

**DNA.** Multilocus G1357, La Junta, CO, S09-82. Two sister species are *G. lineaticeps* (multilocus 2016-033) and *G. staccato* (multilocus 2016-034) (Gray *et al.* 2019). 16S DNA groups all 3 species together (also see Gray *et al.* 2016b).

**Discussion.** *G. personatus* typically has between 5-8 p/c, except for the 3 collected males from Brackettville, Texas (S10-63), its most eastern locality, where each had 4 p/c. *G. assimilis* has similarly spaced chirps but with 6-9 p/c, and it is generally separated ecologically from the former. We initially wondered if calling-song character displacement might be operative in reducing the p/c in this Brackettville *G. personatus* population? We subsequently discovered both species also sympatric at Rio Grande Village (S16-12) in Big Bend National Park, TX, where *G. assimilis* sang its typical song and the 5 recorded males of *G. personatus* had 6-7 (range 5-8) p/c.

*G. personatus* has been used in several recent investigations: Gray *et al.* 2016b, Gabel *et al.* 2016, Hennig *et al.* 2016, Blankers *et al.* 2016.

### ***Gryllus staccato* Weissman & Gray, n. sp.**

Stutter-Chirping Field Cricket

Figs 170–174, 183–188, Table 1

‘*Gryllus* #15’ in DBW notebooks.

‘G15’ and irregular chirping cricket in Sakaguchi & Gray 2011, Blankers *et al.* 2016.

‘*G. staccato*’ in Gray *et al.* 2016b, Gabel *et al.* 2016, Hennig *et al.* 2016.

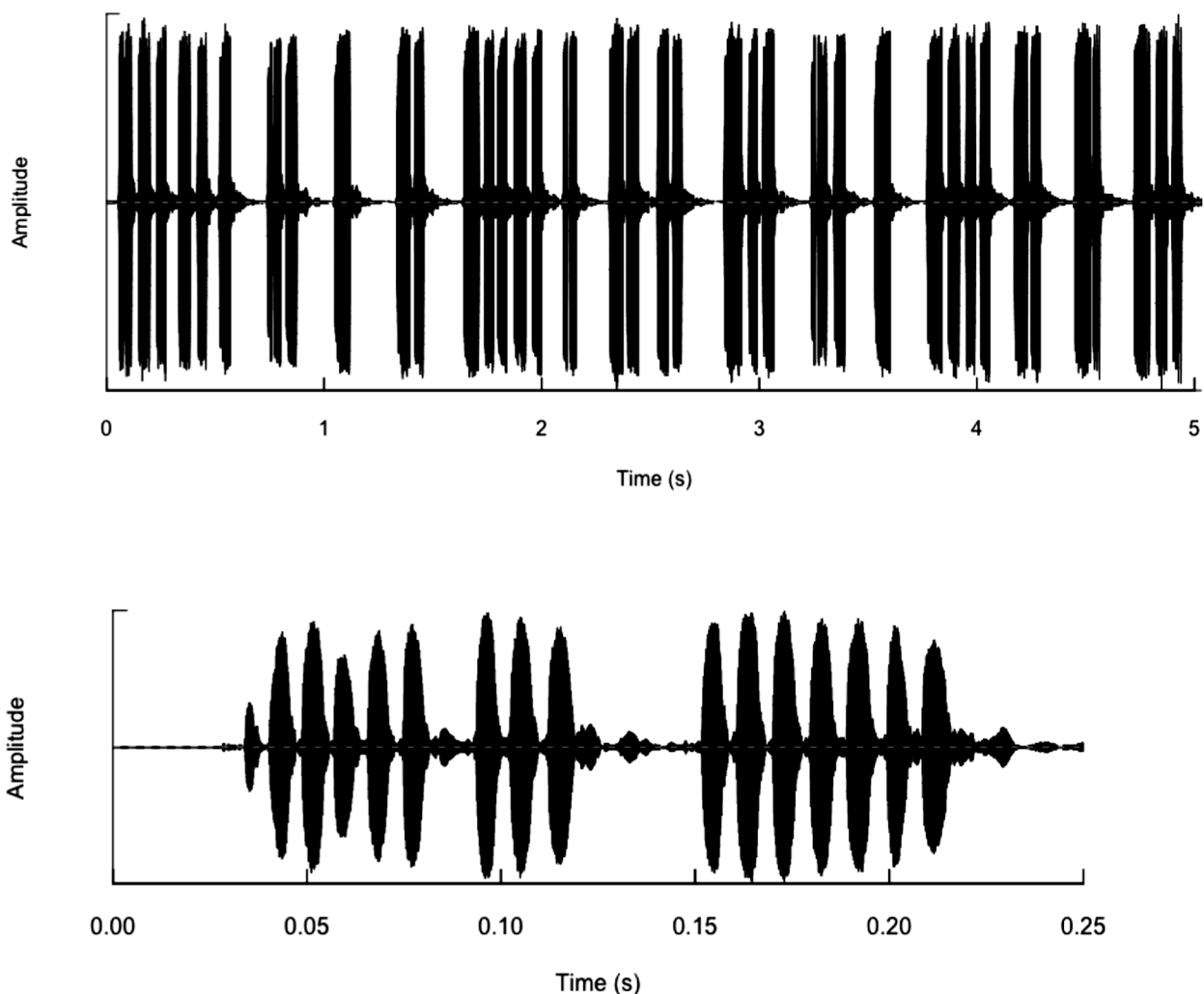
**Distribution.** Arizona and adjacent deserts of California, Nevada, Utah, and New Mexico.

