MARK-RELEASE OF SOUND-ATTRACTED MOLE CRICKETS: FLIGHT BEHAVIOR AND IMPLICATIONS FOR CONTROL

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ABSTRACT

Between 9 April and 22 June 1980, 9347 *Scapteriscus acletus* Rehn and Hebard flying to 3 sound traps were captured, marked and released in 3 Bahiagrass pastures at Gainesville, Florida. Of these, 7% were recaptured at least once. Most recaptures (67%) were at the trapping site where last released, 25% were recaptured at sites 250 or 420 m away (i.e. in an adjacent pasture) and 8% were recaptured 650 m away (i.e. in a pasture at the opposite end). Approximately 75% of the recaptures occurred within 5 days of release. Maximum elapsed time between release and recapture was 58 days. Three individuals were captured 4 times, and one individual returned to the same sound trap 3 consecutive nights. The probability of recapture was not significantly different for individuals released during the early, middle and late portions of the study. Males were less likely to be recaptured than females (2% versus 8%); however, recaptured males were more likely to be recaptured yet again than were recaptured females (16% versus 8%). Recaptured individuals never constituted more than 16% of the weekly catch, suggesting that killing all captured crickets would have had little effect on subsequent captures—i.e. that mole cricket population as judged by sound trapping, are not substantially reduced by sound trapping. A significant peak in recaptures occurred ca. 10 days after release, corresponding to the cycle of female oviposition.

RESUMEN

Desde el 9 de abril hasta el 22 de junio de 1980, 9,347 *Scapteriscus acletus* Rehn y Hebard volaron a trés trampas de sonido y fueron capturados, marcados, y soltados en trés potreros de pasto bahía, *Paspalum notatum* Flugges en Gainesville, Florida. De estos, 7% fueron recapturados por lo menos una vez más. La mayoría de los insectos recapturados (67%) se recapturaron en el mismo sitio donde se soltaron, 25% a 250 y 420 metros de distancia (en un pasto adyacente), y 8% a 650 metros de distancia (en un pasto en dirección opuesta). Aproximadamente 75% de las recapturas ocurrieron en los primeros 5 días después de la liberación. El tiempo máximo entre liberación y recaptura fué de 58 dias. Trés insectos fueron recapturados cuatro veces, y un insecto fué recapturado en la misma trampa de sonido 3 noches seguidas. La probabilidad de ser recapturados no cambió significativamente durante la primera, media, y última parte del estudio. Los machos tuvieron menos probabilidad que las hembras de estar recapturados (2% comparado con 8%); sin embargo, los machos que fueron ya recapturados fueron recapturados de nuevo más frecuentemente que las hembras recapturadas (16% comparado con 8%). Los individuos recapturados nunca constituyeron más de 16% de la captura semanal, sugeriendo que la exterminación de todos los grillos capturados hubiera tenido poco efecto sobre las recapturas subsecuentes—es decir, las poblaciones de cortones, juzgando por las capturas por sonido, no se reducen substancialmente

por las trampas de sonido. El número de capturas fué significativamente extremado cerca del décimo día después de haber soltado los insectos, correspondiente al ciclo de desove de la hembra.

Ulagaraj (1975) studied mole cricket dispersal flights and Forrest (1980, 1981) their phonotactic behavior, but little work has been done on mole cricket dispersal. This research was done simultaneously with that of Walker et al. (1982) to ascertain how often and at what intervals *acletus* males and females fly and to what extent these flights are local or long range (≧250 m). These aspects of mole cricket flight have important consequences relative to population dynamics and to sound trapping as a control technique or sampling device.

