Field observations of a cryptic agamid (Chameleon Dragon *Chelosania brunnea* Gray, 1845) in semi-arid savanna woodland of northern Australia

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ABSTRACT

Chameleon Dragons *Chelosania brunnea* Gray, 1845 are well known amongst naturalists of northern Australia as being one of the most cryptic and least frequently observed of Australia's large, iconic lizards. Despite their broad distribution across the savanna woodlands that dominate northern Australia, very few records exist of this species and, as a consequence, nearly nothing is known about their natural history. Here, we present records of 19 Chameleon Dragons, detected during clearing activities of a small area of semi-arid woodland at Delamere Air Weapons Range, Northern Territory. Additionally, we provide notes on sexual dimorphism, antipredator behaviour and shelter site use in this species. We discuss how some of this novel information may explain why this species is so rarely detected and suggests that this cryptic agamid may be much more common in savanna woodland than currently appreciated.

Key words: *Chelosania*; Chameleon Dragon; Top End; Agamidae.

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INTRODUCTION

Chameleon Dragons *Chelosania brunnea* Gray, 1845 are a medium-sized (90 mm snout-vent length) agamid lizard distributed throughout the savanna woodlands of Australia's wet-dry tropics: from the Kimberley region of Western Australia (WA); across the Top End of the Northern Territory (NT); to just over the very north-western border of Queensland (Cogger 2014). Although very little is known about the ecology of Chameleon Dragons, they are suspected to be an almost entirely arboreal agamid species (Trainor 2005). They are superficially reminiscent of true chameleons (family Chamaeleonidae), with their eyes sunken within scaly turrets and their slow and clumsy gait (Trainor 2005; Wilson 2012). However, the Chameleon Dragon shares no close relation to chameleons and any shared characteristics have evolved convergently (Hutchinson & Hutchinson 2011). It is the sole member of the genus *Chelosania*, and along with a small number of other specialized taxa, diverged from other Australian agamids early in their evolutionary history (Hutchinson & Hutchinson 2011; Stilson *et al*. 2017).

Unlike many Australian agamids, Chameleon Dragons are very seldom encountered, and because of this, are a poorly understood species. There have been few field observations of them, mostly anecdotal, and many major fauna surveys have been unsuccessful in detecting this species (Trainor 2005). Trainor (2005) found that only 103 records (58 specimen-backed) existed across their entire Australian distribution. Surveys in Kakadu National Park, NT and Kalumburu, WA have revealed that trap capture success is remarkably low for this species, with only 10 individuals recorded in pit traps over a 7-year survey period of approximately 4000 pitfall trap nights (Trainor 2005). Infrequent observations of this cryptic species make it almost impossible to accurately to estimate abundance. Chameleon Dragons are most commonly seen on the ground, particularly females that have descended from the trees to lay eggs. Six individuals have been recorded low on trees (Trainor 2005), however, it is assumed that the dragons spend much of their time higher in the canopy. To date, this behaviour is almost entirely speculative as there are no current records of Chameleon Dragons at canopy level. Here, we provide anecdotal evidence of their occurrence in the canopy of *Eucalyptus/Corymbia* woodland, shelter sights, antipredator behaviour, sexual dimorphism and relative abundance in a cleared area.

OBSERVATIONS

Between August and October 2017, land clearing operations at Delamere Air Weapons Range, Northern Territory (NT) presented the authors with an opportunity to collect abundance data of Chameleon Dragons in a large area of savanna woodland. The site is located approximately 120 km southwest of Katherine,

NT. During 2017, this range commenced major redevelopments, including repairing infrastructure and roads, upgrading external boundary fencing and relocating facilities to increase space for target and weapons training (Department of Defence 2013). A small team of fauna spotters were employed during this project to minimise the loss of wildlife caused by this redevelopment and land clearing. The habitat being cleared was semi-arid woodland dominated by a canopy of *Corymbia bleeseri* and *Corymbia latifolia,* with a predominantly *Eucalypus*/*Acacia* mid-storey and with native grass and spinifex groundcover (Fig. 1). The soil was hard, dry, red earth with occasional patches of lateritic gravel.

