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CALIFORNIA AND BAJA CALIFORNIA, MEXICO
(ORTHOPTERA: GRYLLIDAE: GRYLLINAE)

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FIELD CRICKETS (*GRYLLUS* AND *ACHETA*) OF
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ABSTRACT

The status and bionomics of California and Baja California, Mexico, field crickets in the genera *Gryllus* (9 species) and *Acheta* (1 species) are reviewed. *G. pennsylvanicus* Burmeister, *G. integer* Scudder, *G. vocalis* Scudder, *G. assimilis* (Fabricius), *G. veletis* (Alexander and Bigelow), *G. lineaticeps* Stål, and *G. insularis* Scudder are recognized as valid taxa in the study area. A neotype for *G. lineaticeps* is designated, as are lectotypes for *G. integer*, *G. vocalis*, and *G. insularis*. Two new species are described: *G. brevicaudus* Weissman, Rentz, and Alexander, and *G. cohni* Weissman. The known distribution of *A. domesticus* (L.) in western North America is extended.

Comments are made concerning the possible synonymies of the other three western U.S. *Gryllus* names: *personatus* Uhler, *armatus* Scudder, and *alopus* Rehn.

INTRODUCTION

Rehn and Hebard (1915) pointed out in their revision of American species of *Gryllus*, that this group has been one of the greatest systematic problems within the Orthoptera. After studying

over 1500 specimens, they proceeded to synonymize 46 names under *G. assimilis* (Fabricius), a situation maintained until Fulton (1952) and Alexander (1957) showed the value of sound production and associated behavior in separating species. Their work has been extended (Alexander and Bigelow 1960, Alexander and Walker 1962, Nickle and Walker 1975, Walker 1975) such that eight species of *Gryllus* are now recognized east of the Mississippi River.

Western North American *Gryllus* were last studied by Scudder in 1901. Recently (Weissman and Rentz 1977a,b; Rentz and Weissman 1981) we discussed the status of southern California field crickets, recognizing nine taxa: eight *Gryllus* species and the introduced *Acheta domesticus* (L.). However, we chose to give our *Gryllus* species numbers instead of names for several reasons: (i) limited knowledge about the range of all western species, especially at the type localities; (ii) poor type series preservation and lack of ecological and song data, which result in our inability to identify conclusively all specimens; and (iii) the fact that some type series contain more than one species.

Since our earlier work, we have extended our studies to cover all of Baja California, Mexico, and coastal California (that area west of U.S. Highway 101 north of Los Angeles, and Interstate Highway 5 south of Los Angeles — see Fig. 1) between San Diego and San Francisco, including the eight California Channel Islands (Rentz and Weissman 1981). Other scattered localities in California and Oregon have also been sampled, but not as thoroughly as the above areas. Additionally, one of us (RDA), has extensive knowledge of *Gryllus* outside the area covered by this paper and was thus familiar with names already in the literature. Consequently, we are now able to assign names to our previous *Gryllus* I through VIII. For our study area, we validate and give identifying characters for *G. pennsylvanicus* Burmeister, *G. integer* Scudder, *G. vocalis* Scudder, *G. assimilis*, *G. veletis* (Alexander and Bigelow), *G. lineaticeps* Stål, and *G. insularis* Scudder. A neotype for *G. lineaticeps* is designated, as are lectotypes for *G. integer*, *G. vocalis*, and *G. insularis*. Two new species are described. We regard *Gryllus* V (see Rentz and Weissman 1981) from San Nicolas Island as aberrant examples of *G. lineaticeps*.

For all species we present recognition characters, calling song oscillograms (except *G. insularis*), bionomic data, and distribution within the study area. A common name is provided where one does not already exist. If a species is widely found, then only specific localities of significance are given (e.g. highest collected elevation, most eastern known locality). Records on the distribution maps represent collected specimens with verifying recordings.

At present we are able to recognize consistently only *G. insularis* and *G. brevicaudus* n. sp. solely using morphological characters. Selected individuals of other species are occasionally identifiable. A combination of oscillogram and file measurements (i.e., length of file, number of teeth, and teeth per millimeter) is usually adequate for separating males, but locality, size, and color pattern are occasionally necessary for definitive identification. Females, except as noted above, are usually without distinguishing morphological characters and are identified by association with males.

We also present a key to the species in the study area (Fig. 1) which relies heavily on oscillogram characters. Morphological and song parameters are summarized in tables. Such information will enable others to elucidate respective life cycles, extend our limited geographic range information, and also recognize undescribed species. Genitalia are not species-specific in our taxa although they were found to be so in other *Gryllus* (Randell 1964).

MATERIALS AND METHODS

All paratypes and measured specimens, except where noted, are deposited at the California Academy of Sciences, Department of Entomology. Specimens were collected by DBW, unless otherwise stated. Song recordings reside with DBW. Specimens of field crickets are most useful for morphological study when pinned because color, which may be of taxonomic importance, is well preserved. The right tegmen of males is easily removed at the time of mounting and stored in a gelatin capsule for subsequent stridulatory file examination.

Oscillogram and measurement techniques, including file study, are described elsewhere (Rentz and Weissman 1980). Our slightly different technique of counting teeth (different from, for example,

Rakshpal 1960), yields counts no more than 5 teeth lower. Species "descriptions" are given in the form of recognition characters since morphological parameters are variable, not taxon specific, and best presented in table form. Some characters are noted as unique; the tables should be consulted for the alternative conditions.

Institutions are recognized by the following abbreviations:

CAS — California Academy of Sciences.

UMMZ — University of Michigan Museum of Zoology.

ANSP — Academy of Natural Sciences of Philadelphia.

Abbreviations used in the text are as follows:

RDA — Richard D. Alexander,

DBW — David B. Weissman,

P/C — pulses per chirp,

C/M — chirps per minute,

P/S — pulses per second, or pulse rate, is determined by averaging, at each temperature, several intervals from the beginning of a pulse (never the initial short pulse in a chirp) to the beginning of the next one, and then calculating the quantity in one second.

KEY TO THE FIELD CRICKETS OF CALIFORNIA AND BAJA CALIFORNIA, MEXICO

- | | | |
|-------|---|---|
| 1 | Overall color straw brown; head with irregular, dark, transverse bar extending between eyes near their distal border; number of teeth in stridulatory file greater than 175, more than 50 teeth/mm of file length | 3 |
| | <i>Acheta domesticus</i> (L.) | |
| 1' | Overall color black, red, or combination; head and stridulatory file not as above | 2 |
| | <i>Gryllus</i> (L.) | |
| 2(1') | Known only from Guadalupe Island, Mexico; visible portion of tegmina <i>in situ</i> less than 1/3 body length in female, less than 2/5 body length in male; ovipositor averages 20 mm in length | 4 |
| | <i>G. insularis</i> Scudder | |
| 2' | More broadly ranging and not known from Guadalupe Island, Mexico; tegmina and ovipositor not as above | 3 |
| 3(2') | Call rapid, with more than 500 chirps per minute | 4 |
| 3' | Call slower, with fewer than 500 chirps per minute | 5 |
| 4(3) | Call a trill, pulses within trills not grouped; known only from Baja California Sur; hind wings short | 5 |
| | <i>G. cohni</i> Weissman, n. sp. | |
| 4' | Call a "stutter-trilling", pulses within trills paired or grouped in threes as chirps; not restricted to Baja California Sur; hind wings long | 5 |
| | <i>G. integer</i> Scudder | |

