

# Introduction and Spread of Pest Mole Crickets: *Scapteriscus vicinus* and *S. acletus* Reexamined<sup>1</sup>

T. J. WALKER<sup>2</sup> AND D. A. NICKLE

Dept. of Entomology and Nematology, University of Florida, Gainesville, FL 32611, and Systematic Entomology Laboratory, USDA SEA % U.S. National Museum, Washington, D.C. 20560

## ABSTRACT

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Neither of the mole crickets most damaging to turf, pastures, and crops in southeastern United States is taxonomically what it has been thought to be. *Scapteriscus vicinus* Scudder, also called "changa" or "Puerto Rican mole cricket," is distinct in calling song and inter-dactyl distance from the species known by the same name in Puerto Rico. Therefore its introduction at Brunswick, GA, ca. 1899, was from some other source. By 1960 its U.S. distribution included all of Florida, southern Georgia, and southernmost South Carolina. No additional spread has been reported during the past 20 years. *Scapteriscus acletus* Rehn and Hebard, long believed native to southeastern United States, was introduced at Brunswick, Georgia, ca. 1904. It was apparently introduced anew at Charleston, SC (ca. 1915), Mobile, AL (ca. 1919), and Port Arthur, TX (ca. 1925). Variations in pronotal color patterns suggest that the Charleston and Port Arthur introductions had a different origin than the Brunswick and Mobile introductions. By 1960, *acletus* had spread throughout Florida and southern Georgia, as far north as southern North Carolina, and as far west as eastern Louisiana; it had also occupied a large disjunct area in western Louisiana and eastern Texas. It has since spread to central Louisiana and been collected at scattered localities northward. Neither *S. vicinus* nor *S. acletus* reached peninsular Florida prior to 1925, but *Scapteriscus abbreviatus* Scudder, a flightless species of minor pest status, was introduced at six coastal cities of peninsular Florida, as well as at Brunswick, Georgia, prior to 1925. The homelands of U.S. *Scapteriscus* spp. should be located and their pathogens, parasites, and predators studied as potential biological control agents.

Mole crickets of the genus *Scapteriscus* are important agricultural and turf pests in sandy soils of southeastern United States. The two most damaging species are *S. vicinus* Scudder, also known as "changa" or "Puerto Rican mole cricket" and *S. acletus* Rehn and Hebard, the southern mole cricket (Anon. 1953, Tappan 1963, Short and Koehler 1977). A third species, *S. abbreviatus* Scudder, is more restricted in its U.S. distribution and has not been implicated as a significant pest since the early 1900's (e.g. Hebard 1915). *Scapteriscus vicinus* and *S. abbreviatus* are generally conceded to be introductions from Latin America, whereas *S. acletus* has always been treated as a native species. The taxonomic history of each species is summarized below.

Scudder (1869) described *Scapteriscus vicinus* on the basis of specimens from Panama and Brazil. Chittenden (1903, p. 116) was first to report its occurrence in the United States: "January 21, 1903, Mr. S. W. Goodyear wrote in regard to the occurrence of this species in Brunswick and Glynn counties, Ga. . . . [stating that it was]. . . unknown in that vicinity until about 1899. . . ." Worsham and Reed (1912) dated the introduction as no later than 1897 by stating that it had been a pest at Brunswick for fifteen years. They speculated that "the crickets were brought to Georgia in the ballast of ships from the West Indies . . . , and probably from Porto Rico since it seems more abundant there than elsewhere." The name *S. didactylus* (Latreille) was used in these early reports, but Rehn and Hebard (1916) concluded that Latreille's name referred to a different spe-

cies and that *S. vicinus* Scudder was the correct name for the tawny pest mole crickets of southern Georgia and Puerto Rico. As far as we can determine, later workers have added neither new data nor new speculation relative to the identity and source of U.S. *vicinus*.

