

Introduced Species of Mole Crickets in the United States, Puerto Rico, and the Virgin Islands (Orthoptera: Gryllotalpidae)

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ABSTRACT Seven species of mole crickets have been introduced accidentally into the United States (including Hawaii), Puerto Rico, and the Virgin Islands. Five species have been introduced into the United States: *Gryllotalpa africana* Palisot de Beauvois, *G. gryllotalpa* L., *Scapteriscus abbreviatus* Scudder (also introduced into Puerto Rico and the Virgin Islands), *S. acletus* Rehn and Hebard, and *S. vicinus* Scudder. Two other species have been introduced into Puerto Rico: *S. didactylus* (Latreille) and *S. imitatus* Nickle and Castner, a new species described herein. These species have been implicated as pests of agricultural crops, turf, and pasture grass. Finding the homelands of these species is an important first step in locating potential natural enemies that may ultimately resolve the problems associated with mole crickets.

MOLE CRICKETS are burrowing insects with forelegs highly modified for digging. In the United States, Puerto Rico, and the Virgin Islands, several species have been implicated as agricultural pests of vegetable crop seedlings, turf, and pasture grass (Wolcott 1948, USDA 1974, Ulagaraj 1975, Walker and Ngo 1982). As soil inhabitants, they are easily overlooked by man, and several species have been introduced undetected into new areas via commerce. Recently, Walker and Nickle (1981) demonstrated that three species of *Scapteriscus* were introduced into the United States around the turn of the twentieth century and became established in several southern states.

There are basically three kinds of mole crickets: two-, three-, and four-clawed. The "claws" refer to the number of dactyls or digging claws present on the enlarged, flattened foretibia. Two-clawed mole crickets belong to the genus *Scapteriscus*, of which all but two are neotropical in origin. Three-clawed mole crickets are represented by the relict genus *Triamescapter*, with a single species known only from New Zealand (Tindale 1928). The four-clawed mole crickets are distributed worldwide, with 35 species assigned to three genera, *Gryllotalpella*, *Neocurtilla*, and *Gryllotalpa*.

During the course of revising the genus *Scapteriscus*, one of us (D.A.N.) determined that four species of *Scapteriscus* and two species of *Gryllotalpa* became established in various regions of the United States, Puerto Rico, and the Virgin Islands within the last 100 years. Some of these

species have also been introduced into areas of South America beyond their normal range. In addition, during a field study of Puerto Rican mole crickets, one of us (JLC) found behavioral differences in a population of mole crickets which subsequently proved to be an undescribed species of *Scapteriscus*, which was also accidentally introduced by man. Actually, James A. Reinert of the University of Florida's Fort Lauderdale Agricultural Research Center was the first to note the presence of two long-winged species of *Scapteriscus* in Puerto Rico. In June 1981, he called attention to the presence of specimens resembling *acletus* (the undescribed species) and of others resembling *vicinus* (here treated as *didactylus*).

Presently there is no economical method of controlling mole crickets in the United States. Because all pest species have been introduced presumably without their complement of natural enemies, finding the localities of origin of these species is an important first step in developing a biological control program that may ultimately resolve mole cricket problems in the United States and its territories. This paper summarizes current knowledge about the sources of these introduced mole crickets and provides distribution and identification aids for these species. The new species from Puerto Rico is also described and discussed.

The seven species of introduced mole crickets include two species of *Gryllotalpa* and five species of *Scapteriscus*. The following key, which facilitates identification of both introduced and native mole cricket species, is based exclusively on morphology, but differences in the calling songs of males are also useful in species recognition (Table 1).

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Table 1. Calling songs of introduced species of mole crickets in the United States, Puerto Rico, and the Virgin Islands. Values in general are consistent with those reported by Forrest (1983)

Species	Song	Temp (°C)	Pulse rate (pulses/s)	Frequency (kHz)
<i>Gryllotalpa africana</i> (Hawaiian recording, courtesy D. Otte, ANSP)	Trill	10	56	3.3
<i>Gryllotalpa gryllotalpa</i>	Trill	21	40	1.6
<i>Scapteriscus acletus</i>	Trill	26	55	2.6
<i>Scapteriscus vicinus</i>	Trill	26	136	3.2
<i>Scapteriscus didactylus</i>	Trill	26	66	3.2
<i>Scapteriscus imitatus</i>	Trill	26	59	4.3
<i>Scapteriscus abbreviatus</i>	No calling song is known, but males produce a close-range courtship song (T. J. Walker, personal communication)			

Key to the Mole Crickets in the United States, Puerto Rico, and the Virgin Islands

- 1. Four dactyls on foretibia. Hindfemur longer than pronotum. Base of forefemur bearing a short bladeless process. Foretrochanter with or without a minute process (*Gryllotalpa* and *Neocurtilla*) 2
 - Two dactyls on foretibia. Hindfemur shorter than pronotum. Forefemur lacking a basal process. Foretrochanter bearing a long process with a sharp ventral blade (*Scapteriscus*, all species introduced from South America) 6
 - 2(1). Apex of hindtibia armed with 8 spines, 4 long medials and 4 shorter laterals (Fig. 1); forefemur bearing a short, nearly semicircular process armed with stout setae (Fig. 3); foretrochanter not produced beneath forefemoral process ...
 - *Neocurtilla hexadactyla* (Perty), northern mole cricket (a native species throughout North America)
 - Apex of hindtibia armed with 7 spines, 3 long medials and 4 shorter laterals (Fig. 2); process of forefemur knife-shaped, curved, acute (Fig. 4); foretrochanter produced beneath forefemoral process; *Gryllotalpa* (2 native, 2 introduced species) 3
 - 3(2). Dorsomedial margin of hindtibia unarmed
 - *major* Saussure, giant mole cricket (native species in the United States)
 - Dorsomedial margin of hindtibia armed with 5 spines 4
 - 4(3). Ocelli small (<50 mm), nearly circular; ocellar-ocular distance greater than ocellar length. Large species (35-40 mm)
 - *gryllotalpa* (L.), European mole cricket [introduced species into eastern United States]
 - Ocelli large (>50 mm), elliptical; ocellar-ocular distance less than ocellar length. Smaller species (<35 mm) 5
 - 5(4). Intercellar distance less than ocellar length. Species from southwestern United States
 - *cultriger* Uhler, knife mole cricket [native species]
 - Intercellar distance greater than ocellar length ... *africana* Palisot de Beauvois, African mole cricket (introduced species in Hawaii)
 - 6(1). Tibial dactyls widely separated, by more than 0.30 mm 7
 - Tibial dactyls narrowly separated, by less than 0.30 mm 9
 - 7(6). Tegmen short, extending over no more than one-third the length of abdomen. Hindwings vestigial. Ocelli small (0.1-0.3 mm), circular; interocellar distance about 5× diameter of ocellus
 - *abbreviatus* Scudder, short-winged mole cricket
 - Tegmen long, nearly reaching apex of abdomen. Hindwings extending beyond apex of tegmen in repose. Ocelli moderately large (ca. 0.4 mm), elliptical; interocellar distance about 2× as long as greater length of ocellus 8
 - 8(7). In dorsal view, pronotum uniformly dark brown with 4 small pale dots forming the corners of a trapezoid
 - *acletus* Rehn and Hebard (4-dot form), southern mole cricket
 - In dorsal view, pronotum mottled, the 4 light dots much enlarged and open-sided, contiguous with light colored lateral lobes of pronotum
 - *acletus* Rehn and Hebard (mottled form)
 - 9(6). Interdactyl distance very narrow (0.05-0.15 mm), dactyls nearly touching. Ocelli less than 0.5 mm in length, nearly circular; interocellar distance ca. 1.13 mm, ca. 2.5× as wide as length of ocellus *vicinus* Scudder, tawny mole cricket
 - Interdactyl distance not as narrow (0.15-0.30 mm). Ocelli larger (0.5-0.7 mm),

