

Historical and Contemporary Occurrence of *Cylindera* (*s. str.*) *celeripes* (LeConte) (Coleoptera: Carabidae: Cicindelinae) and Implications for Its Conservation

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Source: The Coleopterists Bulletin, 65(3):230-241. 2011.

Published By: The Coleopterists Society

DOI:

URL: <http://www.bioone.org/doi/full/10.1649/072.065.0304>

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**HISTORICAL AND CONTEMPORARY OCCURRENCE OF *CYLINDERA* (*s. str.*)
CELERIPES (LECONTE) (COLEOPTERA: CARABIDAE: CICINDELINAE)
AND IMPLICATIONS FOR ITS CONSERVATION**

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ABSTRACT

New observations of *Cylindera* (*s. str.*) *celeripes* (LeConte) (Coleoptera: Carabidae: Cicindelinae) are presented from Arkansas, Iowa, Missouri, and Oklahoma and discussed in the context of its historical occurrence in the eastern and central Great Plains. Once abundant in eastern Kansas and Nebraska and western Iowa, the species has declined below detectable levels in much of this area during the past century due to loss of its preferred native grassland habitats. On the other hand, robust populations have been found recently in the Red Hills of western Oklahoma, and the species is also reported in Missouri for the first time and confirmed from Arkansas (White River Hills). These recent observations suggest that the Oklahoma Red Hills population is healthy and not under immediate threat, while those in the Flint Hills and Loess Hills are vulnerable due to their small size and low numbers. The White River Hills population is documented by only a single specimen, thus its status currently cannot be assessed. Conservation measures to protect these populations may be warranted.

Key Words: distribution, endangered species, Great Plains, survey, tiger beetles

One of the more enigmatic tiger beetle species in North America is *Cylindera* (*s. str.*) *celeripes* (LeConte). This small (6–8 mm), apparently flightless species has been recorded from a restricted area of the eastern and central Great Plains, ranging from Nebraska and Iowa south through Kansas and Oklahoma to north-central Texas (Hoback and Riggins 2003; Pearson *et al.* 2006). During the late 19th and early 20th centuries, the species was collected abundantly in eastern Kansas, southeastern Nebraska, and extreme western Iowa; however, since that time it appears to have suffered severe population declines. In recent years, only small numbers of individuals have been encountered outside of the type locality near Fort Riley, Kansas, and in Nebraska it has not been seen for nearly 100 years and may be extirpated (Spomer *et al.* 2008). Records of the species from other states have appeared sparingly over the years, including Arkansas, Oklahoma, Texas, Indiana, and Illinois. The latter two records are here considered erroneous or based on misidentification

of *Cicindela cursitans* (LeConte), a closely related species of similar appearance that occurs sympatrically with *C. celeripes* in parts of the eastern Great Plains and allopatrically in the Ohio and lower Mississippi River Valleys.

The reasons for the apparent decline of this species in areas of historical abundance likely involve loss of preferred habitat. *Cylindera celeripes* is associated almost exclusively with upland prairies and grasslands with clay or loess soils and sparse or patchy vegetation (Pearson *et al.* 2006). These habitats have been drastically reduced during the past century by agricultural conversion and urban development, especially in the eastern Great Plains where the remnants that do still exist are often small, isolated, and compromised to varying degrees by encroaching woodlands and invasive species as a result of fire suppression, overgrazing by livestock, and other anthropogenic disturbance. Some species of Great Plains tiger beetles, such as *Cicindela* (*s. str.*) *limbalis* Klug and *Cicindela* (*s. str.*) *purpurea* Olivier, appear

not to have been negatively impacted by these anthropogenic changes. These and other successful species generally possess robust flying capabilities and/or are tolerant of a variety of habitats. *Cylindera celeripes*, on the other hand, is not known to fly (although true flightlessness has not been confirmed—see Zerm and Adis 2002), significantly hampering its ability to disperse across the modern, fragmented landscape, and its narrow tolerance for often small and highly disjunct remnant habitats makes it vulnerable to localized extinction. These features, combined with the dramatic population declines observed during the past century, have led to some feeling among contemporary workers that the species deserves consideration for listing as a federally endangered species (Spomer *et al.* 2008).

Despite the apparent disappearance or reduction of populations in some parts of its range, our knowledge of the full extent of the geographical occurrence of *C. celeripes* appears still to be incomplete. The small size, rapid running capabilities, and tendency of adults to hide at the base of grass clumps makes them difficult to find (Pearson *et al.* 2006). A good search image is needed to reliably detect adults when present in low numbers. From 2008 through 2010, we had the opportunity to observe populations of this species in the Loess Hills of southwestern Iowa and northwestern Missouri (the latter representing a new state record) and the Red Hills of western Oklahoma. In addition, a single specimen collected in 1996 establishes its occurrence in the White River Hills of north-central Arkansas. Details regarding these observations are presented here along with summaries of historical records in all of the states from which it has been reported, to establish a clearer picture of its contemporary and potential occurrence and implications for long term protection and conservation of this tiger beetle species.

MATERIAL AND METHODS

Label data were compiled from 937 specimens of *C. celeripes* residing in the collections of the individuals and institutions listed in the acknowledgments, or observed in the field during 2008–2010 by the authors. The former, which include all of the major insect museums in the states of Iowa, Kansas, Missouri, Nebraska, Oklahoma, and Texas, are presumed to represent the bulk of localities and time periods from which the species has been recorded. Collection codens [brackets] are as given by Evenhuis (2009) or, for collections not listed in that work, as specified in the acknowledgments.

HISTORICAL OCCURRENCE BY STATE

Kansas. LeConte (1848) described *C. celeripes* from “Habitat ad fluminis Kansas Republican Fork.” This is widely regarded as the area occupied by present day Fort Riley Military Reservation in the Flint Hills near Junction City, Kansas (Riley Co.) at the confluence of the Kansas and Republican Rivers. Lantz (1905) reported the species occurring commonly at several localities around Fort Riley and nearby Manhattan during 1902 and 1903, and at least some of this material appears to be represented among the 155 Riley Co. specimens that currently reside in KSUC. Labels on these specimens lack indication of year or collector, but museum logbooks show the specimens were accessioned from 1901 to 1903 and that some were collected by D. E. Lantz (G. Zolnerowich, *in litt.*). Other specimens in the series are labeled “G. A. Dean” or “Popenoe”. Specimens collected by Lantz at Junction City on 6 June 1902 (3) and Manhattan on 2–7 June 1902 (13) are also deposited in USNM, as are specimens collected in Riley Co. on 26 June (23) by Dean [one specimen also in SEMC] and on several dates by Popenoe. An undated specimen from Manhattan is also deposited in UMRM. All of these latter specimens are presumed to have been collected in the early 1900s. No subsequent records have been seen from the area around Manhattan, but the species continues to persist at Fort Riley, which contemporary collectors and observers have come to regard as the primary location for finding this species. Noteworthy collections at Fort Riley in more recent years have been made on several dates from 1984 to 1994 (151) by D. W. Brzoska [DWBC] and on 11 June 2004 (4) by S. M. Spomer and 17 June 2005 (3) by S. M. Spomer and P. Nabity [SMSC]. Despite the regularity with which the species has been encountered at Fort Riley, it seems to be restricted to a very small area within the reservation (S. M. Spomer, *in litt.*).

