"The Pet Store Group"

Acheta domesticus (Linnaeus), *Gryllus bimaculatus* De Geer, *Gryllus locorojo* Weissman

A collection of species included here because they are, or were commonly used in the US commercial pet store trade as feeder crickets. We consider them because one of them, *Acheta domesticus*, has already established feral populations in natural habitat in the western US, and both *G. bimaculatus* and *G. locorojo* could potentially become invasive. A currently common pet store cricket, *Gryllodes sigillatus* (F. Walker) is not discussed as it is easily distinguished and, although feral, appears to be confined to urban and suburban areas. Additional details of the pet store crickets can be found in Weissman *et al.* (2012).

***Acheta domesticus* (Linnaeus)**
(European) House Cricket
Figs 7–10

Although not a *Gryllus* and not native to the US, *Acheta domesticus* is widespread in the western US and seems to be expanding its range (Weissman *et al.* 1980, 2012). Additionally, calling songs of feral males, anecdotally, appear to be getting louder (even as we grow older and our hearing gets worse) and the chirps seemingly more regular, thus sounding more like a native *Gryllus* species (Weissman *et al.* 2012). Because we have been spending more time locating these feral males, for identification purposes and to confirm that they are not a *Gryllus*, we include our collection data here (see Fig. 10). Many more eastern US collection sites are given in Walker (2019). Interestingly, this species appears not to have established permanent colonies in Australia, despite being introduced (Rentz & Weissman 2017).
Distribution. Worldwide cosmopolitan cricket.

FIGURE 7. Color variation found in wild *A. domesticus.* Both individuals from Orange Co., CA (S16-12).

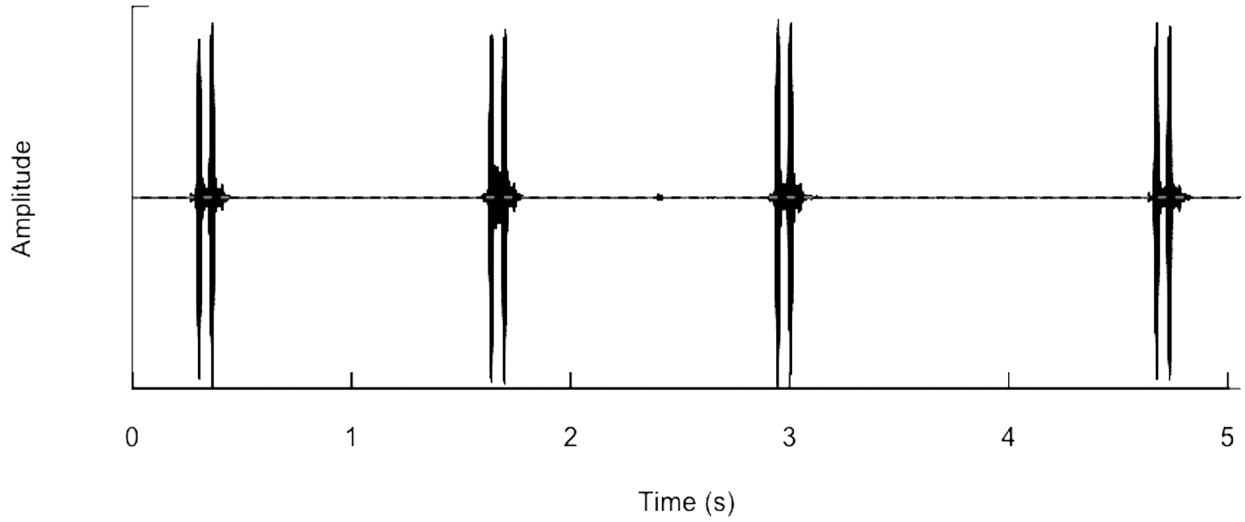

FIGURE 8. Five second waveform of calling song of *A. domesticus*: (R11-133) Telegraph Pass, AZ (S11-94), at 24°C;

