

The vulnerable colombian weasel *Mustela felipei* (Carnivora): new record from Colombia and a review of its distribution in protected areas

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The Colombian weasel *Mustela felipei* is considered the rarest Neotropical carnivore only known from four localities in Colombia and one in Ecuador. It is considered Vulnerable on the IUCN Red List along its distributional range. We present an unexpected photographic record of a living specimen from Colombia that shed lights on its distribution on the Western Cordillera of Colombia, where it was previously known from single a record obtained on 1986. This is the first confirmed record of the Colombian weasel during the 21st century. Finally, we discuss the species' occurrence in protected areas of Colombia, to provide tools for the conservation of this rare species.

La comadreja colombiana *Mustela felipei* es considerada el carnívoro neotropical más raro, solo conocida de cuatro localidades en Colombia y una en Ecuador. Se considera Vulnerable en la Lista Roja de la UICN a lo largo de su rango de distribución. Presentamos un registro fotográfico inesperado de un espécimen vivo de Colombia que arrojó luces sobre su distribución en la cordillera Occidental de Colombia, donde anteriormente se conocía de un solo registro obtenido en 1986. Este es el primer registro confirmado de la comadreja colombiana durante el siglo 21. Finalmente, discutimos la ocurrencia de la especie en áreas protegidas de Colombia, para proporcionar herramientas para la conservación de esta especie rara.

Keywords Andes; Carnivora; photographs; rarity.

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Introduction

The Colombian weasel *Mustela felipei* (Carnivora: Mustelidae) is the smallest of all South American weasels ([Ramírez-Chaves and Patterson 2014](#)). It is considered the rarest carnivore of South America based on its restricted distribution (endemic to the Andes of Colombia and Ecuador), and low population density ([Ramírez-Chaves and Patterson 2014](#); [Ramírez-Chaves and Torres-Martínez 2016](#)). It is known from only five localities and six specimens ([Ramírez-Chaves and Mantilla-Meluk 2009](#); [Ramírez-Chaves and Patterson 2014](#)). Globally, it has been categorized as "Vulnerable" (VU; [González-Maya et al. 2016](#)), however, in Colombia, is listed as "Endangered" mainly due to its restricted distribution and the habitat transformation of the areas in which it has been registered ([Mesa-González 2006](#); [MADS 2017](#)). Little is known on this enigmatic species, with all information coming from labels of museum vouchers, the most recent collected on 1986 ([Alberico 1994](#); [Ramírez-Chaves and Mantilla-Meluk 2009](#); [Ramírez-Chaves et al. 2012](#); [Ramírez-Chaves and Patterson 2014](#)). Morphological traits on this rare species has been documented and can be used to separate from its South American congeners based on its small size, short tail, darker coloration, and the presence of a ventral spot on its chest or neck that is the same color as the dorsum ([Izor and de la Torre 1978](#); [Ramírez-Chaves and Mantilla-Meluk 2009](#); [Ramírez-Chaves et al. 2014](#)). The Colombian weasel lacked photographs alive, either in

nature or in captivity ([Ramírez-Chaves and Patterson 2014](#); [Suárez-Castro and Ramírez-Chaves 2015](#)).

Material and methods

We report an unexpected record of a living specimen based on photographs obtained on February 26, 2011, in the main house of finca Morobia, located in the km 24 in the Cali-Buenaventura road (3.544745° N, -76.615324° W, 1,780 masl). El Carmen, Dagua, department of Valle del Cauca, Colombia. The identification was made based on its small size, short tail lacking a black tip, darker coloration, and the presence of a ventral spot on its chest or neck that is the same color as the dorsum ([Izor and de la Torre 1978](#)).

The new locality is placed between the 1,750 and the 1,800 masl across the road from a relic of primary forest (cloud forest); the climate is very humid and ranges from 10 to 25 °C. This forest extends to the south into the National Natural Park Farallones de Cali. There is a very small mountain stream that runs across finca Morobia, and it is located about 100 m south of the main house.

