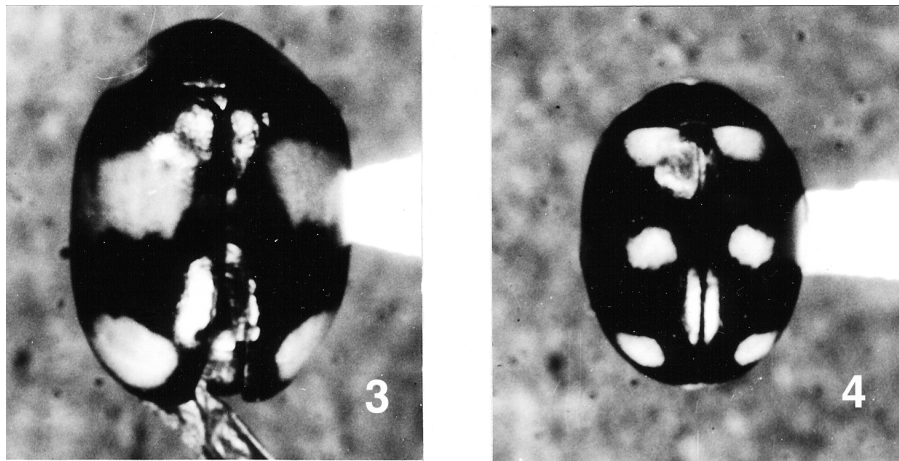
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Figures 1-2. Prothoracic tibiae of *Brachiacantha* species (after Gordon 1985).
1. Spine and arcuate flange of *B. dentipes* (Fabricius).
2. Spine and groove of other Illinois species.



Figures 3-4. Dorsal habitus of *Brachiacantha* species.
3. *B. dentipes* (Fabricius). 4. *B. ursina* (Fabricius).



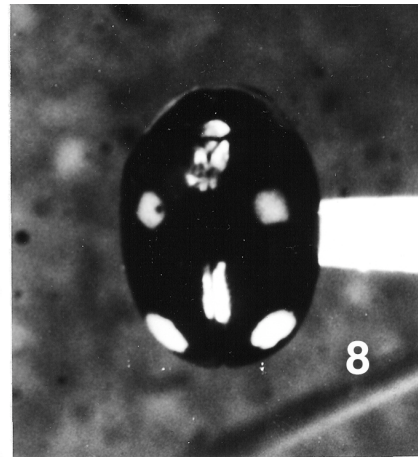
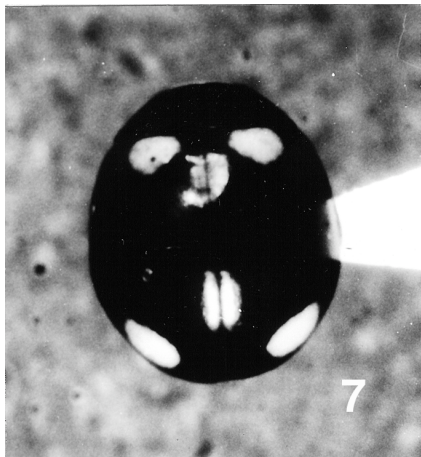
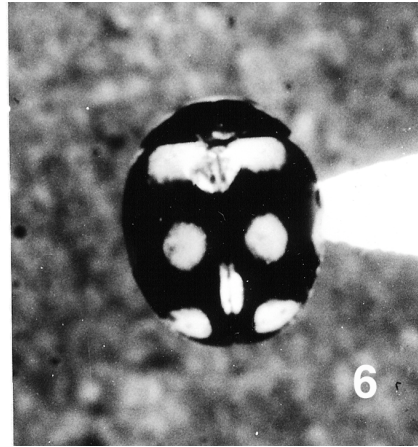
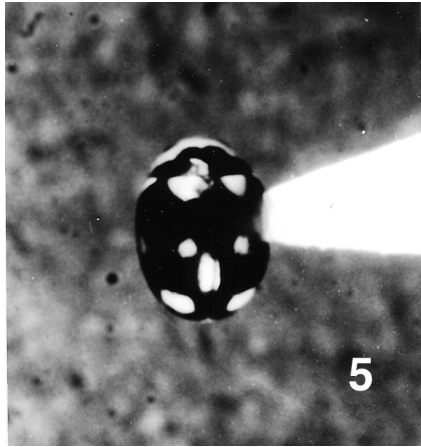
Figures 5-8. Dorsal habitus of *Brachiacantha* species.