Methods

Three unlighted and non-irrigated rectangular fields of Bahiagrass pasture at the University of Florida's Sandhill Farm, Gainesville were used for the mole cricket mark-release study (Fig. 1). The mole crickets were attracted by using electronic devices simulating the male's call (Walker 1982), but louder (ca. 107-113 db at 15 cm). One trap was located in each field (Fig. 1). The mole crickets attracted by the sound were caught in 1.5 m diam. wading pools half filled with water (Fig. 2). Battery operated timers turned the devices on at sunset and off 2 hours later, after flights had ceased (Forrest 1981). The crickets caught were sexed and counted each night and im-

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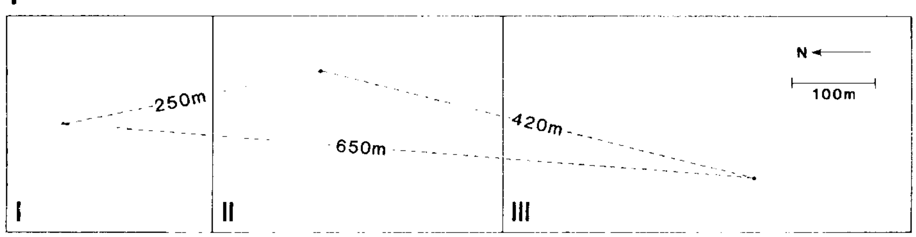

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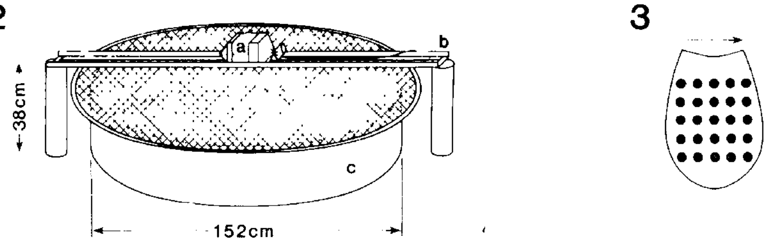

Fig. 1-3. Methods. Fig. 1. Map of bahiagrass pastures (I, II, III) at Sandhill Farm, University of Florida, Gainesville, showing locations and distances of traps. Fig. 2. Sound trap consisting of (*a*) sound synthesizer in protective bag, (*b*) yoke and supporting posts, (*c*) wading pool partially filled with water and covered with coarse net. Fig. 3. Pronotum showing 25 positions, each corresponding to a date. Different colors were used for different pastures and different 25-day periods.

mediately released at the same site, after being marked as follows: Tech-pen ink applied with a toothpick was used to dot the mole cricket's pronotum (Fig. 3: 5 columns and 5 rows). Each position corresponded to a date of capture. Different colors were used in different fields. After 25 days, the colors used were changed to start a new cycle of 25 days. The experiment lasted 75 days starting 9 April and ending 22 June 1980. By reading the marks (dots) in different colors and positions, the captured crickets were identified as to date(s) and site(s) they had previously been captured and released.

RESULTS AND CONCLUSIONS

(1) *Implications for use of sound traps in population control.* Overall, only 7% of the 9347 mole crickets marked and released were recaptured at least once during the course of the experiment (Table 1). If the capture from each night had been destroyed rather than marked and released, nightly catches of individuals would have changed little. We concluded that 3 sound traps had little impact on the total population. Control might be achieved by using large numbers of traps, similar to the approach discussed by Hartstack et al. (1971) for light traps; however, large numbers of traps would be expensive to purchase and operate. Furthermore, sound traps increase the local population by attracting individuals that escape capture (Matheny et al. 1982).

We further classified the data by sex and period of release (Tables 1 and 2). The recapture ratio for females did not change significantly in subsequent recaptures, but males were more likely to be recaptured again after being recaptured once. Overall, females were more likely to be recaptured than males (8% recapture vs 2%). The probability of recapture changed

TABLE 1. NUMBERS AND RATIOS OF *S. acletus* CAPTURED AND RECAPTURED WHILE FLYING TO SYNTHETIC CALLS. POPULATIONS FOLLOWED BY THE SAME LETTER WERE GROUPED FOR HYPOTHESIS TESTING.

