

**DISTRIBUTION, SEASONAL OCCURRENCE, AND
CONSERVATION STATUS OF *CYLINDERA* (S. STR.) *CURSITANS*
(LECONTE) IN MISSOURI**

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ABSTRACT

Cylindera (s. str.) *cursitans* (LeConte) (Coleoptera: Cicindelidae) is a small tiger beetle known from Missouri until now by only a single specimen collected "nr. Portageville" in extreme southeastern Missouri. Beginning in 2007, pitfall traps and direct observations were employed at multiple sites in a 4-season study to more fully characterize its distribution and seasonal occurrence in the area. Adults were observed at seven sites, all of which border the Mississippi or St. Francis Rivers (Dunklin, Mississippi, and New Madrid Counties) and support wet bottomland forest. Population size at each site ranged from one to many observed individuals; however, no adults were taken in pitfall traps at any site. In addition to these surveys, two specimens collected in 2001 further north along the Mississippi River in Cape Girardeau Co. and two collected in 2006 near one of the subsequent study sites in New Madrid County were found in the collections of Mike Smart (Cape Girardeau, Missouri), Peter Messer (Mequon, Wisconsin), and Southeast Missouri State University (Cape Girardeau). Dates of occurrence ranged from 24 May to 13 July, with adults most active during late morning and early afternoon. The inability of pitfall traps to detect robust populations of this species is puzzling and contrasts with its successful use to detect populations of other tiger beetle species in Missouri. The results of this study suggest that *C. cursitans* is secure in suitable bottomland forest habitats along the Mississippi River and St. Francis Rivers in southeast Missouri, and that no special conservation measures are required at this time to ensure its continued presence in the state. However, additional surveys are warranted to determine the full extent of the species distribution within Missouri, especially at more northern locations along the Mississippi and St. Francis Rivers and possibly also along the Missouri River.

INTRODUCTION

A faunal survey of tiger beetles in Missouri is currently being conducted by the first (TCM) and second (CRB) authors (MacRae & Brown 2001). To date, 24 species have been documented from the state, including the

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previously unrecorded *Cylindera* (s. str.) *celeripes* (LeConte) in loess hilltop prairie remnants in northwestern Missouri (MacRae and Brown 2011b) and a vagrant occurrence of *Cicindela* (*Cicindelidia*) *trifasciata ascendens* LeConte in southeastern Missouri (Brown & MacRae 2005). Several species are of potential conservation concern in Missouri due to restricted geographical occurrence in the state. One is *Cylindera* (s. str.) *cursitans* (LeConte), a species that has been associated with wet meadows and other open lowland habitats with moist substrates near waterways and roadside ditches in the Ohio and lower Mississippi River basins, and with an apparently disjunct population also occurring in the upper Missouri River basin (Brust et al. 2005, Pearson et al. 2006). Until now it has been known from Missouri by a single specimen collected "nr. Portageville" (New Madrid Co.) on 7 July 1991 by an unknown collector (deposited in the Enns Entomology Research Museum, University of Missouri, Columbia). For several years, we searched apparently suitable habitats (wet, open ground and roadside ditches) throughout southeastern Missouri, but especially in the vicinity of Portageville, in an unsuccessful effort to locate the species. Ronald L. Huber (in litt.) suggested that populations from the Ohio and lower Mississippi River basins are actually associated with bluff tops overlooking rivers; however, no such habitat exists in southeast Missouri, which forms the northern terminus of the Mississippi River Alluvial Basin.