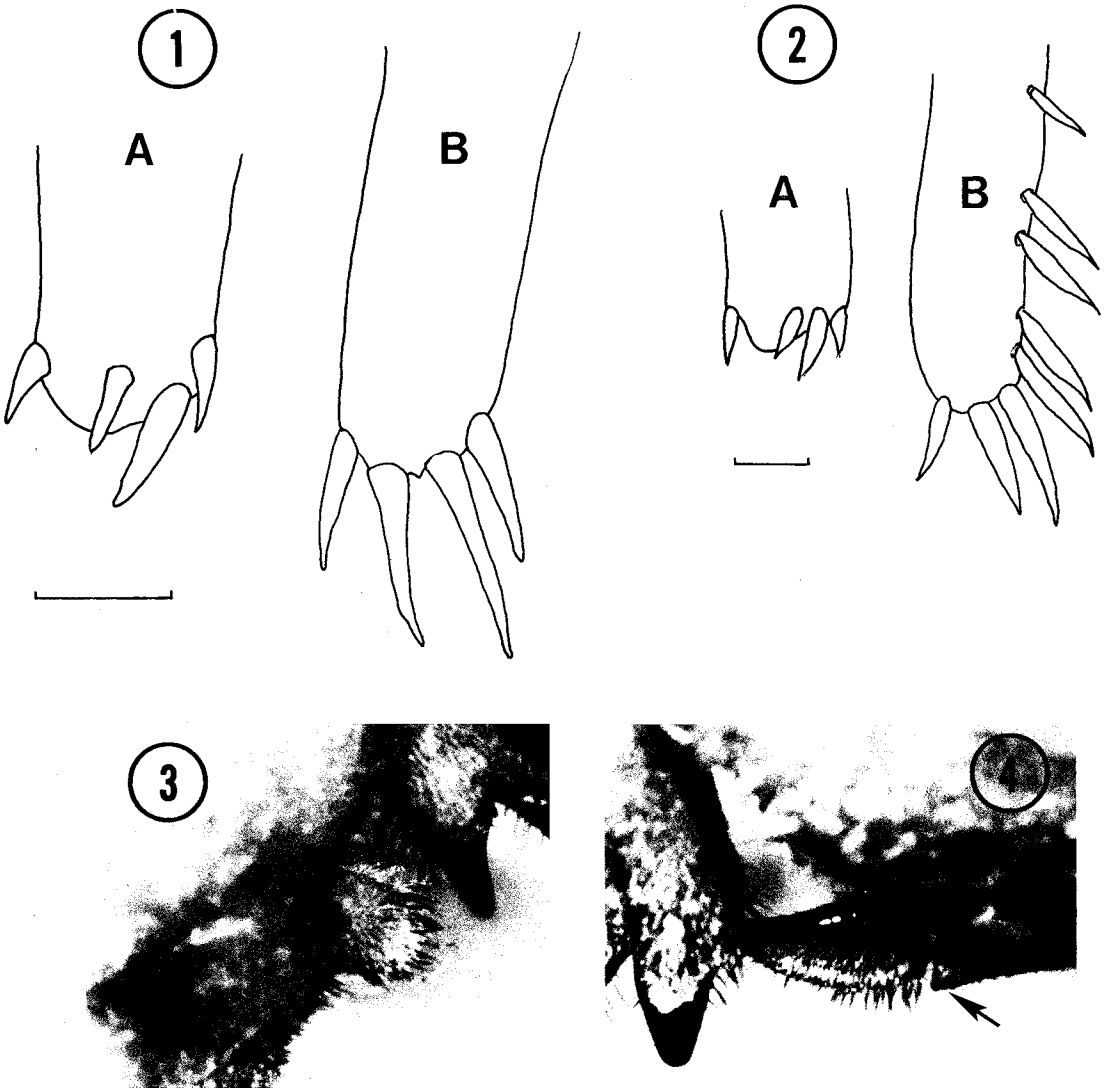


Fig. 1-4. Morphological features of *Neocurtila hexadactyla* compared with species of *Gryllotalpa*. Fig. 1-2. Apex of hindtibia. (A) lateral view, (B) medial view; 1. *N. hexadactyla*. 2. *G. gryllotalpa*. Fig. 3-4. Right forefemur, medial view: 3. *N. hexadactyla*, 4. *G. gryllotalpa*; arrow indicates foretrochanter produced beneath forefemoral process.

elliptical; interocellar distance 0.8-1.2 mm but less than 2x as wide as length of ocellus

- 10(9). Color pattern of pronotum and hindfemur distinctive (Fig. 5A, B). Ocellar length about 0.65 mm; interocellar distance greater than 1.0 mm and interocellar distance usually greater than 2.2 mm *didactylus* (Latreille), changa mole cricket

Color pattern of pronotum and hindfemur distinctive (Fig. 5A, B). Ocellar length usually less than 0.6 mm; interocellar distance less than 1.0 mm and

interocellar distance seldom exceeding 2.0 mm

- *imitatus* Nickle and Castner, new species, imitator mole cricket

The depositories for specimens examined in this study are abbreviated as follows: American Museum of Natural History, New York, N.Y. (AMNH); Academy of Natural Sciences of Philadelphia, Philadelphia, Pa. (ANSP); Florida State Collection of Arthropods, Division of Plant Industry, Gainesville, Fla. (FSCA); Instituto de Zoologia Agricola, Universidad Central de Venezuela, Maracay, Venezuela (IZAV); Instituto Miguel Lillo, Tucuman,

Table 2. APHIS-PPQ records of interceptions of the African mole cricket, *Gryllotalpa africana* Palisot de Beauvois, in United States ports of entry, 1963-1981

| Year | No. of interceptions | Origin of interceptions | Source of interception | Port of entry |
|-----------|----------------------|--------------------------------------|---|------------------------|
| 1963 | 1 | Japan | Cargo (aircraft parts) | HI |
| 1965 | 1 | Korea | Mailbag | WA |
| 1966 | 1 | Vietnam | Cargo | CA |
| 1967 | 1 | Vietnam | In aircraft | AK |
| 1968 | 26 | Asia, Italy, Philippines, Singapore | In aircraft cargo (with <i>Vitus</i> sp. grape seedlings) | AK, CA, DE, HI, NY, WA |
| 1969 | 24 | Japan, Okinawa, Philippines | Aircraft, cargo, baggage, mail | AK, CA, DE, HI, WA |
| 1970 | 9 | Japan, Thailand | Aircraft, mail | AK, CA, HI |
| 1971 | 22 | Japan, Okinawa, Philippines, Vietnam | Aircraft, cargo, mail | AK, CA, HI, WA |
| 1972 | 20 | Japan, Okinawa, Philippines, Vietnam | Aircraft, cargo | AK, HI, WA |
| 1973-1975 | 7 | Korea, Pakistan, Philippines | Mail, <i>Pinus</i> sp. seedlings | AK, CA, TX, WA |
| 1976 | 2 | People's Republic of China | Cargo | AK, WA |
| 1977 | 2 | Ivory Coast | <i>Ficus</i> sp. | NY, WA |
| 1978-1981 | | No interceptions reported | | |

Argentina (LIL); Museo Nacional de La Plata, La Plata, Argentina (LP); Instituto Biología, U. F. R. R. J., Serepedica, Brazil (SB); Museo Nacional, Rio de Janeiro, Brazil (RIO); Zoölogische Staatssammlung, Munich, W. Germany (MUN); Museum National d'Histoire Naturelle, Paris, France (PARIS); and the personal collection of Dr. Carlos Campos Seabra, Rio de Janeiro, Brazil (SEA). The specimens from the National Museum of Natural History, Washington, D.C., are identified as NMNH.

***Gryllotalpa africana* Palisot de Beauvois,
African Mole Cricket
(Fig. 11)**

This species has been intercepted by APHIS-PPQ repeatedly in various ports since 1961 (USDA 1974, APHIS-PPQ files to 1981). Although it has not become established in the continental United States, it is considered a potential major pest. Table 2 lists APHIS-PPQ records of interceptions of this species from 1963 to 1981. Although most involve stowaways in military transports during the Vietnam war (1968-1972), there are three records of its association with rooted plant material (*Vitis* sp., *Pinus* sp., and *Ficus* sp.). It was introduced into Hawaii late in the nineteenth century (Van Dine 1904), probably in nursery stock from southern China (Terry 1910, Swezey 1918). Its broad distribution, which has been described as including southern Europe, Africa, southern Asia, Japan, several Pacific Islands, and Australia, possibly represents range extension involving stowaway mole crickets transported in commerce at a time predating quarantine and plant protection safeguards. However, there is growing evidence to suggest that

africana may be a complex of several sibling species. Otte and Alexander (1983) recently described a new species *monanka* and regard all previous Australian records of *africana* to be *monanka*. Until more is known about the mole cricket in Hawaii, the possibility exists that this species may be incorrectly named.

***Gryllotalpa gryllotalpa* L.,
European Mole Cricket
(Fig. 11)**

The European mole cricket, *Gryllotalpa gryllotalpa* L., was introduced from Europe into the United States about 1913 (Weiss 1916). Sasser (1916) and Weiss and Dickerson (1918) determined that the original introduction of this species was in nursery stock from Holland and Belgium. For some time it was restricted to a nursery in Rutherford, N.J., but new populations were found in Massachusetts (Morse 1920), possibly Florida (a single ♀ specimen collected in Belle Glade, Florida, V-21-1924 [FSCA]), and eastern New York (specimens in NMNH Collection). It apparently was introduced successfully only one time, although it was intercepted again in 1919 in Pennsylvania in soil surrounding root stock of azaleas.

***Scapteriscus abbreviatus* Scudder,
Short-winged Mole Cricket
(Fig. 12)**

The history of the dispersal of this species is perhaps the most complicated of all the mole crickets. *Scapteriscus abbreviatus* has been collected in the United States (Florida and Georgia),

