

Landing Distribution and Density of Two Sound-Attracted Mole Crickets (Orthoptera: Gryllotalpidae: *Scapteriscus*)¹

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ABSTRACT Flying adults of two mole crickets, *Scapteriscus acletus* and *S. vicinus*, were attracted to synthetic, conspecific male calling songs, broadcast at 116 to 117 dB, and centrally positioned over a series of concentric rings to investigate their landing distribution. Landing densities of *S. acletus* were more consistent and concentrated about the sound than were densities of *S. vicinus*. Landing densities per m² were fitted to a power function of the form $Y = (x/a)^{-\beta}$, where x is distance from the sound source, Y is expected density relative to that at 0.5 radius of a 1.5-m-diameter circle (containing sound source at center), and β is the rate at which relative density decreases with distance. Predicting mole cricket landing densities outside a 1.5-m-diameter ring (used in standard sound trapping) is important in estimating total numbers attracted.

The mole crickets *Scapteriscus acletus* Rehn and Hebard and *S. vicinus* Scudder are important turf and agricultural pests in southeastern states. The seasonal flights of these subterranean species occur soon after dusk and last ca. 1 h (Hayslip 1943). In Gainesville, Fla., major flights of adults occur during the spring months, with lesser flights in the fall; the spring flights of *S. vicinus* are earlier than those of *S. acletus* (Ulagaraj 1975). During these flights, large numbers can be attracted by broadcasting synthetic male calling songs at higher than natural intensities. Ulagaraj and Walker (1973) observed that males and unmated females, as well as mated females, are attracted to sound. They suggested that these dispersal flights are both for mating and for selection of a habitat suitable for colonization. Forrest (1980) observed that females are attracted to and select males which call the loudest. He monitored nightly intensity differences among naturally calling males and noted that "high-intensity" males attract up to 10 times as many females as males calling at lower intensities.

Because sound attracts large numbers, and both sexes, of *S. acletus* and *S. vicinus*, phonotaxis in sound trap stations may be used to monitor adult seasonal-geographical distribution and may perhaps also be useful in population estimation and control. Ulagaraj (1974) suggested that a limitation to using sound for control was trap size and efficiency. Using a prototype trapping device, he concluded that no more than 20 to 55% of attracted crickets landed in a 1.2-m-diameter funnel. The remaining crickets he captured landed immediately outside the trap and would have burrowed into the ground. More recently, Dong and Beck (1982) concluded that 1.5 m diameter traps, currently used in routine sound trapping, have little potential for mole cricket control.

No literature is available concerning distribution of mole crickets landing beyond a 1.5-m-diameter trap. We investigated the landing patterns of sound-attracted *S. acletus* and *S. vicinus* to better understand their landing density and distance relative to a synthetic male calling

song. This information may be useful in future sound-trapping studies and also provide a means of estimating potential catch.

Materials and Methods

Landing distribution of *S. acletus* was investigated for 16 consecutive nights (3 to 18 May) in spring 1980 at the University of Florida Green Acres Agronomy Farm (Sec. 27, Tp. R18E, T9S).

Captured *S. acletus* adults were prevented from burrowing into the ground by a sheet of visqueen plastic (6.1 by 6.1 m) spread over a weed-free area (see Fig. 1). Sections of 26-gauge galvanized sheet metal, 1.2 m long by 0.23 m high, were fastened together with screws to form three concentric trapping areas. Circumference of rings, 1.5, 3.1, and 4.6 m in diameter, was maintained by pine boards (1.5 m-long, 2.5 by 15.2 cm), forming intra-ring quadrants. Duct tape and caulk se-

