Female pygmy bluetongue lizards apparently luring mating partners

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Running head: Female lizard luring partner

Keywords: Mating, female, pygmy bluetongue lizard, luring behaviour
Abstract

Mating behaviour in lizards has been well studied, with most reports indicating that the male dominates in initiating the mating, characteristically displaying visually to attract partners. This strategy may be less successful in secretive species that remain in small areas around their refuge, infrequently encountering other conspecifics, like the endangered Australian pygmy blue tongue lizard (*Tiliqua adelaidensis*). Adult lizards of this species spend most of their time in or at the entrance of single entrance vertical burrows, built by spiders, in patches of native grassland in South Australia. We filmed the behaviour of nine female lizards for 10 days in each month from October 2011 to February 2012. During filming in October, the austral spring, we observed 43 cases of females making moves away from their burrows, and back along the same path, in that month, that we did not observe among males, or among females in any other month. We observed 27 cases of males approaching female burrows, only in October and mostly along the paths previously taken by the females. Males attempted to mate, and were successful on five occasions. We describe the female movements and suggest that their function is to attract male mating partners.

Key word: scincid, lizard, female luring behaviour, mating behaviour.

Introduction

Mating behaviour in lizards has been well studied, with most reports indicating that the male dominates in initiating the mating, characteristically displaying visually to attract partners (Jenssen *et al.* 2000; Karsten *et al.* 2009; Ord and Martins 2006). This strategy may be less successful in species that occupy flat habitats such as native grasslands, without obvious perches that would allow a male to transmit his signal over distance, or in secretive species that remain in small areas around their refuge, infrequently encountering other conspecifics. Although it has been well established that many reptiles can also use chemical
communication within their social interactions (Bull et al. 2000; Bull et al. 1999; Cooper 1994), and that lizards can discriminate between male and female chemical signals (Cooper Jr and Trauth 1992; Mason and Gutzke 1990), the use of olfaction to attract mating partners in lizards has received less attention.

The pygmy bluetongue lizard (Tiliqua adelaidensis) is an endangered Australian scincid which lives in highly fragmented remnants of native grassland in the mid north region of South Australia (Hutchinson et al. 1994). It is a medium sized (average adult snout to vent length 95 mm) cryptic species, that occupies single entrance, vertical burrows made by lycosid and mygalomorph spiders (Hutchinson et al. 1994; Milne et al. 2003). The lizards use these burrows as refuges, and as ambush sites to capture passing invertebrate prey and spend most of their time, either in the burrow, or half emerged at the burrow entrance (Milne et al. 2003). Both pitfall trap surveys (Schofield et al. 2012) and video camera observations throughout the activity season (Milne et al. 2003) have indicated that resident adult lizards very rarely move away from their burrow entrances. Movements away from burrows are risky, exposing lizards to predation (Fenner et al. 2008), so that any movements away from the burrow entrance are likely to have special significance. Mating has been observed in the spring months of October and early November (Fenner and Bull 2009; Milne et al. 2003), when males move away from their burrows to seek female mating partners (Schofield et al. 2012). Females produce litters of 2 to 4 live young between late January and mid-March of the following year (Fenner and Bull 2009; Hutchinson et al. 1994; Milne et al. 2002; Schofield et al. 2012). Genetic data from those litters show that multiple males mate with each female, sometimes locating the female from over 100 m away (Schofield et al. 2014). This latter result implies that males can efficiently locate females in their burrows over substantial distances relative to their size. This ability would be more easily explained if there was some form of signaling of sexual receptiveness. All of our previous observations suggest
that it is the male that searches for female partners, so we deduce that receptive females could
be producing the signal that attracts the males. In the grassland habitat that they occupy,
clumps of native grasses will make visual signaling effective only over a short distance.
Olfactory signaling is probably more efficient, and we know that this species is able to
discriminate among olfactory signals from its scats (Fenner and Bull 2010; Fenner and Bull
2011b). We suggest that female lizards produce a form of chemical signal to lure male mating
partners to their burrows, and we set up an observational study to investigate this hypothesis.
Although we did not directly test whether a chemical signal was produced, we predicted that
females would show behaviour consistent with the production of olfactory cues, in that they
would show that behaviour during the mating period and rarely at other times, and that males
would not display a similar behaviour. Further we predicted that males approaching females
to mate would show behavior consistent with them responding to olfactory cues.

