SEASONAL DISTRIBUTION AND PARASITISM OF *SCAPTERISCUS* SPP. (ORTHOPTERA: GRYLLOTALPIDAE) IN SOUTHEASTERN LOUISIANA

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ABSTRACT

Mole crickets of the genus *Scapteriscus* were accidentally introduced into the southern United States almost a century ago and are considered to be economically important pests in southern U.S. regions. Mole crickets were sampled using acoustic traps in Baton Rouge and New Orleans, Louisiana in the fall of 1998, the spring and fall of 1999, and the spring of 2000. In southeastern Louisiana *Scapteriscus borellii* has a seasonal flight period starting in late February and continuing into June. A lesser flight period occurs in the fall, starting in mid-September and continuing into November. *S. vicinus* was captured only from late February to late April. We determined that *S. borellii* was being parasitized inside acoustic traps by the tachinid fly, *Ormia ochracea* and that *S. vicinus* was parasitized by an anthomyiid fly, *Acridomyia* sp.

Key Words: acoustic attraction, mole crickets, *Ormia*, Tachinidae, *Acridomyia*

RESUMEN

Los grillos topo del genero *Scapteriscus* fueron introducidos accidentalmente en el sur de los Estados Unidos hace un siglo y se consideran ser parásitos importantes económicamente en regiones sureñas de EE.UU. Los grillos topo fueron muestreados usando trampas acústicas en Baton Rouge y New Orleáns, Louisiana en el otoño de 1998, la primavera y otoño de 1999, y la primavera del 2000. *Scapteriscus borelli* tiene un periodo de vuelo estacional comenzando tarde en febrero y continuando hasta junio. Un periodo de vuelo mas corto ocurre en el otoño, comenzando a mediados de septiembre y continuando hasta noviembre. *S. vicinus* fue capturado solo entre fines de febrero y fines de abril. Determinamos que *S. borellii* estaba siendo parasitado dentro de las trampas acústicas por la mosca tachinida *Ormia ochracea* y que *S. vicinus* fue parasitado por la mosca esp. *Acridomyia*.

Three species of mole crickets, *Scapteriscus vicinus* Scudder, *S. borellii* Giglio-Tos and *S. abbreviatus S*cudder, were accidentally introduced into the southern United States from South America from around 1899 to 1926 (Walker & Nickle 1981). *Scapteriscus vicinus* and *S. borellii* have since spread throughout the coastal plain from southeastern Texas to southeastern North Carolina (Parkman et al. 1996), with isolated populations of *S. borellii* reported from Arizona (Nickle & Frank 1988) and California (Frank 1994). *Scapteriscus* spp. mole crickets, especially *S. vicinus*, are considered to be serious pests of turf and pasture grasses throughout the southeastern U.S. (Hudson et al. 1988).

Using traps with artificial calling songs of *S. borellii* and *S. vicinus*, surveys of these two species were conducted in Baton Rouge and New Orleans, Louisiana, in the fall of 1998, the spring and fall of 1999, and the spring of 2000. This was done in order to ascertain the population levels in these areas and to determine the flight periods of introduced mole crickets in southeastern Louisiana prior to release of *Ormia depleta* (Wiedemann) (Diptera: Tachinidae) in these cities for biological control. This fly is native to South America, where it attacks mole crickets of the genus *Scapteriscus* (Fowler 1987). It has been released at many sites in Florida and is established there (Frank et al. 1996).

MATERIALS AND METHODS

Acoustic traps that use artificially produced calling songs of mole crickets capture large numbers of these insects, and they are used for population surveys and behavioral studies (Walker 1988). Traps in this study were constructed according to details given in Parkman and Frank (1992) with some modifications. Our traps consisted of 1 m diameter sheet metal funnels suspended from metal yokes. The yokes were supported by 10 cm × 10 cm × 100 cm wooden posts buried into the ground to a depth of 30 cm. A single 20 l plastic bucket was attached to the bottom of each funnel to hold captured insects. Buckets were suspended above ground level to minimize predation of captured mole crickets by red imported fire ants (*Solenopsis invicta* Buren). Holes were drilled through the bottom of the buckets to allow rainwater to drain. Two sound traps were deployed at Burden Research Station

