# MONITORING THE FLIGHTS OF FIELD CRICKETS (*GRYLLUS* SPP.) AND A TACHINID FLY (*EUPHASIOPTERYX OCHRACEA*) IN NORTH FLORIDA

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ABSTRACT

Traps broadcasting synthetic calls sampled flights of *Gryllus firmus* and *G. rubens* for 3 years in a pasture near Gainesville, Florida. Both species flew at all times of year with a major peak in the fall. Average annual catch of *G. firmus* for the trap broadcasting *firmus* call was 163 (39% male), with mean monthly catches varying from <1 in February to 63 in October. The trap broadcasting *rubens* call captured an annual average of 8,209 *G. rubens* (44% male), with mean monthly catches ranging from 29 in January to 1,956 in September. During July and August, *G. rubens* flew throughout the night. Gravid females of *Euphasiopteryx ochracea*, a parasitoid of *Gryllus*, were attracted to the *rubens* trap but not to the *firmus* trap. In one year 948 were caught, with lows of 0 in January, April, and June; and a high of 789 in October.

RESUMEN

Se muestrearon vuelos de *Gryllus firmus* y de *G. rubens* por 3 años en un pasto cerca de Gainesville, Florida, con trampas diseminadoras de llamadas sintéticas. Ambas especies volaron todo el año, siendo su apogeo en el otoño. El promedio anual de captura de *G. firmus* por trampas diseminando llamadas de *firmus* fue de 163 (39% machos), con promedios mensuales de captura variando entre menos de 1 en Febrero a 63 en Octubre. La trampa diseminando llamadas de *rubens* capturó un promedio anual de 8, 209 *G. rubens* (44% machos), con capturas de un promedio mensual entre 29 en Enero a 1,956 en Septiembre. *G. rubens* voló a través de la noche de Julio a Agosto. Hembras preñadas de *Euphasiopteryx ochraea* que es un parasitoide de *Gryllus*, fueron atraidos a la trampa de *rubens* pero no a la de *firmus*. Se atraparon 948 en un año, con números de 0 en Enero, Abril, y Junio, y un máximo de 789 en Octubre.

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The most common southeastern field crickets, *Gryllus firmus* and *G. rubens*, are dimorphic in length of the metathoracic wings (Walker and Sivinski 1986). Short-winged morphs are flightless. Long-winged morphs include strong fliers, although some individuals may not fly. Flying field crickets, like flying mole crickets, often land at broadcasts of the conspecific calling song (Ulagaraj and Walker 1973, Cade 1979a, Walker 1982, Forrest 1983). To study field cricket flights in north Florida, I operated traps that emitted the synthesized call of either *G. rubens* or *G. firmus*. Larvipositing females of *Euphasiopteryx ochracea*, a tachinid parasitoid of crickets, were attracted to the call of *G. rubens*.

## METHODS

Three traps were installed 30 m apart, in an equilateral triangle, near Gainesville, Fla., in a 5-ha bermuda- and bahiagrass pasture surrounded by woods of slash pine and mesic hardwoods (NW corner of sec. 31, tp. R19E, T9S). Each trap consisted of a 1.42-m diameter sheet metal funnel emptying into a screen-bottomed, 2-liter plastic jar (Fig. 1). Centered above the funnel and protected from rain by a plastic bag was an electronic sound synthesizer, similar to one described by Walker (1982) but driven by a programmable microprocessor (Intel 8748). (The synthesizer was made and programmed at Oldacre Electronics, P.O. Box 12951, Gainesville, FL 32604.) Synthesizers used in this study broadcast calls of either *rubens* (4763 Hz carrier frequency, 50.0 pulses per second, 50% duty cycle; continuous trill) or *firmus* (3980 Hz, 16.9 p/s, 50% duty cycle; 4 pulses per chirp, 2 chirps per second) (Fig. 2). Above each synthesizer was a 30 x 43 cm (dia x h) cylindrical electrocution grid of the type used by Mitchell et al. (1972). The grid was attached to a plywood ring (inner and outer diameters 25 and 60 cm) that had a 3.5 cm high sheet-metal rim around its outer circumference. The ring served as a platform to catch fragile, electrocuted insects that might otherwise fall into the funnel and be destroyed by field crickets trapped in the container below.