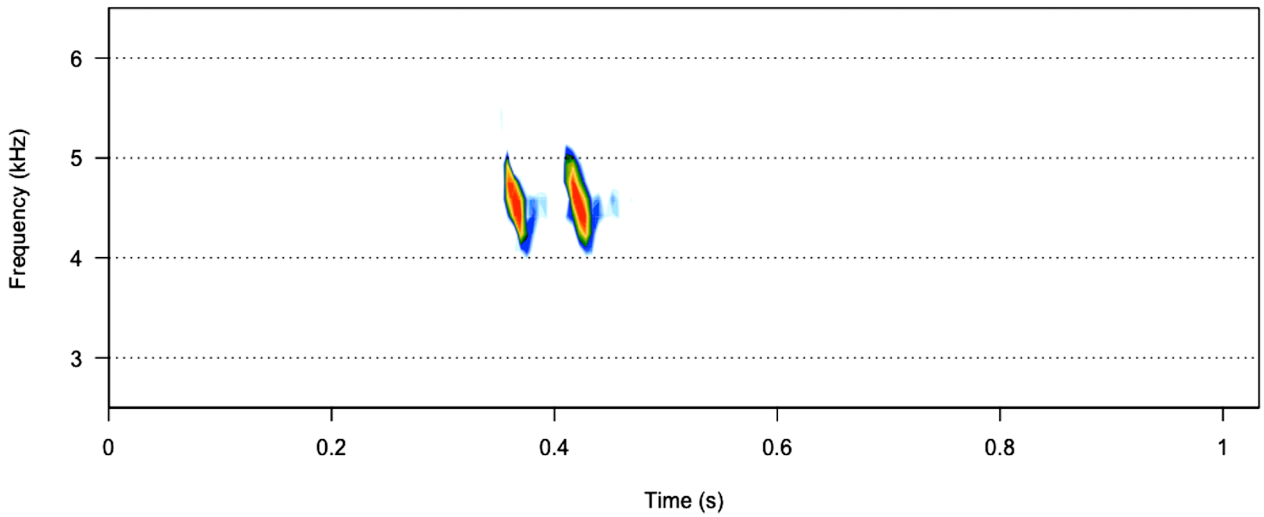

FIGURE 9. One second spectrogram of *A. domesticus*, same male as in Fig. 8.

Recognition characters and song. Usually straw colored (but some individuals dark—see Fig. 7), always with long hind wings, unless apterous (Weissman & Rentz 1977b, Walker 1977), and a distinctive, irregular, dark transverse bar extending between the eyes. A similar bar is seen in introduced *Gryllodes sigillatus* but this other cricket always has short hind wings, longer cerci, more flattened appearance, and quicker evasive movements. *Song* (Figs. 8, 9; R11–133), in *A. domesticus,* 2–4 (usually 2–3) pulses/chirp delivered at 40–200/minute, dominant frequency 4500–5000 Hz. Compare with the more rapid chirp rate of *G. sigillatus* on SINA (Walker 2019).

Geographic range. Fig. 10.

Specimens examined. **Arizona.** *La Paz Co*., Quartzite, 26-vi-1980 (S80-46); 27-vii-1981 (S81-33); 14-ix-2011 (S11-89). *Maricopa Co.,* Buckeye, gas station, 840', 18-ix-2011 (S11-102). Gila Bend, 712', 1-viii-2009 (S09-103); 30-vii-2015 (S15-111). Goodyear, 31-vii-1981 (S81-46). Scottsdale, 22-iv-1985 (S85-41). Hwy 85 10.5 m N Ajo, 1240', 20-viii-1998 (S98-73). *Pima Co.,* Ajo, 1720', 20-viii-1998 (S98-72, 98-74). Catalina, 2940', 18-viii-1998 (S98-65). Organ Pipe National Monument, 1-ix-1961, D.C. Rentz. Outskirts Tucson on Saguaro Rd., 31-vii-1981 (S81-35). *Yuma Co.,* Telegraph Pass, 676', 15-ix-2011 (S11-92, S11-94). **California.** *Imperial Co.,* Algodones Dunes 2.6 m NW Glamis off Ted Kipf Road, 240', 15-ix-2011 (S11-91). El Centro, 27 & 28-i-1959, Kirschbaum, D.C. Rentz. *Inyo Co.,* Death Valley National Park, Furnace Creek, 5-vi-1983 (S83-60); 5-v-2003 (S03-36). *Kern Co.*