**Recognition characters and song.** Most variable calling song of any US *Gryllus*. A medium to large sized cricket with a shiny pronotum generally at low elevations in some of the hottest, driest desert areas of the southwestern US, including most of Arizona (except for the northeast corner). **Song** loud, unique for New World *Gryllus*: many individuals produce a highly irregular “stuttered” series of chirps (Fig. 183, R15-291) with high variability in inter-chirp interval. Chirps at 25°C with variable p/c (typically 3-9; range 1 to 10), variable CR (typically 120-240; range 100-720) depending on p/c and inter-chirp interval, pulse rate 70-110, dominant frequency 5.25 kHz. Within most populations, 10 to 60% of males sing with a more or less constant number of p/c and uniform inter-chirp interval (Fig. 184A, R11-124) with some males (see Fig 184B, R09-147) singing both regular and irregular segments. Color usually light (Fig. 186) but dark individuals (Fig. 187) known even in summer. If male singing irregular stutter-chirp song, then can be confused with no other US *Gryllus*. If singing with constant p/c and uniform inter-chirp intervals in the Southwestern US, then only has to be distinguished from *G. lineaticeps*, *G. personatus*, and *G. multipulsator*. From allopatric sister species *G. lineaticeps*, no overlap in distribution (Fig. 172), DNA (Fig. 174), and pulse rate (Fig. 173). From allopatric sister species *G. personatus*, which it most closely resembles morphologically and which it geographically broadly overlaps in only north-central Arizona and SW New Mexico (but has been only found microsympatric with *G. personatus* at Road Forks [S81-38 and S12-104] and Socorro [S07-50], New Mexico), *G. staccato* is distinguished by a combination of characters (Table 1, p. 18): more file teeth and more teeth/mm on average, shorter ovipositor relative to body size (Fig. 185), microhabitat different (dirt substrate vs. clay substrate), although both can occur at gas stations that have bright night lights, no overlap in dominant frequency (Fig. 173), irregular pulses/chirp, faster PR and CR, and differences in DNA. Both taxa can have linear head stripes, cream colored areas completely around the eyes frequently extending onto the lower, adjacent half of pronotum, and speckles on face between eyes. *G. personatus* usually at higher elevations. From *G. multipulsator*, which it overlaps in distribution in southeastern CA, southern NV, and west-central AZ, the latter has more p/c, slower CR and a hirsute (dull) pronotum and general absence of linear lines on the head.