One site that we searched several times is "Stewart Towhead", a public access on the Mississippi River located 17.6 km ESE of Portageville. This was believed to represent a promising site due to its proximity to the recorded locality for the species and the presence of relatively intact, accessible riverside habitat (most of the Mississippi River Alluvial Basin in Missouri was converted from gum and tupelo swamp to agricultural land, which is protected from the flooding by an extensive system of levees along the Mississippi and St. Francis Rivers). Initial searches at this site had focused on the relatively moist, open areas between the river and adjacent bottomland forest but failed to reveal the beetle's presence. In 2007 the third author (KF) moved to Portageville and contacted TCM to express his interest in tiger beetles. The suggestion by TCM to look for *C. cursitans* at Stewart Towhead was prescient, as the very next day KF observed several *C. cursitans* adults at that site. One was captured as a

voucher, and its identity was confirmed based on a photograph sent to TCM. The beetles were not found in the open areas that had been searched previously, but rather along a shaded sandy-loam track leading into the adjacent bottomland forest. Additional adults were observed there and in similar habitats at two additional sites during subsequent visits by all three authors, and in 2008 an extensive survey was initiated using pitfall traps and direct observation in selected bottomland forests in the Mississippi River Alluvial Basin to more fully characterize the geographical distribution of *C. cursitans* in southeast Missouri. Additional visual surveys were conducted in 2009 and 2010 at several sites further north along the Mississippi and St. Francis Rivers in the northern reaches of the Mississippi River Alluvial Basin. We report details and the results of those surveys here.

METHODS & MATERIALS

In 2007, after the initial discovery of *C. cursitans* at Stewart Towhead by KF, pitfall traps (described by MacRae and Brown 2011a) and direct observation were used to survey for the species at that location and at nearby Girvin Memorial Conservation Area (New Madrid Co.) and Dorena Access (Mississippi Co.) (Table 1, Fig. 1). All three of these sites support wet bottomland forest immediately adjacent to the Mississippi River. A total of 13 traps were placed at Stewart Towhead and Girvin Memorial Conservation Area and checked every 6–8 days during the survey period (Table 1). Direct observations only were made at Dorena Access and at the other locations whenever traps were placed or checked to monitor for the presence of active adults.

In 2008, nine sites in selected bottomland forest habitats along the Mississippi River (Mississippi, New Madrid, and Pemiscot Counties) and along or near the St. Francis River (Dunklin Co.) were surveyed by direct observation and pitfall traps (Table 1, Fig. 1). Sites were selected based on their similarity to the three sites where *C. cursitans* had been observed in 2007. Several additional potentially suitable habitats were noted along the Mississippi River; however, flooding prevented trap placement and subsequent observation at these sites. Few bottomland forests are located in the expanse between the Mississippi and St. Francis Rivers due to its

Table 1. Sites in southeastern Missouri surveyed for *Cylindera cursitans* during 2007–2010, with site number, county, locality description, GPS coordinates, year, and number of pitfall traps placed.

Site No.	County	Locality descriptor	GPS	Year	No. traps
1	Butler	Allred Lake Natural Area	36°31'16"N 90°25'03"W	2010	0
2a	Butler	Big Cane Conservation Area, loop road	36°30'12"N 90°28'48"W	2010	0
2b	Butler	Big Cane Conservation Area, end of Co. Rd. 276	36°30'59"N 90°28'24"W	2010	0
3	Butler	Coon Island Conservation Area	36°33'44"N 90°21'02"W	2010	0
4	Cape Girardeau	6.4 km NE Scott City N end Co. Rd. 307	37°14'41"N 89°27'42"W	2009	0
5	Dunklin	Ben Cash Memorial Conservation Area, vic. parking lot	36°11'06"N 90°12'05"W	2008	10
6	Dunklin	vic. Ben Cash Memorial Conservation Area, nr. NE border Largent Annex	36°10'16"N 90°12'34"W	2008	5
7	Dunklin	Bottomland forest near Campbell, MO	36°27'20"N 90°08'13"W	2010	0
8a	Dunklin	Chalk Bluff Trail River Access, nr. boat ramp	36°29'00"N 90°09'25"W	2010	0
8b	Dunklin	Chalk Bluff Trail River Access, woods nr. upper parking lot	36°29'11"N 90°09'12"W	2010	0
9	Dunklin	Morris State Park	36°33'16"N 90°02'35"W	2010	0
10	Dunklin	Warbler Woods Conservation Area	36°00'18"N 90°03'30"W	2008	5