One trap was equipped with a *rubens* synthesizer, one with a *firmus* synthesizer, and one (the control) with a silent, imitation synthesizer. Positions for the 3 treatments were not changed during the 3 years of the study, 1-I-1983 to 31-XII-1985. After 9 months the control was discontinued since it had captured no *Gryllus* sp. Power supplies for the electrocution grids failed during the 2nd year and were not replaced.

A time clock turned on the power to the 3 traps each evening shortly before sunset and off each morning shortly after sunrise. Output of the *rubens* synthesizer was set at 106 dB, 15 cm above the speaker (through the plastic bag), using a Bruel & Kjaer model 2219 sound level meter. The meter was inadequate to set the level of the *firmus* synthesizer because the chirps were too brief. A Tektronix model 214 portable oscilloscope

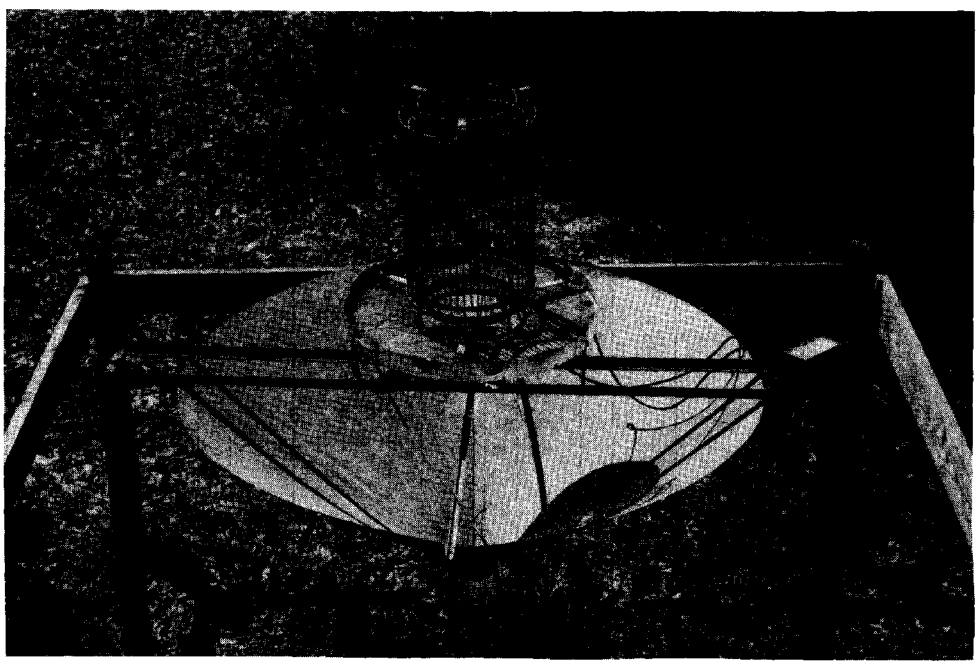

Fig. 1. Sound trap, including electrocution grid, plywood ring, sound synthesizer (protective plastic bag just visible through hole in ring), sheet-metal funnel, and catching jar. Funnel, ring, and synthesizer are supported by a steel yoke attached at either end to posts 1.3 m tall.