The species has also been recorded from several other locations in northeastern Kansas. Again, all of these records apparently date back to the early 20th century. These include specimens from Douglas Co. (no other data [1], F. H. Snow [SEMC]); Leavenworth Co. (Leavenworth, no other data [1] [USNM]); Pottawatomie Co. (Onaga, 6 June 1901 [1], Knaus [KSUC]); Republic Co. (Talmo, 7 June 1904 [5], D. E. Lantz [USNM]; no other data [2] [KSUC]); Geary Co. (no other data [5] [KSUC, USNM]; 25 May [1] [USNM]); and Clay Co. (3 June 1914 [7] [FSCA, USNM] and 6 June 1914 [3] [FSCA]; Morganville, no other data [1] [KSUC]). We also encountered specimens collected in southwestern Kansas at Engelwood (Clark Co.) in July 1902 (3) by D. E. Lantz [USNM]. This locality is about

85 km NW of Woodward Co., Oklahoma, where robust populations of the species have recently been discovered (see discussion below), suggesting that the species may still be found in southwestern Kansas. Willis (1970) included all of the above counties in a statewide distribution map for this species but did not include Sedgwick Co., from which we examined a single specimen collected on 5 June 1918 by J. C. Warren [FSCA]. While this specimen was collected nearly 100 years ago, to our knowledge it represents the last record of the species from Kansas outside of Riley Co. and the only record from southeastern Kansas.

Iowa. As in Kansas, *C. celeripes* appears to have once been common, occurring in great numbers in the Loess Hills along the western edge of the state. Wickham (1899) reported it among scattered grass clumps on the prairie bluffs near Council Bluffs (Pottawattamie Co.) (two specimens collected in 1897 by Wickham are deposited in SEMC and USNM). Eckhoff (1939) mentioned numerous specimens collected from hilly prairie land near the Missouri River by Nebraska collectors, one of whom was F. H. Shoemaker (S. M. Spomer, *in litt.*). A series of 22 specimens collected by Shoemaker on 11 June 1905 with the label “Coun-

cil Bluffs” is deposited in UNSM, and the following excerpt from him in a letter to R. H. Wolcott written the next day (and likely referring to this location) gives an even truer sense of how abundantly he encountered the species:

“There is another trip, down the river to the big spring by the railroad track near Albright, then across the river (the heronry route) where we collect *hirticollis*, *repanda*, *vulgeris*, *cuprascens*, and - vat you call 'im?- *celeripes*! I took 147 of the latter in an hour and a half Sunday, and the supply was undiminished.”

We are aware of no subsequent records from Pottawattamie Co. during the next 100+ years, although specimens collected in adjacent Mills Co. (labeled “County 79”) on 11 June 1937 (3) are deposited in FSCA and SEMC. In 2008, the species was rediscovered in Pottawattamie Co. at Hitchcock Nature Center just north of Council Bluffs by Doug A. Veal (Marion, IA), and its presence there was confirmed on separate visits shortly thereafter by Mathew L. Brust (Chadron, NE) and the authors (Fig. 1a). The habitat at Hitchcock Nature Center was acquired for conservation

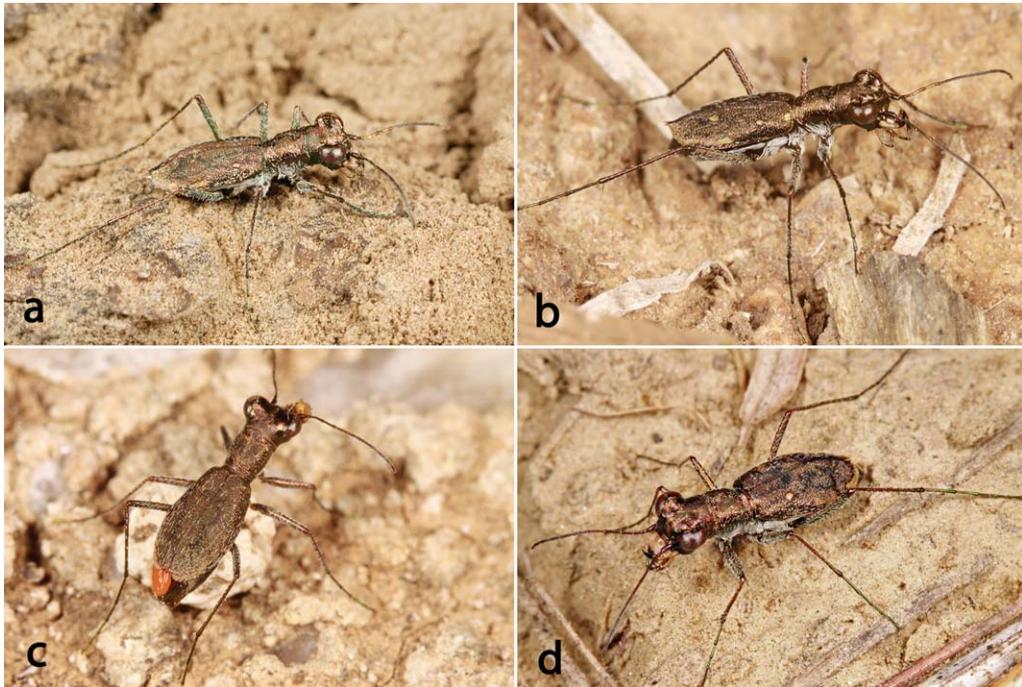
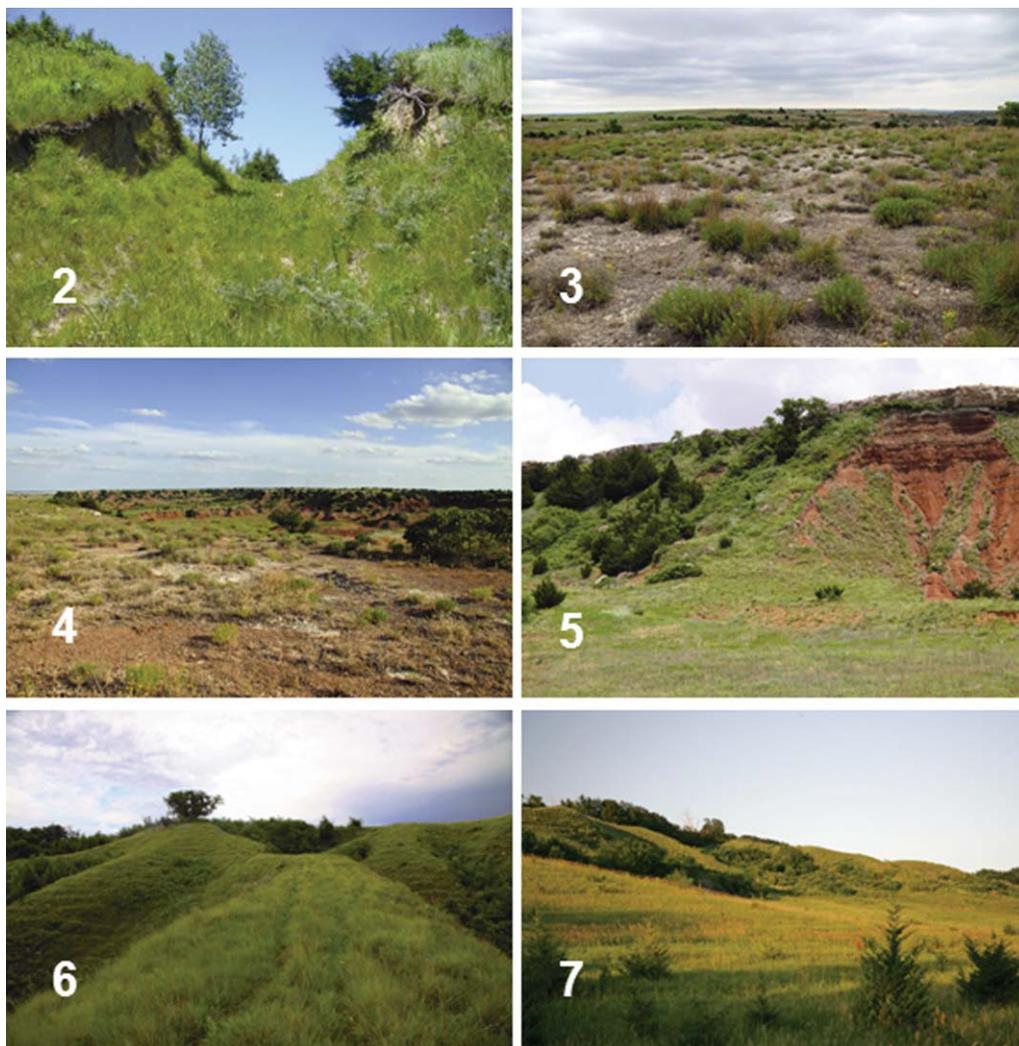


