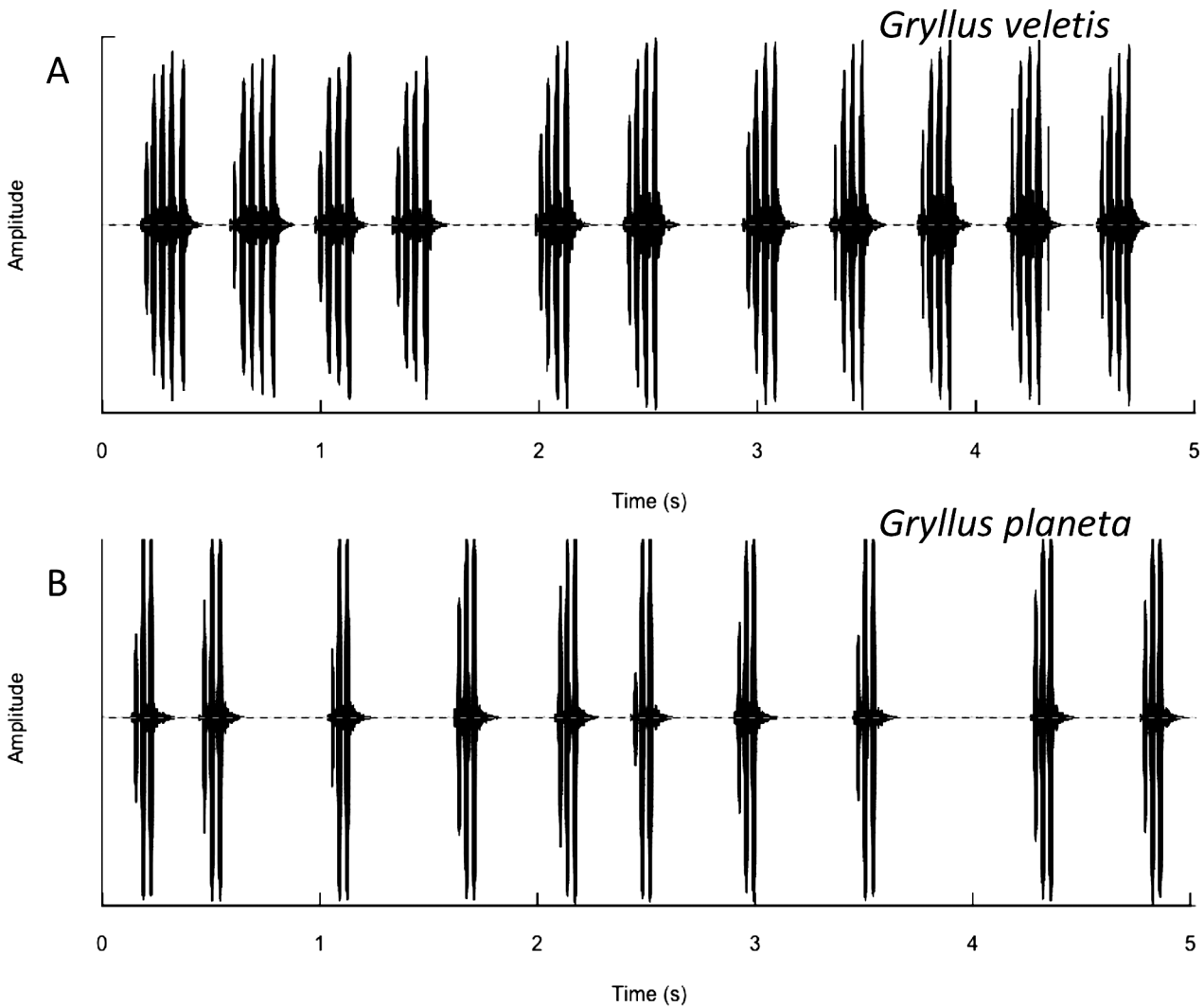


## The Veletis Group

*Gryllus veletis* (Alexander & Bigelow); *Gryllus planeta* Weissman & Gray, n. sp.

This Group consists of the most geographically widespread US *Gryllus*, *G. veletis*, and a sympatric narrow endemic, *G. planeta*. Songs similar, but *G. planeta* typically with fewer pulses per chirp and slightly faster pulse rate (Figs 130, 131); also, distinguishable by DNA (Fig. 132, Gray *et al.* 2019), morphology and probably habitat.



**FIGURE 130.** Five second waveforms of calling songs of (A) *G. veletis* and (B) *G. planeta*. *G. veletis*: (R03-118) near type locality (S03-58), at 24°C; *G. planeta*: (R15-160) near type locality (S15-61), at 24.9°C.

### *Gryllus veletis* (Alexander & Bigelow)

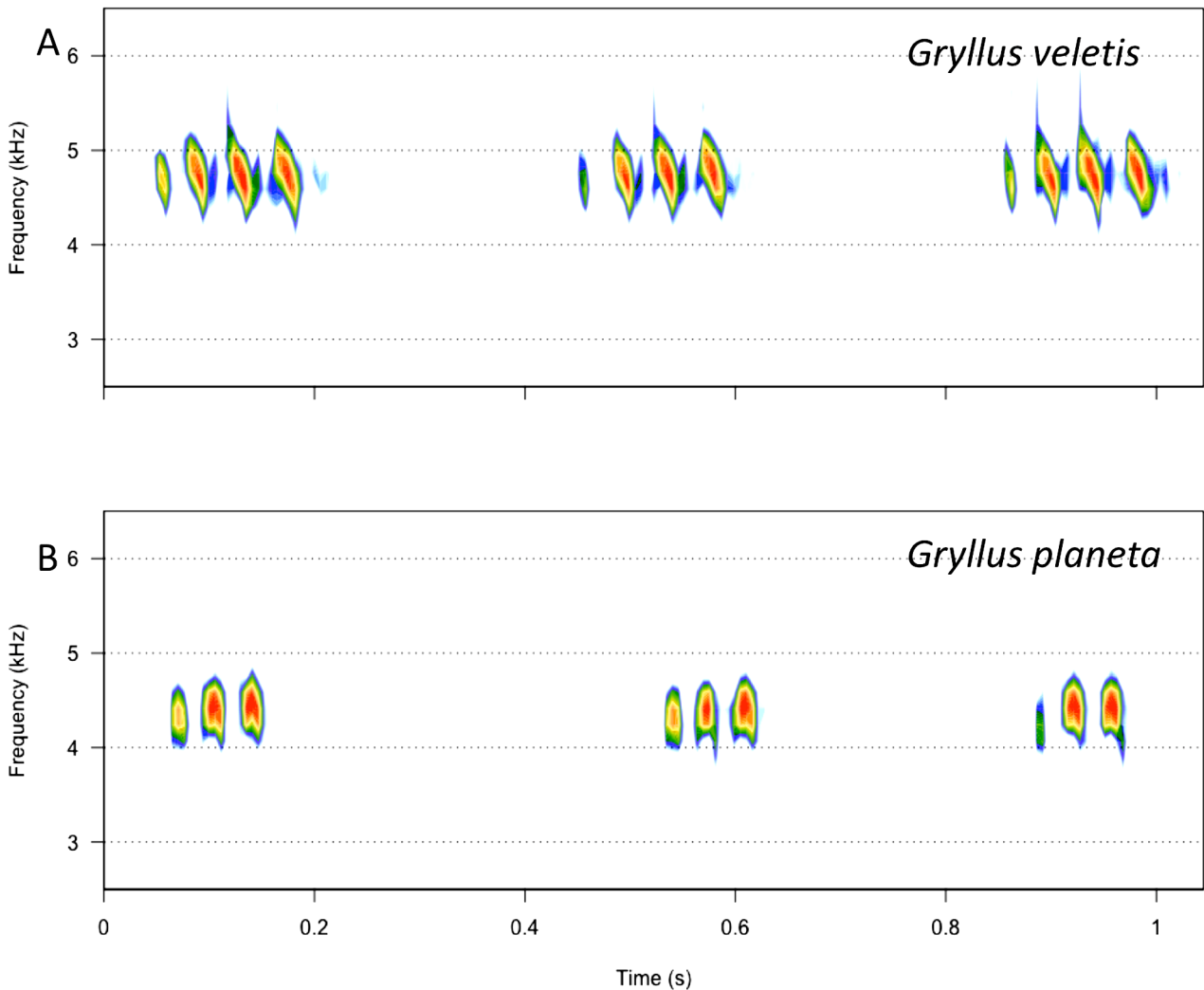
Spring Field Cricket

Figs 56, 57, 130–151, 205, 206, Tables 1, 2

1960 *Acheta veletis* Alexander & Bigelow. *Evolution* 14: 335. Type locality: Illinois, Piatt Co. Types in UMMZ (types photographed on OSF and Fig. 133, courtesy of Mark O'Brien).

1964 *Gryllus veletis*. Randell. R.L. 1964. *Canadian Entomologist* 96:1592.

*G. veletis*, 'G. eastern veletis', 'G. #27', 'G. #30', 'G. #36', 'G. #43' or 'roadside G.', 'G. pecos', and 'G. utahensis' of DBW notebooks.



**FIGURE 131.** One second spectrograms of (A) *G. veletis* and (B) *G. planeta*, same males as in Fig. 130.

*Distribution.* Most widespread US *Gryllus* species and found in every state except for those in the Southeast (Walker 2019, Capinera *et al.* 2004).

*Recognition characters and song.* Shortest cerci (along with *G. veletisoides* and *G. pennsylvanicus*) of any US *Gryllus* species. In fact, the cerci are so short that even in old adults, they are frequently intact and taxonomically useful in identification. Most variable cricket for body size (along with the almost equally widespread *G. pennsylvanicus*—see Fig. 32, p. 49) with western Texas specimens around twice the body length of those from North Dakota (Fig. 134). A small to large sized, black except for occasional red area on inside of hind femur, usually short hind winged, wide pronotum, cerci never as long as ovipositor in situ, spring and early summer species usually associated with a vegetation cover such as grass or roadside weeds. *Song* (Fig. 135, R03-118) a slow, usually irregular chirp with 4–5 (range 3–7) p/c and PR generally between 20 to 30 at 25°C. Males can sing during morning hours, especially in spring when evening temperatures are cool, but also during hot afternoon hours (e.g. Blue Springs, Missouri, 21-vi-1993).

Separated from sympatric sister species *G. planeta*, in the Davis Mts. of Texas (S15-62) by habitat (oak woodland for *G. planeta* vs. grassy meadows for *G. veletis*), and smaller, more slender size, with little or no overlap in the following 6 parameters (Table 1, p. 18): *G. planeta* has fewer file teeth, shorter length file, shorter tegmina length and width, shorter ovipositor and shorter hind femur length. Also overlaps in length of cercus with *G. planeta* but when body length size differences compensated for (Fig. 136, all individuals from the Davis Mts., Texas), cerci relatively longer in *G. planeta* even if only by 1–2 mm.

Tree scale: 0.001



**FIGURE 132.** ITS2 gene tree. *G. planeta* samples: S15-61 (G3088, G3094, G3114, G3135, G3344, G3345, G3347); S15-63 (G3130). *G. veletis* samples: S03-58 (G39); S03-60 (G30); S15-9 (G2939); S15-13 (G2884, G2929); S15-16 (G2927, G2934); S15-21 (G2894, G2895, G2896, G2899, G2942); S15-24 (G2936); S15-25 (G2963, G2968, G2983); S15-53 (G3304, G3343); S15-62 (G3131, G3134); S15-67 (G3137, G3144); S15-78 (G3145, G3147); Salt Lake City, UT (2009-013). Most ITS2 sequenced western US *G. veletis* samples match closely with the two eastern US samples from near the type locality, but a few samples from eastern NV, central NM, and west TX are genetically somewhat divergent. *G. montis* Clade 1 ITS2 sequences fall within this Group, but alternative placements are supported by different genes and analysis methods (see under *G. montis*, page 201, for discussion).

*G. veletis* can be separated from the always allopatric, Clade 1 of *G. montis* from the Chiricahua Mts. in southeastern Arizona, by the longer cerci in *G. montis*.

