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HOSTS OF A PHONOTACTIC PARASITOID AND LEVELS OF PARASITISM (DIPTERA: TACHINIDAE: *ORMIA OCHRACEA*)

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ABSTRACT

In central Texas, females of *Ormia ochracea* (Bigot) find hosts, *Gryllus integer* Scudder (Orthoptera), by homing on the hosts' calling songs. *O. ochracea* is abundant each fall in Alachua County, Florida, where *G. integer* does not occur. *Gryllus rubens* Scudder and *G. firmus* Scudder were collected by three methods and held for emergence of *O. ochracea*. Of 185 *G. rubens* and 100 *G. firmus* collected during January to August, none were parasitized. Levels of parasitism during the remaining months never exceeded 10% except at sound-baited traps—but these attracted larvipositing *O. ochracea* as well as *G. rubens*. For specimens collected in pitfall traps and by searching under objects, levels of parasitism of *G. rubens* and *G. firmus* and of males and females were unexpectedly similar—though *O. ochracea* is not attracted to *firmus* calls and female *Gryllus* do not call. When muted and nonmuted reared males of *G. rubens* were experimentally exposed in the field in the fall for 5 days, no muted males were parasitized but 7 of 13 nonmuted males were.

RESUMEN

En la parte central de texas, las hembras de *Ormia ochracea* (Bigot) encuentran sus hospederos, *Gryllus integer* Scudder (Ortoptera) al ser atraidos por el huesped. *O. ochraceae* es abundante cada otoño en el condado Alachua, Florida, donde no se encuentra

G. integer. Se colectaron *Gryllus rubbens* Scudder y *G. firmis* mediante el uso de 3 metodos y se mantuvieron para esperar la emergencia de *O. acraceae*. Se colectaron 185 *G. rubens* y 100 *G. firmus* entre Enero y Agosto y ninguno fue parasitado. Los niveles de parasitismo durante los meses restantes nunca excedieron mas del 10% excepto en trampas con sonido como atrayente; sinembargo, estas atrayeron no solo *O. ochraceae* sino tambien *G. rubens*. Para los especimenes colectados en trampas de lata enterradas, los niveles de parasitismo de *G. rubens* y *G. firmus* y de machos y hembras fueron similares; aunque *O. ochraceae no es atraida hacia las llamadas de firmus* y las hembras de *Gryllus* no emiten sonidos de llamada. Cuando machos callados de *G. rubens* y machos que emitian sonidos fueron expuestos expirementalmente por 5 dias en el campo durante el otoño, los machos que emitian sonidos fueron parasitados y 7 de los 13 machos callados tambien lo fueron.

At least three species of ormiine tachinids are phonotactic parasitoids of ensiferan Orthoptera (Cade 1975, Burk 1982, Fowler & Kochalka 1985). Interest in the host ranges of these flies and levels of parasitism is sharpened by the recent release in Florida of *Ormia depleta* (Wiedemann), a South American species, for the control of pest mole crickets (*Scapteriscus* spp.) (Wineriter & Walker 1990).

Ormia ochracea (Bigot) is one of six ormiines native to the southeastern United States (Sabrosky 1953a, b). Cade (1975), working in Travis County, Texas, discovered that its larvipositing females were attracted to the taped song of *Gryllus integer* Scudder. Cade (1979) reported that 15 of 58 *G. integer* males he collected were parasitized (26%). Of the 14 males collected by their calls, 11 (79%) were parasitized; of 44 males collected by other means, 4 (9%) were parasitized; of 21 females (which do not call), none was parasitized. Cade (1984) reported 17 of 73 *G. integer* calling males were parasitized (23%), whereas none of the 17 or more males collected under lights were parasitized. These numbers suggest that *O. ochracea* females find few hosts except by their calls. Mangold (1978), working in Alachua County, Florida, attracted small numbers of gravid *O. ochracea* females to the taped song of *Scapteriscus borellii* Giglio-Tos (=*S. acletus* Rehn & Hebard: Nickle 1992). He found that larvae dissected from an *O. ochracea* female could develop in individuals of *S. borellii* and *Gryllus rubens* Scudder, but noted that parasitoids can often be propogated on unnatural hosts. Walker (1986, 1989, and unpublished), in studies at one of Mangold's sites, attracted ca. 1,000 female *O. ochracea*/trap/yr to traps baited with the calling song of *G. rubens*. (*G. rubens* is the southeastern field cricket most closely related to *G. integer*). More than 80% of the sound trap captures were in September through December. Wineriter and Walker (1990) maintained a laboratory colony of *O. ochracea* on *Gryllus rubens*, and showed (1990 and unpublished) that larvae could develop on *Gryllus firmus* Scudder, *Gryllus ovisopis* Walker, *Acheta domesticus* (L.), *Scapteriscus borellii*, and last instar juveniles of *G. rubens*.

