

BIODIVERSITY MONITORING IN THE MIEL I HYDROELECTRIC POWER PLANT, MIDDLE MAGDALENA RIVER VALLEY, CALDAS, COLOMBIA: A CHECKLIST OF AMPHIBIANS AND REPTILES

MONITOREO DE LA BIODIVERSIDAD EN LA CENTRAL HIDROELÉCTRICA MIEL I, VALLE MEDIO DEL RÍO MAGDALENA, CALDAS, COLOMBIA: LISTADO DE ANFIBIOS Y REPTILES

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Resumen.— Este estudio presenta una lista de anfibios y reptiles recopilada durante el monitoreo de fauna silvestre implementado por ISAGEN entre 2014 y 2022 en las áreas de influencia de la Central Hidroeléctrica Miel I. Se registra un total de 109 especies (39 anfibios y 70 reptiles), incluyendo 15 especies endémicas de Colombia y cinco especies amenazadas. Las actividades de reforestación y la delimitación de áreas intangibles, junto con la consecuente recuperación de la conectividad estructural entre los bosques de la Central Hidroeléctrica Miel I, han permitido que la herpetofauna sea muy diversa y han convertido a la cuenca Media del río Manso en un área de gran importancia para la conservación de la biodiversidad endémica y amenazada.

Palabras clave.— Anfibios, biodiversidad amenazada, especies endémicas, monitoreo biológico, reptiles.

Abstract.— This study presents a list of amphibians and reptiles compiled during wildlife monitoring implemented by ISAGEN between 2014 and 2022 in the areas of influence of the Miel I Hydroelectric Power Plant. We display a list of 109 species (39 amphibians and 70 reptiles), including 15 endemic species from Colombia and five threatened species. The reforestation activities and delimitation of intangible areas, with the consequent recovery of structural connectivity between the forests of the Miel I Hydroelectric Power Plant, have allowed the herpetofauna to be very diverse and make the Middle Manso River basin an area of great importance for the conservation of endemic and threatened biodiversity.

Keywords.— Amphibians, biological monitoring, endemic species, reptiles, threatened biodiversity.

INTRODUCTION

The inter-Andean valley of the Magdalena River is an important area of Colombia from the historical, cultural, and ecological perspectives (Mancera-Rodríguez & Rodríguez-Sánchez, 2002; Fernández-Méndez et al., 2013). This valley crosses Colombia from south to north, encompassing a variety of ecoregions from Caribbean mangroves, montane forests, and xeric shrubs to dry

and moist forests (Olson et al., 2001). The middle Magdalena valley (MMRV from this point forward) is composed of lowland and sub-montane ecosystems (Fernández-Méndez et al., 2013). Among the lowland ecosystems, the region has moist forests to the north and dry forests to the south, the reason why the middle part of that area is an ecotone between those types of forests

(Olson et al., 2001; Fernández-Méndez et al., 2013). Among the montane ecosystems of the middle Magdalena valley, it is important to highlight that between 500–1000 m a.s.l. is located the Magdalena sub-Andean Forest (Rodríguez et al., 2006). This area is a transition (ecotone) between the sub-Andean and the lowland ecosystems of the Magdalena valley (Olson et al., 2001; Fernández-Méndez et al., 2013).

In some localities of the MMRV, different studies have been carried out focused on the knowledge of the taxonomic diversity of amphibians (e.g., Acosta-Galvis & Restrepo, 2001; Acosta-Galvis et al., 2006; Acosta-Galvis et al., 2019; Grant et al., 2006, 2007; Gutiérrez & Rivera, 2007; Jiménez et al., 2013; Ospina-Sarria et al., 2015) and reptiles (e.g., Moreno-Arias et al., 2008; Velasco & Hurtado-Gómez, 2014; Rojas-Morales et al., 2018, 2019), but very few studies have focused on habitat degradation and how species respond to their possible spatial variation according to the types of habitat in which they are found (Díaz-Ayala & Zuluaga-Isaza, 2015; Burbano et al., 2016; Vargas-Salinas & Aponte-Gutiérrez, 2016; Duarte-Marín et al., 2018). 135 spp (Arias-Monsalve et al. 2026) species of amphibians are reported in the department of Caldas, representing 14.8 % of the richness known to Colombia, being the eastern region of this department the one that registers the highest concentration of species, near the municipalities of Norcasia, Samaná and Victoria (Lynch & Rueda-Almonacid, 1997; Ruiz-Carranza & Lynch, 1997; Lynch & Rueda-Almonacid, 1998, 1999; Rueda-Almonacid, 2000; Acosta-Galvis, 2009; Ramírez-Chaves et al., 2021).

