A brief observation of Endangered Coquerel's sifaka (*Propithecus coquereli*) feeding on red mangrove (*Rhizophora mucronata*) vegetation in a mangrove environment, northwest Madagascar

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Introduction

Mangrove habitats can provide resources and shelter for primate species (Donati *et al*., 2019). Research into how and why primates use this habitat remains in its infancy, however. Not only are mangrove environments hard to access, but few researchers have acknowledged their value in long-term primate ecology research (but see Nowak et al. 2019).

Madagascar boasts *ca.* 2,800 km^2 of mangrove systems, accounting for 2% of their global distribution (Jones *et al.,* 2016). However, these mangroves are declining steeply due to inadequate protection, and 21% of Malagasy mangroves were lost between 1990 and 2010 (Jones *et al.,* 2016). Lemurs, endemic to Madagascar, use mangrove environments, thus demonstrating their adaptability to flooded habitats (Gardner, 2016; Nowak and Coles, 2019). However, the ecology of lemurs in mangrove environments is largely unknown due to a lack of studies providing contextual information (Donati *et al*., 2019).

Of the 48 records reported in a recent review of mangrove use in lemurs (Gardner 2016), five were of the Endangered Coquerel's sifaka (*Propithecus coquereli*), which is typically found in tropical dry lowland forests in northwest Madagascar. The five records lacked detail beyond basic locality, and only one record stated the number of individuals in the *P. coquereli* group observed with no further information on displayed behaviour (Gardner, 2016). The only other *P. coquereli* observation recorded in Nowak and Coles (Table 7.1, 2019) however, indicated the lemurs were resting and moving with no mention of feeding bouts. *P. coquereli* are hypothesised to use mangroves as a refuge following the loss and degradation of preferred habitat, and for sleeping sites and resources (Gardner, 2016). Here, we describe observations of *P. coquereli* using a mangrove environment to feed, something which has not been documented previously.

Observations

On 11 and 12 July 2018, we opportunistically observed five groups of *P. coquereli* and one individual *ca.* 1-3 m from the river edge in a mangrove environment in the Mariarano region, northwest Madagascar (Figure 1). This region has six wetland routes within a contiguous mangrove system surrounded by a mosaic of wooded grassland and intact dry forest. Operation Wallacea (OpWall), a conservation non-governmental organisation, surveys three of the six routes (Routes A-C) by motorboat 2-4 times per day between June and August. *P. coquereli* have been observed opportunistically in the mangroves since 2010 (P. Long, pers. comm., 2020), but the routes have never been used to survey lemur populations as Opwall's research focusses on bird and crocodile surveys.

We made all observations on Route A during a bird point count survey. We did not survey Routes B and C due to time and logistical constraints. We used a range finder to measure the distance from the boat to the nearest lemur in a group. We observed each group or individual for 10 minutes, recording group demographics, behaviour and lemur height from the ground *ab libitum*.

On 11 July, we observed three groups of *P. coquereli* at high tide, at 15:04, 15:33 and 15:49. Observation ID1 was a group of one female, two sex unknown, 5 m from the boat and 3 m high in a red mangrove (*Rhizophora mucronata*). The two closest individuals fed intermittently on mature red mangrove leaves until all individuals moved out of sight by 5 minutes 12 seconds. Observation ID2 was one female, one male, one sex unknown, 8.1 m away and 11 m high, also in a *R. mucronata* tree. Individuals remained vigilant towards us. Observation ID3 was a group of one female, two sex unknown, 5 m away and 11 m high in a Bismarck palm (*Bismarckia nobilis*); a plant species typically found in open grassland but observed here next to the water's

edge surrounded by mangrove vegetation. The group remained vigilant towards us during 10 minutes of observation.

On 12 July, we observed two groups and one individual at low tide at 08:58, 09:15 and 09:24. Observation ID4 was a group of three individuals of unknown sex, 6 m away and 6 m high in a black mangrove (*Bruguiera gymnorrhiza*). The group were resting when we arrived and were vigilant towards us. Observation ID5 was one individual of unknown sex, 8 m away and resting 6 m high in a *R. mucronata* tree. It fled out of sight as our boat approached. Observation ID6 was a group of three individuals of unknown sex, 7 m away and 0.5 m high in a *B. gymnorrhiza* tree. One individual remained vigilant towards us, whilst the second fled out of sight. The third individual spent 6.5 min resting before the second individual returned and they engaged in an allogrooming bout for 32 s.

Discussion

Our observations support the hypothesis that *P. coquereli* use mangroves for sleeping sites and resources (Gardner, 2016). We observed *P. coquereli* feeding on mangrove vegetation. Although we did not confirm their sleeping sites, all our observations were either *ca.* 3 h after sunrise or *ca.* 2 h before sunset, suggesting that the lemurs may also sleep in the mangroves, as do crowned sifaka (*P. coronatus*) (Gauthier *et al.*, 2000).