**Methods**

This study was based on a wider set of observations of lizard behaviour from filming of 23
burrows, each initially occupied by an adult pygmy bluetongue lizard, for 10 days each
month for five months from Oct 2011 – Feb 2012, a period that included most of one lizard
activity season. The study was located in a 1 ha plot within the Tiliqua property of the Nature
Foundation of South Australia, near Burra (33.67°S; 138.93°E), in the mid north region of
South Australia.

As a component of that study, in October 2011, we attached nine CCTV cameras (SONY
Effio 2.8mm-10mm, 30 fps) to poles so they were positioned 100 cm above the burrow
entrances of nine pygmy bluetongue lizards that we had identified as females. These cameras
were set to record from 0500 – 1900 h for 10 days between 16 and 25 Oct 2011, a total of 140
h of recording per burrow. The field of view of each camera was centered on the burrow
entrance and included an area of 60 cm x 60 cm around the burrow entrance. We made similar observations for male lizards during October, and for all adult lizards in the months November – February.

During playback of the video recordings we noted any reproductive behaviours, and we compared levels of other activity among those females that did or did not show reproductive behaviour. The parameters we considered included activity time, basking time, and movements around burrows.

1) Activity time (h. d⁻¹) was defined as the period from the first time when the lizard head emerged from its burrow to the last time that lizard retreated completely into its burrow on that day. 2) Basking time (min. h⁻¹) was defined as the amount of time when the lizard head or at least part of its body was emerged, and the lizard remained at the entrance of its burrow. We called this basking because the lizard was exposed to solar radiation, but an additional function of this behaviour may have been to watch for and ambush passing invertebrate prey. We divided the total minutes spent basking each day by 14 (total hours of filming) to calculate the basking time as minutes per hour. 3) Number of movements around the burrow was recorded. We considered a single movement was when a lizard fully emerged from its burrow, moved about, usually for a very short distance within the field of view of the camera, and then retreated to the same burrow. We recorded the number of these movements by each lizard on each day.

Parameters are presented as means ± S.E. (n), unless otherwise indicated

Results

Female behaviour

Six of the nine females showed a specific pattern of movements out of their burrows, that we observed only in October. We recorded 43 of these movements, which were distinctly
different from other regular movements that filmed lizards used for basking on the surface, for defecation or for prey capture. Those other moves were made by both males and females, and in each month of the broader study. The October specific moves were only made by females and were never observed during filming in other months. The movements were slow paced (1.68 ± 0.04 (n = 43) cm/sec) and deliberate, compared to more rapid runs to defecate (timed during October at 5.00 ± 0.85 (n = 2) cm/sec). During the October filming no male or female lizard fully emerged from their burrow to capture prey, with all prey captures made while still partially inside the burrow. In other months, when lizards did emerge to capture passing prey, their movements were too fast to be accurately measured from the video recording, and certainly much faster than the moves described here. We cannot discount that the movements, particularly those of longer duration, may have been for wider foraging or to seek alternative burrows, but there was an unusually high frequency of these movements in the October filming (43 cases) and females always returned to the same burrow after the movement.

The six females each made between one and 25 movements (Table 1) over one to nine days during the ten day filming period. The movements usually took the female out of the range of view of the camera, but they always returned to the burrow along the same paths after intervals of 7.5 seconds - 2.5 hours (22.02 ± 1.24 (n = 43) min, Fig 1A), although most of the moves were less than 25 min, and usually less than 5 min (Fig 1B). The movements occurred most frequently early in the morning (0700 – 1000 h) or late in the afternoon (1600 – 1900 h) (Fig 2). The directions taken were apparently random, except that they consistently avoided large clumps of native grasses adjacent to the burrow entrance. For the four females which made three or more of these movements, a path was regularly re-used, and individual females followed almost identical paths on up to eight separate occasions during the filming period (Fig 3). Where a different path was taken, the direction of each different path appeared to be
unrelated to previous paths (Fig 3). Some females made multiple movements (up to six) on
the same day, with intervals of a few minutes to several hours between ending one move and
starting the next. In cases where a female followed the same path more than once on the same
day, sometimes those were consecutive movements, sometimes they were separated by the
female taking a different path. Because our filming was restricted to a 10 day period we
cannot deduce if the three other females did or did not make similar movements outside of
the filming period, or if the number of moves that we recorded were or were not the total
made by each female. We saw no similar movements from six male lizards known to be in
burrows that were filmed over the same period, or in any females during filming in
subsequent months.