Bakersfield near Cal State Bakersfield, 5-viii-1980 (S80-70). *Los Angeles Co.,* CSU Northridge campus, 8-v-2003 (S03-47). Westlake Village, 22-v-1982. *Orange Co*., Crystal Cove, 7-vii-1976. Tustin, 20-vii-1975; 12-vi-1976. *Riverside Co.,* Blythe, 26-vi-1980 (S80-47). Corn Springs, 1-ix-2001; 18-iv-2010, 3-ix-2012; 10-iv-2015. Joshua Tree National Monument, Cottonwood Springs, 3000', 7-viii-1988 (S88-78). Palm Springs, 2-iv-1989 (S89-8). UC Riverside campus, 15-vii-2001 (S01-96). Box Canyon Rd 10.9 m E Mecca, 800', 7-viii-1988 (S88-76). *San Bernardino Co.,* Baker, 1000', 4-viii-1991 (S91-72). Barstow, 2300', 22-vii-2016 (S16-28). Havasu Lake, 460', 13-ix-2011 (S11-84). Newberry Springs, 2160', 16-viii-1998 (S98-59). Route 66 at intersection I40, truck stop. 2103' 23-vii-2016 (S16-32). Ludlow exit off I40, 2060', 16-viii-1998 (S98-60). San Bernardino Mts., Mill Creek Ranger Station, 2800', 25-vii-1981 (S81-27). *San Diego Co.,* Borrego Springs, 8-viii-1988 (S88-83). *Santa Clara Co.,* Los Gatos, 10-ix-1990. Stanford University, Lake Lagunita, 26-viii-1983 (S83-113). *Shasta Co.,* Shasta Lake, Bridge Bay Road yacht area, 4-viii-1980 (S80-67). **Kansas.** *Sedgewick Co.,* Wichita, 9-viii-1980. **Nebraska.** *Red Willow Co*., McCook, 28-viii-1989 (S89-74). **Nevada.** *Clark Co.,* Cottonwood Cove, 750', 24-vi-1980 (S80-36); 26-vii-1981 (S81-31). **Oregon.** *Benton Co*., Corvallis, 18-i-1969, Tao. **Utah.** *Utah Co.,* Provo, 1-ii-1965, A.T. Whitehead. **Texas.** *Brewster Co.,* Big Bend National Park, Rio Grande Village, 1860', 28-v-2016 (S16-12). *Tarrant Co.,* Grapevine Lake Dam, 23-v-2001 (S01-48). *Tom Green Co.,* San Angelo, 11-vi-1988 (S88-30). *Val Verde Co.,* Del Rio, 1000', 27-vi-1986 (S86-48).

DNA. Multilocus 2017-045 (Gray *et al.* 2019) shows that *A. domesticus* is more closely related to *Nigrogryllus* than to *Teleogryllus*.