- 5(3') Hind wings long; 11-17 pulses per chirp, usually fewer than 100 chirps per minute *G. assimilis* (Fabricius)
- 5' Hind wings long or short, 10 or fewer pulses per chirp; rate usually exceeds 100 chirps per minute 6
- 6(5') Ovipositor less than 10 mm long; tegmina with characteristic yellow tinge on lateral field
 *G. brevicaudus* Weissman, Rentz, and Alexander, n. sp.
- 6' Ovipositor greater than 10 mm long; tegmina light or dark, not with yellow tinge on lateral field 7
- 7(6') Six to 10 pulses per chirp *G. lineaticeps* Stål
- 7' Fewer than 6 pulses per chirp 8
- 8(7') Large bodied (average 21.6 mm); length of stridulatory file greater than 3.8 mm and with more than 150 teeth; length of female hind femur greater than 12.3 mm *G. pennsylvanicus* Burmeister
- 8' Small bodied (largest specimen less than 21.5 mm); length of stridulatory file less than 3.8 mm and usually with fewer than 150 teeth; length of female hind femur usually less than 12.3 mm 9
- 9(8') Chirp rate usually more than 180 per minute; average body length 18.6 mm; southern California *G. vocalis* Scudder
- 9' Chirp rate usually less than 180 per minute; average body length 16.5 mm; northern California *G. veletis* (Alexander and Bigelow)

***Acheta domesticus* (Linnaeus)**

House Cricket

1758 *Gryllus domesticus* Linnaeus, Syst. Nat. (ed. 10) 1:428. Type locality: Europe. Type lost. See Chopard 1967, for complete synonymy.

Recognition characters and song. — Overall color straw brown, head with irregular, dark, transverse bar extending between eyes near their distal border; number of teeth in stridulatory file greater than 175; song variable depending upon temperature and other poorly understood factors: below 25°C, 2-4 (usually 2-3) P/C, from 40-200 C/M; above 28°C, song may become a trill with 1 P/C, 1000 C/M, although some pairing may still occur (Fig. 7, Tables 1, 2, 3).

Range. — (Fig. 2). Apparently introduced into eastern U.S. and eastern Canada (Vickery et al. 1974) from Europe; and possibly to Europe from northern Africa or southwest Asia (Ghoury 1961). In the study area: Widespread in southern California and Baja California Norte. Additional localities besides those listed in Weissman and Rentz (1977a) include MEXICO: Baja California Norte, Tijuana, Mexicali, Algodones, Sierra Pinta Dunes 89 km S

TABLE 1. Comparison of morphological patterns in western field crickets. Broad overlap results in inability to discern taxa solely on morphological grounds. Color pattern labeled *variable* indicates color runs gamut from red to black and most intermediate tones. All measurements in mm. The right four columns apply to both sexes; hind femur length only to females.

	Length body ± SD (range)	Length ovi- positor ± SD (range)	Length hind femur (♀) ± SD (range)	Meta-tho- racic wing length	Color of head	Color of tegmen	Color hind femur
<i>A. domesticus</i> N = 15♂	17.7 ± 1.3 (14.5-19.7)			long	uniformly patterned	light	light
10♀	17.8 ± 1.4 (15.5-19.5)	12.2 ± 1.2 (9.5-13.5)	11.2 ± 0.7 (10.2-12.4)				
<i>G. assimilis</i> 65♂	21.0 ± 1.5 (18.5-24.0)			long	variable	variable usually light	variable
24♀	20.3 ± 1.6 (16.0-22.5)	13.8 ± 1.3 (12.0-16.2)	12.2 ± 1.2 (10.5-15.6)				
<i>G. brevicaudus</i> 13♂	18.4 ± 1.8 (14.5-21.5)			short	black	light with yellow tinge	variable
21♀	16.3 ± 2.1 (13.0-20.5)	8.9 ± 0.5 (8.0-9.7)	9.2 ± 0.6 (8.2-10.3)				
<i>G. coxni</i> 6♂	15.9 ± 0.9 (14.9-16.7)			short	variable	dark	variable
8♀	19.2 ± 1.6 (16.7-21.0)	12.6 ± 1.0 (11.3-14.0)	11.3 ± 0.9 (9.7-12.0)				

<i>G. insularis</i>									
5♂	21.9 ± 1.8 (19.7-23.6)	19.9 ± 1.1 (18.4-21.0)	14.3 ± 0.5 (13.7-15.0)	black	light	variable, usually with medial aspect red			
5♀	22.0 ± 1.2 (20.6-23.9)	12.5 ± 1.1 (11.8-13.8)	9.8 ± 0.3 (9.5-10.1)	black	variable, but lighter than body	usually black, light in some Baja California specimens			
<i>G. integer</i>									
29♂	19.2 ± 1.6 (17.1-24.0)	13.1 ± 1.2 (10.4-16.5)	11.1 ± 0.8 (10.0-12.4)	black	variable, usually light	variable with medial aspect red			
3♀	18.5 ± 0.5 (18.1-19.0)	14.6 ± 1.2 (11.6-16.2)	13.7 ± 1.4 (12.3-16.9)	black	dark	variable, with medial aspect red			
<i>G. lineaticeps</i>									
148♂	20.9 ± 3.1 (16.0-26.0)	11.4 ± 0.8 (10.3-13.0)	10.1 ± 0.8 (8.9-11.4)	black	black	variable with medial aspect red			
91♀	20.4 ± 1.4 (17.5-23.5)	13.4 ± 1.0 (12.0-14.8)	11.2 ± 0.7 (10.2-12.5)	black	black	usually black, usually with medial aspect red			
<i>G. pennsylvanicus</i>									
67♂	21.7 ± 2.2 (18.4-26.2)	16.5 ± 1.9 (14.3-19.5)	16.4 ± 1.8 (13.0-18.5)	black	black	variable with medial aspect red			
15♀	21.5 ± 1.8 (19.0-24.5)	18.5 ± 1.5 (15.5-21.4)	18.7 ± 1.1 (17.4-20.5)	black	black	usually black, usually with medial aspect red			
<i>G. veletis</i>									
25♂	16.5 ± 1.9 (14.3-19.5)	11.4 ± 0.8 (10.3-13.0)	10.1 ± 0.8 (8.9-11.4)	black	black	variable with medial aspect red			
14♀	16.4 ± 1.8 (13.0-18.5)	13.4 ± 1.0 (12.0-14.8)	11.2 ± 0.7 (10.2-12.5)	black	black	usually black, usually with medial aspect red			
<i>G. vocalis</i>									
33♂	18.5 ± 1.5 (15.5-21.4)	13.4 ± 1.0 (12.0-14.8)	11.2 ± 0.7 (10.2-12.5)	black	black	usually black, usually with medial aspect red			
13♀	18.7 ± 1.1 (17.4-20.5)	13.4 ± 1.0 (12.0-14.8)	11.2 ± 0.7 (10.2-12.5)	black	black	usually black, usually with medial aspect red			

TABLE 2. Stridulatory file characteristics in western field crickets. Number of males same as in Table 1. All measurements in mm.