Immediately after trees were knocked down by a bulldozer, fallen trees were inspected by fauna spotters. During clearing operations, a substantial number of individual Chameleon Dragons were encountered amongst the fallen tree debris, typically lying on the trunks of fallen trees or among canopy debris. One larger clearance site in particular revealed a reasonable number of individuals. The site was 187.5 hectares of semi-arid savanna woodland dominated by *Corymbia bleeseri* and *C. latifolia* (Figs. 1–2). During pre-clearance habitat surveys, no Chameleon Dragons were observed at ground level, low in trees or in their canopy. During the clearing activities, a total of 19 individual *Chelosania* were located and translocated. Interestingly, three of the individuals found were observed coming out of tree hollows once the tree had been knocked over. Although the abundance of *Chelosania* at this site was only recorded as 0.1/ha, it is unlikely we located all individuals since some may have avoided detection and only two spotters at a time were supervising extensive and rapid clearing. Most of these individuals were found less than a couple of hundred meters of one another, suggesting they were distributed non-randomly across this site. For comparison, a number of species with similar arboreal ecologies that are often found commonly in the Northern Territory were also found in this woodland during clearing operations, but in lower frequencies: four frilled lizards *Chlamydosaurus kingii* and one black-headed monitor *Varanus tristis* were found and relocated.

During a 21-day period at the same time of year that the clearing was proceeding, an open 17 km trench was dug to house a water pipe. This trench was inspected twice daily by fauna spotters and any fauna that had fallen into it was captured and relocated (Table 1). This trench transected very similar *Corymbia* woodland habitat to that in which the majority of *Chelosania* were encountered during clearing activities. Although a very large number of arboreal and terrestrial reptiles were encountered and removed from the trench, no *Chelosania* were ever found in it. Previously, it has been noted that terrestrial activity in *Chelosania* is most common between July and August (Trainor 2005), presumably when females descend trees to lay. However, of the records we are aware of that have been recorded since 2005 (ALA 2020), 33% (3/9 records) of terrestrial encounters of *Chelosania* were recorded during September (*cf.* June: $n = 2$; July: $n = 3$; October; $n = 1$; ALA 2020). Thus, a lack of terrestrial activity during September does not entirely explain why we did not encounter this species in the trench. Despite this, none of the female *Chelosania* we encountered appeared gravid, so it is possible that they had laid prior to the instillation of the trench and, therefore, may have been unlikely to be detected in the trench during September.

Sexual dimorphism

Of the 19 *Chelosania* we collected during clearing activities, both males and females were present in similar proportions. This species is quite sexually dimorphic with males being substantially larger and longer, with considerably larger and more box-shaped heads (Fig. 3). Interestingly, all the males that we encountered were shades of grey, which they could very rapidly change and could make the black rings on their tail more or less prominent (Figs. 3–4). Every female encountered, however, was a shade of yellow (Figs. 3–4). This sexual dimorphism in colour has not been noted in any previous publication (see Trainor 2005). Photographs of two reproductively mature female Chameleon Dragons in other publications were a similar colour to males (Wilson 2012; Wilson & Swan 2017). An additional two published photos of female *Chelosania* show small-headed lizards with a similar yellowish colouration to which we describe (Storr *et al.* 1983; Wilson 2012). We can offer no explanation for this sexual dimorphism in colour pattern but note that the females we observed were very similar in colour to the upper branches of the dominant trees in the area (*Corymbia bleeseri* and *C. latifolia*).