Male behaviour

Male lizards were observed to visit the burrows of seven of the nine filmed females on 27
occasions during the 10 days of filming in October. No observations of male visits to female
occupied burrows occurred in any other month of the filming. Our observations in October
included 17 male visits to four of the six females that had made these movements (Table 1).

Male arrivals were observed only on five of the 10 days of filming and happened at all times
across the day, from 0900 h to 1800 h. Consecutive male visits to a single female burrow on
the same day could be separated by a few seconds to a few hours. For 11 of those 17 visits,
the male approached the female burrow along exactly the same path as the female had
previously used (Table 1; Fig 3). Note that two male visits to female 21861 on day four were
along the same path as the female subsequently used on day five (Fig 3), but these were not
counted as path following, even though that female may have used that path before filming
started. We do not know if males visited the other two females that had made these
movements, after the 10 day filming period had finished. We do not know if the other three
females that were observed to have been visited by males, had made similar movements in
the period before the filming started. Also we were unable to recognize individual males from
the video recordings so we cannot say how many different males were involved in the
observed approaches to female burrows. Males that approached along female paths appeared
to find female burrows easily, and moved directly to the burrow entrances as soon as they
entered the camera field of view. In two of the six cases in which males visited female
burrows but did not use a known female path, they advanced less directly, appearing to
correct their approach path direction by tongue flicking until they were about 10 cm from the
burrow entrance.

Mating and mating behaviour

From the 27 cases of males visiting female burrows, we observed five cases of mating, each
involving a separate female, during the 10 days of filming in October (Table 1). Four of those
five females were subsequently observed to produce litters of offspring in the following
January, in their burrows. The fifth mated female, number 20002, had left her burrow before
the time when litters were produced. One of the four other females, 21861, was assumed to
have mated either before or after the filming period, because she had also delivered young by
January. Two other females, 21860 and 21827, which were observed making the greatest
numbers of movements, were not observed mating during the 10 day filming period, and,
while still in their burrows, were not observed with any offspring in the 10 day filming period
in the following January. The mating activity of the ninth female, 21844, was unknown. She
was not observed to have mated during the 10 days of filming in October, and had left her
burrow before January, so we have no evidence of whether she produced a litter.

We observed three different mating strategies by males. The first, adopted in 20 of the 27
cases, was for the male to bob its head 3-21 times immediately outside of the burrow entrance
for an average of 27.05 ± 0.22 (n = 20) sec. Then in 16 of the 20 cases, the male entered the
burrow, so that up to half of its body was inside the burrow, and apparently tried to grasp the female to bring her to the surface. In five other cases the male adopted a second strategy by entering the burrow without any head bobbing behaviour. The within burrow activity from males adopting both strategies took a mean time of $30.65 \pm 0.27$ (n = 21) sec. From the total 21 cases when the male entered the burrow, there were only three cases in which the male succeeded in bringing the female out of the burrow and onto the surface near the burrow entrance. In all of those three cases the male was then apparently successful in mating. We deduce from the relatively short time that males spent in the burrow, and from the very confined dimensions of the burrows previously reported (Milne and Bull 2000), that mating could not have occurred inside the burrows. All three cases where the male succeeded in bringing the female out, involved the first strategy, where burrow entering was preceded by male head bobbing at the entrance. Among the 16 cases of males that head bobbed and then entered the female burrow, the number of head bobs and the time spent head bobbing did not differ significantly between successful (N = 3) and unsuccessful attempts (N = 13) to bring the female out and mate with her (Table 2). Among the 21 cases where males entered the female burrow there were no significant difference in the time taken between successful (N = 3) and unsuccessful (N = 18) attempts to bring female out of burrow and mate with her (Table 2).

