

Temporal Shifts in Conspicuousness: Mate Attraction Displays of the Texas Field Cricket, *Gryllus texensis*

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Abstract

Conspicuous mate attraction displays can simultaneously draw the attention of potential mates and predators, placing the signaller in peril of becoming prey. The balance between these countervailing forms of selection has the potential to shape mate attraction displays. Male Texas field crickets (*Gryllus texensis*; Orthoptera) signal acoustically to attract mates. Mating signals also attract acoustically orienting parasitoid flies (*Ormia ochracea*; Tachinidae). Both the abundance of female crickets and parasitoid flies fluctuates throughout the night. We show mate attraction displays exhibit diel shifts that correlate positively with expected female cricket presence and negatively with expected parasitoid fly activity. During early evening, when parasitoids are most common and mating is scarce, crickets signal less often and with reduced conspicuousness. During the second half of the evening, when sexually receptive females are abundant and parasitoids are scarce, crickets signal more often and with enhanced conspicuousness. These diel shifts in mate attraction displays do not appear to result from male crickets detecting parasitoid flies or female crickets and altering their behaviour accordingly. Males in close proximity to parasitoid flies or female crickets do not signal differently than lone males. Instead, diel pattern shifts in mate attraction displays appear to be a selective response to trade-offs between natural selection via parasitism and sexual selection via mate choice.

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Introduction

In many animals, males use conspicuous displays to attract mates. Males that are the biggest, produce the loudest songs, or have the brightest coloration usually have a mating advantage (Andersson 1994). These conspicuous displays also endanger males by making them more susceptible to predation (reviewed by

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Kotiaho 2001; Müller & Robert 2002). Therefore, mate attraction displays usually involve a trade-off between countervailing forms of sexual and natural selection, whereby sexual selection favours more conspicuous displays and natural selection favours less conspicuous displays (Andersson 1994; Zuk & Kolluru 1998; Hedrick 2000; Bertram 2002b).

Mate attraction displays should be driven by present and future reproductive profitability, suggesting signal conspicuousness may be shaped by the abundance of sexually receptive females and predators (Walker 1983). Mate and predator abundance often cycles on several temporal scales including seasonal cycles, lunar cycles, and daily cycles (Lima & Bednekoff 1999; Sih et al. 2000). If male display conspicuousness is highest when sexually receptive females are abundant and lowest when predators are abundant the trade-off between these countervailing forms of selection could potentially be altered.

Here we test whether display conspicuousness correlates with nightly shifts in the abundance of predators and sexually receptive females. Male Texas field crickets, *Gryllus texensis*, are an ideal species to examine relationships between signal conspicuousness and prevalence of predators and mates, as both mating success and predation risk are strongly tied to acoustic mate signalling behaviour. Further, both the availability of potential mates and abundance of potential predators cycle in a predictable manner throughout the night (French & Cade 1987; Cade 1989; Cade et al. 1996).

Texas field crickets use two alternative mating strategies: callers produce conspicuous acoustic signals to attract females, whereas satellites silently intercept attracted females. Callers rub their forewings together; each closing stroke produces a pulse of sound. Pulses are concatenated together to produce trills; trills are concatenated together into trilling bouts.

Caller's acoustical signalling conspicuousness may be highly heritable. Using the same population of Texas field crickets as this study, Cade (1981a) performed selection experiments for high and low total calling time on two lines over four generations. His realized heritability estimates are $h_r^2 = 0.50$ for high lines, and $h_r^2 = 0.53$ for low lines. Although heritability of trilling amplitude and trilling bout duration have yet to be estimated in *G. texensis*, the number of pulses per trill have been found to be heritable ($h^2 = 0.39$; Gray & Cade 1999a). Likewise, in *G. integer*, a closely related congener, Hedrick (1988) found male calling bout length to be highly heritable ($h^2 = 0.74$). Heritability enables traits to respond to selection over evolutionary time.

Callers producing the most conspicuous displays typically have the highest mating success. In a low density field-based arena study, Cade & Cade (1992) found *G. texensis* males that signal most often also mate most often (Cade & Cade 1992). Further, several field-based studies have found louder songs attract more sexually receptive females (Cade 1979, 1981b; Walker 1986). To date, no one has examined how trilling bout duration or bout rate influence mating success.

