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ORIGINAL ARTICLE

First confirmed record of *Neogale frenata* (Carnivora, Mustelidae) in the Chocó rainforest

Primer registro confirmado de *Neogale frenata* (Carnivora, Mustelidae) en los bosques húmedos del Chocó

Kaushik Narasimhan[1, 2], Jordan Karubian[1, 2], and Diego G. Tirira[3, 4]

[1] Tulane University, 6823 St Charles Ave, New Orleans, Louisiana 70118, USA.
[2] Fundación para la Conservación de los Andes Tropicales, Quito, Ecuador.
[3] School of Biological Sciences and Engineering, Yachay Tech University, San Miguel de Urcuquí, Imbabura, Ecuador.
[4] Fundación Mamíferos y Conservación, Capelo, Rumiñahui, Ecuador.

Corresponding author: dtirira@yachaytech.edu.ec (Diego G. Tirira)

ABSTRACT

Despite the large geographic and elevational range of *Neogale frenata* (long-tailed weasel), records of this species in the lowland forests of coastal Ecuador are sparse, and some of them are of dubious provenance. Here, we report the first confirmed record of *N. frenata* in the Chocó forests of the province of Esmeraldas in northwestern Ecuador, an area of forests highly threatened by fragmentation and deforestation. For this reason, new surveys are necessary to determine the conservation status of this mammal species from coastal Ecuador.

Keywords: Bilsa Biological Station, Esmeraldas province, long-tailed weasel, Mache-Chindul Ecological Reserve, noteworthy record, Ecuador

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RESUMEN

A pesar del amplio rango geográfico y altitudinal de *Neogale frenata* (comadreja de cola larga), los registros de esta especie en los bosques de tierras bajas de la Costa ecuatoriana son pocos y algunos de ellos dudosos. Aquí reportamos el primer registro confirmado de *N. frenata* en los bosques húmedos del Chocó, en la provincia de Esmeraldas, noroccidente de Ecuador, una zona de bosques altamente amenazados por la fragmentación y la deforestación. Por este motivo, consideramos necesario realizar nuevos muestreos para conocer el estado de conservación de esta especie de mamífero en la Costa ecuatoriana.

Palabras clave: Estación Biológica Bilsa, comadreja de cola larga, provincia de Esmeraldas, Reserva Ecológica Mache-Chindul, registro notable, Ecuador.

Neogale frenata (long-tailed weasel; Lichtenstein, 1831) has the largest distribution of any species of the family Mustelidae in the Western Hemisphere (Helgen & Reid, 2016), spanning 80° of latitude from northern Canada to Bolivia (Helgen & Reid, 2016; Sheffield & Thomas, 1997). In this broad geographical range, 42 subspecies of *N. frenata* have been recognized (Larivière & Jennings, 2009).

This species is common in a variety of habitats but prefers forested areas, including humid and dry primary or secondary forests (Emmons & Feer, 1997; Larivière & Jennings, 2009; Tirira, 2017); also, it tolerates human-disturbed land (e.g., deforested and agricultural areas and even human settlements) (Larivière & Jennings, 2009; Sheffield & Thomas, 1997). *N. frenata* occurs over a wide range of elevations, from sea level to an altitude of 4220 m (Escobar-Lasso & Gil-Fernández, 2014; Hall, 1951; Larivière & Jennings, 2009).

The subspecies *N. f. aureoventris* (Gray, 1864) is restricted to Ecuador and Colombia (Larivière & Jennings, 2009; Tirira et al., 2022), where it is associated with the premontane and montane forests of the Andean slopes, subtropical, temperate, and high Andean altitudes, and paramo (Eisenberg & Redford, 1999; Harding & Dragoo, 2012; Larivière & Jennings, 2009; Solari et al., 2013; Tirira, 2008, 2017). Its confirmed altitudinal range extends from 1100 to 4220 m (Escobar-Lasso & Gil-Fernández, 2014; Palacios et al., 2014; Tirira, 2007, 2017).

Despite its wide distribution on the continent, there are no records of the species in the Chocó ecoregion between the Panama Canal Zone and the Pacific tropical forest of Colombia (GBIF, 2023; Helgen & Reid, 2016; iNaturalist, 2023; Navarro et al., 2005); also, there are no records in northwestern Peru within the Tumbesian ecoregion (Helgen & Reid, 2016; Larivière & Jennings, 2009).