After both lizards were out, the male aligned his body parallel to the female, and started to grasp with his mouth the lateral part of the female body, just behind one of her front limbs. Holding her like that he then started to push the female tail up by forcing his body under her, allowing mating to commence. All of these behaviours, from the burrow emergence to the commencement of mating, took a mean time of $89.00 \pm 1.38$ sec for the three cases described. While mating, the coupled pair sometimes moved around on the ground surface. For those three cases, the actual mating took between 22 and 49 sec. After the three matings were
completed the females immediately returned to their burrows and the males followed them and spent from 1 – 8 min standing by the burrow, with their head just above the entrance, before finally moving away.

The third more opportunistic strategy was recorded twice. In both cases the male was successful in achieving a mating. In the first incident a male came into the camera field of view and stopped at the burrow entrance of female 20002 at 1036 h. That female had in fact left her burrow for one of the described moves 74 min previously. The male lizard head-bobbed for nine times over 36 sec before entering the burrow and then remained with his head emerged at the burrow entrance for a further 17 min. At that point the female resident returned along her outward bound path, moving steadily until she reached 5 cm from the burrow entrance. There she stopped for 5 seconds before starting to retreat, but the male came out of the burrow, grasped her and for the next 17 min tried to manipulate her to a position that would allow mating to commence. Finally he succeeded, although the actual mating time of 260 sec was over five times longer than any of the other observed matings. Also, following mating, the male spent over 14 min at the burrow entrance, far longer than any of the other successful males. In the second incident female (21012) fully emerged from her burrow at 0711 h and left camera field of view for 22 min. She returned to her burrow entrance and remained there for only 6 sec before a male lizard appeared at 0734 h from the opposite direction. Before the female could retreat into her burrow the male darted at her and grasped her front limb in his mouth. He pulled her out of the burrow, and then struggled for 2 min to push her tail up, as the other males had done, to allow mating. At this stage the struggling pair moved beyond the camera field of view, and the actual mating was not observed. But 4 min later the female returned quickly to her burrow. The male returned shortly after, although from a different direction, and passed by, but did not stop at the female burrow entrance.
The five matings that were recorded took place on four separate days of the 10 day filming period, and the times when they occurred were spread from early-morning (0740h) to late afternoon (1658h).

**Behavioural changes after mating**

Paired t-test showed activity time was the only behaviour which was significantly different before and after mating (activity time: df = 4, t = 3.05, p = 0.038). Females stayed active for a longer time each day before than after mating (Fig 4). There were significant differences between activity time and number of movements around burrows between females that were observed to mate (N = 5) and those that were not observed to mate (N = 4) in the filming period (activity time: df = 7, t = 3.45, p = 0.011; number of movements around burrows: df = 7, t = 2.86, p = 0.024). The females not observed to mate stayed active longer (Fig 5A) and moved around their burrows more (Fig 5B). Basking time did not differ either between females that did or did not mate, or between mated females before and after mating.

**Discussion**

We know from genetic analyses that the male that fathers the litter of a pygmy bluetongue lizard female can be located more than 100 m from the female (Schofield et al. 2014). A relatively small male lizard might be able to locate a receptive female mating partner in a burrow more efficiently over these substantial distances if some signals have been provided. We consider below the hypothesis that the female movements away from their burrows that we report in this paper were to provide those signals and to lure male mating partners.