Inasmuch as *S. vicinus* in the United States is believed to have come from Puerto Rico, or at least to be conspecific with the species that is a pest in Puerto Rico, the history of the "changa" in Puerto Rico is of importance. Barrett (1902) and Van Zwaluwenburg (1918) noted that the changa was generally believed to have reached Puerto Rico in a load of guano brought to Mayaguez in about 1850; Wolcott (1950) identified the guano's source as Peru. Barrett (1902, p. 10) thought that the changa was probably in Puerto Rico before the guano arrived, but Wolcott (1950, p. 54) sided with Van Zwaluwenburg (1918) in judging the changa "probably not endemic" to Puerto Rico.

The spread of *vicinus* in southeastern United States from its port of entry in southeast Georgia has not been documented until now. Ulagaraj (1975) published a map purporting to show the extent to which *vicinus* had spread in southeastern U.S., but early and peripheral records were not dated or verified.

*Scapteriscus abbreviatus* was described by Scudder (1869) on the basis of a specimen from Pernambuco, Brazil. Scudder (1900, p. 86) was also first to report its occurrence in the United States but gave the locality only as Southern Florida. Rehn and Hebard (1912, 1914) reported it from Key West, Miami, Ft. Myers, and Port Tampa, FL., and from White Oak, GA. Hebard (1915, p. 460) noted that one of "the older inhabitants" of Miami remembered when *abbreviatus* did not occur

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<sup>2</sup> Research Associate, Florida State Collection of Arthropods.

there and that it "had been accidentally introduced in manure from Key West."

The remaining U.S. species, *S. acletus*, was described by Rehn and Hebard (1916) on the basis of 83 specimens from extreme southeastern Georgia. They did not discuss the possibility that it was introduced or occurred in another country, although they noted that it was related to a Mexican species, *S. mexicanus* (Burmeister). Subsequent workers never questioned the nativeness of *acletus*, even though its spread into Florida evidently precipitated a 1934–39 USDA study at Sanford (Hayslip 1943) and a 1940 USDA control project at Plant City, in which 1,258 tons ( $1.14 \times 10^6$  kg) of poison bait were distributed.<sup>3</sup> Ulagaraj (1975) mapped the distribution of *acletus* but did not remark the lack of early records or the time pattern of records between 1904 and 1950.

In trying to trace the spread of *vicinus* in the U.S., one of us (TJW) noted that the records of *acletus* fit a similar pattern. Furthermore, when Dr. R. I. Sailer (pers. comm. 1979) failed in his attempt to collect *S. vicinus* in Puerto Rico by broadcasting the species-specific calling song (Ulagaraj and Walker 1973), Mr. Edwin Abreu, a University of Puerto Rico entomologist, informed him that the broadcast song was not the call of the Puerto Rican changa. We therefore undertook a re-examination of the status of U.S. *Scapteriscus*, and one of us (DAN) is revising the genus on a worldwide basis.

### Methods

We searched for early U.S. specimens of *Scapteriscus* in the major U.S. collections of Orthoptera (see appendix) and in state collections of GA, FL, AL, MS, LA, SC, and NC, and mapped the records. We studied early and recent specimens of *S. vicinus* from Puerto Rico and analyzed a tape recording of the calling song of the changa made near Isabella, P.R., by Mr. Edwin Abreu.

### Results

The earliest records of *S. vicinus* in the U.S. indicate that it was introduced at Brunswick, GA, in the 1890's (Fig. 2). Its subsequent spread was slow: by 1920 its recorded limits were Du Pont, GA (136 km inland), Savannah, GA (111 km north) and Jacksonville, FL (95 km south). Not until the 1940's did it reach southern peninsular Florida, and the earliest record for westernmost Florida was 1955.

