

Courtship in a pair of wild Coastal Taipans *Oxyuranus scutellatus* (Elapidae)

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Abstract

Using time-lapse photography supplemented by direct observation, courtship behaviour in a pair of Coastal Taipans *Oxyuranus scutellatus* was recorded in the field over a nine-day period and the details of the behaviour are described. During courtship the male remained in close proximity to the female, frequently in direct physical contact with her, where it engaged in a number of stereotypical behaviours such as massaging her dorsal surface by making lateral wave-like movements with its body, chin-rubbing, head-jerking, and probing the length of her body with his snout. The female lay passively at all times during courtship and sloughed on the final day when mating presumably occurred.

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Introduction

The Coastal Taipan *Oxyuranus scutellatus* is a large, primarily diurnal, highly venomous elapid snake that occurs in a wide range of habitats including dry and wet sclerophyll forest, open savannah woodland, monsoon forest and is common in sugar cane fields of coastal Queensland (Worrell 1958; Cogger 2014; Mirtschin *et al.* 2017). It is a specialist rat feeder, though also consumes bandicoots, occupies abandoned burrows of its prey, and is oviparous, producing up to 20 eggs in late spring/early summer (Thomson 1935; Slater 1956; Worrell 1963a,b; Gow 1976; Fleay 1981; Shine & Covacevich 1983; Masci & Kendall 1995; O'Shea 1996; Wilson 2015). Despite Taipans having been successfully bred in captivity for many years, descriptions of their courtship behaviour are typically brief, but more often, entirely absent from published accounts of their breeding (Peters 1973; Banks 1984; Burns 1985; Mirtschin 1988; Barnett 1999). As a species which is noted for its alert but shy disposition, readily retreating on being approached (Worrell 1963a; Gow 1982; Couper & Amey 2007), there is little information on

the behaviour of Taipans in the wild (Masci & Kendall 1995).

Surveillance cameras have become a common tool in field surveys of vertebrates in recent years, particularly in the detection of mammals but also reptiles (Meek & Fleming 2014; Meek *et al.* 2015; Molyneux *et al.* 2017; Richardson *et al.* 2018). Some of these studies have resulted in incidental, novel behaviours being recorded, however, few studies involving surveillance cameras have the recording of species behaviour as their primary purpose. Herein, I describe the courtship behaviour of a pair of Taipans in the field over a period of nine days using a surveillance camera, supplemented by direct observation.

Site description

Observations occurred in a sugar cane field near the town of Silkwood (17°45'S, 146°00'E), 120 km south of Cairns. It is the same site where Taipans were observed mating two years earlier and so I describe the site only briefly and refer readers to a more detailed description of it in a previous publication (Turner 2019). The site (Fig. 1) backed