We started this study to determine how much *O. ochracea* contributed to the mortality of adult *G. rubens*. The abundance of *O. ochracea* in the fall suggested high levels of parasitism, as did Burk's (1982) data on *Ormia lineifrons*, a phonotactic parasitoid of *Neoconocephalus triops* (L.) (40-90% parasitized, n≥39). As a control to our phonotactic biases, we included *G. firmus*, a field cricket common in the same habitats as *G. rubens* but whose song does not attract *O. ochracea* (Walker 1986).

Methods and Materials

Our first method was to collect *Gryllus* spp. adults and hold them 10 days, a time sufficient for *O. ochracea* larvae to complete development, emerge, and pupate (Wineriter & Walker 1990). Three collecting techniques were used: sound-baited traps in pastures

and wooded areas (Walker 1986), linear pitfall traps in pastures (Lawrence 1982), and turning over objects and disturbing litter ("grubbing") in an organic garden. The sound traps broadcast synthetic *rubens* and *firmus* songs and were designed to catch flying crickets as they landed at the sound. About 40% of sound-trapped crickets are males (Walker 1986).

Because parasitized crickets might not fly, thus biasing our sound trap results, we determined parasitization of flying and non-flying crickets in the laboratory. At a sound trap that was heavily visited by *O. ochracea* we captured 360 *G. rubens* and placed them in flight test cages that could be escaped only by flying (Walker 1987). We held, for parasite emergence, 79 crickets that flew from the test cage during the next five nights. We also held a matching sample of 79 crickets that had remained in the test cage.

Our second method for studying natural parasitism was to expose parasite-free, caged *G. rubens* males for 5 days in an *O. ochracea* infested pasture. The males were reared in the laboratory and half were muted before exposure by cutting off their right tegmen. Long-winged males were rendered flightless by cutting off one of their matathoracic wings. The males were exposed individually in a circle of 12, evenly spaced 35 x 28 cm (h x dia) plastic buckets. Muted and nonmuted males were alternated. Each bucket had 5 cm of moist sand and a plug of sod at the bottom to provide shelter for the cricket, and a cover of 12-mm mesh hardware cloth to allow flies to enter while excluding larger enemies. After 5 days the males were taken to the laboratory and held for emergence of parasites; some of those that died during the 10-day holding period were dissected to determine if *Ormia* larvae were present. Four replicates were run between 22 Sep and 15 Oct 1988.

Results and Discussion

Sound trapping. Sound-trapped *G. rubens* were heavily parasitized in the fall (Table 1). However, numerous gravid females of *O. ochracea* are attracted to *rubens* sound traps in the fall (Walker 1986, 1989), suggesting that crickets may have been parasitized after they landed at the trap. Thus we checked the amount of time elapsed between sound-trapping and emergence of parasite larvae from their hosts. Emergence within 6 days would indicate that the crickets were already parasitized when they arrived at the sound trap (Wineriter and Walker 1990). For 61 *rubens* trapped Sep-Dec 1986, 1987, our records of emergence were adequate to apply the 6-day criterion. No larvae had emerged during the first 6 days—i.e., all hosts may have been parasitized after reaching the sound trap.