With one exception the U.S. records of *S. vicinus* are compatible with its being imported once and subsequently spreading by its characteristic dispersal flights (described by Ulagaraj 1975). The exception is a USDA Insect Pest Survey record of a female attacking plants and flowers at Orangefield, TX, 10 May 1932. We could not find the specimen, but the determination was by USNM orthopterist, A. N. Caudell. A misidentification of an *acletus* female cannot be entirely ruled out since some U.S. populations of *acletus* resemble *vicinus*

in pronotal proportions and color pattern (see below). Indeed all records for *vicinus* in AL (e.g. Dakin and Hays 1970) are apparently based on specimens that are in fact *acletus*.

We do not know the country of origin of the *S. vicinus* now occupying FL, southeastern GA, and southernmost SC (Fig. 2). The common belief that it came via Puerto Rico is refuted by our studies of Puerto Rican "*vicinus*." The tape of the call of a changa near Isabella, P.R., showed a pulse rate of ca. 60/sec and a carrier frequency of ca. 4.2 kHz. This compares with ca. 140/sec and 3.2 kHz for Alachua Co., FL, *vicinus* and with 55 and 2.7 for Alachua Co. *acletus* (Ulagaraj 1976). Furthermore, the interdactyl distance (Fig. 4), the character most useful in distinguishing between U.S. *acletus* and *vicinus* (Blatchley 1920), is, for Puerto Rican "*vicinus*," intermediate. Measurements of 28 specimens from Puerto Rico scarcely overlapped those of the 23 Alachua Co., FL, pinned specimens available for comparison (Fig. 5). All but 6 of the Puerto Rican specimens had been collected since 1968; 2 of the 3 earliest specimens (Rio Piedras, Jan.-Feb. 1902) had left interdactyl distances as small as some of the Florida specimens measured (Fig. 5).

Mole crickets resembling U.S. *vicinus* (and Puerto Rico's changa) occur along the Atlantic coast of South America from northern Argentina through tropical Brazil and in Columbia, Panama, and Costa Rica. Uruguay and adjacent areas of Argentina and Brazil seem particularly likely to be the source of U.S. populations, since their climate is similar to the presumed ports of entry into the United States. Furthermore, Bahiagrass cultivars that *vicinus* attacks in Florida originated in that part of South America.

Early records of *S. acletus* in the United States fit a pattern nearly identical to that of *S. vicinus* (Fig. 1). It was first found at Brunswick, GA, and had been collected no farther than 65 km away by 1910. Later events are more difficult to interpret, but an additional introduction at Charleston, SC, by 1915 seems likely, and independent introductions at Mobile, AL, by 1919 and Port Arthur (or Galveston), TX, by 1925 are nearly certain. The spread of *S. acletus* into peninsular Florida is the clearest part of the record and surprisingly recent. The earliest record for Jacksonville is 1924; the species reached Sanford in 1930 and precipitated a USDA study as mentioned above. Like *vicinus*, *acletus* did not complete its spread southward until ca. 1960.

*Scapteriscus acletus* has a much more extensive U.S. range than does *vicinus* and it may yet spread farther. However, scattered records in the 1960's inland from its generally coastal plains distribution (Fig. 1) and the scarcity of such records since then suggest that it has now occupied those areas permanently suited to it.

Conspicuous morphological variation among U.S. populations of *S. acletus* supports our hypothesis of multiple introductions (DAN, unpubl.). Briefly, most U.S. *acletus* specimens fall into one of two easily recognized categories: (1) *Mottled* (=M). Pronotum distinctly ovate; lateral light areas extending irregularly into median dark area of pronotal disc (the holotype of *acletus*—see Fig. 9, plate XIV, Rehn and Hebard 1916—is

<sup>3</sup> H. O. Schroeder, unpublished report, USDA Bureau of Entomology and Plant Quarantine, "Mole Cricket Control Project, Plant City, Florida, Report on Control Activities, September 1–December 31, 1940," 75 pp. (Copy on file in Division of Plant Industry Library, FL Dept. of Agr. Gainesville.)