11a	Dunklin	Wilhelmina Conservation Area, Co. Rd. 203	36°30'50"N 90°11'36"W	2010	0
11b	Dunklin	Wilhelmina Conservation Area, Co. Rd. 207	36°31'36"N 90°10'34"W	2010	0
12	Mississippi	Big Oak Tree State Park hiking trail	36°38'29"N 89°17'26"W	2009	0
13a	Mississippi	Dorena Access along access road	36°36'52"N 89°12'35"W	2008	7
13b	Mississippi	Dorena Access along 2-track near river	36°36'52"N 89°12'35"W	2008	2
14	Mississippi	Dorena Ferry Landing along trail S of parking lot	36°35'11"N 89°12'54"W	2008	11
15	Mississippi	Joseph Hunter Moore Access, in forest S of parking lot	36°54'31"N 89°07'28"W	2008	8
16	Mississippi	1.6 km E Bird's Blue Hole Conservation Area	36°57'57"N 89°06'32"W	2009	0
17	Mississippi	1.6 km NE Birds Blue Hole Cons. Area, Hwy 60 at Mississippi River bridge	36°58'32"N 89°08'48"W	2009	0
18a	New Madrid	Donaldson Point Conservation Area, Cpgd. #8	36°32'08"N 89°25'22"W	2008	4
18b	New Madrid	Donaldson Point Conservation Area, Cpgd. #9	36°32'05"N 89°25'20"W	2008	3
19	New Madrid	Robert Henry property, NE Donaldson Point Cons. Area	36°33'18"N 89°24'17"W	2008	5
20	New Madrid	Stewart Towhead, 11 km ESE Portageville	36°22'34"N 89°31'23"W	2007	8
21	New Madrid	Girvin Memorial Conservation Area	36°22'02"N 89°31'44"W	2007	5
22a	Pemiscot	Wolf Bayou Conservation Area, vic. N parking lot	36°19'21"N 89°38'09"W	2008	5
22b	Pemiscot	Wolf Bayou Conservation Area, vic. S parking lot	36°18'47"N 89°38'43"W	2008	4