	Length file ± SD (range)	Number teeth ± SD (range)	Teeth/mm ± SD (range)
<i>A. domesticus</i>	3.1 ± 0.2 (2.9-3.7)	204.3 ± 15.3 (176-225)	65.9 ± 6.8 (53.2-75.5)
<i>G. assimilis</i>	3.9 ± 0.5 (2.9-4.6)	121.4 ± 8.8 (106-143)	32.1 ± 4.6 (26.7-44.0)
<i>G. brevicaudus</i>	2.7 ± 0.3 (2.2-3.3)	121.8 ± 6.6 (110-135)	46.1 ± 6.0 (38.5-61.4)
<i>G. cohni</i>	2.8 ± 0.2 (2.5-3.0)	124.2 ± 9.4 (116-140)	45.0 ± 3.0 (41.4-48.6)
<i>G. insularis</i>	3.2 ± 0.4 (2.6-3.6)	138.6 ± 7.1 (131-147)	43.9 ± 5.0 (38.1-50.4)
<i>G. integer</i>	3.2 ± 0.3 (2.8-4.1)	136.0 ± 11.8 (115-152)	41.7 ± 3.5 (33.1-46.1)
<i>G. lineaticeps</i>	3.4 ± 0.2 (3.0-3.9)	134.0 ± 8.9 (115-153)	40.0 ± 2.5 (33.3-46.0)
<i>G. pennsylvanicus</i>	4.3 ± 0.3 (3.8-4.9)	168.7 ± 10.9 (150-191)	39.8 ± 2.1 (35.3-42.8)
<i>G. veletis</i>	3.0 ± 0.2 (2.5-3.4)	131.9 ± 9.9 (116-156)	43.8 ± 3.2 (37.9-49.3)
<i>G. vocalis</i>	3.4 ± 0.2 (3.1-3.7)	143.0 ± 10.7 (116-164)	40.7 ± 1.8 (38.5-43.5)

Mexicali adjacent to Mexico 5, 43 km W Mexicali adjacent to Mexico 2. CALIFORNIA: Los Angeles Co., San Gabriel River, Long Beach; San Bernardino Co., Colton.

Habitat. — Weissman and Rentz (1977a) noted the feral nature of the species in Orange Co., but its usual association with human habitation. A population at Sierra Pinta Dunes is large and resides adjacent to an expansive, undisturbed sand dune many kilometers from any human dwelling.

Seasonal occurrence. — Adults probably present entire year, especially in warmer areas of Baja California; most numerous during summer.

Discussion. — All feral individuals had hind wings present (see Weissman and Rentz 1977a, Walker 1977, for a discussion of hind

TABLE 3. Characteristics of calling songs of western field crickets.

	Average chirp rate (per minute) (range) ^{1,2}	Usual number of P/C (range) ²	Range of pulse rate (per second) ¹
<i>A. domesticus</i>	100 (40-200)	2-3 (1-4)	14-18
<i>G. assimilis</i>	60 (25-100)	12-14 (11-17)	31-63
<i>G. brevicaudus</i>	130 (60-216)	4-5 (3-6)	20-33
<i>G. cohni</i>	1900 (1700-2200)	1 (1)	28-37
<i>G. integer</i>	1000 (700-1400)	3 (2-3)	43-70
<i>G. lineaticeps</i>	175 (80-300)	7-8 (6-10)	32-83
<i>G. pennsylvanicus</i>	110 (70-165)	4 (3-5)	16-23
<i>G. veletis</i>	150 (80-180)	3-5 (2-5)	20-33
<i>G. vocalis</i>	250 (150-420)	2-3 (2-4)	20-42

¹Some data from Maskel (1975)

²Temperature 25°C or lower; chirp rate varies directly with temperature although P/C are independent (except in *A. domesticus* — see text).

wing loss). The species is sold as bait and animal food in pet stores throughout California because it lacks any dormancy period and is easily raised.

Occasionally sympatric with *G. integer* (Mexicali, Sierra Pinta dunes) and *G. lineaticeps* (23 km W Mexicali, 33 km S Mexicali). *A. domesticus* has not penetrated far into Baja California or southern Florida (Walker pers. comm.), in spite of its seeming adaptability to warmer temperatures. For example, in southern California coastal areas, males are heard to sing in winter only on warm nights (> 21°C), in contrast to native *Gryllus* species which sing at cooler temperatures.

Gryllus assimilis (Fabricius)

Jamaican Field Cricket

- 1775 *Acheta assimilis* Fabricius, Syst. Ent. 280. Type locality: Jamaica, Montego Bay. Type lost, according to Alexander (1957).
- 1869 *Gryllus determinatus* Walker, Cat. Dermapt. Salt. Br. Mus., 1:19. Type localities: Jamaica; St. Vincent; San Domingo. Types (♂, ♀) in British Museum. New synonym. Types examined by RDA, 1963.
- 1869 *Gryllus contingens* Walker, *ibid.*: 21. Type localities: St. Vincent; Brazil. Types (♀) in British Museum. New synonym. Types examined by RDA, 1963.
- 1869 *Gryllus mundus* Walker, *ibid.*: 23. Type locality: Brazil. Type (♀) in British Museum. New synonym. Type examined by RDA, 1963.

Recognition characters and song. — (= *Gryllus* I of Rentz and Weissman 1981). Macropterous, medium to large size (16.0-24.0 mm); song unique with 11-17 P/C, average 80 C/M at 25°C (Fig. 8, Tables 1, 3).

Range. — (Fig. 1). West Indies, most parts of Mexico, probably into Central America, extreme southern parts of Arizona, southern Florida north to Lake Okeechobee, southern Texas in the vicinity of Brownsville. In the study area: Cape Region of Baja California north to Santa Barbara Co., California, including the California Channel Is. of Santa Catalina and Santa Cruz, east to Mexicali, Baja California Norte, usually at or near sea level.

Habitat. — North of San Diego Co., including the Channel Is., usually associated with water (salt and fresh water marshes, coastal beaches, irrigated fields, reservoirs) and usually found under vegetation. From Camp Pendleton, San Diego Co., and continuing south, individuals still associated with water but also found in cracks in dry grass fields.

Seasonal occurrence. — Most numerous late spring and summer; isolated individuals throughout year, especially in Baja California.

Variation. — WING LENGTH: 1 micropterous female reported from Santa Catalina Is. (Rentz and Weissman 1981) actually without hind wings. COLOR: body darker in coastal marsh areas when compared with more xeric inland sites. HEAD: circumocular area from mostly dark brown (as in Nickle and Walker 1975) to completely black.

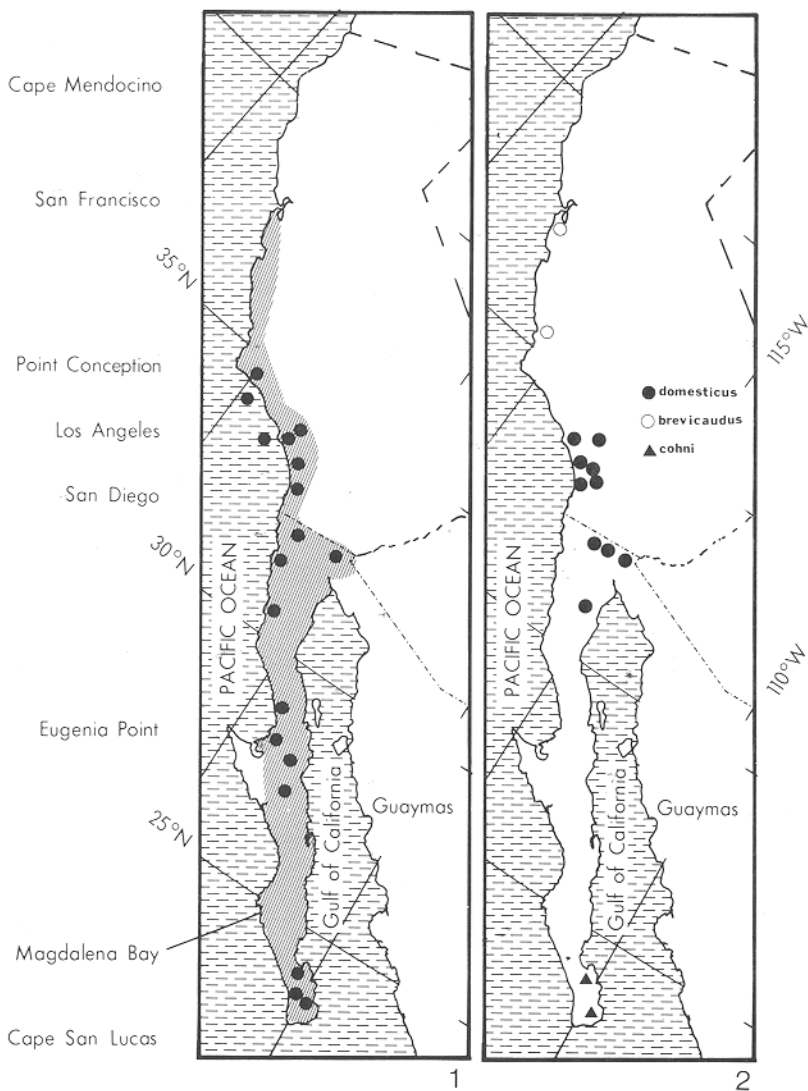


FIGURE 1. Collection localities of *G. assimilis* within the study area. Shaded area represents the study area covered by the Key.