Fig. 1. *Cylindera celeripes* adults at: a) Hitchcock Nature Center, Pottawattamie Co., IA (13 July 2008); b) Alabaster Caverns State Park, Woodward Co., OK (10 June 2009); c) Same locality as “b”, note parasite (possibly Hymenoptera: Dryinidae) protruding from abdomen and ant head attached to right antenna; d) Brickyard Hill Natural Area, Atchison Co., MO (27 June 2009).

by Pottawattamie Co. in 1991 and contains significant loess hilltop prairie remnants that have been subjected to restoration efforts including prescribed burning and mechanical removal of woody vegetation. The beetles were found exclusively within these prairie remnants on open ground amongst the clumps of native warm-season grasses (Fig. 2). Only a few adults were seen during these 2008 visits,

suggesting that while the species has persisted through the years in Pottawattamie Co., it apparently is far less abundant than it was in the early 20th century. More recently, the species was photographed in Mills Co. at Folsom Point Preserve, a Nature Conservancy property just south of Council Bluffs, by Craig Rotermond (Omaha, NE). The identity of the species and its occurrence at the site



Figs. 2–7. Habitats of *Cylindera celeripes*. **2)** Western Iowa (Pottawattamie Co., Hitchcock Nature Center, Badger Trail); adults were active in moderately vegetated 2-track below road cut; **3)** Northwestern Oklahoma (Woodward Co., Alabaster Caverns State Park, upper Nature Trail); adults were active amongst sparse vegetation in lichen-encrusted clay/gypsum exposures; **4)** Northwestern Oklahoma (Major Co., Glass Mountains State Park); adults were active amongst sparse vegetation in lichen-encrusted clay/gypsum exposures on top of butte; **5)** Northwestern Oklahoma (Major Co., Glass Mountains, vic. Scenic Overlook); adults were active in sparsely vegetated clay exposures in undisturbed areas of lower talus slopes and on top of neighboring butte; **6)** Northwestern Missouri (Atchison Co., Star School Hill Prairie Natural Area, south tract); adults were seen amongst rather dense vegetated on upper slopes along the center foreground path; **7)** Northwestern Missouri (Atchison Co., Brickyard Hill Conservation Area, High Creek Prairie); adults were active in sparsely vegetated clay exposures on and below lower slopes.

were confirmed by Stephen M. Spomer (Lincoln, NE). As at Hitchcock Nature Center, adults were observed at Folsom Point Preserve on clay bluffs in a loess hilltop prairie remnant in low numbers (S. M. Spomer, *in litt.*).

NEW RECORDS: *Mills Co.*, Folsom Point Preserve (TNC), "north hills," 24.vi.2011, 20+ adults observed on clay bluffs in loess hilltop prairie, *C. Rotermund*; same locality, "south hills," N41.151979, W95.801816, elev. 1087', 2.vii.2011, adults observed uncommonly in loess hilltop prairie, S. M. Spomer [7 vouchers SMSC]; *Pottawattamie Co.*, Hitchcock Nature Center, along Badger Trail, N41°24'24", W95°51'43", elev. 1,230', 5.vii.2008, M. L. Brust [3 vouchers MLBC, SMSC]; same locality, 13.vii.2008, 7 adults observed on sparsely vegetated 2-track through loess hilltop prairie, T. C. MacRae and C. R. Brown [3 vouchers CRBC, TCMC].

In contrast to its apparent "boom and bust" occurrence in Pottawattamie Co., *C. celeripes* has been encountered farther north in the Loess Hills in Woodbury Co. with some regularity. The first records we are aware of are specimens collected near Sioux City on several dates from 1922 to 1930 (15) by C. N. Ainslie [FSCA, ISUI]; June 1923 (1) by I. L. Griller [USNM]; and 27 June 1953 (3) by J. L. Laffoon [ISUI]. A second locality is documented by collections 4.8 km SE of Holly Springs on 12 June (9) by Slater and Laffoon [FSCA, ISUI, UMRM], and numerous specimens have been collected nearby at a location 4.8–6.4 km E to ENE of Hornick on 13 June 1970 by J. Laffoon [ISUI], 14 June 1970 by B. Cutler [USNM]; 5 July 1971 by W. Johnson [TAMU]; 21 July 1972 by G. C. Gaumer [SEMC]; 4 July 1998 (21), 13 July 2000 (6), and 30 June 2002 (16) by D. W. Brzoska [DWBC]; 8 July 2005 (2) by S. M. Spomer and P. Nability [SMSC]; and 18 July 2005 (6) by S. M. Spomer [SMSC, UNSM]. Cutler (1973) recorded the collection of six specimens from "northwestern Iowa in 1970", likely a reference to the Homick site, which Stephen M. Spomer (*in litt.*) describes as "a very small site and it would not take much to wipe it out." Woodbury Co. (and adjacent Dakota Co., Nebraska) is at the northernmost extent of the recorded distribution of *C. celeripes*. There is also one specimen from the Hubbard and Schwarz collection [USNM] (and, thus, likely collected in the late 1800s) that is labeled "Crawford Co." (adjacent to Woodbury Co.).