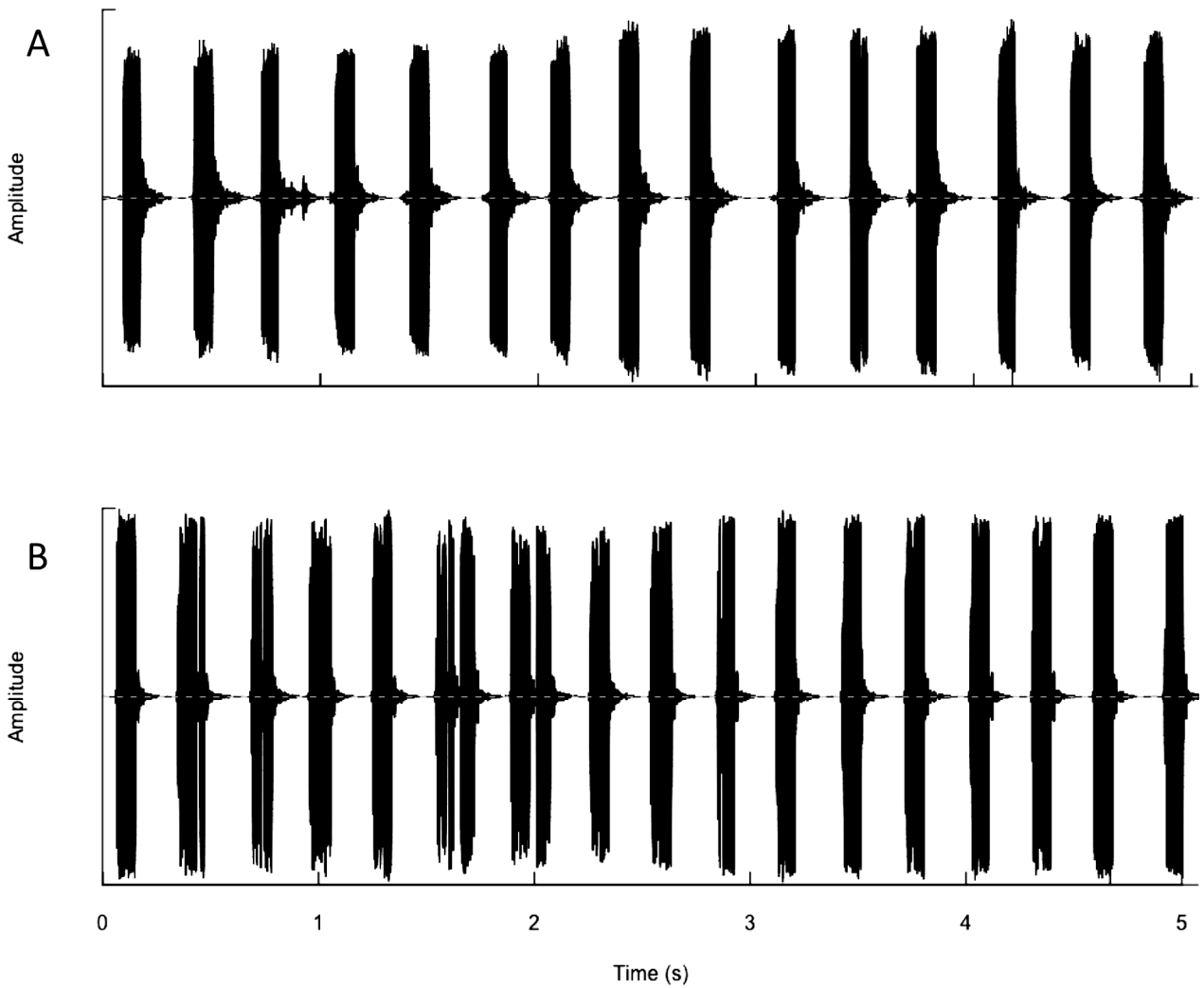
**Holotype.** Male (Fig. 186). USA. Arizona, Pima Co., Ajo. 1-viii-2009. 520m. D.B. Weissman. S09-102, R09-149, DNA sample G1410. 16S ribosomal RNA gene GenBank accession # MN136664. Body 25.3, HF 12.88, LC 13.09. Right tegmen removed: 149 teeth, file length 3.45, TL 14.8, TW 4.6. Type deposited in CAS, Entomology Type #19271.