In western Ecuador, some records of *N. frenata* exist, mainly from dry forests that range from 70 to 1014 m in altitude (iNaturalist, 2023; Parker III & Carr, 1992; Tirira, 2022; Tirira & Azurduy Högström, 2011), but some of these records are questionable or unconfirmed (Table 1, Figure 1). Four records have been reported in locations below 800 m (Parker III & Carr, 1992): Manta Real (Cañar province), Cerro Blanco (Guayas), Jauneche (Los Ríos), and Cerro Pata de Pájaro (Manabí). These records, however, are secondhand accounts from local inhabitants and do not include direct observations or voucher specimens. A museum specimen is preserved at the Goteborg Natural History Museum in Sweden, collected in 1924 at "Santo Domingo de los Colorados (1,625 feet [495 m])" (Tirira & Azurduy Högström, 2011).

Other additional museum specimens from western Ecuador were captured at sites in the province of Loja: Alamor, at an elevation of 1014 m (AMNH 60509), and Huanchi (also Guainche o Huainche), between Alamor and Celica, at 975 m (AMNH 61406). These specimens were collected in 1920 and 1921, respectively. Another museum specimen was reported from Guayaquil, at an elevation of 10 m (Guayas province; USNM 270408), but the record does not include the name of the collector or the date of collection. Due to their historical ages and incomplete collection data, the provenance of these museum specimens cannot be confirmed.

Table 1. Records of *Neogale frenata* in western Ecuador, in chronological order.

Year	Province: Locality [number in Figure 2]	Coordinates, altitude	Comments	Source
Unknown	Guayas: Guayaquil [1]	02°10’58” S, 79°54’28” W, 10 m	Provenance of voucher doubtful	USNM 270408 (USNM museum catalogue; GBIF, 2023)
1920	Loja: Alamor [2]	04°01’32” S, 80°02’21” W, 1014 m	Historical record	AMNH 60509 (AMNH museum catalogue; GBIF, 2023)
1921	Loja: Huanchi, between Alamor and Celica [3]	04°02’14” S, 79°59’18” W, 975 m	Historical record	AMNH 61406 (AMNH museum catalogue; GBIF, 2023)
1924	Santo Domingo de los Tsáchilas: Santo Domingo de los Colorados [4]	00°14’18” S, 79°08’46” W, 495 m	Historical record	GNM 1649 (Tirira & Azurduy Högström, 2011)
1992	Cañar: Manta Real [5]	02°33’56” S, 79°21’13” W, 670 m	Information provided by local inhabitants	Parker & Carr (1992)
1992	Guayas: Cerro Blanco [6]	02°09’19” S, 80°01’43” W, 405 m	Information provided by local inhabitants	Parker & Carr (1992)
1992	Los Ríos: Jauneche [7]	01°14’54” S, 79°39’19” W, 70 m	Information provided by local inhabitants	Parker & Carr (1992)
1992	Manabí: Cerro Pata de Pájaro [8]	00°00’59” N, 79°58’35” W, 725 m	Information provided by local inhabitants	Parker & Carr (1992)
2017	Esmeraldas: Bilsa Biological Station [red star]	00°20’48” S, 79°42’42” W, 512 m	First confirmed record in the tropical rainforest	This report
2018	Imbabura, Parambas [9]	00°49’01” S, 79°20’09” W, 780 m	Confirmed record	iNaturalist (2023)

In 2018, a roadkill specimen was reported on the Ibarra-San Lorenzo highway, near Parambas in the province of Imbabura (780 m in altitude) (iNaturalist, 2023). This is the most recent record and the first that confirms the presence of the species in a tropical climate zone west of the South American Andes, although the ecological conditions of the zone correspond to an ecotone between the Chocó ecoregion and the inter-Andean dry valleys (MAE, 2013).

For these reasons, the status of *N. frenata* in the western lowlands of Ecuador is uncertain, and some distribution maps and analyses exclude coastal Ecuador in the distribution of the species (e.g., Eisenberg & Redford, 1999; Helgen & Reid, 2016; Larivière & Jennings, 2009; Tirira, 1999, 2007).

