

CYPHODERRIS STREPITANS (ORTHOPTERA, HAGLIDAE): REPRODUCTIVE
BEHAVIOR, SINGER MOVEMENT AND PREDATION

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Objectives

Cyphoderris strepitans Morris & Gwynne (1978) is a primitive cricket-like insect, active in both Grand Teton and Yellowstone Parks in early spring. Males stridulate at night in sagebrush habitat, rubbing their tegmina together to produce a high-pitched trill. Females are attracted by these sounds and during the mating which follows, consume a portion of the male's metathoracic wings. This behaviour makes it possible to compare the mating activity of individually marked males under field conditions.

Crickets and katydids (Ensifera: Gryllidae, Tettingoniidae) are notable for the predominance of sound signals in their pair formation, courtship and intermale aggression (Otte 1977). *C. strepitans* is a relict of the Haglidae, a virtually extinct group that gave rise to the modern Ensifera in the mesozoic (Sharov 1968). Studying the reproductive behaviour of this primitive insect can provide insight into the evolutionary origins of ensiferan mating systems.

A spermatophylax accompanies the sperm ampulla transferred by the male; it is an amorphous white mass, subsequently consumed by the female (Gwynne 1982). If females benefit energetically from the spermatophylax and from feeding upon the male's underwings, it might prove adaptive for females to discriminate against recently-mated males in favour of those whose virginity assures a maximally nutritious food gift. In 1979 and 1980 we obtained data suggesting that such discrimination does occur: virgin males seemed to be obtaining mating opportunities out of proportion to their numbers (relative to non-virgins) in the singing population.

Our objectives in 1981 were threefold: 1) to observe and quantify the details of the mating act, 2) to confirm that virgin males are preferred as mates over non-virgins, 3) to characterize the mobility and perch fidelity of singing males.

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Methods

The principal field site was a sagebrush flat (elev. 518 m) southeast of Lozier Hill and north of Pacific Creek in Grand Teton Park. Other sites were at Deadman's Bar on the Snake River and Mt. Washburn in Yellowstone. Mating behaviour was observed by 1) searching the field sites for pairings in progress and 2) releasing males and females into a low-walled enclosure (80 X 27 cm) in the laboratory.

At Pacific Creek, beginning soon after dark, singers were stalked by orientation to their song, captured and the state of their wings examined. They were then marked uniquely with coloured paints and released at their capture site. The singing locations of the males taken on a given night were marked with small surveyor flags; the following day each such location was recorded by measuring two distances from it to a grid of fixed reference stakes. Flash photographs were taken of wings wounded by feeding to allow subsequent assessment of second and third mating opportunities. In addition to recording general weather data, we noted for each singer the perch plant, perch height, body orientation and forewing (tegminial) overlap.

Results

Mating behaviour. The matings of a dozen pairs are summarized in Table 1. As the female arrives the male ceases calling and presents his arched back. She mounts and feeds upon wing material. The male, telescoping his abdomen and using a dorsal clamping device (gin trap), attempts to make genitalic contact. The approximate mean time in copula for 8 of the matings was 3 min 15 s. Males actively terminate copulation: they began to pull away from females immediately after spermatophore transfer. In 7 of 9 cases males resumed stridulation on or just before separation.

Females apparently lose receptivity with mating: all 12 one-mated females showed no interest in subsequent mating opportunities. Hindwing feeding did not always result in copulation (n=3). Duration of feeding was quite variable whether it ended in copulation or not: 44-680 s when copulation resulted and 290-1210 s when it did not.

Mating success. Singing was first detected at Pacific Creek on 23 May. Up to 1 June only limited mating occurred (Table 2). The male population was estimated to be almost 90% virgin. Between 1 and 4 June intense mating activity brought the ratio of virgin to non-virgin males down close to 1:1. Once-mated males were no less than half the singing population over the interval 1-6 June. During this time seven mating opportunities were detected in our sampling, either by observation of freshly-wounded wings (n=5) or discovery of old wounds in previously marked virgins (n=2). In spite of the abundance of non-virgin singers, all seven documented matings appeared to involve virgin males.

Mating activity as revealed in fresh wing wounds virtually ceased after

Table 1. Summary of *C. strepitans* mating interactions. Conservative ranges are provided where an exact onset or ending to an activity was difficult to observe.