FIGURE 2. Collection localities of *A. domesticus* (●), *G. breviceaudus* (○), and *G. cohni* (▲) within the study area.

Discussion. — Under favorable climatic regimes, including adequate precipitation, there appears to be no egg or nymph dormancy period (Alexander and Walker 1962). Sympatric with *G. vocalis* and *G. cohni* in moist areas; sympatric with *G. lineaticeps* and *G. integer* when away from moist conditions. Alexander and Walker (1962) note that individuals fly to lights at night in areas of Florida, a phenomenon not seen in our study area.

See Discussion and Table 5 for comments on the applicability of the name *G. assimilis* for western populations.

***Gryllus brevicaudus* Weissman, Rentz, and Alexander, n. sp.**

Short-Tailed Field Cricket

Recognition characters and song. — (= *Gryllus* VIII of Weissman and Rentz 1977b). Body and legs jet black, micropterous, small to medium (13.0-21.5 mm), ovipositor unique — length shorter to slightly longer than hind femur, tegmina unique in color with yellow tinge on lateral field near site of attachment (most noticeable *in situ*); song 3-6 P/C, average 150 C/M at 25°C (Fig. 9, Tables 1, 3).

Holotype. — Male, "CALIFORNIA: Santa Clara Co., Palo Alto, field at Foothill Expressway and Stanford Ave., 24 July 1974. David B. Weissman. Cal. Acad. Sci. Coll." Types deposited at CAS, #13219. Length of body, 16.7 mm; right tegmen removed, stridulatory file 2.5 mm long, 121 teeth.

Allotype. — Female, same data as holotype, similar to holotype. Length of body, 13.7 mm; length of hind femur, 9.4 mm; length of ovipositor, 8.1 mm.

Paratypes. — 9♂, 12♀, CAS; 3♂, 8♀, UMMZ. CALIFORNIA: San Mateo Co., 2♂, Stanford University's Jasper Ridge Biological Preserve, Area H, 21 iii 1970, D.B. Weissman; Santa Clara Co., 7♂, 12♀, same data as holotype; San Luis Obispo Co., 2♂, 8♀, San Luis Obispo, 14 v 1967 and 27 viii 1967, R.D. Alexander; 1♂, 1 km E Santa Margarita, 14 v 1967, R.D. Alexander.

Range. — (Fig. 2). Known only from type and paratype localities.

Habitat. — Cracks in grassy fields.

Seasonal occurrence. — Apparently overwinter as nymphs with first adults March until late summer.

Variation. — The San Luis Obispo Co. specimens average larger body size (♂ 20.4 mm vs 16.5 mm; ♀ 18.1 mm vs 14.6 mm), longer ovipositor (9.1 mm vs 8.5 mm), longer hind femur (♀ 9.7 mm vs 8.8 mm), and longer stridulatory file (3.1 mm vs 2.5 mm) than individuals from the type locality. Because the stridulatory files of both have approximately the same number of teeth, the average of teeth/mm is lower (40.1 vs 47.8) in specimens from San Luis Obispo Co. The specimens do agree in seasonal occurrence, calling song characteristics, relationship of ovipositor to hind femur length, and coloration pattern such that one species is apparently involved despite a 260 km distribution gap.

Discussion. — This species has the shortest ovipositor of any known *Gryllus* species, hence the origin of its name. Sympatric with *G. lineaticeps* and *G. integer*.

***Gryllus cohni* Weissman, n. sp.**

Baja Cape Field Cricket

Recognition characters and song. — Small to medium (14.9-21.0 mm), micropterous, endemic to the Cape region of Baja California, Mexico; song unique, an intermittent trill, at 25°C 1 P/C, 34 C/S, with series of chirps lasting 0.5-0.8 seconds, 0.1-0.2 second pause, and then repeated (Fig. 10A, Tables 1, 3). At higher temperatures (29°C), series of chirps of greater uniformity and longer duration (Fig. 10B) occur.

Holotype. — Male, "MEXICO: BAJA CALIFORNIA SUR, 0.5 km W Highway Km 8 sign W La Paz on Mex. Hwy 1, 16-vii-1978, D.B. Weissman, D. Lightfoot. Stop 59. Cal. Acad. Sci. Coll.". Types deposited at CAS, #13220. Length of body, 14.9 mm; right tegmen removed, stridulatory file 2.8 mm long, 119 teeth.

Allotype. — Female, same data as holotype, similar to holotype. Length of body 20.7 mm; length of hind femur, 11.4 mm; length of ovipositor, 12.5 mm.

Paratypes. — 4♂, 7♀, same data as holotype, except 1♂ 31 xii 1978 and 1♂ 21 v 1979, both D.B. Weissman; 1♂, Baja California Sur, first wash along road to Miraflores, off Mexico 1, 24 iv 1979, D.B. Weissman.

Derivation of name. — This cricket is named in honor of Dr. Theodore J. Cohn.

Range. — (Fig. 2). Known only from type and paratype localities.

Habitat. — Type locality is a woody, thickly vegetated, damp area of secondary growth along the highway. The Miraflores specimen was dug from cracked soil in a dry river bed.

Seasonal occurrence. — Adults recorded from December, April, and July. Very early instars, captured in April with an adult male in a wash near Miraflores, became adults in early to mid July.

Discussion. — Little is known about this species because of its recent recognition, quiet calling song, and propensity for areas of thick vegetation. At the type locality *G. cohni* is sympatric with only *G. assimilis*, a long winged species. Individuals of this new species were initially captured only because they were micropterous and no song of a short winged *Gryllus* was heard. The species has been heard elsewhere in the Cape region and is most easily captured by being attracted to oatmeal laid in clearings amongst the dense vegetation from which individuals are calling. This technique is apparently successful because males are mobile and sing from under vegetation — not from burrows. Oatmeal laid through colonies of any other *Gryllus* species in the study area might attract females, but rarely males, which appear to be more sedentary.

Females are consistently larger than males, a parameter unique to this species (Table 1). With the exception of small individuals, both sexes are morphologically inseparable from *G. lineaticeps*, a species which occurs in the Cape region but is not known to be sympatric with this species. The simultaneous occurrence of an adult male and very early instars in the wash near Miraflores very likely indicates the absence of an egg dormancy.

Gryllus insularis Scudder

Guadalupe Island Field Cricket

1876 *Gryllus insularis* Scudder, Proc. Bost. Soc. Nat. Hist., 18:268. Type locality: MEXICO: Guadalupe Island, Baja California; Type series (1♂, 2♀) in ANSP. Lectotype male here designated: "*G. insularis* Scudd. ms. Guadalupe, Pacific Ocean, Palmer, Scudder's type 1876. Red label, type 14068." Lectotype in ANSP. Length of body, 19.7 mm; right tegmen removed, stridulatory file 2.6 mm long, 131 teeth.