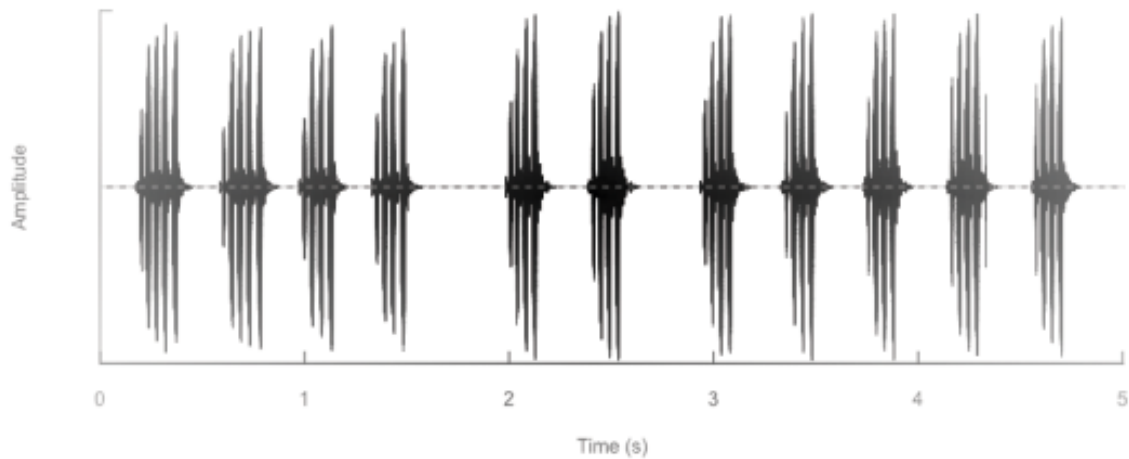
Morphologically most similar to *G. veletisoides* but always allopatric (on different sides of the Sierra Nevada and Cascade Mt. Ranges) and the latter with fewer teeth in file (Fig. 137), but similar length ovipositors (Fig. 138), and ~3.5% divergent in DNA [510 bp of 16S, Tamura-Nei distance, mean  $\pm$  SD, within N = 54 *G. veletisoides*: 0.001  $\pm$  0.001; within N = 219 *G. veletis*: 0.014  $\pm$  0.015; between *G. veletisoides* and *G. veletis*: 0.038  $\pm$  0.004. 698 bp of ITS2, Tamura-Nei distance, mean  $\pm$  SD, within N = 10 *G. veletisoides*: 0.0003  $\pm$  0.0006; within N = 25 *G. veletis*: 0.0064  $\pm$  0.0061; between *G. veletisoides* and *G. veletis*: 0.0359  $\pm$  0.0028].



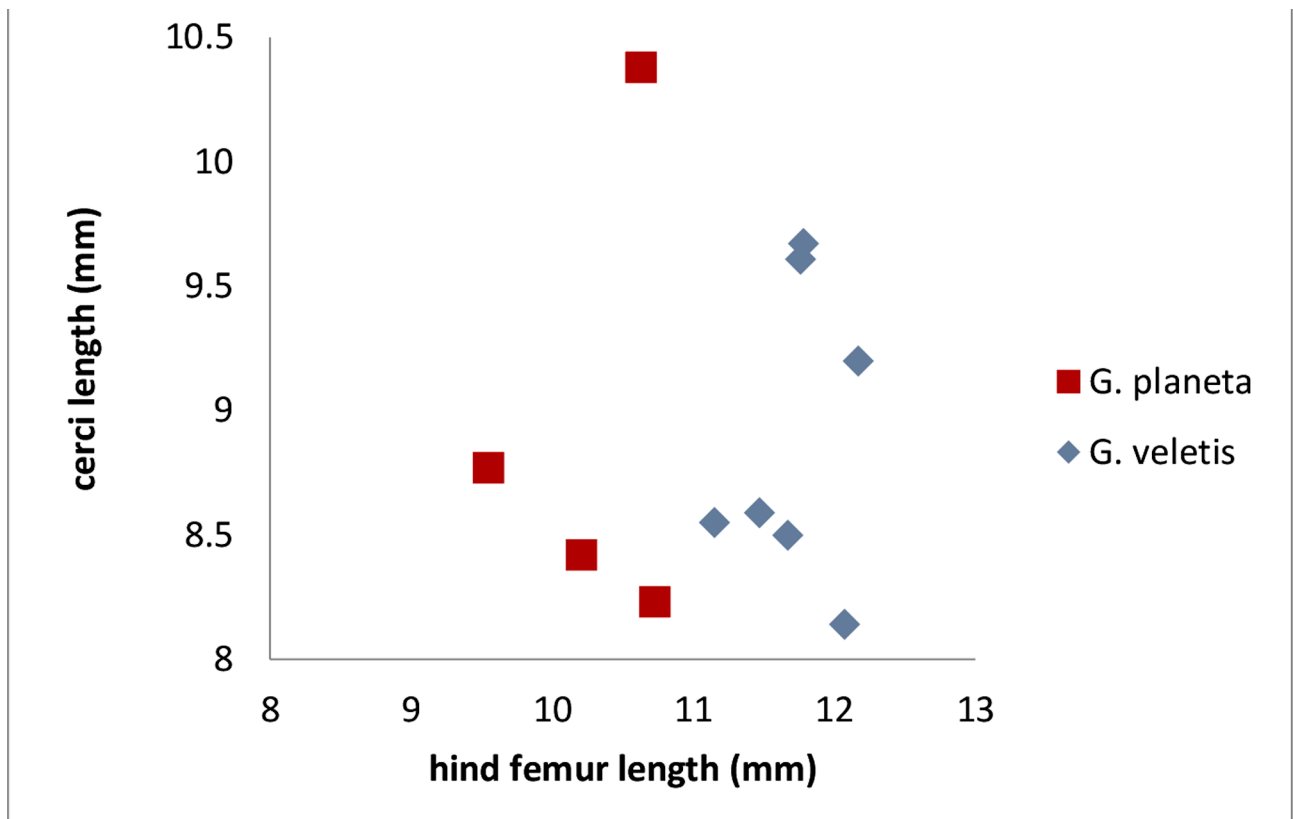
FIGURE 133. Holotype male (left) *G. veletis* and allotype female (right), with labels.



FIGURE 134. Body size variation in *G. veletis*: smallest males (left, S03-52) from North Dakota vs. largest males (right, S03-60) from western Texas. These are typical body sizes at each locality.



**FIGURE 135.** Calling song (R03-118) of *G. veletis* from near type locality (S03-58), recorded at 24°C.



**FIGURE 136.** Regression of hind femur length vs. cerci length of Davis Mts., Texas, *G. veletis* vs. *G. planeta*, to show separation.

Separated from sympatric and sometimes synchronic *G. pennsylvanicus* where latter has a longer ovipositor (Table 1, p. 18), usually a higher tooth count, longer cerci (Fig. 139), overwinters in the egg stage with first adults appearing in August, and different DNA (721 bp of ITS2 ~5.8% divergent, N = 4 *G. pennsylvanicus* and N = 25 *G. veletis*; Gray *et al.* 2019). More teeth in the file apparently results in a lower pulse rate in *G. pennsylvanicus* that is noticeable in the field when both species are chirping near each other and at similar temperatures.

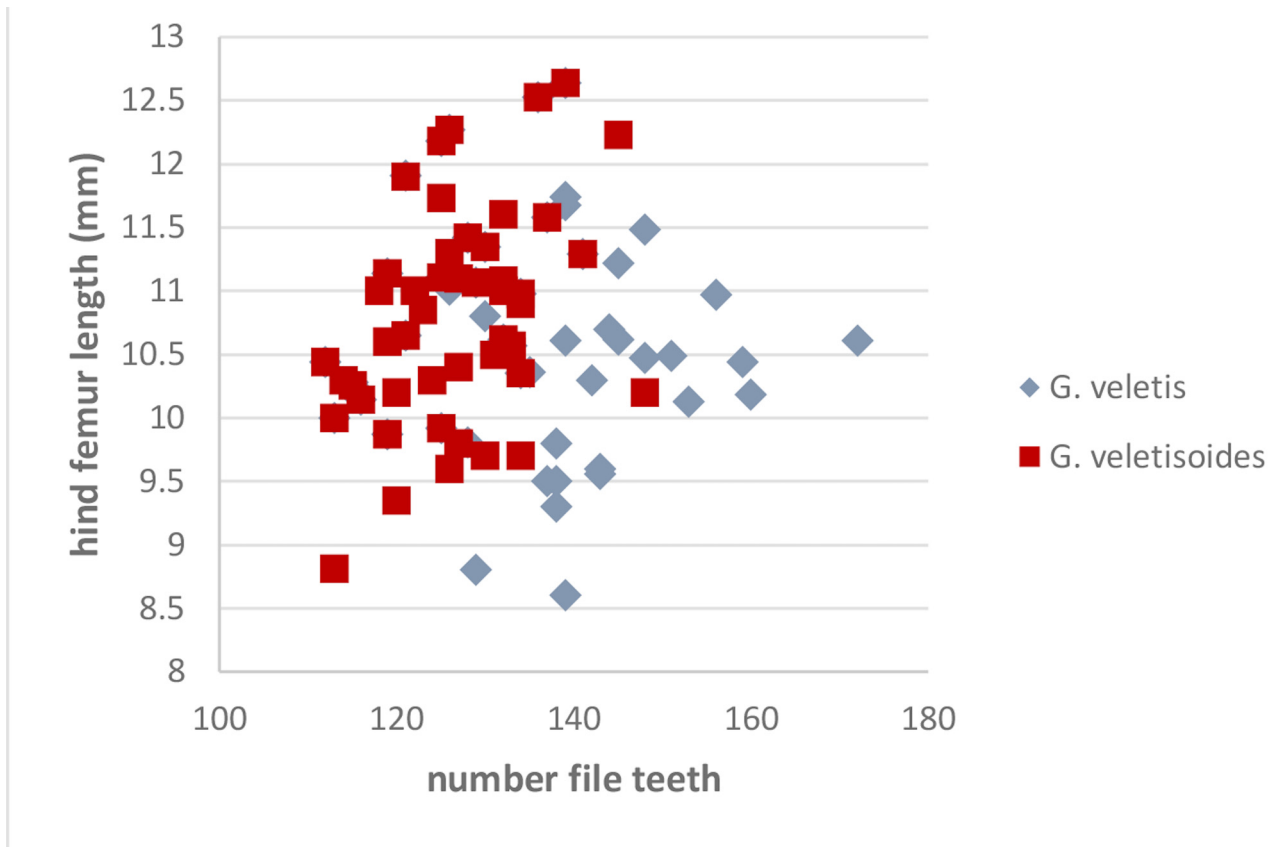


FIGURE 137. Regression of number file teeth vs. hind femur length in *G. veletis* vs. *G. veletisoides*.