We are not able to confirm whether there was or was not a signal produced by the females. We acknowledge that some females that we did not observe making these movements in the ten day filming period were still visited by males, and that some females that did make the movements were not visited by males in the ten day filming period.
Nevertheless, although we recognize that the fundamentally important evidence of an actual chemical signal is still missing, we provide seven observations that strongly support the hypothesis. First we only observed this behaviour in females and never in males, despite equal filming time for each sex. The function of this behavior must be related to female specific requirements. Second we only observed this behavior in the October filming period, and never in any of the other months over the entire activity season when we filmed. October is the only month when we observed mating, and we suggest that it is highly likely that the movement patterns are associated with mating in some way. Third, during October, and only during October, we regularly observed males approaching the burrows of females that had made these movements, and often along exactly the same path. That suggested to us that the females were leaving a chemical trail for males to follow. We know from other studies that this lizard species uses olfactory communication in other circumstances (Fenner and Bull 2011b). Although males also approached and mated with females that we did not observe making these movements, those females may have made the moves before filming started. Fourth, our interpretation that these moves were to lay trails is supported by the fact that females always returned along the same path, and often used identical paths on subsequent excursions, perhaps to reinforce the signal they had laid down. It could be that the females are laying trails to find their own way back to their home burrows, but in that case, we asked, why was this behaviour not observed in other months. Fifth, the females appeared to establish paths in several different directions, consistent with a behaviour designed to attract potential partners from multiple directions. Sixth, although our sample size was small, it appeared that the females that were not mated during the filming period tended to make more moves. This observation is consistent with females reducing luring behaviour after they have been mated. Additionally we observed that females were less active at their burrow entrance after mating, and that females that were not observed mating were more active than those that we saw
mating. Seventh, we can think of no other obvious alternative function for this female
specific pattern of movement activity focused around one brief part of their spring-summer
activity period. The moves were slower, more deliberate and of longer duration than the
defecation dashes from the burrow entrance, or the lunges for passing invertebrate prey that
we have observed at other times of the year. It is true that adult lizards occasionally change
burrows, and that some of the longer duration excursions that we included within our
description of this movement behaviour may have been to explore for alternative burrows.
But for the cases we observed, the movements were too frequent and too focused around one
period, for many of them to be about finding new burrows, and the females always came
back.

We do not know the nature of the lure, although it is likely to be a chemical signal secreted
from the skin or the cloaca as the lizard walks. The congeneric _Tiliqua rugosa_ is known to
use trails to locate and follow monogamous partners (Bull _et al._ 1993; Bull and Lindle 2002).
Our video images were not sufficiently clear to allow us to observe either if the female lizard
was rubbing any part of its body along the ground, or if the male lizard was using tongue
flicks to sense the trail. However, we can deduce that if males were following chemical trails,
the signal has a relatively low volatility and long duration, since males were observed using
trails females had last been along several days before.

The behavioural pattern of females regularly emerging and walking around on the surface
during October is completely different from our observations of the normal behaviour of
pygmy bluetongue lizards at other times of the year when they spend most of their time either
refuging in their burrow or sitting half emerged at the burrow entrance (Milne _et al._ 2003).
We have previously deduced that this sedentary, burrow-centered behaviour is to reduce
exposure to predation (Fenner _et al._ 2008), and to prevent takeover of burrows by
conspecifics (Fenner and Bull 2011a).
An anomalous observation is that, if females were trying to lure mating partners by this
behaviour, why did they appear to resist so often the males that visited their burrows? From
27 observed male approaches we only observed five matings, each with a different female.
We expect that we would have observed more matings over a longer filming period partly
because some females produced litters of young, even though we did not observe a mating,
and partly because genetic analysis of mothers and their litters in the same population shows
that multiple paternity in the litter is common (Schofield et al. 2014). Perhaps females assess
male qualities before accepting a full mating, and can make better choices with more
potential partners.

Our observations of male behaviour and mating confirm, although with more cases, previous
reports of reproductive behaviour (Fenner and Bull 2009; Milne et al. 2003). In previous
observations males have been observed physically dragging the female from her burrow to
mate on the surface. We can now add the opportunistic mating behaviour of males that
encounter females already on the surface.

Whether the female luring has resulted because of the unique habit in this species of
occupying spider burrows is unknown. It may be that, unlike in other lizard species, the
solitary burrow occupancy reduces opportunities for males to encounter females during their
normal activities. For this species females may have to make special efforts to allow males to
locate them.

Acknowledgements

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logistic support.
References


Table 1: Summary of female movement, male behaviour and observed mating in 9 filmed female pygmy bluetongue lizards over ten days of filming in October 2011.

*mating was not observed during 10 days of filming, but this female had 3 young born with her inside the burrows in February 2012. † The day mating happened. ○ Head-bobbing happened on the first and second times the male came to the burrow, but did not happen the third time when mating happened. ‡ The female was already outside the burrow. * Male tried to bring female out but he did not succeed.