From July 2016 to May 2018, we conducted research to determine the species that feed on the fruits of ungurahua (*Oenocarpus bataua*), a species of palm tree that occurs in the tropical rainforests of the country. This study was carried out at the Bilsa Biological Station (00°20’48” S, 79°42’42” W, 512 m a.s.l.), located in the

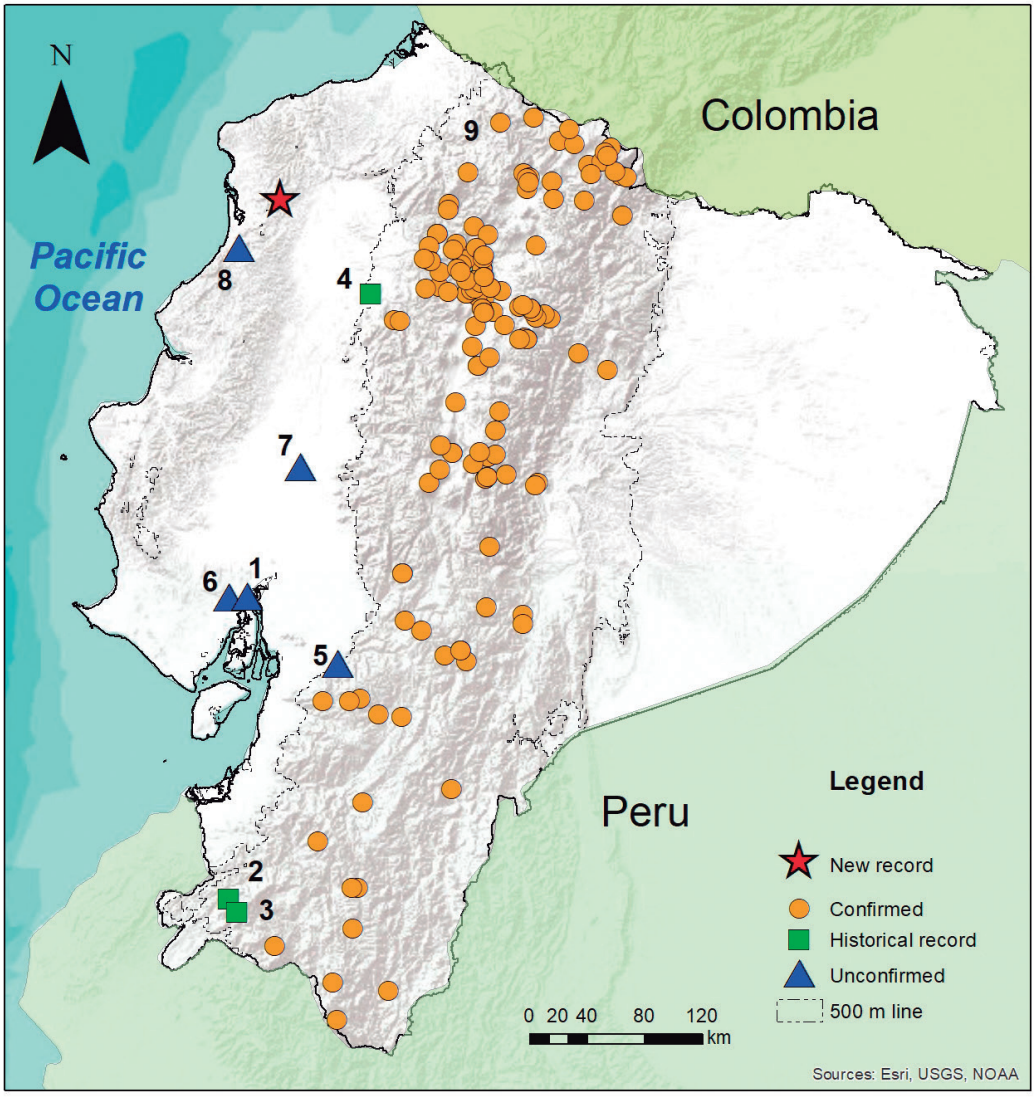

FIGURE 1. *Neogale frenata* in Ecuador. The map shows the new record reported here as well as other records in Ecuador (according to GBIF, 2023; iNaturalist, 2023; and Tirira, 2022). The corresponding numbers (1–9) are indicated in Table 1.