Outside of the Loess Hills, Wickham (1898) reported finding one individual among short grass by a little stream in eastern Iowa near Iowa City (Johnson Co.) and a few individuals several years later (July 1898) frequenting the upper end of a deep gully just west of town. However, these records may be viewed with some doubt as no voucher specimens or other records of the species

from Iowa City have been found. The description of the habitat as an apparently moist site suggests these records refer instead to the closely related and similar *C. cursitans*.

Nebraska. *Cylindera celeripes* was collected abundantly in eastern Nebraska during the late 1800s and early 1900s. Bruner (1901) included the species in a Nebraska checklist, and 30 specimens collected at West Point (Cuming Co.), some indicating Bruner or H. S. Smith as the collector and one bearing a label with date of collection June 1887, are deposited in UNSM and USNM. Large series collected at Lincoln (Lancaster Co.) on several dates from 1906 to 1908 (121) are also deposited in UNSM. Numerous specimens have also been collected at Omaha (Douglas Co.) on 9 June 1906 (38) by R. H. Wolcott and on several dates from 1906 to 1916 (17) by F. H. Shoemaker [FSCA, UNSM, USNM]. Other Nebraska specimens were collected at Bellevue (Sarpy Co.) on 10 June 1906 (1), Louisville (Cass Co.) on 20 May 1908 (1), and Fairmont (Fillmore Co.) on 19 August 1912 (1) [all UNSM]. Carter (1989) included many of these records and also cited a record from South Sioux City (Dakota Co.); however, several additional counties noted in the distribution map in that work are not supported by records and are considered erroneous (S. M. Spomer, *in litt.*).

Whether or not *C. celeripes* still exists in Nebraska is unknown. Carter (1989) and Spomer *et al.* (2008) noted that it had not been seen in the state since 1915 (three specimens collected in 1916 [FSCA] notwithstanding), although the former did suggest that the species probably still occurred in the state but was overlooked because of its small size. On the other hand, recent searches of promising habitat in several areas south of Lincoln and in the Loess Hills between Omaha and Sioux City have failed to find the species (S. M. Spomer, *in litt.*). We did encounter one specimen labeled "NEB. Lancaster Co., Lincoln, 7.vii.1960, rec'd.: B. Ratcliffe" [USNM]. However, Brett Ratcliffe (*in litt.*) has no recollection of this specimen, noting that in 1960 he was a youngster living in Japan. This brings the veracity of the label data, or at least the date, into question. Suitable habitats at most of the historical localities in Nebraska have been eliminated by conversion to agriculture, and most of the existing remnants are small and have been degraded by overgrazing and invasion by woody vegetation and exotic plants such as *Bromus inermis* Leyss. (smooth brome; Poaceae). Spomer (*in litt.*) suggests that bluffs along the Missouri and Platte Rivers and rolling mixed-grass prairie hills along the Kansas border (Thayer and Jefferson Counties) are the likeliest refuges for any remnant populations that may still exist.

Oklahoma. Leng (1902) included Oklahoma in the distribution of this species, but Drew and Van Cleave (1962) provided the first specific localities in Custer Co. These records were based on a single specimen collected at Weatherford on 4 June 1936 by W. Kaiser and six specimens collected at Clinton on 4 June 1939 by Kaiser and Nation [OSEC]. Custer Co. lies within the Red Hills of Oklahoma, and the subsequent collection of a large series of specimens at Weatherford on 20 May 1991 (72) by David W. Brzoska suggests that the beetle remains well-established in Custer Co. and possibly other sites in western Oklahoma.

We were not aware of any other specific records from Oklahoma until a photograph of the species taken on 23 May 2003 at Alabaster Caverns State Park (Woodward Co.) in northwestern Oklahoma was posted on BugGuide (bugguide.net/node/view/8174) by Charles S. Lewallen (Henreyetta, OK). Although Mr. Lewallen did not collect the specimen, he provided us with details regarding the precise location and circumstances of the sighting. On 10 June 2009, the first author observed a robust population of the beetle (Fig. 1b, c) at Alabaster Caverns State Park in mixed-grass prairie with a sparsely vegetated substrate of red clay and gypsum (Fig. 3). Additional searches for the beetle in surrounding areas the following day (11 June 2009) revealed robust populations further east in Major Co. These additional sites also support mixed-grass prairie with lichen-encrusted clay/gypsum exposures. In one of these (Glass Mountains), the beetles occurred both atop the flat-topped mesas that are the prominent feature of the area (Fig. 4), as well as on relatively undisturbed portions of the lower talus slopes (Fig. 5). This area included sites lightly impacted by cattle grazing; however, the beetle was not found in areas where native vegetation had been significantly altered by construction activities or invaded by exotic plants or barren exposures completely lacking vegetation. In the areas where the beetle did occur, lichen encrustations on the soil surface created a cryptic background that made the adult beetles difficult to see until they moved. Similar habitat was observed extensively in the area west of the Glass Mountains and south of Alabaster Caverns, suggesting that the beetle occupies a relatively broad range within the Red Hills of Oklahoma.

NEW RECORDS: *Major Co.*, vic. Gloss Mountains Overlook, large mesa on S side of Hwy 412, N36°21'41", W98°35'07", elev. 1411', 11.vi.2009, numerous adults observed on sparsely vegetated red clay/gypsum exposures in mixed-grass prairie on lower talus slopes, T. C. MacRae [13 vouchers TCMC]; *Gloss Mountains State Park*, atop main mesa, N36°21'56", W98°34'45", elev. 1542', 11.vi.2009, numerous adults ob-

served on sparsely vegetated, lichen-encrusted, red clay/gypsum exposures in mixed-grass prairie, T. C. MacRae [15 vouchers TCMC]; same except 3. vii.2010 [15 vouchers TCMC]; 23.7 km W of Mooreland on Hwy 412, N36°25'13", W98°56'24", elev. 1610', 11.vi.2009, numerous adults observed on sparsely vegetated red clay/gypsum exposures in mixed-grass prairie, T. C. MacRae [13 vouchers TCMC]; *Woodward Co.*, Alabaster Caverns State Park, upper Nature Trail atop mesa, N36°41'56", W99°08'56", elev. 1713', 10.vi.2009, numerous adults observed on sparsely vegetated, lichen-encrusted, red clay/gypsum exposures in mixed-grass prairie, T. C. MacRae [13 vouchers TCMC].