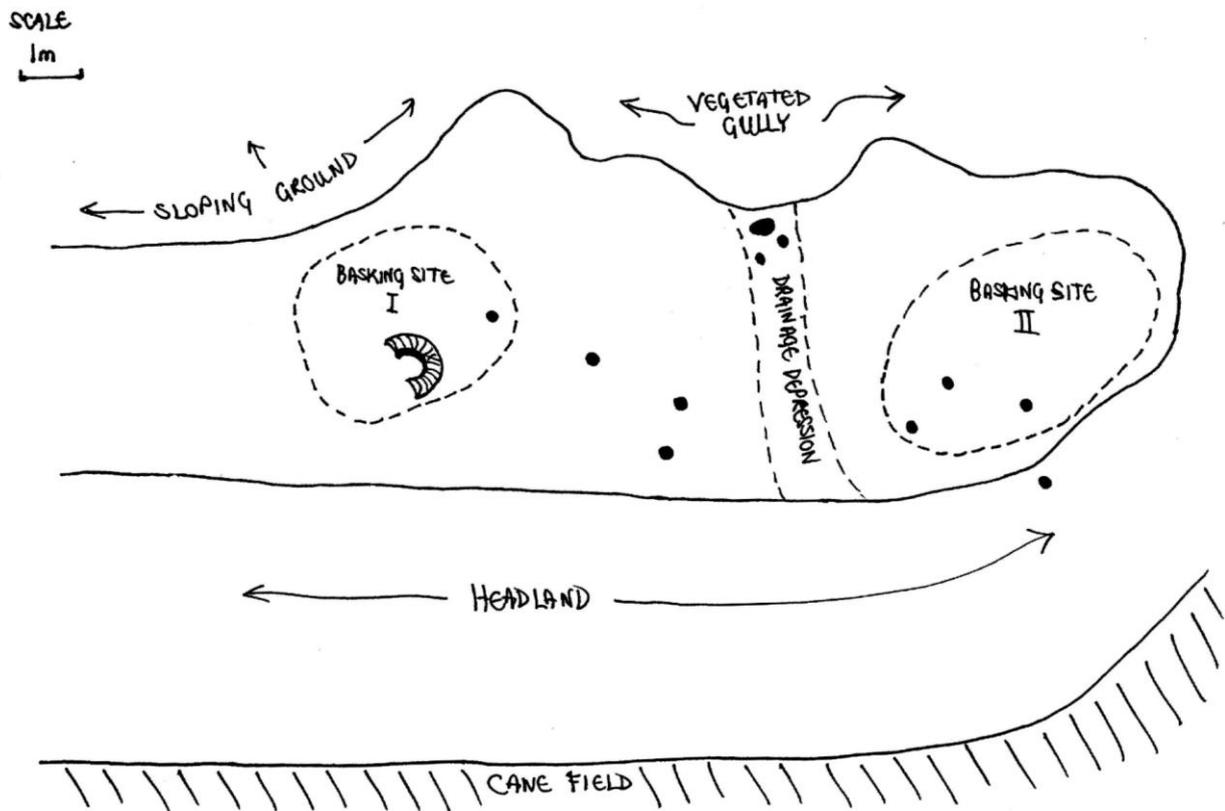


Figure 1. Scaled drawing of study site. Small black circles show burrow entrances.

onto a narrow, open stand of regenerating rainforest on sloping ground while a 5 m wide headland separated it from a fallow sugar cane field. The understory consisted mostly of stands of exotic grasses and ferns while the edges comprised low grasses and weeds such as *Praxelis Praxelis clematidea*. The cane field had a dense stand of Guinea Grass *Panicum maximum* and woody weeds (mainly Cusara Pea *Crotalaria zanzibarica* 1.2 m high). Taipans utilised a network of burrows that occurred at each basking area with multiple entrances at the surface and also a shallow drainage depression where numerous cavities had formed as buried debris was exposed by erosion. A half-buried car tyre was frequented by the female both before and after courtship. Two separate basking areas (labelled I & II in Fig. 1) were consistently used and sloped down to the shallow drainage depression behind which was a shaded gully. Daily maximum and minimum temperatures for the period of observation were obtained from the nearest Bureau of Meteorology (BOM) recording station at South Johnstone and varied between 22 - 26°C and 14 - 21°C respectively.

Methods

Taipans were initially located in early winter by regular inspections of the site, in the early to mid-morning or late afternoon, when snakes were most likely to be out basking. The purpose of visits was to establish where individual Taipans basked and the location of their retreats. A Maginon Vision camera (with an 8 GB memory card) was situated at one of two basking sites where it was mounted on a tripod 1.5 m above ground and set on time-lapse so that a photograph was taken every minute (and every thirty seconds once courtship commenced) to record the movements of Taipans. The basking sites were difficult to approach without causing disturbance of snakes (which were prone to retreating) because the land sloped downwards creating an unobstructed view 20 m from the sites. The frame of each photo taken by the camera extended slightly beyond the basking sites but not to the headland, gully, or cane field. The images were supplemented by direct observations of courtship so that: (i) the location of the snakes away from basking site II could be determined and (ii) the movements of the male during courtship