These results showed the pertinence of our laboratory study about whether parasitized crickets fly. Of the 79 crickets that flew from test cages, 67 (85%) proved to be parasitized by *O. ochracea*. Of 79 crickets that did not fly, 69 (87%) were parasitized. We concluded that parasitized crickets flew and in proportions similar to non-parasitized crickets. In fact, five parasitized crickets flew when the larvae they hosted were well advanced: larvae emerged in 3-4 days, whereas total larval development generally takes 7-8 day.

More sound-trapped *G. rubens* were monitored in the fall of 1990, and about half were parasitized by *O. ochracea*. In 3 cases the parasite emerged in less than 7 days (Table 1), suggesting a prior-to-trapping level of parasitism similar to that revealed by other methods.

Pitfalls and grubbing. As in the case of sound traps, all parasitism was in the fall (Table 1). Of 100 *Gryllus* captured in pitfalls in the fall, 2 *rubens* and 0 *firmus* were parasitized by *O. ochracea*. One of the parasitized *rubens* was female; the other was male or female (the vial contained one of each and a puparium when we received it). Of 131 *Gryllus* grubbed in the fall of 1980, 1 male *rubens* and 1 male and 3 female *firmus*

TABLE 1. RATES OF PARASITISMS BY *ORMIA OCHRACEA* IN FIELD-COLLECTED FIELD CRICKETS, ALACHUA CO., FLA.

Species / Collecting method	Fall (Sep-Dec) Year	N	%P	Other (Jan-Aug) Year	N	%P
Gryllus rubens						
Sound trap	1986-7	269	64	1987	58	0
	1990	106	43			
Sound trap, ≤6 days	1986-7	61	0			
	1990	106	3			
Pitfall	1986-7	42	5	1987	16	0
Grubbing	1980	35	3*	1981	111	0
	1990	41	10			
Gryllus firmus						
Sound trap	1986	12	0			
Pitfall	1986-7	58	0	1987	1	0
Grubbing	1980	96	4*	1981	99	0
	1990	39	8			

*Assuming that the puparia that were recovered and lost were *O. ochracea*.

produced puparia. The puparia were lost, but subsequent results (fall 1990) suggested that some, perhaps most, were *O. ochracea*. Grubbing was resumed in fall 1990, and *O. ochracea* emerged from 4 *rubens* (1 of 11 males and 3 of 30 females), and from 3 *firmus* (1 of 18 males and 2 of 21 females). Three *rubens* and one *firmus* produced puparia of a conopid fly, *Stylogaster biannulata* (Say).

Exposure of lab-reared males. Of the 23 *G. rubens* males that were recovered and assayed, 0 of 10 muted males and 7 of 13 nonmuted males (54%) were parasitized. (Ten males escaped and 15 died prior to 10 days and were not dissected.) A chi square test of the hypothesis that rates of parasitism for muted and nonmuted males were equal yielded a P of <0.025. The level of parasitism for nonmuted males was similar to the 79% and 23% that Cade (1979, 1984) reported for calling male *G. integer* in central Texas.

In Alachua County, only a small proportion of *G. rubens* males call in the fall (TJW, unpublished). This could account for low levels of parasitism among field-collected males. On the other hand, the lab-reared males were apparently ready callers—as suggested by the contrast in rates of parasitism between muted and nonmuted males and as indicated by nonmuted males calling after exposure in the field.

Further discussion. Unlike Cade, who found only males of *G. integer* parasitized by *O. ochracea*, we found females of *G. rubens* and *G. firmus* parasitized at rates indistinguishable from those of males. This was true not only for specimens collected at sound traps, where host finding apparently was largely by common attraction to the synthesized *rubens* call, but also for specimens collected at pitfalls and by grubbing. For example, in the fall 1990 grubbing sample, 1 of 11 *rubens* females and 2 of 21 *firmus* females. Perhaps flies larviposit in response to *rubens* songs, but the larvae attack any *Gryllus* they contact. If this be so, *G. rubens* should be more heavily parasitized than *G. firmus*. Our data that address this issue fairly are in this direction but not significantly so. In the 1990 grubbing samples, 4 of 41 *rubens* and 3 of 39 *firmus* were parasitized. In the pitfall samples, the corresponding figures were 2 of 40 and 0 of 58.