Mache-Chindul Ecological Reserve, on the border between the provinces of Esmeraldas and Manabí. The area corresponds to northwestern tropical rainforests (Tirira, 2017), and the main ecosystem present is the Bosque siempreverde montano bajo de Cordillera Costera del Chocó (Low montane evergreen forest of the coastal Chocó range) (Cornejo et al., 2013). The area has an average annual temperature of 22.8 °C (Hijmans et al., 2005).

In the study area, we placed a total of 151 camera traps (Strikeforce Pro, Browning Trail Cameras, Birmingham, USA) around individual *Oenocarpus bataua* palm trees; we accumulated 25,968 trap-hours (mean ± SE: 298 ± 74.2). In 22 trees, we installed cameras to capture images at ground level, and in an additional 21 trees, we installed cameras that captured images at both ground and canopy level.

Figure 2. Still image extracted from a 10-second camera-trap video taken at the Bilsa Biological Station (00°0'48" S, 79°42'42" W, 512 m), located in the Mache-Chindul Ecological Reserve in the northwestern Ecuadorian province of Esmeraldas.

Here, we report the first confirmed record for the *N. frenata* in the coastal lowlands of western Ecuador based on a photograph and a video (10 seconds of footage) of one individual (Figure 2) taken on 23 June 2017 at 14:33 hours. The *N. frenata* individual crossed the field of view of the camera quickly before passing out of sight.

Out of 5553 videos in which animals appear, *N. frenata* occurs in only one, suggesting either that it is rare in the area or that the camera traps fail to detect small and relatively fast-moving species due to the sensitivity of the passive infrared sensor. We recorded 24 other mammal species in this study (Appendix 1), including the mustelids *Eira barbara* (tayra) and *Galictis vittata* (greater grison).

The *N. frenata* individual at the Bilsa Biological Station was identified based on distinct morphological traits (according to Larivière & Jennings, 2009; Tirira, 2017). First, the dorsal fur of the individual was dark brown and uniform. White facial marks on the head, as well as a creamy-white chin and neck, were evident. The creamy-white underside of the head and neck gave way to a pale orange belly. The individual had a black-tipped tail that was shorter than the length of the head and body. Identification was further aided by the lack of morphologically similar species, as no other species of Neogale are predicted to inhabit the area.

The first question is whether the record corresponds to a wild specimen or an intentional introduction. To begin with, the place where it was registered is located within a large protected area (119,172 hectares; MAE, 2021) in a remote area of the country. There are reports in Ecuador stating that *N. frenata* is an aggressive species when captured and is difficult to handle (D. G. Tirira, pers. obs.), in spite of evidence suggesting that some weasels may be kept as pets in North America (WebMD Editorial Contributors, 2023). Additionally, there are no reports that this species has been detected in wildlife trafficking in Ecuador (CITES, 2022; Tirira, 2012, 2022); therefore, there is no reason to conclude that this individual is not a wild specimen.

This new report represents a significant extension of the confirmed geographical range of *N. frenata*. The nearest confirmed sighting,

120 km to the southeast and at a similar elevation, is the 1924 museum specimen from Santo Domingo de los Colorados in the province of Santo Domingo de los Tsáchilas (Tirira & Azurduy Högström, 2011). The nearest unconfirmed sighting is 40 km south, in an area of similar elevation (725 m) in the dry forests of Cerro Pata de Pájaro in the province of Manabí (Parker III & Carr, 1992).

This new record is the first confirmed record in the province of Esmeraldas, a transition zone between the Tumbesian and Chocó ecoregions (Parker III & Carr, 1992). These ecoregions belong to the Tumbes-Chocó-Magdalena corridor, which extends from the Panama Canal Zone and the Pacific coast of Colombia to the lowlands of southwestern Ecuador and northwestern Peru (Rodríguez-Mahecha et al., 2004). Its estimated area exceeds 100,000 km^2, of which less than 20% lies within Ecuador, including lowland and montane forests of the western foothills of the Andes (Myers et al., 2000). The Tumbes-Chocó-Magdalena corridor is a hotspot characterized by high biological diversity and endemism (Myers et al., 2000) but threatened by anthropogenic pressures, particularly in Ecuador where 98% of the original forest cover has been removed (Rodríguez-Mahecha et al., 2004).