could be better understood (see below). Each day the camera was placed at the site by 7 am and retrieved by 6 pm. Its position was sometimes changed from day-to-day according to the movements of snakes. The camera had a built-in thermometer and was positioned in direct sun and so temperatures recorded by it were at times significantly higher than shade temperatures. The site was monitored daily for 33 days (from 9/6/19 to 15/7/19) and thereafter every few days for a further month until snakes were no longer seen nor recorded on the surveillance camera at the site. Approximately 25,000 images were recorded and examined. Emergence and retreat times were determined from these images along with the duration of courtship behaviours.

The specific behaviours displayed during courtship were recorded and compared with those described in Senter *et al.* (2014) who identified 33 behavioural characteristics relating to courtship and male-male combat in 76 snake species spanning five families.

Observations

The male and female Taipans were similar in size (total length \approx 2 m for both) but were easily distinguished by their body colour, the male being almost black dorsally (and glossy, indicating a recent skin slough) while the female was dull medium brown. In addition, the female had a much heavier build, while the male was comparatively slender. Sex was inferred from the behaviours that ensued during the recording period. The female was first observed on 9/6/19 and its movements were recorded from this time. The male was seen the next day but was then sighted irregularly over the following two weeks and did not make a regular appearance at the site until courtship began towards the end of June. Despite the relatively cool conditions (day-time maximum temp. 22–26°C) during the courtship observation period, Taipans were not recorded in direct sun for more than 2 hours at a time and they would retreat to the headland or the cane field where there was vegetation cover. They remained at the basking site all day only on a few cool, overcast days. Taipans were very familiar with general layout of the site and the locations of burrows as was evidenced by their ability to move in a more or less direct line towards burrow entrances without

apparent hesitation (see below and also Masci & Kendall 1995; Busack 2014).

The female's daily routine during the observation period was: early to mid-morning emergence to bask a short distance from the burrow entrance in the open amongst low vegetation; by late morning moving to the headland/cane field to seek shade and while there largely inactive; in the late afternoon returning to the morning basking site to bask, or, returning directly to the retreat (always before 6 pm). Variations to this routine, mainly due to weather, resulted in movements being confined to the basking area close to the retreat on cool overcast days. More extensive movements in the cane field may have occurred on some warm days. I was able to locate the Taipans on five occasions when they had moved from the morning basking site and on each occasion they were inactive or engaged in courtship, and semi-concealed either amongst patches of low green grass on the headland or amongst woody weeds at the edge of the cane field, both of which shielded them from direct sun. There was no indication of feeding as snakes did not exhibit mid-body bulges nor was any faecal material or uric acid deposits located at either of the basking sites. They were never recorded active or away from their retreat from 6 pm through to 8 am with night temperatures likely to have prohibited movements between these times (with one exception all minimums $<20^{\circ}\text{C}$). Nocturnal activity in Taipans has never been recorded at this site although is known to occur during particularly hot weather in parts of the species' range (Thomson 1935; Covacevich *et al.* 1981; Greer 1997).

Courtship between Taipans spanned nine days from 29/6/19 to 7/7/19. The sequence of courtship behaviour is recorded in Table 1 and briefly summarised here: prior to courtship commencing the male showed initial hesitation in approaching the female and at this time they appeared to occupy separate retreats and basking sites. The male was not recorded approaching the female until 27/6/19 and then courtship began two days later on 29/6/19. From that day, the male remained in close proximity to the female, regularly basking (at site II) with her and following her movements to and from the cane field. They shared the same retreat (burrow) for some of this time. On the ninth, and final, day the female

Table 1. Chronology of courtship behaviour in a pair of Coastal Taipans *Oxyuranus scutellatus*.