this form). (2) *Four-dots (4-D)*. Pronotum with sides subparallel; disc all or nearly all dark with four small pale dots arranged in a trapezoid (Fig. 13, Plate XIV, Rehn and Hebard 1916, resembles this form). Early U.S. specimens and present geographical limits of the

two forms indicate that the introduction at Brunswick was M; at Charleston, 4-D; at Mobile, M; and at Port Arthur, 4-D. The chief complicating factor is that 4-D now occupies peninsular Florida. It may have spread southward along the coastal islands of Georgia, or it

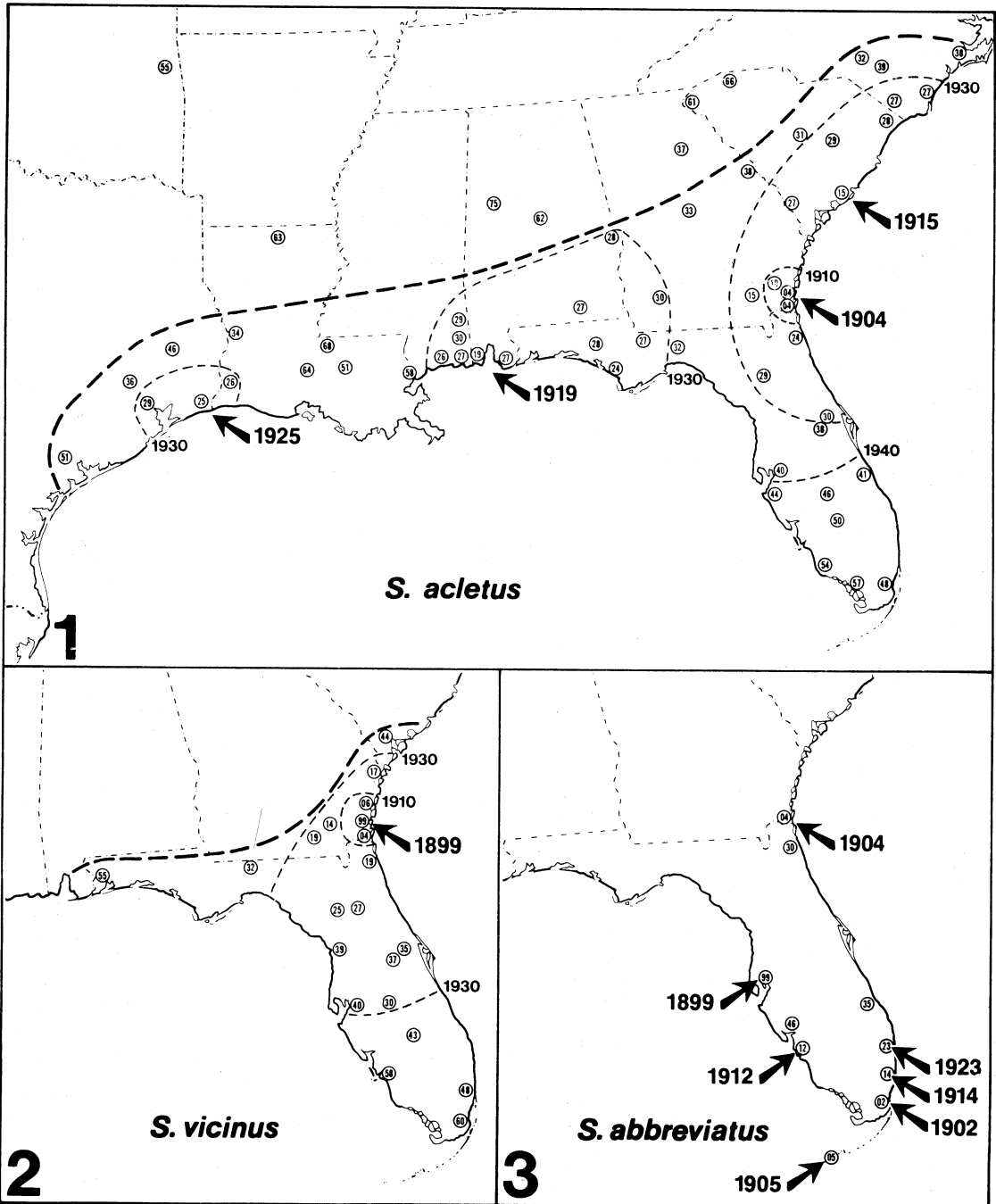


FIG. 1-3.—Introduction of *Scapteriscus* spp. into United States. Circled numbers are the last two digits of the year of the earliest record for that locality. Years with arrows show place and latest approximate date of apparently independent introductions. (Maximum rate of unaided spread for *S. vicinus* and *S. acletus* was estimated at 20 km/yr. Thin dashed lines show limits of spread for indicated date. Heavy dashed lines estimate the limits of continuing populations. Records beyond these limits are probably accidentally transported specimens or short-term