THE IDENTITY OF A TIGER BEETLE FROM THE BLACK HILLS OF SOUTH DAKOTA

A report to the
South Dakota Dept. of Game, Fish, and Parks
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INTRODUCTION

There are 24 or 25 species of tiger beetles known from South Dakota (Kirk & Balsbaugh 1975, Backlund et al. 2005, H.L.Willis, pers. comm.), including one subspecies that is endemic to the Badlands (Spomer 2004). Two species, considered to be closely related (Pearson et al. 2006), *Cicindela longilabris laurentii* Schaupp and *C. nebraskana* Casey, appear to be present in the Black Hills.

The Boreal Long-lipped tiger beetle, *C. longilabris laurentii*, is a beetle found throughout the Rocky Mountains from New Mexico to Canada, with disjunct populations occurring in the White Mountains of Arizona and the Black Hills of South Dakota (Pearson 1997). It is found in meadows or grassy areas with nutrient-poor, acidic soils in or near coniferous forests (Pearson et al. 2006). It is variable in color, but Black Hills specimens are usually dark brown/bronze, with up to three white markings, including a distinct middle band. Spanton (1988) examined a population he referred to as *C. longilabris* in the Black Hills as "lightly marked". Ventrally, they are usually metallic blue-green. They are considered a spring-fall species, but are often seen in mid- to late-July at higher elevations in the Black Hills. Both sexes are reported as having white labra.

The Prairie Long-lipped tiger beetle, *C. nebraskana*, is a species found throughout western North America, including the Great Plains. As its name suggests, it is found on treeless or near treeless prairies with rich soils (Pearson et al. 2006). It is black, both dorsally and ventrally, and appears to have smoother elytra than *C. longilabris*. The labrum of the male is white, while that of the female is black or dark brown. It is also a spring-fall species, but most records are from spring. In its "pure" form, *C. nebraskana* may not occur in the Black Hills *per se*, but is found outside the general area on the surrounding grasslands.

A third entity is also present in the Black Hills. Individuals of this form have characteristics of both *C. longilabris* and *C. nebraskana* and cannot be identified with certainty. They are usually unmarked like *C. nebraskana*, but have coloration more like *C. longilabris* (e.g. metallic blue-green ventrally). They occur on prairie hilltops within Ponderosa pine forests and seem to be more common in the lower-elevation southern Black Hills. There are several possibilities as to the identity of this third entity: (1) they are variants of *C. nebraskana*, with metallic undersides, (2) they are unmarked variants of *C. longilabris* (typically-marked *C. longilabris* are also found in the Black Hills), (3) they are a third, undescribed species, (4) they are part of a hybrid population between *C. longilabris* and *C. nebraskana*, or (5) they are intergrades between two subspecies of one species, *C. longilabris* (thus, *C. nebraskana* would be a synonym of *C. longilabris*). The goal of this study will be to try to determine the identity of these currently unidentifiable beetles.

From a conservation and taxonomic viewpoint, it is important to determine the identity of these beetles. Although not rare in the Black Hills, *C. longilabris* is disjunct from the populations inhabiting the Rocky Mountains. At this point, it is unknown if these Black Hills populations are genetically distinct from their Rocky Mountain counterparts. In

contrast, *C. nebraskana* does not appear to be disjunct in SD, but nevertheless is a rare beetle in SD and NE (Backlund et al. 2005, Brust and Hoback 2005), so identification is crucial before conservation steps can be taken to ensure its survival.

The objectives of this study are to compare morphological, ecological, and behavioral characteristics between *C. longilabris*, *C. nebraskana*, and the unknown entities in the Black Hills and vicinity. Key characteristics will be determined for the two species, and an identity, based on these characteristics, will be given to the unknown populations.

MATERIALS AND METHODS

Two trips were made to coincide with spring-fall adult activity of *C. nebraskana* and *C. longilabris*: 11-14 May and 6-8 Sept. 2006. The following sites were visited in May: Wilson Ranch (Sioux Co. NE), Robinson Flats (Fall River Co. SD), Cottonwood Springs (Fall River Co. SD), Sturgis BLM (Meade Co. SD), Boundary Gulch (Crook Co. WY/Lawrence Co. SD), and McNenny Fish Hatchery (Lawrence Co. SD). The same sites were visited in Sept., along with an additional site in the Bear Lodge Mts. (Crook Co. SD) and Timon Campground (Lawrence Co.).