Recognition characters and song. — Known only from type locality, large (20.6-23.9 mm), visible portion of tegmina *in situ* less than 1/3 body length in ♀, less than 2/5 body length in ♂, ovipositor averages 20 mm in length; song unknown (Table 1).

Range. — (Fig. 3). Restricted to Guadalupe Is., 252 km W of the Baja California peninsula.

Habitat. — One adult ♂ taken 13 July, 1976, by V.F. Lee under rock on Twin Cinder Cones; one nymph taken near base camp. General habitat in both cases was volcanic substrate with some introduced ice plant (*Mesembryanthemum* spp.).

Seasonal occurrence. — Of 17 individuals collected 19-21 April (CAS), 9 were adult with some instars at least 3 molts from imago.

Variation. — *SIZE:* In comparison with 4 males at CAS, the type is considerably smaller (21.2-23.6 mm range for these 4 males), with a shorter file (3.3-3.6), fewer teeth (133-147), but considerably more teeth per mm (38.1-44.0). The 5 males agree in all other characters.

Discussion. — We have seen no other *Gryllus* species from Guadalupe Is.

Gryllus integer Scudder

Western Stutter-Trilling Cricket

1901 *Gryllus integer* Scudder, Psyche 9:267. Type locality: California; West Berkeley to San Diego. Type series (2♂, 3♀) in ANSP. Lectotype male here designated: "W. Berkeley, Calif., Aug. 20, 1897. S.H. Scudder coll. *Gr. integer*, Scudder's type 1901. Red label, type 14065." Specimen labeled Weissman and Rentz cotype #1. Lectotype in ANSP. Length of body, 18.8 mm; right tegmen removed, stridulatory file 3.2 mm long, 142 teeth.

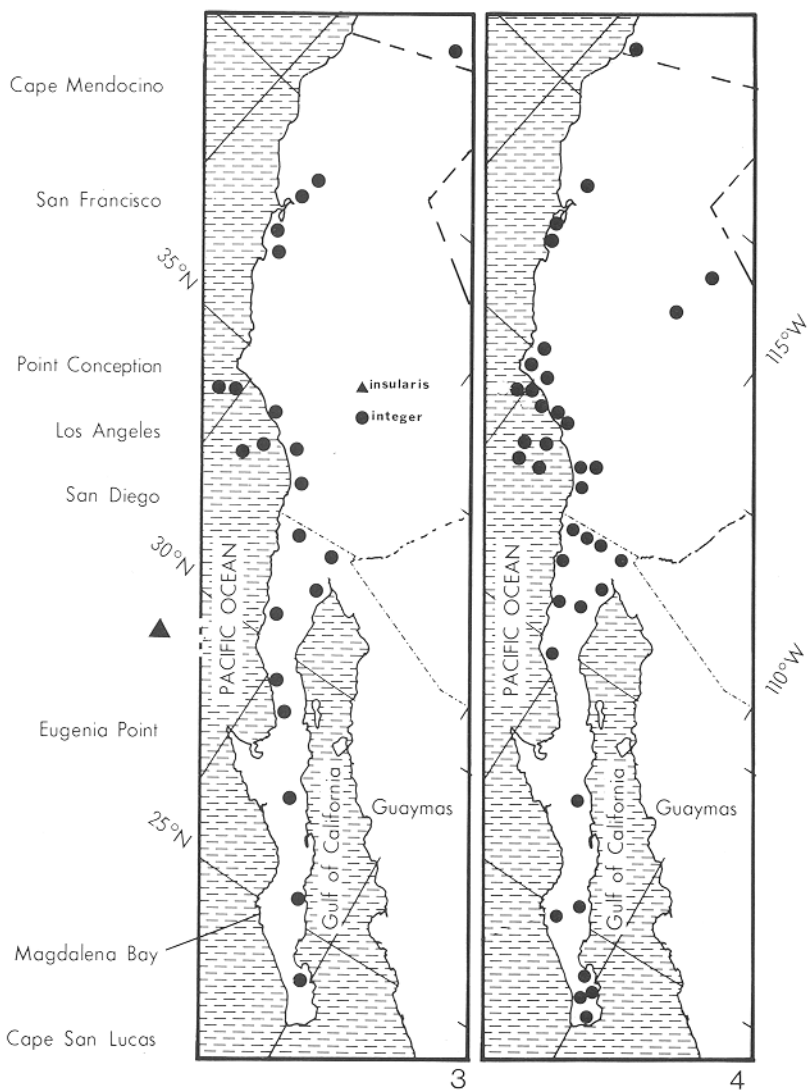


FIGURE 3. Collection localities of *G. integer* (●), and *G. insularis* (▲) within the study area.

FIGURE 4. Collection localities of *G. lineaticeps* within the study area.

Recognition characters and song. — (= *Gryllus* VI of Weissman and Rentz 1977b, Rentz and Weissman 1981).

Medium to large (17.1-24.0 mm), macropterous, head and pronotum jet black, tegmina light brown; song unique with 3 (rarely 2) P/C, 1000 C/M at 25°C (Fig. 11, Tables 1, 3).

Range. — (Fig. 3). Cape region of Baja California north to Berkeley, Marin Co., California, including the California Channel Is. of Santa Cruz, San Miguel, Santa Barbara, San Nicolas, northeast to Harney Co., Oregon, east to Mono and Inyo Co., California. Additional localities besides those in Weissman and Rentz (1977b) and Rentz and Weissman (1981) include MEXICO: numerous localities throughout Baja California peninsula most notably Baja California Sur: La Paz, Puerto Escondido; Baja California Norte: Mexicali, Colonia Guerrero, 68 km S El Rosario. CALIFORNIA: Mono Co., 5 km S Lee Vining, 1946 m; Inyo Co., 5 km W Lone Pine on Whitney Portal Rd; Yolo Co, Davis. OREGON: Harney Co., near Fields.

Habitat. — Usually associated with human habitation — cracks in fields near houses, watered lawns, gas stations, supermarkets, under building sidings, and occasionally in cracks some distance from dwellings (5 km S Lee Vining).

Seasonal occurrence. — Spring and summer peak abundance, adults probably any time of year, especially in Baja California.

Variation. — COLOR: hind femur variable in Baja California specimens; otherwise black. WING LENGTH: All 7 males from 5 km S. Lee Vining were without hind wings. SONG: Individuals show differences in duration of uninterrupted song (i.e. stutter-trilling) from 1 to every 20+ seconds, with southern California males generally having shorter uninterrupted periods than northern California specimens. We nevertheless believe one species is represented because of morphological and ecological similarities; because the same individual, as the evening passes (and the temperature drops?), may shorten considerably the duration of uninterrupted song; and because individuals that displayed a long uninterrupted period in the field, may shorten this interval once in the laboratory.

Discussion. — This species flies well, probably explaining its presence on the most isolated California Channel Is. and its

TABLE 4. Differences between eastern and western *G. pennsylvanicus* and *G. veletis*. Superscripts indicate appropriate literature reference to eastern species with legend at foot of table.