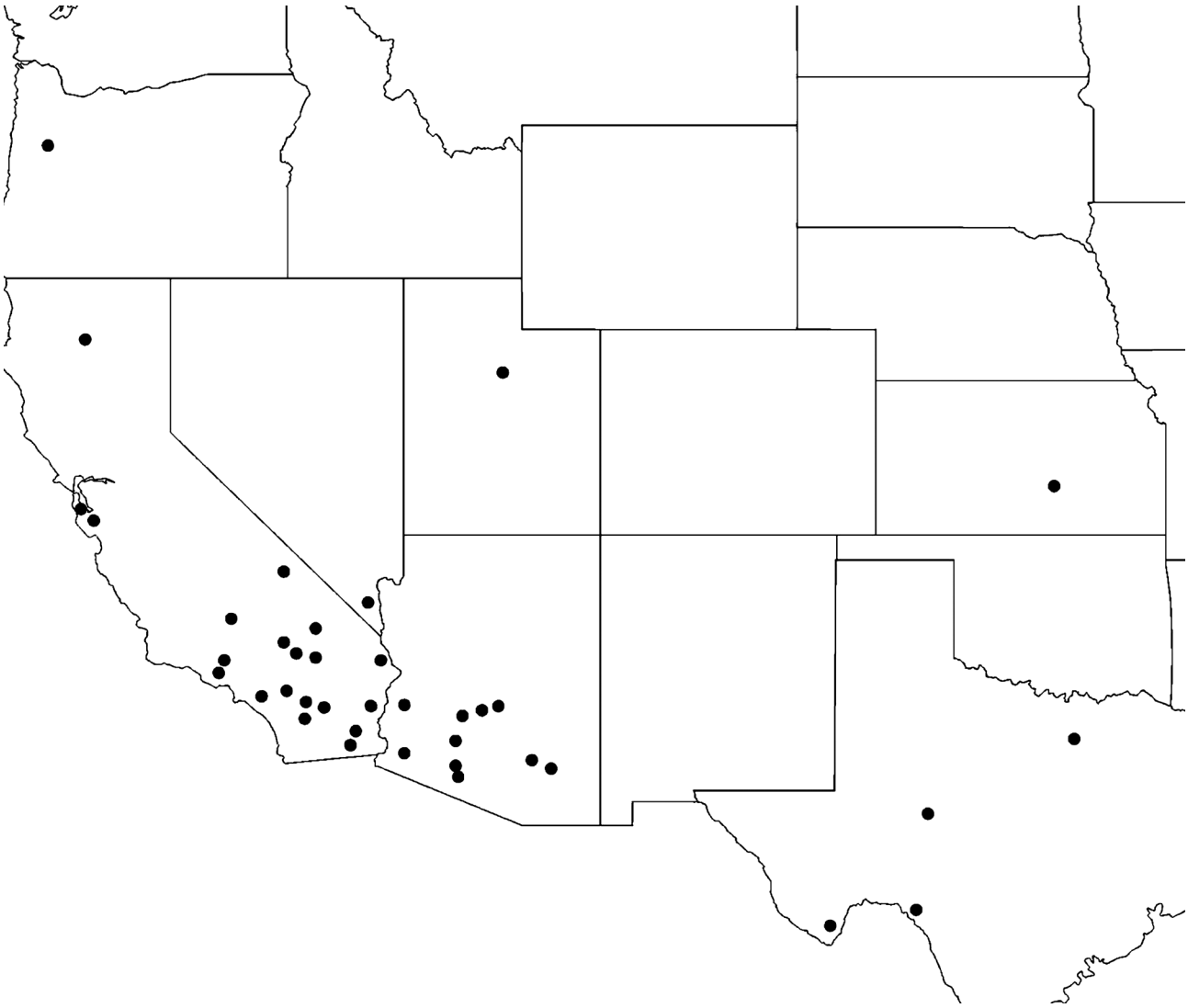

FIGURE 10. Populations of *Acheta domesticus* that we studied.

Discussion. Several of the above localities are natural habitats away from human disturbance—e.g. Algodones Dunes (S11-91), Telegraph Pass (S11-92), Box Canyon Road (S88-76), 10.5 m N Ajo (S98-73), which is why we recommended (Weissman *et al.* 2012) a switch to *Gryllodes sigillatus* by the pet-feeder industry, because the latter does not appear to readily exist away from human disturbance. Olzer *et al*. (2019) compared behavior of feral and commercially reared *A. domesticus*.

***Gryllus bimaculatus* De Geer**

Two Spotted or Black Field Cricket
Figs 11–13

1773. *Gryllus bimaculatus* De Geer. Mémoires pour servir à l'histoire des insectes 3:521. Type locality: Africa, West Tropical Africa, Mali, Mourdiah. Type deposited in ANSP.

Recognition characters and song. Apparently the most widely, naturally distributed *Gryllus* species found from the tip of South Africa north into Europe and east as far as Thailand (Otte & Cade 1984). This is a medium-large sized, short hind femur, usually pure black, short or long hind winged cricket with a shiny pronotum. Most males have a pale, yellowish area (Fig. 11a) at the base of each tegmen where they attach to the pronotum. Adult females may be without or have a slight indication of pale tegminal areas (Fig. 11b). Brown males are known (see Fig. 11a, and Otte and Cade 1984). *Song* (Figs. 12, 13; R12–14) with 2–6 pulses/chirp, usually 3–5 chirps/second, pulse rate 21–28 at 25°C, dominant frequency 4633–5816 Hz in pet store specimens.

