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It is here: new records and range extension of *Hemidactylus frenatus* (Duméril & Bibron, 1836) (Squamata, Gekkonidae) in the Cordillera Oriental, Boyacá, Colombia

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Abstract. *Hemidactylus frenatus* (Duméril & Bibron, 1836) is an invasive lizard distributed across Europe, Africa, and the Americas. In Colombia, it occupies over 70% of the territory in lowlands and mid-elevation areas, with only one record above 2,500 m above sea level (a.s.l). We provide two new records at 2,800 m a.s.l. which expand the distribution of *H. frenatus* in the Cordillera Occidental of Boyacá, Colombia. These records are the highest in the Neotropics. We discuss the importance of monitoring invasions and the effects of a warming climate in high-mountain ecosystems.

Key words. Andes, biological invasion, distributional expansion, geckos, climate change.

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Introduction

The genus *Hemidactylus* Gray, 1825 comprises 199 species worldwide (Uetz et al. 2025) and is mainly distributed throughout the Indo-Pacific region of Asia (Carranza and Arnold 2006). Several species within this genus have become invasive, largely because of anthropogenic dispersal mechanisms associated with global trade and human settlement (Vences et al. 2004; Caicedo 2019). In Colombia, *Hemidactylus* represents the most prominent invasive genus of lizards, currently with six species recorded from the country: *H. angulatus* Hallowell, 1854, *H. brookii* Gray, 1845, *H. frenatus* Duméril & Bibron, 1836, *H. garnotii* Duméril & Bibron, 1836, *H. mabouia* (Moreau de Jonnès, 1818), and *H. palaichthus* Kluge, 1969 (Vásquez and Lapwong 2018; Uetz et al. 2025). Among them, *H. frenatus*, native to Asia and the Indo-Pacific region, is the most widespread species, with 524 occurrence records in lowland and mid-elevation areas of Colombia, including the Caribbean, Pacific, Andean, Orinoquia, and Amazon regions (GBIF 2025). The first record of *H. frenatus* in the Andean region was reported from the municipality of Puerto Boyacá, at approximately 300 m above sea level (a.s.l.), in the basin of the middle Magdalena River (Castaño 2000); however, the year of introduction and the source population remain unknown. Subsequent records indicate a rapid expansion into the Caribbean, Pacific, Amazonian, and Llanos Orientales lowlands (Henao et al. 2021). As documented for other invasive reptiles, *H. frenatus* can displace native geckos such as *Thecadactylus rapicauda* (Houttuyn, 1782) and *Gonatodes albogularis* (Duméril & Bibron, 1836), as well as other invasive congeners (*H. angulatus*, *H. brookii*, and *H. mabouia*), primarily through competitive interference (Caicedo and Dulcey 2011).

Globally, records of *H. frenatus* are mostly restricted to elevations between 0 and 1,500 m a.s.l. (GBIF 2025), where the species exhibits high versatility in performing metabolic functions such as thermoregulation, feeding, and reproduction (Abarca 2006). Like other members of the genus, it is characterized by a strong adaptive capacity to diverse environments (Torres 2015) and prefers anthropogenic substrates, such as walls and ceilings, where it feeds on a wide variety of arthropods (Villegas et al. 2016). Additionally, it has a high reproductive capacity, laying up to eight eggs every two months (Caicedo and Dulcey 2011); this could be important in outcompeting native lizard species and its effective invasion of new territory.

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In high-mountain areas above 2,500 m a.s.l., records of representatives of the superfamily Gekkota, including species of the genus *Hemidactylus*, are scarce or absent (Jamal et al. 2018), since typical climatic conditions in high-mountain ecosystems are a limiting factor for the thermoregulatory processes of lizards (Pafilis et al. 2024). In high-mountain ecosystems at 2,600–3,600 m a.s.l., such as páramos, high Andean, and sub-Andean forests, reptiles exhibit moderate diversity, represented by the families Gymnophthalmidae, Sphaerodactylidae, Dactyloidae, and Tropiduridae (Henao et al. 2021). However, the expansion of Andean cities in Colombia has led to urban warming and large-scale transport of industrial materials, which are key in the spread of *H. frenatus* (Caicedo and Dulcey 2011). In these high-Andean urban environments, only one incidental record of this species exists, from Tocancipá, Cundinamarca, at 2,600 m a.s.l. (Caicedo and Dulcey 2011).

We report three new high-Andean records of *H. frenatus* in the city of Tunja, from elevations above 2,800 m a.s.l. Two of these records are based on juvenile individuals: one found dead in the urban centre of the city and another thought to be in transit, as it was recorded on a moving bus. The third record is of an adult specimen collected in an urban area of Tunja. We discuss and hypothesize the role of urban growth and climate warming in high-mountain areas of Colombia in facilitating the dispersal and subsequent invasion of *H. frenatus* into new areas.