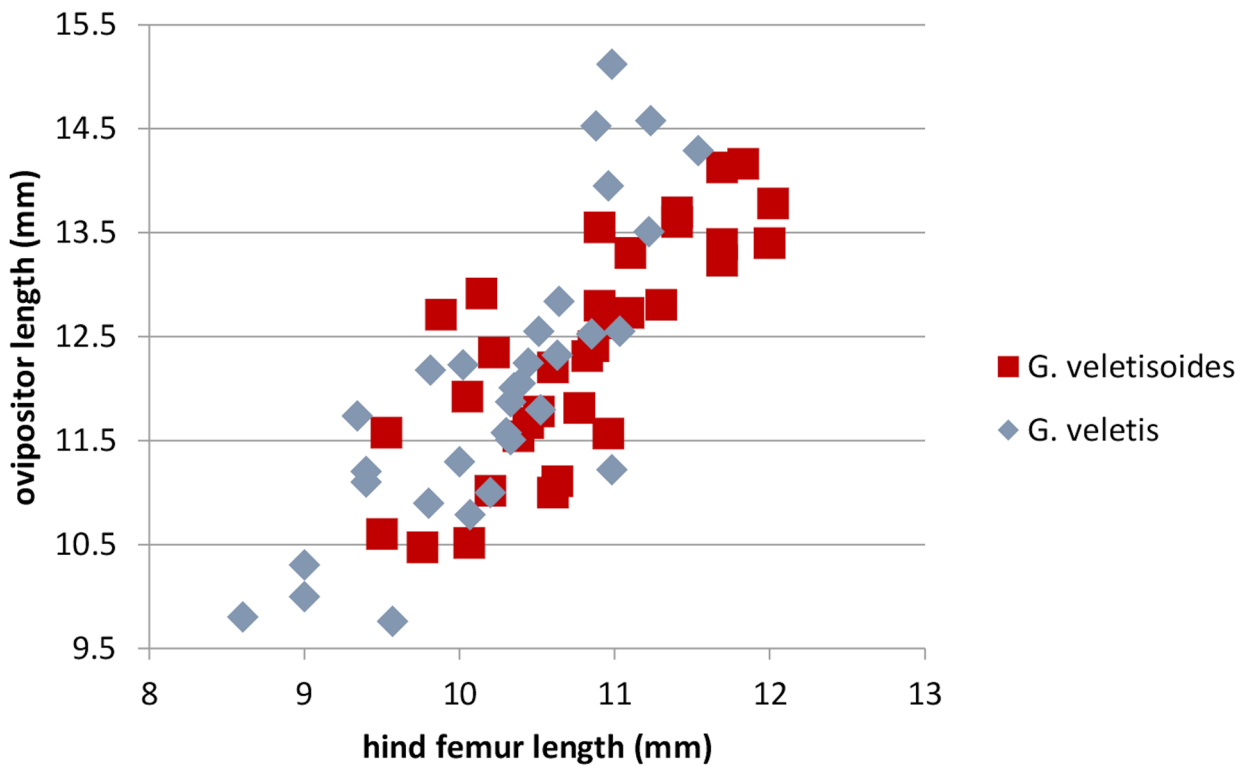
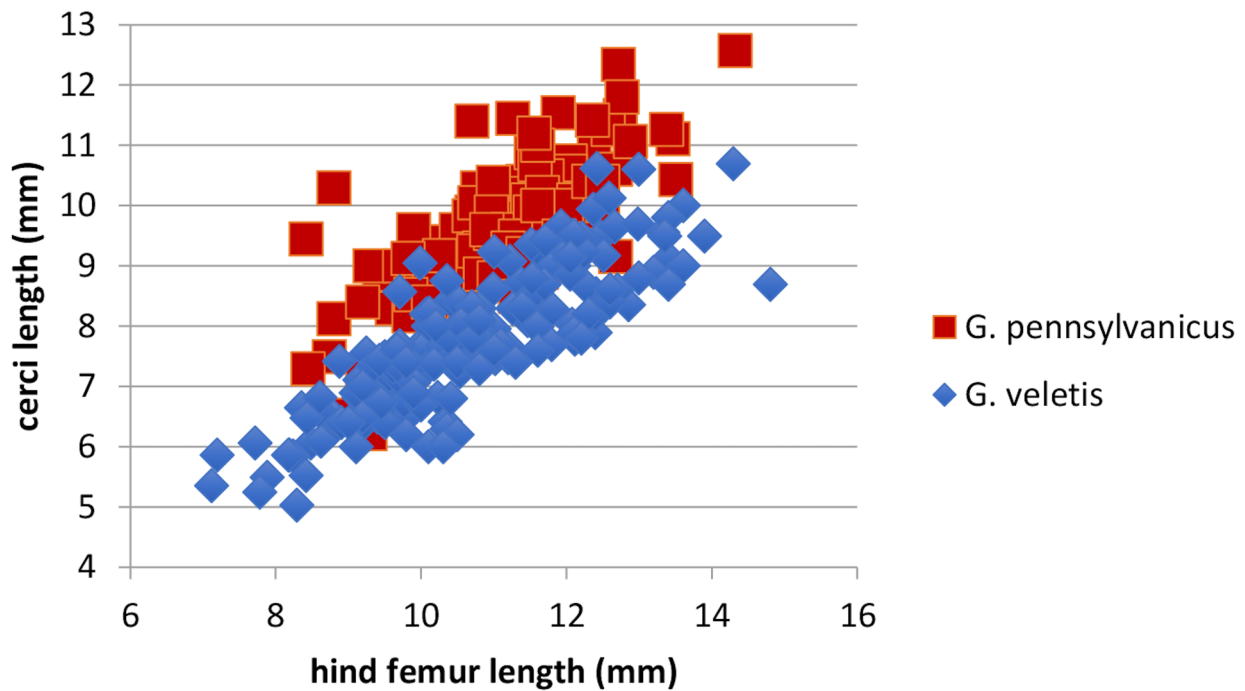


FIGURE 138. Regression of hind femur length vs. ovipositor length in *G. veletis* vs. *G. veletisoides*.





**FIGURE 139.** Regression of hind femur length vs. cerci length in *G. veletis* vs. *G. pennsylvanicus*.

Separated from faster chirping, microsympatric Clade 4 of *G. montis* near Reserve, NM (S07-53, 54) by longer cerci and narrower pronotum in latter, and DNA (Gray *et al.* 2019). Separated from *G. fultoni*, where *G. veletis* has almost no overlap with the former's faster chirp rate and higher pulse rate, and in *G. veletis*, usually more p/c, lack of yellow cerci, and larger head not narrower than pronotum. Compared to *G. veintinueve*, *G. veletis* is larger in size, has a louder and faster chirp rate, longer tegmina, broader pronotum, and different DNA (Fig. 6, p. 28). Microsympatric with *G. vulcanus* at El Malpais, NM (S07-52), but only at edges of lava flows. The two species are easily separated there by the longer cerci and lower pulse rate in the latter.

*Derivation of name.* “*veletis*” chosen “in reference to its aggressive behavior” (Alexander & Bigelow 1960) as individuals are more solitary than its 1960 “proposed” sister species *G. pennsylvanicus*. The web site *Latin-dictionary.net* defines “veles” or “velitis” (note spelling difference) as a masculine noun with the following definitions: 1. Guerrilla forces (pl.), irregular bands. 2. Light-armed foot-soldier. 3. Skirmishers. R. D. Alexander (pers. comm. to DBW, August, 2013) stated that he and Bigelow used this modified spelling in *Acheta veletis* (before their taxon was moved to *Gryllus*) “because the ‘e’ sounds in the two words went together so appropriately.”

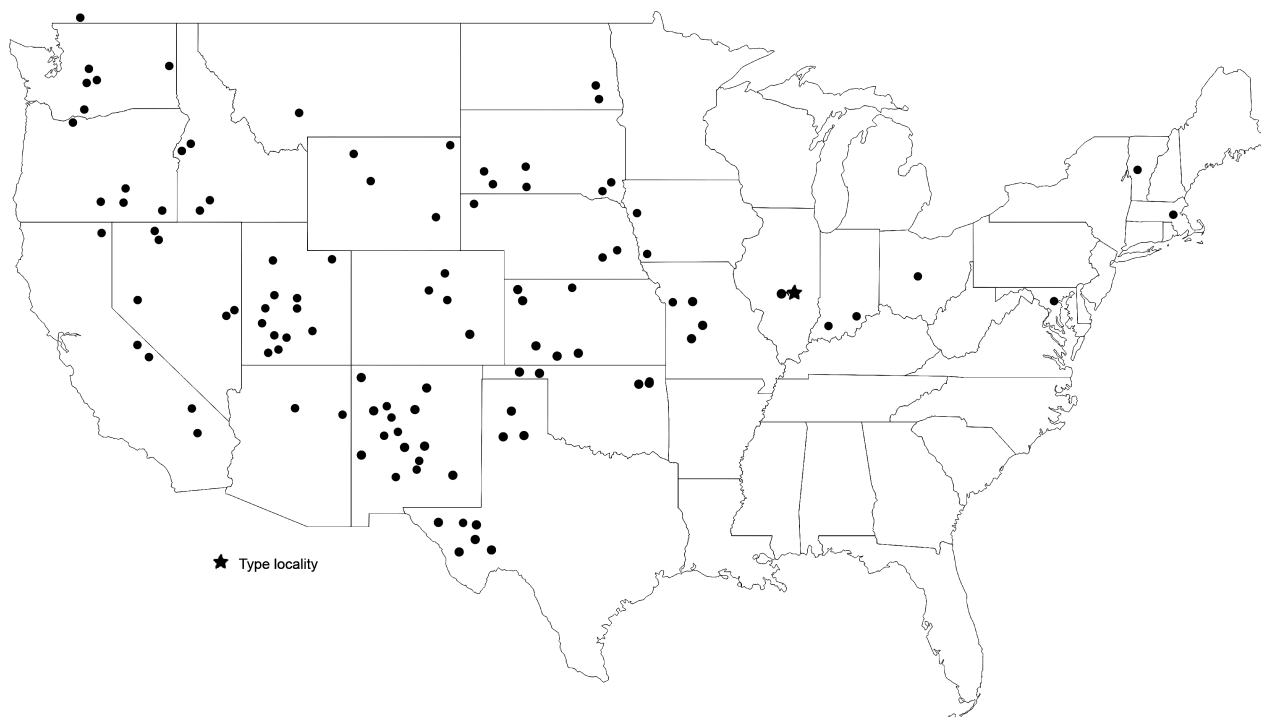
*Geographic range.* Fig. 140. See Walker (2019) for more eastern US localities. Probably into adjacent Mexico. Contrary to Alexander & Meral (1967), *G. veletis* does occur in many southwestern US areas without *G. pennsylvanicus* (compare Fig. 140 with Fig. 32, p. 49), but avoids the lower elevation, hotter desert regions.

*Habitat.* Usually in areas with increased vegetation cover, either natural or planted, around water courses, and on both sandy and loam surfaces. In western Utah, very easy to collect during the daytime, in May, 2015, since almost every area with good grass cover had individuals hiding under boards, rocks, and various items of trash. Rarely at edges of lava flows in New Mexico (S94-41). Also in Oregon at sulfur-saline hot springs (S04-44) and in cracks of saline-saltmarsh grassland (S04-54). From near sea level to over 2440 m (Otero Co., near Cloudcroft, NM). At La Junta, Colorado (S87-65), one singing male on tree trunk 3 m above ground with female nearby and a second female starting to climb up the same trunk. In another tree, one male singing 1 m above ground from under loose bark. At Sedalia, Missouri (S93-51), one male singing 1 m up in shrub. May be riparian associated in otherwise hot dry areas, e.g. *G. veletis* found in moist areas along Deer Creek, Garfield Co., UT (at 1740 m elevation) replaced by *G. saxatilis* within a few meters of transition to dry rocky slopes; the same situation applies in Lodore Canyon on the Green River, Moffat Co., CO (at 1560 m elevation).

*Life cycle and seasonal occurrence.* No egg diapause: Wanapum Dam Reservoir, WA (S83-42); north of Alturas, CA (S83-48); Sacramento Mts., NM (S83-80 & S85-53); Alpine, TX (S85-59); La Junta, CO (S87-65); near

Farmington, NM (S87-81); west of Medicine Lodge, KN (S88-41); Tulsa, OK (S88-45); Mirror Pool, ND (S88-55); Flagstaff, AZ (S91-75); Kadoka, SD (S97-87); Tooele, UT (S04-107).