	Females	Males	Total (♂ + ♀)
A/Captured only once	6838	1862	8700
B/Recaptured only once	553	38	591
Recapture ratio (B/A)	0.08[bd]	0.02[cd]	0.07[a]
C/Recaptured only twice	47	6	53
Recapture ratio (C/B)	0.08[bd]	0.16[cd]	0.09[a]
D/Recaptured thrice	2	1	3
Recapture ratio (D/C)	0.04[bd]	0.17[cd]	0.06[a]

[a]H_0 = Probability of recapturing males and females combined remains the same regardless of previous recaptures. $X^2 = 4.23$, $P = 0.275$

[b]H_0 = Probability of recapturing a female remains the same regardless of previous recaptures. $X^2 = 1.06$, $P = 0.6$

[c]H_0 = Probability of recapturing a male remains the same regardless of previous recaptures. $X^2 = 37.03$, $P < 0.005$

[d]H_0 = Probability of recapturing males and females is the same (compared over all recaptures). $X^2 = 81.53$, $P < 0.005$

TABLE 2. PROBABILITY OF RECAPTURE AS A FUNCTION OF PERIOD OF RELEASE. POPULATIONS FOLLOWED BY THE SAME LETTER WERE GROUPED FOR HYPOTHESIS TESTING.

	Females	Males	Total
9-30 April			
Released[a]	2387	465	2852
Recaptures[b]	248	10	258
Ratio	0.104	0.022	0.090[c]
1-20 May			
Released	4206	1328	5534
Recaptures	270	34	304
Ratio	0.055	0.025	0.054[c]
21 May-22 June			
Released	847	114	961
Recaptures	84	1	85
Ratio	0.099	0.099	0.088[c]

[a]All crickets released during the specified time period.

[b]Recaptures include all subsequent captures (no restriction as to date or number).

[c]H_0 = Probability of recapture is not the same for all seasons. $X^2 = 45$; df = 5; $P<0.01$.

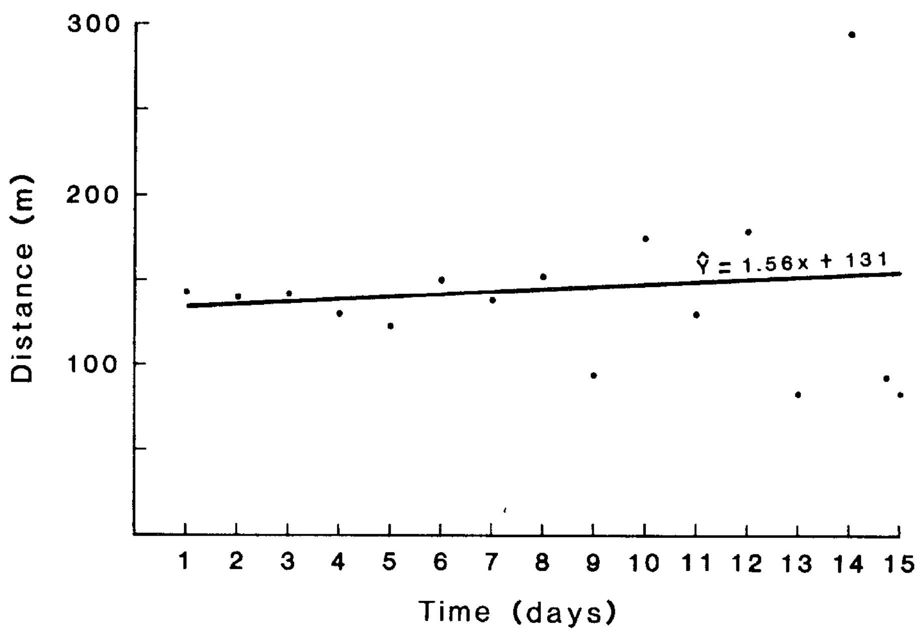

Fig. 4. Average distance traveled by marked mole crickets between release and recapture as a function of time between release and recapture. H_0: Slope = 0. Not rejected ($P>0.05$).