The weather data in the second column (maximum daily temperature) was obtained from the South Johnstone recording station (BOM). The temperatures quoted in the third column were measured by the surveillance camera which on overcast days were very similar to shade temperature but on sunny days were significantly above shade temperature as the camera was positioned in the open (see Methods). The movements and the locations of burrows described in the table all occurred at basking site II (see Fig. 1) unless otherwise stated.

Date	Weather	Description of movements & behaviour
29/6/19	Completely overcast day with no sun; 23°C	<p>8:15 am (21°C): female emerged from burrow and assumed an open coil.</p> <p>8:22 am: female moved to a patch of grass 3 m away from burrow entrance.</p> <p>10:29 am (24°C): male moved from the gully to the basking site, directly to the female, and began courtship immediately; the pair remained together loosely coiled; the female moved several times over small distances (< 2 m) with the male following suit and maintaining body contact at all times.</p> <p>4:17 pm (24°C): a disturbance caused snakes both to retreat.</p> <p>4:27 pm (24°C): male returned to the basking site and moved in a wide arc, apparently searching.</p> <p>4:37 pm (23°C): male retreated to the gully.</p>
30/6/19	Clear, sunny day; 25°C	<p>10:11 am (35°C): both the female and male emerged together from the gully and basked intertwined at the edge of the basking site.</p> <p>10:17 am (35°C): both snakes moved into direct sun with the male straddling the female and engaged in courtship, the male massaging the female with lateral body movements ('waves').</p> <p>11:12 am (38°C): male retreated into the shaded gully.</p> <p>11:19 am (38°C): male reappeared and joined the female at the basking site and immediately resumed courtship.</p> <p>11:30 am (38°C): together both snakes moved into the headland.</p> <p>3:45 - 4:05 pm: courtship was directly observed with the male exhibiting jerking movements of the head and neck as it moved along the length of the female as well as chin-rubbing.</p> <p>5:11 pm (22°C): both snakes returned to the basking site, the male straddling the female, and retreated down the same burrow entrance.</p>
1/7/19	Sunny breaks in morning but afternoon overcast and rain from 3pm onwards; 23°C	<p>10:06 am (30°C): female emerged from the burrow and lay out-stretched less 1 m from the entrance; over the next half-hour she gradually moved 3 m from burrow while basking.</p> <p>10:34 am (31°C): female moved into headland.</p> <p>10:38 am (31°C): male's head appeared at the entrance of the same burrow.</p> <p>11:10 am (31°C): male emerged fully and headed directly to where the female was previously basking before retreating down another burrow.</p> <p>2:31 pm (27°C): male re-emerged from the gully and moved across the basking site apparently searching.</p> <p>2:42 - 2:46 pm (26°C): male moved into the headland where the female retreated earlier; simultaneously the female emerged from the headland only 2 m away and immediately retreated down an adjacent burrow entrance.</p>
2/7/19	Mostly fine & sunny; slightly overcast in the afternoon; 25°C	<p>10:04 am (28°C): female emerged from a burrow and moved about 1 m and basked near the edge of headland in an open coil in direct sun.</p> <p>10:34 am (31°C): male's head appeared at the same burrow entrance.</p> <p>10:40 am (30°C): male fully emerged from burrow to bask within 0.5 m of the entrance; the pair lay basking about 3m apart but seemed to be aware of each other's presence as the female raised her head when the male emerge and the male had its head raised after the female moved.</p> <p>10:45 - 10:48 am (30°C): female moved into the headland; the male continued to bask.</p> <p>11:29 - 11:43 am (38°C): male moved along the edge of the basking site and then into the headland at the same point the female exited.</p> <p>12:43 - 12:58 pm: courtship activity was directly observed at the edge of the cane field during which the male exhibited jerking movements along the length of the female and at other times lay draped over her making slow lateral movements with his body.</p> <p>5:15 pm (31°C): the pair returned together from the headland, the male straddling the female, and both retreated to the gully</p> <p>5:26 pm (31°C): male returned briefly to the basking site and then immediately doubled back down the gully.</p>
3/7/19	Sunny morning; overcast afternoon cloud; 24°C	<p>10:20 am (34°C): female emerged from the gully and assumed an open coil in direct sun at the furthest end of the basking site; she moved frequently within a small area while basking.</p> <p>10:52 am (34°C): female moved into the headland.</p> <p>12:47 am (31°C): male moved across the basking site in wide arc, apparently searching, and then into the headland near where the female exited.</p> <p>3:40-3:45 pm: courtship activity was directly observed at the edge of the cane field with the male chin-rubbing the length of the female.</p> <p>5:06 pm (32°C): the pair return together from the headland, the male straddling the female.</p>