in Baton Rouge (31°24.46 N, 91°06.74 W) during fall 1998, the spring and fall of 1999 and spring 2000. A second set of traps was also deployed in City Park, New Orleans (29°59.70 N, 90°05.33 W) during fall 1999 and spring 2000. A different song was played over each of the traps; one synthesized the song of *S. borellii* males and the other the song of *S. vicinus* males. The traps were separated by at least 2 m as suggested by Walker (1982). Artificial crickets were obtained from Night Caller Artificial Crickets (Eco-Sim, Gainesville, FL), and they were powered by 12V, 7.0 amp-hour, lead acid gel-cell rechargeable batteries (Power Sonic PS-1270). Batteries were recharged once per week.

Traps were serviced at least every other day. Captured adults of *Scapteriscus* spp. were placed in zippered plastic bags which were placed in a cooler for transport to the laboratory. Adults were held individually in 15 dram snap-lid, plastic vials (WWR Scientific, West Chester, PA). Each vial contained at least 4 cm (~35 ml) of moist sand. The mole crickets were checked each day for parasitism. Dead mole crickets were removed from vials and the sand searched for fly puparia. Larvae of *O. ochracea* Bigot require approximately one week to complete development in the laboratory at 23-25°C (Wineriter & Walker 1990). After three weeks, all puparia were removed from the sand and placed inside 15 dram snap-lid vials onto 3 cm × 3 cm moist paper towels until emergence of adults. Adult flies were identified using keys in Sabrosky (1953). Voucher specimens of *O. ochracea, G. rubens* Scudder, *S. borellii* and *S. vicinus* were deposited in the Louisiana State University Arthropod Museum. Larvae of *Acridomyia* were identified using keys to immature Diptera in Teskey et al. (1991).

Results And Discussion

Seasonal Distribution

Numbers of *S. borellii* and *S. vicinus* captured in fall 1998, spring and fall 1999, and spring 2000 are shown in Figures 1 and 2. The flight period for *S. borellii* in southeastern Louisiana begins in late February and lasts into June. A lesser flight period occurs in the fall, starting in mid-September and lasting into November. For *S. vicinus*, the flight period in southeastern Louisiana also begins in late February and continues into late April. No *S. vicinus* were captured at either of the two trapping locations during fall of the years 1998 or 1999. Flight periods of *S. borellii* and *S. vicinus* in southeastern Louisiana are similar to those reported by Walker et al. (1983) for *S. borellii* and *S. vicinus* at Gainesville, Florida (29°40'N), except that we never captured *S. vicinus* in our traps during the fall months. In addition, numbers of mole crickets captured in our sound traps were much lower than those reported in Florida.

Trap abundance cycles of 7-12 days were observed during the fall 1998 and 1999, and spring 1999 and 2000 trap data (Figs. 1 and 2). Ngo and Beck (1982) also observed trap abundance cycles lasting ca. 9 days for *S. borellii* in Florida and attributed this phenomenon to egg laying cycles of *S. borellii* females. Walker and Nation (1982) reported that some *S. borellii* males will call during the fall months and females can respond in significant numbers. They found that some *S. borellii* females do mate during the fall, since 7 out of 25 females attracted to synthetic calling song in October to December had sperm in their spermathecae. It is not generally believed, however, that egg laying occurs during the fall.

Parasitism of *S. borellii* by *O. ochracea*

Ormia ochracea adults were commonly collected in the *S. borellii* traps but were never collected from the *S. vicinus* traps during fall 1998 and 1999. *O. ochracea* were often observed resting inside trap buckets and caller housings. No *O. ochracea* were reared from ca. 200 *Scapteriscus* spp. collected during each spring of 1999 and 2000. This was expected because *O. ochracea* adults were never observed at our traps during spring 1999 and 2000. Of 88 *S. borellii* captured at New Orleans and Baton Rouge between 7 October and 18 October 1999, 18 were parasitized by *O. ochracea*, yielding 34 puparia (range 1-4 puparia per host), (Table 1). A total of 14 adults of *O. ochracea* eclosed from the puparia. Flies (n = ca. 5-10) were regularly observed resting inside the caller housing during the day. When the *S. borellii* trap buckets were opened to inspect the contents, several dozen flies would escape. We were often able to collect flies, usually 10-20, from inside the trap buckets that were either dead or too weak to fly. Walker (1993) found that calls of *S. borellii* and *S. vicinus* attracted few and zero *O. ochracea*, respectively.