Gryllus texensis males producing conspicuous acoustic mate signalling displays are also regularly attacked and eventually killed by acoustically orienting gravid female parasitoid flies *Ormia ochracea* (Diptera, Tachinidae, Ormiini)

(Cade 1975). Female parasitoid flies have directional tympanal hearing organs that allow the host-location of acoustically signalling crickets (Robert et al. 1992, 1996a; Robert & Hoy 1994; Miles et al. 1995; Robert et al. 1996b, 1998). Female parasitoids are larviparous; gravid females deposit larvae on and around the host. Larvae enter the cricket, feed and grow; cricket host death results from pupae emergence approx. 7 d after larviposition (Wineriter & Walker 1990; Robert et al. 1992; Adamo et al. 1995). Parasitism rates vary from 9 to 26% (Cade 1975, 1979, 1984; Adamo et al. 1995). Because *O. ochracea* parasitism is fatal for the Texas field cricket, the parasitoid is expected to be an important selective agent influencing mate attraction behaviour (Walker 1983; Zuk et al. 1993; Simmons & Zuk 1994; Murray & Cade 1995; Cade et al. 1996).

Like female crickets, female parasitoid flies appear to be preferentially attracted to loud, long and frequent trills (Wagner 1996; Müller & Robert 2002). Using the trilling song of the congener *Gryllus rubens* in two-choice discrimination tests, Müller & Robert (2002) revealed that gravid female *O. ochracea* show a preference for trills of high amplitude. This research corroborated earlier results that *O. ochracea* females are preferentially attracted to louder *G. texensis* and *G. lineaticeps* trills (Cade 1981b; Wagner 1996). Wagner (1996) also revealed that gravid female *O. ochracea* flies favour trills produced at a higher rate and longer duration. These results were corroborated by Müller & Robert (2002) who experimentally showed that *O. ochracea* females are preferentially attracted to longer trills, and the spatial accuracy of gravid female flies is slightly less efficient at low repetition rates. Overall, these results indicate that males producing the most conspicuous songs are likely to attract the most acoustically orienting parasitoid flies. One study, however, suggests otherwise. In a field experiment, Gray & Cade (1999b) found female parasitoid flies prefer calls with average numbers of pulses per trill over calls with the number of pulses per trill one standard deviation greater than the mean.

Parasitoid females are most prevalent and phonotactic in the first few hours following dusk (Cade et al. 1996). Cade et al. (1996) broadcasted tape recorded *G. texensis* song through loudspeakers with attached fly traps at the Brackenridge Field Laboratory (BFL) of University of Texas at Austin. *Gryllus texensis* trills were broadcasted over five nights in Jul. and Aug. 1984, two nights in Oct. 1992, and seven nights in Aug. and Sep. 1994. Broadcasts were initiated at 22:00 hour local time (approx. 1.5 h after sunset) in all years except 1992, when broadcasts were initiated at 16:00 hours (approx. 4 h prior to sunset). Acoustic traps were inspected hourly, and flies were removed and counted. Data from all years indicate that *O. ochracea* parasitoid flies are most active just after sunset. Fly phonotaxis peaks immediately following sunset, drops dramatically over the next few hours, and is greatly reduced by sunrise. Decline in fly activity through the night does not result from fly removal from the population, as collected flies were released following capture and counting in all years but 1992 (Cade et al. 1996).

The majority of sexually receptive females crickets also phonotactically orient to acoustically signalling males early in the night (Cade 1979, 1989). Cade (1989) monitored the hourly attraction of *G. texensis* to broadcasts of conspecific

male tape-recorded trills and to conspecific male trills at high and low density in 1983 and 1985–1988. Hourly attraction rates of female *G. texensis* did not differ between broadcasted tape-recorded trills and males signalling in a natural setting. Although both males and females were attracted to conspecific signals throughout the night, significantly more crickets were attracted in the first half of the night ($n = 521$; 2–6 h after sunset) than in the second half of the night ($n = 202$; 7–11 h after sunset) (Cade 1989). Likewise, of the 107 crickets (41 male and 66 females) that entered the monitored area during the four nights that the tape-recorded *G. texensis* trills were broadcasted, there were significantly more crickets collected in the first half of the night ($n = 63$) than in the second half of the night ($n = 34$). This data on male and female *G. texensis* attraction to conspecific acoustic trills was collected from the same location as the data on *O. ochracea* parasitoid fly phonotaxis to *G. texensis* mate attraction trills.

