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NEWS

Nearly extirpated by plague and distemper in the 1980s, Black-footed Ferrets now vaccinated for covid-19

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Two-thirds of captive Black-footed Ferrets *Mustela nigripes* have been vaccinated for covid-19 (Fritts 2021, Learn 2021). There are no known cases of these ferrets contracting the disease so far (Fritts 2021, Learn 2021).

The Black-footed Ferret was listed as endangered by the U.S. Fish and Wildlife Service in 1967 and the species was believed to have become extinct in 1979 (Black-footed Ferret Connection no date). A wild population discovered in Wyoming in 1981 was nearly extirpated by sylvatic plague and canine distemper (Fritts 2021). The 18 surviving animals were captured and became the foundation for the Black-footed Ferret breeding programme that continues today (Fritts 2021). There are now about 320 individuals in captive breeding centres and about 300 in the wild (Fritts 2021).

When the covid-19 pandemic spread in early 2020, researchers and breeding programme managers were concerned about the potentially catastrophic impact of the virus on Black-footed Ferrets, which are closely related to other small carnivores that were known to succumb to the disease (Fritts 2021, Learn 2021). Ferret buildings were locked down, barriers erected between individual enclosures, and contact between caretakers and between caretakers and ferrets was minimized (Fritts 2021, Learn 2021).

In 2020, two-thirds of ferrets at the National Black-footed Ferret Conservation Center in Colorado, the main hub in the captive-breeding and release programme, were vaccinated with a version of the Moderna or Pfizer vaccinations now being used for humans (Learn 2021). Six vaccinated post-breeding-age Black-footed Ferrets experimentally exposed to covid-19 became infected but did not become seriously ill (Fritts 2021).

The pandemic did have a negative impact on ferret conservation, including an approximate 50% drop in kits produced (Fritts 2021). Numbers have rebounded, however. The breeding facility in Phoenix, Arizona, had its best breeding season in 20 years and, as of September 2021, the programme aimed to release about 200 ferrets into the wild this year (Fritts 2021).

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ARTICLE

First records and possible range extension of the American Hog-nosed Skunk into Grand Canyon National Park, U.S.A.

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Abstract

Current knowledge of the geographic distribution of the American or White-backed Hog-nosed Skunk *Conepatus leuconotus* suggests contractions in the northernmost reaches of its range. Recently, American Hog-nosed Skunk was documented along the Colorado River through the Grand Canyon National Park (GCNP) for the first time, extending the north-western geographic range of this species. We employed a camera-trap study to determine the extent to which American Hog-nosed Skunks may be distributed along the Colorado River through GCNP and found American Hog-nosed Skunks distributed across a 55-river mile reach along the canyon bottom, including both sides of the river. This constitutes the first time this species has been documented west and north of the Colorado River. Progressive increases in shoreline vegetation since the completion of the Glen Canyon Dam in 1963 has potentially amplified terrestrial invertebrate biomass and prey availability and encouraged American Hog-nosed Skunks to establish along the Colorado River through the Grand Canyon.

Keywords: *Conepatus leuconotus*, Hog-nosed Skunk, Grand Canyon, Colorado River

Introduction

The geographic distribution of the American or White-backed Hog-nosed Skunk *Conepatus leuconotus leuconotus* (Lichtenstein, 1832) at the northern end of its range in the U.S.A. is defined primarily by data from historical museum specimens and sporadic sightings, and recent reports suggest that the species may be undergoing population declines across much its range within the U.S.A. The species has likely disappeared from Colorado and northern New Mexico and has dramatically declined in Texas (Cuaron *et al.* 2008), presumably due to habitat loss and fragmentation (Dragoo & Honeycutt 1999, Helgen 2016). In Arizona, records of American Hog-nosed Skunks are concentrated in the south-eastern region of the state (Fig. 1). Although Hoffmeister (1986) suggested that American Hog-nosed Skunks in Arizona may have been expanding their range in the north-western part of the state, he did not report any records of this species in his 1971 account, *Mammals of Grand Canyon*. In 1956, an immature male Hog-nosed Skunk (catalogue no. 160255, Museum of Southwestern Biology, University of New Mexico, accessed at https://arctos.database.museum/guid/MSB:Mamm:160255 on 22 January 2020) was trapped in the Hualapai Mountains in western Arizona (Musgrove & Hoffmeister 1957), extending the previously known range of this species nearly 160 km to the north-west. This specimen was captured 100 km south–south-west of the nearest point to the Colorado River in Grand Canyon. A few years later, Huey

(1961) reported an American Hog-nosed Skunk in 1960 along U.S. Route 93 in Arizona and about 66 km to the west of the Grand Canyon.