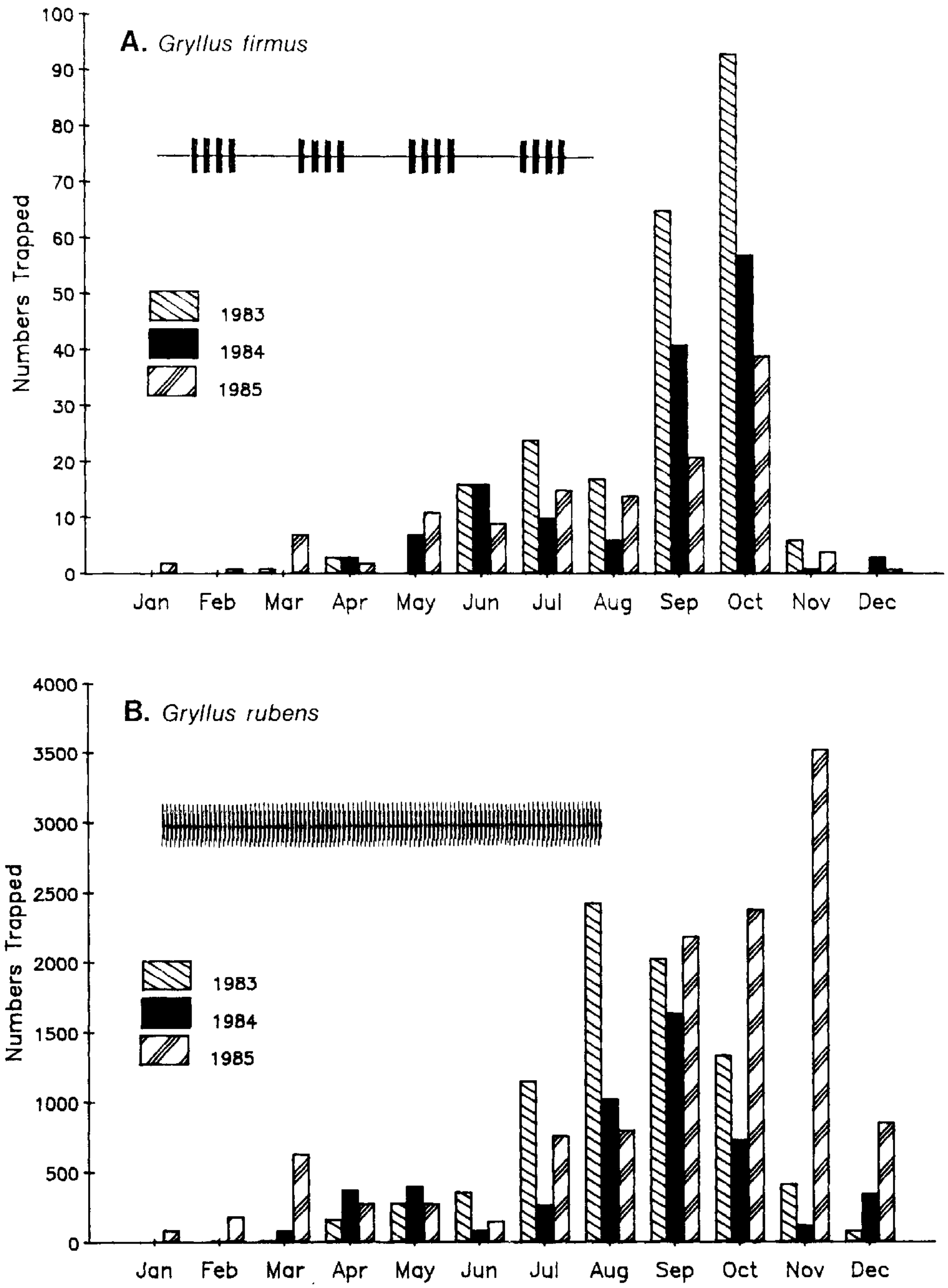


Fig. 2. Numbers of *Gryllus* trapped monthly, 1983-85. A. *G. firmus* caught in a trap broadcasting synthetic *firmus* calling song. (Oscillogram is 2 sec of the broadcast signal.) B. Numbers of *G. rubens* caught in a trap broadcasting synthetic *rubens* calling song. (Oscillogram is 2 sec of the broadcast signal.)

was used to adjust synthesized *firmus* pulses to agree in amplitude with those of *rubens* at 106 dB.