**Paratypes.** (Total: 132♂ 109♀) **Arizona.** *Cochise Co.*, Benson, 1240m, 27-vi-2009 (S09-54) 1♂. Wilcox Playa, 4155', 29-vii-2015 (S15-104) 32° 11' 55.5" -109° 52' 42.4", 2♂ 1♀. *Coconino Co.*, Sedona, 4400', 25-vi-1980 (S80-45) 4♂; 15-vi-1990 (S90-49) 1♂; 30-vi-1994 (S94-35) 1♂; 12-vi-1996 (S96-61, at airport) 1♀; 15-vi, 2007 (S07-61) 1♂ 5♀. *Gila Co.*, Coolidge Dam, 2400', 30-vii-1981 (S81-43) 2♂. Globe, 3548', 30-vii-1981 (S81-44)

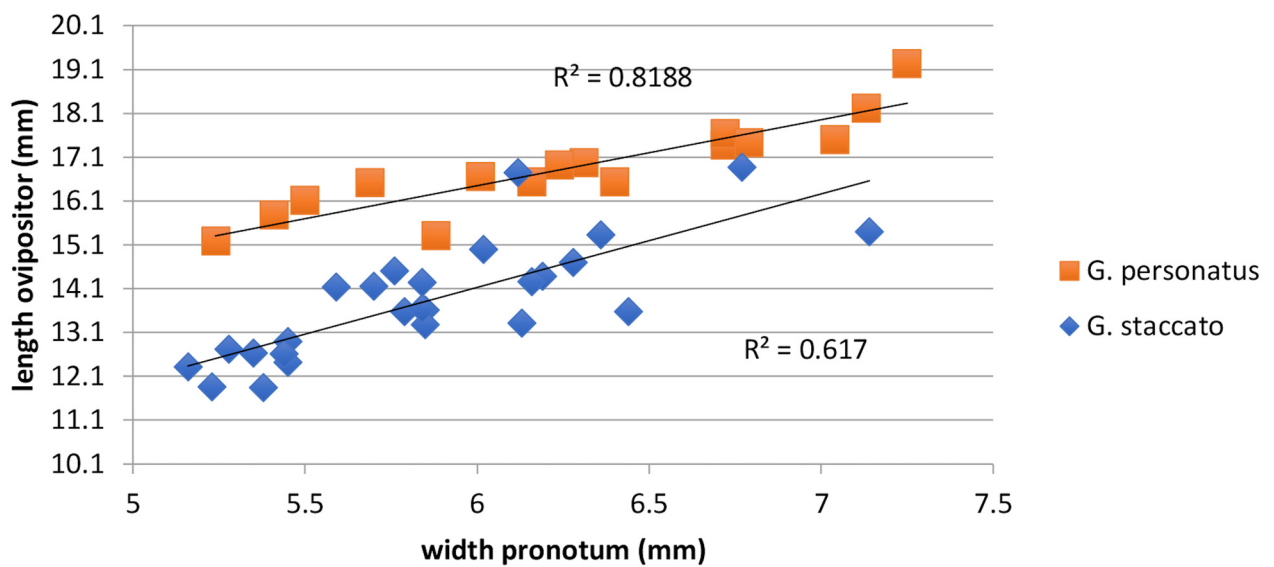
3♂. *Graham Co.*, Safford, 2920': 16-vi-1990 (S90-51) 6♂ 1♀; 28-vii-2015 (S15-103) 1♂ 2♀. 4.5m S Safford, 3180', 10-vi-2012 (S12-20) 1♀. Hwy 366 near intersection with Hwy 191, 3333', 28-vii-2015 (S15-102) 4♂ 2♀. *La Paz Co.*, Wenden, 550m, 14-ix-2011 (S11-87) 2♂ 2♀. *Maricopa Co.*, Aguila 2100' 23-vii-1990 (S90-71) 2♂ 2♀. Buckeye, 260m, 18-ix-2011 (S11-102) 5♂ 6♀. Gila Bend, 220m: 31-vii-1981 (S81-47) 1♂ 4♀; i-viii-2009 (S09-103) 2♂ 2♀; 18-ix-2011 (S11-101) 2♂; 30-vii-2015 (S15-111) 28♂ 23♀. Goodyear, 31-vii-1981 (S81-46) 1♂. Phoenix, 30-vii-2015 (S15-113) 1♂ 1♀. *Mohave Co.*, Hwy 68 2m E California border, 1000', 24-vi-1980 (S80-38) 1♂. Kingman, 3700', 2-viii-1992 (S92-113) 3♂ 2♀; 16-vi-2007 (S07-68) 1♂. 3 m SE Kingman on road to Hualapai Mt. Park, 3950', 3-viii-1991 (S91-67) 5♂ 2♀. *Pima Co.*, Ajo, 540m, 20-viii-1998 (S98-72 & 74) 7♂ 3♀; 15-v-1999 (S99-26) 1♂; 17-ix-2011 (S11-99) 2♂ 1♀; 29-vii-2015 (S15-109) 1♂ 2♀. Catalina, 2940', 18-viii-1998 (S98-65) 2♂ 10♀. Robles Junction, 29-vii-2015 (S15-106) 1♀. Hwy 286 6.3 m S Robles Junction, 1100m, 17-ix-2011 (S11-95) 2♂ 1♀. Hwy 86 10.5 m W Hwy 286, 850m, 17-ix-2011 (S11-97) 3♂ 1♀. Sells, 29-vii-2015 (S15-107) 1♂ 2♀. Tucson, 930m, 27-vi-2009 (S09-53) 5♂ 2♀. Saguaro Rd into Tucson, 2200-2900', 28-vii-1981 (S81-35) 8♂ 3♀. Why, 1740', 20-viii-1998 (S98-71) 4♀. *Pinal Co.*, Picacho Peak State Park, 1780', 18-viii-1998 (S98-66) 1♂. *Yavapai Co.*, Agua Fria Nat. Monument, 1130m, 19-ix, 2011 (S11-105) 1♂ 8♀; 12-vi-2012 (S12-24) 1♀. Camp Verde, 22-viii-2012, (S12-107) 1♀. Cordes Junction, 1100m, 18-ix-2011 (S11-103) 2♂. *Yuma Co.*, Telegraph Pass, 210m, 15-ix-2011, (S11-92) 1♂. Yuma, Arizona Western College, 200', 18-vi-1990 (S90-54) 1♂ 1♀. **California.** *San Bernardino Co.*, Essex, 5.1 m W, 1500', 21-viii-1998 (S98-76) 1♀. Havasu Lake, 140': 6-vi-1983 (S83-62) 1♂ heard; 13-xi-2011 (S11-84) 3♂. **Nevada.** *Clark Co.*, Cottonwood Cove: 750', 24-vi-1980 (S80-36) 1♀; 26-vii-1981 (S81-31) 1♂. **New Mexico.** *Hidalgo Co.*, Road Forks, 4195', 29-vii-1981 (S81-38) 1♂; 21-viii-2012 (S12-104) 5♂ 9♀. **Utah.** *Washington Co.*, Hurricane, 1040m, 20-iv-1999 (S99-12) 1♂. La Verkin, 1040m, 11-ix-2004 (S04-121) 3♂.