Arkansas. Leng (1902) and Horn (1930) listed Arkansas in the distribution of this species, but Graves *et al.* (1973) regarded this listing as erroneous and possibly based on a misidentification of *C. cursitans*. However, a single specimen of this species was collected near Calico Rock in August 1996 by W. Wyatt Hoback (Kearney, NE). This area lies at the southeastern extent of the White River Hills, a deeply dissected portion of the Springfield Plateau in the Ozark Highlands ecological section (McNab *et al.* 2005) that features thin, rocky soils supporting xeric calcareous or igneous prairies (commonly called "cedar glades"). The specimen was collected on one of these glades in association with the Missouri/Arkansas eastern disjunct population of *Cicindela (Cicindelidia) obsoleta vulturina* LeConte (Mawdsley 2009). The occurrence of *C. celeripes* in the White River Hills is remarkable, since the locality lies more than 480 km SE of the nearest historic locality (Leavenworth, KS) and a minimum of 720 km S and E of any known extant population. The specimen is also one of only two known to have been collected as late as August, suggesting it may have been a lingering survivor from a temporally earlier population. Dedicated surveys to confirm the occurrence and extent of this species in the White River Hills are underway; however, two trips to the site on 4 and 25 June 2011 by the first author have failed to confirm the species' presence.

NEW RECORDS: *Stone Co.*, 1.9 mi S of Calico Rock on Hwy 5, N36.095788, W92.147312, viii.1996, 1 adult observed in cedar glade habitat, W. W. Hoback [voucher WWHC].

Illinois. Leng (1920) listed the species from Illinois, and this record is apparently the source of information for subsequent listings as well (Bousquet and Larochelle 1993; Freitag 1999; Erwin and Pearson 2008). However, we are not aware of any specific records from Illinois and regard the listings as erroneous, perhaps a result of the earlier confusion that existed between this species and *C. cursitans*.

Indiana. Montgomery and Montgomery (1931) reported *C. celeripes* on "moist, bare soil near

streams" in Indiana; however, Knisley *et al.* (1990) regarded this as an error for *C. cursive*. Despite this, the listing has persisted in more recent works (Bousquet and Laroche 1993; Freitag 1999; Erwin and Pearson 2008). Again, the mention of moist habitat is suggestive of a misidentification of *C. cursive*, and we concur with Knisley *et al.* (1990) in regarding the record as erroneous.

Texas. *Cylindera celeripes* has been listed from Texas in several recent works (Willis 1970; Freitag 1999; Pearson *et al.* 2006; Erwin and Pearson 2008), apparently based on the collection of the species in Wichita Falls (Wichita Co.) on 15 May 1939 (4) [FSCA] and 15 May 1941 (23) by E. L. Thachrey [FSCA, OSEC]. Specimens with the same label data (latter date) are also deposited in JSTC, OSAC, and PESC (R. L. Huber, *in litt.*). Wichita Falls is in north-central Texas, approximately 16 km south of the Oklahoma border. We are unaware of any other published records from the state, and no other specimens from Texas were found in any of the insect museums in Texas that were contacted (listed in Acknowledgments). These Texas records are now almost 70 years old and confirmation is needed to determine whether the species still occurs in this or nearby areas of Texas.

South Dakota. Pearson *et al.* (1997, 2006) show the distribution extending into the extreme southeastern corner of South Dakota. We are not aware of any specific records or specimens from that state, but its historical occurrence in northeastern Nebraska (Dakota Co.) and present day occurrence in northwestern Iowa (Woodbury Co.) suggest it could occur there.

Missouri. There are no historical records of *C. celeripes* from Missouri; however, its occurrence in extreme northwestern Missouri—where the Loess Hills reach their southern terminus—has long been considered a possibility. We began looking for this species in Missouri after initiating a survey of tiger beetles in the state (MacRae and Brown 2001). While presettlement occurrence in northwest Missouri seemed possible, present-day occurrence was considered less likely. Loess hilltop prairies have never been as extensive in the Missouri Loess Hills as they are in Iowa, and during the past 50–100 years they have been reduced even further by woody vegetation encroachment resulting from fire suppression and heavy grazing. These habitats are now a critically imperiled natural community in Missouri, persisting only as small, isolated remnants on south and west facing slopes where rapid drainage and exposure to sun and prevailing winds have maintained sufficiently xeric conditions to prevent conversion to woodlands.

After extensive searches, we finally located this species in June 2009 at Brickyard Hill Conservation Area (Fig. 1d) and Star School Hill Prairie

Natural Area, both in Atchison Co., and at McCormack Loess Mounds Natural Area in Holt Co. These three sites contain Missouri's largest and highest quality loess hilltop prairie remnants. As in Iowa, these remnants have been variably subjected to restoration efforts that include prescribed burning and mechanical removal of woody vegetation. The beetles were found along trails, tracks, and other small openings amongst thick stands of native warm-season grasses. We found most individuals at the base of slopes or along their ridgetops (Figs. 6–7), but a few were encountered also on the slope faces themselves. The number of individuals seen at any given site was always less than 10, and adults were seen primarily only in areas that had not been recently burned (it should be emphasized that periodic fires are necessary for long-term maintenance of loess hilltop prairie remnants; however, burning may also have negative short-term impacts on the beetle as a result of altered tertiary structure and reduced prey availability).

Follow-up surveys during two visits in June 2010 confirmed occurrence of the beetle in small numbers at Brickyard Hill and McCormack Loess Mounds in the same areas they were observed in 2009, but no beetles were seen at Star School Hill Prairie (where only two beetles were seen in 2009). Additional sites with significant loess hilltop prairie remnants (Squaw Creek National Wildlife Refuge and three privately owned properties—Slocum, Kunkel, and Bachle) were also surveyed in June 2010; however, the beetle was not seen at any of these sites. None of these remnants exhibit both the size and quality of the three sites where the beetle has been found. The Squaw Creek remnants are of high quality but are small due to woody encroachment of perimeter areas (despite implementation of prescribed burning). The Slocum property near Mound City (Holt Co.) is relatively large, but its slopes are extensively encroached and its ridgetops significantly altered. This property has been enrolled in a Wildlife Habitat Incentives Program contract through the USDA Natural Resources Conservation Service, which will provide fencing for exclusion of livestock, removal of encroaching woody vegetation, and implementation of patch burning—efforts that will surely benefit the beetle should it still occur there. Remnants on the Kunkel and Bachle properties are small and highly altered; although they are in varying stages of restoration, we do not consider them capable of supporting populations of the beetle. Altogether, the remnants surveyed in northwest Missouri comprise a majority of the state's remaining loess hilltop prairie, suggesting that *C. celeripes* exists in the area as only a few small, locally restricted populations.

NEW RECORDS: *Atchison Co.*, Brickyard Hill Conservation Area, High Creek Hill Prairie, past

east end, N40°30'05", W95°34'38", elev. 1041', 27.vi.2009, 2 adults observed on narrow 2-track through loess hilltop prairie, T. C. MacRae & C. R. Brown [1 voucher TCMC]; same except 26.vi.2010, 7 adults observed; same locality except west end, N40°30'12", W95°34'53", elev. 1009', 27.vi.2009, 2 adults observed on sparsely vegetated clay exposures in loess hilltop prairie, T. C. MacRae & C. R. Brown [1 voucher TCMC]; same except 26.vi.2010; Star School Hill Prairie Natural Area, south tract, N40°33'02", W95°37'22", elev. 1097', 27.vi.2009, 2 adults observed on narrow trail through loess hilltop prairie, T. C. MacRae & C. R. Brown [2 vouchers CRBC, TCMC]; *Holt Co.*, McCormack Loess Mounds Natural Area, main hilltop prairie (north spur), N40°03'11", W95°14'31", elev. 962', 28.vi.2009, 2 adults observed on narrow ridgetop trail through loess hilltop prairie, T. C. MacRae & C. R. Brown; same locality, 13.vi.2010, 8 adults observed, T. C. MacRae & M. I. MacRae [5 vouchers TCMC].