<i>G. pennsylvanicus</i>		Parameter	<i>G. veletis</i>	
Western	Eastern		Eastern	Western
fields	fields ¹	habitat	fields ¹	fields, damp areas
few nymphs, rock piles, burrows	many nymphs, few in borrowings ³	# nymphs, type of shelter	few nymphs, many in burrows ³	many nymphs, under vegetation, in burrows
±	yes ²	day chirpers?	yes ²	±
2?	1 ²	# generations per year	1 ²	1
all year	August-1st front ⁴	adults present	May-July ⁴	April-September
nymphs and eggs?	egg ²	overwintering stage	nymph ²	nymph
7/10	4/5 ¹	ovipositor/body length	2/3 ¹	2/3
variable, over 80% in some areas	4 ⁴	% macropterous	4 ⁴	0
169±11	162±9 ⁶	# teeth in file (range)	143±11 ⁶ (130-178)	132±10 (116-156)
3-5	3-7 ¹	pulses/chirp	3-5 ³ , 3-7 ¹	2-5
16-23 ⁵	24-29 ⁷	pulse rate	24-29 ⁷	20-33

¹ Alexander, 1957² Alexander, 1968³ Alexander and Bigelow, 1960⁴ Alexander and Meral, 1967⁵ Maskel, 1975⁶ Rakshpal, 1960⁷ Given in Alexander (1957) as *G. pennsylvanicus*. Could be that species of *G. veletis*.

tendency to come to lights at night. Nevertheless, its distribution is puzzling as calling individuals are rare, widely separated, and usually associated with human habitation, a pattern seen throughout its known 3400 km N-S range. Perhaps populations contain numerous silent males. The densest population was 5 km S Lee Vining, where all 7 captured males were without hind wings, a parameter of unknown significance. Occasionally sympatric with *G. assimilis*, *G. lineaticeps*, *G. veletis*, *G. brevicaudus*; rarely with *G. vocalis* and *G. pennsylvanicus* (both at 5 km W Lone Pine) and *A. domesticus* (Mexicali).

The remaining male and three females in the type series probably represent two species: *G. integer* (W. Berkeley, ♂, our cotype #2; W. Berkeley and "Cal.", 2 ♀, #3, 6); and *G. sp.*, possibly *assimilis* or *lineaticeps*, but possibly from outside study area as locality on label is "Cala." (♀, #5).

We have examined the type series of *G. armatus* Scudder (described in 1902) with type localities of Beaver Dam, Utah, and Ehrenberg and Fort Whipple, Arizona, and find the series probably includes 3 species, one of which may be *G. integer* (Arizona, ♂, our cotype #7). Additional specimens resemble *G. lineaticeps* (Utah, ♂, #5; ♀, #8; Arizona, ♂, #4) and an unrecognized species (Arizona, ♂, #6).

G. integer has been used incorrectly in the literature (Scudder 1902, Alexander 1968, Nickle and Walker 1975, Cade 1979) to represent an unnamed bivoltine species distributed from Texas and Oklahoma eastward to NW Florida, that RDA now believes does not extend into California.

Gryllus lineaticeps Stål

Variable Field Cricket

- 1858 *Gryllus lineaticeps* Stål, Kongl. Svensk. Freg. Resa, Zool., 1:314. Type locality: California; San Francisco. Type ♀ lost according to Alexander (1957). Neotype ♂ here designated: "California: Santa Clara Co., Palo Alto, Stanford University Campus, Lake Lagunita, 4-vii-1979. David B. Weissman. Calif. Acad. Sci. Coll." Neotype in CAS, #13221. Length of body, 23.7 mm; right tegmen removed, stridulatory file 3.9 mm long, 136 teeth.

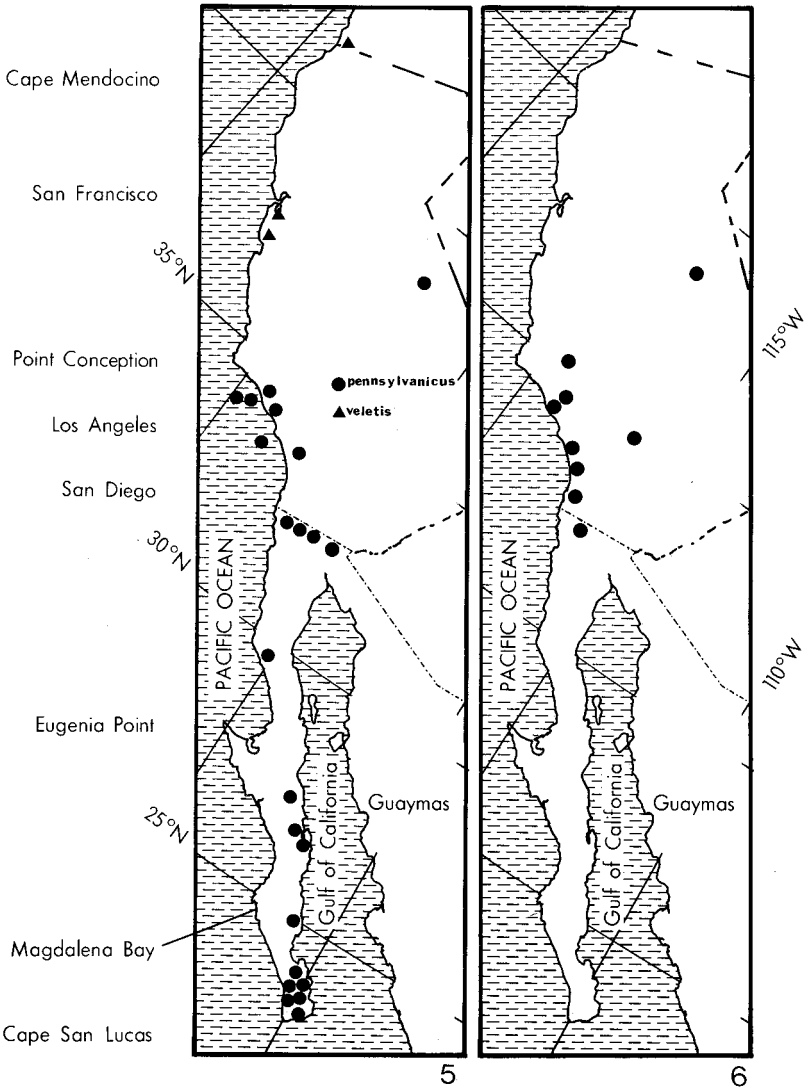


FIGURE 5. Collection localities of *G. pennsylvanicus* (●) and *G. veletis* (▲) within the study area.
 FIGURE 6. Collection localities of *G. vocalis* within the study area.

TABLE 5. Differences between eastern and western *G. assimilis*. Superscripts indicate appropriate literature reference to eastern species with legend at foot of table.

EASTERN	PARAMETER	WESTERN
Apparently recently introduced, geographically restricted, lawns, tropical fruit groves, large population size fluctuations ¹	ecology	Apparently not recently introduced, geographically widespread, not cosmopolitan, without large population size fluctuations.
120 ± 5 (114-128) ⁴	# teeth in file (range)	121 ± 9 (106-143)
113 ± 5 (102-121) ³		
8-9 ¹	pulses/chirp	11-17
90 ¹	pulse rate	31-63 ²

¹Alexander and Walker, 1962

²Maskel, 1975

³Nickle and Walker, 1975

⁴Rakshpal, 1960

Recognition characters and song. — (= *Gryllus* III of Weissman and Rentz 1977b; Rentz and Weissman 1981). Medium to large (16.0-26.0 mm), widespread and ecologically diverse, extremely variable morphologically; song unique with 6-10 P/C, average 200 C/M at 25°C (Fig. 12, Tables 1, 3).

Range. — (Fig. 4). Cape region of Baja California, Mexico, north through California, including all California Channel Is. except San Miguel, to Josephine Co., Oregon, east to Lone Pine, Inyo Co., California. Additional localities besides those in Weissman and Rentz (1977b) and Rentz and Weissman (1981) include MEXICO: numerous localities in Baja California, most notably Baja California Norte: Vallecitos meadow area, Sierra San Pedro Martir National Park, 2430 m. CALIFORNIA: Fresno Co., Coalinga; Yolo Co., Davis; Inyo Co., Lone Pine. OREGON: Josephine Co., Hugo.