ABBREVIATUS

ACLETUS

FOUR-DOT

ACLETUS

MOTTLED

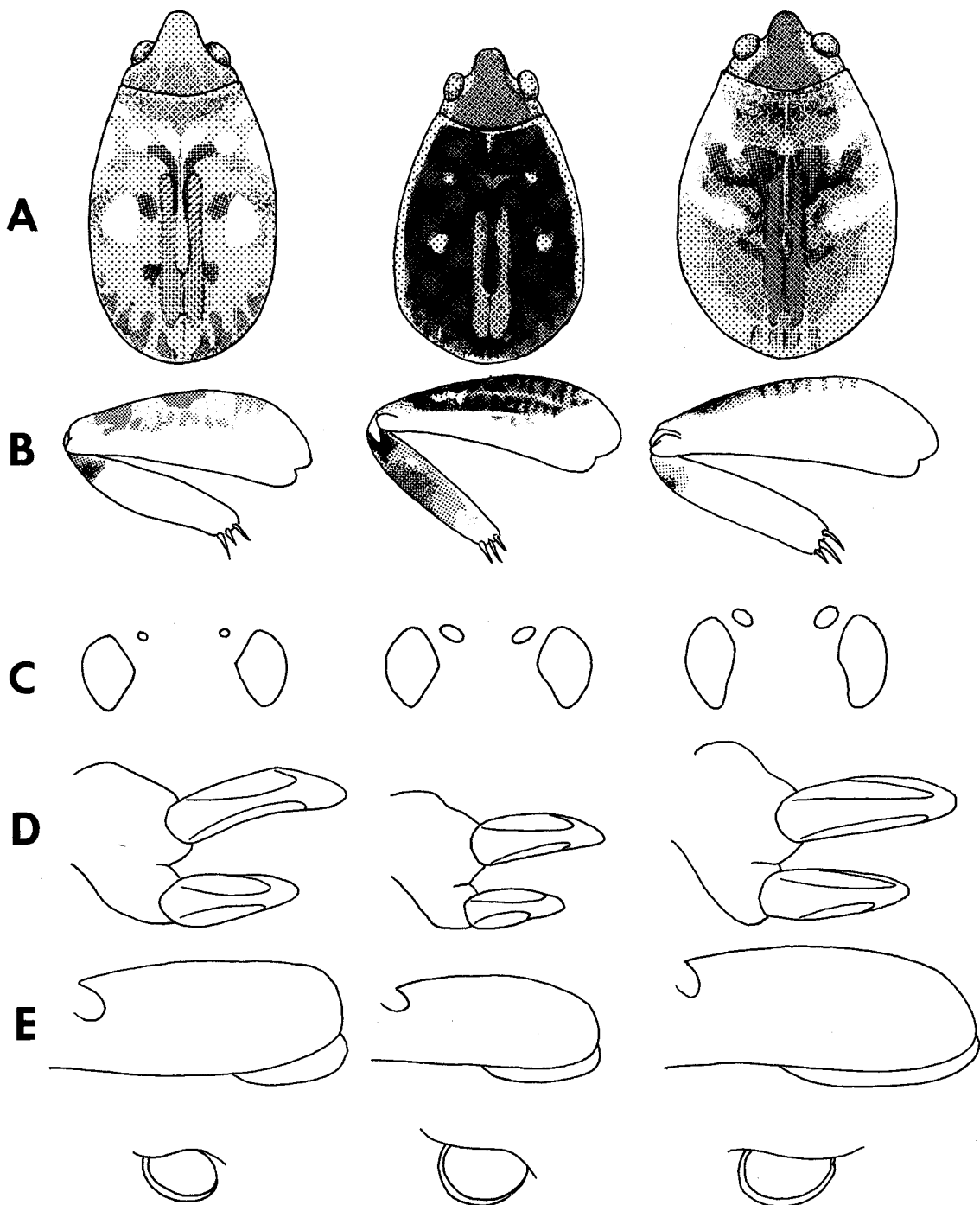
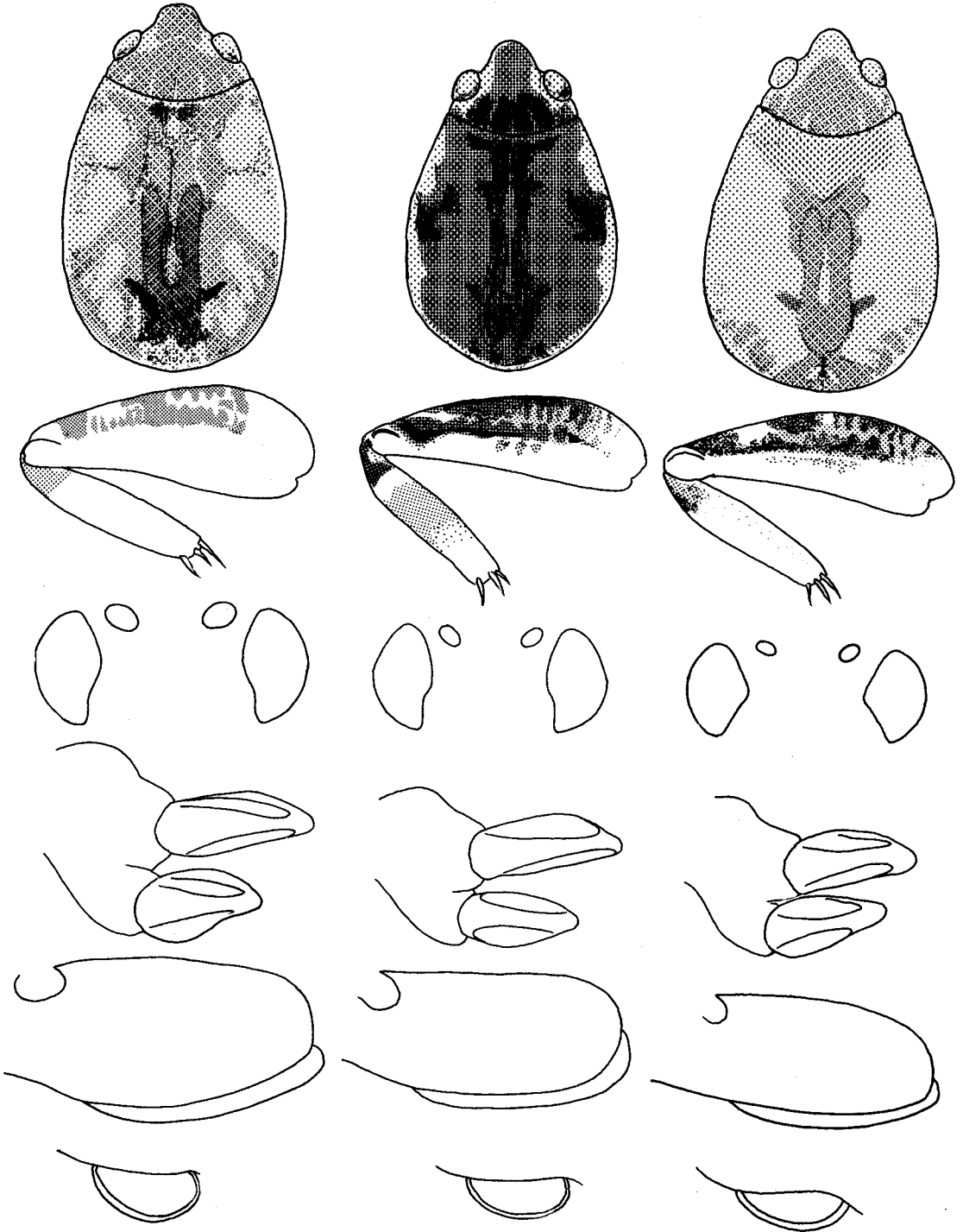


Fig. 5. Morphological features of *Scapteriscus* species of mole crickets in the United States, Puerto Rico, and the Virgin Islands. (A) Color pattern of head and pronotum, dorsal view. (B) Color pattern of hindfemur and tibia, left lateral view. (C) Spatial arrangement of ocelli and compound eyes, frontal view. (D) Tibial dactyls of left

DIDACTYLUS

IMITATUS

VICINUS



foreleg, anterior view. (E) Foretrochanter and blade of trochanter, anterior view. (F) Tympanum on right foretibia, showing degree of exposure in dorsal view.

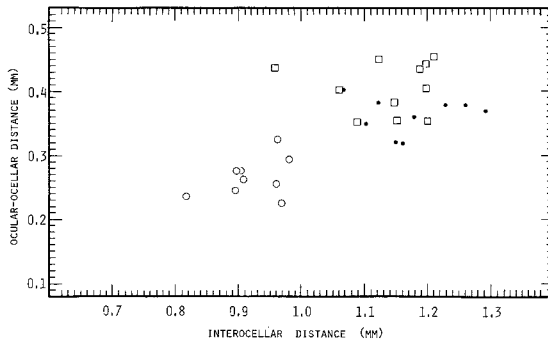
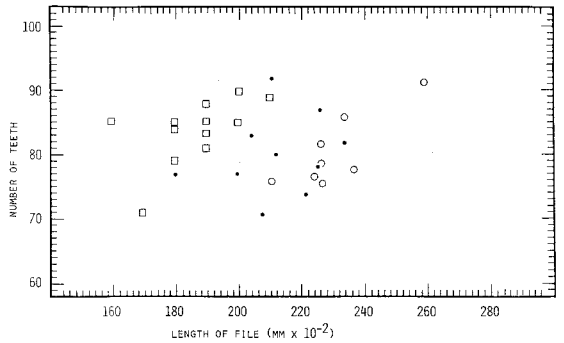
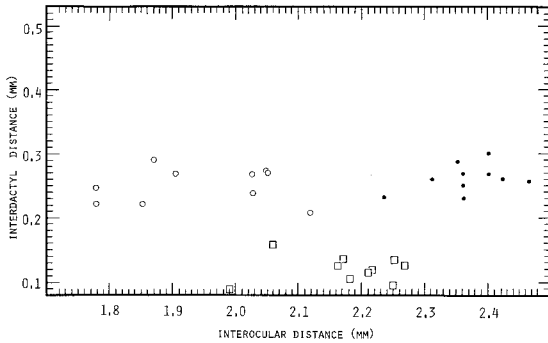
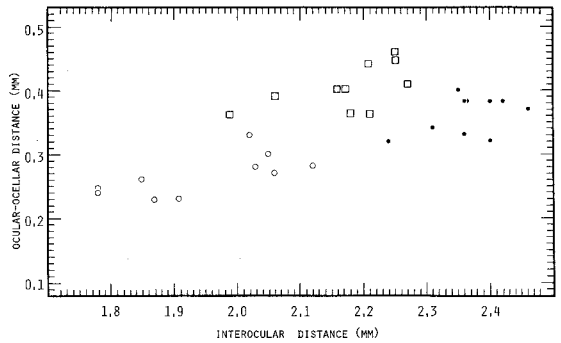
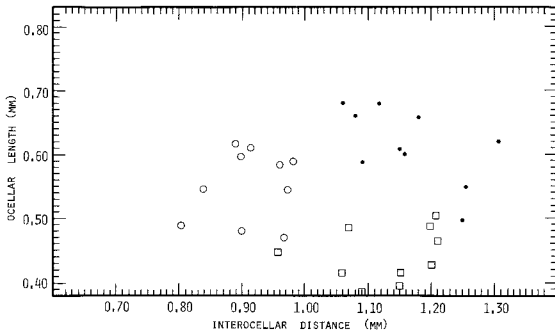


Fig. 6-10. Scatter diagrams of morphological features of *Scapteriscus* species. Means of plotted values are listed in Table 4. Symbols for species are as follows: *didactylus* (●), *imitatus* (○), *vicinus* (□). Values are expressed in mm. Fig. 6. Ocellar length vs. interocular distance. Fig. 7. Interdactyl distance vs. interocular distance. Fig. 8. Ocular-ocellar distance vs. interocular distance. Fig. 9. Number of teeth on male stridulatory file vs. length of file.