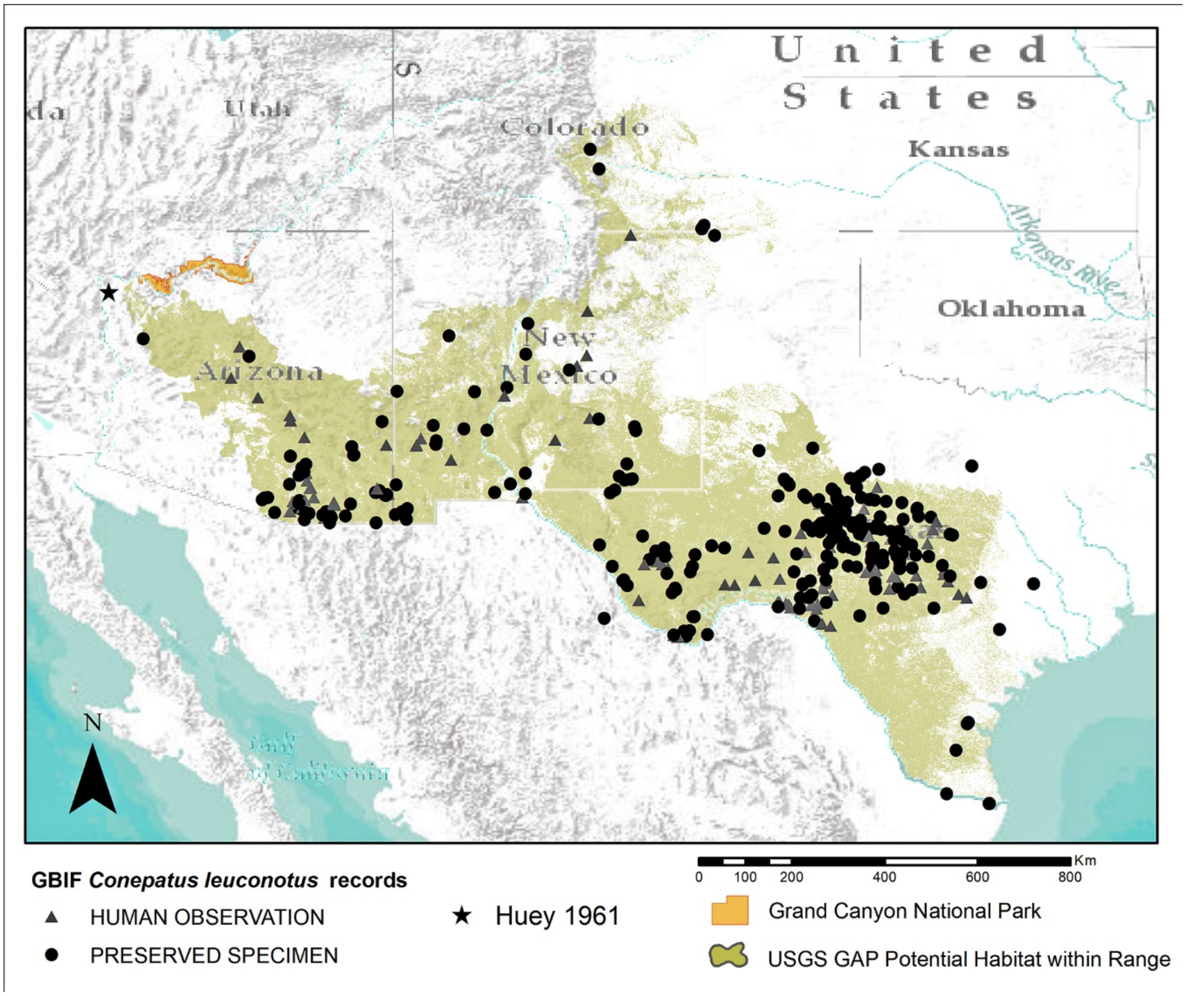

Fig. 1. Museum (preserved specimen) and verified sightings (human observation) of American Hog-nosed Skunks *Conepatus leuconotus* in the south-western U.S.A. relative to the position of Grand Canyon National Park (U.S. Geological Survey 2017, GBIF.org 2019).

Recent evidence of Hog-nosed Skunk in Grand Canyon

The first reports of American Hog-nosed Skunks in Grand Canyon National Park (GCNP) occurred along the Colorado River in 2012 (35°48.86′N, 113°19.84′W). In August of that year, a recreational rafter photographed a solitary American Hog-nosed Skunk on the north side of the Colorado River in the Grand Canyon (Fig. 2a). A year later, in August 2013, another recreational rafter photographed a juvenile American Hog-nosed Skunk on the south side of the Colorado River, seven miles upriver from the original observation (Fig. 2b). Probable signs of American Hog-nosed Skunk (tracks, burrowing and scat) were further documented in 2014 in locations where these initial observations were made. To further verify the presence of American Hog-nosed Skunks in the park and determine the extent of their presence, in June 2015, we deployed 21 Bushnell HD Trophy Cams along 60 river miles in the western reaches of the Grand Canyon from June 2015 to September 2016. We detected American Hog-nosed Skunks at 17 of the 21 (81%) camera traps across a 55-mile stretch between river miles 181 and 236. Given the distances between cameras relative to home range sizes reported for American Hog-nosed Skunks elsewhere (Brashear *et al*. 2015), we suspect that most skunks captured at different cameras represented different individuals. Thus, we recorded a minimum of 26 individuals, including one mother–offspring pair (Fig. 2c). Rather than suggesting dispersing individuals, observations of multiple American Hog-nosed Skunk individuals, including kits and juveniles, across 55 river miles indicates that a breeding population has been established along the Colorado River in Grand Canyon.

Fig. 2. (a) First photographic documentation of an American Hog-nosed Skunk *Conepatus leuconotus* in Grand Canyon National Park, an adult along the north side of the Colorado River at 220 Mile Canyon in August 2012. (Photo: Jen Hiebert.) (b) Second documentation of the species in the park, a juvenile along the south side of the Colorado River, at Pumpkin Springs, in August 2013. (Photo: Ariel Leonard.) (c) Female and kit camera-trapped along the north side of the Colorado River in Grand Canyon National Park, in June 2016 (Photo: Grand Canyon Wildlife Program).

Discussion

Overall, this study verified the occurrence of American Hog-nosed Skunks in the Grand Canyon and documented a population widespread along the river corridor in western Grand Canyon, both north and west of the Colorado River. Prior to this study, the nearest record of American Hog-nosed Skunk was a road-killed individual along U.S. Route 93 north of Kingman, AZ, and over 60 km to the west–south-west of Grand Canyon. Either American Hog-nosed Skunks have been present – but undetected – in the Colorado River corridor in GCNP or they have more recently extended their range into these areas. The remoteness of the Grand Canyon, the relatively infrequent human visitations and the cryptic behaviour of American Hog-nosed Skunks may have allowed them to go undetected, but other small carnivores along the river corridor (e.g. Spotted Skunks *Spilogale gracilis* and Ringtails *Bassariscus astutus*) have been recorded numerous times over several decades in the same riverside habitats where American Hog-nosed Skunks were detected. Climatological and anthropogenic changes to vegetation and the invertebrate prey associated with that vegetation may have allowed a sparse Hog-nosed Skunk population to increase in the Colorado River corridor in GCNP or, if they were not already there, encouraged American Hog-nosed Skunks to expand into the area. Prospects for long-term occupancy of Hog-nosed Skunks in the Grand Canyon appear robust given the widespread distribution reported here, coupled with recent climate modelling that indicates suitable habitat in the Grand Canyon region (Hass & Dragoo 2017), including north of the Colorado River, where records of Hog-nosed Skunks had never been reported previous to our study.

Fig. 3. Putative American Hog-nosed Skunk *Conepatus leuconotus* digging activity in a tamarisk *Tamarix* spp. thicket along the Colorado River in Grand Canyon National Park.