Our study area is experiencing ongoing agricultural encroachment, which can cause overcrowding of populations and a shift in home ranges, suggesting the lemurs may use the mangroves as a refuge following the loss and degradation of preferred habitat, as hypothesised by Gardner (2016). However, *Propithecus* species favour mangroves over other habitats (Gardner, 2016). Phytochemical analyses on mangrove trees have shown comparable nitrogen content to that of forest trees, suggesting mangroves could be high value food sources for folivores such as *P. coquereli* (Nowak and Coles, 2019). There is little extensive, systematic

research however, exploring the diet of mangrove-using lemur species (Donati et al 2019). Research on *P. coquereli* population density and feeding ecology in this region, including monitoring of this species' apparent habitat adaptability across seasons, and their use of mangroves, would shed light on the reasons why lemurs use mangroves. This will help inform us as to whether mangroves are indeed a refuge habitat for this species or will provide explanations as to why this environment is perhaps favoured over the adjacent dry forest.

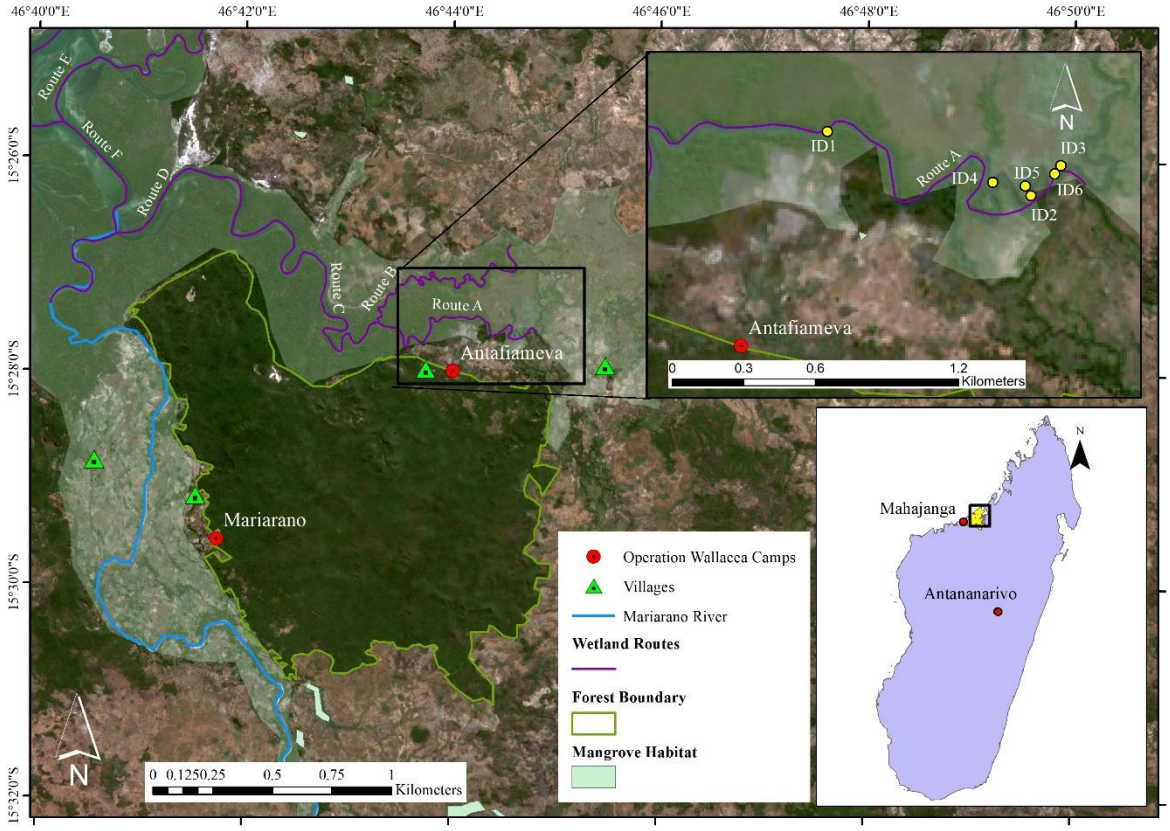

Figure 1. Satellite map of the Mariarano region, northwest Madagascar, showing the GPS localities of six Coquerel's sifaka (*Propithecus coquereli*) sightings in mangrove habitat (labelled ID1-ID6) on the 11 and 12 July 2018. The six permanent wetland routes are labelled Routes A-F.

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