Attempts were made to collect all specimens seen, and these were either preserved in 70% EtOH or kept alive in glassine envelopes. Third-stage larvae of presumed species were dug up from Wilson Ranch, Robinson Flats, and Sturgis BLM and transferred to terraria with their native soil. Three pairs of live adults of *C. nebraskana* (Wilson Ranch) and the Robinson Flats population were set up in terraria with soil and grasses from their native habitat in an attempt to start a colony.

Soil samples from Wilson Ranch, Robinson Flats, and Boundary Gulch were analyzed at UNL for various nutrients and organic matter.

A small sample (1 to 6 adults) from Wilson Ranch, Robinson Flats, Boundary Gulch, Sturgis BLM, and McNenny Fish Hatchery, as well as an outgroup of *C. longilabris longilabris* Say from Ontario (provided by M.L.Brust) were killed in 95% EtOH and sent to Alfried Vogler in London for DNA analysis.

After all adults had died, they were pinned and allowed to dry. These specimens, along with specimens from the collections of Scott Weins (Spearfish, SD), Doug Backlund (Pierre SD), and Matt Brust (Lincoln, NE), were examined. For each specimen, the following data were collected: locality, altitude (if known), habitat (if known), date of capture, sex, labrum color, total length (tip of labrum to tip of abdomen, unless genitalia were everted; then, tip of elytra), meta (hind) tarsus length, presence or absence of middle band, humeral lunule, apical lunule, dorsal color, ventral color, proepisternum color, and elytral luster or reflectance (shiny, dull, or intermediate). In addition, metatibia:metatarsus ratio was determined for a small sample of adults, as was labrum length:width ratio, and density of setae on the metathoracic sternite.

In all, 198 specimens were examined. Of these, 114 were directly from the Black Hills (Fall River, Custer, Pennington, Meade, Lawrence Cos. SD, Crook Co. WY), 42 were from nearby counties in NE, WY, and SD within 100-150 miles from the Black Hills, and 42 were from other states and provinces.

Typical *C. nebraskana* were examined from Harding Co. SD (1 specimen), Ziebach Co. SD (2 specimens), Scotts Bluff Co. NE (2 specimens), and Sioux Co. NE (23 specimens). The site in Sioux Co. (Wilson Ranch; 3 mi. N, 8.5 mi. NW of Harrison) is probably very close to the locality where Casey collected his type series (M.L.Brust, pers. comm.). These were compared to what was determined to be *C. longilabris* (based on several morphological characters, habitat, altitude, etc.) to try to determine defining, or key, characteristics of each species. Individuals from each population were then rated and compared with the rated characteristics in an attempt to categorize populations as *C. nebraskana*, *C. longilabris*, both, or hybrids (intermediates) between the two.

For metatibia:metatarsus ratio, metatarsal length, and labrum length:width ratio comparisons, specimens from outside the Black Hills were used. These included *C. l. longilabris* (ON, NB), *C. l. laurentii* (CO, NM, WY, UT), *C. l. longilabris* X *C. l. laurentii* (MB), and *C. l. perviridis* Schaupp (ID, WA, OR, CA).

GPS coordinates were taken at visited sites with a Garmin etrex Vista.

RESULTS AND DISCUSSION

Detailed descriptions of sites reported in Table 1 are found in Appendix 1.

Distinguishing *C. longilabris* from *C. nebraskana* morphologically

Pearson et al. (2006) and Leffler (1979) list the following differences:

C. nebraskana	*C. longilabris*
• elytral punctures irregularly arranged, not in distinct transverse row, few, thus appearing shiny	• elytral punctures in disting, but sometimes wavy transverse rows, thus appearing dull
• ratio of metatibia length/metatarsus length < 0.99	• ratio of metatibia length/metatarsus length ≥ 1.0
• black dorsally and ventrally	• metallic purple to green ventrally
• thin, white middle band only, if any	• up to 3 distinct maculations
• female with dark or partially dark labrum	• female with white labrum

From Table 1, ventral and proepisternal color (black vs. metallic greens, blues, purples, etc.), presence or absence of a middle band, and elytral luster were the most useful characters to distinguish the two species. Next was the hind tarsal length. Labrum color was not as consistent, with only 79% of female *C. longilabris* having white labra, while 5% of female *C. nebraskana* also had white labra. In total length, male *C. nebraskana*

averaged a full millimeter shorter than *C. longilabris*, but females of both species were nearly identical (13.9 mm for *C. nebraskana* vs. 14.1 mm for *C. longilabris*).