continued on next page

Table 1 continued

Date	Weather	Description of movements & behaviour
4/7/19	Overcast with some brief showers; 23°C	<p>9:12 am (24°C): female emerged from the gully and assumed an open coil in direct sun at the furthest end of the basking site remaining still.</p> <p>9:30 am (26°C): male emerged from the gully and lay basking in part sun about 1 m from the female.</p> <p>9:43 am (27°C): male moved directly to the female and began courtship.</p> <p>10:23 am (25°C): male abruptly headed to the gully while the female remained at the basking site, moving little.</p> <p>11:30 am – 2:31 pm (25-29°C): male returned from the gully and immediately resumed courtship.</p> <p>2:32 pm (24°C): female initiated a retreat with the male immediately following her to the gully.</p>
5/7/19	Light showers and completely overcast; 22°C	<p>10:44 am (23°C): female emerged from the gully and lay in open coil in low grass at the edge of the basking site.</p> <p>12:27 – 1:08 pm (26°C): female moved to the far end of the basking site and assumed an open coil and then later a more tightly coiled posture.</p> <p>1:33 -1:55 pm (26-27°C): male emerged from the gully and immediately went to the female, resting its head on her body before then probing her body with his head and tongue flicking along her flanks several times; the male's body was completely outstretched while the female was loosely coiled and unmoved.</p> <p>1:56 -3:29 pm (27-22°C): male made a few minor head movements, the female repositioned her coils and made a mouth gape (yawn?).</p> <p>3:30 pm (22°C): male retreated down a burrow.</p> <p>3:57 pm (22°C): female retreated to the gully.</p>
6/7/19	Overcast morning with light showers; sunny breaks in the afternoon; 23°C	<p>9:26 – 10:28 am (24°C): female emerged from the gully and as she moved onto the basking site the male appeared from grass at the edge of the headland and intercepted her whereupon they both moved to the far end of the basking site; the male sat with the anterior half of his body on top of the female while their posterior bodies were separate; the male moved very little with its head resting on top of the female's neck.</p> <p>10:29 – 11:30 am (24°C): male lay on top of the female with his body closely aligning with hers, his head on her neck, and slowly massaged her body.</p> <p>11:31am - 1:17 pm (27-28°C): male doubled back on itself and began to tongue-flicker the posterior body/flank of the female before returning to the anterior body and neck of the female which it began to probe with his snout; this behaviour was repeated another four times over the next hour; male temporarily moved off the female and then circled back around to join her (12:53 pm) followed by a 15 min. lull in activity; male moved on top of the female and began constantly probing her with his snout; female appeared to lift her tail in the air several times.</p> <p>1:18 - 3:13 pm (28-33°C): female moved to the far end of the basking site and lay outstretched with the male straddling her and maintaining close body alignment; minimal movement otherwise.</p> <p>3:32 - 3:52 pm (27°C): male moved off the female, across the basking site, and then into the headland, circling around the female twice before returning to her.</p> <p>3:48 - 3:52 pm (28-32°C): male moved off the female down to the bottom of the basking site where it basked directly in the sun.</p> <p>3:56 pm (32°C): male returned to the female.</p> <p>4:03 – 4:30 pm (32-27°C): the pair moved to a grassy area at the edge of the basking site and courtship resumed.</p> <p>4:35 pm (27°C): the pair retreated to the gully.</p>
7/7/19	Sunny from mid-morning through to mid-afternoon then overcast; 25°C	<p>9:34 am (27°C): male's head appeared at the burrow entrance.</p> <p>9:38 - 9:42 am (27°C): male slowly emerged from burrow, moved in a small circuit, before laying outstretched and basking a small distance from the burrow entrance.</p> <p>9:58 am (28°C): male raised its head in response to the female emerging from the gully; she stopped just at the edge of basking site in shade; the male by contrast was basking in full sun.</p> <p>10:15 – 10:31 am (29-31°C): male lifted its head and then moved directly to the female and immediately began courtship (10:21 am).</p> <p>10:32-10:40 am (32°C): male ceased courtship and moved approx. 0.5 m from female where it lay basking, unmoved, in full sun.</p> <p>10:41 am (32°C): male re-joined the female and resumed courtship by massaging her body and probing her flanks.</p> <p>11:01 am (36°C): male abruptly retreated to the gully.</p> <p>11:09 am (37°C): male re-joined the female and courtship immediately resumed at the edge of the basking site.</p> <p>11: 50 am (37°C): the pair moved a short distance towards the shade at the edge of the basking site.</p> <p>11:55 am (38°C): female commenced sloughing while the male continued to court her.</p> <p>11:59 am (38°C): both moved into the gully with the male straddling the female.</p> <p>5:40 pm (23°C): female was curled-up in the car tyre at basking site 1.</p>