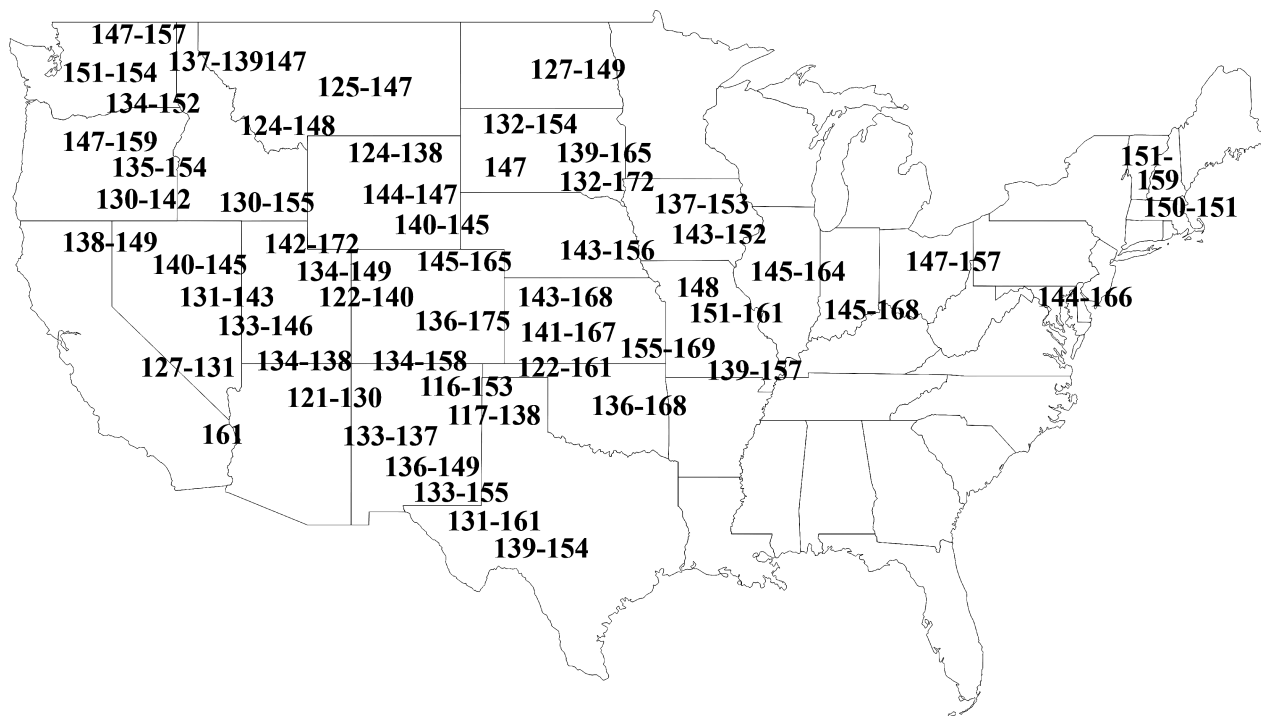
One generation/year. Overwinter as late instars with adults first appearing in mid to late spring, even as far north as Mirror Pool, North Dakota (S03-52). Present at Lakin, Kansas (S87-67) on 23-vi-1987 but adults absent here 27-viii-1989 (S89-67) when we only found late instars of *G. veletis* (doubt that they were *G. pennsylvanicus*, which should have already been adult starting in early August) in the same habitat. Alexander & Bigelow (1960) note how “a small percentage (of *G. veletis*) matures without apparent delay (thus accounting for 2<sup>nd</sup> generation adults), but most require several months.” We note possible 2<sup>nd</sup> generation adults from Jensen, Utah (10-ix-1999, S99-127) and Tooele, Utah (collected 9-ix-2004, S04-107, with no egg diapause in collected females) but late surviving first generation individuals are also a possibility.



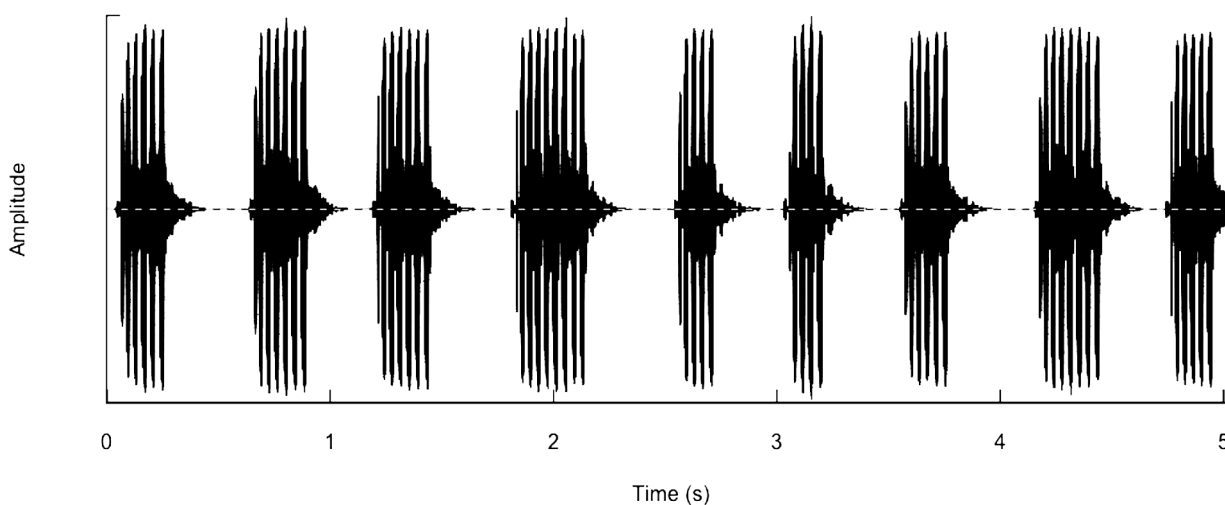
**FIGURE 140.** Distribution of *G. veletis* specimens that we studied.

**Variation. Body size:** *G. veletis* displays more variation in body size (see Fig. 134) than any US *Gryllus*, and this property has been partially responsible for our confusion as to how many populations are actually *G. veletis*. Individual body lengths, measured immediately upon killing, vary from 13.42/13.70 mm (male/female) from Mirror Pool, North Dakota (S03-52) to 29.5 mm (male from Alpine, Texas, S91-44)/26.78 mm (female from Columbus, Ohio, S03-65). Upon complete drying after pinning, these four individuals, respectively, measured 13.50/11.69 and 23.23/21.42 mm. **Color:** We have a few individuals that are light-colored as discussed by Alexander & Bigelow (1960, p. 337). **Cercus length:** As individuals get larger going north to south, within the US, cercus length also increases. **Female tegmina length:** Individuals, especially those from New Mexico and in populations with large sample sizes, display a range of tegmina lengths where from ½ to the entire female abdomen is covered, and not directly related to the shrinkage associated with drying. **File teeth:** see Fig. 141. Varies from 116 (Pecos, NM, S01-45) to 175 (La Junta, CO, S87-65). **Head size:** Larger males, especially those from New Mexico and Colorado, occasionally have heads much wider than the pronotum. This pattern was not seen in those larger adults (our ‘G. #36’) from the Alpine-Marathon area of Texas. **Hind wing length:** Of 1091 collected US adults, 200 (18.3%) had long hind wings and 891 (81.7%) had short hind wings. Those adults with long hind wings were approximately 60% male. Also see under Discussion. **Songs:** Roswell, NM (S09-58) male with 4-10 p/c (see Fig. 142, R09-73). **Tegmina color:** Guymon, Oklahoma (S88-39 vs. S09-77) and La Junta, Colorado (S87-65 vs. S09-82) show that both 2009 samples have much darker tegmina than the browner 1987 and 1988 samples.





**FIGURE 141.** Map of *G. veletis* file tooth counts showing geographic variation. Tooth counts vary from 116 (Pecos, NM, S01-45) to 175 (La Junta, CO, S87-65).



**FIGURE 142.** Atypical *G. veletis* song with 4-10 p/c (R09-73) from near Roswell, NM (S09-58), recorded at 26°C.

*Specimens examined.* **CANADA:** **Alberta:** Lethbridge, Old Man River, 3-vi-2001. **British Columbia:** Osoyoos, Haynes Ecological Reserve, 18-vi-2004, 1160' (S04-61 & 62). **USA:** **Arizona:** *Apache Co.*, St. Johns, 20-v-2001, 5830' (S01-38). *Coconino Co.*, Flagstaff, 5-viii-1991, 6810' (S91-75); 15-vi-2007 (S07-57). **California:** *Inyo Co.*, Bishop, 5-vi-1983, 4140' (S83-56). 9 m N Bishop, 4-vi-1983, 4700' (S83-55). Lone Pine, 5-vi-1983, 3700' (S83-58). *Modoc Co.*, 9.1 m N Alturas, 3-vi-1983, 4600' (S83-48). *San Bernardino Co.*, Barstow, 28-vi-2003, 2300' (S03-73). **Colorado:** *Boulder Co.*, Boulder, 30-vi-2007, 5800-7200' (S07-72). *Jefferson Co.*, 9.3 m W Golden, 26-vii-1997, 6440' (S97-75). *Larimer Co.*, Ft. Collins, 3-viii-1997 (S97-112). *Otero Co.*, La Junta, 22-vi-1987, 4200' (S87-65); 2-vii-2009 (S09-82). **Idaho:** *Elmore Co.*, Mt. Home, 26-vi-2014 (S14-31). 1.5 m W Hill City, 16-v-2000, 5040' (S00-8). 34 m E Mt. Home, 16-v-2000, 5520' (S00-7). *Owyhee Co.*, Mt. Home, 7-vi-1996, 3260' (S96-41). 2 m N Bruneau, 2900' (S04-40). 2 m S Bruneau, 7-vi-1996, 2600' (S96-37). *Valley Co.*, 6 m S Donnelly, 18-v-2000, 4700' (S00-12). *Washington Co.*, Andrus Wildlife Management Area, 11-v-1998, 3000' (S98-41). **Illinois:** *DeWitt*