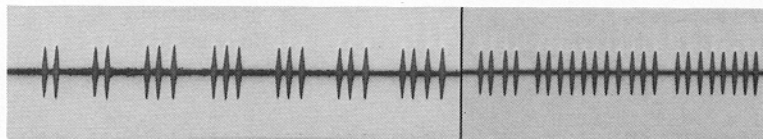
Habitat. — Extremely diverse, usually in cracks in grassland, chaparral, coastal sage, coastal strand, oak-woodland, and around human habitation.

Seasonal occurrence. — Most numerous in summer, some adult individuals present most of year, especially in Baja California.

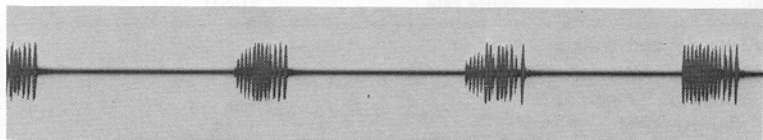
7 *A. domesticus*

(a) 20°

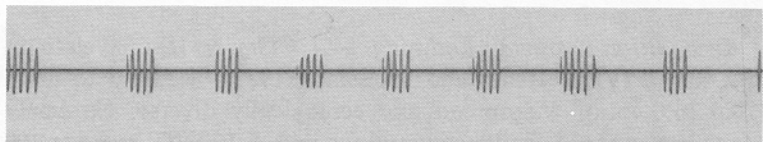
(b) 30°

8 *G. assimilis*

20°

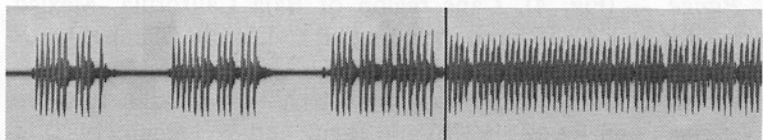
9 *G. brevicaudus*

24°

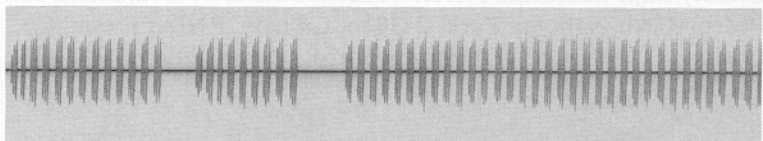
10 *G. cohni*

(a) 23.5°

(b) 29°

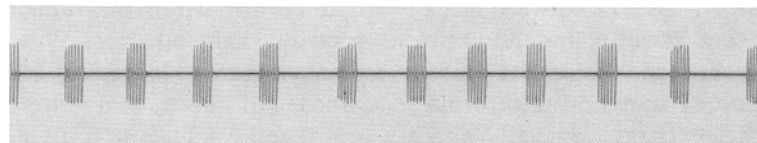
11 *G. integer*

25°

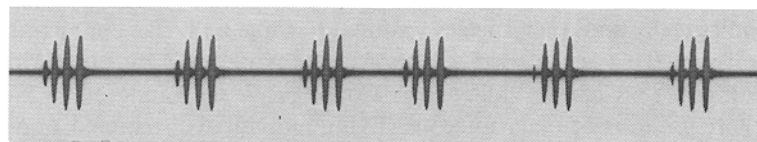


12 *G. lineaticeps*

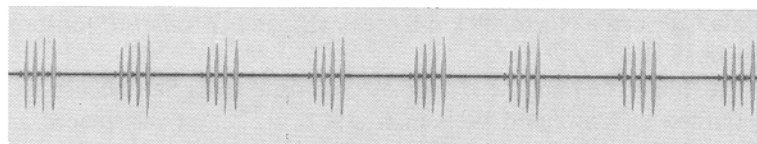
24°

13 *G. pennsylvanicus*

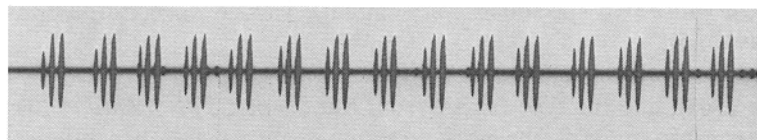
21°

14 *G. veletis*

21°

15 *G. vocalis*

22.7°



1 sec.

FIGURES 7-15. Oscillograms of field crickets (except *G. insularis*) from the study area. Specimens were from the following localities: 7, *A. domesticus* — Orange Co. A. male at 20°C with usual 2-3 P/C. B. Another male at 30°C with song tending towards a trill with 1 P/C. 8, *G. assimilis* — Santa Catalina Is. 9, *G. brevicaudus*-type locality; 10, *G. cohni*-type locality. A. Male at 23.5°C with chirp rate irregular, short series. B. Same male as in A. but now at 29°C with chirp rate more regular, longer series. 11, *G. integer* — Santa Clara Co.; Fig. 12, *G. lineaticeps* — Santa Clara Co.; 13, *G. pennsylvanicus* — Ventura Co.; 14, *G. veletis* — Santa Clara Co.; 15, *G. vocalis* — Orange Co.

Variation. — COLOR: body, pronotum, head, wings, and femur usually variable between black to red and brown within individuals at one locality; beach specimens generally light all over. WING LENGTH: most localities uniform for either short or long; 3 of 150 coastal southern California specimens of both sexes were macropterous, while all Vallecitos ($n = 4$) and Coalinga ($n = 10$) individuals were macropterous.

Discussion. — Our most ecologically diverse and morphologically variable species, although song and file characters uniform. This is the species responsible for periodic outbreaks in California's Central Valley (e.g. Coalinga — see Lindgren 1978) where millions of macropterous, flying individuals become a summer nuisance. Often sympatric with *G. pennsylvanicus*, *G. integer*, *G. brevicaudus*; rarely with *G. vocalis* (Lone Pine), *A. domesticus* (Baja California Norte, 89 km S Mexicali), and *G. veletis* (Stanford University).

The one male and one female of *Gryllus* V from San Nicolas Is. described in Rentz and Weissman (1981) are tentatively placed as aberrant individuals of this species. Repeated trips to that island in August, 1978, and May, 1979 (thus corresponding to the time of year those two specimens were caught), yielded no additional individuals.

The type female from New Mexico of *G. alogus* Rehn (described in 1903), and the type female from Kansas of *G. personatus* Uhler (described in 1864) (the latter now pinned but apparently previously preserved in alcohol), both deposited at ANSP, have been examined and both types fall within the morphological range displayed by the more than 230 specimens of *G. lineaticeps* at CAS. Synonymization is not now appropriate, though, because of the geographical disparities involved, and because *G. lineaticeps* is so morphologically variable, that selected individuals can resemble most other *Gryllus* species.

***Gryllus pennsylvanicus* Burmeister**

Fall Field Cricket

- 1838 *Gryllus pennsylvanicus* Burmeister, Handb. Ent., II, abth. II, pt. 1:734. Lectotype male from North America, designated by Alexander (1957) who lists complete synonymy. Type in Zoologische Museum, Humboldt-Universität zu Berlin.

Recognition characters and song. — (= *Gryllus* II of Rentz and Weissman 1981). Medium to large size (18.4-26.2 mm), generally micropterous, stridulatory file unique for *Gryllus* species in the study area, always with more than 150 teeth; song with 3-5 P/C, 16-23 P/S, average 110 C/M at 25°C (Fig. 13, Tables 1, 2, 3).

Range. — (Fig. 5). Nova Scotia south to Virginia and in a ragged line diagonally to northern Georgia, westward and southward to the Mexican border in western Texas; west to the Rockies and California and north, far into Canada (Alexander 1968). In the study area: Cape region of Baja California, Mexico, north to Santa Barbara Co., California, including the California Channel Is. of Anacapa, Santa Catalina, Santa Cruz, northeast to Inyo Co., from sea level to over 2600 m. Additional localities besides those in Rentz and Weissman (1981) include MEXICO: numerous localities in Baja California, most notably Baja California Norte: La Rumorosa, 10 v 1978, 1280 m; Baja California Sur: La Laguna Mts., 21 vii 1978, 1824 m; San Jose del Cabo, 23 vii 1978. CALIFORNIA: Inyo Co., 18 km W Lone Pine on Whitney Portal Rd., 6 viii 1978, 2280 m.