Tachinid flies of the tribe Ormiini are orthopteran parasitoids specializing on crickets and katydids (Walker 1986, 1989). They are known to occur throughout the southeastern United States from Florida to Texas (Walker 1989; Robert & Hoy 1994). Females of the phonotactic tachinid fly *O. ochracea* are larviporous (Frank 1994), are attracted to artificially produced songs of its host, *Gryllus integer* and larviposit in the vicinity of calling males (Cade 1975; Walker 1989). Walker (1986, 1989) captured large numbers of *O. ochracea* at traps using artificially produced *Gryllus rubens* Scudder songs. Mangold (1978) found that *O. ochracea* also was attracted to synthesized songs of *S. borellii* males and was able to successfully rear *O. ochracea* to adulthood on 1 of 5 *S. borellii* and on one *G. rubens* artificially infested. Wineriter and Walker (1990) also reared

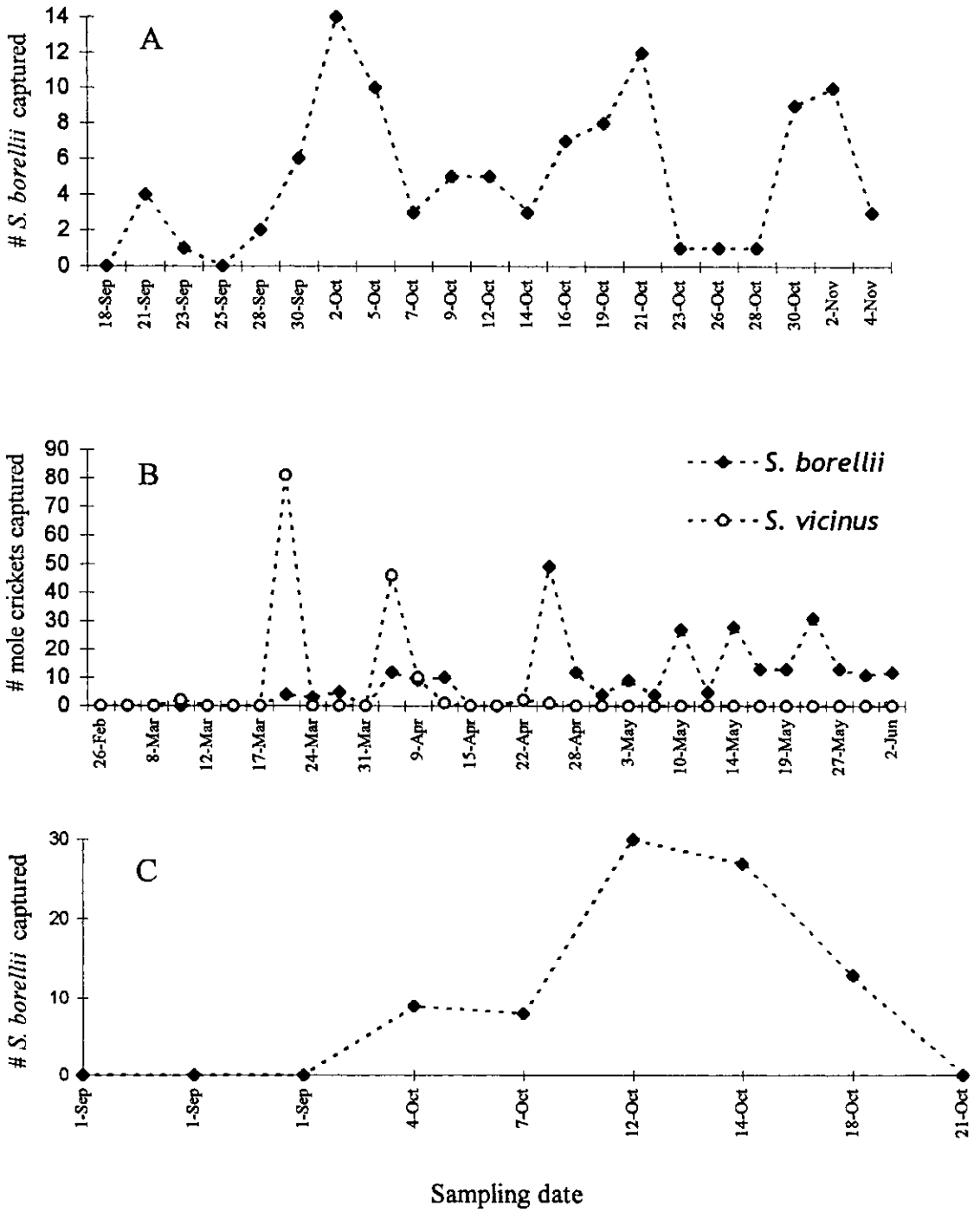

Fig. 1. (A) Numbers of *S. borellii* captured in sound traps at Burden Research Station, Baton Rouge, LA. Traps were operated from 16 September to 4 November, 1998, (B) Numbers of *S. borellii* and *S. vicinus* captured in sound traps at Burden Research Station, Baton Rouge, LA. Traps were operated from 16 February to 2 June, 1999, (C) Numbers of *S. borellii* captured in sound traps at Burden Research Station, Baton Rouge, LA. Traps were operated from 14 September to 21 October, 1999.