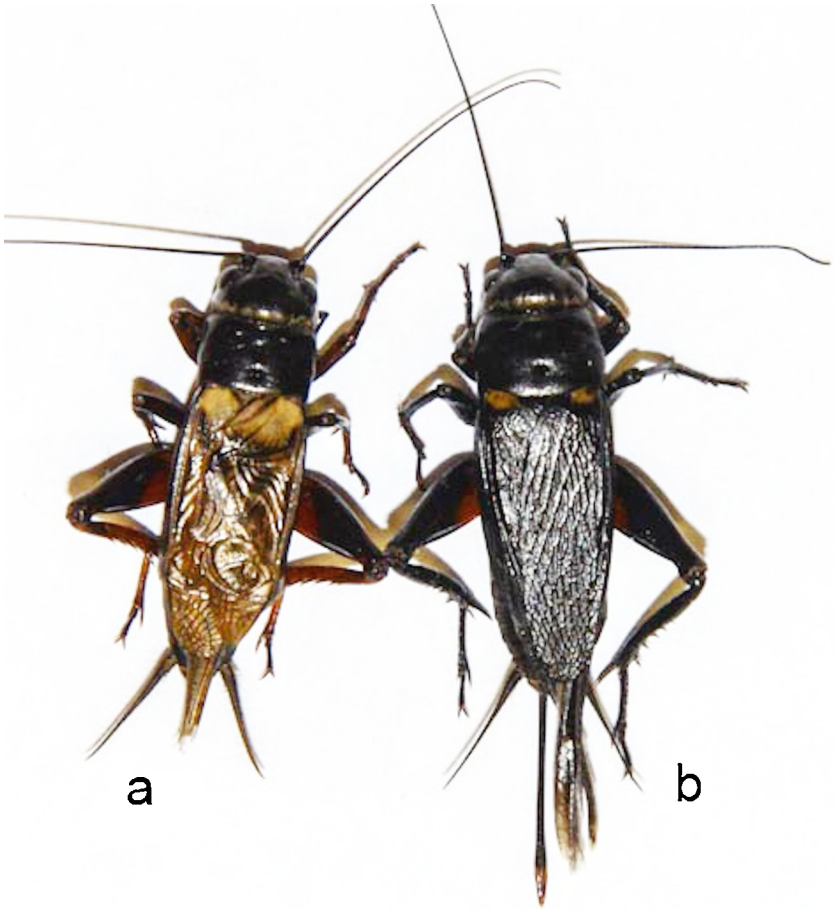

FIGURE 11. Male (a) *G. bimaculatus* with obvious bilateral, pale-yellowish area at base of tegmina. Female (b) with similar, but smaller areas. Both specimens from commercial pet store.

Discussion. As discussed in Weissman *et al*. (2012), this is one of two non-native US *Gryllus* (the other being *G. locorojo*) that was being commercially raised in 2012 and shipped to US pet food stores for sale to the general

public. Such activities will invariably result in the release, either by accident or on purpose, of this species into the environment, similar to what has probably occurred with *Acheta domesticus* (Weissman *et al*. 1980). The effect of such releases is unknown, as is whether or not these crickets can survive and multiply outside of commercial farms. We discussed (Weissman *et al.* 2012) why regulatory oversight by federal and state regulatory agencies has been inadequate and suspect that such surveillance has only gotten worse, since 2012, given continued tightening US federal budgets and malaise from both state and federal regulators. Additionally, we have no idea what the current commercial status is for these two species because they are more aggressive and cannibalistic than the replaced *A. domesticus*, and tend to bite the lizard they are usually being fed to. Thus, the pet-food industry may be voluntarily replacing *G. bimaculatus* with the ecologically preferred (Weissman *et al.* 2012) *Gryllodes sigillatus*. We present *G. bimaculatus* here in case they establish feral populations encountered by an inquiring biologist.

DNA. Multilocus 1999-101, from Zimbabwe, maps closest to Old World *G. campestris* Linnaeus, and at the base of the *Gryllus* tree along with several other *Gryllus* taxa (Fig. 6, p. 28). This position agrees with that seen in more limited 16S mapping (see Fig. 6 in Weissman *et al*. 2012).