For many years, the MMRV has settled important megaprojects of oil exploitation, mega-mining, damming rivers for hydroelectric power plants, and even fracking pilot projects (Palacios-Sierra, 2013; UPME, 2013). One of them is the Amani reservoir formed by the damming of the rivers La Miel, Moro and the Santa Bárbara creek, the project covers about 3000 ha, its construction began in 1996 and ended in the year 2000. The reservoir is 58 km long and contains 571 million cubic meters of water, thus generating 396 MWh of energy that goes to the national energy system. Since 2010, the power plant has had the Guarinó diversion dam in commercial operation, which increased the generation capacity of the Power Plant by 308 GWh/yr. In 2013, the operation of the Manso diversion dam began, increasing the capacity of the Power Plant by 104 GWh/yr.

Environmental legislation in Colombia through Decree 1180 of 2003 of Law 99 of 1993, requires that infrastructure projects such as those above mentioned have to do a detailed set of activities that are aimed to prevent, mitigate, correct or compensate the negative environmental impacts that are caused

by the development of a project (MADS, 2003; UPME, 2013). To achieve the above, the infrastructure projects in Colombia have to design and implement an environmental management plan, which allows the execution of conservation, restoration and monitoring programs of biodiversity in the affected areas of the projects (MADS, 2003; UPME, 2013). Due to limited knowledge about the richness, composition and distribution of wildlife species in many parts of Colombia and the scarcity of economic resources to support the research (Samper, 1997; Rangel, 2005; Arbeláez-Cortés, 2013) the information collected during the execution of the environmental management plans of any infrastructure project is an excellent opportunity not only to achieve that such project could be implemented in a sustainable way but also to fill the knowledge gaps about the wildlife that inhabit in Colombia. Therefore, the aims of this work are (A) to describe the composition and richness of amphibians and reptiles that inhabit the influence area of the Miel I hydroelectric power plant; (B) to disclose and discuss new information about the distribution range of six species of amphibians and reptiles that inhabit the area: *Hyalinobatrachium aureoguttatum*, *Teratohyla pulverata*, *Oedipina* sp., *Epicrionops parkerii*, *Atractus obtusirostris* and *Corallus batesii*; (C) to provide conservation measures at the local level for the protection of the herpetofauna and their habitat in the area, (D) and finally to provide a detailed photo guide of the amphibians and reptiles of the area.

MATERIAL AND METHODS

Study area. The fieldwork was carried out in the area of influence of the Miel I Hydroelectric Power Plant, located in the municipalities of Norcasia and Samaná, department of Caldas, on the eastern slope of the Central Andes of Colombia, between 460-900 m a.s.l. elevation (Fig. 1 and 2A). The sites visited have an average temperature of 27 °C and precipitation between 3500 - 4000 mm per year, of a bimodal type, concentrated in the months of April-May and October-November, while the June-August period corresponds to the least rainy period (Fig. 3). This area exhibits two types of ecosystems; in the lower zone it presents humid forests of the Magdalena-Urabá and in the upper zone it presents montane forests of the Magdalena valley (Olson et al., 2001).

In general, the landscape is dominated by a matrix of early regenerating pastures (Fig. 2B) containing areas of crops (mainly avocado and cocoa) and fragments of native forest restricted to the ridges of the mountains and the adjacencies of rivers, creeks, and streams (Fig. 2C-E). In the regenerating sites, there is evidence of an interaction between native vegetation, fruit trees and pastures with high dominance of grasses (Fig. 2F).