**FIGURE 183.** Typical (upper panel), irregular calling song (R15-291) of *G. staccato* from Gila Bend, AZ (S15-111), recorded at 25.1°C. Lower panel shows more detailed structure of the 'stutter-chirp'.



**FIGURE 184.** (A). Regularly spaced calling song (R11-124) of *G. staccato* from Buckeye, AZ (S11-102), recorded at 26°C. (B) Calling song (R09-147) of *G. staccato* from Tucson, AZ (S09-53), recorded at 27.5°C showing both regular and irregular spacing of chirps within the same individual.



**FIGURE 185.** Regression of width pronotum vs. length ovipositor in *G. staccato* vs. *G. personatus*.



**FIGURE 186.** Holotype male (upper) of *G. staccato*. Female (lower) from Pima Co., AZ (S11-95). Note cream colored area, below eye, on male.

*Song records only.* (only one male heard at each locality): **Arizona**, Coconino Co., Flagstaff, 6900', 21-viii-1982 (S82-86); **California**, Inyo Co., Death Valley Nat. Park, Furnace Creek, -52m, 23-vi-1980 (S80-32). **New Mexico**, Socorro Co., Socorro, 4460', 13-vi-2007 (S07-50).

*Derivation of name.* Staccato means "something that is abruptly discontinuous or disjointed in quality or character," which describes the calling song of most males.

*Geographic range.* (Fig. 188). Also, south into the Mexican states of Sonora, Chihuahua, and Sinaloa.



FIGURE 187. Dark color variation in *G. staccato* from Colonia Juarez, Chihuahua, Mexico (S01-71).