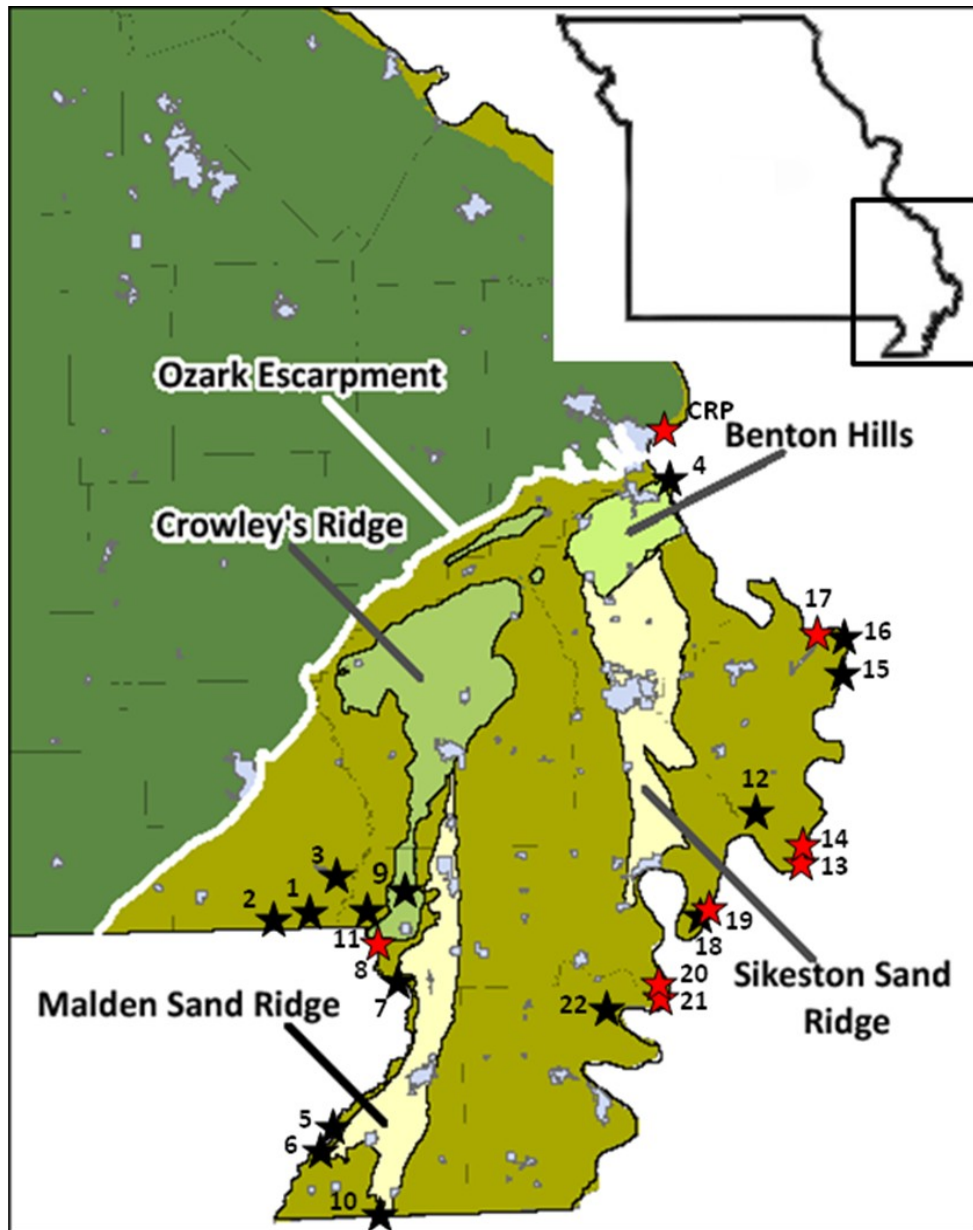


Figure 1. Sites surveyed in southeastern Missouri for *Cylindera cursitans* during 2007–2010. Site numbers are referenced in Table 1 (CRP = Cape Rock Park), with red stars indicating sites where *C. cursitans* was observed. Black box on inset map of Missouri denotes main map area (bordering states include AR to the south and TN, KY, and IL to the east).

nearly complete conversion to agricultural lands supporting crops of cotton, soybean, wheat, or rice. No traps were placed in this area, as it is unlikely that such lands could support populations of *C. cursive* – the lone exception being Warbler Woods Conservation Area (Dunklin Co.), a small bottomland forest remnant. Survey activities were initiated 21 June and concluded 13 July to coincide with the presumed peak adult activity period for the species. A total of 69 traps were placed at the nine sites and checked every 6–8 days during the survey period. Direct observations were also made whenever traps were placed or checked to monitor for the presence of active adults. At least two and up to ten pitfall traps were placed at each site (Table 1), with the number placed intended to provide adequate sampling of available habitat.

In 2009, four new sites in Cape Girardeau and Mississippi Counties were surveyed 20 June by direct observation (Table 1, Fig. 1). Three of the sites are adjacent to the Mississippi River in the northernmost reaches of the Mississippi River Alluvial Basin, and a remnant forest adjacent to a swamp at Big Oak Tree State Park (Mississippi Co.) was also surveyed. Again, sites were selected based on the presence of wet bottomland forests similar to those seen at sites where *C. cursive* had been observed in previous years.

In 2010, seven new sites in Butler and Dunklin Counties were surveyed 12 June by direct observation (Table 1, Fig. 1). The sites are located along or near the St. Francis River and were selected based on presence of bottomland forest and their proximity to a known *C. cursive* population in Arkansas (Lavers 2007).

Since many tiger beetle species exhibit specific soil type preferences (Pearson et. al 2006), soil samples were collected at the five sites where *C. cursive* was observed during the 2007 and 2008 surveys in an effort to determine the soil preferences for this species in southeastern Missouri. Six random 15-cm soil cores were taken from a 1-m radius circle centered about collection sites of adult *C. cursive* using a Hoffer soil probe (JBK mfg. PO Box 80 Alpha, OH 45301), pooled, and analyzed at the University of Missouri Delta Research Center Soil Analysis Laboratory using the hydrometer method of particle size

analysis (Day 1965). Soil samples were collected in the same manner from two sites included in the 2008 survey and where *C. cursitans* was not observed. Samples were collected from points located within the pitfall trap arrays utilized at these sites.