Methods

We obtained records of *Hemidactylus frenatus* in urban areas of Tunja, Boyacá Department (Figure 1). One individual was recorded on a pedestrian bridge, whereas another was found among debris located near human dwellings. Collected specimens were fixed in 10% formaldehyde, preserved in 70%

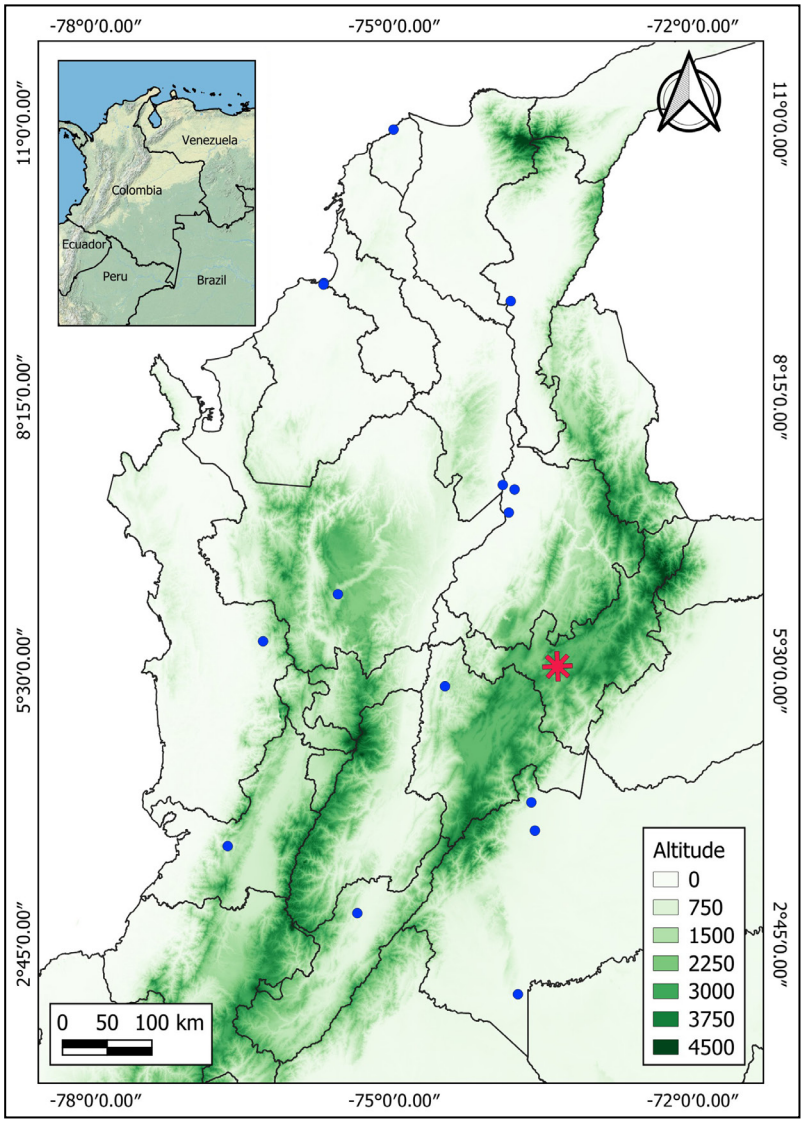

Figure 1. Distribution map of *Hemidactylus frenatus* in the Eastern Cordillera of the Andes. Yellow points represent observation records, blue points represent specimen records from biological collections, and the red point indicates the new record from Tunja, Boyacá, Colombia.

ethanol, and deposited in the Reptile Collection of the Luis Gonzalo Andrade Natural History Museum at the Universidad Pedagógica y Tecnológica de Colombia (UPTC-RE), Tunja, Boyacá, Colombia. We generated an updated distribution map of *Hemidactylus frenatus* in the Cordillera Orientale by combining our new records with occurrence data retrieved from GBIF (2023). All GBIF records were carefully curated, and only those with reliable species-level identifications were retained, excluding records with taxonomic uncertainty or insufficient metadata (Table 1). Specimens were identified based on morphological traits following Krysko and Daniels (2005) and Vásquez and Lapwong (2018). Included diagnostic traits are the extension of subdigital lamellae on the fourth toe (extending to the base in *H. frenatus*), the shape and arrangement of the second pair of mental shields, the form and distribution of dorsal scales, the femoral pore pattern, and the tail scalation pattern, as well as several other morphological characters (Table 2).

Table 1. Records, localities, and geographic coordinates of *Hemidactylus frenatus* in Colombia, with voucher specimens deposited in biological collections and accessed through GBIF (2023).