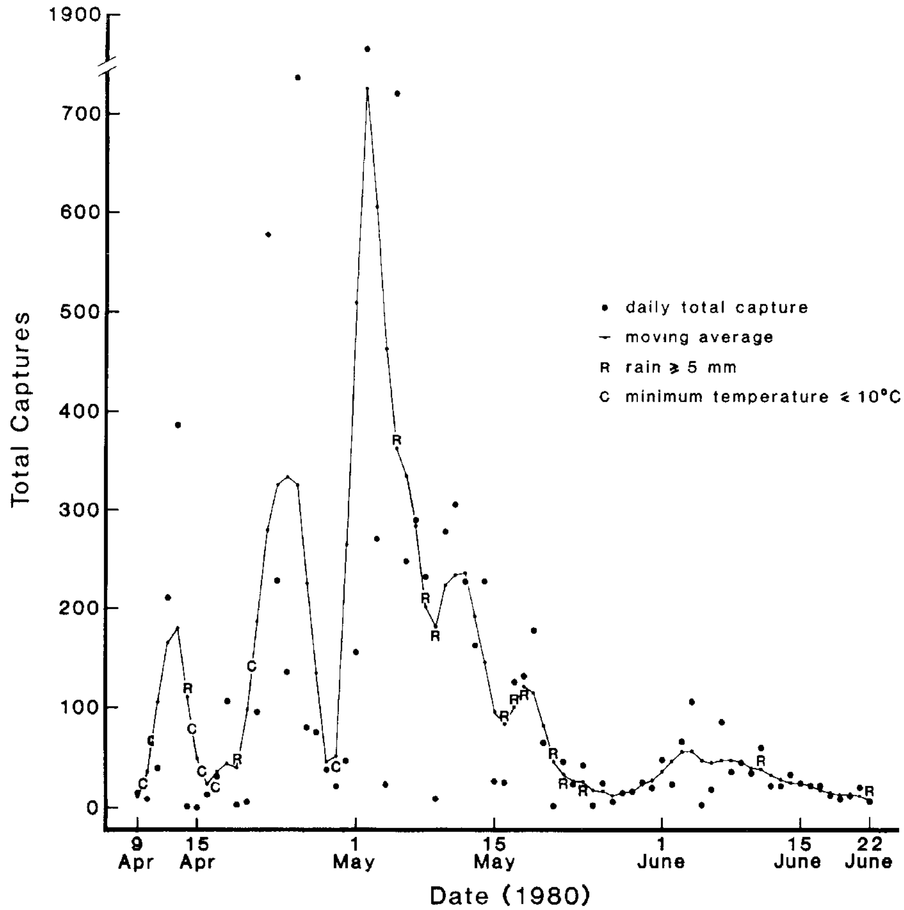

Fig. 5. Total daily captures, s(t), and double 3-day average, m(t), calculated as follows:

$$m(t) = \frac{s(t\text{-}2) + 2s(t\text{-}1) + 3\,st + 2s(t+1) + s(t+2)}{9}$$

slightly during the season. Minor changes in recapture ratio in various subpopulations do not change our conclusion regarding control.

(2) *Dispersal by flight and other population behavior.* Because the traps were located in 3 places, we were able to obtain measurements on distance traveled. We calculated average distances traveled between point of release and point of recapture for all mole crickets recaptured the same number of days after release. The calculations were repeated over intervals from 1-day to 15-day recapture times. Mean distance traveled between release and recapture does not increase significantly ,with time (Fig. 4). This is not characteristic of a mobile population. Pielou (1977, p. 166-80) described a random walk model in which the variance of distance between individual and point of release increased linearly with time. Our results indicate that recaptured individuals had remained in the area (possibly during maturing of eggs and contruction of egg cells). Of course we know nothing about those individuals that were not recaptured—whether they flew again but stayed in the area, or whether they permanently left the experimental area.

A double three-day moving average was used to smooth the graph of total captures each night (Fig. 5). The moving average eliminates disturbances which occur on a time scale of 0 to 3 or 4 days. Cycles in trap counts lasting ca. 9 days are evident. Neither rain nor cold weather account for the cycles (Fig. 5). Other trends are apparent in the sex ratio of captured crickets (Fig. 6). A sharp drop in the portion of male captures occurred around 20 May, about the time the total catch declined.

A final aspect of behavior is examined in the time to recapture curve (Fig. 7). The number recaptured versus time (from release to recapture) can be described by the exponential decay curve:

$$y = 0.3075\ e^{-.28x}$$

Most (75%) of the recaptures occur within 5 days after release. A significant peak occurs in the curve around day 10 ($P<0.05$ using X^2 test). Previous reports (Forrest 1981) indicate an egg laying cycle of 9-12 days. This corresponds with the peak on day 10 in Fig. 7, as well as the cycles in flight activity in Fig. 5.

