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SOUND TRAPS FOR SAMPLING MOLE CRICKET FLIGHTS (ORTHOPTERA: GRYLLOTALPIDAE: *SCAPTERISCUS*)

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ABSTRACT

Mole crickets (*Scapteriscus acletus* and *S. vicinus*) end their flights at conspecific calling songs. Routine monitoring of mole cricket flights was accomplished using timer-operated electronic sound synthesizers over 1.5 m diameter catching devices. Standard trapping stations, consisting of one *acletus* trap and one *vicinus* trap, have been operated nightly at various sites in Florida for up to 3 years. The record catch, thus far, of *acletus* at one station for one night is 3,297; for one year, 27,069. Corresponding values for *vicinus* are 1,216 and 2,959.

RESUMEN

Los cartones (*Scapteriscus acletus* y *S. vicinus*) terminan sus vuelos durante llamadas especiales de su especie. Observaciones rutinas de los cortones fueron hechas usando sintetizadores de sonidos electrónicos operados por temporizadores en receptores de 1.5 m. de diámetro. Las estaciones de trampas clásicas, consistentes de una trampa de *acletus* y una trampa de *vicinus,* fueron operadas por las noches en varios sitios en la Florida, por un máximo de tres años. La captura máxima de *acletus* hasta ahora en una estación durante una noche ha sido de 3,297; por un año, 27,069. Los valores correspondientes de *vicinus* son 1,216 y 2,959.

Ulagaraj and Walker (1973) were first to prove with controlled tests that flying mole crickets land at electronic reproductions of their calling songs. However, 2 students, each independent of the other, had earlier discovered the phenomenon as they replayed tape recordings of mole cricket calls outdoors (reported to me by J. E. Lloyd, ca. 1970, and by Buford Smith, 1979).

Ulagaraj (1975) and Ulagaraj and Walker (1973, 1975) developed basic techniques for using sound to trap mole crickets. Three components were involved: (1) *Sound source.* Ulagaraj and Walker (1973, 1975) used battery-operated, reel-to-reel or casette tape recorders to play recordings of natural or electronically synthesized sounds into battery-operated amplifiers that drove high-fidelity tweeters. (2) *Catching device.* They used 1.2 m diameter sheet-metal funnels beneath the speakers. Landing mole crickets slid down the sides of the funnel into an attached jar. (3) *Controller.* The electronic components of the traps were set up each evening at sunset and switched on and off by hand.

In this report I describe major improvements in each of the components and the application of the new techniques in establishing and operating trapping stations that automatically sample mole cricket flights. A by-product of sound trapping is an abundance of adult mole crickets for experimental purposes.