The vast majority of matings occur at and just after dawn (French & Cade 1987). French & Cade (1987) monitored the temporal relationships between acoustic signalling and mating in *G. texensis* at the BFL in Austin, Texas. They recorded the number of signalling males and matings every 5 min from 22:00 to 08:00 hours (approx. 2 h past sunset to 3 h past sunrise) over several nights from Apr. to Aug. 1986. Although signalling and mating were observed throughout the night, both showed statistical departure from random distributions: most mating was observed just after dawn (French & Cade 1987).

Given the temporal distributions in activity levels of male and female crickets and parasitoid flies, we proposed early evening trillers should be exposed to more parasitoids, while dawn trillers should have access to more mates (French & Cade 1987; Cade et al. 1996; Bertram 1999, 2002b). We examined whether callers may have evolved a shift in the conspicuousness of their mate attraction displays in conjunction with temporal shifts in the probability of being parasitized and mating. Specifically, we asked whether callers signalling early in the evening produced fewer calls of lower amplitude, and shorter duration, than callers signalling closer to dawn. We also tested whether shifts in conspicuousness result from crickets detecting the presence of gravid female parasitoids and/or sexually receptive females and altering the conspicuousness of their calls. We determined whether males in the presence of parasitoids or sexually receptive females altered their total signalling time, trilling amplitude, bout duration, and/or trilling bout rate.

Methods

We collected male Texas field crickets from bright light aggregations at a driving range in north Austin, Texas. Collections were made over a 10-d period in Sep. 2001, and a 12-d period in May 2002. Both male and female crickets are attracted to these bright lights and can be easily captured from the flat surfaced parking lot.

Males were housed together in clear plastic containers with shelter, ground rat chow (Harland's Tekland Rodent diet 8604) and water in natural light

conditions for the first 18–42 h in the BFL in Austin, TX, USA. Male crickets were then individually placed in plastic containers (15 × 15 × 15 cm), and their acoustic mate attraction signals were monitored from 6:00 PM to 10:00 AM each night.

Cricket mate signalling behaviour was monitored in the BFL greenhouse. We monitored the mate signalling behaviour of field-collected males in the greenhouse to provide an environment with natural light and temperature fluctuations. Our previous research indicates that monitoring environment does not significantly influence field collected adult male *G. texensis*'s acoustic mate signalling behaviour (Bertram 2002a).

Temporal Shifts in Conspicuousness

To test whether males alter the conspicuousness of their mate attraction displays through the course of the night in conjunction with parasitism risk and mating benefits, we analysed the behaviour of 205 males. We predicted that these males would produce less conspicuous mate attraction displays (shorter calls with lower amplitudes) during the first half of the night when parasitoids are typically most prevalent. We also predicted that males would call more often with louder and longer calls in the second half of the night when mating typically occurs. We used repeated measures ANOVA to compare mate attraction songs during the first half of the night (6:00 PM to 2:00 AM) to the second half of the night (2:00 AM to 10:00 AM). Critical p-values were Bonferroni corrected to $p < 0.01667$.

Altering Conspicuousness in the Presence of Predators or Mates

To test whether male crickets reduce their mate attraction behaviour in the presence of acoustically orienting gravid female parasitoids, and enhance their mate attraction behaviour in the presence of sexually receptive female crickets, we examined the trilling behaviour of male crickets exposed to female crickets, parasitoid flies, or left alone (control). We used a repeated measures design (males randomly exposed to all three treatments) and a single factor design (males randomly assigned to one of three treatments).

We collected 25 female parasitoids in fall 2001 and three female parasitoids in spring 2002 at the BFL using an acoustic slit trap (Walker 1989) broadcasting *G. texensis* mate attraction trills. Parasitoid flies were housed together in a mesh sided box in BFL for 18–42 h with cotton balls saturated with a sugar water solution.

Male crickets were individually placed in plastic containers (15 × 15 × 15 cm). Each container was then paired with an identical container housing nothing (control males), a female cricket (female), or a parasitoid fly (parasitoid). The walls separating the two containers were replaced with wire screening (12 × 12 cm), allowing the male cricket to use visual, auditory, and olfactory cues to detect the parasitoid fly, female cricket, or empty container that

was placed next to him. No physical contact was possible between the individuals held within the two containers. The two containers were housed inside a larger plastic container (20 × 20 × 40 cm), to ensure no influence between neighbouring treatments. Crickets were provided with shelter, water, and ground rat chow (Harland's Tekland Rodent diet 8604); parasitoid flies were supplied with cotton balls saturated with a sugar water solution.