populations. (See Appendix for documentation of all mapped records.) Fig. 1. *S. acletus*. Fig. 2. *S. vicinus* (one 1932 Texas record omitted—see text). Fig. 3. *S. abbreviatus*.

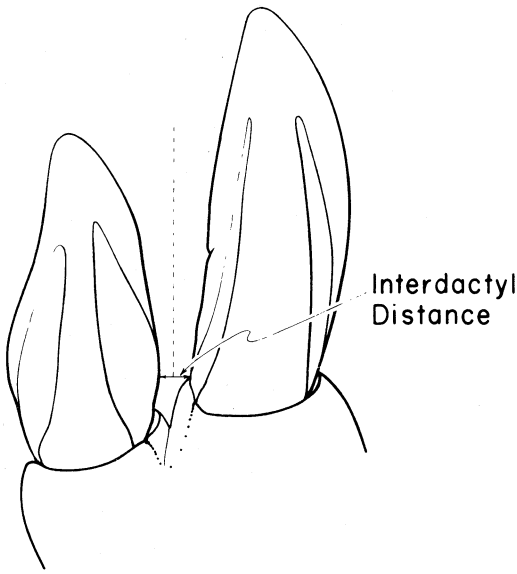


FIG. 4.—Measurement of *interductyl distance*, the separation of the tibial dactyls at their bases.

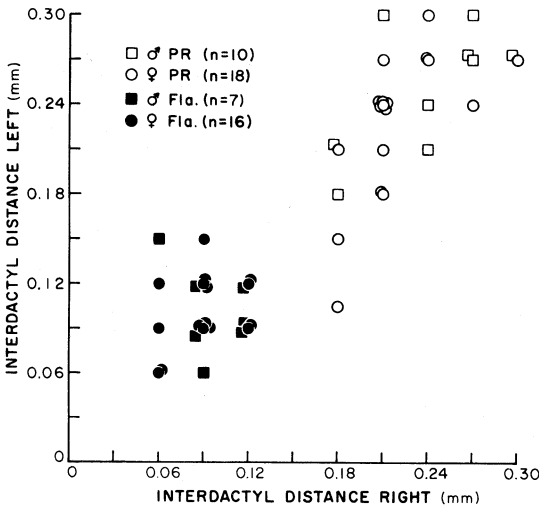


FIG. 5.—Interductyl distances of pinned specimens of *S. vicinus* from Alachua County, Fla., and changa from Puerto Rico.

may have been introduced anew at Jacksonville ca. 1924. Intermediates between the two types occur in north peninsular Florida and along the Savannah River—supporting the hypothesis that 4-D and M are conspecific but from different sources.

These sources are likely to be in South America south of the equator and east of the Andes—mole crickets resembling *acletus* occur in northern Argentina, Uruguay, Paraguay, Bolivia, and Brazil. The same areas identified as likely sources of *vicinus* are prime prospects as *acletus* sources as well. On the basis of turn-

of-the-century commerce, Buenos Aires and Montevideo seem the most likely ports of origin.