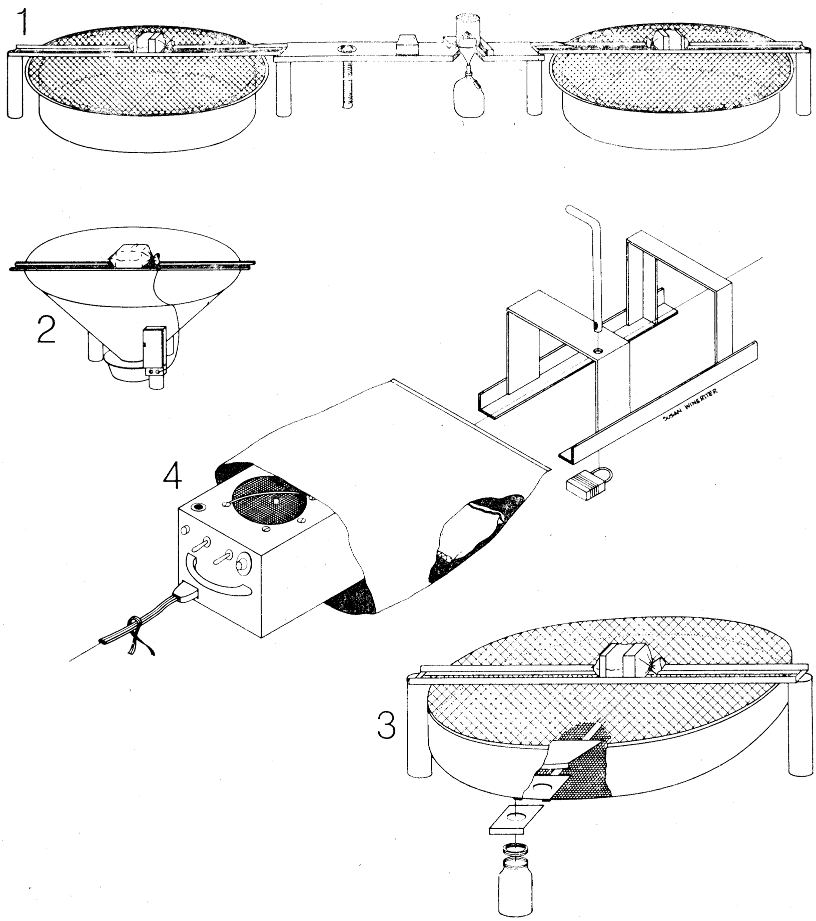

Fig. 1-4. A standard trapping station for mole crickets, other catching devices, and detail of an artificial cricket. 1) Standard trapping station, consisting of *acletus* trap, *vicinus* trap, timer, rain gauge, and graduated cylinder (for measuring rain). The traps are 2.0 m apart. A station can be powered by line current (110 v AC) or an automotive 12 v storage battery. Catching devices are "Flex-Wall" wading pools (Hampshire Manufacturing, Nashua, NH), partially filled with water. Cover of coarse net, stretched over hoop of plastic pipe, prevents mole crickets from flying from water surface and vertebrate predators from feeding on swimming crickets. 2) Sheet metal funnel (also 1.5-m diameter) emptying into covered plastic container. Either water or soil in the container increases its capacity to hold crickets without injury. 3) Obliquely truncated sheet metal cylinder, also 1.5-m diameter. Cover of coarse net (19 x 19 mm mesh, nylon fish net or poultrywire) prevents crickets from flying from cylinder. Sloping bottom of 3 x 3 mm mesh wire cloth allows rain to pass through but directs mole crickets into a removable wide-mouth, 4-liter plastic jar half filled with alcohol. If living crickets are desired, a 0.9 m diameter, shallow, covered container, partially

THE SOUND SOURCE: DEVELOPING AN "ARTIFICIAL CRICKET"

The previously used sound source was cumbersome, was difficult to keep in calibration, and required manual operation. Tape recorder, amplifer, speaker, and connecting cables had to be assembled and taken down each sampling period. Vagaries in the battery-operated tape transport mechanisms caused signal characteristics to deviate from target values. William Oldacre (Oldacre Electronics Co., Inc., P.O. Box 12951, Gainesville, FL 32604) overcame these difficulties by putting a power supply, synthesizer, amplifier, and speaker in a single 15 x 13 x 10 cm box (Fig. 4). A switch changes the synthesizer between *acletus* (2.7 kHz, 50 pulses/sec) and *vicinus* (3.3 kHz, 130 pulses/sec). Six nickel-cadmium "C" batteries provide sufficient power for 4 h portable operation at full output (ca. 118 dB at 15 cm). The internal nickel-cadmium cells can be fully recharged by connecting the unit for about 16 h to 120 v, 60 Hz AC. The unit can also be powered directly by AC connection. A third means of powering the artificial cricket is by an external lead-acid storage battery. A fully charged automotive battery can operate 2 units 2 hours every night for more than a month.

The artificial cricket synthesizes mole cricket calls by means of a dual-timer integrated circuit containing 2 square wave generators made to run at the carrier and wingstroke frequencies of the call. The wingstroke frequency is used to gate the carrier frequency on and off with a 50% duty cycle. A level potentiometer couples the composite output from the 2 oscilators to a high power complementary symmetry output stage. A transformer matches the low impedance amplifer output to a high impedance piezoelectric speaker. An external switch selects the carrier and wingstroke frequencies for either of the 2 species. These frequencies can be brought to exact target values by 4 internal trimpot controls.

CATCHING DEVICES: FUNNELS AND POOLS

Increasing the size of the catching device increases the numbers of crickets caught (Matheny et al. 1982), and the first improvement was to substitute 1.5 m diameter sheet metal funnels (Fig. 2) for the 1.2 m ones. However, large metal funnels are expensive and bulky to transport. Funnels of 6 mil (152 μm) polyethylene (Walker 1979) were inexpensive and easily transported, but support was troublesome and the crickets slid more slowly, giving them the opportunity to fly from the funnel. As used, all funnels had the effect of concentrating the catch in a small collecting container. On nights when hundreds of crickets were caught, they dismembered one another, rendering themselves difficult to identify and useless to experimenters needing healthy mole crickets.

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filled with water or soil can be substituted for the jar. 4) Detail showing "artificial cricket," protective plastic bag, cloth bag of desiccant, and security yoke. AC cord shown is for line operation or for recharging internal NiCad batteries. For operation from external 12 v DC source, power and timing controls connect to round socket on top. Wire across speaker prevents water from puddling on surface of plastic bag above. From left to right across front panel of artificial cricket are indicator red light for AC operation or battery charging, switch for power mode or manual operation, switch for *acletus* or *vicinus* call, level potentiometer.

The solution to most of these difficulties was to substitute a 1.5-m-diameter foldable wading pool for the funnel and partially fill it with water (Fig. 1). Mole crickets landing in water are buoyed up by their hydrofuge pile for 12-24 hours. Few can fly away (none, if the pool is covered with a coarse net), and they do not injure each other.