The Colorado River is dammed above GCNP by Glen Canyon Dam, and human regulation of river flow has resulted in a progressive increase in riparian vegetation over the last five decades since the dam's completion (Sankey *et al.* 2015). In the absence of scouring floods, non-native tamarisk (*Tamarix* spp.) has become ubiquitous throughout the Colorado River drainage through the Grand Canyon, replacing native trees such as willows and establishing permanent stands of streamside vegetation. American Hog-nosed Skunks are primarily insectivorous (Hall & Dalquest 1963); more so than other skunks (Bailey 1905, Seton 1926), although their diet also includes small vertebrates (Dragoo & Honeycutt 1999). American Hog-nosed Skunks are especially adapted for digging for prey, with long claws and large shoulders and often roots in soil using its pig-like snout. Therefore, an increase in terrestrial invertebrate biomass associated with more shoreline woody vegetation could potentially have served as the ecological driver for growth in the population of Hog-nosed Skunks already present or range expansion of skunks into GCNP. We found a strong anecdotal association with tamarisk thickets in our study and often noted extensive areas of digging by skunks associated with the understorey of these introduced trees (Fig. 3). We therefore hypothesise that the ecological changes caused by the Glen Canyon Dam, upriver from GCNP, encouraged the recent occupancy and establishment of American Hog-nosed Skunk population along the Colorado River through the Grand Canyon. Given the current concern over the potential decline in populations and range of American Hog-nosed Skunks in other parts of the U.S.A., our findings represent hope that the species may be doing better than suspected in this largely protected area.

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ARTICLE

Cullenia exarillata – a potentially important resource for Brown Palm Civet *Paradoxurus jerdoni* during a period of fruit scarcity in the Western Ghats

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Abstract

Spatio-temporal variation in resource availability influences the diet preferences of mammals. This rapid survey assessed the food preference of the frugivorous Brown Palm Civet *Paradoxurus jerdoni* during a period of fruit scarcity in the Kakachi area of Kalakad-Mundanthurai Tiger Reserve, Western Ghats, India. A systematic survey was carried out for the scats of Brown Palm Civet. We analysed 73 scats collected from two habitats: mid-elevation tropical wet evergreen forest and abandoned cardamom plantations. The flower of the Western Ghats endemic tree *Cullenia exarillata* constituted the major component of the civet diet (72.6%) during the survey. This suggests the possibility of an important ecological relationship between the tree species *Cullenia exarillata* and Brown Palm Civet during periods of resource scarcity in the Kakachi area of Kalakad-Mundanthurai Tiger Reserve.

Keywords: *Cullenia exarillata*, fruit scarcity, Western Ghats, frugivorous carnivores, seed dispersal

Introduction

Studies have documented that tropical forests show clear inter and intra-annual, temporal and spatial variations in fruiting patterns (Ganesh & Davidar 1997, Foerster *et al.* 2012, Polansky & Robbins 2013). Temporal variation in fruiting is an evolutionary strategy of tropical trees to avoid competition for seed dispersal and to attract a large number of frugivores (Schaik *et al.* 1993). Due to fluctuating seasonal availability of fruit resources, the frugivorous animals face inconsistent supply of nutrients and thereby physiological stresses in fulfilling their energy requirements (Goldizen *et al.* 1988, Conklin-Brittain *et al.* 1998, Pereira *et al.* 2010, Vogel *et al.* 2012). Under resource-scarce situations, animals can cope by broadening their trophic niche, increasing feeding time, altering group size, changing their ranging pattern, or by relying on some keystone food resources (Thompson & Colgan 1990, Hanya 2004, Yamagiwa & Basabose 2006, Zhou *et al.* 2008, Thinley *et al.* 2011). These strategies vary based on the behaviour, trophic positions and trophic-niche width of species. In the case of territorial frugivores, floristic composition and productivity within an individual's territory add to the challenge of seasonal fruit scarcity and it are also linked to the fitness of the individual (Borges 1993, Kusch *et al.* 2004).

Civets are known to have diversified food preferences into either largely carnivorous or frugivorous diets (Zhou *et al.* 2008, Mudappa *et al.* 2010, Colon & Sugau 2012). Studies have documented the diet of civets and their resource switching capacity (Bekele *et al.* 2008, Zhou *et al.* 2008, Mudappa *et al.* 2010, Jothish 2011, Mullu & Balakrishnan 2015), but very little is known about their ability to cope with extreme food shortages. The Brown Palm Civet is an endemic small carnivore of the Western Ghats (Mudappa 2002). It is a canopy-dwelling species, occurring in wet evergreen forests and adjacent plantations (Rajamani *et al.* 2002). This species has a highly frugivorous diet and is assumed to be an important disperser of many plant species; however, very little is known about the ecology of the species on account of their elusive, arboreal and nocturnal nature (Mudappa *et al.* 2010). A study by Ganesh & Davidar (1997) found a decline in community-level fruit resource availability in the wet evergreen forest of the Kalakad-Mundanthurai Tiger Reserve (KMTR) from December to April. In KMTR, the flowering of the most abundant tree species *Cullenia exarillata* coincides with the fruit scarcity period and when most of the other plant species do not flower (Ganesh & Davidar 1997). In this survey, we examined the food preference of Brown Palm Civet during a period of fruit scarcity in KMTR.

Materials and methods

Study area

The survey was in Kakachi (8°50′ N latitude and 77°30′ E longitude; 1240 m asl) in KMTR in the Agasthyamalai Ranges of the southern Western Ghats, India (Fig. 1). Kakachi is part of one of the largest contiguous stretches of undisturbed tropical mid-elevation evergreen forest (MEF; 700 – 1400 m asl) in the southern Western Ghats and an important catchment area for the Manimuthar River (Ramesh *et al.* 1997). The region experiences heavy rainfall of over 3500 mm annually from both south-west and north-east monsoons (Ganesh & Davidar 1999). The relatively dry spells occur from March to May. The natural forest has a rich floral and faunal diversity (Ganesh *et al.*1996, Ganesh & Davidar 1997, Raman & Sukumar 2002); however, large areas of habitat in the area have been converted to tropical cash crops such as tea, cardamom and coffee. This has led to disruption in the continuity of forest tracts and has created a mosaic of land use.

The MEF of KMTR supports an impressive floral diversity, with about 173 woody plant species belong to 58 families comprising 42 canopy trees and 48 understorey trees (Ganesh *et al.* 1996). The area is dominated by *Cullenia exarillata, Aglaiabourdillonii* and *Palaquium ellipticum* trees (Ganesh *et al.* 1996). This habitat type shows a well-connected canopy with typical stratification of sub-canopy and understory. In the adjacent cardamom plantation (ACP), the understorey trees were removed completely. Canopy trees have been selectively felled to ensure the availability of sunlight for cardamom plants during the establishment of the plantation. This made the canopy less contiguous and the understorey is now dominated by a light-loving and moisture demanding *Solanum erianthum* shrub. The remnant canopy in ACP is dominated by *Cullenia exarillata*. The other civet species that occur in KMTR are Small Indian Civet *Viverricula indica* and Common Palm Civet *Paradoxurus hermaphroditus.* These species are mostly recorded from the deciduous forests of KMTR with the former species being rarely seen in undisturbed evergreen forests and more frequently recorded in plantations (Mudappa *et al.* 2010).