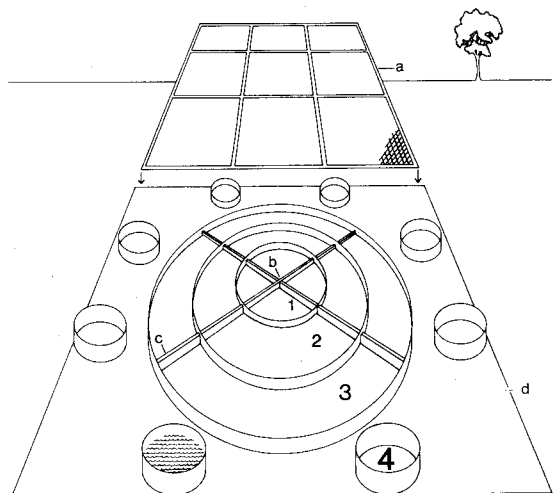


FIG. 1.—*S. acletus* trapping set-up. Area 1, 1.5-m-diameter center ring; 2, 3.1-m-diameter second ring; 3, 4.6-m-diameter third ring; 4, 0.9-m-diameter wading pools positioned 0.3 m from third ring and forming a peripheral fourth ring. (a) Removable top for trap; (b) position of sound unit; (c) pine boards used to maintain circumference of rings; (d) plastic sheet.

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cured the base of boards and sheet metal rings to plastic to prevent mole cricket migration. A 4.9-m² removable top, which prevented crickets from flying out after landing, was constructed of three sections of 1.3-cm-diameter, thin-wall PVC pipe, forming a frame, and covered with 2.5-cm-diameter wire netting. Eight wading pools (0.9 m in diameter by 0.46 m high), filled partially with water, were positioned equidistantly 0.3 m from outer trap ring. Numbers of crickets landing in these pools were multiplied by 4.2 to reflect a fourth trapping ring, 7 m in total diameter. Landing areas (m²) in each ring were: center ring, 1.8; second ring, 5.8; third ring, 9.0; fourth ring, 21.9.

A sound-synthesizing unit (Walker 1982), simulating a calling *S. acletus* male, broadcast each evening at 116 dB at the center of the center trap ring. After the nightly flight period, crickets captured in each trapping ring were counted by sex and removed.

Mole crickets are efficient swimmers and the ease with which landing crickets could be collected from the water surface of wading pools prompted a different (and larger) trapping design when investigating landing distribution and density of *S. vicinus* the following spring (26 March to 27 April 1981). Twenty-five 1.5-m-diameter wading pools, filled partially with water, were positioned to form four sampling rings (Fig. 2) in a grass field at the University of Florida Horticultural Unit (Sec. 9, Tp. R19E, T9S). The first or center ring consisted of one pool which sampled 100% of area. Subsequent rings were formed, around the center ring, by equidistant pool placement which allowed 50% of each added ring area to be sampled: second ring, 4.6 m in diameter, (4 pools); third ring, 7.6 m in diameter, (8 pools); fourth ring, 10.7 m in diameter, (12 pools). Areas (m²) of rings were (center) 1.8; (second) 14.8; (third) 28.8; and (fourth) 4.5.

A sound-synthesizing unit, simulating *S. vicinus* calling, was secured by a yoke over the center ring and powered by a 12-V automobile battery. An automatic timing device operated the caller at 117 dB. After each nightly flight period, crickets captured in pools were counted by sex and removed.

In both studies, air temperatures were recorded nightly, midway through the calling period. Nonlinear regression analysis was used to fit a power curve to the data on relative catch as a function of landing distance from the sound unit.

Results and Discussion

Totals of 12,565 *S. acletus* and 4,517 *S. vicinus* were trapped during their respective study periods. *Scapteriscus acletus* catches ranged from 28 to 2,557, with >1,000 crickets captured on each of four nights. An *S. vicinus* flight yielding >1,000 trapped crickets occurred only once; other nightly catches ranged from 2 to 552. In both species, more female crickets than male crickets landed in each trap; additionally, percent captured females decreased and % males increased with increasing distance from the sound unit. Overall sex ratio of trapped crickets was 3.3 females to 1 male for *S. acletus* and 7.5 females to 1 male for *S. vicinus*.

Mole crickets occasionally are attracted to heterospecific male calling songs but not in large numbers. Ulagaraj and Walker (1973) played taped, natural and synthetic male songs and showed that the conspecific attraction of both *S. acletus* and *S. vicinus* is mainly due to distinct differences in pulse rates and carrier frequencies of their songs. In our studies, mole crickets were highly specific in their response to male calling, with <1% attracted heterospecifically.