Catalogue number	Department	Municipality	Elevation (m)	Latitude	Longitude	Identifier
IAvH-R-9448	Meta	Puerto Gaitán	202	03°51′46.58″N	071°36′00.02″W	Daniela García-Cobos
IAvH-R-9495	Meta	Acacías	366	03°53′37.68″N	073°35′13.96″W	Daniela García-Cobos
IAvH-R-9583	Bolívar	Cantagallo	62	07°22′2.72″N	073°54′36.05″W	Daniela García-Cobos
IAvH-R-8272	Valle del Cauca	Dagua	888	03°44′14.28″N	076°40′27.84″W	C. Guerrero
IAvH-R-9321	Huila	Neiva	510	03°03′50.02″N	075°22′18.33″W	Daniela García-Cobos
IAvH-R-9862	Córdoba	San Antero	27	09°23′46.03″N	075°42′28.51″W	Daniela García-Cobos
IAvH-R-9870	Córdoba	San Antero	58	09°22′49.98″N	075°42′42.62″W	Daniela García-Cobos
IAvH-R-8548	Casanare	Paz de Ariporo	113	05°37′14.53″N	070°42′24.95″W	Argelina Blanco-Torres
IAvH-R-8660	Antioquia	Medellín	1459	06°16′10.00″N	075°34′00.02″W	Andrés-Rymel Acosta-Galvis
IAvH-R-9629	Santander	Barrancabermeja	78	07°05′23.50″N	073°50′57.80″W	Daniela García-Cobos
IAvH-R-9762	Santander	Puerto Wilches	109	07°19′19.09″N	073°47′29.62″W	Leonardo Niño-Cárdenas
IAvH-R-7602	Atlántico	Tubará	174	10°56′19.92″N	075°00′27.67″W	Nestor-Orlando Nonzoque
IAvH-R-7748	Cesar	Chimichagua	27	09°12′51.00″N	073°49′49.00″W	Azarys Paternina-Hernández
UTCH:COLZOOCH-H:2051	Chocó	El Carmen de Atrato	728	05°47′48.00″N	076°19′08.00″W	Vanessa Mosquera Moya
MHNU-H:313	Meta	Villavicencio	426	04°10′38.80″N	073°37′22.70″W	Jorge A. Astwood
UIS-MHN-R-4131	Cundinamarca	Caparrapí	1252	05°20′37.47″N	074°29′26.29″W	Rances Caicedo
IAvH-R-08779	Meta	La Macarena	223	02°14′55.21″N	073°45′27.54″W	Lucas S. Barrientos

Table 2. Meristic data of *Hemidactylus frenatus* specimens (UPTC-RE01629 and UPTC-RE01748) from the Cordillera Occidentale, Boyacá, Colombia.

Character	UPTC-RE01629	UPTC-RE01748
Sex	♀	♀
Snout–vent length	39.97	21.31
Tail length	40.21	18.24
Head length	9.08	4.58
Head width	8.49	4.53
Obital diameter	2.55	1.87
Distance between naris	4.44	2.09
Snout–eye distance	5.50	2.50
Eye–ear distance	3.94	1.84
Ear length	0.94	0.67
Interorbital distance	4.54	2.13
Number of supralabials	11	13
Number of infralabials	9	9
Postmental scales	2	2
Expanded subdigital lamellae on 4th toe	10	10
Scales between eye and nostril	17	16
Interorbital scales	42	30
Femoral pores (males)	NA	NA
Ventral scale rows across belly	29	24
Dorsal tubercles	Projecting	Projecting
Ventral scales	Smooth	Smooth
Tail spines	Projecting	Projecting

Figure 2. Specimen of *Hemidactylus frenatus* collected in the high mountain zone of the Eastern Cordillera of the Andes, municipality of Tunja, Boyacá, Colombia (UPTC-RE01629). Scale bar: 10 mm.

Results

***Hemidactylus frenatus* Duméril & Bibron, 1836**

Figure 2

New records. COLOMBIA — **Boyacá** • Tunja, San Rafael neighbourhood; 05°32'38.58"N, 073°21' 27.27"W; 2,702 m a.s.l; 15 Jul. 2023; Óscar Morales leg; 1 juvenile ♂, UPTC-RE01629 • Tunja, Santa Inés neighbourhood; 05°33'5.94"N, 073°21'8.15"W; 2,687 m a.s.l; 22 Aug. 2021; Juan E. Carvajal leg; 1 juvenile ♂, UPTC-RE01748.