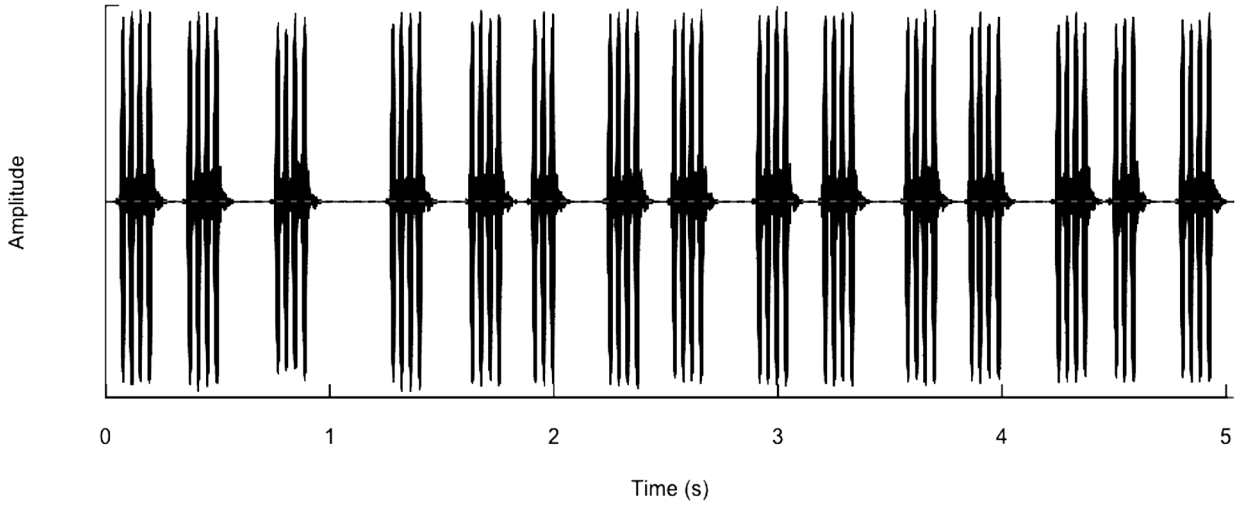

FIGURE 12. Five second calling song of *G. bimaculatus* (R12-14) commercial pet store, at 25°C.

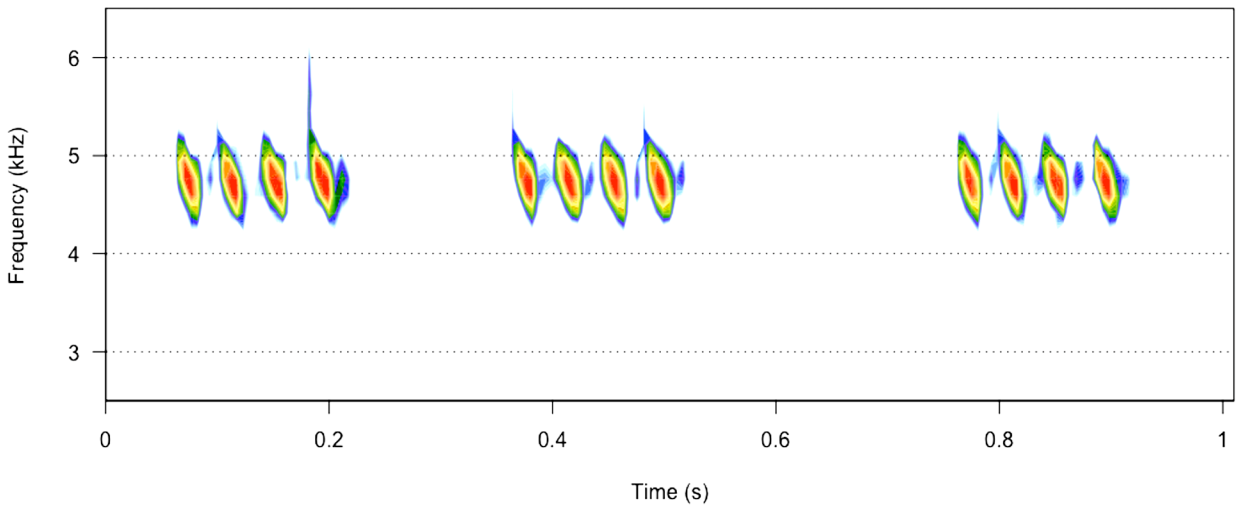

FIGURE 13. One second spectrogram of *G. bimaculatus*, same male as in Fig. 12.