Puerto Rico, the Virgin Islands, Cuba, Nassau, Haiti, Guadeloupe, Brazil, Paraguay, and Argentina. In 1869 Scudder described this species from a single male from Pernambuco, Brazil. Since it is brachypterous and incapable of flight, its invasion into new territories, especially across the Caribbean and Gulf of Mexico, must be attributed to the vagaries of man.

Walker and Nickle (1981) documented its introduction into the United States. Like *acletus* and *vicinus*, it was introduced into Brunswick, Ga., around 1904. Probably the same shipping commerce from Uruguay or Argentina was responsible for all three introductions. However, unlike *acletus* and *vicinus*, *abbreviatus* was also introduced directly into southern Florida. This occurred several times: in Tampa ca. 1899, Key West ca. 1900, Miami ca. 1902, and Ft. Myers ca. 1912. Since

acletus and *vicinus* do not occur in the Antilles and *abbreviatus* does, it is likely that *abbreviatus* was first introduced into the Caribbean region from Argentina, perhaps as long ago as the Spanish colonial period; inter-island commerce probably facilitated its spread into Puerto Rico, Cuba, and the Antilles. Then, in the 1890s, as Florida opened up to international trade with the West Indies, local shipping, perhaps directly with Cuba, resulted in multiple introductions into Florida.

The distribution of this species outside the U.S. is not well documented and is based here on only 35 specimens in the world's collections. Most of these are coastal records in Brazil: Pernambuco, Salvador, and Rio de Janeiro. However, specimens from Tucuman, Argentina, and from Chaco, Paraguay, suggest an inland endemic population that probably predates the coastal records.

Rehn and Hebard (1916) mentioned that this species was a pest of vegetables in south Florida. When *vicinus* arrived in central (Hayslip 1943) and south Florida, *abbreviatus* ceased to be considered a pest. It is possible that either *vicinus* displaced *abbreviatus* by competitive exclusion or, more likely, that some of the damage attributed to *vicinus*, which is conspicuous through its flights, is caused by *abbreviatus*.

The short-winged mole cricket is easily recognized by its short tegmina, which cover only about one-third of the abdomen. The hindwings are vestigial. The pronotum is more elongated than in other species of *Scapteriscus* and has a distinctive mottled color pattern (Fig. 5A). The interdactyl distance of the tibial dactyls is about 0.6 mm, and the dactyls are divergent (Fig. 5D). It is the only species of introduced mole crickets in which males are not known to call, although males do produce courtship songs.

Specimens Examined. 10 ♂♂, 18 ♀♀, 7 nym. UNITED STATES: See Walker and Nickle 1981. ARGENTINA: Tucuman, Las Cerillas 1,100 m 3-VI-1913 (P. Jorgensen) 1 ♀ (LP).

BRAZIL: Rio de Janeiro, San Francisco, Niteroi 29-VIII-1943 (Ruv Jarden) 1 ♀ (SB); Niteroi 10-V-1943 (A. Kersten) 1 ♂ (SB); Abrolhos 1 ♂ (RIO); Sarapui 24-III-1962 (E. A. Souza) 1 ♀ (RIO); Rio de Janeiro IV-1907 (Coll. Carlos Mareira) 1 ♀ (RIO); Bahia, Salvador VI-VII-1951 (Rita Kloss) 4 ♂♂, 4 ♀♀ (RIO); Ciera VI-1920 (Coll. Eduard C. Bererra) 3 nym (RIO).

BAHAMA ISLANDS: Nassau 1 ♀ (NMNH).

CUBA: Havana 1 nym (AMNH); Camaguay 3-VI-1939 (A. Valls) 1 ♀ (NMNH).

GUADELOUPE: Pointe-a-Pietra 1938 (Henri Stehle) 1 ♀ (NMNH).

HAITI: Port au Prince 23-VIII-1944 (A. Curtiss) 1 ♀ (NMNH); Gonaives 9-IX-1937 (A. Audant) 1 ♀ (NMNH); Isle de Tortue, St. Louis IV-1929 (E. C. and G. M. Leonard) 1 ♀ (NMNH).

MEXICO: Puerto 15-III-1931 1 ♂ (ANSP).

PARAGUAY: Chaco, P. N. Defensores del Chaco, Madrejon 10-17-IX-1982 (caminando en el suelo por la noche) (J. A. Kochalka) 1 nym (NMNH).

PUERTO RICO: Rio Piedras III-1920 (E. G. Smyth) 1 ♀ (NMNH); Arecibo V-1983 (H. Fowler) 1 ♀ (FSCA, NMNH); Arecibo 27,30-V-1983 (H. Fowler and J. Castner) 1 ♂, 2 ♀♀, 1 nym (FSCA, NMNH); "Puerto Rico" only 1 ♀ (ANSP).

VIRGIN ISLANDS: St. Croix, Christiansted 10-VI-1940 (Harry Beatty) 2 ♂♂, 1 nym (UMMZ).

Scapteriscus vicinus Scudder,
Tawny Mole Cricket
(Fig. 13)

Although this species has a complicated taxonomic history, the history of its dispersal is actually very simple. It was introduced only into Brunswick, Ga., ca. 1899. Walker and Nickle (1981) documented its arrival into southern Florida. It

continues to spread in the United States and was reported recently in Alabama for the first time (Patricia Cobb, personal communication).

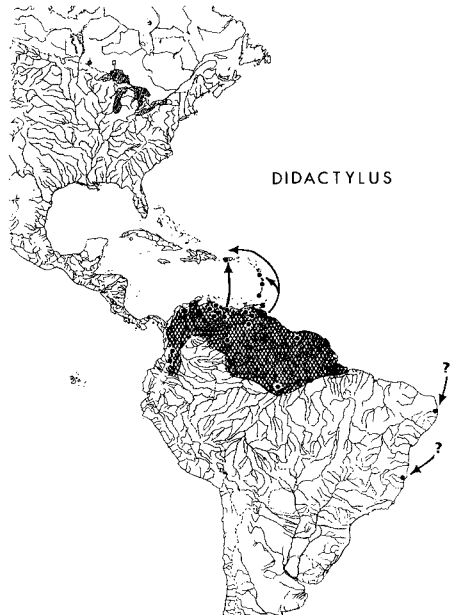
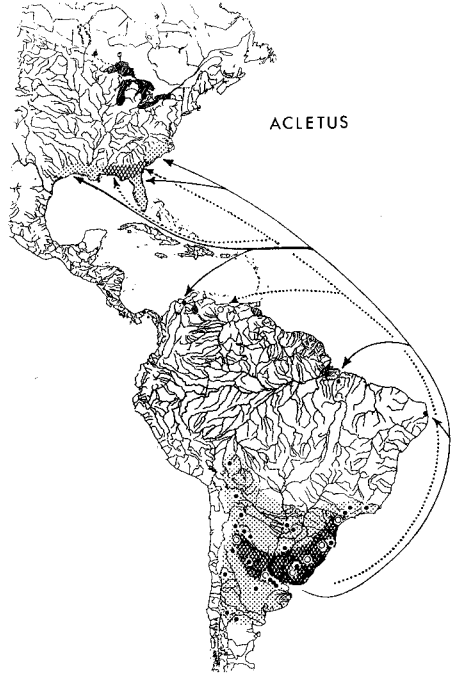
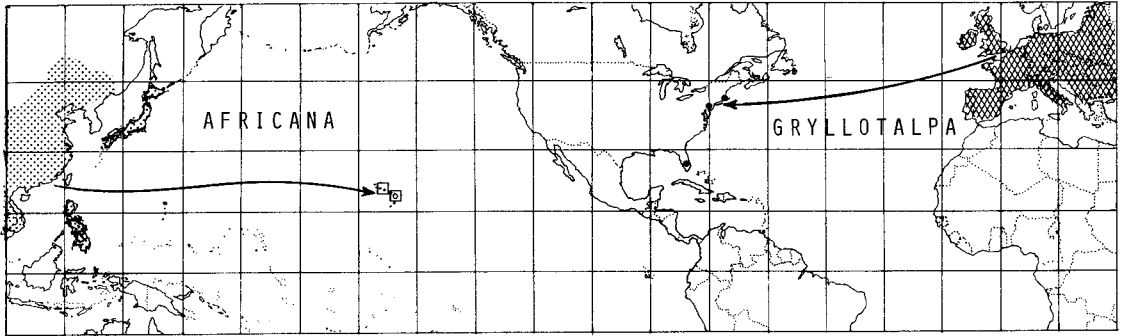
Its present distribution is indicated on Fig. 13. The type locality for *vicinus* is "Rio Negro, S. A." Although previous workers presumed that "Rio Negro" meant the large river basin in Amazonas, Brazil feeding into the Amazon, research (by DAN) on the systematics of *Scapteriscus* has shown that *vicinus* is primarily an Argentine species, occurring also in Uruguay, Paraguay, and southern Brazil. Reviewing the South American range of *vicinus*, we located two areas bearing the name "Rio Negro." One is a province in Uruguay, the other a province in Argentina, south of La Pampa Province. Either of these localities places the type locality of *vicinus* within its known geographic distribution. In addition to its introduction into the United States, *vicinus* apparently was introduced into Columbia, probably in commercial traffic through the port city of Cartagena.