Co., Clinton, 3-vi-2003, 820' (S03-58). 3 m SE Clinton, 3-vi-2003, 850' (S03-59). **Indiana:** *Floyd Co.*, Georgetown, 4-vi-2003, 500' (S03-63). *Spencer Co.*, Dale, 4-vi-2003, 700' (S03-60). **Iowa:** *Freemont Co.*, Waubonsie State Park, 1-vi-2003, 1250' (S03-55). Monona Co., Lewis and Clark State Park, 1-vi-2003, 1140' (S03-54). **Kansas:** *Barber Co.*, Medicine Lodge, 23-vi-1987, 1550' (S87-68). 27 m W Medicine Lodge on Hwy 160, 14-vi-1988, 1750' (S88-41). *Comanche Co.*, at junction of Highways 160 and 183, 14-vi-1988 (S88-40). *Kearny Co.*, Lakin, 23-vi-1987, 2950' (S87-67). *Norton Co.*, near Edmond 23-vi-1993, 2900' (93-55). *Sherman Co.*, Sherman Co. State Park, 24-vi-1987, 3500' (S87-73). Goodland, 24-vi-1987, 3500' (S87-74). **Maryland:** *Prince George Co.*, College Park, 30-v-2004, 500' (S04-35). **Massachusetts:** *Berkshire Co.*, 29-vii-2006, 1700' (S06-67). **Missouri:** *Hickory Co.*, Hermitage, 20-vi-1993, 1000' (S93-50). Pomme de Terre State Park, 20-vi-1993, 1000' (S93-49). *Jackson Co.*, Kansas City, 8-viii-2002, 860' (S02-54). *Pettis Co.*, Sedalia, 20-vi-1993, 950' (S93-51). **Montana:** *Gallatin Co.*, Bozeman, 15-vii-2004, 4450' (S04-66). **Nebraska:** *Dawes Co.*, 3 m E Crawford, 3-vii-2009, 3680' (S09-88). *Fillmore Co.*, Geneva, 7-viii-2002, 1420' (S02-51). *Lancaster Co.*, Lincoln, 7-viii-2002, 940' (S02-52). **Nevada:** *Humboldt Co.*, Paradise Valley, 8-vi-1996, 4600' (S06-42). *Elko Co.*, Angel Creek Camp, Ruby Mts., 6600', 16-vi-2002, (DAG 2002-011). *White Pine Co.*, Baker, 5300', 9-vi-1996 (S96-49); 23-v-2015 (S15-16). 4.7-5.0 m W Baker, 9-vi-1996, 6520' (S96-46 & 47a). **New Mexico:** *Apache Co.*, Springerville, 20-v-2001 (S01-42). St. Johns, 20-v-2001, 5830' (S01-38). *Bernalillo Co.*, Tijeras Canyon ~2 m W Tijeras, 6600-6900', 3-5-vii-2019, S19-37 & S19-38, DC & K Lightfoot. UNM Campus, 13-vi-1994 (S94-33). 6 m NE Cedar Crest, 7035', 12-vii-2015 (S15-78) DC Lightfoot. Manzanito Mts., Carolino Canyon, 7500', 19-vii-2008 (S08-53) DC Lightfoot. *Catron Co.*, Apache Creek, 3-vii-1994, 6420' (S94-49). Reserve, 3-vii-1994, 5770' (S94-50); 2.1-2.2 m SW Reserve, 3-vii-1994, 5920-6120' (S94-51 & 52); 20-v-2001 (S01-40); 14-vi-2007 (S07-53). *Chaves Co.*, Roswell, 28-vi-2009, 3800' (S09-58). Hwy 82 near Elk, 28-vi-2009, 5840' (S09-57). *Cibola Co.*, El Malpais National Monument, Hwy 117 at 31 m S I40, 18-viii-1993, 7200' (S93-71 & 73); 1-vii-1994 (S94-40 & 41); 14-vi-1996, (S96-68); 14-vi-2007 (S07-51 & 52). Grants, 18-viii-1993, 6340' (S93-74); 1-vii-1994 (S94-43); 13-vi-1996 (S96-67). Hwy 117 at 35 m S I40, 14-vi-2007, 6870' (S07-51). Hwy 53 at mile-post 61, 13-vi-1996, 7800' (S96-66). *Eddy Co.*, Guadalupe Mts., Dog Canyon 30-vii-2003, 6289'. *Lincoln Co.*, Carrizozo Rec Area, 2-vii-1994, 5560' (S94-47). Valle del Sol Municipal Golf Course, 13-vi-2007, 5320' (07-45). 12 m W Capitan, 2-vii-1994, 7060' (S94-45). *Otero Co.*, 1.8 m W Cloudcroft, 29-vi-1983, 8300' (S83-80); 7-vi-1985 (S85-53). 5 m E Cloudcroft, 30-v-2011, 8200' (S11-24). *San Juan Co.*, Farmington, 19-vi-1987 (S87-81). 12 m W Farmington, 19-vi-1987, S87-81, DC Lightfoot. *San Miguel Co.*, Pecos, 21-v-2001, 6944' (S01-45). Pecos National Historic Park, 21-v-2001, 7280' (S01-44). Pecos National Monument, 6-x-1994 (S94-106). Hwy 63 at mile-post 7.3, 21-v-2001, 7440' (S01-46). Hwy 25 at Exit 307, 21-v-2001, 7270' (S01-43). *Socorro Co.*, Los Pinos Mts., Goat Draw, 16-viii-1993, 6440' (S93-69). Sevilleta National Wildlife Refuge, 21-vi-1995, 5400' (S95-50), DC Lightfoot. *Valencia Co.*, 1 m S Los Lunas Bridge, 1-vii-1994 (S94-44). **North Dakota:** *Richland Co.*, Mirror Pool, 30-vi-1988, 1030' (S88-55); 31-v-2003, 46° 32.963' -97° 19.310' (S03-52). **Ohio:** *Franklin Co.*, Columbus, 5-vi-2003, 800' (S03-65). **Oklahoma, Texas Co.**, Guymon, 13-vi-1988, 3380' (S88-39); 1-vii-2009 (S09-77). Optima Wildlife Refuge 15 m E Guymon, 1-vii-2009, 3120', 36° 41' 49.8" -101° 9' 36.3" (S09-76). *Tulsa Co.*, Tulsa, near intersection Hwy 244 and I44 around 5828 W. Skelly Dr., 232m, 36° 04' 56.7" -96° 02' 58.0", 15-vi-1988 (S88-45); 23-vi-1993 (S93-57); 15-vii-2013 (S13-67); Near Exit 238 off I44, 2 m E Tulsa city limit, 15-vii-2014 (S13-68), 796', 36° 09' 37.4" -95° 47' 33.1". **Oregon:** *Harney Co.*, Alvord Hot Springs, 13-vi-2004, 4000' (S04-44). Burns, 2-vi-1997, 4020' (S97-51). 23.5 m S Burns, 14-vi-2004, 4000' (S04-48). *Jackson Co.*, Phoenix, 1500', 24-ix-2004 (S04-132). *Lake Co.*, 16-vi-2004, 4500' (S04-54). *Sherman Co.*, 0.7 m SE Biggs, 31-v-1997, 220' (S97-47). **South Dakota:** *Jackson Co.*, Badlands National Park, Cedar Pass Overlook, 22-vi-1993, 3100' (S93-53); 3-vii-2009 (S09-89). Kadoka, 30-vii-1997, 2200' (S97-87). *Jones Co.*, Murdo, 22-vi-1993, 2600' (S93-54). *Minnehaha Co.*, Sioux Falls, 1-vi-2003, 1450' (S03-53). *Yankton Co.*, Lewis and Clark Lake, 21-vi-1993, 1500' (S93-52). **Texas:** *Brewster Co.*, Alpine, 9-vi-1985, 4200' (S85-59); 5-vi-1991 (S91-44); 12-vi-2007 (S07-41); 2-vii-2015 (S15-73). Marathon, 12-vi-2007, 3840' (S07-40). 22 m E Marathon, 12-vi-2007, 3850' (S07-35). *Culberson Co.*, Hwy 10 25 m E Van Horn, 29-vi-2009, 4780', 31° 4' 20.4" -104° 23' 21.8" (S09-63). *Jeff Davis Co.*, Davis Mts., 1.1 m below Observatory, 6246', 1-vii-2015 (S15-62). Fort Davis, Ft. Davis National Historic Site, 4852', 1-vii-2015 (S15-67). 1 m SW Ft. Davis, 6-vi-1991, 4800' (S91-46). **Utah:** *Beaver Co.*, Beaver, 5878', 23-v-2015 (S15-20). Milford, 4990', 24-v-2015 (S15-19). Minersville, 19-iv-1999, 5140' (S99-11). *Garfield Co.*, Boulder, 24-iv-2006, 6580' (S06-18). Panguitch, 19-v-2001, 6560' (S01-35); 23-iv, 2006 (S06-17). *Juab Co.*, Eureka, 5800', 19-iv-1999 (S99-8); 23-v-2015 (S15-13). Nephi, 5200', 10-ix-2004 (S04-115); 24-v-2015 (S15-23). *Kane Co.*, Hwy 89 9.3 m SSW Long Valley Junction, 19-v-2001, 6740' (S01-34). Road to Zion Narrows, 18 m NE Springdale, 10-

vi-1996, 6740' (S96-51). *Millard Co.*, Delta, 4670', 23-v-2015 (S15-14). Fillmore, 4920', 31-vii-1992 (S92-102). Fillmore, Canyon Rd. 0.9 m E Business I15, 4920' 18-v-2001, 38° 57.728' -112° 18.439' (S01-30). 8.5 m NW Fillmore, 18-v-2001, 4450' (S01-28). Lava fields near Flowell, 19-iv-1999, 4520' (S99-10); 18-v-2001 (S01-29). *Salt Lake Co.*, Riverton, 4500', 24-v-2015 (S15-24). Salt Lake City, near Airport, 24-v-2015 (S15-25); Salt Lake City, Avenues residential area, 19-v-2009. *Sanpete Co.*, Manti, 5515', 24-v-2015 (S15-23). 1.4 m SW Manti, 21-iv-1999, 5660' (S99-17). 11 m N Manti, 21-iv-1999, 5700' (S99-18). *Sevier Co.*, Richfield, 5300', 24-v-2015 (S15-21). Salina, 17-viii-2009, 5300' (S09-122). *Tooele Co.*, James Walter Fitzgerald Wildlife Management Area, 5200', 23-v-2015 (S15-12). Stockton, 5200', 30-vii-1992 (S92-93); 23-v-2015 (S15-11). Tooele, 5200', 9-ix-2004 (S04-107); 23-v-2015 (S15-10). *Uintah Co.*, Jensen, 10-ix-1999, 4740' (S99-127). *Wayne Co.*, Hanksville, 11-vi-1996, 4500' (S96-60). **Vermont:** *Addison Co.*, Middlebury, 23-v-2009 (S09-16). **Washington:** *Grant Co.*, Wanapum Dam Reservoir, 1400', 1-vi-1983 (S83-42). Ephrata, 30-v-1997, 1240' (S97-46). Grand Coulee, 30-v-1997, 1400' (S97-43). Lake Lenore, 19-vi-2004, 1020' (S04-60). Moses Lake, 21-vi-2014, S14-18). *Lincoln Co.*, 2.5 m SE Grand Coulee, 30-v-1997, 1640' (S97-42). **Wyoming:** *Crook Co.*, Aladdin, 4-vii-2009, 3780' (S09-90). *Fremont Co.*, Shoshoni, 18-vii-2011, 4849' (S11-72). 11 m N Shoshoni, 18-vii-2011, 4788' (S11-71). *Park Co.*, Cody, 16-vii-2004, 5140' (S04-73). *Platte Co.*, Guernsey, 27-vii-1997, 4000' (S97-80). Near Guernsey, Road 270 3.9 m N Hwy. 26, 12-ix-1999, 4300' (S99-139).

**DNA.** Multilocus G30, from near type locality of *G. veletis*, Spencer Co., Indiana (S03-60); and multilocus G2958, 'Gryllus utahensis', Nephi, UT (S15-23) comprise one close pair within *G. veletis*. Multilocus G1345, our 'Gryllus #27', Guymon, OK (S09-77); and multilocus G3075, our 'Gryllus #36', Alpine, TX (S15-73) comprise a second close pair within *G. veletis*. All are sister species (Gray *et al.* 2019) to *G. planeta*. See Discussion below for consideration of whether or not DNA supports further sub-division of this widespread species.

**Discussion.** Our initial sorting of this species resulted in six different, geographically separate "species." Further efforts to delineate these "species" boundaries, using morphological and genetic properties, were unsuccessful probably, in large part, due to the vast geographical area and ecological diversity covered and the fact that just one (or perhaps two) species seems to be involved. As an example, adult females of *G. veletis* from near the most northern limits in North Dakota are small and very agile while their western Texas conspecifics are large and so bulky (including males) that they jump poorly, if at all.

Nevertheless, it seems prudent to briefly discuss those characters that in certain populations gave us pause, as to species identification, so that further investigations can be directed here:

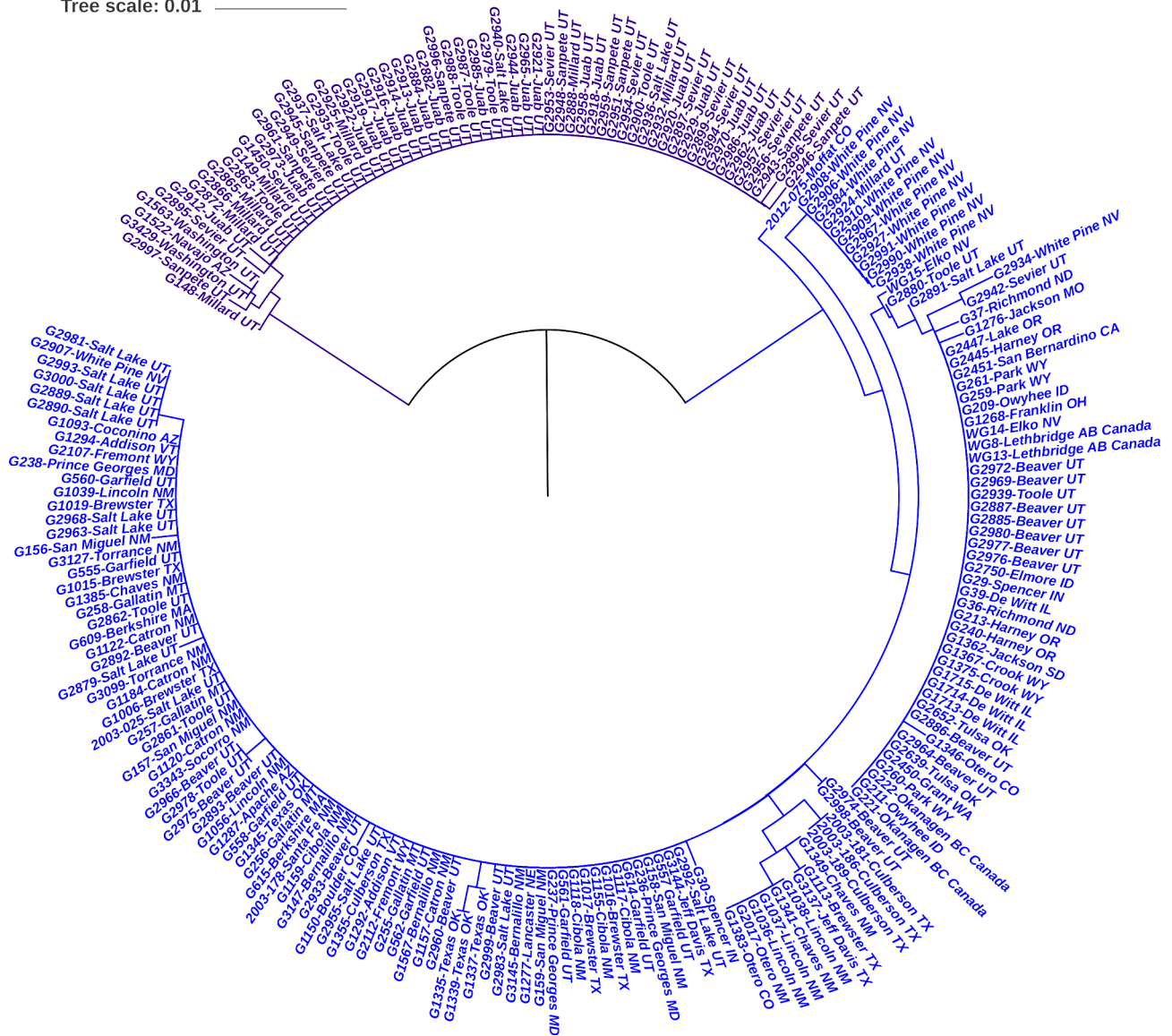
1. We initially (1987) considered a "Great Plains" grouping (our 'Gryllus #27') from south-eastern Colorado, western Oklahoma, and Kansas to be distinct from *G. veletis* based upon the usual presence of long hind wings. For example, we found that 10 of 12 from La Junta, CO (S87-65); all 20 from Lakin, KS (S87-67); 3 of 4 from Medicine Lodge, KS (S87-68); all 11 from Goodland, KS (S87-74); and 21 of 23 from the town of Guymon, OK (S88-39 and S09-77), had long hind wings, loud songs, were very colonial, and at high, outbreak densities in these towns. More widespread collecting in nearby central Missouri in 1993, showed that this pattern was geographically limited since all 22 Missouri adults, about half from within towns, had short hind wings. The final tally for this 3-state region, within towns only, was that 65 out of 70 (93%) individuals had long hind wings. This pattern contrasts with ~12.5% long hind wings for *G. veletis* in the rest of its US distribution, both within and outside of towns. For 'natural' Optima Wildlife Refuge, Oklahoma (S09-76), 15 m E Guymon, 7 of 8 adults had short hind wings.

2. We initially considered individuals from around Tulsa, Oklahoma (our 'G. #30') to be distinct because males generally have fewer p/c and a more regular, faster chirp rate. But in comparison with our other US *G. veletis*, we find no consistent characters, including DNA, to separate them.

3. We initially considered individuals from western Texas (including Alpine, Marfa, Marathon, Davis Mts. and Amarillo—our 'Gryllus #36') to be distinct because adult females are so large and bulky, that they cannot hop. Additionally, when the males in these western Texas populations are compared with those male *G. veletis* from throughout New Mexico (our 'Gryllus #43'), we find the heads in New Mexico to be wider, relative to pronotum width, than those of the larger males from Texas. It is doubtful that the few Texas adults that have long hind wings can fly because of their weight.

4. Sequencing of the 16S gene in individuals from western Utah revealed a second, distinctive clade (see Fig. 143), which we initially called 'G. utahensis'. Subsequent ITS2 and multilocus sequencing revealed that all of these individuals were consistent with *G. veletis* from Illinois and Indiana (near type locality), and that individuals in two Utah populations (Tooele, S15-10 and Richfield, S15-21) contained both haplotypes.

Tree scale: 0.01



**FIGURE 143.** Radial 16S gene tree showing large and distinct 16S clade (in purple) in central Utah. Labels indicate County and State; the ‘*G. utahensis*’ 16S clade is in purple, whereas geographically widespread *G. veletis* samples (including other Utah samples) are in blue.

Despite our unwillingness now to further subdivide *G. veletis*, we do note strong subdivision within the nuclear ITS2 gene (see Fig. 132) consistent with the two-pairs of the four samples in the multilocus tree. ITS2 similarity based on Tamura-Nei distances was  $99.1 \pm 0.76$  within individuals from NV, NM, TX, and OK ( $n=10$ ),  $99.4 \pm 0.45$  within individuals from IN, IL, and UT ( $n=15$ ), but  $94.09 \pm 0.26$  between these groups.

*G. veletis* and *G. pennsylvanicus* are sympatric over much of their northern US distribution. Because the former overwinters as a late instar and the latter as an egg in obligate diapause, they mature and sing at different times in the subsequent spring and summer. They may have a brief period of synchronicity but such has only been studied in detail in Michigan (Alexander & Meral 1967), and even then, complete resolution was difficult because of morphological similarity between the two taxa and almost identical songs, although Alexander & Bigelow (1960) noted that *G. pennsylvanicus* females tend to have longer ovipositors than *G. veletis*. We were consequently surprised to find the two species synchronic and easy to distinguish, based on pulse rate, number of file teeth, and length of ovipositor at localities in South Dakota, Nebraska, Missouri, and Utah (Table 2). For instance, at Kadoka, SD (S97-87), both *G. veletis* and *G. pennsylvanicus* adults were singing on 30-vii-1997 although most individuals of the latter were several molts to adult. Our 2 collected adult male *G. veletis* had 134 and 138 teeth with laboratory recorded pulse rates of 25-35, at 23°C and 26.5°C, respectively. These rates were faster than the 4 male *G. pennsylvanicus* collected as late



**TABLE 2.** Where *G. veletis* and *G. pennsylvanicus* are synchronic and can be separated.

Species	Locality	Stop number(s)	Collection date(s)	file teeth	teeth/mm	Pulse rate	ovipositor length (mm)
<i>G. veletis</i>	Hanksville, UT	S96-60	11-vi-1996	130-144	40-43	27.8-29.4	none
	Kadoka, SD	S97-87	30-vii-1997	134-138	40-40.6	25-35	11.7
	Jensen, Utah	S99-127	10-ix-1999	141-143	46.1-46.2	25-29.4	none
	Geneva, NB	S02-51	7-viii-2002	156	43.3	25	none
	Lincoln, NB	S02-52	7-viii-2002	143-148	37.6-41.1	20.8	none
	Kansas City, MO	S02-54	8-viii-2002	148	43.5	25	none
<i>G. pennsylvanicus</i>	Hanksville, UT	S92-109, 98-88, 99-119, 04-128	1-viii-1992, 11-ix-1998, 9-ix-1999, 12-ix-2004	173-214	40.4-51.8	12.5-17.9	14.4-19.4
	Kadoka, SD	S97-87	30-vii-1997	149-171	39.8-44.4	17.9-21.7	17.6 x 2
	Jensen, Utah	S99-127	10-ix-1999	173-177	39.8-40.7	13.2-16.1	16.1
	Geneva, NB	S02-51	7-viii-2002	174-200	44.3-51.3	10.9-17.2	17.81-19.36
	Lincoln, NB	S02-52	7-viii-2002	169	45.7	not recorded	20-22.29
	Kansas City, MO	S02-54	8-viii-2002	163-171	49.4	16.7-20.8	none
	Oklahoma City, OK	S02-48	6-viii-2002	211-223	51.9-53.4	10.4-14.3	none
	Salina, KS	S02-49	7-viii-2002	161-215	43.7-55.2	13.9-20	18.03-21.93
<i>G. veletis</i> also occurs sympatric	Concordia, KS	S02-50	7-viii-2002	174-199	45.8-56.5	11.7-13.5	16.14-17.15
	Millersville, MO	S02-58	9-viii-2002	195	56.5	16.7	none
	Rifle, CO	S09-109	15-viii-2009	168-191	41-45.2	10-15.6	16.71-18.06



instars (we were unable to collect any adult males) and that molted to adults in mid-late August: they had 149-171 teeth and laboratory recorded pulse rates between 17.9-21.7, at 22.5-25°C. Interestingly, teeth/mm were essentially the same: 40.0-40.6 in the 2 *G. veletis* males and 39.8-44.4 in the 4 *G. pennsylvanicus* males. But these pulse rate differences were easily appreciated in the field when the two taxa were singing together at similar temperatures. We also collected 1 adult female *G. veletis* with a short ovipositor, long tegmina, and no egg diapause when compared to those female *G. pennsylvanicus* collected as nymphs and that molted to adult 2 weeks later in mid-late August. A similar situation existed at the 5 other Nebraska, Missouri, and Utah localities listed in Table 2, although we were never at Hanksville at the right time of year to document potential synchronicity. Likewise, the 5 localities from Oklahoma, Kansas, Missouri, and Colorado, where *G. pennsylvanicus* also has increased numbers of file teeth when compared with surrounding areas, do not have documented populations of *G. veletis*, but we suspect they do exist if we had been there earlier in the season. We wonder if these increased number of file teeth in *G. pennsylvanicus* are a reflection of character displacement in areas where the 2 taxa have overlap in singing adult males? In any case, these localities should be compared, for synchronicity between these 2 taxa, with the areas around Chadron, NB (S97-83 and 97-84), where, on 28-vii-1997, we collected 2 adult males and many late instars that yielded 9 *G. pennsylvanicus* males with 139-166 teeth, 39.7-48.8 teeth/mm, and pulse rates of 19.2-25, and 1 adult female and several late instars that yielded 5 *G. pennsylvanicus* females with ovipositor lengths of 14.0-16.0 mm. While we didn't collect or hear any *G. veletis* there, we did see many small *Gryllus* nymphs that could be recently hatched *G. veletis*. Perhaps the 2 species around Chadron are not synchronic, or minimally so, so that character displacement doesn't occur there?

Where it occurs, *G. veletis* is usually the most common field cricket, with apparent outbreaks, in towns, of mostly long hind winged individuals, occurring in certain Colorado, Kansas, and Oklahoma localities in 1987, 1988 and 2009. This finding is in contrast to reports of typically solitary individuals for more eastern US populations (summarized in Alexander & Bigelow 1960). We frequently find nymphs and adults of *G. veletis*, in normal population-size years, congregating together under objects in spring and early summer and infrequently associated with specific burrows. Because most of the western US dries out in the summertime, resulting in deep substrate cracks and suitable refuges, burrows may be less necessary for shelter. Eastern populations, where summer rains can be more significant and substrate cracks rare, could find burrows more important.

Although males in different populations can vary by over 100% in body length (Figs 144, 145, 146), showing a distinct north to south size cline, we find no similar differences in tooth file architecture with reference to number of teeth (Figs 141, 147). Because southern males are much larger than northern males, they also have correspondingly longer files (Fig. 148). If tooth density remained the same going south, then files would contain many more teeth, a situation not seen (Fig. 147). We do find that the density of file teeth increases (Fig. 149) going northward. Given that the PR (Fig. 150) and dominant frequency remain essentially the same throughout *G. veletis*' range, this suggests that the larger southern males apparently close their wings faster (over a longer file with fewer teeth/mm) in order to have a constant pulse duration and a constant dominant frequency.

Preliminary hybridization studies conducted in 2003 between California virgin *G. veletisoides* and virgin *G. veletis* from the Midwestern US produced the following results: 3 females from Indiana crossed with Fresno, CA, males—two females had documented matings (with passed spermatophores) but only one of the two females laid eggs. The female in the third pairing laid eggs but no eggs from any female hatched. One female, from Illinois, mated with a Fresno, CA, male and laid eggs but none hatched. One female from Iowa mated with a male from Los Gatos, CA, laid eggs (never saw a passed spermatophore) but they never hatched. As controls, an Indiana female mated with a North Dakota male produced lots of eggs that hatched while a North Dakota female that mated with an Illinois male produced eggs that didn't hatch.

*G. veletis* appears in the literature as an example of allochronic speciation (Alexander & Bigelow 1960), studies on calling, movement, parasites, age, and mating (Alexander & Meral 1967; French & Cade 1987; Zuk 1987, 1988; Thomson & Bertram 2014), genetics of wing morphology and diapause (Bégin & Roff 2002), changes in calling songs as males age (Fitzsimmons & Bertram 2011), and freeze tolerance adaptations (Toxopeus *et al.* 2018).