***Gryllus locorojo* Weissman & Gray**
Crazy Red Field Cricket
Figs 14–16, 54, 62, Table 1

2012 *Gryllus locorojo* Weissman & Gray. Zootaxa 3504: 67–88. Type locality: USA: California, Los Angeles Co., Compton, Rainbow Mealworms. Type deposited in CAS, Entomology type #18657.

Distribution. Known only from pet food stores and commercial cricket farms in North America, Europe, and western Asia. Original locality still unknown, but most likely somewhere in South America, perhaps Ecuador (Weissman *et al.* 2012).

Recognition characters and song. Body size medium-large, long or short hind wings, reddish/brownish colored (Fig. 14), head frequently with three or four longitudinal stripes. *Song* variable (Figs 15, 16; R12–3), usually 2 (range 1–3) p/c, less than 1 chirp/second, PR 25–42 at 25°C.

FIGURE 14. Head on view of male *G. locorojo* showing head stripes.

Discussion. We repeat here the same concerns as under *G. bimaculatus.* As discussed in Weissman *et al*. (2012), this is one of two non-native *Gryllus* (the other being *G. bimaculatus*) that was being commercially raised in the US, in 2012, and shipped to US pet food stores for sale to the general public. Such activities will invariably result in the release, either by accident or on purpose, of this species into the environment, similar to what has probably occurred with *Acheta domesticus* (Weissman *et al.* 1980). The effect of such releases is unknown, as is whether or not these crickets can survive and multiply outside of commercial farms. We discussed (Weissman *et al*. 2012) why oversight by federal and state regulatory agencies is inadequate and suspect that such surveillance has only gotten worse, since 2012, given continued tightening US federal budgets and malaise from both state and federal regulators. Additionally, we have no idea what the current commercial status is for these two non-native species because they are more aggressive and cannibalistic than the replaced *A. domesticus*, and tend to bite the lizard they are being fed to. Thus, the pet-food industry may be voluntarily replacing *G. locorojo* with the ecologically preferred (Weissman *et al*. 2012) *Gryllodes sigillatus*. We present *G. locorojo* here in case they establish feral populations encountered by inquiring biologist. Similar concerns were presented by Barranco (2012), who discussed the possible invasive situation of "*G. assimilis"*, which was being sold for pet food in Spain. As discussed in Weissman *et al*. (2012), this is probably *G. locorojo*, although inquiries to P. Barranco, in 2013 and 2014, as to the number of p/c in the calling song of their cricket, which would easily distinguish true *G. assimilis* from *G. locorojo,* went unanswered. *G. locorojo* has been used for studies on calling song and phonotactic selectivity (Rothbart & Hennig 2012) as well as courtship song (Vedenina & Pollack 2012).

DNA. Multilocus G2159, from a commercial pet food store, maps (Fig. 6, p. 28) this species closest to *G. assimilis* and *G. multipulsator*, despite very different calling songs between *G. locorojo* and the other two species.

However, as noted in Weissman *et al.* (2019), courtship songs of these three species are similar in having a double-tick structure unlike any other US *Gryllus* for which courtship song is known to us.

