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Natural History Notes

The attempted predation of a sand goanna (*Varanus gouldii*) by a juvenile red fox (*Vulpes vulpes*)

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Abstract Predation is a dynamic process that is directly influenced by resource availability (e.g. prey types), and the health and welfare conditions of the predator (e.g. body condition, health status). When these conditions are altered, predators may need to adapt new modes of predation for survival. On 26 October 2019, a mid-day attempted predation event occurred between a juvenile fox and a subadult sand goanna. This event occurred in an area that has been subject to long-term drought conditions with significant vegetation die-off, which may have influenced the availability of preferred small mammal prey. Additionally, this event occurred in broad daylight, which may be considered risk-taking behaviour for the juvenile fox. Supporting this, the fox was in poor body condition (e.g. underweight with sarcoptic mange). Until this recording, no direct evidence has been reported regarding the predator/prey relationship between the two species. This observation supports that foxes may adopt prey-switching behaviour under certain environmental and health conditions. As drought conditions continue to fluctuate in Australia, it is important that the full scope of fox predatory behaviour is well understood for the future management of Australian ecosystems.

Key words: drought, mesopredator, predator, prey relationship.

INTRODUCTION

The red fox (*Vulpes vulpes*) is a mesopredator that was introduced into Australia in the 1830s (Long 2003). Foxes function as both predators and scavengers, hunting a diverse group of prey and benefiting from carrion from larger prey killed by apex predators, such as dingoes (*Canis dingo*; Coman 1973). In Australian ecosystems, foxes are considered opportunistic predators that regularly hunt, or attempt to hunt, prey sizes that extend from invertebrates to larger vertebrates, such as lambs (Dickman 1996) and macropods (e.g. wallabies, Dovey *et al.* 1997, Kinnear *et al.* 2010; adult grey kangaroos, Meek & Wishart 2017). While much is known about the typical predatory behaviour of foxes, there are gaps in knowledge surrounding the predator–prey relationships between alternative prey species, such as large reptiles. As Australia is drought prone, it is important to understand the predator–prey interactions involving foxes throughout various ecological conditions.

Sand goannas (*Varanus gouldii*) are large monitor lizards whose species range extends across most of terrestrial Australia (Thompson 2004). Although considered a common species, many aspects of its natural history remain poorly studied. To date, the only known predators of adult sand goannas are Aboriginal people (Thompson 2004) and some large snakes (Bruton 2013). Indirect evidences of predation, such as scat and stomach contents, reveal that sand goannas are also consumed by cats, dingoes, foxes (Webb 1996; Paltridge 2005), birds of prey (Brooker & Ridpath 1980) and other varanid lizards (King 1978; Pianka 1994), including conspecifics (King & Green 1979; Shine 1986). In these instances, it is unclear whether sand goannas are consumed as a result of direct predation or through indirect processes, such as the ingestion of roadkills or scavenging.

On 26 October 2019, a predation event between a juvenile red fox and a subadult sand goanna was opportunistically recorded at 14:33 from inside a vehicle parked along a dirt road in an arid mallee scrubland environment in the mid-north region of South Australia (33°59′24.360 S, 139°13′6.600 E; Appendix S1). This area had experienced prolonged periods of drought conditions, with the Rainfall Percentile Ranking described as between 'Severe Deficiency' and 'Lowest on Record' from April 2018 to January 2020 (Australian Government Bureau of Meteorology 2020). During the attempted predation event, the fox chased and nipped at the tail and back of a sand goanna as it fled across a dirt road, into the understorey vegetation and leaf litter,

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and back along the dirt road (Fig. 1). The attempted predation only ceased when the fox noticed the parked vehicle, discontinued its pursuit and fled (Fig. 2).

This event was considered unusual as foxes are predominantly nocturnal (Lucherini *et al.* 1995; Wooster *et al.* 2019) and use temporal patterns both to hunt opportune prey (i.e. small mammals) and to avoid larger predators (Mueller *et al.* 2018). Thus, this type of diurnal behaviour, especially for a juvenile, can be perceived as risk-taking due to the increased susceptibilities to predation. Additionally, diurnal activity significantly decreases the likelihood of obtaining preferred prey, which may be indicative of an advanced hunger state (Berger-Tal *et al.* 2009). These behavioural deviations could be an indicator of a compromised health or welfare state, given the significant relationship between welfare and behaviour (Mellor 2016) and between risk-taking behaviour and energetic state (Berger-Tal *et al.* 2009). Further, it appeared that the juvenile fox had sarcoptic mange pathologies (Appendix S1), such as the presence of large matted patches of fur on the mid-body and lack of fur on the tail (Nimmervoll *et al.* 2013). Additionally, the animal was in poor body condition, as evidenced by well-pronounced hip bones. It is unclear whether the emaciation was an artefact from mange (Davidson *et al.* 2008) or due to potential reduced prey abundance. Regardless of the aetiology of the poor body condition, it was evident that the health and welfare of this animal was compromised, which may have influenced it to take on a risk-seeking predatory behaviour.