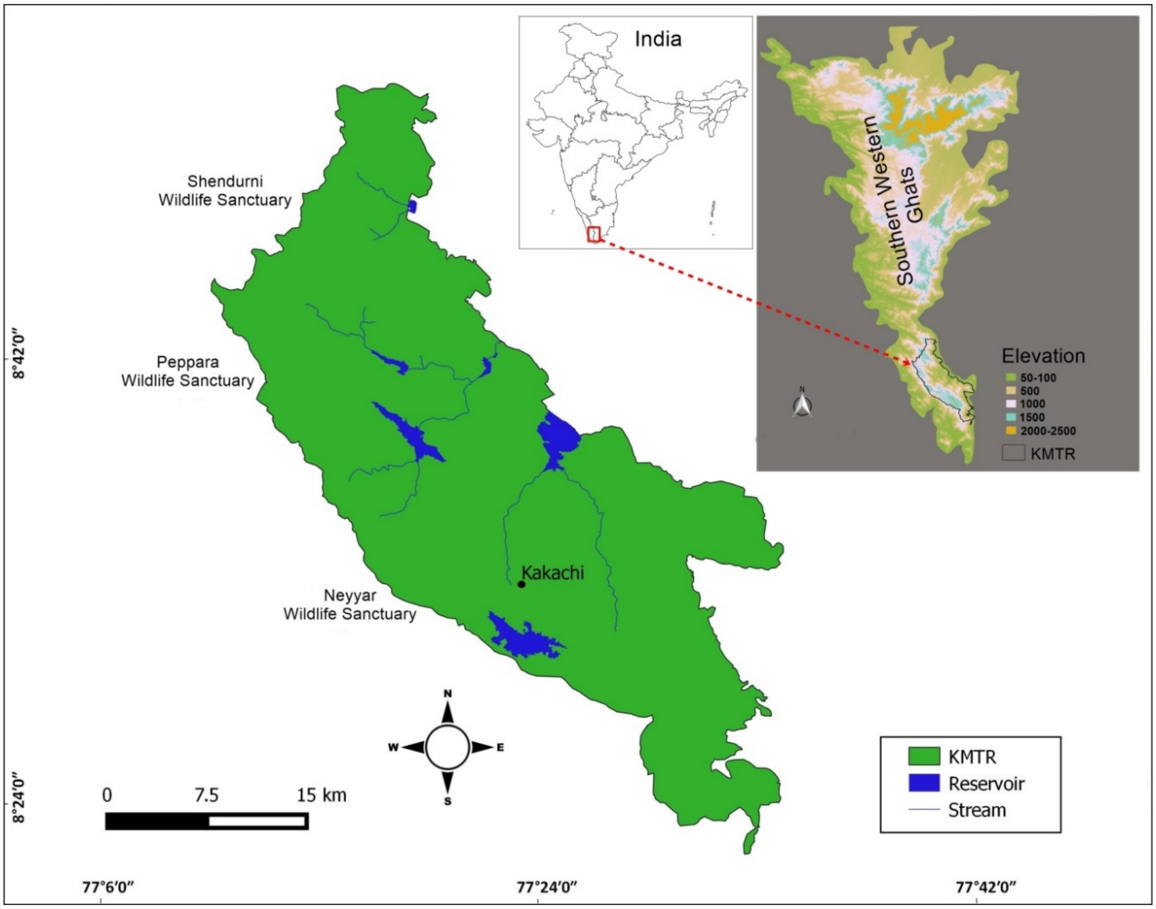

Fig 1. Map of the study area showing Kakachi area within the boundary of KMTR.

Collection and analysis of scats

In order to understand the resource availability and diet preferences of Brown Palm Civet (Fig. 2**)** during a fruit scarcity period, sampling was carried out in the mid-elevation evergreen forest and the adjacent cardamom plantation, which had been abandoned for over 20 years. To assess the diet composition of Brown Palm Civets, we used the technique of analysing scat samples for trophic components (Habtamu *et al.* 2017, Aroon 2008, Bekele *et al.* 2008, Mudappa *et al.* 2010, Jothish 2011). The scat of the Brown Palm Civet is distinguished from Small Indian Civet and other small mammals in the study area on the basis of their size, shape and location. The scats of Brown Palm Civets are straight, cylindrical (≤ 2 cm in diameter), rounded at both ends, and usually found as a single bolus in prominent places like on fallen logs, buttress roots and rocks along the trails. The scat also lacks pungent odour (Mudappa *et al.* 2010). No DNA analysis of the collected faeces was done; it is, therefore, unknown if there were any species misidentification errors.

Fig. 2. Brown Palm Civet *Paradoxurus jerdoni* in the wet evergreen forest of the southern Western Ghats, Southern India.

Extensive scat sampling was carried out for three days (6 to 9 May 2016) in MEF and ACP. For scat collection, transects of 2–3 km lengths were identified from pre-existing trails in the selected habitats. Each route was sampled once by a team consisting of 3–5 persons moving along the trails searching for the scats and paying special attention buttress roots, roots, fallen trees and rocks. A 10-m distance on either side of the transect was searched for scats. The trails were walked between 9:00 and 17:00. A total of 9 km was surveyed in MEF and 8 km in ACP. Since the focus was on food preferences of civets during the resource-scarce season, which starts at the end of April, scats older than 2–3 weeks at the time of the survey in early May were not sampled.

The collected scat samples were individually bagged in Ziploc polythene bags. For each collection event, the following data were recorded; coordinates (using a GPS), identification number, date of collection and habitat type. The analysis of scat was carried out at the field station, where the flowers, fruit seeds and other plant matter as well as insect and other animal material in the scats were identified with the help of specialist botanists and zoologists. The flowers of *Cullenia exarillata* in the scat were easily distinguishable by their colour, partially digested sepals and undigested pollen. The identified materials were segregated based on species/genus and estimated as the percentage of different components (number of times a specific item was found as a percentage of all items found) in the scats.