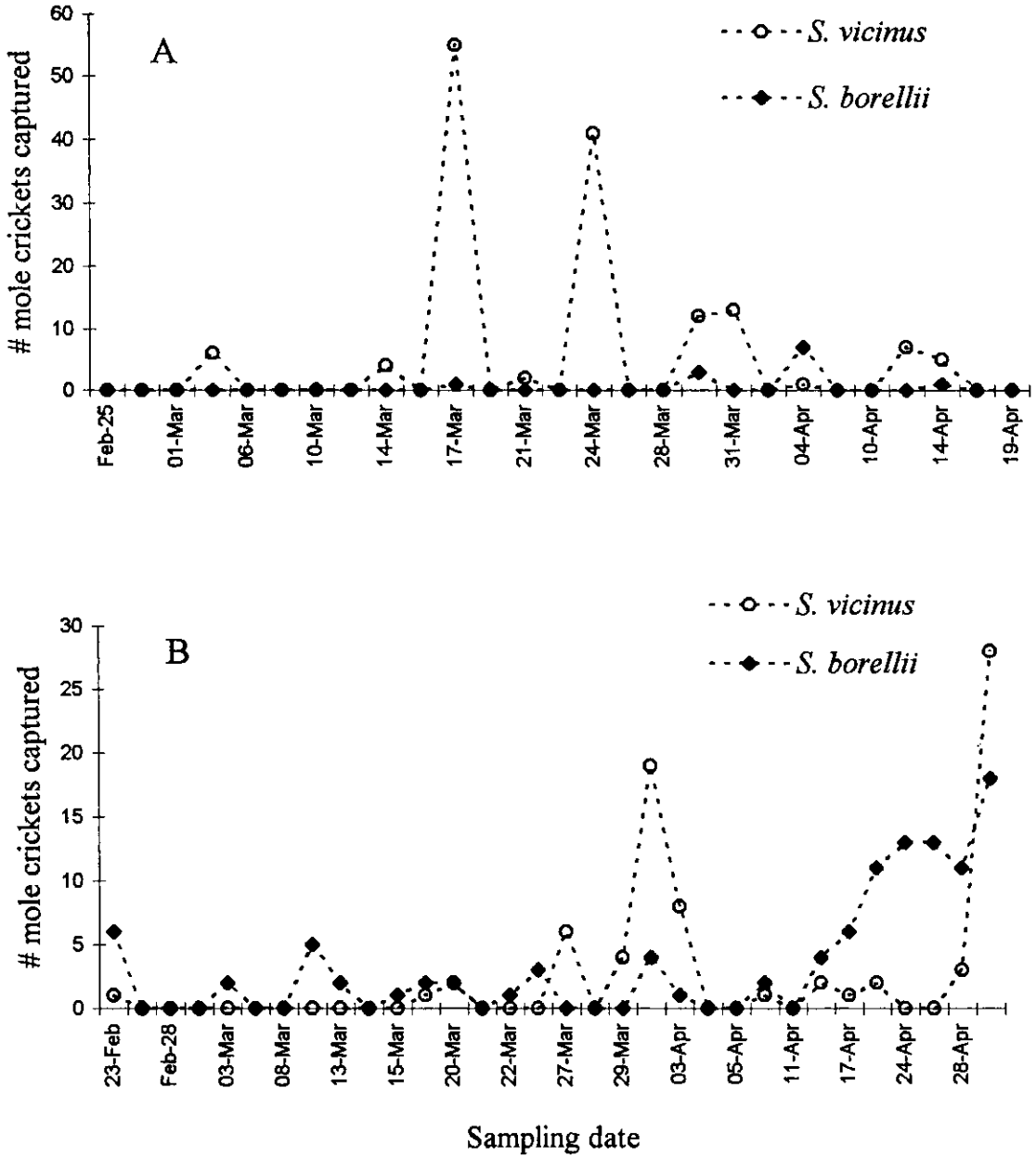

Fig. 2. Numbers of *Scapteriscus* spp. captured in sound traps at (A) City Park, New Orleans, LA. Traps were operated from 22 February to 1 May, 2000, (B) Burden Research Station, Baton Rouge, LA. Traps were operated from 16 February to 1 May, 2000.

O. ochracea from *S. borellii*. According to Hudson et al. (1988), larvae of *O. ochracea* have been collected in the field only from crickets of the genus *Gryllus*. As Mangold (1978) points out, the rearing of *O. ochracea* on S. *borellii* does not indicate that this is a natural host. Instances of parasitism of *S. borellii* by *O. ochracea* are probably an artifact of the trapping technique (Walker & Wineriter 1991). Confinement of *O. ochracea* females with *S. borellii* for several days in our traps invariably resulted in a portion of the mole crickets being parasitized. Hundreds of first-instar larvae of *O. ochracea* also were collected from the trap buckets, suggesting that larvipositing by *O. ochracea* females occurred inside the trap buckets. Our results are in contrast to data reported in Frank et al. (1996), where only one out of tens of thousands of *Scapteriscus* mole crickets captured

TABLE 1. NUMBERS OF *SCAPTERISCUS BORELLII* PARASITIZED BY *ORMIA OCHRACEAE*: BATON ROUGE (BR) AND NEW ORLEANS (NO), LA. OCTOBER, 1999

Date	Site	No. *S. borellii* captured	No. *S. borellii* parasitized	No. *Ormia ochraceae* adults obtained
7.x	BR	8	3 (7)*	5
11.x	BR	30	10 (20)	6
14.x	BR	27	2 (3)	2
18.x	BR	13	1 (1)	1
12.x	NO	10	2 (3)	0
Totals		88	18 (34)	14

*$_1$ = numbers of *O. ochracea* puparia reared from *S. borellii* in parentheses.

in a survey was parasitized, presumably by *O. ochracea*. The authors did not state what species of *Scapteriscus* was parasitized.