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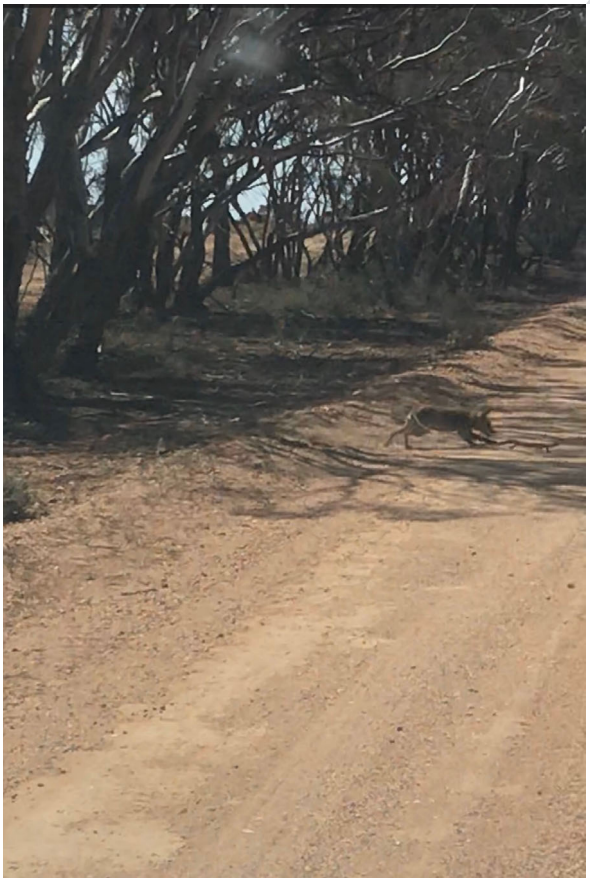

Fig. 1. Active predation attempt by a juvenile red fox (*Vulpes vulpes*) on a subadult sand goanna (*Varanus gouldii*).

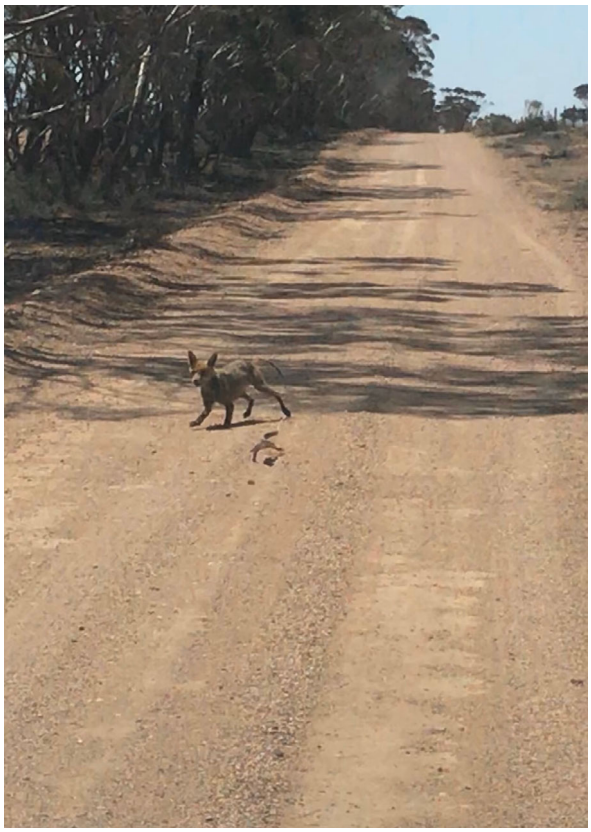

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Fig. 2. Juvenile red fox (*Vulpes vulpes*) abandoning the predation attempt after observing the parked vehicle.

Significant consumption of reptiles by foxes is rarely observed, as rabbits (*Oryctolagus cuniculus*) and other small mammals are known as the predominant prey species of foxes in Australia (Catling 1988; Molsher *et al.* 2000; Mitchell & Banks 2005). However, during drought or arid conditions sand goannas have been reported as a prey item for foxes (Martensz 1971; Paltridge 2005; Cupples *et al.* 2011). The previous studies documented sand goannas in either fox stomach contents or scat (Martensz 1971; Paltridge 2005; Cupples *et al.* 2011), which does not definitively determine the source (e.g. scavenging from roadkill or from kills made by dingoes) or age (i.e. adult, subadult, juvenile) of the sand goannas consumed. This recording is consistent with previous dietary studies and helps provide evidence of a direct predator/prey relationship between the two species. As the climate and drought conditions continue to fluctuate in Australia, it is important that the full scope of fox predatory behaviour, including

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prey-switching, is well understood for the future management of Australian ecosystems.

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AUTHOR CONTRIBUTIONS

Amber Brown: Conceptualization (lead); investigation (lead); project administration (lead); visualization (lead); writing-original draft (lead); writing-review & editing (lead). **Eamonn Wooster:** Conceptualization (equal); investigation (equal); writing-original draft (equal); writing-review & editing (equal). **Gerrut Norval:** Conceptualization (equal); investigation (equal); writing-original draft (equal); writing-review & editing (equal). **Michael G. Gardner:** Conceptualization (equal); resources (equal); writing-review & editing (equal). **Maiken Ueland:** Conceptualization (equal); funding acquisition (lead); resources (equal); visualization (equal); writing-original draft (equal); writing-review & editing (equal).

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