

1 Foxes in trees: a threat for Australian arboreal fauna?

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11 Running head: Foxes in trees in Australia

12 **Abstract**

13 We document the first evidence of tree climbing by red foxes (*Vulpes vulpes*) in
14 Australia. Camera traps recorded foxes in trees on the Liverpool Plains, NSW. This
15 finding prompts a re-assessment of the impact that this invasive predator has on
16 Australian fauna: from purely terrestrial to also potentially arboreal.

17 **Additional keywords:** tree climbing, koala, exotic predator, feathertail glider, camera
18 trapping

19 **Introduction**

20 During the past 200 years, Australia has suffered the highest rate of mammal extinction
21 in the world (Johnson, 2006, Woinarski *et al.*, 2015). This decline has largely been
22 attributed to the vulnerability of Australian fauna to recently introduced predators, such
23 as the cat (*Felis catus*), the red fox (*Vulpes vulpes*) and the dog (*Canis familiaris*)
24 (Burbidge and McKenzie, 1989, Lunney *et al.*, 2007). Critical weight range (35-5500 g)
25 ground-dwelling mammals seem to be mostly affected by these predators (Short and
26 Smith, 1994). Cats, foxes and dogs are opportunistic predators which exploit a large

27 variety of prey species in Australia (Denny, 2008, Catling and Coman, 2008, Glen *et*
28 *al.*, 2006). Although predatory habits of cats, foxes and dogs are mainly terrestrial, cats
29 are known to prey opportunistically in trees (Major *et al.*, 1996, Dickman, 2009, Barratt,
30 1997). In contrast, arboreal behaviour by red foxes has rarely been documented
31 (Sklepkovych, 1994) and there are no published accounts for it in Australia. Hence,
32 many Australian native arboreal species are considered inaccessible to foxes (Abbott *et*
33 *al.*, 2014) and regarded as less vulnerable to fox predation when in the safety of trees
34 (e.g. Pickett *et al.*, 2005). However, red foxes are versatile predators and their diet in
35 Australia includes arboreal species such as gliders, possums and numerous birds (e.g.
36 Mitchell and Banks, 2005, Glen *et al.*, 2006, Roberts *et al.*, 2006). Here, we report for
37 the first time, evidence of tree-climbing behaviour by red foxes in Australia. Whether
38 such behaviour is common, and whether it ever leads to arboreal predation is unknown.
39 Nevertheless, predation risk alone can have indirect sub-lethal effects on prey, such as
40 altering behaviour (Lima, 1998). Therefore, the use of trees by foxes provides the
41 potential for impacts on native arboreal fauna and should be noted for future reference.

42 **Materials and methods**

43 The observations took place on the property Dimberoy, near Gunnedah, in the
44 Liverpool Plains, in north-west NSW, Australia (31°07'33.2"S, 150°00'38.3"E). 10
45 infra-red heat-in-motion sensing cameras (ScoutGuard model SG560K) were installed
46 on trees to monitor the use of artificial water stations by koalas (*Phascolarctos*
47 *cinereus*), as part of a different experiment. The water stations were positioned in the
48 bifurcation of the trunks of eucalypt trees at a height of ~1.3 m. All the tree branches
49 were above this height (Fig. 1). The cameras were fixed 1 m above the water stations
50 facing downwards, to record visits by koalas during the night (video mode set on high
51 sensitivity; operational hours: 6 pm to 8 am; 60 sec recordings with no time lapse).

52 **Results**

53 On the 20th April 2016 at 22:26 AEST, a recording from the camera revealed one fox
54 visiting a poplar box (*Eucalyptus populnea*). The video started with the fox already in
55 the fork of the tree where the water station was positioned, at a height of 1.36 m. It is
56 unclear whether the fox climbed or jumped up to the water station. The tree had a

57 straight trunk with rough bark structure (typical box bark), lightly tessellated, which
58 might have facilitated climbing, but had no low lying branches (Fig. 1). The fox
59 remained in the tree for one minute. The fox investigated the water station (without
60 drinking) and the trunk of the tree thoroughly, repeatedly sniffing these areas.
61 Numerous native birds visit the water station during the day, including eastern rosellas
62 (*Platycercus eximius*), musk lorikeets (*Glossopsitta concinna*), noisy miner (*Manorina*
63 *melanocephala*), galahs (*Eolophus roseicapilla*) and magpies (*Cracticus tibicen*). A
64 koala had visited the same tree five days before (on the 15th April 2016 at 21:30 AEST)
65 and the fox appeared to follow the scent of this individual on the trunk of the tree (Fig.
66 2). At one point, the fox climbed higher in the tree and out of the camera field of vision,
67 following the same path as the koala (Fig. 2), then returning to the water station and
68 descending the tree trunk just before the end of the video.