DISCUSSION

Our observations suggest that Chameleon Dragons in semi-arid savanna woodland are perhaps much more common than would be anticipated based purely on observations and surveys. However, they are clearly very difficult to detect from ground level and may rarely venture down from the trees. These lizards were found to be the most common arboreal dragon in this habitat during clearing activities, despite both *C. kingii* and the monitor *V. tristis* being far more commonly encountered while driving, walking and checking trenches around site. This evidence suggests that *Chelosania* may be far less rare than suggested by encounters rates based on traditional survey techniques. *Chelosania brunnea* may simply almost never venture to ground level where they can be casually detected. Previous anecdotal evidence suggested that this species probably spend much of their time in tree canopies, yet it was noted that they have never been observed in the canopy (Trainor 2005). We provide evidence to suggest that Chameleon Dragons do indeed spend much of their time high up in the canopy, and perhaps inside hollows. All of the *Corymbia* that *Chelosania* were found to have come from were almost entirely hollow,

Figure 1. Chameleon Dragon *Chelosania brunnea* habitat in semi-arid savanna woodland dominated by *Corymbia bleeseri* and *C. latifolia* at Delamere, Northern Territory.

Figure 2. *Corymbia bleeseri* and *C. latifolia* woodland after being cleared at Delamere, NT.

Table 1. All reptile species caught in a water pipeline trench during a 21-day period in September 2017 when *Chelosania brunnea* were relocated during nearby clearing activities.

Family	Common Name	Species	Total abundance	Abundance/day
Skink	Two-spined Rainbow-skink	*Carlia amax*	11	0.52
Skink	Shaded Rainbow-skink	*Carlia munda*	3	0.14
Skink	Desert Rainbow-skink	*Carlia triacantha*	7	0.33
Skink	Plain Ctenotus	*Ctenotus inornatus*	3	0.14
Skink	Leopard Ctenotus	*Ctenotus pantherinus*	3	0.14
Skink	Eastern Striped Skink	*Ctenotus robustus*	9	0.43
Skink	Main's Dwarf Skink	*Menetia maini*	4	0.19
Skink	Northern Blue-tongued Skink	*Tiliqua scincoides intermedia*	23	1.10
Skink	Centralian Blue-tongued Skink	*Tiliqua multifasciata*	4	0.19
Gecko	Zig-zag Velvet Gecko	*Amalosia rhombifer*	6	0.29
Gecko	Northern Fat-tailed Gecko	*Diplodactylus hillii*	1	0.05
Gecko	Northern Dtella	*Gehyra australis*	1	0.05
Gecko	Bynoe's Gecko	*Heteronotia binoei*	22	1.05
Gecko	Sand-plain Gecko	*Lucasium stenodactylum*	1	0.05
Gecko	Northern Spiny-tailed Gecko	*Strophurus ciliaris*	36	1.71
Gecko	Rusty-topped Delma	*Delma borea*	6	0.29
Gecko	Burton's Legless Lizard	*Lialis burtonis*	67	3.19
Gecko	Northern Hooded Scaly-foot	*Pygopus steelscotti*	5	0.24
Dragon	Frilled Lizard	*Chlamydosaurus kingii*	4	0.19
Dragon	Yellow-sided Two-lined Dragon	*Diporiphora magna*	5	0.24
Dragon	Lally's Two-lined Dragon	*Diporiphora lalliae*	7	0.33
Dragon	Horner's Dragon	*Lophognathus horneri*	5	0.24
Dragon	Savanna Earless Dragon	*Tympanocryptis macra*	1	0.05
Blindsnake	Robust Blind Snake	*Anilios ligatus*	1	0.05
Python	Children's Python	*Antaresia childreni*	3	0.14
Python	Black-headed Python	*Aspidites melanocephalus*	3	0.14
Elapid	Top End Death Adder	*Acanthophis rugosus*	34	1.62
Elapid	Northern Shovel-nosed Snake	*Brachyurophis roperi*	2	0.10
Elapid	Olive Whipsnake	*Demansia olivacea*	1	0.05
Elapid	Greater Black Whipsnake	*Demansia papuensis*	14	0.67
Elapid	Grey Whipsnake	*Demansia simplex*	11	0.52
Elapid	Moon Snake	*Furina ornata*	3	0.14
Elapid	Pygmy King Brown Snake	*Pseudechis weigeli*	8	0.38
Elapid	Northern Brown Snake	*Pseudonaja nuchalis*	2	0.10
Elapid	Eastern Brown Snake	*Pseudonaja textilis*	3	0.14
Elapid	Little Spotted Snake	*Suta punctata*	2	0.10
Elapid	Intermediate Bandy-bandy	*Vermicella intermedia*	1	0.05