Walker and Nickle (1981) speculated that *vicinus*, *acletus*, and *abbreviatus* were transported in soil ballast in ships sailing between Argentina or Uruguay and the United States. Sand was probably loaded in areas surrounding Buenos Aires or Montevideo harbors and placed in the holds of merchant sailing vessels. Upon arrival in the United States, the sand was dumped overboard in the harbor or removed to designated ballast-disposal sites. Similar shipping procedures have been documented in early commerce between Europe and the eastern United States (Lindroth 1957), resulting in the introduction of many soil-borne arthropods. It is reasonable to expect similar events to have transpired in inter-American commerce.

Scapteriscus vicinus is a robust mole cricket with a distinctively marked, short, ovoid pronotum (Fig. 5A). The tibial dactyls nearly touch, being separated at their base by less than 0.15 mm. The ocelli are small, nearly circular in shape, and widely separated (Fig. 5C).

Specimens Examined. 23 ♂♂, 60 ♀♀. UNITED STATES: Alabama, Mobile, Mobile 1 ♂, 2 ♀♀ (D. A. Nickle) (NMNH). See Walker and Nickle 1981.

ARGENTINA: Buenos Aires, Buenos Aires (R. Brusking) 1 ♂, 1 ♀ (NMNH); III-1935 1 ♂, 1 ♀ (NMNH); Rio Salado, Rt. 3S, San M. d. Monte 7-XII-1979 (C. M. and O. S. Flint, Jr.) 2 ♀♀ (NMNH); Rio Parana de las Palmas, Lima 16-XII-1979 (C. M. and O. S. Flint, Jr.) 1 ♀ (NMNH); San Fernando 5-X-1968; 9-XI-1955 (J. Daguerre) 1 ♂, 3 ♀♀ (NMNH); La Plata Oct. (Spegazzini) 1 ♂ (ANSP); Hurlingham 4-X-1973 (Luego de Fuerte) 2 ♂♂ (FSCA); Delta del Parana 9-XI-1932 (L. NacDonag) 1 ♀ (LP); Santa Fe (J. Daguerre) 1 ♀ (NMNH); Santa Fe 1 ♂ (LP); Entre Rios, Rio Parana Ibicuy, Pto. Ibicuy 10-XII-1979 (C. M. and O. S. Flint, Jr.) 1 ♀ (NMNH); Pronunciamento X-1963, II, III-1964 (Walz) 4 ♂♂, 13 ♀♀ (ANSP); Cordoba, Bellville X-1928 1 ♀ (LP); Laguna Paiva 21-23-II-1920 (Cornell Univ. Exp.) 1 ♀ (ANSP); La Pampa 1968 (J. Daguerre) 1 ♀ (NMNH).



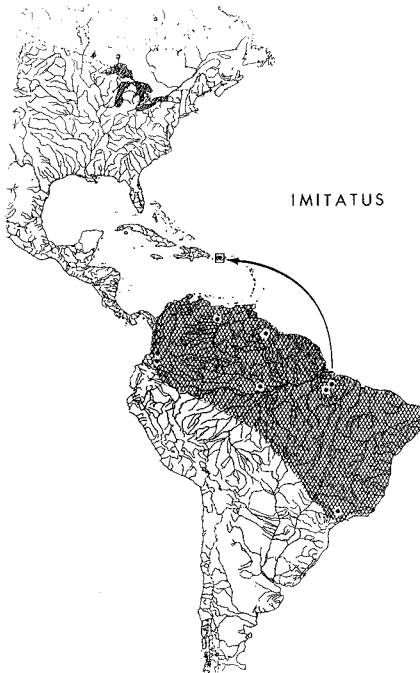


Fig. 11–16. Distribution and probable transport routes of introduced species of mole crickets.

BRAZIL: Santa Catarina, Nova Teutonia, 6 km SW Seara (27°11'S, 52°23'W) 300–500 m 29-XII-1959, 28-X-1960, 19-I-1965, XI-1974 (F. Plauermann) 3 ♂♂, 4 ♀♀ (UMMZ); Cauna XII-1945 (A. Maller Coll.) 1 ♂, 1 ♀ (AMNH); Corupa (Hansa Humboldt) IX-1961 (Anton Maller) 1 ♂ (UMMZ); Rio de Janeiro, between Murundu and Campos VIII-1978 (Moscir Alvarenga) 1 ♀ (UMMZ); Esc. Nac. Agr., Serapedica 1981 3 ♀♀ (SB); Tres Rios, Est Rio (Rego Barros) XI-1954 3 ♀♀ (RIO); Santana (E. R. ?) XI-1945 (Feio Coll.) 1 ♀ (RIO); Sao Paulo, Umuarama 10-II-1937 (C. Jordao, Travassos, Orficeira F.) 1 ♀ (RIO); Lagoinha 10-II-1937 (C. Jordao, Travassos, Orficeira F.) 1 ♂ (RIO); km 47, Estr. Rio (Kloss Coll.) VIII, IX-1958 1 ♂, 1 ♀ (RIO); Faz. Penedo, Italtaiá 15-II-1942 1 ♀ (RIO); Sao Paulo 4 ♀♀ (ANSP); Rio Grande do Sul, Santa Maria (T. White) 1 ♂ (ANSP); Pelatos 16-IV-1947, 17-III-1949 (C. Biezanko) 1 ♂ (AMNH); 3 ♀♀ (PARIS); Pelatos 5-IV-1947, 14-III-1949, 9-XI-1952 (C. Biezanko) 3 ♀♀ (NMNH).

COLOMBIA: Magdalena, Rio Frio 28-V-1925 (F. W. Walker) 2 ♀♀ (UMMZ).

PARAGUAY: Central Asuncion, Asuncion 21-VIII-1956 (C. J. D. Brown) 1 ♀ (UMMZ).

URUGUAY: Montevideo, Montevideo (flew against house at twilight) 1-XI-1940 (Parker) 3 ♀♀ (NMNH); Manga 2-X-1980 (A. Silvero-Guido) 1 ♂, 1 ♀ (FSCA); Juanico 10-X-1980 (A. Silvero-Guido) 1 ♀ (FSCA).

Table 3. Attraction of flying mole crickets to broadcast artificial calling songs of *Scapteriscus acletus* (55 pulses per s; 2.7 kHz; 106 dB) and *vicinus* (130 pulses per s; 3.3 kHz; 106 dB). Collections were made on golf courses over a period of 45 min (2100–2145 hours, beginning approximately 20 min after sunset) on successive clear evenings from 29 May to 6 June 1981. Each golf course had large populations of mole crickets. All specimens of *acletus* were the four-dot form

| Locality | <i>S. vicinus</i> song | | <i>S. acletus</i> song | |
|-------------------|------------------------|-------------------|------------------------|-------------------|
| | <i>S. vicinus</i> | <i>S. acletus</i> | <i>S. vicinus</i> | <i>S. acletus</i> |
| Charleston, S.C. | 2 | 0 | 0 | 61 |
| Brunswick, Ga. | 7 | 0 | 0 | 11 |
| Gainesville, Fla. | 9 | 1 | 0 | 16 |
| Monticello, Fla. | 11 | 0 | 0 | 0 |
| Mobile, Ala. | 2 | 0 | 1 | 0 |
| Baton Rouge, La. | 0 | 0 | 0 | 14 |
| Total | 31 | 1 | 1 | 102 |

Scapteriscus acletus Rehn and Hebard, Southern Mole Cricket

(Fig. 14)

Scapteriscus acletus occurs in the United States in two morphologically recognizable forms, mottled and four-dot (Walker and Nickle 1981). The mottled form entered the United States through Brunswick, Ga. (1904) and Mobile, Ala. (1921), and currently infests an area extending across Mississippi, Alabama, Georgia, and the Florida panhandle. The four-dot form entered through Charleston, S.C. (1916), Port Arthur, Tex. (1926), and probably Jacksonville, Fla. (1920). These dispersed introductions have resulted in three disjunct populations of four-dot *acletus* contiguous with a central mottled population: one in North and South Carolina, one in peninsular Florida extending northward along the coast of Georgia at least as far as Brunswick, and one in Texas and Louisiana. The latter population seems to be expanding eastward into the territory of the mottled population in Alabama. It may eventually reach western Florida and unite with the four-dot population in peninsular Florida.

We do not know what occurs at the zones of contact of these four populations. Although both forms have the same calling song, the apparent attraction response of mole crickets to artificial calling songs broadcast in the heart of each population differs (Nickle's data, Table 3; T. J. Walker, Univ. of Florida, personal communication). In 1904 only the mottled form was found in Brunswick, Ga., but in 1981, on a field trip to Brunswick to record and collect mottled *acletus*, one of us (DAN) was unable to locate any mottled specimens, although the four-dot form was abundant. Artificial calling songs of the four-dot *acletus* (simulated from peninsular Florida specimens) broadcast for 45 minutes at 80 dB (2200–2245 h, 29 May 1981) in Brunswick attracted 11 four-dot *acletus* but no mottled forms. The same song broadcast at

the same time (30 May and 6 June 1981) attracted a total of 102 four-dot *acletus* in Charleston, S.C., Gainesville, Fla., and Baton Rouge, La., but failed to attract a single specimen in Monticello, Fla., or Mobile, Ala., where one would expect to find mottled *acletus* (Table 3). At least in Brunswick, four-dot *acletus* may have replaced the mottled form.

Both forms of *acletus* apparently were transported beyond their natural range to several South American ports. The four-dot form was collected in several coastal ports in northern Brazil, Venezuela, and Colombia (the same region where *vicinus* was collected beyond its natural range). The mottled form entered Venezuela in the vicinity of Maracay.