5. *B. decempustulata* (Melsheimer).

6. *B. felina* (Fabricius).

7. *B. q. quadripunctata* (Melsheimer).

8. *B. indubitabilis* Crotch.



Figures 9-12. Illinois distribution maps of *Brachiacantha* species for which we have numerous records.

9. *B. ursina* (Fabricius).

11. *B. felina* (Fabricius).

10. *B. decempustulata* (Melsheimer).

12. *B. q. quadripunctata* (Melsheimer).

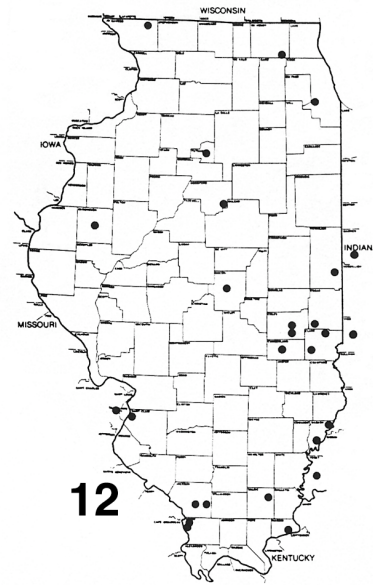
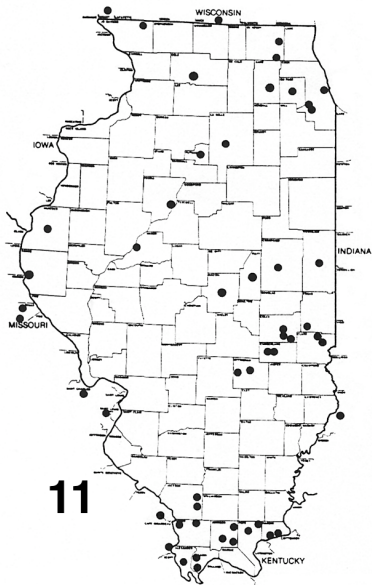
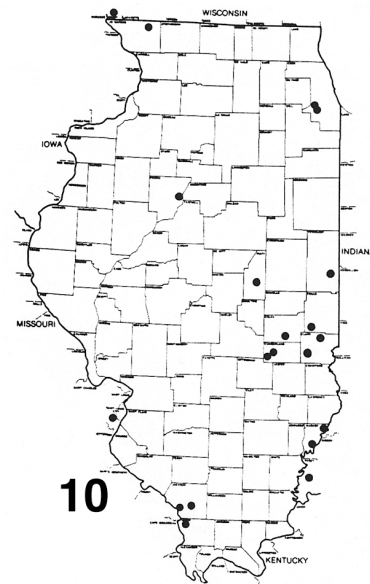
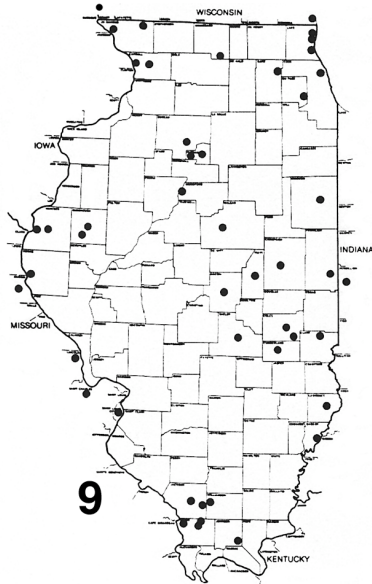


Table 1. Collecting methods and number of *Brachiacantha* specimens collected by us in Illinois since 1990.

Species	Malaise trap	Manual collecting	Sticky trap	Total
<i>B. ursina</i>	0	8	0	8
<i>B. decempustulata</i>	41	3	10	54
<i>B. felina</i>	15	12	0	27
<i>B. q. quadripunctata</i>	38	16	3	57
Total	94	39	13	146

Table 2. Seasonal occurrence and number of specimens examined of *Brachiacantha* species in Illinois for which seasonal data are available.

Species	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
<i>B. ursina</i>	1	14	17	71	17	1	2	1		124
<i>B. decempustulata</i>			1	12	44	29	4			90
<i>B. felina</i>		11	35	10	6	3	8	13	1	87
<i>B. q. quadripunctata</i>		7	25	30	9		1	5	1	78