sloughed late morning with the male in attendance and engaged in courtship behaviour; the male was not seen again after this day while the female remained at the site for at least a further three weeks. No courtship was recorded at the basking site on two of the nine days (1/7/19 and 5/7/19); on one of these days the weather was cool and overcast and the pair lay together but they did not move from the basking site; on the other day they moved at different times both to and from the basking site but may have engaged in courtship at the edge of the cane field. The observations indicate a courtship period spanning nine days culminating in mating on 1/7/19, immediately after which the male left the site.

Courtship behaviour

Courtship behaviour typically commenced after the male had emerged from its retreat mid-morning and had spent some time basking. On most days it did not begin before about 10:20 am. The pair were observed engaged in courtship (with the male straddling the female) returning from the headland late in day on four occasions, the latest time being 5:15 pm. Whether courtship behaviour continued once they had retreated is unknown but the overnight temperatures during the period of observation would have likely precluded further activity. The female typically emerged first to bask each morning ($n = 6$; except in two instances: once when then they emerged together and the other when the male emerged first) while the male emerged in some instances more than two hours later ($n = 3$). The male followed the movements of the female, rarely leaving her during the day and when with her was engaged in courtship behaviour for much of that time. On three occasions the male was recorded to cease courtship abruptly and move out of the camera frame towards the shaded gully and then return to resume courtship.

Courtship behaviour did not vary greatly from day to day in terms of the behaviours displayed by the male and so a general account of the behaviour is presented below while a description of the chronology of movements and behaviours recorded each day is given in Table 1. In all instances the male initiated courtship behaviour. The female lay passively, only moving or altering position occasionally while basking. In contrast the male was often highly active with more or less continuous, relatively slow movements with only