Finding the native homeland(s) of the two forms was difficult. The four-dot form is common in northern Argentina, Paraguay, and Uruguay. Only a few mottled specimens from South America are in museum collections. These are from southern Brazil, Uruguay, and northeastern Argentina (see Fig. 14). Whether the two forms in South America are the same species or different is uncertain. The four-dot form in Argentina behaves like the same form in the United States. This was determined (by DAN) during a 1982 field trip to Argentina (Buenos Aires, La Pampa, Tucuman, and La Rioja Provinces) where nearly 100 four-dot crickets were attracted to the artificial calling song of *acletus*. Analysis of tape-recordings of calling songs of 20 four-dot crickets from the four provinces showed that they had the same song as U.S. four-dot *acletus*, i.e., a trill of ca. 55 pulses/sec with a carrier frequency of ca. 2.6 kHz. However, because no mottled crickets were captured, nor was the study extended to southern Brazil where the mottled form may be more abundant, it is not possible at this time to evaluate its taxonomic status.

Scapteriscus acletus was described by Rehn and Hebard (1916) from mottled specimens collected in south Georgia. Until recently (Walker and Nickle 1981), it was considered to be the only species of *Scapteriscus* endemic to the United States. In 1894 Giglio-Tos described an Argentine mole cricket, *S. borellii*, which apparently is conspecific with the four-dot form of *S. acletus*. Regarding the taxonomic status of these two species, one is faced with several alternatives: assume both forms in the United States to be a single species and treat *acletus* as a junior synonym of *borellii*; or delay making a final decision, pending further biological studies on the two forms in the United States. If they prove to be different species, then two species have been introduced, a mottled species, *acletus*, whose type locality just happens to be Hebardville, Ga., and a more widespread species found from Argentina to Brazil, *borellii* (the four-dot form). We will follow the second alternative as the course least destructive to the stability of names, and continue to regard the two forms in the U.S. as a single species, *acletus*.

Scapteriscus acletus is easily distinguished by its

pronotal coloration pattern of four dots (altered somewhat in the mottled form) and by the widely spaced dactyls (Fig. 5A-F). This is the only species in which the male subgenital plate is not elongated.

Specimens Examined. 65 ♂♂, 115 ♀♀. (In South America, these specimens belong to the species *S. borellii*).

Four-dot Population. UNITED STATES: See Walker and Nickle 1981.

ARGENTINA: Santa Fe, Carcarana, Depto. San Lorenzo XII-1897-I-1898 (Lawrence Bruner) 16 ♂♂, 25 ♀♀ (AMNH, NMNH, UMMZ); Cordoba, Cruz de Eje, 475 m (L. Bruner) 7 ♂♂, 5 ♀♀ (ANSP, AMNH, NMNH, UMMZ); Rosario (H. Stempleman) 1 ♂, 1 ♀ (AMNH); Rosario (Davis) 6 ♀♀ (ANSP, exMCZ); La Pampa 1968 (J. Daguerre) 2 ♀♀ (NMNH); Entre Rios, Palmar 2-XII-1941 (Biraben-Bezzi) 1 ♂ (LP); Entre Rios, Pronunciamento X-1963, II-1964 (Walz) 10 ♀♀ (ANSP); "Entre Rios" only (C. S. Reed) 1 ♀ (UMMZ); Buenos Aires, Ao. Pescado, Rt. 11, 15 km E La Plata 20-XII-1979 (C. M. and O. S. Flint, Jr.) 1 ♀ (NMNH); Laguna de Gomez, Junin 12-XII-1979 (C. M. and O. S. Flint, Jr.) 1 ♀ (NMNH); San Fernando I-1956 (J. Daguerre) 3 ♀♀ (NMNH); Epequen I-1978 (Cicchino) 5 ♂♂ (LP); Jujuy, Jujuy 1-XII-1911 (P. Jorgensen) 1 ♀ (ANSP); Jujuy XII-1911 1 ♀ (LP); Mendoza, Mendoza 767 m 12-II-1908 (P. Jorgensen) 1 ♀ (ANSP); Mendoza (C. S. Reed) 2 ♂♂ (UMMZ); Chacras de Coria 936 m 9-XII-1907 (P. Jorgensen) 1 ♂ (ANSP); Valle Fertil, San Juan 5-6-XI-1970 (Williner) 2 ♂♂ (LP); San Juan, Rt. 510 30 km S Valle Fertil (Willink-Fildalgo) 1 ♂ (LIL); Nigrillani, Nor-Yungas I-1950 (Williner) 1 ♀ (LP); Rio Negro, Villa Regina I-1962 (Luis E. Pena G.) 1 ♀ (UMMZ); Pico XII-9 1 ♀ (NMNH); Tucuman, Puerta Quemada 1-XI-1929 (R. A. Jaynes) 1 ♀ (NMNH); Corrientes, Moonantiales XI-1946 (Th. de Apostol) 1 ♀ (LIL); Salta, Molinos, 10 km S Rumibola 15-II-1969 (Barrera-Paganini) 1 ♀ (LIL); Cordoba, Capilla d. Monte (Prf. Hosseus) 2 ♀♀ (MUN); Santiago del Estero III-1957 (R. Golbach) 1 ♀ (LIL); Neuquen, Barrancas 21-II-1977 (L. Stange) 1 ♂, 1 ♀ (LIL); La Rioja, Piedra Pintada 23-II-1939 (Biraben-Scott) 1 ♀ (LP); La Rioja, Los Pozuleos 19-I-1969 (A. Teran-A. Willink) 1 ♂ (LIL).

BOLIVIA: Villa Montes XI-1917 1 ♂, 2 ♀♀ (ANSP); Cochabamba 2,600 m 20-XI-1969 (Zischka) 2 ♀♀ (MUN); Cochabamba 1 ♂ (LP); Beni, Rurrenabaque (Wm. M. Mann) (1921-1922 Mulford Biol. Expl.) 1 ♀ (NMNH); Sara, 450 m 1922 (J. Steinbach) 1 ♀ (ANSP).

BRAZIL: Para, Belem I-1938 (B. N. Wolcott and L. F. Martorell) 3 ♂♂, 4 ♀♀ (AMNH); Belem 1952 (R. Correa) 1 ♀ (UMMZ); Belem 10-VII-1952 (O. Rego) 1 ♂ (SEA); Cachimbo VI, IX-1955 (Travassos) 1 ♂, 3 ♀♀ (RIO); Natal (Wm. M. Mann) 1 ♂ (ANSP); Natal 25-VI-1943, IX-1944, 1945 (H. T. Dalmat) 1 ♂, 2 ♀♀ (NMNH); Forteleza IX-1943 (D. MacCreary) 1 ♂ (AMNH); Pernambuco 4-I-1882 1 ♀ (NMNH); Recife 1949 (M. B. Carvalho) 1 ♀

Table 4. Morphological features used to recognize species of *Scapteriscus* mole crickets. Values (expressed in mm except where noted) are means of 10 specimens for each species, except for *imitatus*, in which stridulatory file data are based only on 6 individuals available for study. Individual values of most features are plotted on scatter diagrams in Fig. 6-10

| Morphological characters | <i>S. didactylus</i>
(n = 10) | <i>S. imitatus</i>
(n = 10) | <i>S. vicinus</i>
(n = 10) |
|---------------------------------|----------------------------------|--------------------------------|-------------------------------|
| Interdactyl distance | 0.26 | 0.25 | 0.12 |
| Trochanter blade length | 1.87 | 1.71 | 1.95 |
| Ocellar length | 0.62 | 0.55 | 0.45 |
| Interocellar distance | 1.16 | 0.91 | 1.13 |
| Interocular distance | 2.37 | 1.95 | 2.18 |
| Ocellar-ocular distance | 0.36 | 0.27 | 0.40 |
| Length, stridulatory file | 2.12 | 1.80 | 1.87 |
| No. teeth, stridulatory file | 80 | 78 | 85 |
| No. teeth/mm, stridulatory file | 37.9 | 32.7 | 43.8 |

(NMNH); Mato Grosso, Lassanco 1935 (D. M. Cochran) 1 ♂ (NMNH); Ponte Nova 10-X-1964 (Luiz L. Moogan) 1 ♂, 1 ♀ (RIO); Alto Xingu, P. I. Col. Iansconcelos XI-1958 (R. Arle) 1 ♀ (UMMZ); Paracatu VII-1960 1 ♀ (RIO); Minas Geraes, Vicasa (P. H. Rolfs) 1 ♀ (UMMZ); Sao Paulo, Yhaliha (sp.?) IV-1926 1 ♀ (ANSP); Jundiáhy (Schrottky) 1 ♂ (UMMZ); Yharanja (sp.?) 1 ♂ (ANSP); Peruhubi (sp.?) IV-1926 (R. Spritz) 1 ♀ (ANSP); Rio Grande Dam, Santo Amaro 17-II-1931 (R. von Ihering) 2 ♀♀ (ANSP); Goias, Santa Izabel do Moro, Ilha do Bananal VI-1961 (M. Alvarenga) 1 ♂ (UMMZ); Rio de Janeiro, Theresopolis (R. Schirch) 2 ♀♀ (RIO); Santa Catarina, Nova Teutonia, SW Seara (27°11'S, 52°23'W) 30-VIII-1935, 21-II-1965, X-1974 (Fritz Plaumann) 2 ♂♂, 1 ♀ (ANSP, FSCA, UMMZ); Juazeirinho Paraiba 25-VI-1956 (A. G. A. Silva) 1 ♂ (SEA); Parahyba, Independencia (Mann and Heath) 1 ♀ (ANSP); Ceara (Mann and Heath) 1 ♂ (ANSP).

COLOMBIA: Magdalena, Rio Frio 28-V-1925 (F. W. Walker) 1 ♀ (UMMZ).