Habitat. — Under rocks especially in dry river beds, less frequently in cracks in chaparral and areas of scrub vegetation.

Seasonal occurrence. — Adults most numerous in summer, isolated individuals throughout year, especially in Baja California.

Variation. — WING LENGTH: always micropterous (40♂, 8♀) in southern California; 5 of 6 ♂ from Inyo Co., were macropterous; 3 of 10 ♂ from San Ignacio, Baja California Sur were macropterous. Only macropterous ♀ known is from Puerto Escondido, Baja California Sur.

Discussion. — Often sympatric with *G. lineaticeps*, rarely, as in town of Lone Pine, Inyo Co., with *G. vocalis* and *G. integer*. Sympatric throughout its eastern range with *G. veletis*, except in Nova Scotia (Alexander and Bigelow 1960).

See Discussion and Table 4 for comments on the applicability of the name *G. pennsylvanicus* for these western populations.

***Gryllus veletis* (Alexander and Bigelow)**

Spring Field Cricket

1960 *Acheta veletis* Alexander and Bigelow, Evolution 14:335. Type locality: Illinois, Piatt Co. Type (♂) in UMMZ.

Recognition characters and song. — (*Gryllus* VII of Weissman and Rentz 1977b). Northern California, spring adults, dark, micropterous, small to medium (13.0-19.5 mm); song with 2-4 P/C, 12-16 P/S, average 120 C/M at 25°C (Fig. 14 and Tables 1, 3).

Range. — (Fig. 5). East of the Great Plains, southward to New Jersey and Maryland along the Atlantic Coast, and to about 34° N in northern Georgia. West of the Great Plains, from Canada to central Mexico (Alexander and Bigelow 1960, Alexander 1968). In the study area: Santa Cruz Co., California north to Josephine Co., Oregon. Additional localities besides those in Weissman and Rentz (1977b) include CALIFORNIA: Santa Cruz Co., U.C. Santa Cruz campus, 16 vii 1977. OREGON: Josephine Co., 3.6 km SE Hugo, 25 vi 1978.

Habitat. — In cracks in the ground and under prostrate vegetation along banks of lakes and streams, in redwood litter. Oregon individuals were in cracks in grassy fields.

Seasonal occurrence. — Overwinter as nymphs with first adults early spring, peak levels late spring, and stragglers through September (Palo Alto, Santa Clara Co., California).

Discussion. — Sympatric with *G. integer* and *G. lineaticeps*. Sympatric throughout its eastern U.S. range with *G. pennsylvanicus* (Alexander and Bigelow 1960).

See Discussion and Table 4 for comments on the applicability of the name *G. veletis* for the western populations.

G. vocalis has many morphological and song characteristics in common with *G. veletis*, such that the latter may actually represent small individuals of the former. The two forms are not sympatric, with a minimum separation of some 480 km in the study area (although only 360 km from Santa Cruz to Lone Pine, Inyo Co.).

***Gryllus vocalis* Scudder**

Vocal Field Cricket

1901 *Gryllus vocalis* Scudder, Psyche 9:267. Type locality: California; Palm Springs and Los Angeles. Type series (2♂, 1♀) in ANSP. Lectotype male here designated: "L. Angeles, Calif., July 29, 1897. *Gr. vocalis*, Scudder's

type 1901. Red type label, type 14070." Specimen labeled Weissman and Rentz cotype #8. Lectotype in ANSP. Length of body, 20.0 mm; right tegmen removed, stridulatory file 3.5 mm long, 139 teeth.

Recognition characters and song. — (= *Gryllus* IV of Rentz and Weissman 1981). Southern California, dark, micropterous, small to medium (15.5-21.4 mm), locally common species; song with 2-3 P/C, 25-42 P/S, average 220 C/M at 25°C (Fig. 15, Tables 1, 3).

Range. — (Fig. 6). Northern Baja California, Mexico, north to Los Angeles Co., California, along the coast, inland to Inyo, Kern, and Riverside Co. Additional localities besides those in Rentz and Weissman (1981) include MEXICO: Baja California Norte: Tecate, 13 v 1978. CALIFORNIA: Riverside Co., Whitewater Canyon near Palm Springs, 1 iv 1978; Orange Co., Orange, 9 iv to 7 ix 1978; Inyo Co., Lone Pine, 5 viii 1978, 1064 m; Kern Co., Frazier Park, 12 vi 1978. The species was not found on Santa Catalina Is., contra Caudell (1908).

Habitat. — Usually associated with verdant vegetation and moist ground in salt water marshes, along streams, in gardens. Usually under vegetation but occasional individuals in cracks in ground, which are typically absent in moist habitats.

Seasonal occurrence. — Peak adult abundance, at lower altitudes, in spring and early summer, with occasional August and September individuals; individuals from higher elevations mature in summer.

Variation. — WING LENGTH: Single specimen (♂) from Lone Pine was macropterous; all 45 remaining individuals short winged.

Discussion. — Frequently sympatric with *G. assimilis* and rarely (at Lone Pine) with both *G. integer* and *G. pennsylvanicus*.

In areas of southern California that are either naturally (e.g. marshes) or artificially moist, this species may have two generations — a more numerous widespread spring generation, ending in early summer, with a smaller, restricted summer generation, associated with water. The remaining male (Palm Springs, our cotype #9) and female (Palm Springs, #4) in the type series are probably *G. lineaticeps*.

DISCUSSION

This paper documents the existence of 9 *Gryllus* species in California and Baja California, an area of less than 200,000 km², and emphasizes the diversity of the group in the west when compared with only 8 known eastern species from an area some 15 times larger. Also, RDA is aware of at least an additional 5 undescribed western U.S. taxa. There are localities in California where 4 *Gryllus* species can be heard simultaneously during summer nights.

Life histories, including dormancy stages, are not well understood in the study area and undoubtedly vary geographically. Adults of all the *Gryllus* species (*assimilis*, *cohnii*, *integer*, *lineaticeps*, *pennsylvanicus*) of the Cape region of Baja California, have been found during visits in January, April, July, and August, perhaps indicating continuous generations without any dormancy period. Of southern California species, only *G. assimilis*, and perhaps *lineaticeps* and *pennsylvanicus*, can be heard throughout the year. In the San Francisco Bay area, by contrast, no singing adults are heard in mid-winter.

Three eastern species, (*assimilis*, *pennsylvanicus*, and *veletis*) are found within the study area. We only have serious reservations about the use of the last 2 names. RDA's trips throughout the country have demonstrated that similar sounding and appearing members of this complex occur across the U.S. north into Canada and west into Washington, Oregon, and California. But there are disturbing differences between eastern *G. pennsylvanicus* and *veletis* as described in the literature and what is known about the complex in the study area (Table 4).

At this time it seems reasonable to apply the names *pennsylvanicus* and *veletis*, within this study area, to the forms herein discussed. Regardless of what these forms may prove to be, the two possess uniform characters throughout our study area. Researchers are urged to publish collection localities when discussing aspects of these taxa in the west since they may eventually prove to be different from the eastern U.S. species.

There are also some differences between published data on eastern *G. assimilis* and those populations of the west. Such

discrepancies (Table 5) may be due to the small size of the samples or recent colonization of the south-eastern U.S., rather than actual specific differences. Nevertheless, further investigations are required, including determination of its distribution in mainland Mexico to see if a genetically continuous population exists across the U.S.

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