Male mating histories	Duration of wing feeding prior to coupling (min)	Coupled		Duration of copulation (min)
		Yes	No	
virgin	2:00	X		4:57
once-mated	9:31		X	
virgin	4:50		X	
once-mated ^a	7:34	X		3:33
virgin	1:06 - 2:55	X		2:38 - 4:27
virgin ^b	0:44	X		3:21
once-mated	20:10		X	
virgin	?	X		2:30 - 3:30
virgin	10:00 - 11:20	X		1:16 - 2:36
virgin	5:00	X		1:45
virgin ^c	3:00	X		3:57
unknown	Less than 12 min for total hindwing feeding including copulation			

^a wings fed upon twice previously, but only resulting in one copulation

^b unmated but its wings chewed previously in the lab by another male

^c the final two entries occurred in the field

Table 2. Changing proportions of located virgin and non-virgin males in relation to detected mating opportunities at Pacific Creek, 1981.

Dates	Total located per night		% Virgin	Mating opportunities detected	
	Virgin	Non-virgin		Virgins	Non-virgins
23 V					
24	First singing 4	1	89%		
25	7				
26	Rain 8				
27				3	0
28					
29	11	3			
30					
31	1				
.....					
1 VI	5	3			
2					
3					
4	2	9	52%	7	0
5	6	15			
6	9	17			
7	4		29%		
8	Heavy rain 12	15			
9	Heavy rain 7	22	34%	2	1
10					

a revealed by fresh wounds in first-time captures (n=9) or by old wounds in previously marked virgins (n=4)

10 June: of 50 males taken in first-time captures subsequent to this date, none had freshly-wounded wings. Several individuals, recaptured over the last half of June, retained intact wings (n=8). Photographs of wing wounds are under analysis to determine whether non-virgins obtained any second and third matings.

Singer mobility and relocation. Males do not show high fidelity to singing sites. The average distance a non-virgin male could be expected to move from his singing location of the previous night of active calling (i.e. nights of suitable weather were discounted) was 4.4 m (n=34 measures of 28 males, variance = 31.0 m) (Fig. 1). Virgin males were found to move more than non-virgins: mean displacement was 8.0 m (n=20 measures of 16 males, variance = 70.0 m).

We attempted to capture and mark all singers heard in the approximately 0.2 hectare study area. Only about 40% of the 145 males for which records were obtained were relocated beyond 4 days from their initial capture (Fig. 2). For more than 70% of our marked animals we could expect disappearance from our study population after 8 days.

Conclusions

1) Caution must be exercised in the use of wing wounds to assess a male's mating success. Wounds are not inevitably accompanied by sperm transfer. Limited wounding has been taken as an indication of virgin (first-time) mating and this is probably a valid procedure, but we need further information on the extent of wing damage in known second matings. 2) Because females only mate once and then become sexually unreceptive, mating activity is largely confined to a few days in early June. Fewer matings were intercepted through our records this year, but the results confirm those of 1979, indicating a mating success for virgin males disproportionate to their numbers in the population. 3) The high rate at which marked individuals are lost from our study population must reflect either mortality or extreme mobility. A cursory examination of singer location data, much of which remains to be analysed, makes it apparent that movements of tens of meters do occur. However, an extensive peripheral search conducted on 26 June failed to discover any significant emigration of marked males from the study area. We are inclined to attribute the high disappearance rate to predation. Such an hypothesis makes sense of the low song-cessation threshold seen in this species and of its defensive display. We have also observed repeated feeding by Peromyscus maniculatus on C. strepitans in the laboratory and have established by live-trapping that this rodent is very abundant in the study area.

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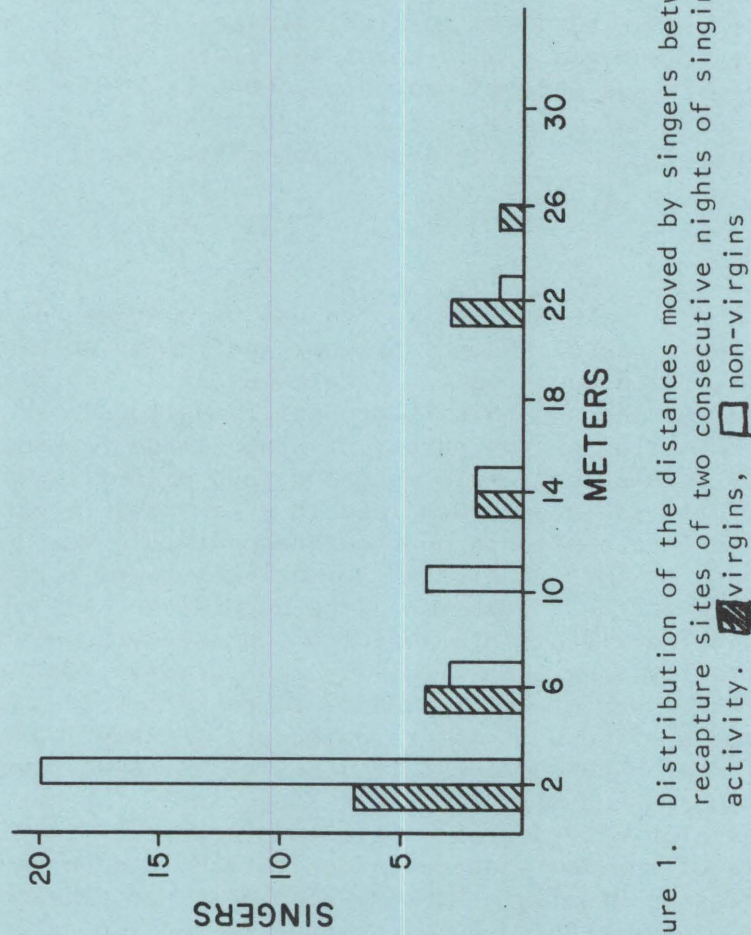