Tachinid fly *Exoristoides johnsoni* emerged from adult males from Utah (S96-50 and S96-51), Nebraska (S97-83), and South Dakota (S03-53), the latter from a penultimate instar male.

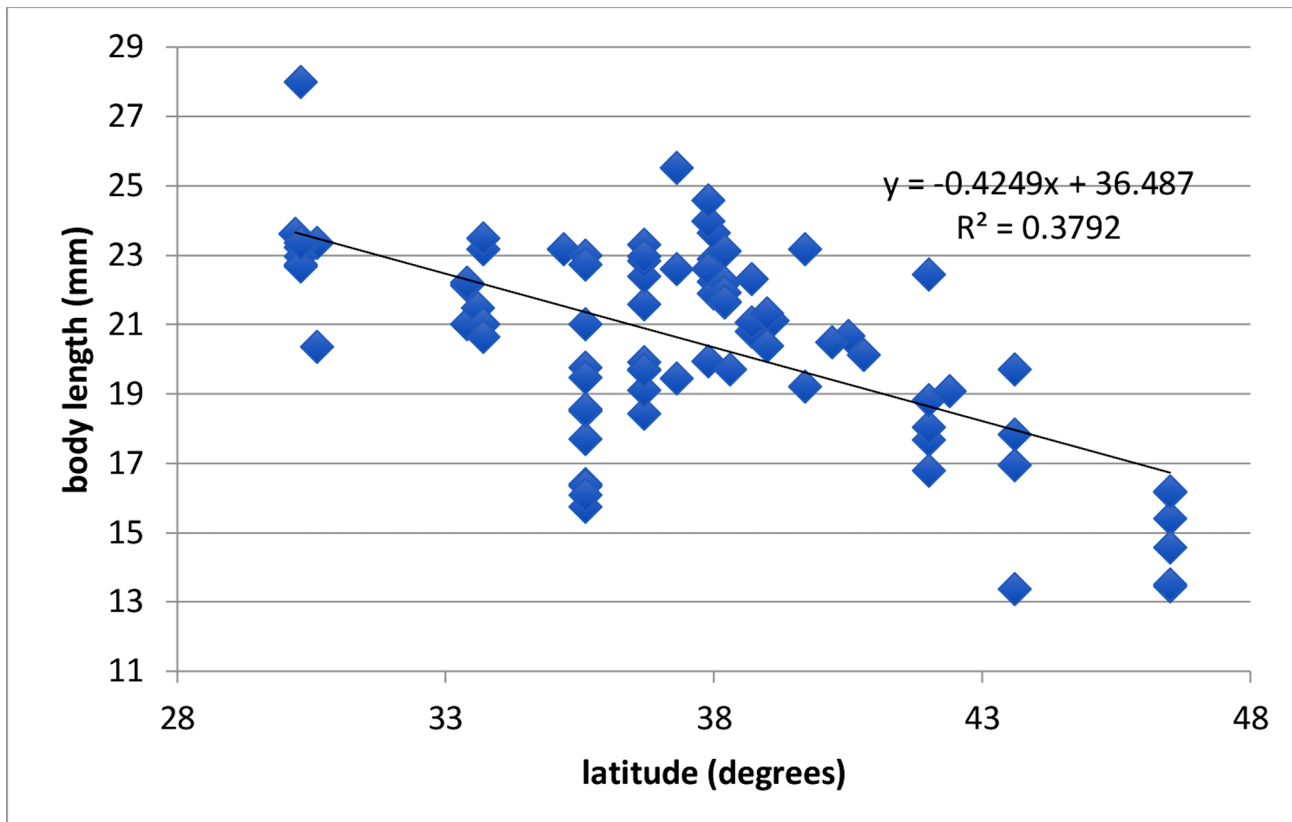


FIGURE 144. Regression latitude vs. body length in *G. veletis*.

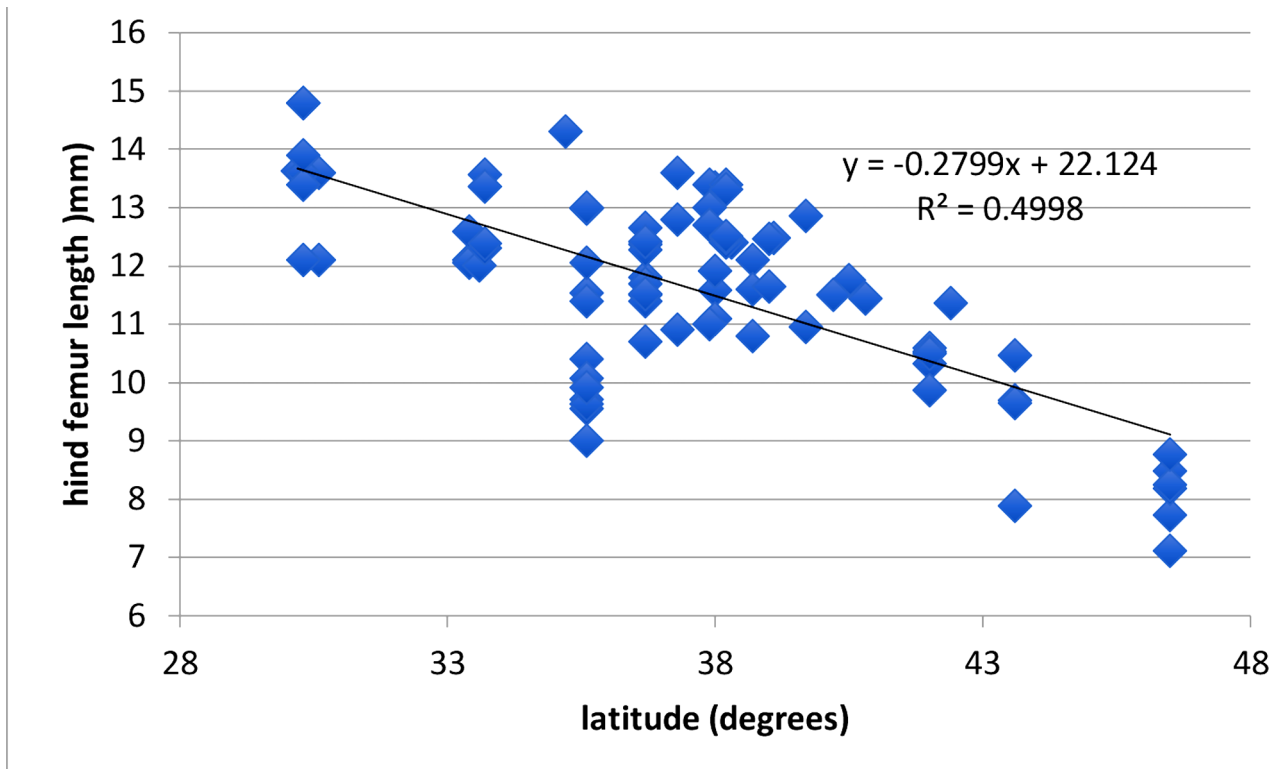


FIGURE 145. Regression latitude vs. hind femur length in *G. veletis*.

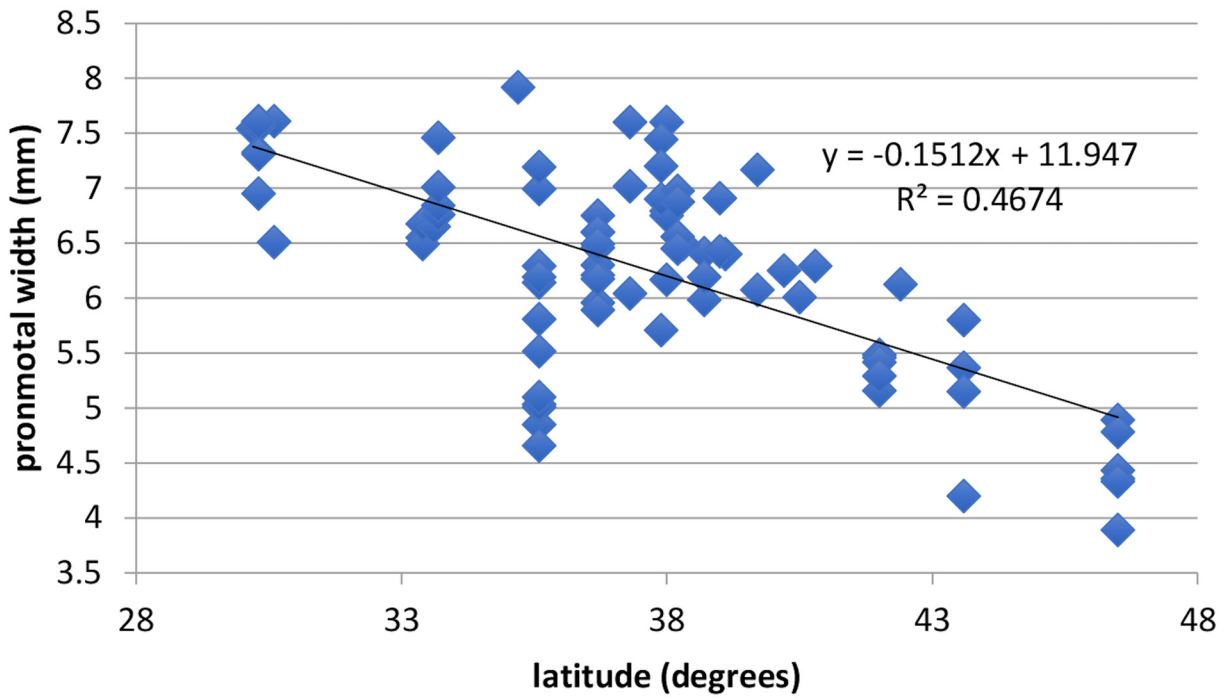


FIGURE 146. Regression latitude vs. pronotal width in *G. veletis*.

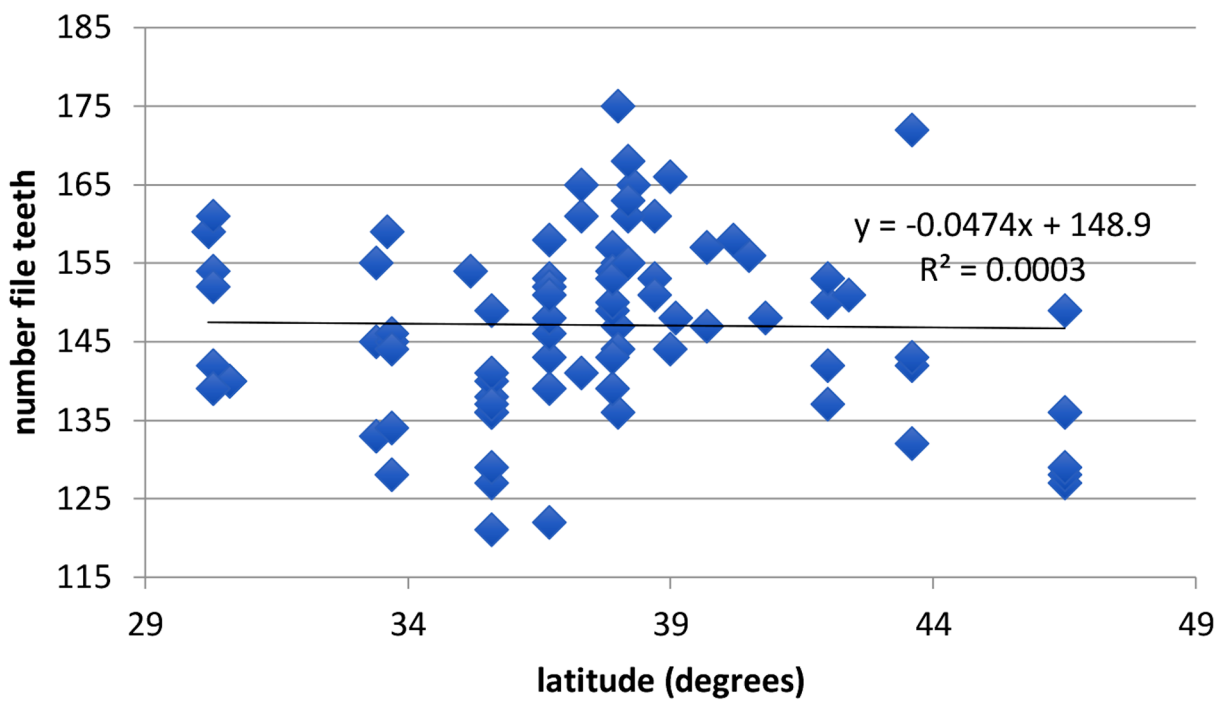


FIGURE 147. Regression latitude vs. file teeth number in *G. veletis*.