The traps were serviced each morning by counting and removing insects on the plywood platform and by substituting a fresh jar below. Jars were sometimes placed in a freezer to kill the contents prior to identification and counting. No trapped insects were released in the vicinity of the traps.

During much of July and August 1983 the *rubens* trap was serviced at 2350-2400 h (EDT) as well as the following morning. On the nights of 5 and 6-VIII-1983 it was serviced at the end of each quarter of the period between sunset (2020 h) and sunrise—viz. at 2258, 0136, 0414, and 0652 h.

## RESULTS AND DISCUSSION

### CONTROL TRAP

During 1-I-1983 to 30-IX-1983 the control trap caught three female mole crickets (*Scapteriscus vicinus*) but no other crickets and no *Euphasiopteryx*.

### *FIRMUS* TRAP

*Gryllus firmus* flew during every month with peak catches in September and October (Fig. 2A). Flights were never large. The greatest 1-night catch was 17 (30 September 1983); catches of 5 or more occurred in July (n=1), September (3), October (14), and November (1). Annual catches were 225, 144, and 120. Overall sex ratio was 39% male, with no evident seasonal trend.

Only 14 crickets other than *G. firmus* were caught in the *firmus* trap: 3 *G. rubens* 8 *Scapteriscus vicinus*, and 3 *S. acletus*. One of the *S. vicinus* was a last instar juvenile, surely flightless and incapable of climbing into the trap. (Perhaps a bird dropped it.) On 15 occasions a short-winged *firmus* was captured. These probably made it into the trap unassisted, since they are capable of climbing wooden posts, and males occasionally call from perches well above the ground. Short-winged *firmus* were excluded from the counts but their presence raises the possibility that some long-winged *firmus* climbed rather than flew into the trap. However, all long-winged *firmus* are included in the data reported here (e.g. Fig. 2A).

### *RUBENS* TRAP

*Gryllus rubens* flew during every month, with peak catches in August (1983), September (1984), or November (1985) (Fig. 2B). Flights were often large, the biggest one-night catches being 572 (30-IX-1983) and 480 (27-XI-1985). Flights resulting in catches of 100 or more occurred during 6 months: March (n= August (10), September (16), October (16), November (15), December (3). Annual catches totaled 7984, 4894, and 11,750. Overall sex ratio was 44% male with monthly ratios from November to March being 49% or more and those from April to September being 43% or less. Flights seemed to occur whenever weather was favorable, i.e., nearly nightly from mid-April through early November (Fig. 3). Only during 3 January to 18 February, the coldest time of year, did *G. rubens* not fly in this study. The seasonal distribution of catches of 20 or more was bimodal (Fig. 3). The peak of large catches in April-May probably resulted from maturation of overwintering juveniles and the peak in August from maturation of progeny of the earlier peak.

Nightly timing of *rubens* flights differed greatly from flights of *Scapteriscus vicinus*