Other morphological measurements

Metatibia:metatarsus ratio:

Leffler (1979) reported that the metatibia:metatarsus ratio was a good distinguishing character for *C. longilabris* and *C. nebraskana*. He stated that the ratio was always less than 0.99 (most were 0.95 or less) for *C. nebraskana* and greater than 1.00 for *C. longilabris*. I measured a sample (n=10) of NE *C. nebraskana*, SD *C. longilabris* (n=10), Rocky Mountain *C. longilabris laurentii* (n=7), MB *C. l. longilabris* X *C. l. laurentii* (n=9), and *C. l. perviridis* (n=9). Ratio means were 0.996 for *C. nebraskana* (range of 0.97 to 1.04), 0.974 for SD *C. longilabris* (range of 0.92 to 1.03), 1.02 for Rocky Mtn. *C. l. laurentii* (range of 0.95 to 1.08), 0.984 for MB *C. l. longilabris* X *C. l. laurentii* (range of 0.89 to 1.17), and 0.92 for *C. l. perviridis* (range of 0.82 to 1.02). Because of the large amount of variability, I concluded that the metatibia:metatarsus ratio was not a good character to use to distinguish the two species. However, while examing the ratios, I noticed what appeared to be a difference in hind tibia lengths, which led to the discovery of *C. nebraskana* having shorter hind tibia lengths than *C. longilabris* (and females having shorter hind tibia than males in both species, which was unexpected). Hind tibia lengths were as follows: *C. nebraskana* (male, n=10, 4.8 mm; female, n=18, 4.7 mm), SD *C. longilabris* (male, n=16, 5.4 mm; female, n=13, 5.0 mm), Rocky Mtn. *C. l. laurentii* (male and female combined, n=8, 5.2), MB *C. l. longilabris* X *C. l. laurentii* (male and female combined, n=7, 5.2), NB/ON *C. l. longilabris* (male and female combined, n=10, 5.4), and *C. l. perviridis* (male and female combined, n=15, 5.4). Only one male *C. nebraskana* had a tarsal length of > 5.0, and only two female *C. longilabris* (SD) had a tarsal length < 5.0, so tarsal length was a good, consistent character to distinguish the two species.

Labrum width:length ratio:

A sample of *C. nebraskana* and *C. longilabris* were used to determine the width:length ratio of the labrum. Width:length ratio averaged about 1.5 for *C. longilabris* (1.47 to 1.55 depending on location), while *C. nebraskana* (from NE and Albany Co. WY; n=24) averaged 1.63. At first, this appeared to be a consistent character difference; however, when *C. nebraskana* from other states (CO, MT, ID, w WY) were measured, width:length ratio ranged from 1.38 (CO) to 1.57 (MT), so it was decided that while the ratio may be a useful factor in distinguishing *C. longilabris* and *C. nebraskana* in the Black Hills region, it was not a useful character elsewhere.

Hairs on metathoracic sternite:

A cursory examination of the hairs on the metathoracic sternite first appeared to differ between *C. nebraskana* and *C. longilabris* by being denser on *C. longilabris*. After

examining all specimens, however, it was decided that the hairs were too variable of a character to be useful.

Distinguishing *C. longilabris* from *C. nebraskana* ecologically

Pearson et al. (2006), Spanton (1988), Wallis (1961), Wickham (1899), and Criddle (1907) list the following ecological characteristics:

C. nebraskana
- prairie, bare soil in grasslands with few or no trees
- nutrient rich soils
- shortgrass plains, heavy clay soils
- Chernozemic soils dominate
- flies into the grass when disturbed

C. longilabris
- meadows or grassy areas with open coniferous forest
- sandy, often nutrient poor, acidic soils in or around coniferous forests
- stony banks, roads and paths, at some distance from water
- higher altitudes

For the most part, my observations were consistent with published information on the two species. The Wilson Ranch site (true *C. nebraskana*) was open, short grass prairie at about 5000' elevation. Typical *C. longilabris* (from Timon CG, Deerfield Lake, Moon CG, Keough Draw, Black Fox CG) were from altitudes of 5800-6000'. Boundary Gulch (about 4800'+, with habitat more similar to higher altitude sites) had individuals that appeared to be true *C. longilabris*, along with individuals that had *C. nebraskana*-like qualities. Other sites (McNenny, Sturgis BLM, Cottonwood Springs, Robinson Flats) were lower in altitude (3500-4200'), even more so than Wilson Ranch, but had similar habitat as Wilson Ranch, and beetle phenotype was more *C. nebraskana*-like, although some intermediate-looking individuals were found.