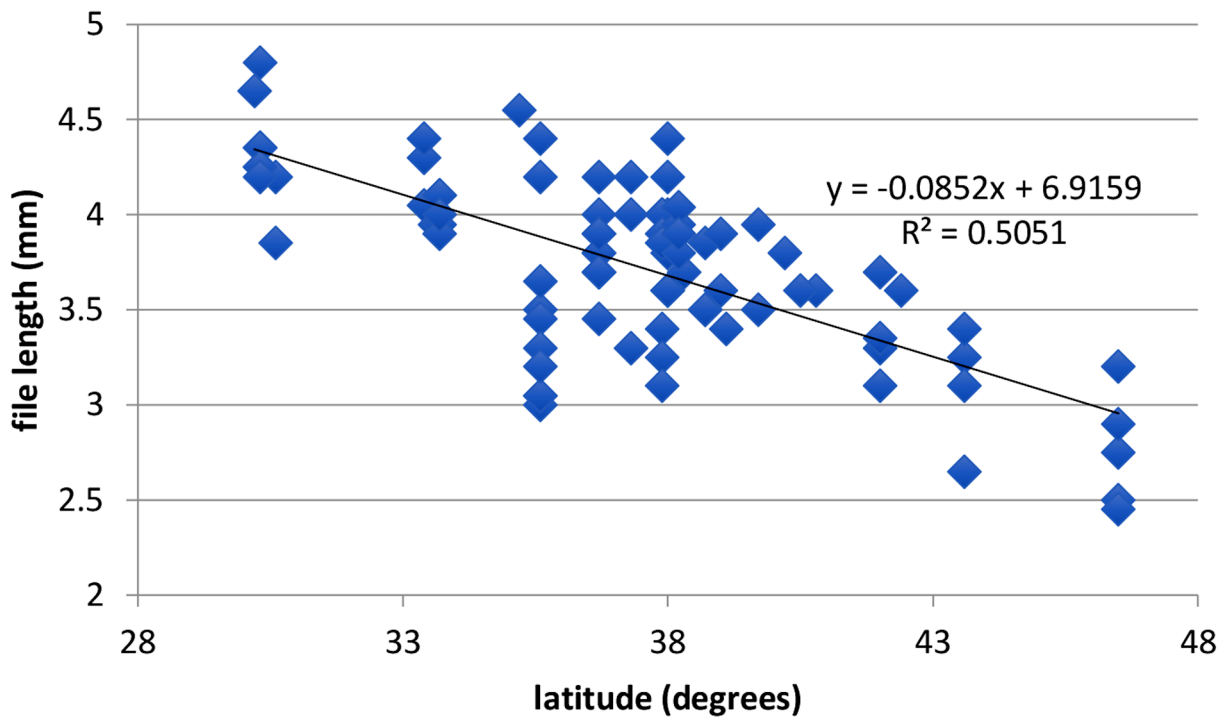


FIGURE 148. Regression latitude vs. file length in *G. veletis*.

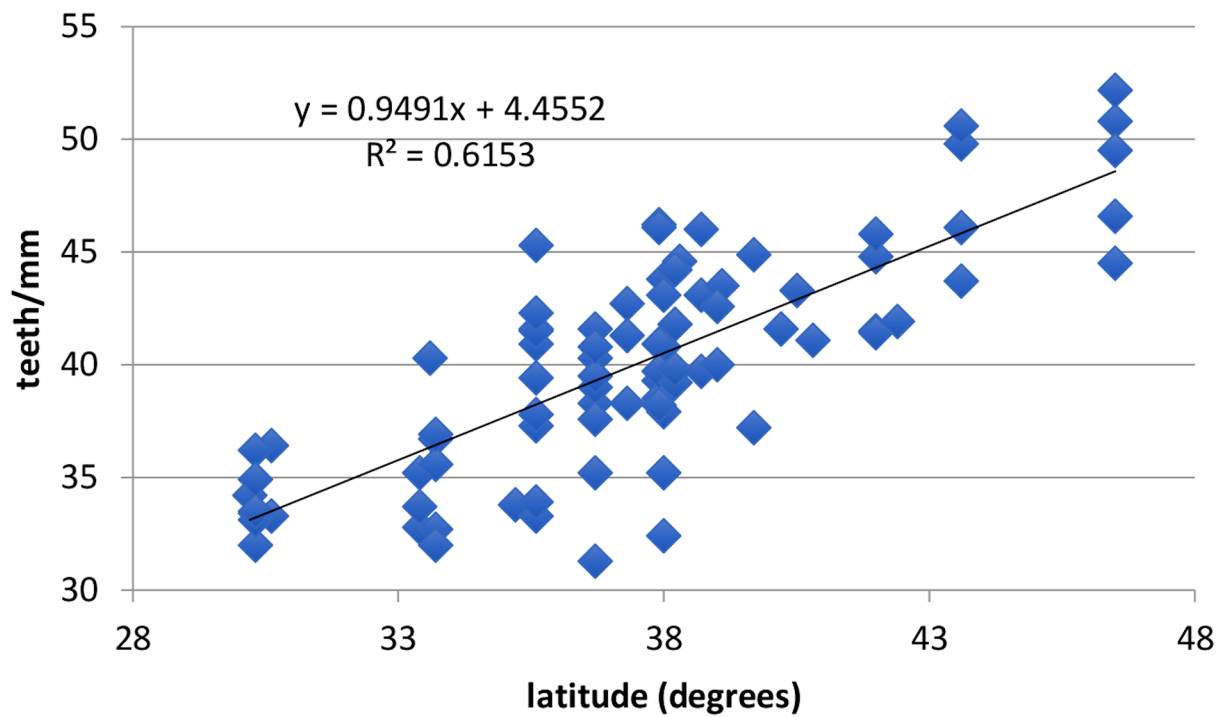


FIGURE 149. Regression latitude vs. teeth/mm in *G. veletis*.

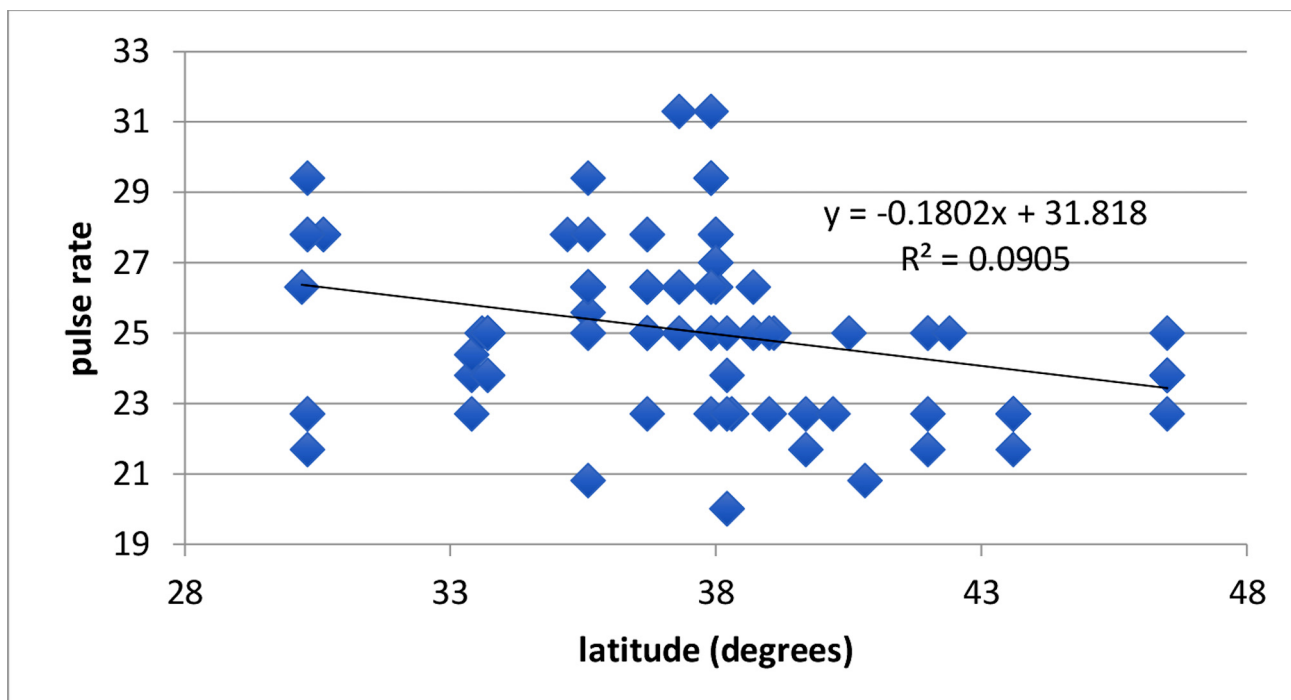


FIGURE 150. Regression latitude vs. pulse rate in *G. veletis*.

***Gryllus planeta* Weissman and Gray, n. sp.**

McDonald Observatory Wood Cricket

Figs 130–132, 136, 151–154, 205, Table 1

*Distribution.* Known only from the sky island oak-woodlands of the Davis Mountains in west Texas, around the area of the McDonald Observatory.

*Recognition characters and song.* *G. planeta* is microsympatric with each of the other three slow chirping *Gryllus* species in the Davis Mts., but with only one species at a time. A small-medium body length, black (except for inside of hind femur), always short hind winged, cricket characterized by short cerci (Fig. 151). *Song* (Fig. 152) a slow chirp with 3 p/c, 150–200 c/m, and a PR of around 27 at 25°C. Morphologically most similar to western Texas *G. veletis* (microsympatric at S15-62) but generally separated by habitat (oak woodland vs grassy meadows), smaller, more slender size, and no overlap in the following 6 parameters (Table 1, p. 18): *G. planeta* has shorter file length with higher tooth density, shorter tegmina length and width, shorter ovipositor and shorter hind femur length even where they occur microsympatric. Also overlaps in length of cercus with *G. veletis* but when body length size differences compensated for (Fig. 151), cerci relatively longer in *G. planeta* even if only by 1–2 mm.

Genetically different from *G. veletis* for multilocus (Gray *et al.* 2019) and ITS2 (Fig. 132) but similar for 16S (Fig. 143). Separated from microsympatric *G. transpecos* (Davis Mts., S15-61) by 6 mostly non-overlapping characters (Table 1, p. 18): shorter cerci length in *G. planeta*, number of teeth, file length, tegminal length and width, and faster chirp rate in addition to genetics (different multilocus, 16S and ITS2 gene profiles). Separated from microsympatric *G. longicercus* (Davis Mts., S15-63) by non-overlapping (Table 1, p. 18) number of teeth, file length, teeth/mm, cerci length, PR, and DNA. *G. planeta* is morphologically similar to other narrow, small, spring-adult, black, slow chirping, allopatric western *Gryllus* species, such as *G. montis* (nearest population ~500 km west in Chiricahua Mts., Arizona) and *G. saxatilis* (nearest population ~1000 km west in Arizona) but, except for *G. veletis*, *G. planeta* can immediately be separated in the field on the basis of its short cerci and restricted geographic distribution. Also, similar to New Mexico, Organ Mountains sky island endemic *G. sotoi*, ~280 km to the NW, but can be separated by cerci length, DNA, habitat, and maturation time (summer for *G. sotoi* vs. spring for *G. planeta*).

*Holotype.* Male (Fig. 153). Texas, Jeff Davis Co., Davis Mts., Mt. Locke, McDonald Observatory, in oak woodland at base of Otto Struve Telescope, 1-vii-2015. 6747', 30° 40' 16.82" -104° 01' 24.76". D.B. Weissman & D.W. Weissman. S15-61, R15-189, G3114. 16S GenBank accession # MK446549; ITS2 GenBank accession #