Voucher specimens were retained from all sites where the beetle was observed and are deposited in the following collections: Cory B. Cross collection (CBCC); Christopher R. Brown collection (CRBC); University of Missouri Delta Research Center collection (DRCC); Enns Entomology Research Museum, University of Missouri, Columbia (EERM); Richard S. Thoma collection (RSTC); Ted C. MacRae collection (TCMC).

RESULTS & DISCUSSION

Cylindera cursitans adults (Fig. 2) were encountered at a total of seven sites, including all three sites surveyed in 2007 (Dorena Access, Mississippi Co.; Girvin Memorial Conservation Area and Stewart Towhead, New Madrid Co.), three of the nine sites surveyed during 2008 (Dorena Access and Dorena Ferry Landing, Mississippi Co.; Robert Henry property, New Madrid Co.), one of the four sites surveyed in 2009 (Hwy 60 at Mississippi River bridge, Mississippi Co.), and one of the seven sites surveyed in 2010 (Chalk Bluff Access, Dunklin Co.) (Table 2). Dates of adult occurrence in the study ranged from 24 May to 13 July, but subsequent to the study, Cory Cross (Portageville, Missouri) collected a specimen at Stewart Towhead on 3 Aug 2009, extending the known temporal occurrence of the species in Missouri by several weeks. Our survey activities did not begin each season until mid-late June, thus it is possible that adults might have been encountered at additional sites had surveys been initiated earlier. Two additional specimens came to light after the conclusion of this study in the personal collection of Mike Smart (Cape Girardeau, Missouri) with the following collection data: Missouri, Cape Girardeau Co., Cape Rock Park, 60 yards N of lower parking lot, 24.v.2001, coll. Mike Smart. Cape Rock Park lies at the northernmost extent of the Mississippi River Alluvial Basin (Fig. 1), bringing to eight the number of sites in southeastern Missouri known to support *C. cursitans*.



Figure 2. *Cylindera cursiveans* in southeast Missouri: a) New Madrid Co., Girvin Memorial Conservation Area, 6.vii.2007; b-c) Mississippi Co., Dorena Ferry Landing, 6.vii.2008; d) Mississippi Co., Hwy 60 at Mississippi River bridge, 20.vi.2009. Photos by CRB (a) and TCM (b-d).

Table 2. Sites in southeastern Missouri where *Cylindera cursitans* was observed during 2007-2010, with site name, date, # observed, and voucher number and collection.

Site	Date	# Observed	Vouchers
Chalk Bluff Trail River Access	12.vi.2010	1	1 DRCC
Dorena Access	09.vii.2007 22.vi.2008 28.vi.2008 06.vii.2008 13.vii.2008	8 -* many -* few	1 DRCC - 12 CRBC - -
Dorena Ferry Landing	22.vi.2008 28.vi.2008 06.vii.2008 13.vii.2008	5 many many 2	4 TCMC, 1 DRCC - 35 TCMC 1 DRCC
Girvin Memorial Conservation Area	23.vi.2007 29.vi.2007 06.vii.2007	2 none 1	2 TCMC - 1 CRBC
1.6 km NE Birds Blue Hole Hwy 60 at Mississippi River bridge	20.vi.2009	~12	3 TCMC, 2 RSTC
Robert Henry property	22.vi.2008 28.vi.2008 06.vii.2008 13.vii.2008	none none 5 none	- - 5 TCMC -
Stewart Towhead	19.vi.2007 29.vi.2007 06.vii.2007 03.viii.2009	1 none none 1	1 EERM - - 1 CBCC

* Not accessible due to flooding.