Results of the soil analyses are shown in Table 2. Soil samples from Wilson Ranch were lowest in pH, highest in Potassium (K), organic Carbon (C), Nitrogen (N), and organic matter. Soil from Boundary Gulch was neutral in pH, high in K, and slightly lower than Wilson Ranch in organic C and N. Robinson Flats was highest in pH, and lowest in K, organic C, and N. These results were fairly consistent with the scant published data, although Boundary Gulch (a *C. longilabris* site) was not acidic. Though the soil from Wilson Ranch (*C. nebraskana* site) was the most nutrient rich and highest in % organic matter, differences between the three sites were not dramatic.

Larval comparisons

Several third-stage larvae from Wilson Ranch and Robinson Flats were excavated and transferred to terraria with their native soil. These were presumed to be *C. nebraskana* (Wilson Ranch) and the unidentifiable beetle (Robinson Flats) because they were collected where adults were most numerous. In addition, several of the burrows appeared to be funnel-shaped, which is listed as characteristic of *C. nebraskana* (Pearson 2006). Unfortunately, when the adults emerged in late August, they were *C. purpurea audubonii*

Le Conte, another beetle that was present at both sites. On the September trip, two third-stage larvae were excavated at Sturgis BLM from the ridgetop where adults were observed and collected in May. These larvae have plugged their burrows and should emerge in the spring. However, the Sturgis larvae appeared to be identical (black head, etc.) to the Wilson Ranch and Robinson Flats larvae, so these may also turn out to be *C. purpurea*.

Attempts to start a colony

Three pairs of adults from Wilson Ranch and Robinson Flats were transferred to two terraria with soil and grasses from their native habitat in an attempt to start a colony in the laboratory. Although mating was often observed, oviposition was not. Unfortunately, none of the females apparently laid eggs, as no larval burrows resulted. As adults died, they were transferred to 95% EtOH for the DNA analysis.

DNA analysis

Samples of *C. nebraskana* and *C. longilabris* were sent to A. Vogler for DNA extraction. These included *C. nebraskana* from Wilson Ranch, *C. l. longilabris* from ON, and unknowns from Boundary Gulch (at least some were *C. longilabris* phenotype), Sturgis, Robinson Flats, and McNenny.

As of December 2006, samples had not yet been analyzed.

SUMMARY

Phenotypic determinations of populations from specific sites are shown in Table 3. Individual characters were scored and an overall determination as to species was given. In my opinion, many of the populations were not assignable to either one species or the other, and probably represent hybrid populations, showing past gene flow (introgression and recombination) between both species.

Hybrids are not rare in insects between closely-related species. There is a hybrid, or "tension", zone between the swallowtail butterflies *Papilio glaucus* and *P. canadensis* in the Great Lakes region (Collins 1991). A hybrid swarm between the butterflies *Papilio zelicaon nitra*, *P. polyxenes asterius*, and possibly *P. machon dodi* exists in Cheyenne Co. NE, extending at least to Scotts Bluff Co. (personal observations). Other well-documented hybrid swarms include the saturniids *Hyalaphora euryalus* and *H. gloveri* in the Lake Tahoe area and elsewhere in the Pacific Northwest (Collins 1991).

Although altitude and habitat tend to separate *C. longilabris* and *C. nebraskana* populations, altitudinal and habitat overlaps have probably provided the means for the two species to hybridize. Boundary Gulch is one such site that showed a large mixture of phenotypes, from typical *C. longilabris* to near *C. nebraskana*. Long-range dispersal of fertile individuals with genes from both species probably resulted in "unidentifiable" populations at lower altitudes, such as McNenny, Robinson Flats, Sturgis, and

Cottonwood Springs. These populations may not currently receive new gene flow from either species, and have maintained a "hybrid-appearing" phenotype. From my observations, these "hybrid-appearing" populations are not restricted to the Black Hills, but are also found in the foothills of the Rocky Mountains and likely elsewhere. However, there appears to be gene flow between these foothills populations of *C. nebraskana* and *C. longilabris*, which may not be the case at most sites in the Black Hills.