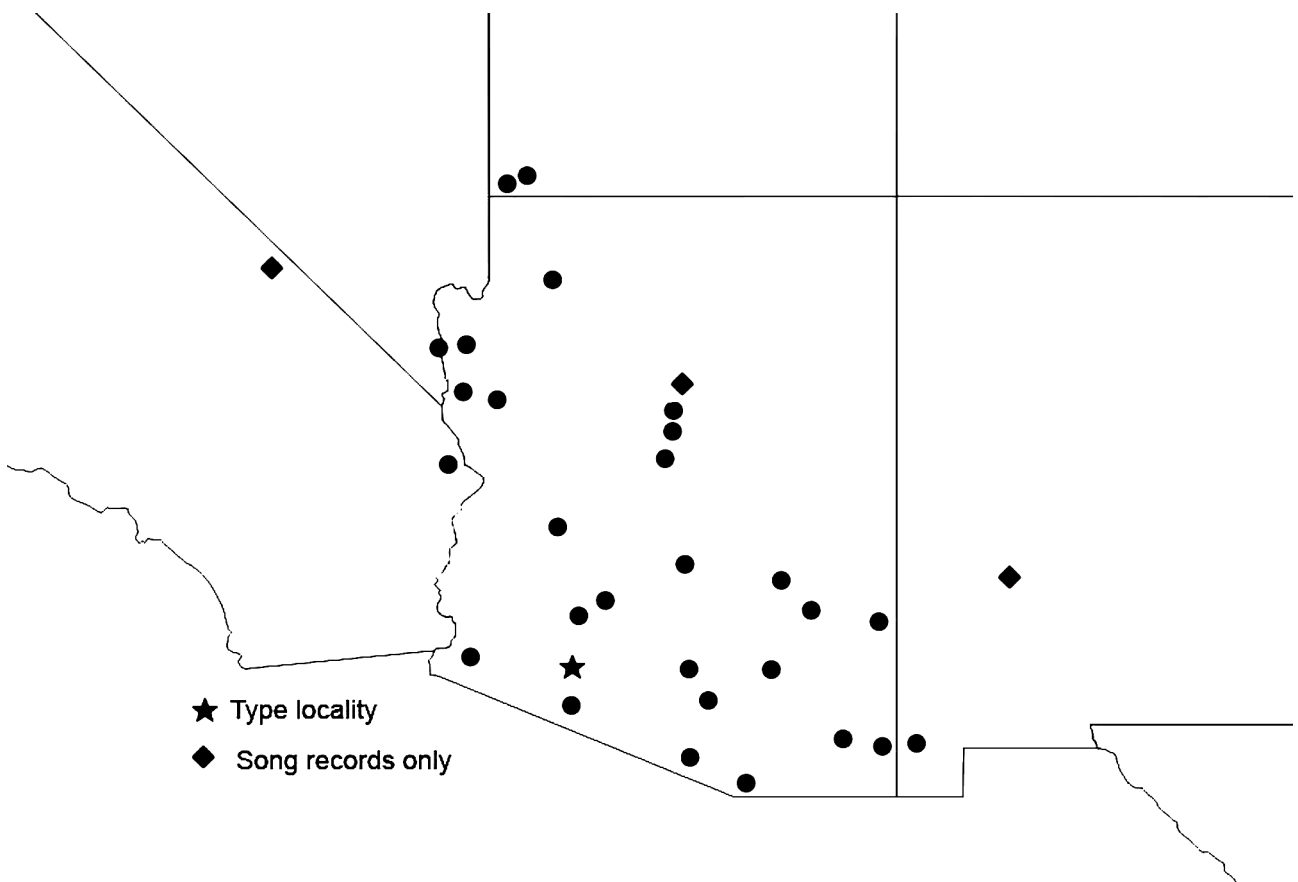


FIGURE 188. Known US distribution of *G. staccato*.

*Habitat.* Primarily open desert grassland/scrubland below 1220m but occasionally at higher elevations, e.g. mixed oak/juniper/pine woodland at 2026m (Schnebly Hill, ~5 m E Sedona, AZ, 7-vii-2003 [DAG 2003-305]) and 2103m within the town of Flagstaff, AZ (S82-86). Flies well and frequents lighted areas around human structures, especially gas stations with all night florescent lights. Can sing in the open or from cracks in the ground. Large population in rock garden area at McDonald's in Gila Bend (S15-111). Wilcox Playa, AZ, (S15-104) males sang in daytime 1 meter above ground, along with *G. lightfooti*, from within *Yucca elata* plants.