The populations at Dorena Access and Dorena Ferry Landing were quite robust, with many individuals noted on several survey dates. Despite these observations, no individuals were captured in pitfall traps at any of the sites in this study. This was unexpected, since another tiger beetle, *Tetracha virginica* (Linnaeus), was collected in pitfall traps at many of the sites included in this survey, and we have used identically designed pitfall traps successfully in surveys of *Dromochorus pruinina* Casey in west-central Missouri (MacRae and Brown, 2011a). Interestingly, after the conclusion of this survey, Peter Messer (in litt.) notified us of two specimens with the following collection data: Missouri, New Madrid Co., Donaldson Point, 1.vii.2006, pitfall trap, Maupin & Wood (specimens deposited in the collections of P. W. Messer Collection and Southeast Missouri State University). Donaldson Point is immediately adjacent to the Robert Henry site recorded in this study—the collection of these two specimens by pitfall trap either represents an uncommon event within a robust population, or the traps utilized were of a different design that made them more effective than those utilized in this study.

The sites where *C. cursitans* was observed share similar features – wet bottomland forest adjacent to the Mississippi and St. Francis Rivers, with a canopy dominated by eastern cottonwood (*Populus deltoides* Bartram ex Marsh.), silver maple (*Acer saccharinum* L.), sycamore (*Platanus occidentalis* L.), and boxelder (*Acer negundo* L.), an open understory dominated by poison ivy (*Toxicodendron radicans* (L.) Kuntze) and trumpet creeper (*Campsis radicans* (L.) Seem. ex Bureau) (Fig. 3), and a ridge/swale topography of clay loam or sandy clay loam soil (Table 3). Adults were found exclusively within these forests, where they foraged in small openings amongst the understory plants. This contrasts not only with the preference of most U.S. tiger beetles for open, sunny habitats, but also with the reported preference of this species for open roadside ditches and wet meadows (Brust et al. 2005, Pearson et al. 2006). Adult beetles seemed to favor the relatively drier, more sparsely vegetated ridges over the moister, more densely vegetated swales; however, they were not found associated with very dry soil, moist sand beach areas near the water's edge, drier sand beach areas, or relatively sand-free soils found further away from the river. Numerous larval burrows – presumably of this species – were also observed in the areas where robust



Figure 3. Wet bottomland forest habitat for *Cylindera cursitans* in southeast Missouri (New Madrid Co., Robert Henry property). Photo by TCM.

Table 3. Results of soil analyses of samples collected at five sites in southeastern Missouri supporting *Cylindera cursitans* and two sites where the beetle was not observed.

Site	Abundance	Sand	Silt	Clay	Texture
Dorena Access	High	45%	26%	29%	Sand clay loam
Dorena Ferry Landing	High	65%	14%	21%	Sand clay loam
Robert Henry property	Moderate	39%	32%	29%	Clay loam
Steward Towhead	Moderate	49%	24%	27%	Sand clay loam
Girvin Memorial Conservation Area	Low	37%	22%	41%	Clay loam
Ben Cash Memorial Conservation Area	Absent	35%	26%	39%	Clay loam
vic. Ben Cash Memorial Conservation Area	Absent	65%	0%	35%	Sand clay loam

adult populations were observed and appeared to be concentrated in areas close to understory plants. Soil sample analyses reveal that the sites with the highest populations were characterized by sandy clay loam soil with relatively higher sand content and lower amounts of silt and clay; however, other sites with clay loam soil containing only a moderate amount of sand were also found to support populations of this species (Table 3). Similar plant communities and soil profiles were found at two locations along the St. Francis River; however, populations of *C. cursitans*, while they do exist along this river, are not nearly as robust as those seen along the Mississippi River. This could be due to the absence of the ridge/swale topography with which *C. cursitans* populations were so commonly associated along the Mississippi River. Diane Wood (in litt.) notes that the pitfall traps at Donaldson Point that captured two specimens were placed in giant cane (*Arundinaria gigantea* (Walt.) Muhl.) stands, a natural community that we did not include in our survey. As has been frequently noted for this species, the small size and rapid running capabilities of the adults makes them difficult to detect – appearing instead to be ants or small spiders, and the shaded forest habitats within which they occur in Missouri makes them especially difficult to detect.