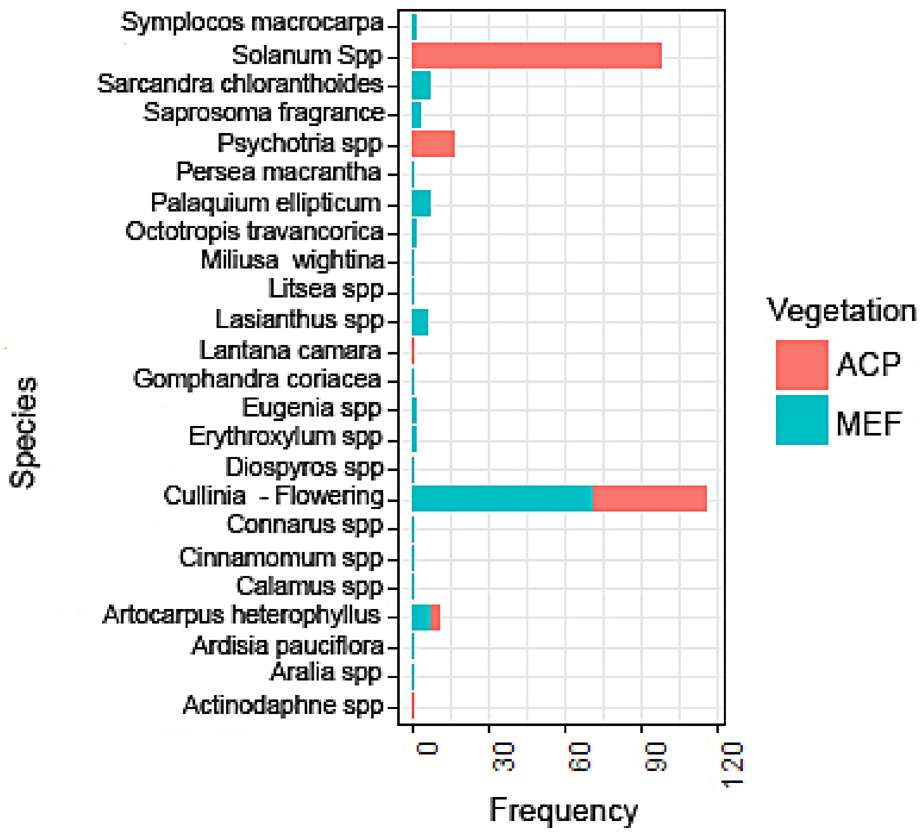

Fig. 3. Frequency of occurrence of different plant species with food resource (fruit and flower) recorded in MEF and ACP of KMTR during the study period (May 2016).

Vegetation sampling

During the study period, a vegetation survey was conducted to record the food resource availability for civets. A total of 14 linear vegetation plots (seven in each of the two habitat types) of 250 m × 5 m were laid along the scat routes. Both understorey and overstorey plant species with fruit resources within the plots were recorded. Overstorey tree species were observed with the help of a pair of binoculars. Since several arboreal mammals, including the Brown Plam Civet and Lion-tailed Macaque (*Macaca silenus*) (Ganesh & Davidar 1997, Mudappa *et al.* 2010, Krishnadas *et al.* 2011), are known to consume the flower of *Cullenia exarillata*, both fruiting and flowering trees were recorded for this species. Plant species that the team were unable to identify in the field were photographed and identified with help of a botanist. The species richness (total number of species in each plot) and Shannon-Weiner Diversity index (H; Shannon & Weiner 1949) of the plants were used to assess plant species diversity in the two habitat types.

Results

Seventy-three scat samples were collected and analysed in total: MEF (*N* = 65) and ACP (*N* = 8). The analysis of faecal contents identified *Cullenia* flowers (72.6 %), fruits of 13 species (26.4%), insects (12.1 %), leaves (2.2%) and reptiles (1.1 %) during the survey period. The number of identifiable species consumed and the percentage and frequency of occurrence of different items in the scats are shown in Table 1. The MEF vegetation plots had the maximum number of species bearing fruits or flowers, with 21 species belong to 16 families (H = 1.43, species richness/plot = 5.4 ± 2.9; see Fig 3). In contrast, only six species belonging to five families (H = 0.9 and species richness/plot = 2.7 ± 0.8) were recorded fruiting or flowering in the ACP plots. In MEF and ACP, flowering *Cullenea exarillata* was the most abundant tree species, with a density of 65.71 and 58 per hectare, respectively. In the MEF, *Artocarpus heterophyllus* and *Palaquium ellipticum* were the next most abundant trees. In ACP, it was the exotic *Solanum erianthum*. Comparison of the abundance of flowering, fruiting and non-flowering trees of *Cullenia* in the two habitat types showed that the trees with flowers (61.7 %) were more abundant in MEF, followed by non-flowering (36.4%) and fruiting (1.7 %).

Table 1. Percentage frequency of occurrence of different food items as shown by scat sample analysis (*n* = 73) during the study in two habitat types.

Sample no.	Food categories	Percentage of occurrence	Frequency of occurrence
1	*Cullenia exarillata* (flower)	72.6	39.1
2	*Elaeocarpus munroii* (seed)	1.4	0.7
3	*Solanum erianthum* (seed)	8.2	4.4
4	*Bentinckia condapanna* (seed)	1.4	0.7
5	*Acronychia pedunculata* (seed)	5.5	2.9
6	*Annonaceae* sp. (seed)	1.4	0.7
7	*Embelia* spp.(seed)	1.4	0.7
8	*Mesua* sp. (seed)	1.4	0.7
9	*Gomphandra* sp. (seed)	2.7	1.4
10	*Ficus* spp. (seed)	4.1	2.2
11	*Fagaria* sp. (seed)	1.4	0.7
12	*Toddalia asiatica* (seed)	1.4	0.7
13	Leaf (unidentified)	2.7	1.4
14	Insects	15.1	8
15	Reptiles	1.4	0.7
16	Unidentified items (seeds of two species)	9.6	5

Discussion

For the effective implementation of the community-level conservation planning, it is important to understand which plants are more important for frugivore communities. For example, the genus *Ficus* was recorded as a 'keystone' resource provider for frugivore communities in several forest ecosystems (Goodman *et al*. 1997, Korine *et al.* 2000). *Cullenia exarillata* is a mammal-pollinated tree species that is an important resource for several vertebrates during resource-scarce seasons (Ganesh & Davidar 1999, Ganesh & Devy 2006). Hence, this species could be considered as one of the 'keystone' species in the MEF of the Western Ghats (Ganesh & Davidar 1997, Ganesh & Devy 2006). Previous research in KMTR identified very high levels of intra- and inter-annual variation in the diets of Brown Palm Civet (Mudappa *et al.* 2010). Although the scats collected during the research reported here indicated that the civets in the survey area had a strong seasonal preference for *Cullenia* flowers, the scats were collected over three days: this is too short a sampling period to assess the relative importance of *Cullenia exarillata* to the survival of Brown Palm Civet.

Studies have documented the importance of civets in seed dispersal (Su & Sale 2003, Bekele *et al.* 2008, Zhou *et al.* 2008, Mudappa *et al.* 2010, Jothish 2011, Mullu & Balakrishnan 2015). Civets play an important role in maintaining forest structure and the passive restoration of disturbed habitats through the dispersal of viable seeds (Zhou *et al.* 2008, Mudappa *et al.* 2010). Mudappa *et al.* (2010) documented that Brown Palm Civet feed on fruits of 57 species from KMTR. The results from this survey also support the important role that civets have in dispersing seeds from a variety of plant species, including both canopy and understorey species.