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Table 1. Morphological comparisons between *C. nebraskana* (NE and SD) and *C. longilabris* (Black Hills), and between Black Hills populations of "unknowns".

	Length, mm.		Hind tarsus length, mm.		Labrum color, %						Ventral color, % black	
					White		Brown/Mottled		Black			
Taxon	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
C. nebraskana	12.8 (n=13)	13.9 (n=18)	4.8 (n=10)	4.7 (n=18)	92	5	8	39	0	56	100	100
C. longilabris	13.8 (n=16)	13.9 (n=14)	5.4 (n=16)	5.0 (n=13)	100	79	0	21	0	0	6	0
Site												
Sturgis BLM	13.0 (n=6)	13.9 (n=6)	5.0 (n=6)	4.8 (n=6)	100	17	0	17	0	67	50	67
McNenny	13.3 (n=3)	13.8 (n=3)	4.9 (n=3)	4.9 (n=3)	100	0	0	67	0	33	33	0
Robinson Flats	13.3 (n=15)	14.0 (n=7)	5.0 (n=15)	4.7 (n=7)	100	14	0	71	0	14	7	29
Cottonwood Springs	13.6 (n=10)	14.0 (n=8)	5.0 (n=9)	4.7 (n=8)	100	13	0	63	0	25	0	0
Boundary Gulch	13.6 (n=6)	13.9 (n=6)	5.2 (n=5)	4.8 (n=6)	100	50	0	33	0	17	0	0
TimonCG	14.3 (n=2)	14.3 (n=2)	5.4 (n=2)	5.1 (n=1)	100	100	0	0	0	0	0	0
Black Fox CG	14.0 (n=2)	15.3 (n=2)	5.4 (n=2)	5.3 (n=2)	100	100	0	0	0	0	0	0
Moon CG	12.5 (n=1)	14.2 (n=1)	5.1 (n=3)	5.2 (n=2)	100	100	0	0	0	0	0	0
Keough Draw	13.8 (n=2)	---	5.4 (n=2)	---	100	---	0	---	0	---	0	---
Deerfield Lake	14.0 (n=1)	13.8 (n=2)	5.5 (n=1)	5.1 (n=2)	100	100	0	0	0	0	0	0

Table 1 (cont.)

	Middle band presence, %		Proepisternum color, % black		Luster, %					
					Dull		Shiny		Intermediate	
Taxon	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
C. nebraskana	8	0	100	100	0	0	92	100	8	0
C. longilabris	88	86	6	0	81	93	0	0	19	7
Site										
Sturgis BLM	17	0	67	67	0	0	100	100	0	0
McNenny	0	0	33	0	0	0	100	100	0	0
Robinson Flats	13	0	7	29	0	0	100	100	0	0
Cottonwood Springs	0	0	0	0	0	0	100	100	0	0
Boundary Gulch	33	50	0	0	50	67	17	0	33	33
TimonCG	50	100	0	0	50	100	0	0	50	0
Black Fox CG	100	100	0	0	100	100	0	0	0	0
Moon CG	0	100	0	0	0	67	0	0	100	33
Keough Draw	50	---	0	---	100	---	0	---	0	---
Deerfield Lake	100	100	0	0	100	100	0	0	0	0

Table 2. Soil analysis from selected sites.

Site	Total C %	Organic C %	Organic matter, % (LOI)	Total N P, %	Bray PPM	K PPM	Buffered pH
Wilson Ranch	1.2	1.1	2.3	0.12	11.7	387	6.8
Boundary Gulch	1.1	1.1	1.5	0.08	34.4	174	7.0
Robinson Flats	0.8	0.8	1.5	0.09	9.1	183	7.0

Table 3. Phenotypic determination of populations, based on altitude of site, habitat, and morphological characteristics [N=*C. nebraskana*, L=*C. longilabris*, and I=intermediate (hybrid)]

Population/Site	Altitude	Habitat type	Total length	Metatarsal length	Labrum color	V/Proepis. color	Middle band	Luster	Overall determination
Robinson Flats	N	N	I	I	N	I	N	N	N/I
Cottonwood Springs S.R.A.	N	N	L	I	N	L	N	N	I
McNenny Fish Hatchery	N	N	I	N	N	I	N	N	N/I
Sturgis BLM	N	N	N	I	N	I	N	N	N/I
Boundary Gulch	N	L	L	L	I	L	I	I	L/I
Deerfield Lake	L	L	L	L	L	L	L	L	L
Timon Campground	L	L	L	L	L	L	L	L	L
Moon Campground	L	L	I	I	L	L	L	I	L/I
Black Fox Campground	L	L	L	L	L	L	L	L	L
Keough Draw	L	L	L	L	L	L	L	L	L

Appendix 1. Detailed descriptions of sites mentioned in text.