In our repeated measures design we exposed 76 males to all three treatments (parasitoid, control males, and female). Each male's calling behaviour was monitored over three nights, from 6:00 PM to 10:00 AM. Males were placed in a different treatment each night. To ensure observed responses were because of treatment effects, and not treatment order, we randomized the treatment order for all males. We monitored 56 males in fall 2002 and 20 males in spring 2002. We used repeated measures ANOVA to investigate how individuals change their calling behaviour with the different treatments, allowing us to determine if males reduce their mate attraction displays in the presence of parasitoids, or enhanced their calling behaviour in the presence of potential mates. Because we ran six comparisons, critical p-values were Bonferroni corrected to $p < 0.0083$.

In our single factor design, we divided 420 males into the three different treatments (148 control males, 151 female and 121 parasitoid) and monitored male calling behaviour for one night, from 6:00 PM to 10:00 AM. We used an ANOVA to statistically compare the acoustic mate attraction behaviour of males with parasitoids to males alone and males with females. Critical p-values were Bonferroni corrected to $p < 0.0083$.

Acoustic Monitoring

Our electronic monitoring apparatus allowed us to acoustically monitor up to 64 male crickets each night. A microphone hung inside each male's container, attached to a central circuit board and computer. The microphone monitored the sound decibel level in the male's container. The central circuit board converted amplitude into a score between 0 and 10. When the cricket was silent, a 0 was scored on the computer's hard drive. When the cricket was trilling, a number between 1 and 10 was scored. The number scored by the microphone correlates strongly and positively with amplitude (ANOVA: $F = 10202$, $p < 0.0001$, $df = 534$, $R^2 = 0.95$), and amplitude levels (dB) are presented here, estimated from a distance of 10 cm. Male's mate attraction displays were monitored 10 times per second, and an average microphone score was recorded each second, ensuring continuous information on mate attraction displays. For further details on this electronic device, consult (Bertram & Johnson 1998).

Because female parasitoid flies acoustically orient to calling males, are preferentially attracted to loud trills with long trill durations, and are most prevalent early in the evening, our research focused on four characteristics of mate attraction: the total amount of time each male spent signalling each night, trilling amplitude (dB), average trilling bout duration (number of minutes trilling continuously with interruptions < 1 min), and when during the course of the

night each male signalled [temporal calling pattern (TCP)]. TCP includes a trio of parameters including start time, mean time and stop time (Bertram 2000). ‘Start time’ is when the cricket first signals. ‘Mean time’ is the average time of night in which the cricket calls. ‘Stop time’ is the last time the cricket signals [refer to Bertram (2000) for details]. We tested results for normality using the Shapiro–Wilk statistic, and then log-transformed total signalling time, start time, and trilling bout duration data to meet the assumptions of normality necessary for parametric statistical analyses.

Results

Males reduced the conspicuousness of their mate attraction displays during the first half of the night, and enhanced their displays during the second half of the night (Table 1). Males trilled significantly more often during the second half of the night. Males produced softer trilling bouts with shorter durations during the first half of the night, and produced louder trilling bouts with longer durations during the second half of the night. Further, two-thirds of the signalling occurred during the second half of the night. These temporal shifts in conspicuousness correlated negatively with the abundance of gravid female parasitoid flies and correlated positively with temporal shifts in prevalence of sexually receptive females.

Males did not alter their mate attraction displays in the presence of parasitoid flies or female crickets (Table 2). Males in the presence of parasitoids did not trill less often, produce shorter trilling bout durations, or produce trills of lower amplitude. Further, males exposed to parasitoids did not shift their acoustic signalling to later in the evening in comparison with control males. Neither start time, mean time, or stop time differed significantly between males exposed to parasitoids and control males. Males did not enhance their mate attraction displays in the presence of potential mates. Males in the presence of females did

Table 1: Change in mate attraction behaviour through the course of a night. Males signal less often with softer and shorter calls in the early evening, when parasitoids are typically present. In the dawn hours, when most mating occurs, males signal often, with louder and longer calls

	Evening	Morning	Statistic	p-value	df
Parasitoids	Prevalent	Uncommon			
Matings	Uncommon	Prevalent			
No. of callers	21	107	$\chi^2 = 84.01$	<0.00001	1
No. of non-callers	184	98			
Total signalling time ^a	21.8 ± 3.5	45.1 ± 4.6	F = 34.29	<0.001	91
Trilling amplitude ^b	63.4 ± 1.2	72.1 ± 1.2	F = 16.74	<0.001	91
Trilling bout duration ^a	1.9 ± 0.4	3.5 ± 0.4	F = 27.36	<0.001	89

^aMeasured in minutes.