CONTEMPORARY OCCURRENCE AND IMPLICATIONS FOR CONSERVATION

The presettlement distribution of *C. celeripes* appears to have coincided with much of the

mixed- and tallgrass prairies that stretched from northwestern Iowa and northeastern Nebraska to north-central Texas (Fig. 8). Historical records are concentrated in northeastern Kansas, southeastern Nebraska, and western Iowa; however, other available records make it clear that the species was more broadly distributed further south as well. During the 20th century, prairie habitats throughout its former range were extensively converted to row crops and pastureland, while those that survived suffered increasing fragmentation and isolation, invasion by non-native species, and encroachment by woody vegetation. These threats stem largely from large-scale suppression of fire and replacement of intermittent pressure by native grazers with intense grazing by livestock. These changes are the most likely explanation for the now fragmented distribution of *C. celeripes* that includes three primary areas: 1) the Flint Hills of Kansas; 2) the Loess Hills of western Iowa and northwestern Missouri; and 3) the Red Hills of western Oklahoma. A possible fourth population in the White River Hills of north-central Arkansas and southwestern Missouri is suggested by a single specimen collected in 1996. It is possible that the beetle still occurs in other areas between these core sites; however, the extensive conversion of native grasslands to pasture

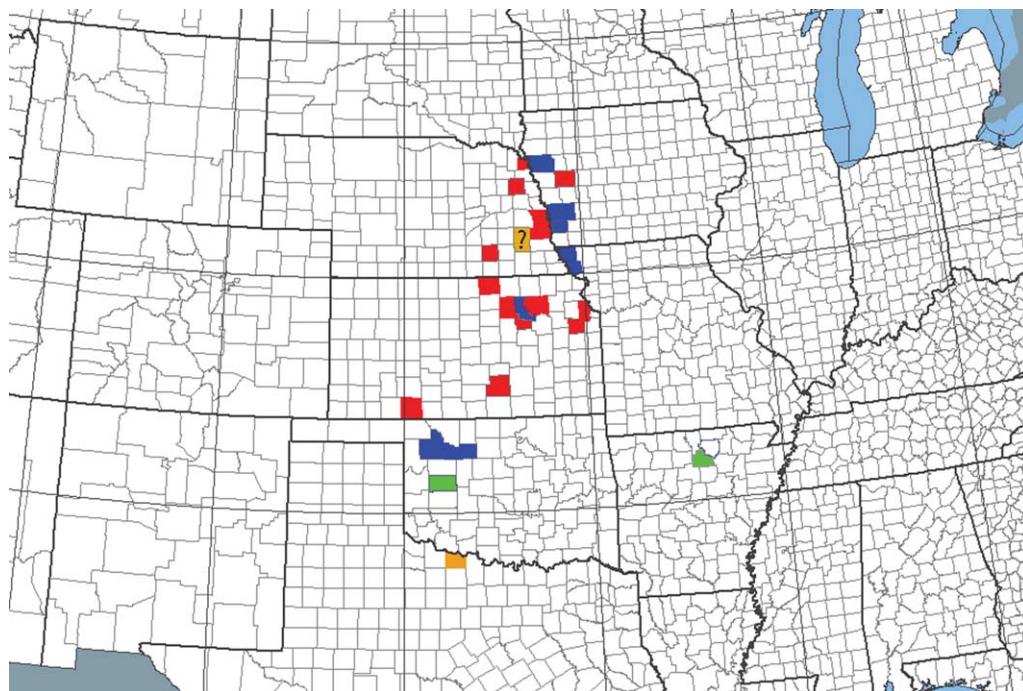


Fig. 8. Historical and currently known geographical occurrence of *Cylindera celeripes* by county. Red = last record prior to 1920; orange = last record 1941–1960 (“?” = questionable record); green = last record 1991–1996; blue = last record 2005–2011.

and row crops during the past century, especially in more eastern localities, suggests that any populations that do remain are likely to be small and disjunct.

The Flint Hills population appears to be secure based on recent adult beetle incidence; however, the apparent restriction of the population to a small area around the type locality is cause for concern. At a minimum, conservation efforts at the state level may be desirable to reduce the potential for extirpation within the state. Such efforts might include public ownership or conservation easements at specific sites where the beetle is known to occur and addition of the species to the state list of Species in Need of Conservation (Kansas Department of Wildlife and Parks 2009). At the same time, numerous prairie remnants of substantial size still exist throughout eastern Kansas, including the 3,487-hectare Konza Prairie Biological Station and the 4,395-hectare Tallgrass Prairie National Preserve. Given the small size and cryptic habits of *C. celeripes*, it is possible that the beetle might occur in these areas and has thus far evaded detection. Further census in these areas may be warranted.

The Loess Hills populations appears to be more vulnerable, especially in Missouri where both the beetle and the loess hilltop prairie remnants that support it have been classified as critically imperiled (Missouri Natural Heritage Commission 2010). Only ~20 hectares of loess hilltop prairie remain in Missouri, and only half of these (including the three remnants where the beetle has been observed) are under conservation ownership (Rushin 2005). Loess hilltop prairie remnants in Iowa are larger and more extensive than in Missouri; however, they are still small and isolated compared to grassland remnants in more western parts of the range of *C. celeripes*. Additionally, the beetle is not currently listed on the Iowa list of Endangered, Threatened, and Special Concern Species (Iowa Department of Natural Resources 2009) and, thus, is not currently afforded any special protection or conservation measures. Throughout the Loess Hills, land management practices should be devised and implemented at sites known to support populations of *C. celeripes* to reduce the threat of localized extinctions. Such measures should include the use of disturbance factors that favor grasslands over forests, including removal of encroaching woody vegetation, judicious use of prescribed burning, and selective grazing. It is essential that these measures be implemented in a manner that minimizes impacts to beetle populations—*e.g.*, if prescribed burning is done it should be done on a rotational basis and when adults and larvae are not active (late fall through early spring), perhaps also establishing permanently unburned refugia in which alternative disturbance factors are used to maintain open ground and limit woody vegetational encroachment. Lastly,

as much as possible, areas adjacent to known sites should be renovated to expand available habitat and minimize isolation distances between sites. This is especially important in Missouri, where the beetle is considered to be under imminent threat of extirpation—as may have already happened with Missouri's disjunct population of Johnson's tiger beetle, *Habroscelimorpha circumpecta johnsonii* (Fitch) (Brown and MacRae 2011).

Recent observations of robust populations in the Red Hills of Oklahoma greatly improve the long-term survival outlook for the species as a whole. The numbers of adult beetles and extensiveness of apparently suitable habitat observed in the Red Hills suggest that beetle populations within this region are healthy and not under immediate threat. The Red Hills are considered a functioning landscape, and while grazing, altered fire regimes, and agricultural conversion continue, these are not considered severe or immediate threats (Steuter *et al.* 2003). The Red Hills extend into southwestern Kansas as well, where a historical record of the beetle exists. The presence of robust populations of the beetle in adjacent Oklahoma suggests that *C. celeripes* might still occur in southwestern Kansas.