Nonlinear regression curves applied to *S. acletus* and *S. vicinus* landing data, as a function of distance from the sound source, are shown in Fig. 3. For both species, density of crickets landing in the 1.5-m-diameter center ring each sampling night (*S. acletus*, $n = 16$; *S. vicinus*, $n = 26$) was used as the standard (100%). Nights when <80 total crickets were trapped (*S. acletus* males, $n = 2$; *S. vicinus* males, $n = 12$; *S. vicinus* females, $n = 1$) sometimes resulted in crickets not landing in the center ring, and these landing data were not included in analyses.

The curve chosen to describe decay in expected catch was a power function of the form $Y = (x/a)^{-\beta}$, where $Y =$ density per m² at a distance x from the center. The model parameters a and β were estimated under the restriction that $Y = 1$ at 0.5 radius of the 1.5-m-diameter center ring (i.e., at $x = 0.38$ m). This results in the requirement that $a = 0.38$ m. Parameter β is the rate at which relative density decreases with distance from the center ring. Estimates of β were obtained by using nonlinear regression with relative densities for each ring assigned to the midpoint radius for that ring; therefore, using β values, expected relative densities per m² of mole crickets landing at specific distances from a sound source can be estimated. Beta value for total *S. acletus* was 1.237; for *S. vicinus*, 4.220.

0.422

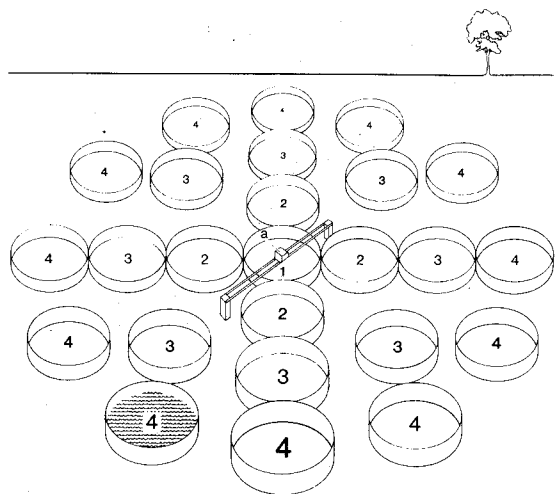


FIG. 2.—*S. vicinus* trapping set-up. Twenty-five 1.5-m-diameter wading pools formed four sampling rings: 1, 1.5-m-diameter center ring; 2, 4.6-m-diameter second ring (4 pools); 3, 7.6-m-diameter third ring (8 pools); 4, 10.7-m-diameter fourth ring (12 pools). Sound unit (a) was over center of center ring.