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IUCN/SSC Small Carnivore Specialist Group

ARTICLE

Recent photographic records of Otter Civet *Cynogale bennettii* from Brunei, Borneo

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Abstract

Otter Civet *Cynogale bennettii* is an endangered semi-aquatic viverrid found in the Thai-Malay Peninsula and on the islands of Sumatra and Borneo. The habitat requirements and distribution of this elusive, infrequently observed and apparently rare species remain largely unknown, hindering conservation planning. Here we report several camera-trap records, dating from 2018 and 2020, of the enigmatic Otter Civet from three locations in Brunei Darussalam. One camera-trap recorded an adult and an offspring together. These photographic records contribute to our knowledge of the current distribution of Otter Civet in Brunei and add records to its presence in lowland dipterocarp forests on Borneo. Protection of wetland habitats as well as lowland dipterocarp forests is important for this species

Keywords: Viverridae, semi-aquatic small carnivore, tropical lowland forest, swamp forest, logging, camera-trapping

Introduction

The Otter Civet *Cynogale bennettii* is one of the least known small carnivores of the family Viverridae. The species has a Sundaic distribution and is found on the Thai-Malay Peninsula, Sumatra and Borneo (Veron *et al.* 2006). The paucity of recent Otter Civet records, despite the growing number of intensive camera-trap programmes in the region, suggests that it occurs patchily and at low population densities throughout its range. Morphological adaptations in the Otter Civet, including broad, webbed feet, dorsally opening nostrils and specialized muscles to prevent the ingress of water to the nose and ears when submerged, strongly point to a semi-aquatic lifestyle (Pocock 1915, Schreiber *et al.* 1989) and the species is thought to be closely associated with wetlands (Cheyne *et al.* 2016).

Population declines inferred from the loss of wetlands (largely from logging) throughout its range underpin the classification of the Otter Civet as Endangered (Ross *et al.* 2015). Reports of Otter Civet being hunted and kept as pets in Kalimantan, the Indonesian part of Borneo (Bouhuys 2019), suggest another threat to the population on Borneo. The fine-scale distribution and habitat requirements of this species are poorly known, hindering conservation planning. On Borneo, the species occurs in coastal and lowland wetland forests, particularly peat-swamp and freshwater swamp forests (Cheyne *et al* 2015; 2016). Sightings have also been reported from lowland dipterocarp forests (Sebastian 2005; Ross *et al.* 2015). The species has also been recorded in secondary logged forests (Cheyne *et al.* 2016, Heydon & Ghaffar 1997, Ross *et al.* 2017) and in degraded and fragmented habitats (Evans *et al.* 2016).

There is limited information available on this species in Brunei, northern Borneo. There are two confirmed records from Brunei: one from Tasek Merimbun (Yasuma & Abdullah 1997) and one from Sungai Ingei (Charles 2012). Here we present photographic records of Otter Civet from three additional locations in Brunei.

Otter Civets camera-trapped in three locations

Camera-traps (Reconyx Hyperfire 2 Covert IR and Bushnell Trophy Cam HD digital camera-traps) were deployed in forest trails near or along streams, attached to tree trunks. The study areas were located in selectively-logged (Labi and Selapon) and unlogged (Ulu Temburong National Park) mixed-lowland dipterocarp forest (Fig. 1). The camera-traps were deployed to survey the occurrence of small carnivore species in the area and were set at 30-50 cm above ground level.

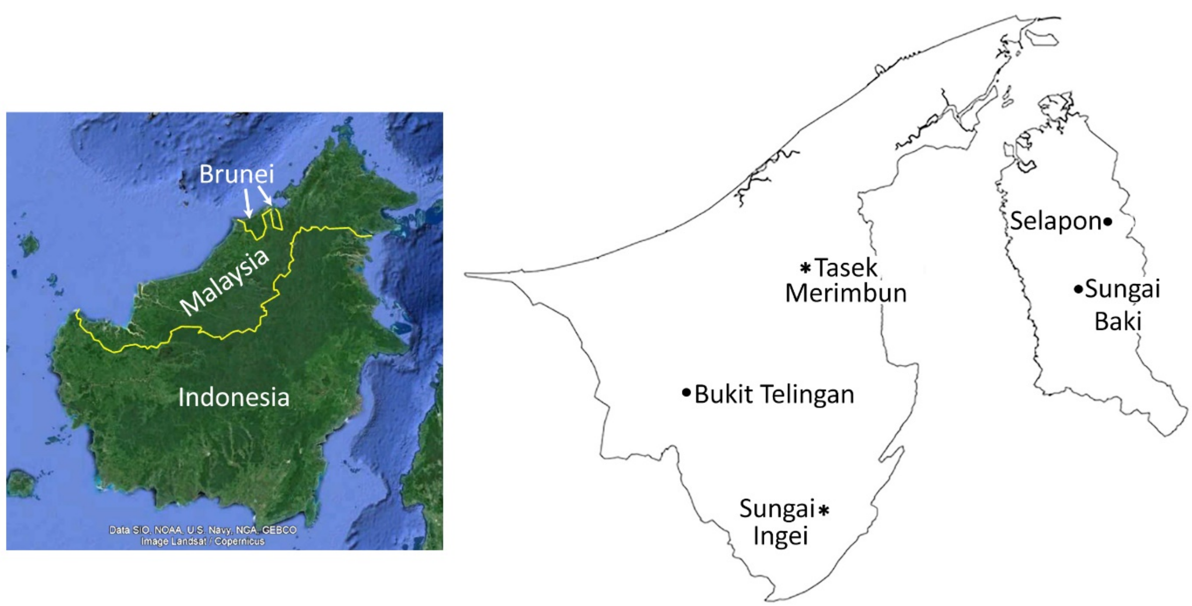

Fig. 1. The island of Borneo (left; based on a Google Earth map) and map of Brunei Darussalam (right) showing the locations of camera-trap records reported herein at Bukit Telingan, Selapon and Sungai Baki. Previous records from Tasek Merimbun and Sungai Ingei are indicated with asterisks.