^bMeasured in decibels.

Table 2: Influence of gravid female parasitoid fly and sexually receptive female cricket presence on male calling behaviour in the Texas field cricket

	Control	Female	Parasitoid	Statistic	p-value	df
Repeated measures ANOVA						
Monitored (no.)	76	76	76			
Calling (no.)	46	58	50			
Signalling time ^a	90.7 ± 17.0	87.0 ± 15.7	72.7 ± 18.6	F = 0.32	0.587	7
Amplitude ^b	75.5 ± 1.3	76.4 ± 1.2	77.7 ± 1.3	F = 7.26	0.115	7
Bout duration ^a	5.4 ± 1.3	4.0 ± 0.8	5.5 ± 1.7	F = 1.68	0.324	7
Start ^c	01:24 ± 36	01:00 ± 36	01:36 ± 66	F = 0.04	0.845	7
Mean ^c	04:36 ± 30	04:54 ± 24	04:06 ± 54	F = 0.01	0.938	7
Stop ^c	08:00 ± 24	08:12 ± 18	06:54 ± 48	F = 2.30	0.173	7
Single factor ANOVA						
Monitored (no.)	148	151	121			
Calling (no.)	119	113	92			
Signalling time ^a	89.2 ± 22.8	36.5 ± 7.0	73.0 ± 16.4	F = 3.05	0.052	93
Amplitude ^b	74.2 ± 1.2	74.6 ± 1.2	76.8 ± 1.3	F = 1.80	0.173	93
Bout duration ^a	4.1 ± 0.9	4.3 ± 0.3	4.9 ± 1.2	F = 1.76	0.180	93
Start ^c	02:00 ± 42	01:54 ± 54	01:00 ± 48	F = 1.91	0.154	93
Mean ^c	05:54 ± 24	05:36 ± 36	04:30 ± 42	F = 1.49	0.229	93
Stop ^c	08:24 ± 24	07:30 ± 36	06:48 ± 42	F = 1.64	0.200	93

^aMeasured in minutes.

^bMeasured in decibels.

^cTimes are presented using the 24 h clock (averages ± SE = time of day ± min).

not trill more often, produce louder or longer trilling bouts, or shift their temporal calling behaviour away from control males. Our single factor design results corroborated our repeated measures design results (Table 2).

Discussion

Texas field crickets may compensate for their conspicuous mate attraction displays by shifting their diel mate attraction patterns in correlation with expected prevalence of parasitoid flies and potential mates. During the first half of the night when parasitoid flies are prevalent and mating is uncommon, many males do not trill. The few males that do signal, trill significantly less often and produce softer trilling bouts of shorter duration. During the second half of the night when parasitism is rare and most mating occurs, callers' signal significantly more often and more conspicuously, producing louder trilling bouts of longer duration. These results are consistent with the notion that selection, resulting from temporal differences in the abundance of potential predators and mates, has shaped the temporal patterns of male Texas field cricket mate attraction displays.

Conclusions about the evolutionary effects of temporal shifts in abundance of parasitoid flies and sexually receptive females on sexual traits are difficult to

draw for *G. texensis* because our study only involves crickets from one population, and therefore provides only a single data point. Unfortunately, comparisons with other populations are unlikely to clarify the story, because *G. texensis* appears to be attacked by *O. ochracea* across its range. *O. ochracea* parasitizes several different cricket species, however, so correlative and comparative research allow conclusions to be drawn about selection's role in shaping cricket mating behaviour.

Ormia ochracea attack and kill *G. rubens* and *G. firmus* in Florida (Walker 1986; Walker & Wineriter 1991), *G. texensis* in Texas (Cade 1975), *G. lineaticeps* in California (Wagner 1996), and *Teleogryllus oceanicus* in the south pacific islands. Comparisons across parasitized and unparasitized cricket species support our hypothesis that selection is shaping cricket mate attraction signals (Cade & Wyatt 1984; Zuk et al. 1993, 1995, 1998; Simmons & Zuk 1994; Kolluru 1999). Cade & Wyatt (1984) compared the total signalling time of several cricket species exposed and unexposed to *O. ochracea*. They found that cricket species exposed to parasitoids signal significantly less often than cricket species never exposed to parasitoids.