(3) *Implications for sampling.* The mark-release experiment was also studied as a possible survey tool. The results in Fig. 5 suggest that the trap is a relative indicator of flight activity, but we have no independent method for verifying that the trap catch is specifically related to the size of the flying population. The effect of weather (wind speed, temperature) on trap catch needs to be explored.

As far as indicating absolute densities of mole cricket populations, some important assumptions of mark-release census are violated. Most important of these is that the probability of being captured is not the same for all individuals in the population. We can only capture that part of the popula-

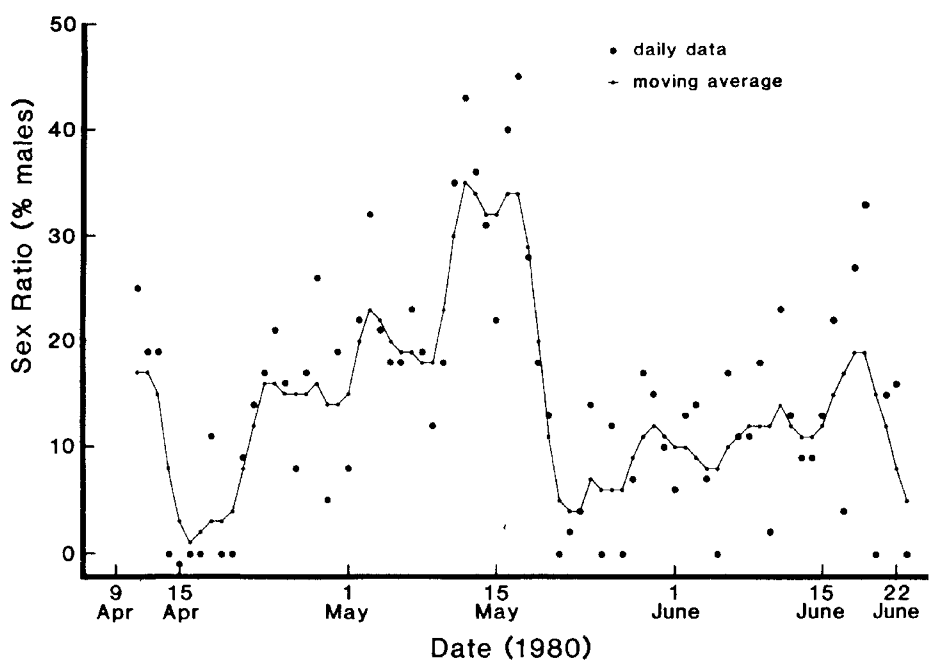

Fig. 6. Sex ratio of captured mole crickets and as a function of date. Moving average calculated as in Fig. 5.

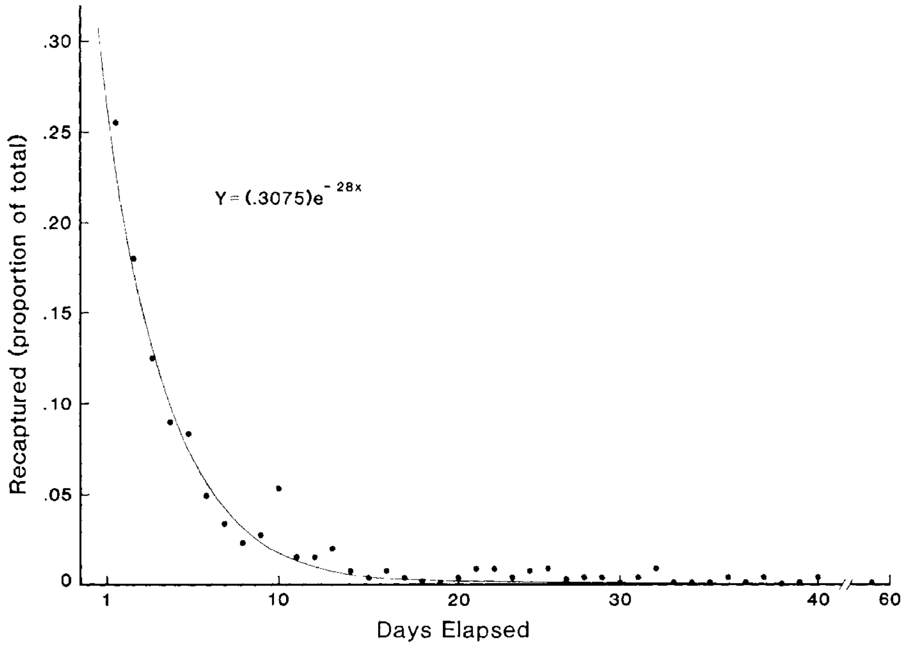

Fig. 7. Recaptures as a function of time since release.