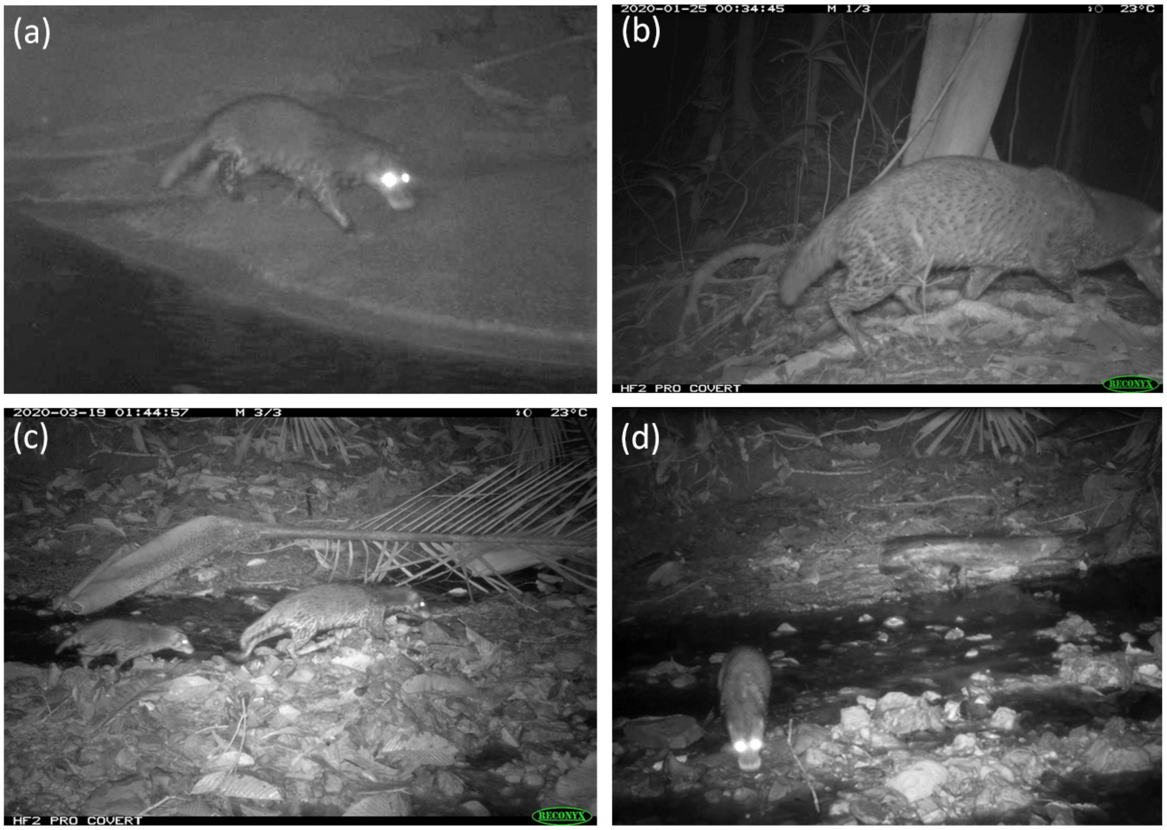

Fig. 2. Camera-trap images of Otter Civet *Cynogale bennettii* at Bukit Telingan, Labi, Brunei: (a) adult, 22h47, 12 January 2020; (b) adult, 00h34, 25 January 2020; (c) adult and offspring, 01h44, 19 March 2020; (d) adult, 19h33, 20 April 2020.

First location

The Otter Civet was recorded five times at three spots along 480 m of a stream at Bukit Telingan, Labi, in the Belait district of Brunei (4°21′40″N, 114°28'59″E). On 12 January 2020 at an Otter Civet (Fig. 2a) was camera-trapped along the riverbank of a stream. On 25 January 2020 another animal (Fig. 2b) was captured on a small ridge between a loop of the same stream. On 19 March 2020 a camera-trap recorded an adult and an offspring Otter Civet (Fig. 2c) walking downstream, confirming the presence of a breeding unit in the area. There is little information on the breeding patterns of Otter Civets. The only report of breeding in the literature is from Peninsular Malaysia (Yong 2017) and there is no known breeding record in captivity (Veron *et al.* 2006). The next night, on 19 March 2020, an individual was captured walking upstream at the same site. On 20 April 2020 a camera-trap recorded a video of a solitary Otter Civet that was foraging and feeding (Fig. 2d). The camera-trap station was located along a small rocky stream. The animal recorded on camera on 19 March and on 20 April may represent the same or two different individuals.

Second location

The Otter Civet was recorded once at Selapon, in the Temburong district of Brunei (4°40′49″N, 115°13′19″E) on 13 August 2018. The Otter Civet (Fig. 3) was camera-trapped on the bank of a stream in a disturbed logged forest.

Fig. 3. Camera-trap image of an adult Otter Civet *Cynogale bennettii* at Selapon, Temburong, Brunei, on 13 August 2018 at 02h58.

Third location

The Otter Civet was recorded three times at the same stream at Sungai Baki, around the vicinity of the Kuala Belalong Field Studies Centre in the Ulu Temburong National Park (4°32′27″N, 115°9′58″E) in the Temburong district of Brunei on 12 February 2020 (Fig. 4).

Fig. 4. Camera-trap image of an adult Otter Civet *Cynogale bennettii* at Sungai Baki, Ulu Temburong National Park, Brunei, on 12 February 2020 at 23h48.

Discussion

The new photographic records of Otter Civet from Brunei, Borneo, add to our understanding of the distribution of the species. In the predictive Habitat Suitability Index models by Cheyne *et al.* (2016) most of Brunei is highly suitable for Otter Civet. Low to moderate elevation areas and wetlands were predicted by the model to be high suitable habitats and these habitats should be protected for this species. However, it should be noted that Cheyne *et al.* had only one historical record from Tasek Merimbun fitted into the model, which underscores the urgent need for survey efforts in Brunei. Others have recorded the species in peat-swamp forests and freshwater swamp forests (Cheyne *et al.* 2015, 2016), secondary logged forests (Heydon & Ghaffar 1997, Cheyne *et al.* 2016, Ross *et al.* 2017) and degraded and fragmented habitats (Evans *et al.* 2016). Sightings have also been reported from lowland dipterocarp forests on Borneo (Sebastian 2005, Ross *et al.* 2015). Our photographic records contribute to our knowledge of the current distribution of Otter Civet in Brunei and add records to its presence in lowland dipterocarp forests on Borneo. Therefore, protection of wetland habitats as well as lowland dipterocarp forests is important for this species. Brunei should remain a priority area for further surveys to determine the current distribution, status and threats to the Otter Civet.

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IUCN/SSC Small Carnivore Specialist Group

ARTICLE

First camera-trap evidence of the Western Mountain Coati *Nasuella olivacea* in San Martin, Peru

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Abstract

The Western Mountain Coati *Nasuella olivacea* is one of the least studied small carnivores in Peru. While its distribution is thought to extend well into the interior of Peru, it remains largely unknown. Between September and November of 2018, we obtained camera-trap photographs of *N. olivacea* from the province of Mariscal Cáceres in the San Martin Region of north-central Peru. These are new locality records for *N. olivacea*, extending the known geographical range of live specimens approximately 318 km southward.