*Scapteriscus abbreviatus* has a curious history in the U.S. (Fig. 3). It was established at five widely separated southeastern ports by 1912 and by 1915 was considered a significant pest of vegetables in the vicinity of Miami (Hebard 1915). *Scapteriscus abbreviatus* at Miami may have arrived in manure from Key West (Hebard 1915), but the other four early localities seem likely to represent independent importations to the U.S. Unlike *vicinus* and *acletus*, which are strong fliers, *abbreviatus* is flightless, and its natural spread into new areas should be scarcely perceptible. In fact it is as yet known at few localities other than its presumed ports of entry. The only inland record (Gainesville, FL, April, 1924, Univ. Mich. Mus. Zool.) lacks confirming details. The species is seldom collected; perhaps it has become rarer since *vicinus* and *acletus* spread into its habitats. The most recent U.S. specimens we have seen are from Hollywood, Fla. (3338 McKinley Street, 24 May 1968, 2 ♂, many early instars, FL. St. Coll. Arthrop.).

The homeland of U.S. *abbreviatus* is as uncertain as for the other two species. Although Scudder (1869) described *abbreviatus* on the basis of a specimen from Pernambuco, Brazil, all the foreign material we have seen is from the West Indies. We doubt it is native there.

**Discussion**

The fact that important pest species in the United States are poorly studied taxonomically should come as no surprise to those familiar with similar circumstances for imported fire ant (Buren 1972), alfalfa weevil (Schroder and Steinhauer 1976), and European corn borer (Cardé et al. 1978). In the case of *Scapteriscus* spp. the economic consequences of improved taxonomic knowledge may be great. Foremost is the clear indication that both *acletus* and *vicinus* are species introduced to the United States without their normal complement of natural enemies. The high population levels, and accompanying damage, may thus be analogous to cottony cushion scale in California in 1888 or prickly pear in Australia in 1925 (Huffaker and Messenger 1976). Of less and opposite consequence is the diminution of prospects for biocontrol of *vicinus* in the U.S. through introduction of the sphecoid wasp, *Larra bicolor* (Fabr.) from Puerto Rico. *Larra bicolor* was introduced from Belem, Brazil, into Puerto Rico, where it became established and preys only on changa (Wolcott 1941). Although its effect on changa populations has not been documented, it is the only natural enemy of *Scapteriscus* spp. studied well enough to make it a candidate for immediate introduction into the U.S. Its success will entail a greater change in host than previously thought necessary. Finding the localities of origin for *vicinus* and *acletus* and searching there for their natural enemies are clearly of highest priority in seeking a long term solution to mole cricket problems in southeastern United States.

The improved knowledge of the taxonomic status of U.S. pest mole crickets may not necessitate changes in their scientific names. The *vicinus* that occurs in the United States is morphologically closer to Scudder's

extant syntype (Otte 1978) than is Puerto Rico's change. The apparently mixed origins of *acletus* in the United States should make it significantly different from any Latin American population, and our quarantine procedures should insure that it continues as an evolutionarily isolated line—regardless of possible reproductive compatibility with one or more named populations of Latin American *Scapteriscus*.

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#### Appendix

Listed below are the records of *Scapteriscus* spp. used to reconstruct their introduction and spread in the United States. The source collections are abbreviated as follows: ANSP (Academy of Natural Sciences of Philadelphia), AMNH (American Museum of Natural History), AU (Entomology Museum, Auburn University), CU (Insect Museum, Clemson University), FSCA (Florida State Collection of Arthropods), LSU (Insect Collection, Louisiana State University), MSU (Insect Collection, Mississippi State University), NCDA (North Carolina Department of Agriculture), UMMZ (University of Michigan Museum of Zoology), USNM (U.S. National Museum). The records are arranged by date to facilitate verifying the mapped data (Fig. 1–3).