Identification. The collected specimens conform to the general description of the species (Duméril and Bibron 1836) and are characterized as follows: dorsal surface of the head with small granular scales and occasionally flat tubercles in the parietal and temporal regions; four small shields fused with the labial plates (Figure 2), two on each side, covering the anterior end of the lower jaw; presence of tubercles in the parietal and temporal regions; 9–12 supralabials and 7–10 infralabials; body covered with small granular scales along with scattered, flat, rounded tubercles; ventral scales larger, flat, and overlapping; limbs well developed, each with oblong digital pads; lamellae of the pads rectangular, medially divided except for the terminal one; subdigital lamellae numbering 8–11 and extending to the base of the fourth toe; 26 femoral pores arranged in a single row; and small semicircular spines on the dorsal part of the tail.

Discussion

Hemidactylus frenatus was first reported in Colombia by Castaño (2000). Subsequently, Caicedo and Dulcey (2011) suggested that the species may have entered the country earlier than this initial record, as its first detection did not occur in port areas or near international borders, which are commonly associated with introductions of non-native reptiles. Although the precise introduction pathway remains uncertain, several non-exclusive explanations can be proposed, including an early, undetected introduction through inland commercial routes, passive transport associated with construction materials or household goods, or secondary dispersal from previously established populations within the region. Additionally, the species' nocturnal and synanthropic habits may have facilitated its persistence at low densities prior to detection, delaying its initial documentation. Together, these factors suggest that the current distribution of *H. frenatus* in Colombia likely reflects a combination of cryptic early establishment and subsequent human-mediated expansion rather than a single, well-defined introduction event. Currently, its distribution in Colombia is strongly biased toward lowland areas, with 85.6% of records occurring between 0 and 1,000 m a.s.l., followed by mid-elevations (11.2%; >1,000–1,800 m a.s.l.), the Andean region (2.9%; >1,800–2,500 m a.s.l.), and the high-Andean region (0.3%; >2,500–4,000 m a.s.l.). Overall, the number of records has increased in recent years across the country. This pattern closely resembles that documented in Asia, where the species expanded rapidly and early, to the extent that its native range and colonization routes into the Americas remain uncertain (Torres 2015).

The increasing number of *H. frenatus* records over time suggests that this invasive species has expanded into areas different from those previously documented. Its occurrence in the high mountain zone of the Eastern Cordillera, between 2,700 and 2,850 m a.s.l., complements the earlier record reported by Caicedo and Dulcey (2011) in Tocancipá, Cundinamarca, at 2,600 m a.s.l. Although native lizard species are present at these elevations, they generally occupy natural habitats and do not exploit anthropic or artificial structures, which constitute the primary microhabitats used by *H. frenatus*. Consequently, the colonization of these high-Andean environments may reflect the occupation of a vacant or weakly competed synanthropic niche rather than the displacement of native taxa.

Although current records remain sporadic and spatially scattered, they may indicate the early stages of invasion in high-Andean urban systems and thus represent an early warning of potential biological invasion in these areas. Consistent with the introduction pathways discussed above, the location of high-elevation records suggests that dispersal may be facilitated by motor vehicles and inland transport routes. For instance, the record documented by Caicedo and Dulcey (2011) was obtained at a brewery facility, pointing to introduction via freight trucks, whereas near the city of Tunja, we observed a juvenile individual on the window of a bus. Finally, the absence of individuals within human constructions in the new records suggests that the species may currently be in a dispersal phase, without evidence of established populations at these elevations.

The colonization of high-Andean environments implies physiological challenges related to thermoregulation in ectothermic organisms (Vitt and Caldwell 2013), given the low ambient temperatures that constrain activity in heliothermic and thigmothermic lizards (Valdecantos et al. 2013). This raises questions regarding the physiological versatility of *H. frenatus*, including its capacity to maintain body temperature, adjust periods of activity, expand limits of thermal tolerance, and acclimatize to lower temperatures. Moreover, high-Andean cities in Colombia, such as Tunja, are projected to experience an increase in mean annual temperature of approximately 1.4 °C by 2040 (IDEAM 2010). In this context, rising temperatures may facilitate the colonization, persistence, and recruitment of *H. frenatus* in high-mountain urban environments. Consequently, systematic monitoring of synanthropic reptiles in Andean cities is strongly recommended, as early detection in these climatically sensitive systems may provide a critical opportunity to document invasion dynamics, assess establishment stages, and inform timely management and prevention strategies.

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Additional information

Conflict of interest

The authors declare that no competing interests exist.

Ethical statement

No ethical statement is reported.

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Author contributions

Conceptualization: DAP-R, GSL-M, JEC-C. Data curation: DAP-R, GSL-M, JEC-C. Formal analysis: DAP-R, GSL-M, JEC-C. Investigation: DAP-R, GSL-M, JEC-C. Visualization: DAP-R, GSL-M. Writing – original draft: DAP-R, GSL-M, JEC-C. Writing – review and editing DAP-R, JEC-C.

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Data availability
All data that support the findings of this study are available in the main text.

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