Figure 3. Female (top) and male (bottom) Chameleon Dragons *Chelosania brunnea* showing sexual dimorphism at Delamere, NT. Note distinct difference in typical size and head shape of an adult male and female.

from the base, throughout the trunk and into all their major limbs. Within these hollows were large numbers of termites and termitaria. Potentially, these hollow trees could provide all the shelter and food resources required by individual *Chelosania*, reducing their need to come to ground level outside of periods of breeding and nesting. To our knowledge, this is the first published evidence of this species sheltering in hollows and this behaviour could further explain why this species is rarely sighted and/or encountered in the wild. Previous surveys for *Chelosania* have revealed that detection rates are exceptionally low (Trainor 2005), which is unsurprising considering their apparent tendency to reside largely at canopy level, undetectable to the human eye and most survey methods.

Previous anecdotal and published evidence suggests that although this species of agamid is almost entirely arboreal, they do not seem adept at climbing, nor are they particularly graceful in their arboreal movements (Trainor 2005). In fact, it has been suggested by a number of observers that the species is rather clumsy and is prone to falling from their arboreal retreat sights (Trainor 2005). We agree with these observations and during relocations observed a number of dragons struggling to clamber up the rough barked trunks of the dominant trees in this woodland. Interestingly, we did not observe these dragons to utilise the technique of many other arboreal agamids of shifting to the opposite side of the trunk or branch to avoid detection by an approaching