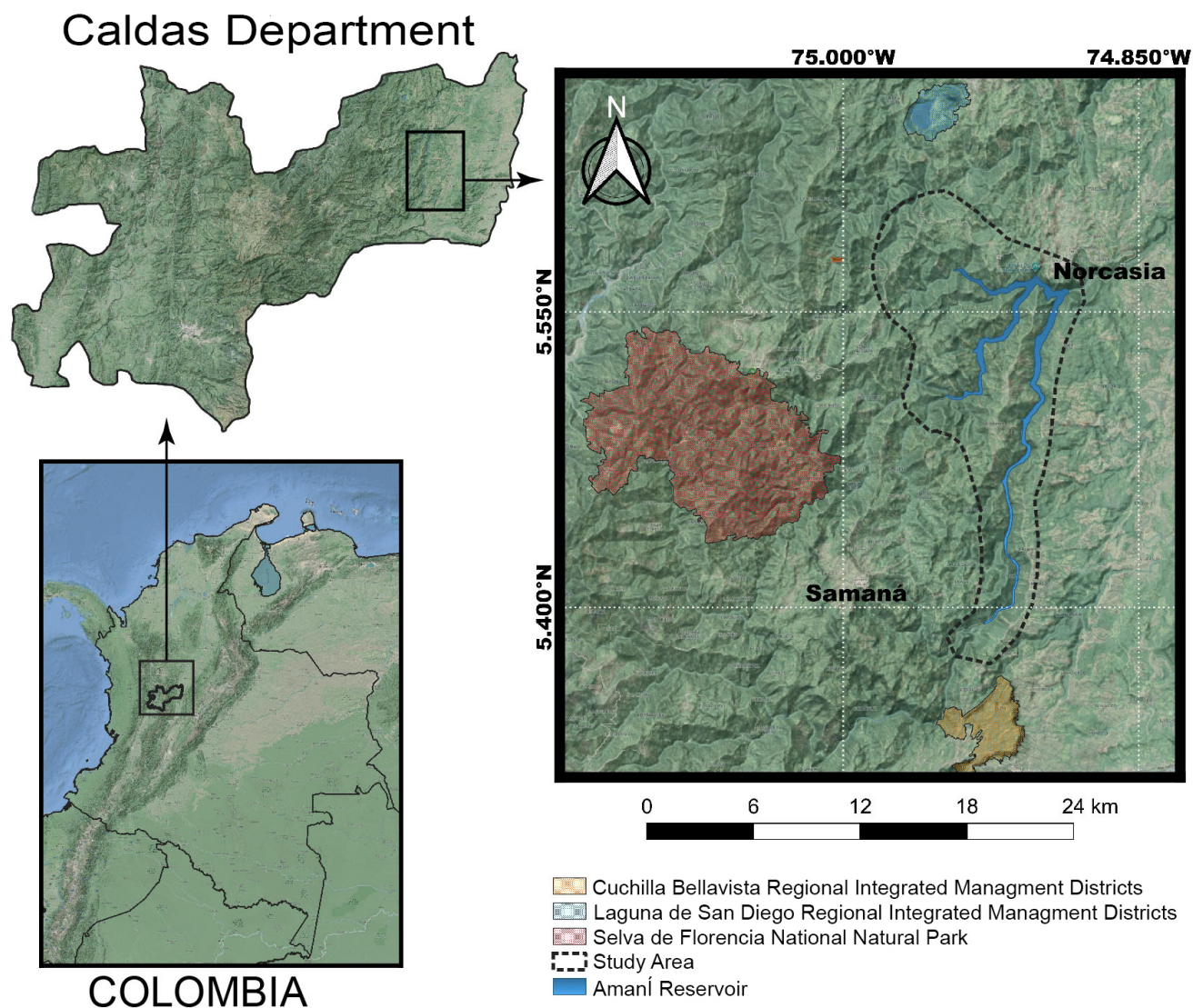


Figura 1. Ubicación del área de estudio. A la derecha, se muestra el área de influencia del embalse Amaní, y los polígonos de colores representan los Distritos Regionales de Manejo Integrado y el Parque Nacional Natural Selva de Florencia. La línea punteada indica el área donde se llevó a cabo el muestreo.

Figure 1. Location of the study area. On the right, the area of influence of the Amaní reservoir is shown and the colored polygons represent the Regional Districts of Integrated Management and the Selva de Florencia National Natural Park. The dotted line represents the area where the sampling was carried out.

The most preserved areas have a high abundance of epiphytic vegetation, terrestrial and rupicolous herbs, like Araceas (*Anthurium*, *Dracontium*, *Spathiphyllum*), orchids (*Epidendrum*, *Cynoches*, *Masdevallia*, *Sobralia* and *Odontoglossum*), bromeliads (*Aechmea*, *Guzmania*, *Pitcairnia*, *Racinaea* and *Werauia*), ferns, lianas, lichens and bryophytes (Andrade et al., 2013; Baranow,

2015). A high abundance and dominance of palms of the genera *Geonoma*, *Oenocarpus* and *Welfia* (Arecaceae), in addition to having abundant vegetation riparia belonging to the genera *Asplundia*, *Dicranopygium*, *Cyclanthus* (Cyclanthaceae), and *Costus* (Costaceae). In the interior of the forest there are rare species of vegetation that are in an advanced stage of ecological