In addition, with the new locality, we estimated the Extent of Occurrence (EOO) and the Area of Occupancy (AOO), based on a 2 km cell-width. We also fitted an Ecological Niche Model (ENM) using the six localities in Maxent v 3.4.1 ([Phillips et al. 2017](#)). Maxent has been shown to outperform other algorithms, including when applied to small

data sets (Elith *et al.* 2006; Pearson *et al.* 2007). We defined our study area as a Minimum Convex Polygon plus a 2.5° buffer, to ensure that Maxent select the bioclimatic data from 'background' pixels from a region in which known records are more likely to form a representative sample of the climatic conditions suitable for the species (Anderson and Raza 2010). Environmental datasets were obtained at 30 seconds (~1 km²) resolution from the WorldClim Version 2 (<http://worldclim.org/version2>; Fick and Hijmans 2017), and to avoid highly-correlated and redundant variables, correlations between pairs of bioclimatic variables were assessed using the Variance Inflation Factor (VIF>10, Zuur *et al.* 2010). The resulting 12 bioclimatic variables were used to build the ecological niche model (BIO2 = Mean Diurnal Range, BIO3 = Isothermality, BIO4 = Temperature Seasonality, BIO5 = Max Temperature of Warmest Month, BIO6 = Min Temperature of Coldest Month, BIO7 = Temperature Annual Range, BIO11 = Mean Temperature of Coldest Quarter, BIO13 = Precipitation of Wettest Month, BIO14 = Precipitation of Driest Month, BIO15 = Precipitation Seasonality, BIO18 = Precipitation of Warmest Quarter and BIO19 = Precipitation of Coldest Quarter).

Since our sample sizes is low (six localities), we used the linear and product features (see Phillips *et al.* 2006, and Phillips and Dudík 2008 for recommendations regarding sample sizes and features usage). We run the delete-one jackknife modeling approach (Pearson *et al.* 2007; Shcheglovitova and Anderson, 2013, called "n – 1 jackknife"), and we estimated optimal model complexity considering several regularization multipliers (0 to 2, by 0.5), using ENMeval (Muscarella *et al.* 2014). Logistic output format was used to describe the probability of presence or suitability (Phillips and Dudík 2008), this is a continuous suitability map which range between 0 (unsuitable) and 1 (the most suitable). Then we applied the minimum training presence threshold associated with any one of the observed records at the suitability map to obtain a boolean map and representing the potential distribution of the species. We report the accuracy of the model using the average of the Area Under the Curve (AUC > 0.75) of the Receiver Operating Characteristic (ROC) curve based on the test records and considering AIC = 0 (Muscarella *et al.* 2014).

Results

The new record is based on an individual of *M. felipei* photographed by J. M. de Roux, while it was stuck in an outside bathroom. Back then, in 2011, the main house was getting remodeled (the wooden floor was being lifted, and the roofing refurbished). The individual delivered a strong odour (sort of like urine or musky) as it moved frantically, looking for a way out. After taking the photographs, J. M. de Roux left the door open for it to escape. The diagnostic characters (*e. g.*, the presence of a ventral spot on its chest or neck, of the same color as the dorsum), are visible in the photographs (Figure 1) casting no doubt on its correct identification.



Figure 1. The Colombian weasel *Mustela felipei* alive from finca Morobia, Dagua, Valle del Cauca, Colombia. Note the diagnostic characters: the dark coloration, short tail without a black tip, and the presence of a ventral spot on its neck of the same color as the dorsum. Photograph: J. M. de Roux.

This is the second validated record of the species in Western Cordillera and the first near a protected area in this Cordillera (Farallones National Natural Park). The locality is close to the northernmost record at Alto de Galápagos, on the limits between the departments of Chocó and Valle del Cauca (Alberico 1994). With this new locality, the approximated Extent of Occurrence (EOO) is near to 40,146 km², of which 37,238 belong to Colombia. The Area of Occupancy (AOO) is 24 km² (based on a 2 km cell-width; Figure 2).

The fit model (LQ0) had a very high (0.94) average test and shows higher probabilities (Figure 1a) of the species to occur in six departments of Colombia (Cauquetá, Cauca, Huila, Nariño, Risaralda and Valle del Cauca) and four provinces in Ecuador (Carchi, Imbabura, Pichincha and Napo). The potential distribution indicated that the species can be found along the Western and Central range of the Colombian Andes from Department of Antioquia to Department of Nariño (Figure 2b). In Nariño we found an untypical potential distribution, because there is a clear separation