The White River Hills population is documented thus far by a single specimen collected in 1996 in north-central Arkansas. It has not been seen in more recent visits to the collection site, thus, its status in the area cannot be assessed. The locality is disjunct from all recorded *C. celeripes* sites by a distance of at least 480 km. Potentially, the species is more widespread in the White River Hills, which extend from north-central Arkansas into southwestern Missouri. Pitfall trap surveys conducted in southwestern Missouri in 2005 failed to detect this species at several locations (Brown and MacRae 2005); however, the species may not be effectively captured by the type of pitfall traps utilized, as was found with robust populations of the closely related *C. cursitans* at several sites in southeastern Missouri (MacRae *et al.* 2011). The White River Hills population may represent a relict outpost from the Holocene Thermal Optimum of 6,000–9,000 years ago, when warmer and drier conditions caused expansion of grassland habitats into the eastern United States (Graham 1999). Although deciduous forests reclaimed much of this area in subsequent millennia, significant grassland remnants persist in the White River Hills and other areas along the western reaches of the eastern deciduous forest biome in Missouri and Arkansas. These remnants provide refugia for a number of plants and animals more typically found in the central and southern Great Plains, including tiger beetles such as *C. obsoleta vulturina* in the White River Hills (Mawdsley 2009), *H. circumpecta johnsonii* in central Missouri (Brown and MacRae

2011), and *Dromochorus pruinina* (Casey) in west-central Missouri (MacRae and Brown 2011). The occurrence of *C. celeripes* in the White River Hills is significant, not only because it represents an expansion of its known historical range, but also because it raises the possibility that additional remnant populations might be found in suitable grassland habitats within the disjunction zone in western Arkansas and Missouri and eastern Kansas and Oklahoma.

These findings suggest that *C. celeripes* has experienced significant reductions in its geographical occurrence during the past 100 years. In many areas of its former range where it once occurred in abundance it has either been extirpated or is now threatened or critically imperiled. Conservation measures are clearly warranted at the state level to prevent further extirpations, as are additional surveys in areas that offer potential habitat—particularly the Flint Hills of eastern Kansas, Red Hills of south-central Kansas and northwestern Oklahoma, and White River Hills of southwestern Missouri and north-central Arkansas. At the same time, its present day distribution does still greatly exceed those of most other tiger beetle species that have been listed or proposed for listing as federally threatened or endangered, including *Cicindela* (*s. str.*) *albissima* Rumpff (Morgan *et al.* 2000), *C. (s. str.) ohlone* Freitag, Kavanaugh, and Morgan (1993), *C. (Cicindelidia) highlandensis* Choate (1984), and *Ellipsoptera nevadica lincolniana* (Casey) (Spomer and Higley 1994). This and the potential for finding additional populations with new survey work suggest that *C. celeripes* probably does not meet the threshold for listing as a threatened or endangered species at the federal level.

ACKNOWLEDGMENTS

We thank the Missouri Department of Conservation (MDC) (Jefferson City), Chad Graeve (Hitchcock Nature Center, Honey Creek, IA), Tandy Keenan (Alabaster Caverns State Park, Freedom, OK), Ronald L. Bell and Corey Kudrna (Squaw Creek National Wildlife Refuge, Mound City, MO), Charles Bachle (Rock Port, MO), Brian and Kathy Kunkel (Mound City), and Sean and Erin Slocum (Mound City) for permission to survey lands under their stewardship. Special appreciation is extended to Tom Nagel (MDC, St. Joseph, MO) for aerial maps and details on the vegetational/land use history of loess hilltop prairie remnants in Missouri, and to Jim Pierson (MDC, Mound City) for facilitating contact with private landowners. Appreciation is also extended to Charles S. Lewallen (Henreyetta, OK) for details on his sighting of *C. celeripes* at Alabaster Caverns State Park; Mathew L. Brust (Chadron State Col-

lege, NE) for details that allowed us to find *C. celeripes* at Hitchcock Nature Center; Stephen M. Spomer (University of Nebraska, Lincoln) for providing quotes pertinent to this species from the personal correspondence of Frank Shoemaker; Yves Bousquet (Agriculture and Agri-Food Canada, Ottawa, Ontario), Aaron Brees (Iowa Department of Natural Resources, Des Moines), Terry L. Erwin (Smithsonian Institution, Washington, DC), C. Barry Knisely (Randolph-Macon College, Ashland, VA), and David L. Pearson (Arizona State University, Tempe) for help with literature records; Kent Fothergill (Portageville, MO) and David L. Pearson for reviewing an earlier version of the manuscript; and the following individuals and institutions for help with records or providing label data from or access to specimens under their care: Mathew L. Brust [MLBC], David W. Brzoska [DWBC] (Naples, FL), Florida State Collection of Arthropods, Gainesville (Paul E. Skelley), W. Wyatt Hoback (University of Nebraska, Kearney) [WWHC]; Ronald L. Huber (Bloomington, MN), Kansas State University, Manhattan (Gregory Zolnerowich), Oklahoma State University, Stillwater (Don Arnold), Brett C. Ratcliffe (University of Nebraska, Lincoln), Craig Rotermund (Omaha, NE), Smithsonian Institution, Washington, DC (Terry L. Erwin), Stephen M. Spomer [SMSC], Texas A&M University, College Station (Edward G. Riley), Texas Tech University, Lubbock (James Cokendolpher), University of Kansas, Lawrence (Zachary H. Falin), University of Missouri, Columbia (Kristin B. Simpson), University of Nebraska, Lincoln (Matthew J. Paulsen), University of Oklahoma, Norman (Brenda Smith-Patten), University of Texas, Austin (John C. Abbott), and West Texas A&M University, Canyon (David Sissom). Finally, we thank two anonymous reviewers for their insightful comments that greatly improved this manuscript.