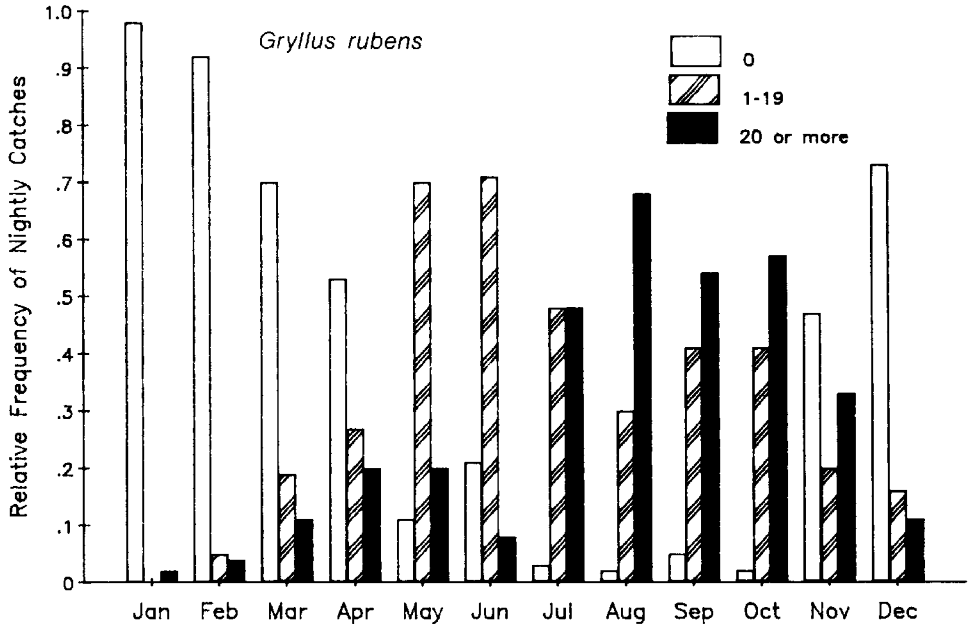


Fig. 3. Frequency of nights with catches of 0, 1-19, or 20 or more *Gryllus rubens* in the *rubens* trap.

and *S. acletus* the only other local crickets known to have frequent mass flights. Whereas *S. vicinus* and *S. acletus* restrict their flights to the first 20 to 90 minutes after sunset (Forrest 1983), *G. rubens* apparently flies at all times of night with late-night numbers equal to or greater than early-night numbers (temperature permitting). During the 39 nights during July and August 1983 that traps were emptied at midnight as well as the following morning, 29% of the males (244 of 834) and 23% of the females (273 of 1186) were captured prior to midnight (Table 1). At that season, sunset to midnight is 34 to 36% of the period from sunset to sunrise. Chi square tests of the hypothesis that 35% of captures were prior to midnight and 65% were after midnight were made separately for males and females and for each of the 3 periods because preliminary chi square tests showed the data to be heterogeneous ($P<0.05$). In 3 of the 6 tests the distribution of captures before and after midnight deviated significantly from 35:65 (Table 1), and in every case fewer that 35% were captured prior to midnight. During the 2 nights that crickets were collected after each quarter between sunset and sunrise, totals for the quarters were 43, 62, 58, 54. The hypothesis that equal numbers flew during each quarter was not rejected (chi square; $0.5 > P > 0.1$).

During the 1st and 3rd, but not the 2nd, of 3 approximately biweekly periods (Table 1), a significantly higher proportion of males than of females was captured prior to midnight. Why sex ratio changes with season (see above) and sometimes with time of night is not known.

Cade (1979b) made the only other study of flying times of field crickets. He observed *Gryllus integer* (the closest relative of *G. rubens*) flying to lights at Austin, Texas, during August 1974. He reported that the greatest numbers flew between 1 and 2 hours after sunset and that flying had ceased by 4 hours after sunset. On 1 occasion he continued observations until sunrise and saw no late-flying crickets. Since the species, season, and latitude were similar in our 2 studies, the contrasting results are unexpected. Both species call all night (Cade 1979a, Walker unpublished), and Cade (1979a)

TABLE 1. *G. RUBENS* CAUGHT BEFORE AND AFTER MIDNIGHT DURING 39 NIGHTS.

| Date (1983) | <2400 h | | | >0000 h | | | % <2400 | |
|---|---|---|---|---|---|---|---|---|
| | M | F | %M | M | F | %M | M | F |
| 3-16 July[c] | 75 | 76 | 50 | 160 | 251 | 39 | 32[a] | 23[b] |
| 17-31 July[d] | 84 | 96 | 47 | 178 | 197 | 47 | 32[a] | 33[a] |
| 2-4, 16-22 Aug[c] | 85 | 101 | 46 | 252 | 465 | 35 | 25[b] | 18[b] |
| Total | 244 | 273 | 47 | 590 | 913 | 39 | 29 | 23 |