The levels of natural parasitism of *G. rubens* and *G. firmus* that we found are so low that the abundance of *O. ochracea* at *rubens*-baited sound traps in the fall is surprising. Two explanations seem worth discussing.

(1) One or more host species other than *G. rubens* and *G. firmus* produce large numbers of *O. ochracea*. Candidate alternative hosts would be crickets that are abundant, large enough to mature *Ormia*, and have a call known or likely to be attractive to *O. ochracea*. Only two local species meet these requirements: *S. borellii* and *Orocharis luteolira* Walker. The latter is arboreal and will be difficult to study (Walker 1969). For the former species and the related *S. vicinus*, there are many data. We and others have held thousands of both *S. borellii* and *S. vicinus* Scudder that were collected at sound traps in Alachua County. The only instances of parasitism by *O. ochracea* have been three sound-trapped *S. borellii*. Because larvipositing *O. ochracea* females are occasionally attracted to *S. borellii* sound traps, these instances may be an artifact of the collecting technique—as shown above for sound-trapped *G. rubens*. We tried manually parasitizing *S. vicinus* and *S. abbreviatus* Scudder (n=50 and 20) but produced no pupae. Dissection of individuals that died showed developing larvae in *S. abbreviatus* but none in *S. vicinus* (unpublished).

(2) Numbers of *G. rubens* in the fall are so great that low parasitism levels are enough to produce an abundance of *O. ochracea*. This is supported by the numbers of *G. rubens* flying to sound traps. Walker (1986) reported an annual average catch of 8,209 during a 3 year study with approximately 72% being trapped during August to November. Furthermore, only the long-winged morph of *rubens* is caught at sound traps, and by several techniques Walker (1987) estimated that fewer than 50% of wild *rubens* are long winged. Thus fall numbers of *rubens* may be great enough to produce large numbers of *O. ochracea* even at low levels of parasitism.

Either or both of these explanations could account for the abundance of *O. ochracea* in the fall. The second is surely part of the answer—and the low percentage parasitism concurs with the observation that wild *G. rubens* males (unlike the reared, experimentally exposed males) do relatively little calling in the fall.

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EFFECT OF INTERMALE DISTANCE AND FEMALE PRESENCE ON THE NATURE OF CHORUSING BY PAIRED *AMBLYCORYPHA PARVIPENNIS* (ORTHOPTERA: TETTIGONIIDAE) MALES

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ABSTRACT

Pairs of chorusing *Amblycorypha parvipennis* Stål males alternate the production of 3-5 s long phrases with frequent partial overlap of phrases. To determine the effect of intermale distance and the presence of a sexually receptive, sound-producing ("ticking") female on the nature of paired male chorusing, pairs of males were recorded, with and without the presence of a ticking female placed midway between the caged males, chorusing 3.3 m and 40 cm apart. The presence of a ticking female elicited a shortening of intervals between phrases (increase in phrase rate) and an increase in the extent of phrase overlap. In contrast, shortening the distance between males in the absence of a ticking female resulted in a lengthening of phrase interval (decrease in phrase rate) and a reduction in phrase overlap. Possible proximate and ultimate causes of these chorusing changes are discussed.

RESUMEN

Pares de machos de *Amblycorypha parvipennis* Stal, cantando en coro, alternan la produccion de frases de 3-5 segundos de duracion, con la frequente sobreposicion parcial de las frases. Para determinar el efecto de la distancia entre machos y la presencia de una hembra sexualmente receptiva y productora de sonido en la naturaleza del par de machos cantando en coro, los pares de machos fueron grabados, con y sin la presencia