occasional pauses. There were lulls in the activity of the male during hours of courtship, but photographs show it to be rarely still for more than a few minutes. The male was almost always in direct physical contact with female, often laying on top of her. Frequently his head, much of his body and tail were aligned closely with hers, giving the appearance of him 'pinning' the head of the female (Fig. 2a); at other times just the head and tail were aligned and his body straddled hers (Fig. 2b). When assuming the latter posture the male would slowly move its body laterally in a wave-like fashion (sometimes referred to as 'caudocephalic waves'; see Lillywhite 2014), rubbing the dorsal surface and flanks of the female. This rubbing, or massaging, included the tail and cloacal region of the female on some occasions ($n = 5$). The male's body crossed over the female's at four or five points which seemed to loosely act as pivot points about which the lateral movements occurred. Consequently, the male did not move forwards or backwards but rather maintained his alignment with the female during the process. Occasionally the body rubbing would cease and the male would rub the anterior third of the female's body with his chin, moving his head either side of her midline and tongue-flicking as he progressed towards her head. Often associated with chin rubbing were peculiar staccato or jerking movements of the head and neck of the male. These jerking movements were also exhibited on other occasions as it moved in close vicinity to, but not always in direct body contact, with the female. The male would often come to rest with his head on her neck or head. At other times the male, while straddling the posterior half of the female, would double back and probe her posterior flanks with its head while tongue-flicking, working its way down as far as her vent before realigning his body with hers (Fig. 2c). The female was recorded on several occasions to lift her tail in the air with the tip being about 10 cm above the ground; it was unclear what prompted this action or whether it was rapid tail flick or a slower waving movement (Fig. 2d). The male's vent/tail was not near the female's when this behaviour occurred. On several occasions the male made a circuit around the female and then stopped head-to-head (only a few centimetres apart) where it paused for 2-3 minutes. The male was recorded apparently searching for the female when she was not at the



Figure 2. Sequence of photographs of courtship in Coastal Taipans *Oxyuranus scutellatus*.

In each photograph the position of the male's head is indicated by an arrow.

a. The male aligning his body with the female from head to tail.

b. The male engaged in chin rubbing the neck of the female.



c. The male tongue-flicking the flanks of the female.

d. The female lifting her tail several times – it is seen here raised in the air.



basking site ($n = 3$), traversing a wide arc before moving to the headland. It was also the first to respond to disturbances at the site.

Seven of the 18 courtship behaviours identified by Senter *et al.* (2014) were exhibited by Taipans. Six exhibited by the male Taipan were: the chin-rub (CR), head & neck jerk (J2), head and/or neck pressing (MN1 and/or MN1b), mounting in which body bends align (MN 2), mounting with body draped and also lateral undulations (MN3 & 4), and one by the female, the tail raise (TR); a further two behaviours were not directly observed but were suggested by the photographs to have occurred, although it was not possible to say with certainty because of the time interval between consecutive images. Behavioural characteristics relating to head movements (bob, raise, shake) by the male appeared to occur during mating rather than courtship (see Turner (2019)) although are not easily discerned from photographs.

Discussion

I have been unable to locate any other accounts describing courtship behaviour of Taipans in the field. This is perhaps not surprising, for unlike field observations of mating which is a rather more subdued activity in snakes, courtship involves an active male and passive female, both of which are capable of quickly retreating. There is one brief account of courtship behaviour in captive Taipans with which to compare the observations above. Banks (1984) remarked that courtship behaviour in captive Taipans always followed a similar pattern in which he identified three components: (i) the male continually flickering his tongue and jerking the head and forebody when he approached the female (or her sloughed skin), (ii) the alignment of his body next to, or on top of, the female, the posterior portion of his body crossing hers several times and, (iii) the male moving his tail anteriorly or posteriorly along her cloacal region. Burns (1985) describes 'jerking and twitching' by a captive male in the lead-up to mating (i.e., (i) above) but no other details were given. Masci & Kendall (1995) mention that the male Taipan rubs his chin over the female's back. Body and chin rubbing by the male Taipan recorded in this work were part of every courtship sequence and are a stereotypical behaviour that is observed in the courtship sequences of various snake species (Greene 1997; Lillywhite 2014; Senter *et al.* 2014).