[a]Proportion captured before midnight not significantly different from 35%. (Chi square; P>0.25.)
[b]Proportion captured before midnight significantly different from 35%. (Chi square; P<0.001.)
[c]Sex ratio significantly different for periods before and after midnight. (Chi square; P<0.05.)
[d]Sex ratio not significantly different for periods before and after midnight (Chi square; P>0.90.)

showed that *G. integer* males and females were attracted to a loudspeaker on the ground at all hours of night. He also observed their making short flights of a few meters as they approached the speaker (personal communication). Thus *G. integer* may fly to an area only in early evening but may walk or make short flights to a source of calling song at any time of night. I cannot refute the hypothesis that *G. ruben* has the behavior that Cade postulates for *G. integer.* I observed males and females flying about the trap at midnight but did not determine whether they were just arriving or had been in the area since early evening. It is unlikely that late-trapped *G. rubens* climbed into the trap (as proposed for short-winged *G. firmus*). Short-winged *G. rubens* were locally common but were never trapped.

Individuals of 11 other sound-signalling insect species were captured in the *rubens* trap. The 3 caught in significant numbers were *Scapteriscus vicinus* (n=787), *S. acletus* (34), and *Oecanthus celerinictus* (14). The calling song of each of these species is a continuous trill with a lower carrier frequency than *rubens.* A standard sound trapping station for *S. vicinus* and *S. acletus* (Walker 1982) was operated in the same pasture 30 m from the *rubens* trap. During the study period this station caught 20,410 *vicinus* and 8,765 *acletus.* Other species caught more than once were *Oecanthus niveus* (7), *Neonemobius cubensis* (2), *Tibicen resonans* (2), and *Diceroprocta olympusa* (2). One (long-winged) *Gryllus firmus* and 1 *Gryllus* sp. juvenile were caught.

During 1983, gravid females of *Euphasiopteryx ochracea* were attracted to the *rubens* trap every month except January, April, and June. However, only 14 flies were caught during the first 2/3 of the year, and 934 were caught during the final 3rd (Fig. 4). Of the latter, 789 were caught in October. Three or more flies were caught nightly 29 September to 8 November and 10 or more were caught on 29 of those 41 nights. More than 50 were caught on the nights of 10, 12, 15, 16, and 23 October.

Cade (1975, 1979a, 1981) showed that *E. ochracea* was an important parasitoid of *Gryllus integer* at Austin, Texas, and that larvipositing females were attracted in large numbers to its host's calling song—which resembles that of *rubens* but has a faster pulse rate. He did not report the seasonal distribution of fly activity. Mangold (1978) collected *E. ochracea* females attracted to the calling song of *Scapteriscus acletus* during a 14-month study at Gainesville, Florida. His maximum catch was fewer than 15, but, as in this study, most flies were caught September to November. The song of *S. acletus* has a carrier frequency of ca. 3 kHz, much lower than that of *G. rubens.* Although *S. acletus* can be a host (Mangold 1978), it is seldom if ever naturally parasitized by *E. ochracea.*