Once a vast assemblage of bald cypress (*Taxodium distichum* L.) and tupelo gum (*Nyssa aquatic* L.) swamps and mixed deciduous bottomland forest, the Mississippi River Alluvial Basin of southeastern Missouri has been nearly completely drained, cleared, and converted to agriculture. Only small remnants of wet bottomland forest remain in the narrow corridors between the levees along the Mississippi and St. Francis Rivers and the rivers they confine. Nevertheless, these forests seem to offer adequate suitable habitat for *C. cursitans* in Missouri. The detection of populations, some robust, in forests adjacent to these rivers at multiple sites in Cape Girardeau, Dunklin, Mississippi, and New Madrid Counties suggests that the species' status within the state is secure and that it does not require any special conservation measures at this time to assure its continued presence. What remains to be learned is whether the species occurs in similar habitats further north along the Mississippi and St. Francis Rivers, or even the Missouri River which lies within the species' apparent disjunction zone. It is possible that *C. cursitans* is a more

widespread species that has gone undetected in much of Missouri due to its small size, limited temporal occurrence, habitat specificity, cryptic appearance, and lack of intensive field work (perhaps due in part to the hordes of deer flies, swarms of mosquitoes, and dense stands of poison ivy that confront those who attempt to collect insects in Missouri's wet bottomland forests during the heat of summer!). Another possibility, raised by Ron Huber (in litt.), is that populations in the Ohio and lower Mississippi River basins (represented by *Cicindela alata* Liljeblad, type locality: Chicago, Illinois) are distinct from those in the upper Missouri River basin (represented by *Cicindela cursitans* LeConte, type locality: Fort Riley, Kansas). If this is the case, the absence of populations elsewhere in Missouri is the result of a true disjunction between two sister species or subspecies, with the populations in southeast Missouri likely representing the "alata" form. Clearly, additional studies to determine whether *C. cursitans* occurs in the apparent disjunction zone are warranted.

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LITERATURE CITED

- Brown, C. R. and T. C. MacRae. 2005. Occurrence of *Cicindela* (*Cicindelidia*) *trifasciata ascendens* LeConte (Coleoptera: Cicindelidae) in Missouri. *CICINDELA* 37(1-2):17–19.

- Brust, M., W. Hoback, and C. B. Knisley. 2005. Biology, habitat preference, and larval description of *Cicindela cursitans* LeConte (Coleoptera: Carabidae: Cicindelinae). *COLEOPTS. BULL.* 59(3):379–390.
- Day P. R. 1965. Particle fractionation and particle-size analysis. In: *METHODS OF SOIL ANALYSIS PART I*. C. A. Black, D. D. Evans, L. E. Ensminger, J. L. White and F. E. Clark (Eds.). American Society of Agronomy, Inc., Madison, WI, 770 pp.
- Lavers, N. 2007. The Tiger Beetles of Crowley's Ridge.
<http://picasaweb.google.com/norman.lavers/crowleysridgetigerbeetles#5378076248511223346>. Accessed 16 June 2010.
- MacRae, T. C. and C. R. Brown. 2001. A survey of the tiger beetles of Missouri. *POSTER, ENTOMOL. SOC. AMER. ANNUAL MEETING*, San Diego, CA.
- MacRae, T. C. & C. R. Brown. 2011a. Distribution, seasonal occurrence and conservation status of *Dromochorus pruinina* (Casey) (Coleoptera: Cicindelidae) in Missouri. *CICINDELA* 43(1):1–13.
- MacRae, T. C. & C. R. Brown. 2011b. Historical and contemporary occurrence of *Cylindera* (s. str.) *celeripes* (LeConte) (Coleoptera: Carabidae: Cicindelinae) and implications for its conservation. *COLEOPT. BULL.* 65: in press.
- Pearson, D. L., C. B. Knisley & C. Kazilek. 2006. *A FIELD GUIDE TO THE TIGER BEETLES OF THE UNITED STATES AND CANADA: IDENTIFICATION, NATURAL HISTORY, AND DISTRIBUTION OF THE CICINDELIDAE*. Oxford University Press, New York, 227 pp.