Figure 1. Distribution of the distances moved by singers between recapture sites of two consecutive nights of singing activity. ▨ virgins, □ non-virgins

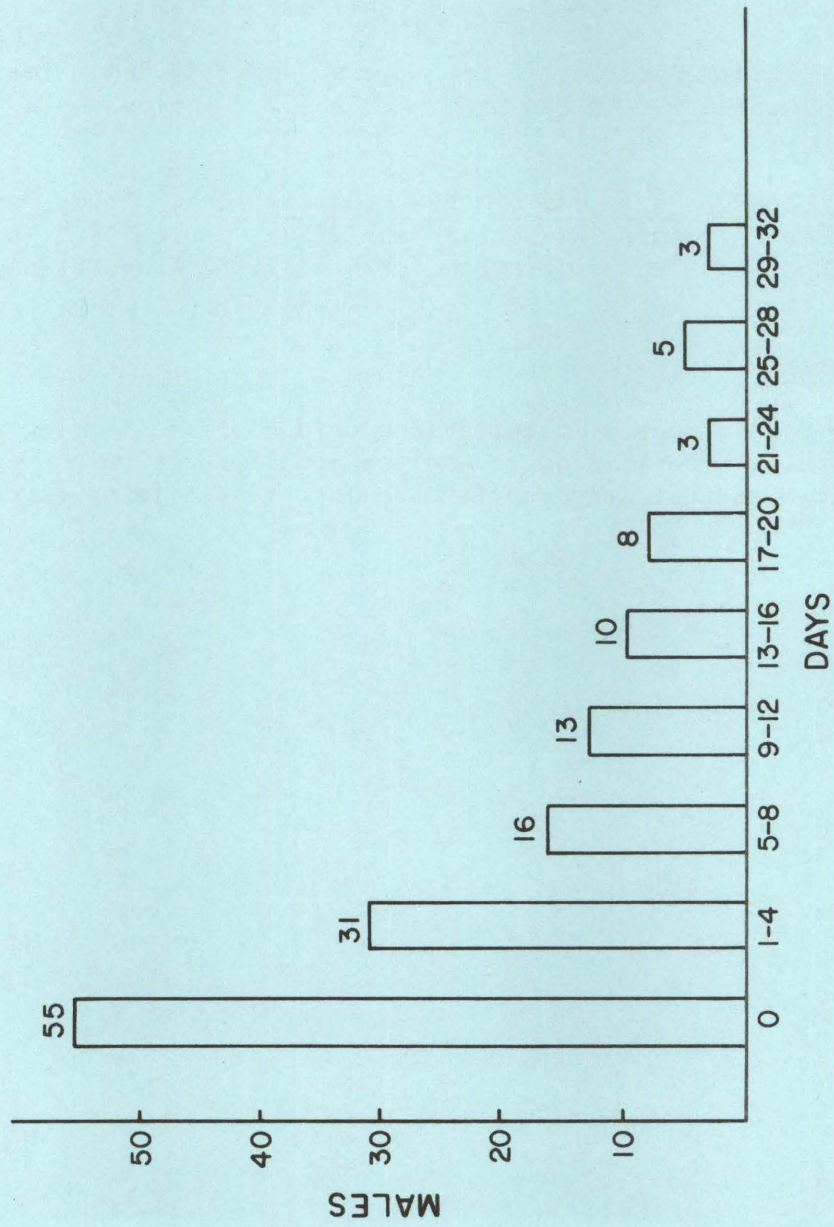


Figure 2. Frequency distribution of maximum relocation intervals.

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