PARAGUAY: Central Asuncion, Sapucay 17-II-1901 (W. T. Foster) 2 ♂♂, 2 ♀♀ (ANSP, NMNH); Asuncion 7-17-X-1956, 25-31-VIII-1956, 20-IX-10-X-1956 (C. J. D. Brown) 2 ♂♂, 3 ♀♀ (PARIS, UMMZ); Rio Yguagu III- (Donald Wees) 1 ♀ (ANSP, exMCZ); "Paraguay" only 1 ♂, 1 ♀ (NMNH, LP).

VENEZUELA: km 107 El Dorado, Santa Elena BO 520 m 30-VIII-1957 (F. Fernandez-Y. C. J. Rosales) 1 ♀ (IZAV).

Mottled Population. UNITED STATES: See Walker and Nickle 1981.

ARGENTINA: Catamarca 1968 (J. Daguerre) 1 ♂, 1 ♀ (NMNH).

BRAZIL: Sao Paulo, Dertiaga (sp.?) Santos 1 ♀ (ANSP); Rio Grande do Sul, Rio Grande 11-X-1919 (E. G. Holt) 1 ♀ (NMNH).

URUGUAY: "Uruguay" only (H. H. Smith) 1 ♂ (NMNH).

VENEZUELA: Aragua, Maracay (P. Vogt) 2 ♀♀ (MUN).

Scapteriscus didactylus (Latreille),
Changa
(Fig. 15)

This species occurs from Puerto Rico south along the Antilles into northern South America. It was introduced into Puerto Rico in the mid 1800s, although its mode of introduction is not known. There is some indication that it was brought into the country in guano used as fertilizer (Barrett 1902, Van Zwaluwenberg 1918), but this has not been confirmed. Earlier in the 1830s, it was reported to have been introduced into St. Vincent (Johnstone 1837). At any rate, it has travelled up the Antilles, and specimens have been collected in Puerto Rico, St. Vincent (Brunner von Wattenwyl and Redtenbacher 1892), St. Lucia, Grenada, Martinique, Dominica, and Trinidad. Gundlach (1886) reported the species in Puerto Rico and noted (1887) flights of adults attracted to lights in Mayaguez. Cardin (1913) mentioned its occurrence in Cuba but stated that it was rare. The specimen upon which he based his record turned out to be a parasitized scarab larva. Wolcott (1938) described a special search by Cardin for *didactylus*, in order to establish whether it was present on the island. Only one mole cricket was found, but it was never identified and is presumed lost. In the same paper he also reported that all mole crickets in the collection of the Experiment Station at Santiago de las Vegas were *Gryllotalpa* (= *Neocurtilla*) *hexadactyla* Perty. Zayas (1974) reported the occurrence of only *Neocurtilla hexadactyla* and *Scapteriscus abbreviatus* on the island. We presume that all previous Cuban records of *didactylus* were based on these two species, and we do not believe *didactylus* occurs in Cuba. Gowdey (1926) reported *didactylus* in Jamaica, but we have no specimens to verify its presence on that island. Wolcott (1938, 1941) reported it from Haiti and St. Kitts, but again we have no specimens to verify these records. Four specimens of *vicinus* were reported from St. Croix by Beatty (1944), who sent them for identification to A. B. Gurney of the U.S. National Museum, Washington, D.C. Supposedly they were deposited at the Museum, but a thorough search of the Collection has not uncovered the specimens.

In South America *S. didactylus* has been collected in Colombia, Venezuela, Surinam, and Brazil. The existence of two specimens from Bonito in Pernambuco, Brazil, suggests that this species may have travelled southward in commerce.

Walker and Nickle (1981) first demonstrated that *vicinus* and *didactylus* were different species by comparing interdactyl distances of U.S. and Puerto Rican forms. Differences between the two species involve interdactyl distance (<0.15 mm in *vicinus*; >0.15 mm in *didactylus*), size and arrangement of ocelli (see Fig. 5C), and the number of teeth per mm of the male stridulatory file (43.8 in *vicinus* and 37.9 in *didactylus*).

Specimens Examined. 70 ♂♂, 134 ♀♀, 69 nym.
 BRAZIL: Pernambuco, Bonito I-1883 2 ♀♀ (NMNH).

COLOMBIA: Magdalena, Rio Frio 11-III, 19-V, 18-X, 19-XI, 17-XII-1925, 12, 31-V-1926 (F. W. Walker) 4 ♂♂, 6 ♀♀ (UMMZ); Aracataca 12-XII-1925 (F. W. Walker) 1 ♀ (UMMZ); Santa Marta Mts., Fundacion I-1917 (E. B. Williamson) 1 ♀ (UMMZ); Cordoba, Valle 23-V-1918 (M. A. Carriker, Jr.) 1 ♂ (ANSP); Quibdo IX-1896 1 ♀ (ANSP); Rio Tamana (M. G. Palmer) 1 ♀ (ANSP).

DOMINICA: Clarke Hall 1964-1965 (various dates) (Bredin, Archbold-Smithsonian Biol. Survey Dom.) 6 ♂♂, 10 ♀♀, 2 nym (NMNH); Caprit Swamp 3-XI-1964 (P. J. Spangler) 1 nym (NMNH); Roseau 15-XII-1933 (L. E. Chadwick) 1 ♀ (NMNH).

GRENADA: "Grenada" only XI-1905 (W. E. Broadway) 2 ♂♂, 1 ♀ (AMNH, NMNH).

MARTINIQUE: Basse Pointe (at lights) 11-VI-1952 (Martorell) 1 ♀ (NMNH).

PUERTO RICO: Coamo Springs 6-I-1915, 5-7-VI-1915 1 ♂, 4 ♀♀ (AMNH); San Juan, Rio Piedras 5-XI-1901 7 ♂♂, 7 ♀♀ (NMNH); Rio Piedras II-25, 26-V-1902 (O. Barrett) 3 ♀♀, 1 nym (ANSP); Rio Piedras III-1920 (E. G. Smyth) 4 ♀♀ (NMNH); Rio Piedras 18-XI-1960 (Harold Heatwole) 1 ♀ (UMMZ); San Juan Naval Air Station I-1945 (J. J. Friauf) 1 ♂ (UMMZ); San Juan (Joseph Schrol) 1 ♂ (NMNH); 4.8 km NW Yabucoa, Mun. d. Yabucoa 18-I-1971 (S. L. H. Fuker) 1 ♂, 1 ♀ (ANSP); Toa Baja 30-VI-1920 (G. N. Wolcott) 1 ♂ (NMNH); Utuado I-1899 (Aug. Busck) 1 ♂ (NMNH); Luquillo 5-III-1900 (C. W. Richmond) 1 ♂ (NMNH); Luquillo National Forest 17-II-1925 1 ♂ (ANSP); Toro Negro Forest, Dona Juana 23-24-VI-1969 (O. S. Flint, Jr.) 1 ♀ (NMNH); Ahogodo Key 12-16-III-1966 1 ♂ (NMNH); El Yunque 267 m 21-II-1900 (C. W. Richmond) 2 ♀♀ (ANSP); San German 4-VIII-1967 (T. E. Rogers) 1 ♂ (FSCA); Fajardo II-1899 (Aug. Busck) 1 ♂ (NMNH); Punta Boriquen (flushed with water and detergent) 6-VI-1983 (J. Castner) 2 ♂♂, 3 ♀♀, 44 nym (FSCA, NMNH); Dorado, 1 ♂, 2 ♀♀, 7 nym (FSCA); Loizu, Berwind Country Club (flushed with water and detergent) 3 ♂♂, 3 ♀♀, 16 nym (FSCA); Arecibo 24-VI-1915 1 ♂ (AMNH); Aibonito 1-3-VI-1915, VIII-1932 (R. G. Oakley) 1 ♂, 1 ♀ (AMNH, NMNH); La Plata 10-XI-1914 (G. B. Merrill) 1 ♀ (UMMZ); Bayamon I-1899 (Aug. Busck) 1 ♂, 1 ♀, 2 nym (NMNH); Adjuntas 4-X-1935 (Chapin and Blackwelder) 1 ♀ (NMNH); Bayamas 1 ♂ (UMMZ); Patillas 15-V-1940 (D. DeLeon) 1 ♀ (NMNH); "Puerto Rico" only 9 ♂♂, 17 ♀♀, 1 nym (AMNH, ANSP, NMNH, UMMZ).

ST. LUCIA: La Fargue Station No. 18 5-I-1973 (J. Hance, G. Whitmyre) 1 ♀ (FSCA).

ST. VINCENT: Windward side (H. H. Smith) 1 ♀ (UMMZ, ex Bruner Coll.).

SURINAM: Kwattawig 6-IX-1979 2 ♂♂, 1 ♀ (FSCA); Para, Zanderij I., Boven 19-IV-1927 1 ♀ (ANSP).

TRINIDAD: Caparo VI, VIII-1913 (S. M. Klages)

3 ♂♂, 7 ♀♀ (ANSP); Carenage VIII-1909 (M. A. Carriker, Jr.) 6 ♀♀ (ANSP); Maraval (W. Buthr) 1 ♂ (ANSP); Nariva Swa. 5-XII-1934 1 ♂, 1 ♀ (ANSP); Heights of Aripo 1-8-IX-1909 (M. A. Carriker, Jr.) 1 ♀ (ANSP); Port of Spain XII-1912-V-1913 (R. Thaxter) 4 ♀♀ (ANSP); Blue Basin 9-VIII-1973 (T. E. Rogers) 2 ♂♂ (FSCA); Arima Valley 267-400 m 10-12-II-1964 (J. G. Rozen and P. Wgodzinsky) 2 ♀♀ (AMNH); Brasso 10, 14-XI-1930 (G. Belmontes) 1 ♂, 1 ♀ (ANSP); St. Augustine 4-XI-1915 (R. A. Wood) 1 ♂ (ANSP); 1-15-VII-1964 (J. M. Capriles) 1 ♀ (NMNH).