Keywords: camera-trapping, conservation concession, San Martin, Alto Huayabamba

Introduction

The Western Mountain Coati *Nasuella olivacea* is scarcely studied and, consequently, its distribution is not well defined throughout South America (Helgen *et al.* 2009). It is believed to be present in forested habitats above 1300 m and paramos, including both disturbed and pristine areas (González-Maya *et al.* 2016). Various authors have studied this Coati in Colombia and Ecuador (Balaguera-Reina *et al*. 2009, Helgen *et al.* 2009), and its distribution has been predicted to extend to northern Peru (Balaguera-Reina *et al.* 2009; Cossíos *et al.* 2012; Helgen *et al.* 2009; Pacheco *et al.* 2011). Evidence of live specimens have only been documented in the far north of the country (Mena & Yagui 2019). The only evidence of Western Mountain Coatis in Southern Peru is from two museum specimens from the regions of Cusco and Apurímac (Pacheco *et al*. 2007).

The Concession for Conservation Alto Huayabamba (CCAH) is in the provinces of Mariscal Cáceres and Huallaga in San Martin, Peru. The 144,000-hectare concession is partially located in the Yungas ecoregion, which extends from 800 to 3600 m asl, on the eastern flank of the Andes Mountains and is characterised by dense vegetation on extremely steep slopes and a particularly humid climate (CDC-UNALM & TNC 2006). This is a priority area for the conservation of endemic species because of the presence of 10 of the 18 ecosystems identified for the Peruvian Yungas (Ministerio de Agricultura y Riego 2013).

Methods

Forty-four camera-traps (Cuddeback model 1347) were installed between 1831 and 2672 m a sl in the CCAH from September to November of 2018. The cameras were placed on trails and other points of interest in single stations with a linear distance of 500 m between stations. Researchers collected GPS coordinates, land cover, canopy cover, tree species, distance from water and other covariates at the time of installation. Cameras were programmed for continuous capture, with two photographs taken with each detection, and 30-second intervals between detections. The cameras remained in place for more than seven weeks, accumulating 2319 trap-nights with 219 wildlife records. Photographs were reviewed by trained researchers, who used relevant literature to identify species (Emmons & Feer 1997; Pacheco *et al.* 2009; SERFOR 2018).

Results and discussion

During this sampling we detected 17 species from eight orders, 12 families and 16 genera; six of them being carnivores. *Nasuella olivacea* was detected in three photographs from two different stations, at elevations of 2118 to 2182 m asl (Table 1; Fig. 1).

Nasuella olivacea has been reported to occur in other countries, like Colombia and Ecuador, in both conserved and disturbed habitats (Balaguera *et al.* 2009; Helgen *et al.* 2009; Fig. 2). Helgen et al. (2009) used geographic range modelling to predict the occurrence of *N. olivacea* in the northern Andes in Peru. This was confirmed by the presence of live specimens reported in the northern region of the department of Cajamarca (Mena & Yagui 2019). However, museum specimens collected in the departments of Cusco and Apurimac (Pacheco et al. 2007), suggest the possibility that they occur much further south.

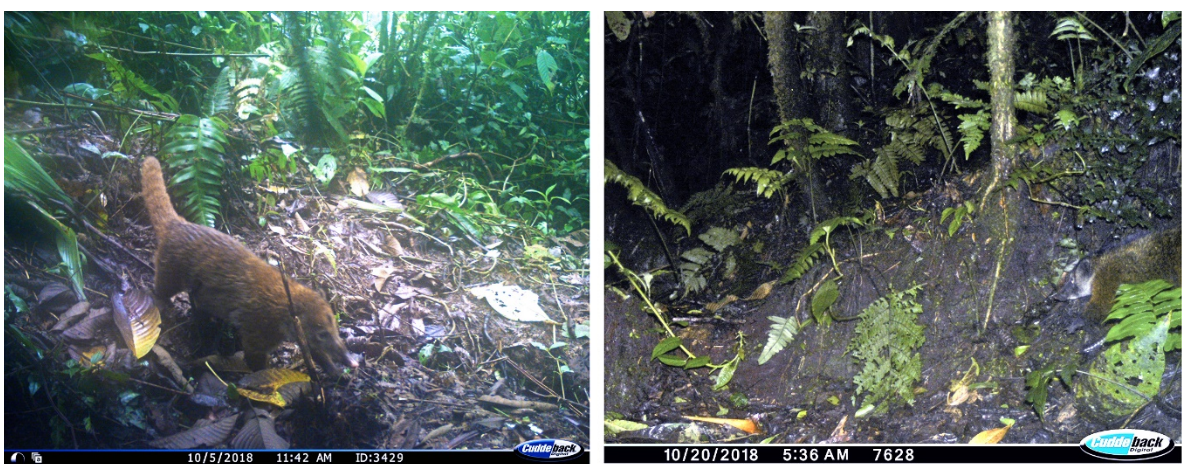

Fig. 1. Western Mountain Coati *Nasuella olivacea* camera-trapped at (left) 11h42, 5 October 2018, in a patch of primary forest and (right) at 05h36, 20 October, in secondary forest in Conservation Concession Alto Huayamamba, Peru. As is characteristic of this species, it presents apparently coarse fur with olive-brown tones and a long, ringed tail.

Table 1. Records of Western Mountain Coati *Nasuella olivacea* at the study site. Exact location records of the species from Mena & Yagui (2020) and Pacheco *et al.* (2007) are not available.

Camera station	Latitude	Longitude	Elevation	Land cover
26	7°19′43.428″S	77°26′57.228″W	2182	Secondary forest
32	7°20′35.884″S	77°26′41.568″W	2118	Primary forest

Fig. 2. Distribution and records of Western Mountain Coati *Nasuella olivacea* in Peru.

To the best of our knowledge, this is the first photographic evidence of the Western Mountain Coati in the department of San Martin, and the first evidence of live individuals in the deep interior of the country. These records can help refine the current range map of the species and thus influence Red Lists and conservation priorities. We strongly recommend further camera-trapping studies to increase our understanding of this Coati's geographical range (de Bondi *et al.* 2010) and continued collection of genetic samples from specimens from Peru to investigate population connectivity and barriers to it (Ruiz-García *et al.* 2021). This would also help to increase scientific knowledge of Peru's Yungas region and could inform plans and action on conserving the connectivity of Andean forests.

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