69 A second fox was filmed in a different poplar box (~1.7 Km away) on the 16th June
70 2016 at 20:57 AEST. The fox initially circled the base of the tree then leaped to the
71 ledge in the tree at 1.3 m, resting its front legs in the fork of the tree while the back legs
72 gripped the trunk. The fox investigated the branches for about 20 seconds, then left.
73 This tree is regularly visited by sugar gliders (*Petaurus breviceps*), koalas and native
74 birds.

75 Another fox was recorded in this tree on 28th July 2016 at 23:27 AEST. Just a few
76 minutes earlier (at 23:23 AEST) a koala had climbed up the tree. At the base of the tree
77 the fox frequently looked at the branches above, before jumping up to the bifurcation of
78 the tree as showed in the previous video, suggesting this fox might be the same
79 individual. Although the fox was in the tree at the same time as the koala, no interaction
80 was recorded. The fox visit was brief (18 seconds) and similar to the previous one at
81 this location (i.e. fox sniffing branches and then leaving). We recorded no more glider
82 visits at this tree after the date of the fox visit on 28th July 2016.

83 **Discussion**

84 Tree climbing behaviour in Canidae is unusual (but see Murdoch *et al.*, 2004) and
85 though red foxes can be agile and opportunistic climbers, we could only find one other
86 study in the literature that reported observations of red foxes in trees (Sklepkovych,

87 1994). The study described arboreal foraging tendencies of red foxes in Canada during
88 winter food shortage and foxes were observed up to a height of 8 m in the tree canopy.
89 Sklepkovych (1994) concluded that when faced with severe hunger, red foxes may
90 search food in trees. Other species of foxes can also exhibit arboreal tendencies
91 (Murdoch *et al.*, 2004, Terres, 1939) but our observations provide first evidence that red
92 foxes can be found in trees in Australia. This behaviour was unlikely due to food
93 scarcity, as the foxes observed did not look undernourished and recordings from other
94 cameras in the vicinity show that many potential and preferred prey species, including
95 hares (*Lepus europaeus*) and mice (*Mus musculus*), were abundant in the area at the
96 time. Therefore, we suggest that tree climbing behaviour by red foxes is not necessarily
97 linked to food unavailability.

98 Our water stations attract a variety of wildlife and may have acted, inadvertently, as a
99 focal point of interest for foxes. Future research is needed to determine the possible
100 negative impacts of providing water stations for wildlife. However, one of the authors
101 recounts sightings of foxes in trees on the same property 6-8 years before the
102 observations described here (R. Frend, personal observation). In one instance, a fox was
103 lying on the branch of a poplar box, extending out horizontally about 4 m above ground
104 level, basking in the sunlight. The tree had features which facilitated climbing,
105 including numerous protuberances on the trunk. Sklepkovych (1994) reported red foxes
106 climbing trees using ‘bumpy growths’ on the trunks of conifers. These observations
107 suggest that tree use by red foxes might be more common than anticipated and not
108 always related to foraging.

109 Tree climbing behaviour by foxes is of particular concern given the impacts that this
110 predator has on Australian fauna (Saunders *et al.*, 2010). Foxes are opportunistic
111 predators and select prey based on immediate availability (Catling and Coman, 2008).
112 Therefore, the foxes may have been attracted to the trees by the smell of potential prey.
113 The fox observed in the first video appeared to be following the scent of a koala filmed
114 in the same tree a few nights beforehand. The fact that in one of our subsequent
115 observations, a koala climbed up a tree just a few minutes before a fox arrived
116 strengthens the idea that foxes might have been searching for potential prey and
117 climbing trees to follow their scent. The foxes were repeatedly sniffing around the water

118 stations but never drank from them, indicating that thirst was not likely to be the reason
119 for climbing the trees.

120 Other water stations in the vicinity have been visited by feathertail gliders (*Acrobates*
121 *pygmaeus*), for which there is no other record in the Liverpool Plains (Atlas of NSW
122 Wildlife Database for Fauna and Flora Data; www.environment.nsw.gov.au). Therefore,
123 the presence of foxes in trees could represent an unrecognised threat for Australian
124 arboreal fauna (for mammals, in particular for those within the critical weight range),
125 and one that is important for accurately quantifying the impacts of this predator in
126 Australia. We did not witness any predation, so it is unclear whether red foxes can
127 successfully prey on arboreal fauna while in trees. Nevertheless, our observations
128 suggest the potential for foxes to exert sublethal arboreal impacts and possibly some
129 predation capacity. This has obvious significance and possible repercussions for
130 conservation of Australian arboreal fauna and should therefore be noted for future
131 reference.

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188 European settlement. *Proceedings of the National Academy of Sciences* **112**,
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190 **Figure legend**

191 **Figure 1:** On the left, a poplar box tree where one of the foxes was filmed. On the right,
192 the structure of the tree trunk which might have facilitated climbing.

193 **Figure 2:** Sequential photos showing a koala climbing a tree on the 15th April 2016 at
194 21:30 AEST and a fox in the same tree investigating the trunk and following the path of
195 the koala on the 20th April 2016 at 22:26 AEST.