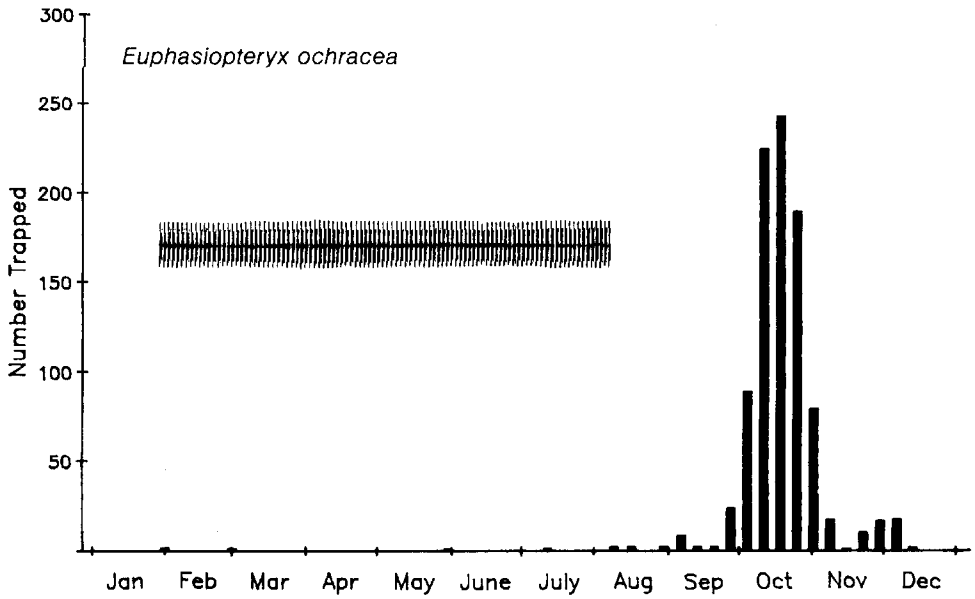


Fig. 4. Numbers of *Euphasiopteryx ochracea* caught weekly, 1983, at a trap broadcasting synthetic *rubens* calling song. (Oscillogram is 2 sec of the broadcast signal.)

## Overview

Except for continuously cold periods, the 2 species of *Gryllus* flew at all times of year, but in much larger numbers in summer and fall. Peak flights appear to correspond to times when large numbers of adults have recently matured. *E. ochracea* had large flights in fall and was nearly absent otherwise. Its natural hosts at Gainesville and its seasonal life cycle are unknown.

## Acknowledgements

I am grateful to J. C. Webb for help with the electrocution grids, to Todd Pickard and Sue Wineriter for help with trap emptying and cricket counting, and to T. G. Forrest, W. H. Cade, and J. E. Lloyd for criticizing the manuscript. This research was supported by NSF Grant BNS 81-03554. Florida Agricultural Experiment Station Journal Series No. 7278.

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# EFFICACY OF *BACILLUS SPHAERICUS* NEIDE AGAINST LARVAL MOSQUITOES (DIPTERA: CULICIDAE) AND MIDGES (DIPTERA: CHIRONOMIDAE) IN THE LABORATORY

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## ABSTRACT

The primary powders of strains 1593 (IF-119) and 2362 (IF-118 and ABG-6184) of *Bacillus sphaericus* Neide were tested as larvicides of laboratory-reared mosquitoes and field-collected midges, and were compared with the activity of strain 1593-4 (RB-80), the international standard of *B. sphaericus*. Two mosquito species, *Aedes aegypti* (Linn.) and *Ae. taeniorhynchus* (Wiedemann), and two midge species, *Chironomus crassocaidatis* Malloch and *Glyptotendipes paripes* Edwards were insensitive to *B. sphaericus* ($LC_{50} > 50$ ppm). Among the five susceptible mosquito species, *Culex quinquefasciatus* Say, *Cx. nigripalpus* Theobald, *Anopheles albimanus* Wiedemann, and *An. quadrimaculatus* Say, were most susceptible to ABG-6184 (strain 2362) with $LC_{90}$ values of 0.0044, 0.0067, 0.54, and 7.35 ppm, respectively. *Wyeomyia mitchellii* (Theobald) was almost equally susceptible to ABG-6184 ($LC_{90} = 0.276$ ppm) and strain 1593 (IF-119) ($LC_{90} = 0.261$ ppm).

## RESUMEN

Los polvos primarios de las razas 1593 (IF-119) y de 2362 (IF-118 y ABG-614) de *Bacillus sphaericus* Neide, fueron probados como larvicidas de larvas de mosquitos criadas en el laboratorio y de larvas de moscas de agua colectadas del campo, y fueron comparadas con la actividad de la raza 1593-4 (RD-80) que es el patrón internacional de *B. shaericus*. Dos especies de mosquitos, *Aedes aegypti* (Linn.) y *Ae. taeniorhynchus*