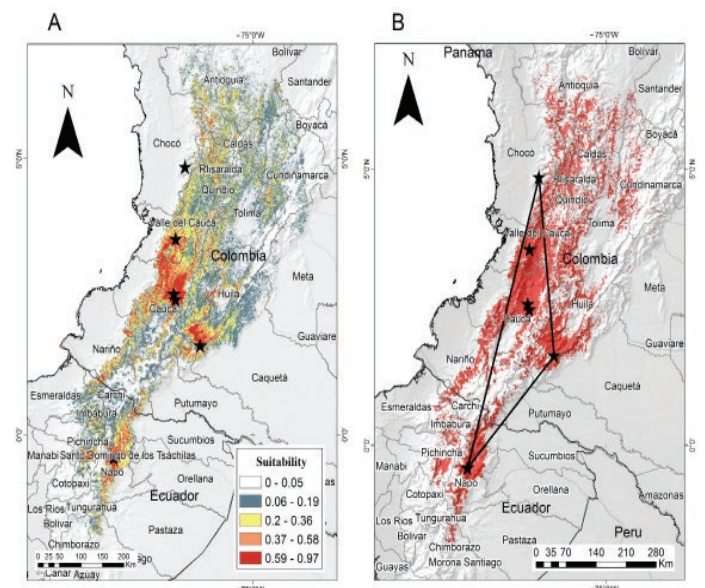


Figure 2. a) Suitability model of the Colombian weasel *Mustela felipei*. b) Updated potential distribution of *M. felipei* in South America. The star within the circle represents the new locality in finca Morobia, Valle del Cauca, Colombia. The polygon (black line) indicates the Extent of Occurrence (EOO) and black stars represent confirmed records.

between the western and the eastern slopes of the Nudo de los Pastos. According to the model, the potential distribution of the species extends from Carchi Province to Chimborazo and Morona Santiago provinces in the Eastern cordillera of Ecuador.

Discussion

The distribution of *M. felipei* has been previously studied (Burneo et al. 2009; Ramírez-Chaves and Mantilla-Meluk 2009; Ramírez-Chaves and Patterson 2014), and there were only five confirmed localities in Colombia and Ecuador (Table 1). Other localities, including records from Western Cordillera of Colombia (e. g., Avila et al. 2017) have been proved to be wrong or impossible to validate (Ramírez-Chaves et al. 2012; Ramírez-Chaves and Torres-Martínez 2016). However, this record represents the sixth confirmed locality, and the first time the Colombian weasel is photographed alive. Based on the six confirmed localities, the AOO suggest that the species should be assessed globally as Endangered (EN), as is listed in Colombia (Mesa-González 2006).

The complete potential distribution of *M. felipei* comprises 82,659 km². However, the Andean lands represent the most impacted ecosystems of Colombia and one of the most impacted in Ecuador (Harden 2006; Hofstede et al. 2002; Rodríguez Eraso 2013). Therefore, it is probable that the available natural vegetation for the species is much lower than the estimate potential distribution. *M. felipei* has been only recorded in two protected areas in Colombia (the first was the National Natural Park Cueva de Los Guácharos, in the Western Cordillera; Mesa-González 2006). The distribution model shows a high probability of presence of the Colombian weasel in a second protected area in the Western Cordillera, the National Natural Park Munchique, which is close to the locality of the new record, and in the Cen-

tral Cordillera, the Puracé National Natural Park. Two of the previous records come from localities near to Puracé (Mesa-González 2006). Although the Colombian weasel has not been registered at Munchique yet, connectivity between Farallones and Munchique protected areas is crucial for the species' persistence, and the creation of wildlife corridors might represent an invaluable tool to enhance the effectiveness of conservation strategies for this species.

Finally, this is the first time that photographs provide evidence on the presence of this rare carnivore during the 21st century (Table 1). The photographs were firstly available at the website iNaturalist, showing the relevance of citizen science in providing useful information to the knowledge of poorly known carnivores, as also has been shown for other species (i. e., Gerstner et al. 2018).

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Table 1. Locality records of the Colombian weasel in Colombia and Ecuador. Elevation is shown in meters (m). Vouchers: AMNH: American Museum of Natural History, New York. FMNH: Field Museum of Natural History, Chicago. IAvH: Instituto Alexander von Humboldt, Villa de Leyva. UV: Universidad del Valle, Cali.

Locality	Coordinates	Elevation	Date and bases of record
Ecuador			
Napo, Baeza	-0° 25' S, -77° 55' W	1,525	January 1923: AMNH 63839
Colombia			
Huila, San Agustín, Santa Marta, Eastern slopes of Cordillera Central,	02° 33' N, -76° 39' W	2,700	October 2, 1951: FMNH 70999
Cauca, Popayán, western slopes of Cordillera Central	2° 27' N, -76° 37' W	1,750	September 29, 1956: FMNH 86745
Huila, Palestina, P.N.N. (National Natural Park) Cueva de Los Guacharos, valle del río Suaza	01° 37' N, -76° 06' W	2,080	October 23, 1980: IAvH 7434
Border between departaments of Valle del Cauca and Chocó, Alto de Galápagos, Western Cordillera	4° 51' N, -76° 25' W	2,000	August 4, 1986: UV 7483
Valle del Cauca; Dagua, corregimiento de El Carmen. Cali-Buenaventura road. Km 24-25, finca Morobia	3° 32' 41" N, -76° 36' 55" W	1,780	February 26, 2011: Photographs

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