REFERENCES CITED

- Bousquet, Y., and A. Larochele.** 1993. Catalogue of the Geodephaga (Coleoptera: Trachypachidae, Rhysodidae, Carabidae including Cicindelini) of America north of Mexico. *Memoirs of the Entomological Society of Canada* 167: 1–397.
- Brown, C. R., and T. C. MacRae.** 2005. Survey for three species of tiger beetles (Coleoptera: Cicindelidae) in western and southwestern Missouri. Report submitted to Missouri Department of Conservation.
- Brown, C. R., and T. C. MacRae.** 2011. Assessment of the conservation status of *Habroscelimorpha circumpecta johnsonii* (Fitch) in Missouri. *Cicindela* 42(4) (2010): 77–90.
- Bruner, L.** 1901. The tiger beetles of Nebraska. *Proceedings of the Nebraska Academy of Science* 7: 97–99.
- Carter, M. R.** 1989. The biology and ecology of the tiger beetles (Coleoptera: Cicindelidae) of

- Nebraska. Transactions of the Nebraska Academy of Science 17: 1–18.
- Choate, P. M. 1984.** A new species of *Cicindela* Linnaeus (Coleoptera: Cicindelidae) from Florida, and elevation of *C. abdominalis scabrosa* Schaupp to species level. Entomological News 95(3): 73–82.
- Cutler, B. 1973.** Adult behavior of *Cicindela cursitans*. *Cicindela* 5(4): 77–80.
- Drew, W. A., and H. W. Van Cleave. 1962.** The tiger beetles of Oklahoma (Cicindelidae). Proceeding of the Oklahoma Academy of Science 42: 101–122.
- Eckhoff, D. E. 1939.** The Cicindelidae of Iowa (Coleoptera). Iowa State Collection Journal of Science 13: 201–230.
- Erwin, T. L., and D. L. Pearson. 2008.** Treatise on the Western Hemisphere Caraboidea (Coleoptera): Their classification, distributions & ways of life, Carabidae - Nebriiformes 2—Cicindelitae (Pensoft Series Faunistica). Pensoft Publishers, Sofia.
- Evenhuis, N. L. 2009.** The insect and spider collections of the world website. Available from: hbs.bishopmuseum.org/codens/ (Accessed on 1 October 2010).
- Freitag, R. 1999.** Catalogue of the tiger beetles of Canada and the United States. NRC-CNRC Research Press, Ottawa, Canada.
- Freitag, R., D. H. Kavanaugh, and R. Morgan. 1993.** A new species of *Cicindela* (*Cicindela*) (Coleoptera: Carabidae: Cicindelini) from remnant native grassland in Santa Cruz County, California. The Coleopterists Bulletin 47(2): 113–120.
- Graham, A. 1999.** Late Cretaceous and Cenozoic history of North American vegetation, North of Mexico. Oxford University Press, Inc., New York, NY.
- Graves, R. C., and D. L. Pearson. 1973.** The tiger beetles of Arkansas, Louisiana, and Mississippi (Coleoptera: Cicindelidae). Transactions of the American Entomological Society 99: 157–203.
- Hoback, W. W., and J. J. Riggins. 2003.** Tiger beetles of the United States. Northern Prairie Wildlife Research Center Online. Available from: www.npwr.usgs.gov/resource/distr/insects/tigb/index.htm (Accessed on 12 December 2010).
- Horn, W. 1930.** Notes on the races of *Omus californicus* and a list of the Cicindelidae of America north of Mexico (Coleoptera). Transactions of the American Entomological Society 56: 73–86.
- Iowa Department of Natural Resources. 2009.** Iowa's threatened and endangered species program. Available from: www.iowadnr.gov/other/threatened.html (Accessed on 12 December 2010).
- Kansas Department of Wildlife and Parks. 2009.** Species in need of conservation. Available from: www.kdwp.state.ks.us/news/Other-Services/Threatened-and-Endangered-Species/Species-in-Need-of-Conservation-SINC (Accessed on 12 December 2010).
- Knisley, C. B., D. W. Brzoska, and J. R. Schrock. 1990.** Distribution, checklist and key to tiger beetles (Coleoptera: Cicindelidae) of Indiana. Proceedings of the Indiana Academy of Science 97 (1987): 279–294.
- Lantz, D. E. 1905.** Notes on collecting Cicindelidae. Transactions of the Kansas Academy of Science 19: 252–260.
- LeConte, J. L. 1848.** A descriptive catalogue of the Geodephagous Coleoptera inhabiting the United States east of the Rocky Mountains. Annals of the Lyceum of Natural History of New York 4: 173–474.
- Leng, C. W. 1902.** Revision of the Cicindelidae of boreal America. Transactions of the American Entomological Society 28: 93–186.
- Leng, C. W. 1920.** Catalogue of the Coleoptera of America, north of Mexico. J. D. Sherman, Jr., Mount Vernon, VA.
- MacRae, T. C., and C. R. Brown. 2001.** Missouri Tigers. Missouri Conservationist 62: 14–19.
- MacRae, T. C., and C. R. Brown. 2011.** 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, and K. Fothergill. 2011.** Distribution, seasonal occurrence, and conservation status of *Cylindera* (s. str.) *cursitans* (LeConte) (Coleoptera: Cicindelidae) in Missouri. *Cicindela* 43(3) (in press).
- Mawdsley, J. R. 2009.** Geographic variation in U. S. populations of the tiger beetle *Cicindela obsoleta* Say (Coleoptera: Cicindelidae). *Insecta Mundi* 0094: 1–10.
- McNab, W. H., D. T. Cleland, J. A. Freeouf, J. E. Keys, Jr., G. J. Nowacki, and C. A. Carpenter. 2005.** Description of ecological subregions: Sections of the conterminous United States. US Department of Agriculture, Forest Service, Washington, DC.
- Missouri Natural Heritage Commission. 2010.** Species and communities of conservation concern checklist. Missouri Department of Conservation, Jefferson City, MO.
- Montgomery, B. E., and R. W. Montgomery. 1931.** Records of Indiana Coleoptera. I. Cicindelidae. Proceedings of the Indiana Academy of Science 40 (1930): 357–359.
- Morgan, M., C. B. Knisley, and A. P. Vogler. 2000.** New taxonomic status of the endangered tiger beetle *Cicindela limbata albissima* (Coleoptera: Cicindelidae): Evidence from mtDNA. Annals of the Entomological Society of America 93(5): 1108–1115.
- Pearson, D. L., T. G. Barraclough, and A. P. Vogler. 1997.** Distributional maps for North American species of tiger beetles (Coleoptera: Cicindelidae). *Cicindela* 29(3–4): 33–84.
- Pearson, D. L., C. B. Knisley, and C. J. 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, NY.
- Rushin, J. 2005.** The Loess Hills: Missouri's prairie giants. Missouri Prairie Journal 26: 4–8.
- Spomer, S. M., M. L. Brust, D. C. Backlund, and S. Weins. 2008.** Tiger beetles of South Dakota and Nebraska. University of Nebraska, Department of Entomology, Lincoln, NE.
- Spomer, S. M., and L. G. Higley. 1994.** Population status and distribution of the Salt Creek tiger beetle,

- Cicindela nevadica lincolniana* Casey (Coleoptera: Cicindelidae). Journal of the Kansas Entomological Society 66(4): 392–398.
- Steuter, A., J. S. Hall, and M. Lammert Khoury. 2003.** Conserving the biological diversity of the Central Mixed-Grass Prairie: A portfolio designed for conservation action. The Nature Conservancy, Nebraska Field Office, Omaha, NE.
- Wickham, H. F. 1899.** The habits of American Cicindelidae. Proceedings of the Davenport Academy of Science 7: 206–228.
- Zerm, M., and J. Adis. 2002.** Flight ability in nocturnal tiger beetles (Coleoptera: Carabidae: Cicindelinae) from Central Amazonian floodplains (Brazil). The Coleopterists Bulletin 56(4): 491–500.

(Received 9 May 2011; accepted 16 July 2011. Publication date 20 September 2011.)