The chief limitation of pools is that the crickets must be collected daily (or every other day if live crickets are not required). When traps are to be tended at infrequent or irregular intervals, the captured mole crickets must be directed into a container of moist soil (for living specimens) or alcohol (for preserved ones). Traditional funnels direct not only crickets but rain water into the attached container. An obliquely truncated 1.5 m diameter sheet metal cylinder with a wire mesh bottom meets all requirements (Fig. 3). Landing mole crickets are directed into a 2- or 4-liter plastic container of alcohol or, if living crickets are needed, into a shallow, 0.9 m diameter covered container that holds water (for easy nightly collections) or soil (for collections at longer intervals).

CONTROLLERS: MAKING TRAPPING AUTOMATIC

When an artificial cricket is AC operated, it can be turned on and off each evening by means of a line-operated timer (Fig. 1,2). When it is battery operated, it can be turned on and off by a battery operated digital timer, such as either of 2 models available from Oldacre Electronics.

DEVELOPMENT OF TRAPPING STATIONS

Trapping stations that automatically sample flights of *acletus* and *vicinus* each evening are useful for a variety of studies (e.g. Walker et al. 1982, Walker and Fritz 1982). For the past 3 years the standard trapping station used by University of Florida researchers throughout the state has consisted of two 1.5-m-diameter catching devices spaced 2 m apart (Fig. 1,3). Over one is an artificial cricket that synthesizes *acletus* calling song; over the other is a unit set for *vicinus*. Each artificial cricket is protected from theft by a security yoke and from the weather by a 3 mil (76 μm) black plastic bag containing a cloth sack of desiccant (Fig. 4). A timer turns the units on at sunset each evening and off 2 h later, when the flight period for both species is over. The units are set to produce 106 dB, through the plastic bags, at 15 cm above the speakers. Since soil moisture has pronounced effects on mole cricket flights and Florida rains are often local, each station is equipped with a simple rain gauge (Fig. 1).

The traps are serviced nightly or weekly depending on the nature of the catching devices, the purposes of the study, and the intended uses for the trapped mole crickets. Sound levels are checked and adjusted semimonthly or monthly where feasible and no less often than quarterly. Calibration of carrier and wingstroke frequencies is monthly or quarterly. The timer is adjusted semimonthly to seasonally changing time of sunset; the plastic bag and sack of desiccant are replaced monthly, or more often if needed.

Trapping stations seldom failed to operate properly. For the 2 stations I tended during 1980 there were 4 instances of missed data: in 2 cases power interruptions of more than an hour had retarded the timer's clock so that the artificial crickets began their broadcasts after the flights were over. In 2 cases I erred by leaving switches in wrong positions.

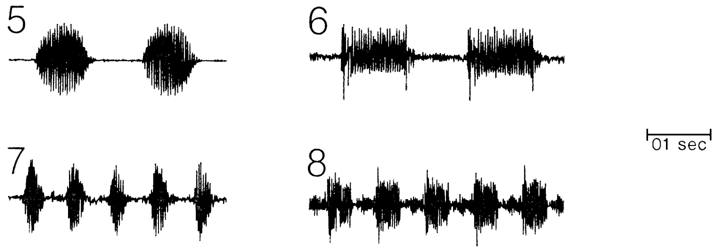

Fig. 5-8. Oscillograms of natural and synthetic mole cricket calls. 5) Natural *acletus*. 6) Synthetic *acletus*. 7) Natural *vicinus*. 8) Synthetic *vicinus*.

Additional problems have occurred at other stations and times. For example, armadillos got beneath a 1.5 m pool and destroyed it (Jerry Hagedorn, personal communication); white ibises used their long beaks to reach through the coarse netting and harvest the swimming crickets (J. A. Reinert, personal communication); raccoons and opossums forced their way into traps and consumed the crickets; thieves pried apart the parallel rails of the security yoke and made off with the artificial crickets; a dental assistant could not tolerate the dental-drill-like sound of synthetic *vicinus* as he tried to relax at his nearby house after a hard day's work.

The artificial crickets showed little drift in signal output. At least 95% of the times that units were calibrated, the values after one month operation in the field fell within these ranges: 2.70 ± 0.03 or 3.30 ± 0.03 kHz; 50 ± 1 or 130 ± 3 Hz; 106 ± 3 db.

The numbers of mole crickets caught in the sound traps at one station in one night are sometimes astonishing: up to 3,297 for *acletus* and 1,216 for *vicinus*. Yearly catches have totaled as high as 27,069 and 2,959. Matheny et al. (1982) showed that only about 36% of *acletus* ending flight in response to an artificial cricket land within a 1.5 m catching device; for *vicinus* the value was 7.5%. If these figures are used to estimate the maximal numbers *landing* in one night or one year at a single station, the values become 9,158 and 75,192 for *acletus* and 16,213 and 39,453 for *vicinus!*

Acknowledgements

Given minimal specifications, William Oldacre designed and manufactured artificial crickets of remarkable durability, reliability, precision, and power. T. G. Forrest participated importantly in improving the catching devices and in developing the trapping stations. E. L. Matheny, J. A. Reinert, and D. J. Schuster improved the manuscript. Florida Agricultural Experiment Station Journal Series No. 3216.

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