*Scapteriscus vicinus* (Fig. 2): 1899, Brunswick, GA (Chittenden 1903: 116, as *didactylus*); 1903 (not mapped), Brunswick, GA, 23 Jan.–5 Feb. (3 ♂, 3 ♀, 2 juv., ANSP, USNM); 1904, White Oak, GA, 9 Apr. (2 ♂, 1 ♀, ANSP), 1906, Darien, GA, Sep. (1 ♂, ANSP); 1914, Waycross, GA, 20 Oct. (1 juv., USNM); 1915 (not mapped), Hebardville, GA, 15 May (2 ♂, 2 ♀, ANSP); 1917, Savannah, GA, 9 Mar. (1 ♀, 1 juv., USNM); 1919, Du Pont, GA; 12 Mar. (1 ♀, USNM); 1919, Jacksonville, FL, Sep. (1 ♂, 1 ♀, 1 juv., USNM); 1925, Gainesville, FL, 30 Mar. (1 ♀, FSCA); 1927, Palatka, FL, Mar. (1 ♂, USNM); 1930, Winter Haven FL, 21 Aug. (1 juv., FSCA); 1932, Monticello, FL, 10 Jun. (1 ♂, UMMZ); 1932 (not mapped), Orangefield, TX, 10 May (USNM record, det. A. N. Caudell; no specimen found; 1 ♀ “attacking plants and flowers”); 1935, Sanford, FL, 15 Jan. (2 ♂, 2 ♀, USNM); 1939, Winter Park, FL, 15–21 Feb. (3 ♂, 7 ♀, AMNH); 1939, Inverness, FL, 2 Mar. (1 ♂, FSCA); 1940, Plant City, FL, (20 ♂, 32 ♀, 3 juv., FSCA); 1943, Lake Placid FL, Feb. (1 ♂, 41 ♀, AMNH); 1944, Levy, SC, 4 Oct. (1 ♀, USNM); 1948, Hollywood, FL, 23 Nov. (2 juv., FSCA); 1955, Century, FL, 22 Oct. (1 ♀, 2 juv., FSCA); 1958, Corkscrew Swamp, (1 ♂, FSCA); 1960, Dade Co., FL, Apr. (1 ♀, FSCA).

*Scapteriscus acletus* (Fig. 1): 1904, Brunswick, GA, 16 Apr. (1 ♂, 1 ♀, USNM); 1904, White Oak, GA, 23