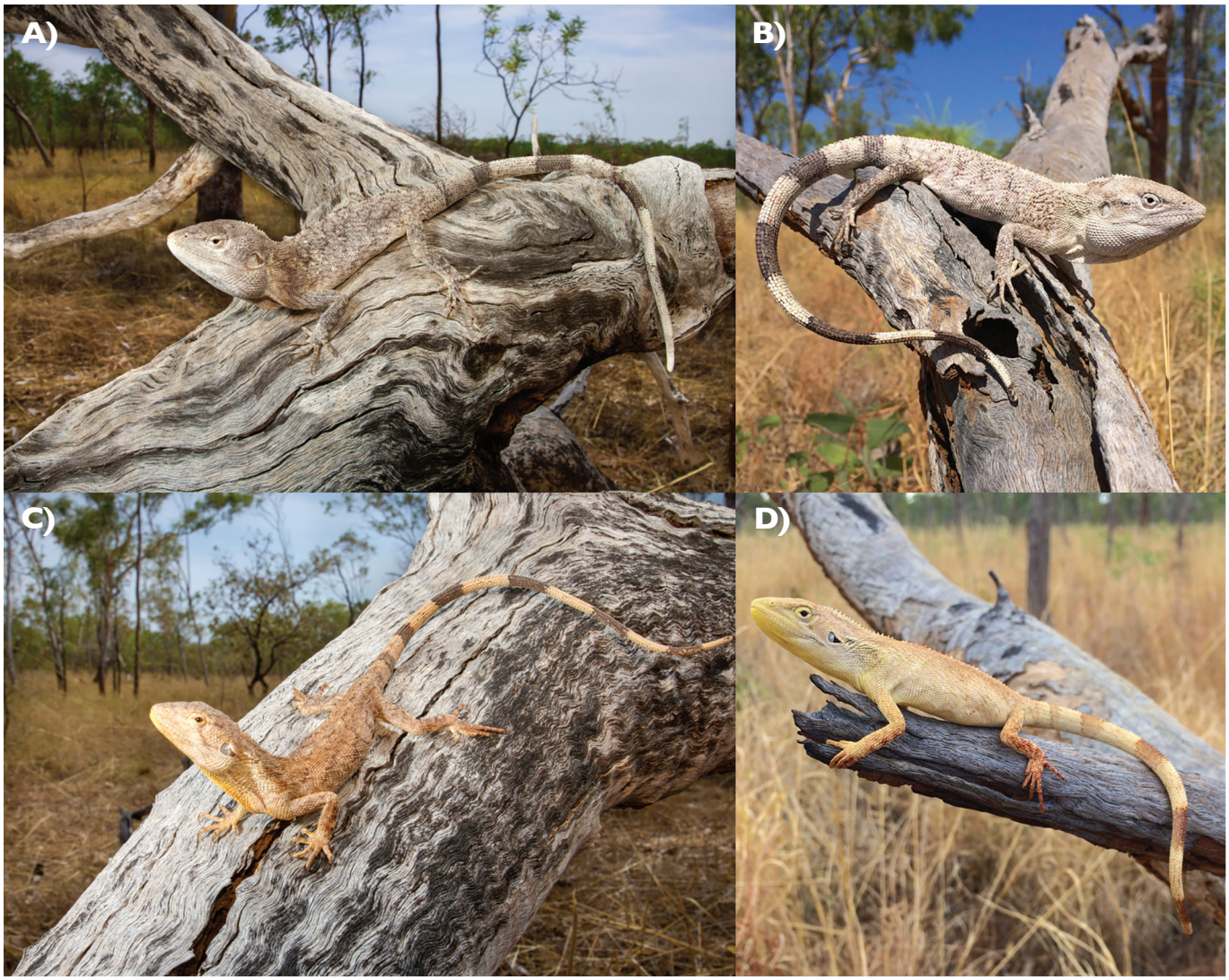

Figure 4. Two male (a & b) and two female (c & d) Chameleon Dragons *Chelosania brunnea* showing sexual dimorphism at Delamere, NT. Note distinct differences in colour.

observer. This has been hypothesized as a potential reason that no Chameleon Dragon had been observed in the canopy of trees (N. Gambold, pers. comm. in Trainor 2005). Instead, as these dragons were approached, they remained motionless despite how poorly they were concealed and how conspicuous they were on the fallen trunks of trees. The only movement they tended to make while being approached was to follow the observer with their eyes. These dragons also tended to gaze upwards to the sky, as if in anticipation of an avian predator. While shock following the felling of retreat trees may explain some of these behavioural observations, some dragons were found hours and days after the felling of trees in the area and these dragons did not differ in their lack of response to approaching humans. All these behavioural observations would suggest that this species may rely entirely on crypsis to avoid detection or, alternatively, they may spend a large proportion of their time sheltering in hollows where detection is unlikely.

Chameleon Dragons are restricted to habitat that is prone to frequent burning, it has been suggested that this species may be impacted by late dry season bushfires (Trainor 2005). Since European settlement, Top End fire regimes have shifted significantly (Russell-Smith *et al.* 2003; Ritchie 2009) and are widely believed to negatively impact regional biodiversity (Woinarski *et al.* 2011; Russell-Smith *et al.* 2012). However, this impact, along with other potential threatening processes, may be difficult to quantify with such an inadequate knowledge of the abundance and ecology of this cryptic species. Here we provide some detail of the abundance of this species in semi-arid savanna woodland. There is a strong possibility that we only detected a fraction of the lizard abundance in the area during clearing operations, and there is a strong possibility that the lizards we did find were skewed towards the clumsy and conspicuous *Chelosania*. Comparatively, when approached, *C. kingii* and *V. tristis* were observed to either rapidly flee (*V. tristis*) or attempt to avoid detection by slipping away to the opposite side of branches (*C. kingii*). We suggest future surveys or studies of Chameleon Dragons should take our findings into consideration and not assume that these dragons are extremely rare or occur at very

low abundances. Unfortunately, it seems likely that the best way to find this cryptic species is by clearing the habitat in which they reside. In future, it may be possible to seek to collect more data of the abundance, behaviour and ecology of this species during land clearing projects across its range.

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