Wilson Ranch- GPS N42° 47.547' W104° 01.316', elevation 5000'. Private property, ca. 3 mi. N, 8.5 mi. NW of Harrison, Sioux Co. NE. Treeless shortgrass prairie with some interspersed forbs, used for cattle grazing. Small rolling hills with eroded gullies dominate the landscape. Soil is well-drained, sandy, loamy, and silty. Some *C. nebraskana* were found along the roadside ditches, but the majority were found foraging on cattle trails (in the spring) or on bare soil patches in the prairie (in the fall).

Robinson Flats- GPS N43° 25.971' W103° 50.189' to N43° 25.440' W103° 50.207', elevation 4100-4200'. Public property, Black Hills National Forest (BHNF) ca. 9 mi. N of Edgemont, Fall River Co. SD. Hills or mesas of shortgrass prairie with forbs, surrounded by Ponderosa pine. Beetles at two sites were found along dirt trails or eroded roadsides. Grazed by cattle in September. Soil here is silty, loamy, mesic.

Cottonwood Springs State Recreation Area- Public (state) property, elevation ca. 4100', ca. 4 mi. W of Hot Springs, Fall River Co. SD. Beetles here were found along the trail going to the windmill. Mixed grasses, forbs are present, along with hardwoods and pines.

Sturgis Bureau of Land Management- GPS N44° 23.990' W103° 28.131', elevation 3500l-3600'. Public property, ca. 2 mi. SE of Sturgis, Meade Co. SD. Ridgetop trail through disturbed (smooth brome) and native shortgrass prairie, surrounded by Ponderosa pine. Grazed in September. Beetles were found along the hiking trail on top of the ridge, amid native prairie.

McNenny Fish Hatchery- GPS N44° 33.642' W104° 01.067', elevation 3500'. Public property, NW of Spearfish, Lawrence Co. SD. Eroded clay hills of shortgrass prairie with nearby hardwoods and lakes. Soil here is very red, probably from sandstone influence. Beetles were found along a hiking trail on a ridgetop.

Boundary Gulch- GPS N44° 27.267' W104° 00.853', elevation 4700-4800'. Public property (BHNF). Trail starts in Crook Co. WY and continues into Lawrence Co. SD. Habitat is aspen, bur oak, Ponderosa pine, and other conifers and hardwoods. The bur oak saplings are present where formerly there had been pine, but the area burned about 20 years ago. Some open or cleared areas along the trail consisting of mixed grasses and forbs. Beetles were found entirely along the trail, but often flew off of the trail into grasses. Soil is channery, sandy loam, and (unexpectedly) less acidic than other sites.

Timon Campground- Public property (BHNF), elevation 6000'. Lawrence Co. SD. Trail runs along a creek in cool forest of spruce, pine, and willows. Beetles were found along this trail and along paved roadsides above the campground.

Deerfield Lake- Public property (BHNF), elevation 6000'. Lawrence Co. SD. Higher elevation pine and spruce forest. Beetles were found on trails surrounding the lake (Weins and Krueger 2005).

Black Fox Campground- Public property (BHNF), elevation 5800'. Lawrence Co. SD. Similar habitat as Timon Campground. Beetles were found along the road near the campground and along a logging road in spruce, Ponderosa pine forest (Weins and Krueger 2005).

Moon Campground- Public property (BHNF), elevation 6400'. Pennington Co. SD. Highest elevation of any of the sites. An ATV trail runs through Ponderosa pine forest, vegetated with grasses and forbs (Weins and Krueger 2005).

Keough Draw- Public property (BHNF), elevation 5900'. Lawrence Co. SD. Road runs along a stream with willows, spruce, Ponderosa pine. Road bed is rocky with sparse vegetation (Weins and Krueger 2005).