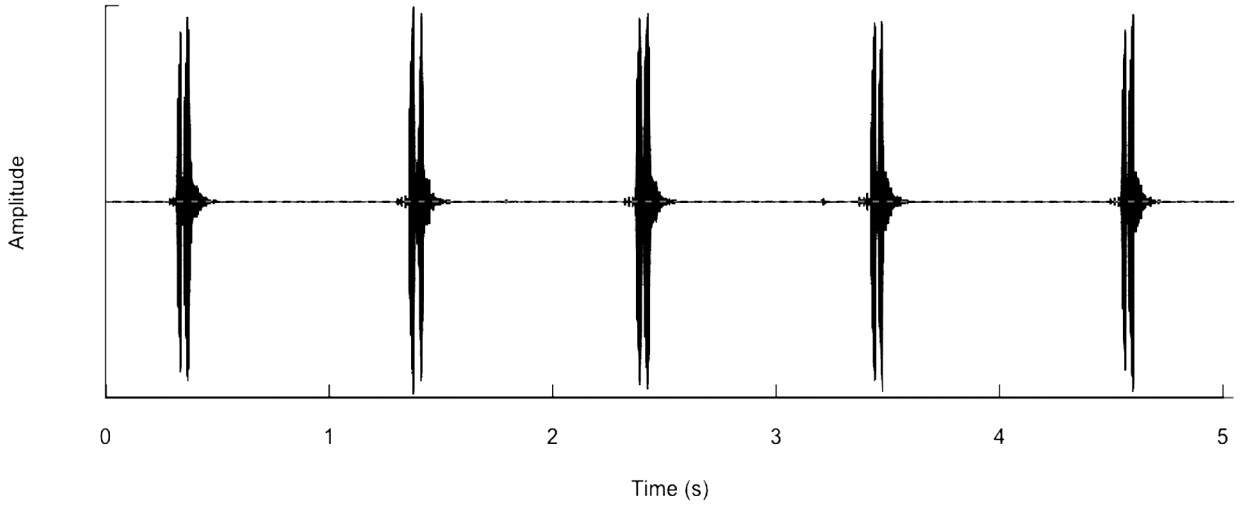

FIGURE 15. Five second calling song of *G. locorojo*: (R12-3) commercial pet store, at 22°C.

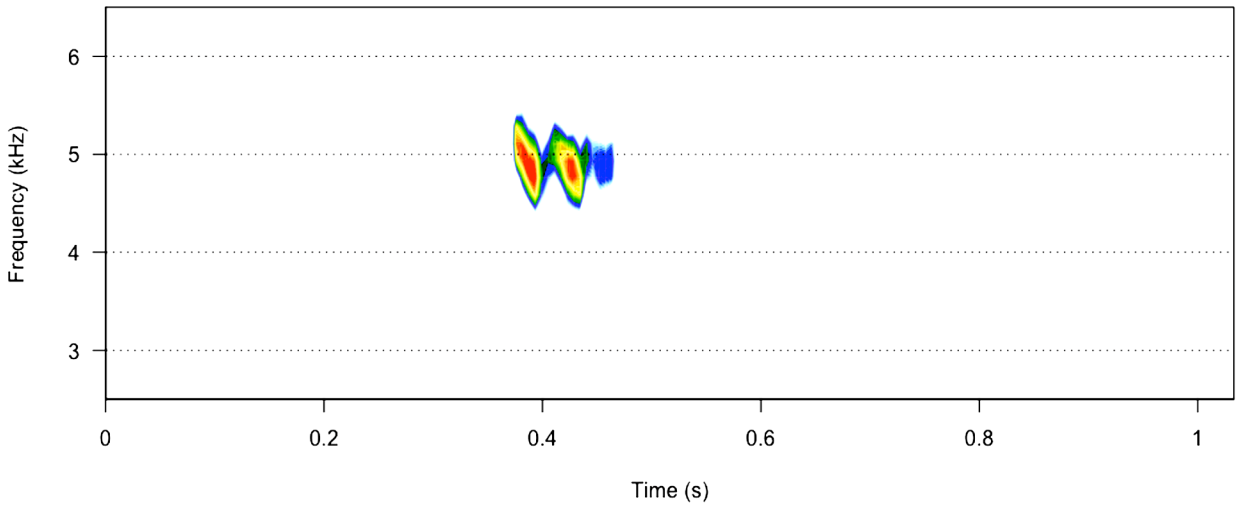

FIGURE 16. One second spectrogram of *G. locorojo,* same male as in Fig. 15.

The Brevicaudus Group

G. brevicaudus Weissman, Rentz, and Alexander

Within the US, *G. brevicaudus* is the only representative; however three other island-inhabiting endemic species (*G. insularis*, *G. alexanderi*, and *G. bryanti*) are close relatives (Fig. 6, p. 28). These island species are all flightless, short winged, slow chirpers. While loss of flight capability is common in many island taxa (Carlquist 1974, Darlington 1938), these 3 dispersed island endemics still generate interesting biogeographical questions. *G. bryanti* is discussed here (p. 40), but treatment of *G. alexanderi* and *G. insularis* will be included in future work on the *Gryllus* of Mexico.