<table>
<thead>
<tr>
<th>Female ID</th>
<th>21005</th>
<th>21842</th>
<th>21847</th>
<th>20002</th>
<th>21012</th>
<th>21861</th>
<th>21860</th>
<th>21827</th>
<th>21844</th>
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<tr>
<td>No. of female movements</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>25</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>No. of male visits female</td>
<td>3</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>5</td>
<td>0</td>
<td>0</td>
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<tr>
<td>The day in the filming sequence when a male visits</td>
<td>7, 7, 7†</td>
<td>4, 4, 5, 5, 7†</td>
<td>2†, 9</td>
<td>8, 9†</td>
<td>2, 4†</td>
<td>4, 4, 7, 7, 8, 8, 8, 9</td>
<td>4, 4, 4, 4</td>
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<td>No</td>
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<tr>
<td>No. of times male used the female paths</td>
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<td>NA</td>
<td>NA</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>4</td>
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<td>No</td>
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<tr>
<td>Male head-bobbing</td>
<td>Yes○</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Mean male head-bobbing time (sec)</td>
<td>14.0</td>
<td>40.0</td>
<td>16.5</td>
<td>42.0</td>
<td>0</td>
<td>36.6</td>
<td>4.4</td>
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<tr>
<td>Time male spent to bring female out of burrow (sec)</td>
<td>15</td>
<td>30</td>
<td>57</td>
<td>0○</td>
<td>0○</td>
<td>32a</td>
<td>16a</td>
<td>NA</td>
<td>NA</td>
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<td>Mating observed during filming</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
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</tr>
<tr>
<td>Time when mating happened</td>
<td>1658 h</td>
<td>1417 h</td>
<td>1255 h</td>
<td>1039 h</td>
<td>0740 h</td>
<td>NA</td>
<td>NA</td>
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<td>NA</td>
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<tr>
<td>Mating duration (sec)</td>
<td>49</td>
<td>22</td>
<td>38</td>
<td>260</td>
<td>?</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Time male spent near female burrow after mating (min)</td>
<td>1.73</td>
<td>7.63</td>
<td>0.95</td>
<td>14.30</td>
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<td>NA</td>
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<td>Young present with female in January</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>?</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>?</td>
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Table 2. Comparison of head-bobbing number, time and time male spent to bring female out of the burrow between males that enter female burrows and are successful in mating (N = 3) and those that enter burrows but are unsuccessful (N = 18). Note that degrees of freedom is lower for head bob data because 5 of the 18 unsuccessful males did not head bob before entering the burrow.

<table>
<thead>
<tr>
<th></th>
<th>Mating</th>
<th>Mean (SE)</th>
<th>df</th>
<th>t</th>
<th>p value</th>
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</thead>
<tbody>
<tr>
<td>Mean number of head bobs</td>
<td>Successful</td>
<td>9.25 ± 0.58</td>
<td>14</td>
<td>0.6</td>
<td>0.56</td>
</tr>
<tr>
<td></td>
<td>Unsuccessful</td>
<td>9.75 ± 0.13</td>
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<tr>
<td>Mean time of head bobbing (sec)</td>
<td>Successful</td>
<td>23.50 ± 1.83</td>
<td>14</td>
<td>0.43</td>
<td>0.67</td>
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<tr>
<td></td>
<td>Unsuccessful</td>
<td>30.07 ± 0.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean time male spent to bring female out (sec)</td>
<td>Successful</td>
<td>53.67 ± 2.42</td>
<td>19</td>
<td>0.9</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Unsuccessful</td>
<td>25.61 ± 0.27</td>
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</table>
Figure 1) Number of female movements away from the burrows (A) in 25 minute bands for all recorded movements; and (B) in 5 min bands for all moves of 25 minutes or less.
Figure 2) Time of day when female movements away from the burrow occurred for all observed movements.
Figure 3) Movement paths of females away from burrows (solid lines) and days when movements occurred, in the ten day October filming for four female that made three or more movements. Large circle represents the burrow entrance with the number inside representing the identity of the female occupant. Also shown are the location of native grass clumps around two burrows (in grey), the paths taken by males (dotted lines) approaching those burrows and the days in the filming sequence when the male approach occurred.
Figure 4) Box plots of activity time of five mated females on days before and after mating. Plots show the median value, the 25th percentile (below the median), the 75th percentile (above the median), and the minimum and maximum values.
Figure 5) Box plots of (A) activity time; and (B) number of movements around burrows for females that were mated (N = 5) or were not mated (N = 4) during 10 days of filming in Oct. Display as in Fig 4.