- Mar., Apr. (2 ♂, 1 ♀, USNM); 1910, Jesup, GA, 15 May, 1 Jun. (2 ♀, ANSP); 1915, Charleston, SC, Sep. (1 ♂, USNM); 1915, Hebardville GA, 15 May (21 ♂, 21 ♀, 20 juv., ANSP, USNM); 1919, Mobile, AL, 10 Nov. (1 ♀, USNM); 1924, Jacksonville, FL, 4 Sep. (2 juv., USNM); 1924, Panama City, FL, 9 Oct. (1 ♀, UMMZ); 1925, Beaumont, TX (1 ♂, 1 juv., USNM); 1926, Lake Charles, LA, 23 Oct. (1 ♂, USNM); 1926, Gulfport, MS, 1-9 Sep. (3 ♂, USNM); 1927, Moss Point, MS, 24 May (3 ♂, MSU); 1927, Bay Minette, AL, Sep. (4 juv., USNM); 1927, Enterprise, AL, 15 Jun. (1 ♂, AU); 1927, Quincy, FL, 20 Jan. (2 juv., USNM); 1927, Hampton Co., SC, 21 Apr. (2 ♀, CU, USNM); 1927, Carolina Beach, NC, 21 May (1 ♂, ANSP); 1927, Lake Waccamaw, NC, 20 Apr. (1 ♂, ANSP); 1928, Chipley, FL, 15 Oct. (1 ♂, AU); 1928, Auburn, AL, 12 Apr. (1 ♀, AU); 1928, Marion, SC, 14 May (1 ♀, CU); 1929, Gainesville, FL, 22 Apr. (1 ♀, UMMZ); 1929, Green Co., MS, May (2 ♂, 1 juv., MSU); 1929, Summerton, SC, 26 Apr. (2 ♀, CU); 1929, Baytown, TX, 6 Jun. (1 ♀, USNM); 1930, Albany, GA, 10 May (1 ♂, UMMZ); 1930, Bexley, MS, 18 Mar. (1 ♂, 2 ♀, 1 juv., MSU); 1930, Sanford, FL, 20 July (1 ♀, 2 juv., USNM); 1931, Columbia, SC, Aug. (1 ♀, USNM); 1932, Monticello, FL, 30 May-8 Oct. (5 ♂, 25 ♀, UMMZ); 1932, Aberdeen, NC, 23 Jun. (1 ♂, NCDA); 1933, Ft. Valley, GA, 2 Nov. (1 ♀, 3 juv., USNM); 1934, Vernon Par., LA, 2 Jun. (1 ♂, 1 ♀, USNM); 1936, Conroe, TX, 16 May (2 ♀, USNM); 1937, Athens, GA, 7 Oct. (1 ♂, UMMZ); 1938, Winter Park, FL, Mar. (4 ♂, AMNH); 1938, Augusta, GA, 28 May (1 ♀, FSCA); 1938, Bath, NC, 10 Aug. (1 ♂, North Carolina State Univ.); 1939, Fayetteville, NC, 28 Jan. (1 juv., NCDA); 1940, Plant City, FL, 22 Sep. (3 ♂, 3 ♀, FSCA); 1941, Fellsmere, FL, 28 Oct. (1 ♂, 1 ♀, USNM); 1944, Tallevast, FL, 5 Sep. (26 juv., USNM); 1946, Sebring, FL, 18 May (1 ♀, FSCA); 1946, Livingston, TX, 4 Apr. (1 ♂, 3 ♀, AMNH); 1948, Dade Co., FL, 24 Apr. (1 ♂, FSCA); 1950, Hendry Co., FL, (1 ♀, FSCA); 1951, Victoria, TX, 27 May (1 ♂, UMMZ); 1951, Baton Rouge, LA, 30 Oct. (1 ♂, 1 ♀, LSU); 1954, Marco, FL, 28 Mar. (1 ♂, USNM); 1955, Cherokee, OK, 17 Aug. (1 ♀, USNM); 1957, Collier Co., FL, 28 Apr. (1 ♀, USNM); 1958, Covington, LA, 27 Jun. (1 ♀, UMMZ); 1961, Clemson, SC, 1 Aug. (1 ♀, CU); 1962, Clanton, AL, 13 Sep. (2 ♀, AU); 1963, Farmerville, LA, 2 Jun. (1 ♀, LSU); 1964, Krotz Springs, LA, 4 July (1 ♀, LSU); 1966, Spartanburg Co., SC, 11 Aug. (1 ♀, CU); 1968, Elm Park, LA, 12 May (1 ♀, LSU); 1975, Samantha, AL, 30 May (1 ♂, USNM).
- Scapteriscus abbreviatus* (Fig. 3); 1899, Tampa, FL, 7 Feb. (2 ♂, 1 ♀, ANSP, USNM); 1902, Miami, FL, 21 Nov. (3 ♂, 2 ♀, 4 juv., USNM); 1904, White Oak, GA, Apr. (1 ♂, 3 ♀, 1 juv., ANSP, USNM); 1905, Key West, FL, (2 ♂, 1 ♀, 1 juv., USNM); 1912, Ft. Myers, FL, 22 Apr. (5 ♂, 1 ♀, 2 juv., AMNH); 1914, Ft. Lauderdale, FL, 30 Nov. (1 juv., USNM); 1923, Lake Worth, FL, 2 Sep. (1 ♂, FSCA); 1930, New Berlin, FL, 17 Sep. (1 juv., FSCA); 1935, Salerno, FL, 1 Nov. (1 juv., FSCA); 1946, Punta Gorda, FL, 12 Jan. (1 juv., AMNH).