VENEZUELA: Carabobo, Vigitima 450 m 30, 31-VIII; 3, 27, 28-IX; 4-X; 8-XI-1969 5 ♂♂, 11 ♀♀ (IZAV); Rio Borburata, 250 m 17-24-VI-1971 (F. Fernandez and J. Salcedo) 1 nym (IZAV); Tacatigua 430 m 10, 11, 27, 30-IX-1969 1 ♂, 4 ♀♀ (IZAV); Matiata 460 m 5-X-1969 1 ♀ (IZAV); Aragua, Maracay 23-V-1948; 23-I, 26-VI, 4-V-1951 (F. Fernandez and C. J. Rosales) 3 ♂♂, 4 ♀♀ (IZAV); Maracay V-1936 (P. Vogt) 1 ♂, 2 ♀♀ (MUN); Tocoton 450 m 27-XI-1969 (IZAV); Monagas, Josepin 50 m 20-IX-1965 (F. Fernandez and C. J. Rosales) 1 ♀ (IZAV); Borburata, Planta 300 m 6-IV-1950 (F. Fernandez and C. J. Rosales) 2 ♂♂ (IZAV); Yarecuy, Yumare 12-13-II-1970 (J. Salcedo) 1 ♀ (IZAV); Ciudad Bolivar IX-1909 (M. A. Carriker, Jr.) 1 ♀ (ANSP); Barinas, Reserva Forestal Ticoporo 230 m 22-28-V-1968 1 ♀ (IZAV); Terr. Amazonas, Puerto Ayacucho 15-VII-1950 (J. Maldonado Capriles) 1 ♀ (NMNH); District Federal, Caracas 21-V-1950 (F. Fernandez) 1 ♀ (IZAV); Carabobo, San Estaban 24-XI-20-XII-1939 (Pablo Anduze) 4 ♀♀ (ANSP); Cumaragua (B. J. Blanco) 1 ♀ (NMNH); Boqueron, Varacuy 16-III-1921 (E. B. Williamson) 1 ♀ (UMMZ); Sucre, Cumanacua 14-XII-1929 (G. Netting) 1 ♂ (ANSP).

Scapteriscus imitatus Nickle and Castner,
 New Species, Imitator Mole Cricket

(Fig. 16)

Scapteriscus vicinus Scudder, Wolcott 1938:193
 [misidentification].

The mode of introduction of this species is unusual. As the change became a major agricultural pest in Puerto Rico, a biological control program was initiated. An early attempt to introduce two species of toads from southern Texas (Van Dine 1912, Dexter 1932, Wolcott 1937) was ultimately unsuccessful. Wolcott (1938) described the events leading to the search for a hymenopterous parasite of the change. While in Trinidad searching for mole cricket parasites, he read a paper by Williams (1928), who reported finding in Belem, Brazil, abundant populations of *Larra americana* Saussure (Hymenoptera: Sphecidae) (a synonym of *L. bicolor* F.), a parasite of *didactylus*.

Travelling to Belem, Wolcott found *Larra bicolor* actively searching for mole crickets and frequenting the flowers of *Borreria verticillata* Mey-

er [now a synonym of *Spermacoce verticillata* (Meyer) Wunderlin]. After several unsuccessful attempts to transport adult parasites to Puerto Rico, he obtained mole crickets in Brazil, exposed them to female parasites, and transported the parasitized mole crickets to Puerto Rico, where they were released. It is not recorded how many parasitized changas from Belem were released in Puerto Rico, but several shipments of parasites totalling several hundred mole crickets were released.

We have since determined that the "changa" from Brazil is a different species than the pest encountered by Wolcott in Puerto Rico. This was recently discovered when one of us [JLC], while exposing mole crickets to parasitization by *Larra bicolor* in Puerto Rico in the same manner that Wolcott used, found evidence that while the Brazilian mole cricket was readily parasitized, the changa (*didactylus*) was resistant to parasitism, thus supporting other evidence that the two populations in Puerto Rico are different species. JLC spent 9 weeks in 1981, 1982, and 1983 collecting biological data on Puerto Rican mole crickets and specimens of *Larra bicolor* as part of a preliminary biological control study. He found all stages of the new species abundant at field sites near Isabela. Adults flew throughout the night (dusk until dawn) in response to the synthesized calling song of this species, broadcasted at 120 dB by an electric caller of the type described by Walker (1982) (calibrated at 60 pulses/s, 4.2 kHz). Specimens attracted to the broadcast calling song were aggressive and did not hesitate to bite when captured. The changa, on the other hand, when captured by excavation during daylight, often "played dead," remaining motionless for a considerable period of time. Collections from Isabela so far have yielded only the new species, although it has also been collected at two other sites on the island. The changa, on the other hand, has been collected extensively and is probably widespread on the island.

The new species has been collected also in Brazil, Guyana, Venezuela, and Ecuador. In choosing the holotype for this species, we have had to decide whether to use a specimen representing the native range of the species or a specimen from which the calling song has been recorded. We chose a tape-recorded Puerto Rican specimen. Cryptic species are common in mole crickets; morphologically similar or identical forms produce different calling songs. Until more is known of this species across its entire range, it is reasonable to expect that several cryptic species may be involved. Therefore, the specimen from Puerto Rico possesses the most reliable specific character upon which to base a mole cricket species, its calling song.

Diagnosis. As with most species of *Scapteriscus*, *imitatus* is recognized only when several characters and measurements are used in combination: interdactyl distance, 0.22–0.28 mm; ocelli ovoid, greatest length, 0.48–0.62 mm; interocellar dis-

tance, 0.82–0.98 mm; ocellar-ocular distance, 0.24–0.33 mm; interocular distance, 1.78–2.05 mm. The pronotal and hindfemoral color patterns are also useful in separating it from *didactylus* and other species within its range. The stridulatory file has 78 teeth; 32.7 teeth per mm. The calling song of the holotype consists of a trill of 59 pulses/s with a carrier frequency of 4.3 kHz (at 26°C).

Male Holotype. PUERTO RICO: Isabela (Coll. T. Forrest) [NMNH].

Description. *Head.* Ocelli oval; greatest diameter, 0.48–0.62 mm; interocellar distance equal to 1.5× ocellar length; ocellar-ocular distance less than one ocellar length; interocular distance slightly greater than length of compound eye. Lacinia of maxilla bearing a well developed pre-apical tooth.

Thorax. Pronotum oval, 1.2× longer than wide; greatest width at midpoint. Ventral margin of pronotum fringed with long setae from deepest point and extending along posterior margin. Mesosternal keel triangulate, barely protrusive, bearing 6–10 stout bristles. Metasternal bristles ovoid, extending vertically into body, separated from each other by a distance equal to greatest diameter of apophysis.

Legs. Forefemur ca. 1.7× longer than wide. Exposure of tympanum in dorsal view as in Fig. 5F. Tibial dactyls moderately separated (0.25 mm). Anterior dactyl longer and more slender, its dorsal edge mildly inflated and rounded, its ventral edge linear. Posterior dactyl about 0.75× as long as anterior dactyl, both edges subequally inflated (Fig. 5D). Margins of foretrochanter weakly equally curved (rounded, inflated). Blade of foretrochanter about 0.33× as long as trochanter, ventral edge straight and apically extending forward of rounded anterior margin of trochanter (Fig. 5E). Dorsal internal margin of hindtibia armed with 4 spines. Apex of hindtibia bearing 6 spurs, increasing in size from posterior external to posterior internal spine.

Wings. Tegmina long, extending to tergum VIII. Hindwings extending to apex of cercus, recurving ventrally beneath abdomen. Stridulatory file with 78 teeth; 32.7 teeth per mm.

Abdomen. Supra-anal plate of male lingulate. Subgenital plate medioapically produced, meeting apex of supra-anal plate, apically truncate; apical width ca. 0.5 mm.

Coloration. Dark, mottled, distinctively patterned. Head dark brown with buff patches extending from beneath ocelli to antennae and eyes. Area laterad of compound eyes also buff. Pronotum brown with dorsal light patches and posterior dark brown patches (Fig. 5A). Dorsal half of hindfemur brown, ventral half buff with 3 small brown patches extending below axial midline of femur. Base of hindtibia banded with a dark brown patch on external face (Fig. 5B).

Paratypes. 13 ♂♂, 27 ♀♀, 7 nym. BRAZIL: Para, Para 8-VII-1919 (H. S. Parish) 1 ♂ (ANSP); Para, Mangabaira, Mogajuba VII-1953 (Orlando Rego)

1 ♀ (SEA); Belem P. R. Acc. No. 20-38 I-1938 (G. N. Wolcott and L. F. Martorell) 1 ♂ (AMNH); Belem XII-1952 (Orlando Rego) 1 ♀ (SEA); Amazonas, Manaus 7-9-X-1920 1 ♀ (ANSP); Manaus I-1862 (J. C. Fletcher) 1 ♂ (ANSP); Sao Paulo, Piracicaba 1 ♂ (ANSP); "Brazil" only 1 ♀ (MUN).

ECUADOR: Bucay 900 ft 11-III-1922 (G. H. Tate) 1 ♂ (ANSP). GUYANA: Bartica, Kartabo (W. Beebe) 1 ♀ (ANSP).

PUERTO RICO: Isabela 13-15, 21-V-1982 (J. L. Castner) 8 ♂, 13 ♀, 4 nym (FSCA, NMNH); Arcibo 30-V, 6-VI-1983 (Castner and Fowler) 1 ♂, 7 ♀, 3 nym (FSCA); "Puerto Rico" only 1 ♂ (NMNH).

VENEZUELA: Guarico, San Juan de los Morros, E Guarico 28-IV-1938 (C. H. Ballou) 1 ♀ (IZAV).

Distribution. This species occurs in Brazil, Guyana, Ecuador, and Venezuela and has been introduced into Puerto Rico.

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