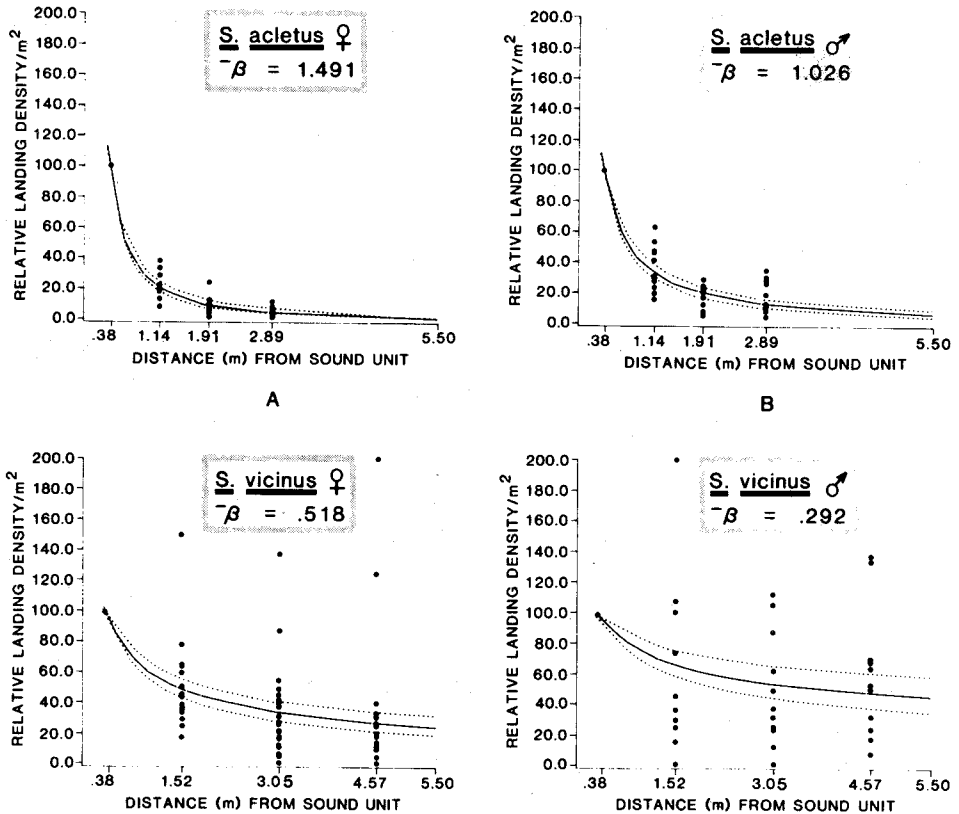


FIG. 3.—Landing density, as a function of distance from sound unit, for *S. acletus* (A, B) and *S. vicinus* (C, D). Center curves (solid lines) are expected relative landing densities; outer curves (dotted lines) are 95% confidence limits on the predicted mean curve. Distances are from the sound unit to the midpoint of each of the four rings (i.e., to 0.5 radius of each trap ring).

S. acletus (Fig. 3A and B) were more consistent in their landing density and their landing distribution was clustered more closely about the sound source than were *S. vicinus* (Fig. 3C and D) (some points on graphs, for both species, are overlapping). Observed and expected relative landing densities per m² for female and male *S. acletus* decreased sharply from center ring outward, with the greatest decrease occurring among females. At 3 m from the sound unit, expected relative densities of landing *S. acletus* had dropped to ca. 10% for females and 20% for males.

Observed and expected relative landing densities for *S. vicinus* were higher in outer rings than for *S. acletus*. Observed densities for *S. vicinus* (Fig. 3C and D) above 100%, which occurred almost twice as often for males than for females, indicate samples in which individuals landed at higher densities in outer trap rings than in center ring; night-to-night landing distributions varied considerably for both sexes of *S. vicinus*. At 4.5 m from the sound unit, the expected density, relative to the center ring, was ca. 30% for females and 50% for males.

Based on mean daily proportions (proportions of total crickets landing in different trap rings, each collecting night), more than one-third (36%) of trapped *S. acletus*, compared with only 7.5% *S. vicinus*, would be expected

to land in a 1.5-m-diameter ring. Mean daily proportions of *S. acletus* expected to land in a 4.6-m-diameter trap (total of center, second, and third trap rings [Fig. 1]) would be ca. 75% as compared with ca. 30% for *S. vicinus* landing in a 4.6-m-diameter trap (center ring plus second trap ring; Fig. 2).

Expected mole cricket relative density, for any distance from the sound source, can be predicted by inverting the equation

$$\left[Y = (x/a)^{-\beta} \right] \text{ to } \left[\frac{a}{-\beta\sqrt{Y}} = x \right]$$

Through interpolation, a specified relative landing density can be selected (e.g., 65% of density landing in center ring) and determined at what distance from the sound unit it would be expected to occur. Considering differences in landing patterns observed between the two species in this study it would appear to be a more reliable indicator for *S. acletus* than for *S. vicinus*. More work is needed to ascertain and better understand the significance of landing differences, relative to a sound source, between the two species. Results obtained from these studies, however, may be useful in population estimation and for determining the optimal circumference around

a sound unit in which materials should be applied to kill attracted mole crickets.

Other factors also may affect mole cricket flight and landing behavior. Ulagaraj (1975) noted that crickets do not fly at temperatures $<18^{\circ}\text{C}$ and the *S. vicinus* flight period may range from February to May in Gainesville when, early in the season, temperatures often approach or fall below this mark soon after sunset. About one-third of the nights during our *S. vicinus* study period, 80 crickets or less per night were captured when temperatures were near or below 18°C . Wind velocity and direction also affect their flight; R. L. Kepner (unpublished data) reports that they often fly downwind, and Beugnon (1981) observed that *S. acletus* would land less often on a sound source in windy weather. Additional information is needed concerning distances from which mole crickets may be attracted to sound. Intensity of the sound would undoubtedly affect this attraction (Forrest 1980) and possibly their landing distribution in relation to a sound source.

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