Three female *G. rubens* were collected in the *S. borellii* sound trap at Baton Rouge between 14-18 October 1999. Mangold (1978) also reported that several *Gryllus spp.* were attracted to artificial songs of *S. borellii* in Florida. Of particular interest is the attraction of *O. ochracea* and *G. rubens* to artificial songs of *S. borellii* but not of *S. vicinus*. The calling songs of *S. borellii* and *G. rubens* are similar (Burk 1982). Males of *S. borellii* broadcast songs at a carrier frequency of 2.7 kHz, with a pulse rate of ~50 pulses s^{-1} (Walker 1982). Males of *G. rubens* broadcast songs at a carrier frequency of 4.8 kHz, also with ~50 pulses s^{-1}. (Walker 1986). In addition, calling songs of *S. vicinus* have a carrier frequency that falls in between that of *S. borellii* and *G. rubens* (3.3 kHz), but have a much faster pulse rate of ~130 s^{-1} (Walker 1993). Robert et al. (1992) found that the hearing organ of *O. ochracea* females is most sensitive to frequencies in the range of 4 to 6 kHz. There is, however, no reason to suggest that *O. ochracea* females would not respond to carrier frequencies outside these ranges. In fact, Walker (1993) demonstrated that *O. ochracea* females are attracted to carrier frequencies between 2.4 and 6.8 kHz. According to Chapman (1982) there is no evidence that frequency discrimination alone is especially important to the insect. The pulse repetition frequency of insect songs is probably a more important factor in their recognition because impulses occur in the auditory nerves in synchrony with sound pulses. This may explain why *O. ochracea* and *G. rubens* were attracted to artificial calling songs of *S. borellii* at our trapping stations but not to those of *S. vicinus*. In Walker (1986), *O. ochracea* females were attracted to synthesized calls of *G. rubens* but not *G. firmus*. The carrier frequencies of these two species fall within the most sensitive range of *O. ochracea* females (4-6 kHz), but songs of *G. firmus* have a much slower pulse rate of ~17 s^{-1} (Walker 1986). The pulse rate of *S. vicinus* (~130 s^{-1}) is much faster than both *S. borellii* and *G. rubens*. In addition, the carrier frequencies *of S. borellii* and *S. vicinus* are much lower than *G. rubens*. As Walker (1993) points out, our knowledge of cricket communication, and that of their acoustically attracted parasitoids, is far from complete and future studies should examine other components of sound that may be important.

Parasitism of *S. vicinus* by *Acridomyia* sp.

In late March 2000, two *S. vicinus* that were captured in an acoustic trap in New Orleans were found to have been parasitized by *Acridomyia* sp. (Diptera: Anthomyiidae). One of the parasitized *S. vicinus* contained six maggots, the other contained only one. Unfortunately, no adult flies were obtained. Larvae of flies in this genus are parasitoids of grasshoppers (Acrididae) (Dahlem & Thompson, 1991). Little else is known about members of this genus. Are *Acridomyia* sp. attracted to the calling songs of *S. vicinus* or were these two mole crickets accidentally parasitized?

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REFERENCES CITED

CADE, W. 1975. Acoustically orienting parasitoids: fly phonotaxis to cricket song. Science 190: 1312-1313.

BURK, T. 1982. Sticky panel catches of the tachinid *Euphasiopteryx ochracea*. Florida Entomol. 65(2): 291-292.

CHAPMAN, R. F. 1982. Insects: Structure and Function. Third Edition. Harvard University Press. Cambridge, MA. 919 pp.

DAHLEM, G. A. AND F. C. THOMPSON. 1991. Anthomyiidae (Muscoidea). Chapter 37: Diptera, pp. 853-857. *In* Immature Insects, Volume II. F. W. Stehr (ed.). Kendall/Hunt Publishing Company. Dubuque, IA. 975 pp.

FOWLER, H. G. 1987. Field behavior of *Euphasiopteryx depleta* (Diptera: Tachinidae): Phonotactically orienting parasitoids of mole crickets (Orthoptera: Gryllotalpidae: *Scapteriscus*). J. New York Entomol. Soc. 95(4): 474-480.

FRANK, J. H. 1994. Biological control of pest mole crickets, pp. 343-352. *In* Pest Management in the Subtropics: Biological Control a Florida Perspective. D. Rosen, F. D. Bennett and J. L. Capinera (eds.). Intercept Ltd. Andover, U.K. 717 pp.

FRANK, J. H., T. J. WALKER, AND J. P. PARKMAN. 1996. The introduction, establishment, and spread of *Ormia depleta* in Florida. Biological control 6: 368-377.

HUDSON, W. G., J. H. FRANK, AND J. L. CASTNER. 1988. Biological control of *Scapteriscus* spp. mole crickets (Orthoptera: Gryllotalpidae) in Florida. Bull. Entomol. Soc. Am. 34: 192-198.