tion which is flying. We cannot account for movement of individuals in or out of the area, or for sources of mortality, which must be known to estimate population densities. Unless sound trap catches can be related to a population dynamics model that describes movements, birth, mortality and migration, there is little hope for obtaining absolute density estimates.

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REFERENCES CITED

FORREST, T. G. 1980. Phonotaxis in mole crickets: its reproductive significance. Florida Ent. 63: 45-53.

———. 1981. Acoustic behavior, phonotaxis and mate choice in two species of mole crickets (Gryllotalpidae: *Scapteriscus*). M.S. thesis, Univ. of Florida, Gainesville. 72 p.

HARTSTACK, A. W., JR., P. P. HOLLINGSWORTH, R. L. RIDGEWAY, AND H. H. HUNT. 1971. Determination of trap spacings required to control an insect population. J. Econ. Ent. 64: 1090-100.

MATHENY, E. L., JR., R. L. KEPNER, AND K. M. PORTIER. 1982. Landing distribution and density of sound attracted mole crickets. Ann. Ent. Soc. America 75: (in press).

PIELOU, E. C. 1977. Mathematical ecology. John Wiley and Sons, New York, NY.

ULAGARAJ, S. M. 1975. Mole crickets: ecology, behavior and dispersal flight (Orthoptera: Gryllotalpidae: *Scapteriscus*). Envir. Ent. 4: 265-73.

WALKER, T. J., R. C. LITTELL, AND NGO DONG. 1982. Which mole crickets damage bahiagrass pastures? Florida Ent. 65: 110-16.

WALKER, T. J. 1982. Sound traps for sampling mole cricket flights. Florida Ent. 65: 105-10.

THE GENUS *NEOPHYLLAPHIS* AND ITS SPECIES (HEMIPTERA: HOMOPTERA: APHIDIDAE)

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ABSTRACT

The genus *Neophyllaphis* Takahashi and its described species (*araucariae* Takahashi, *brimblecombei* Carver, *fransseni* Hille Ris Lambers, *gingerensis* Carver, *grobleri* Eastop, *michelbacheri* (Essig), *podocarpi* Takahashi, *rappardi* Hille Ris Lambers, *totarae* Cottier, *viridis* Ilharco) are reviewed. Keys are provided to the adults of known morphs. The alate oviparous female of *fransseni* and the alate viviparous female of *viridis* are described for the first time, and additional descriptive notes are given for 9 previously described morphs. *N. podocarpi* is reported from Hawaii for a new state record. Annotated citations are given to virtually all of the literature on the genus and its species.

RESUMEN

Se revisan el género *Neophyllaphis* Takahashi y sus especies descritas (*araucariae, brimblecombei, fransseni, gingerensis, grobleri, michelbacheri, podocarpi, rappardi, totarae, viridis*). Se presentan claves para los adultos de formas morfológicas conocidas. Se describan por primera vez la hembra alada ovipara de *N. fransseni* y la hembra alada vivipara de *N. viridis* y se presentan notas descriptivas adicionales para 9 formas previamente descritas. *N. podocarpi* se registra de Hawaii por primera vez. Se presentan citaciones anotadas para toda la literatura sobre este género y sus especies.

This publication is an assemblage and synthesis of new, and relevant old, information on the genus *Neophyllaphis* Takahashi and its 10 known species. It consists of a characterization of the genus, keys to adults of all known morphs, first descriptions of two morphs, partial descriptions of several previously described morphs, illustrations of various structures, discussion of pertinent subject matter, and a virtually complete, annotated bibliography of the group.