As a result of its large distribution and apparently stable populations across its range, *N. frenata* was listed as Least Concern by the IUCN Red List (Helgen & Reid, 2016) and the *Libro Rojo de los mamíferos del Ecuador* [*Red Book of Mammals of Ecuador*] (Tirira, 2021). While *N. frenata* is tolerant of moderate human disturbance (King, 1990), populations of small carnivores can fluctuate and may become locally extirpated due to reduced prey numbers and the introduction of exotic predators (Zapata Ríos & Branch, 2016). This species may be sensitive to agriculturally-induced habitat fragmentation, indicating the importance of maintaining landscape connectivity for its populations (Gehring & Swihart, 2004). Additionally, *N. frenata* faces persecution since it preys on poultry, with individuals killing entire flocks, a phenomenon known as surplus killing (Tirira, 2017). Road mortality is also a significant threat to *N. frenata* (R. Benavides in iNaturalist, 2023; R. Cisneros-Vidal and D. G. Tirira, pers. obs.).

In Ecuador, *N. frenata* has been found in some high-elevation protected areas: Cajas, Cayambe-Coca, Cotacachi-Cayapas, Cotopaxi, Llanganates, Podocarpus, and Sumaco-Napo Galeras national parks; and the El Ángel Ecological Reserve (Tirira, 2017).

Other camera-trap studies have noted that species with short limbs and slender, low-to-the-ground bodies make detection difficult (Hackett IV, 2008; Hodge & Arbogast, 2016; Jiménez et al., 2010; O'connell et al., 2006), as in the case of *N. frenata*. However, due to habitat loss in the coastal lowlands of Ecuador (Dodson & Gentry, 1991), it is unlikely that *N. frenata* has a stable population.

The question that remains is whether there are small populations of *N. frenata* in western Ecuador as a result of recent colonization or if the documented records correspond to a much longer occupation in the region. Future surveys of *N. frenata* populations in the lower elevations west of the Ecuadorian Andes are necessary in addition to genetic analysis of museum samples (Table 1), thereby obtaining better information about this species in western Ecuador and, if applicable, prioritizing conservation efforts.

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Authors' contributions: KN: fieldwork and data analysis. DT: database with Ecuadorian records and map. All authors contributed to the conceptualization of the manuscript and its writing.

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Orcid:
KN https://orcid.org/0000-0002-1164-6822
JK https://orcid.org/0000-0001-8201-9992
DT https://orcid.org/0000-0002-5344-6175

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Appendix 1

Mammal species captured with camera traps at Bilsa Biological Station, Ecuador

Scientific name	Common name	Sightings	Percentage
Undetermined	Rodents	1385	24.9
Dasypus novemcinctus	Nine-banded Armadillo	1028	18.5
Syntheosciurus granatensis	Red-tailed Squirrel	675	12.2
Nasua nasua	South American Coati	458	8.2
Cuniculus paca	Lowland Paca	416	7.5
Dasyprocta punctata	Central American Agouti	260	4.7
Dicotyles tajacu	Collared Peccary	136	2.4
Proechimys semispinosus	Tomes' Spiny Rat	136	2.4
Didelphis marsupialis	Common Opossum	100	1.8
Potos flavus	Kinkajou	84	1.5
Metachirus myosuros	Temminck's Brown Four-eyed Opossum	82	1.5
Tamandua mexicana	Northern Tamandua	19	0.3
Leopardus wiedii	Margay	11	0.2
Eira barbara	Tayra	7	0.1
Leopardus pardalis	Ocelot	6	0.1
Mazama gualea	Gualea Red Brocket	5	0.1
Herpailurus yagouaroundi	Jaguarundi	3	0.1
Canis familiaris	Domesticated Dog	1	0.0
Procyon cancrivorus	Crab-eating Raccoon	1	0.0
Galictis vittata	Greater Grison	1	0.0
Neogale frenata	Long-tailed Weasel	1	0.0
Undetermined	Bat	1	0.0
Other records	Birds, reptiles, and others undetermined	737	13.3
	Total records	5553	100.0