While this behaviour was not mentioned in Bank's (1984) account, the other three components he described were observed in the field. In addition, apparent searching behaviour by the male was recorded in this work whereby it moved in a wide arc across the basking site, and then, failing to locate the female, it would move to the headland or else retreat. Mating has been observed in the Inland Taipan *O. microlepidotus* based on an hour-long field observation of a single pair but this did not include courtship behaviour (McRae & Covacevich 1997). The photograph accompanying the account showed the pair mating, with the male laying on top of the female, a posture seen only during courtship rather than mating in the Coastal Taipan (see above; cf. Turner (2019)).

The behaviours exhibited during courtship by Taipans share the same basic elements observed in other Australian elapid snakes. Greer (1997) describes the various accounts of courtship (and mating) in Australian elapid snakes as usually beginning with the male moving up and down the female tongue-flicking her and rubbing his chin on her body, eventually reaching her head whereupon he may rub the top part of her head and neck with his chin, the two snakes lying side by side or with the male's body loosely draped over the female's, and brief spasmodic 'quivering' or 'jerking' movements of the male's body. No biting or hissing by the male Coastal Taipan during courtship was recorded/observed but these behaviours have been recorded in a few species of Australian elapids (see Greer 1997) and also in colubrid snakes (see Lillywhite 2014). Chin rubbing, jerking movements, and body alignment by courting males has been observed in Red-bellied Black Snakes *Pseudechis porphyriacus* (Shine *et al.* 1981) in the field and in many species of colubrid snakes (Greene 1997; Senter *et al.* 2014).

Several accounts of the captive breeding of Taipans state that the male is introduced to the female immediately after she has sloughed and in one account the fresh slough of the female is placed in the enclosure to help stimulate courtship (Banks 1984; Barnett 1999). In the captive breeding of some snake species the female may be rubbed with the sloughed skin of another individual to stimulate the male's interest (Mirtschin *et al.* 2017). These observations are confirmed, in part, by those above since only courtship, rather than mating, was recorded while the female was pre-

slough. On the day the female sloughed, there was an abrupt change in the behaviour of both the male, which was not seen again, and female, who returned to her original retreat and basking site. This change of behaviour suggests mating took place on the afternoon of the 7/7/19 away from the basking sites. Barnett (1999) commented that mating in captive Taipans normally 'occurs within hours' of the male being introduced which might explain why few snake breeders have bothered to record, or indeed have observed, courtship.

The observations in this work suggest that in the field courtship in Taipans is a more protracted event compared to captivity with males likely remaining with a female until she sloughs and then mating occurs. It follows that the precise timing of mating is likely determined, at least in some instances, by the sloughing cycle of the female. The timing of the courtship observations in this work is consistent with timing of mating in the field and in captivity. Mating in Taipans has been recorded to take place from March to December, with a peak from July to October in captivity (Banks 1984; Barnett 1999; Mirtschin 1988) and from late July through to at least late August in the field (Slater 1959; Turner 2019).

The availability of inexpensive surveillance cameras which have a time-lapse setting offers opportunities to record the behaviour of vertebrates that are either relatively sedentary and/or are difficult to approach and directly observe. Surveillance cameras have been mainly employed in surveys to detect the presence of vertebrate species rather than recording the behaviour of a particular species as in this study. While most cameras have PIR-based motion sensors these are not always sufficiently sensitive to record the movements of reptiles at a distance (of several metres) because of their small size relative to the area being photographed and also their naturally slow movements (pers. obs.). For this reason, the time-lapse setting was chosen to record the behaviour of Taipans with the main disadvantage being that the camera needed to be switched-off at the end of each day and photographs downloaded at least thrice weekly (depending on the size of the memory card) but preferably on a daily basis so that the snakes' movements were known and the camera could be repositioned in response to daily movements. Because of the difficulty in approaching the basking site where most of the

courtship behaviour occurred without disturbing the Taipans, the camera proved to be a valuable tool for recording their natural behaviour. It has revealed additional behaviours, such as rainwater drinking (Turner 2020) and interactions with other species which would have been very difficult to directly observe.

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