*Life cycle and seasonal occurrence.* No egg diapause in Arizona localities: Ajo (S11-99), Yuma (S90-54), and Safford (90-51). Probably 2 generations/year although may depend upon rainfall. Adults known from April to October, but months outside of these have not been checked. Breeds continuously under laboratory conditions.

*Variation.* See Table 1 (p. 18) for measurements. **Color:** Varies from light tan to almost solid black (Fig. 187), although face always with some areas of tan or cream. Most light-colored individuals with three longitudinal stripes on top of head, middle stripe sometimes broken. In very dark individuals, stripes not visible. **Hind wing length:** Variable in both sexes, with about 80% of all adults with long hind wings. Yet even in individuals whose hind wings don't extend beyond the tip of the abdomen, the hind wings present are longer than those in taxa that always have short hind wings. Of 62 individuals from Gila Bend (S81-47, S09-103, S11-101, S15-111), 60 had long hind wings and 2 had shed their hind wings. **Song:** *Chirp rate*—Within a population, both regular and irregular chirp rate songs are commonly heard. We found mixed song populations at several Arizona localities: Kingman (S91-67), Ajo (S98-74), Tucson (S09-53), Sedona (S94-35), Buckeye (S11-102), Gila Bend (S11-101) and Robles Junction (S11-95); and at Road Forks, New Mexico (S12-104). We have recorded a number of individuals that produce both regular and irregular songs (e.g. DAG 2004-006, Wickenburg, Maricopa Co., AZ, 4-iv-2004; DAG 2004-084, Organ Pipe Cactus National Monument, Pima Co., AZ, 8-iv-2004). DNA from individuals of *G. staccato* with both regular and irregular songs confirms that one species is involved (Fig. 174). **Pulse rate**—Since we measured pulse rate between the last two pulses in a chirp, the pulse rate decreases as the number of pulses increases. This phenomenon was illustrated in *G. multipulsator* (Fig. 69, p. 81, and Fig. 2B in Weissman *et al.* 2009) where a pulse-by-pulse analysis showed that the pulse period increases for each sequential pulse in a chirp, due to increasing pulse duration. Extrapolating this general finding (Weissman unpubl.) to *G. staccato* males with songs with 7-9 p/c and comparing their PR (calculated between the last two pulses in a chirp) to irregular songs with 2-8 p/c, shows a similar phenomenon: the PR in a chirp with 3 pulses is higher than the PR in a chirp with 8 pulses. Even so, the PR in *G. staccato* is higher than *G. personatus* chirps with the same number of pulses. Thus, an irregular-song *G. staccato* male with 3 p/c can have a PR of 111 at 25°C. This same male, in a chirp of eight pulses, can have a PR of 83 at the same temperature. For comparison, a *G. personatus* with 8 p/c would have a PR around 65 at 25°C.

*DNA.* Multilocus 2016-034 from Yavapai Co., AZ. Two sister species *G. lineaticeps* 2016-033 (Tracy, CA) and *G. personatus* G1357 (Otero Co., CO) (Gray *et al.* 2019).

*Discussion.* There were unusual sex ratios at some Arizona and New Mexico gas station collections: Catalina (S98-65), Why (S98-71), and Road Forks (S12-104). At these localities, night collecting mostly yielded adult females, possibly from two causes: (1) males were in better hiding places, especially if singing or (2) males were already dead because parasitized by tachinids. At Agua Fria National Monument (S11-105), on 19-ix-2011, only one male *G. staccato* heard but unable to collect since singing from deep soil crack. That same night we collected one male and eight females at oatmeal trails. This one collected male sang with 7-8 p/c with a variable CR. We wonder if this male survived the tachinid onslaught because he was taciturn or his song was not attractive to the fly parasitoids (see Sakaguchi & Gray 2011, for discussion).

Singing males are easy to approach. They should make excellent material for female choice studies given the variability in the calling song.

*G. staccato* and *G. personatus* can hybridize and backcross in the laboratory (DAG, unpublished) but different microhabitats, and geographic allopatry, probably prevent such events in nature, although they can be “brought together” at bright lights in gas stations (e.g. Road Forks, NM, S81-38).

Male *G. staccato* parasitized by tachinid *Ormia ochracea* were collected from the following Arizona localities: Catalina (S98-65); Wenden (S11-87); 6 m S Robles Junction (S11-95); Cordes Junction (S11-103), and Agua Fria (Sakaguchi & Gray 2011).