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

Introduction

Mangrove habitats can provide vital resources and shelter for primate species (Donati *et al*., 2019). Research into how and why primates use this key habitat remains in its infancy, however. This is largely due to a lack of published observations. Not only are mangrove environments hard to access, but few researchers have acknowledged the value and influence of mangroves for long-term primate behaviour and ecology.

Madagascar boasts *ca.* 2,800 km^2 of mangrove systems, accounting for 2 % of the global distribution (Jones *et al.,* 2016). Despite this, they are declining at an alarming rate due to inadequate protection, and as a result, 21 % of Malagasy mangroves were lost between 1990 and 2010 (Jones *et al.,* 2016). Endemic to Madagascar, lemur species have been observed to use mangrove environments, highlighting their potential adaptability to flooded habitats (Gardner, 2016; Nowak and Coles, 2019). Of the 48 records reported by Gardner (2016), five of these were of the Endangered Coquerel's sifaka (*Propithecus coquereli*) typically found in tropical dry lowland forests in northwest Madagascar.

P. coquereli have been hypothesised to use mangroves as a refuge following the loss and degradation of preferred habitat, and for the procurement of sleeping sites and resources (e.g. food and water) (Gardner, 2016). Due to a lack of published observations, systematic follows, and low survey effort within this environment however, conclusions regarding the importance of mangroves to this species are yet to be made. Herein, we describe and discuss further observations of *P. coquereli* using a mangrove environment to feed, which has not yet been documented in this species.

Observations

On 11 and 12 July 2018, we opportunistically observed five groups of *P. coquereli* and one individual in a mangrove environment in the Mariarano region, northwest Madagascar (Figure 1). Of the six wetland routes, only three are systematically surveyed between June and July (Routes A-C) by Operation Wallacea (Opwall), a conservation non-governmental organisation. These wetland routes are designated for bird point counts and crocodile surveys conducted by motorboat. All our observations were recorded opportunistically on Route A during a bird point count survey. We used a range finder to measure the distance (in metres) from the boat to the nearest lemur within a group. Due to time and logistical constraints, we could not survey Routes B and C. Despite *P. coquereli* being opportunistically observed in the mangroves since the start of Opwall's research in 2010 (P. Long, personal communication, 2020), the routes have never been used to survey lemur populations. This is due to Opwall's research focus on bird and crocodile species in this mangrove habitat.