Zuk et al. (1993) revealed a continuum of parasitism across *T. oceanicus*, populations in the south pacific islands and Australia (Zuk et al. 1993). Differences across parasitized and unparasitized populations suggest evolutionary changes in calling song structure resulting from selection (Zuk et al. 1993; Rotenberry et al. 1996; Kolluru 1999). Zuk et al. (1993) compared the song structure and diel signalling pattern in three populations of *T. oceanicus*, two not parasitized and one heavily parasitized. Unparasitized males from the population that experiences heavy parasitism produced signals that were generally reduced in comparison to the other two non-parasitized populations: they produced signals with shorter pulse durations, trill durations, inter-chirp intervals, and inter-song intervals (Zuk et al. 1993). They also found that the cricket population attacked by *O. ochracea* signal using truncated diel calling patterns (Zuk et al. 1993; Kolluru 1999). While song differences in these populations could result from genetic drift following isolation, the shifts in call structure and diel pattern correlate strongly with parasitoid abundance, providing support for the hypothesis that they result from evolutionary responses to selection. To statistically evaluate the contribution of parasitoid pressure to variation in the structure of acoustic signals, Rotenberry et al. (1996) analysed the mating signals of crickets collected from five areas along a gradient of prevalence of parasitization. They used canonical correlation analysis to simultaneously test the robustness of alternative hypotheses and predictions. Their results enabled them to strongly infer that selection by phonotactic parasitoid flies has shaped the signal characteristics of field crickets in the Hawaiian islands (Rotenberry et al. 1996).

Together, this multi-species evidence suggests that selection influences the evolution of mating signals. Future work should examine the temporal aspects of mate attraction behaviour of several parasitized and unparasitized cricket species and populations to determine if individuals alter their mate attraction calls in conjunction to mate availability and parasitoid presence.

If temporal shifts in signal conspicuous result from temporal shifts in parasitoid and mate abundance, an intriguing question remains: why do not parasitoid flies shift their phonotactic activity to later in the evening to match cricket acoustic activity levels? Cade et al. (1996) proposed that parasitoid flies could face physiological constraints that contribute to their activity patterns, such as an incapacity for phonotaxis at lower temperatures. To date, physiological constraints influencing acoustically orienting parasitoid fly activity patterns have yet to be examined.

Can Crickets Detect Parasitoids or Potential Mates and Alter their Behaviour?

Males in the presence of parasitoids or female crickets did not differ from control males in their total signalling time, how loud they signalled, their trilling bout durations, or when they signalled through the night. Male crickets were unlikely to have become habituated to the presence of parasitoid flies or female crickets, because female crickets and flies can move around in their containers, thereby providing novel stimulus cues throughout the night. Our results suggest that without physical contact, male crickets either ignore or are unable to detect nearby parasitoid flies and sexually receptive females. The primary means by which male crickets are alerted to the presence of sexually receptive female crickets is via contact chemoreception and tactile cues (Tregenza & Wedell 1997). If tactile cues are necessary to alert male crickets to the presence of gravid parasitoid flies, then evasive responses may be too little and too late.

Overall, there is only minimal evidence that crickets can detect approaching parasitoid flies. Müller & Robert (2002) proposed that because *O. ochracea*'s flight tone ranges from 100 to 200 Hz, crickets might use their sensitive cercal wind receptors to detect approaching parasitoid flies. In partial support of this hypothesis, several studies have shown that air disturbances cause escape responses in crickets (Bentley 1975; Gnatzy and Kämper 1990; Gras and Hörner 1992; Känou 1999). To fully avoid parasitism, however, crickets would have to detect parasitoids in flight and quickly leave the area because parasitoid flies exhibit remarkably accurate nocturnal phonotaxis even once signalling has stopped (Müller & Robert 2002).

An intriguing line of research suggests that the most conspicuous signallers may not experience the greatest risks (Hedrick 2000). Using *G. integer*, a congener of *G. texensis* that is not parasitized by *O. ochracea*, Hedrick (2000) showed that males that produce the most conspicuous mate attraction displays act with the greatest caution. Likewise, using three populations of *T. oceanicus* that experience very different levels of parasitism, Kewkiewicz and Zuk (2004) showed that latency to resume calling increases with increasing parasitoid levels: males crickets from the island with the lowest parasitism levels show the shortest time lag to start signalling again following a standardized disturbance, while males from the island with the highest parasitism levels stay quiet for the longest period following disturbance. It would be interesting to determine whether male *G. texensis* that

signal using the most conspicuous displays act the most cautiously, potentially altering the trade-off between natural and sexual selection.

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