MANGOLD, J. R. 1978. Attraction of *Euphasiopteryx ochracea*, *Corethrella* sp. and Gryllids to broadcast songs of the Southern Mole Cricket. Florida Entomol. 61(2): 57-61.

NGO DONG AND H. W. BECK. 1982. Mark-release of sound attracted mole crickets: flight behavior and implications for control. Florida Entomol. 65(4): 531-538.

NICKLE, D. A., AND W. FRANK. 1988. Pest mole crickets, *Scapteriscus acletus* (Orthoptera: Gryllotalpidae), reported established in Arizona. Florida Entomol. 71(1): 90-91.

PARKMAN, J. P., AND J. H. FRANK. 1993. Use of a sound trap to inoculate *Steinernema scapterisci* (Rhabdita: Steinernematidae) into pest mole cricket populations (Orthoptera: Gryllotalpidae). Florida Entomol. 76(1): 75-82.

PARKMAN, J. P., J. H. FRANK, T. J. WALKER, AND D. J. SCHUSTER. 1996. Classical biological control of *Scapteriscus* spp. (Orthoptera: Gryllotalpidae) in Florida. Environ. Entomol. 25(6): 1415-1420.

ROBERT, D., J. AMOROSO, AND R. R. HOY. 1992. The evolutionary convergence of hearing in a parasitoid fly and its cricket host. Science 258: 1135-1137.

ROBERT, D., AND R. R. HOY. 1994. Overhearing cricket love songs. Natural History 103(6): 49-50.

SABROSKY, C. W. 1953. Taxonomy and host relations of the tribe Ormiini in the western hemisphere. Proc. Entomol. Soc. Washington 55: 167-183.

TESKEY, H. J., B. A. FOOTE AND F. W. STEHR. 1991. Key to families of larvae. Chapter 37: Diptera, pp. 708-730. *In* Immature Insects, Volume II. F.W. Stehr (ed.). Kendall/Hunt Publishing Company. Dubuque, IA. 975 pp.

WALKER, T. J. 1982. Sound traps for sampling mole cricket flights (Orthoptera: Gryllotalpidae: *Scapteriscus*). Florida Entomol. 65(1): 105-110.

WALKER, T. J. 1986. Monitoring the flights of field crickets (*Gryllus* spp.) and a tachinid fly (*Euphasiopteryx ochracea*) in north Florida. Florida Entomol. 69(4): 678-685.

WALKER, T. J. 1988. Acoustic traps for agriculturally important insects. Florida Entomol. 71(4): 484-492.

WALKER, T. J. 1989. A live trap for monitoring *Euphasiopteryx* and tests with *E. ochracea* (Diptera: Tachinidae). Florida Entomol. 72(2): 314-319.

WALKER, T. J. 1993. Phonotaxis in female *Ormia ochracea* (Diptera: Tachinidae), a parasitoid of field crickets. J. Insect. Behav. 6(3): 389-410.

WALKER, T. J. AND D. A. NICKLE. 1981. Introduction and spread of pest mole crickets: *Scapteriscus vicinus* and *S. acletus* reexamined. Ann. Entomol. Soc. Am. 74(2): 158-163.

WALKER, T. J. AND J. L. NATION. 1982. Sperm storage in mole crickets: fall matings fertilize spring eggs in *Scapteriscus acletus*. Florida Entomol. 65(2): 283-285.

WALKER, T. J., J. A. REINERT, AND D. J. SCHUSTER. 1983. Geographical variation in flights of the mole cricket, *Scapteriscus* spp. (Orthoptera: Gryllotalpidae). Ann. Ent. Soc. Am. 76(3): 507-517.

WALKER, T. J. AND WINERITER, S. A. 1991. Hosts of a phonotactic parasitoid and levels of parasitism (Diptera: Tachinidae: *Ormia ochracea*). Florida Entomol. 74(4): 554-559.

WINERITER, S. A., AND T. J. WALKER. 1990. Rearing phonotactic parasitoid flies (Diptera: Tachinidae: *Ormia* spp.). Entomophaga 35: 621-632.