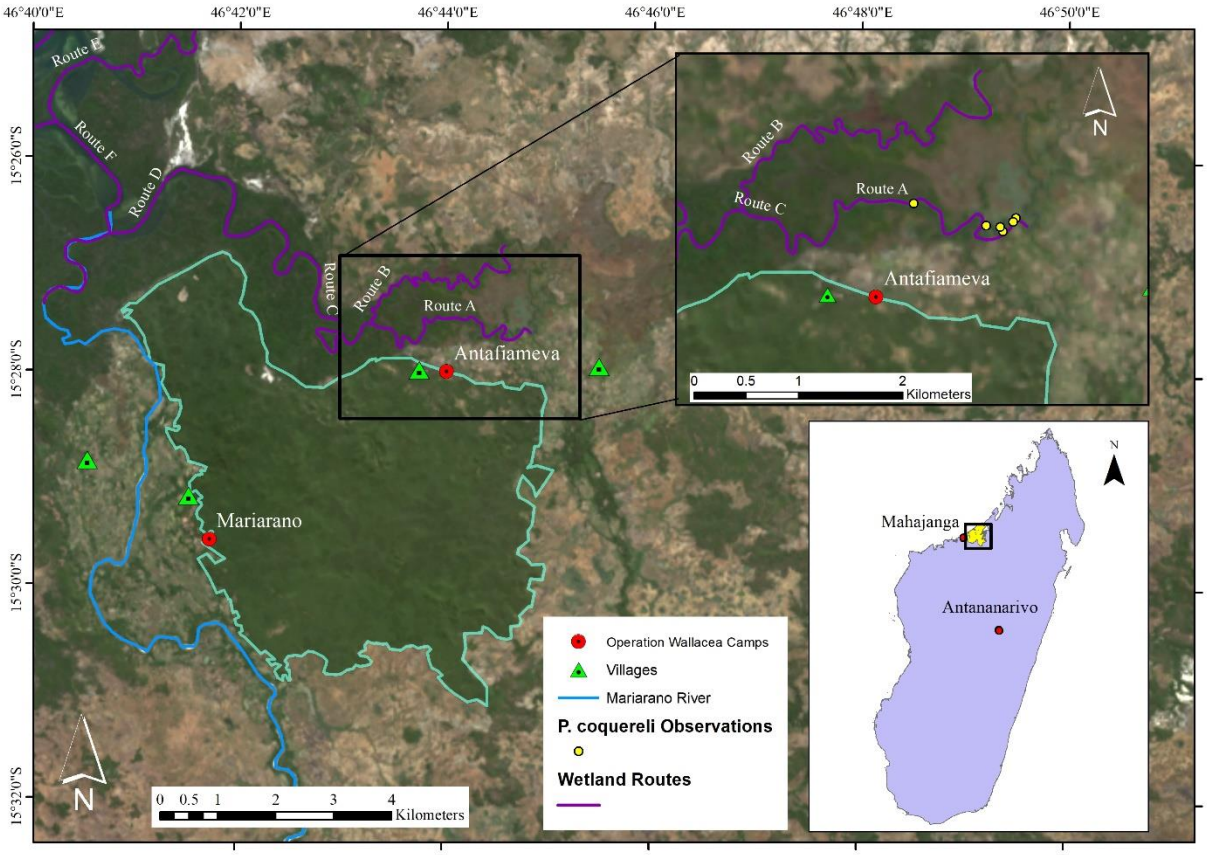

Figure 1. Satellite map of the study site within the Mariarano region, northwest Madagascar, showing the GPS localities of the six Coquerel's sifaka (*Propithecus coquereli*) observations on the 11 and 12 July 2018. The six permanent wetland routes used by Operation Wallacea are labelled Routes A-F.

On 11 July, we observed three groups of *P. coquereli* at 15:04, 15:33 and 15:49. Group ID1 (one female, two sex unknown) were 5 metres from the boat, 3 metres high in a red mangrove (*Rhizophora mucronata*). The two closest individuals fed intermittently on the leaves of this tree species until all individuals moved out of sight by 5 minutes 12 seconds. Group ID2 (one female, one male, one sex unknown) were 8.08 metres from the boat, also in a *R. mucronata* tree at 11 metres high. The observed male and female appeared to be very vigilant towards us and did not feed during this time. We observed the individuals for 10 minutes before we had to move on as our presence was impacting the bird count survey. Group

ID3 (one female, two sex unknown) were 5 metres from the boat, 11 metres high in a Bismarck palm (*Bismarckia nobilis*). The group remained vigilant towards the boat and demonstrated no feeding behaviours during 10 minutes of observation.

On the 12 July, we observed two groups and one individual at 08:58, 09:15 and 09:24. Group ID4 (three individuals of unknown sex) were 6 metres away in a black mangrove (*Bruguiera gymnorrhiza*) at 6 metres high. The group were resting upon our arrival and then showed vigilance towards the boat during a 10-minute opportunistic observation session. Group ID5 (one individual of unknown sex) was 8 metres from the boat, 6 metres high, resting in a *R. mucronata* tree. It fled out of sight as our boat approached. We recorded Group ID6 (three individuals of unknown sex) 7 metres away in a *B. gymnorrhiza* tree at 0.5 metres high. During 10 minutes of observation, one individual remained very vigilant towards our presence, whilst another spent 6.5 minutes resting and engaged in a 32 second allogrooming bout.

Discussion

The ecology of lemurs in mangrove environments is largely unknown as few studies have been published, and reports often lack contextual information (Donati *et al*., 2019). This short communication documents the first observation of *P. coquereli* in a mangrove environment feeding on a mangrove plant species.

Previous phytochemical analyses on mangrove trees have highlighted their comparable nitrogen content with that of forest trees, thus suggesting mangroves could be potential, high value food sources for folivores (Nowak and Coles, 2019), such as *P. coquereli*. The reduction in food availability within the Mariarano region due to habitat disturbance and human encroachment, or the influence of seasonality, could provide explanations for the observed *P. coquereli* presence and feeding bout in this mangrove environment.

74 *P. coquereli* are known to occupy sleeping sites between dawn and dusk. We observed all five
75 groups and the one individual in trees *ca.* 3 hours after sunrise and *ca.* 2 hours before sunset,
76 indicating possible sleeping site localities inside the mangroves, as supported by crowned
77 sifaka (*P. coronatus*) observations (Gauthier *et al.*, 2000). Due to time constraints when
78 opportunistically observing the groups in this account, the exact lemur sleeping site localities
79 cannot be confirmed.

80 We observed the lemurs in a very barren landscape with trees below 20 metres in height. The
81 region has experienced habitat degradation in the form of deforestation which can cause
82 overcrowding of lemur populations and a shift in home ranges, suggesting the lemurs could be
83 using the mangroves as a refuge habitat. Nevertheless, *Propithecus* species have been shown
84 to favour mangroves over other habitats for unknown reasons (Gardner, 2016).

85 Little information is available on lemur species found within mangrove environments, with
86 only five published observations of *P. coquereli* (Gardner, 2016). We speculate that the lemurs
87 observed in this communication could be using the mangrove environment for feeding and
88 sleeping due to possible human encroachment evident in the surrounding Mariarano region, or
89 due to a lack of seasonal resources. Currently little to no extensive, systematic research exists
90 exploring the diet of mangrove-using lemur species. We, therefore, call for future research
91 efforts to focus on *P. coquereli* population density and feeding ecology in this region, as well
92 as year-round behavioural monitoring to investigate this species' apparent habitat adaptability
93 across seasons and use of mangroves previously thought to be a marginal habitat type for most
94 primates.

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