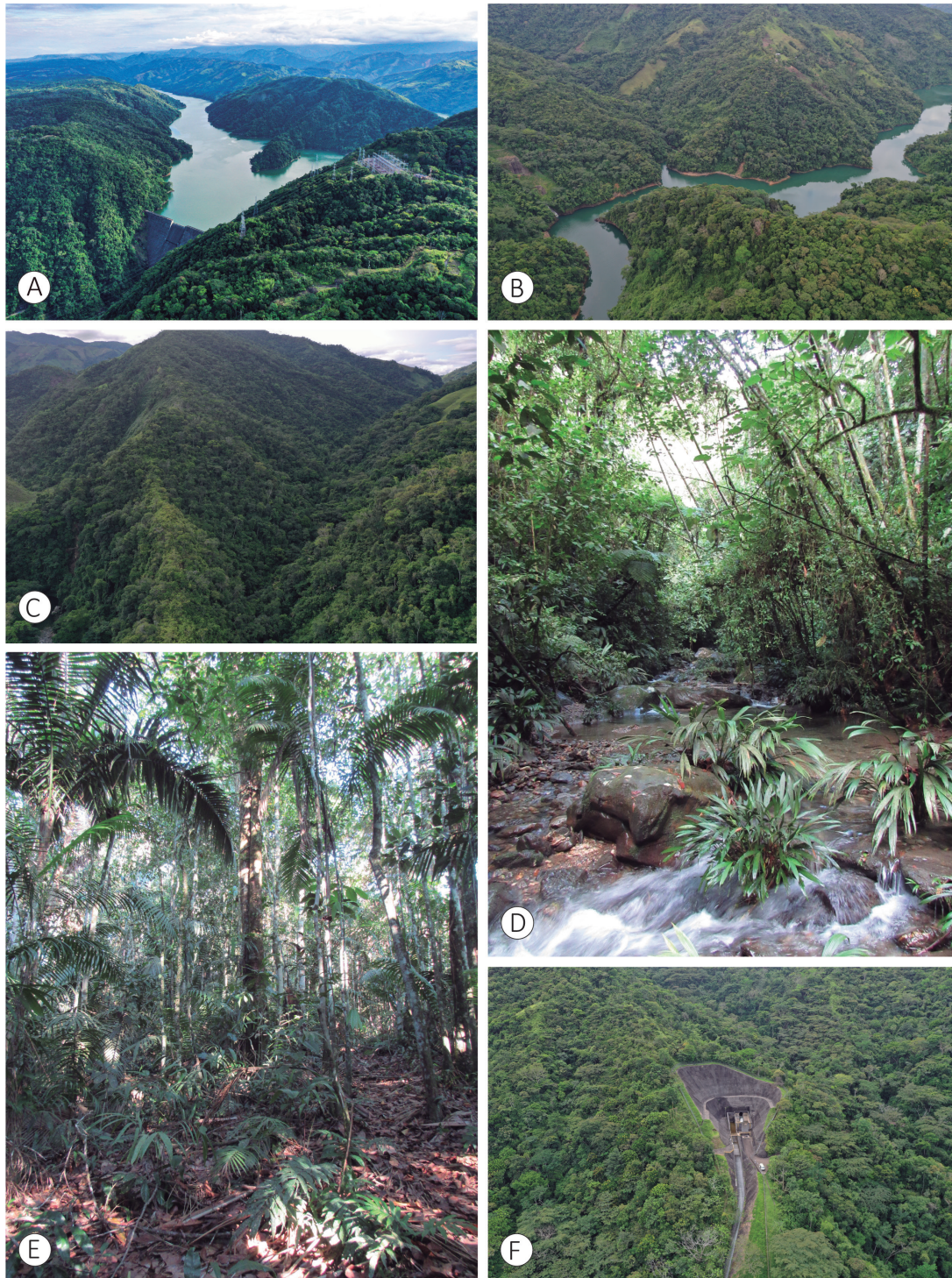


Figura 2. Ubicación del área de estudio. (A) Embalse Amani; (B) Matriz de pastizales en regeneración temprana que incluye áreas cultivadas; (C) Bosques nativos restringidos a las crestas de las montañas "Portal de entrada"; (D) Bosque conservado adyacente a una quebrada con abundante vegetación ribereña; (E) Interior de bosque maduro con especies vegetales en un estado avanzado de sucesión ecológica; (F) Sitios en regeneración "Portal de salida". Fotos: Juan Camilo Zuluaga-Isaza.

Figure 2. Location of the study area. (A) Amani Reservoir; (B) Pasture matrix in early regeneration containing cultivated areas; (C) Native forests are restricted to the crests of the mountains "Portal de entrada"; (D) Preserved forest adjacent to a creek with abundant riparian vegetation; (E) Interior of mature forest with species of vegetation in an advanced stage of ecological succession; (F) Regenerating sites "Portal de salida". Photos: Juan Camilo Zuluaga-Isaza

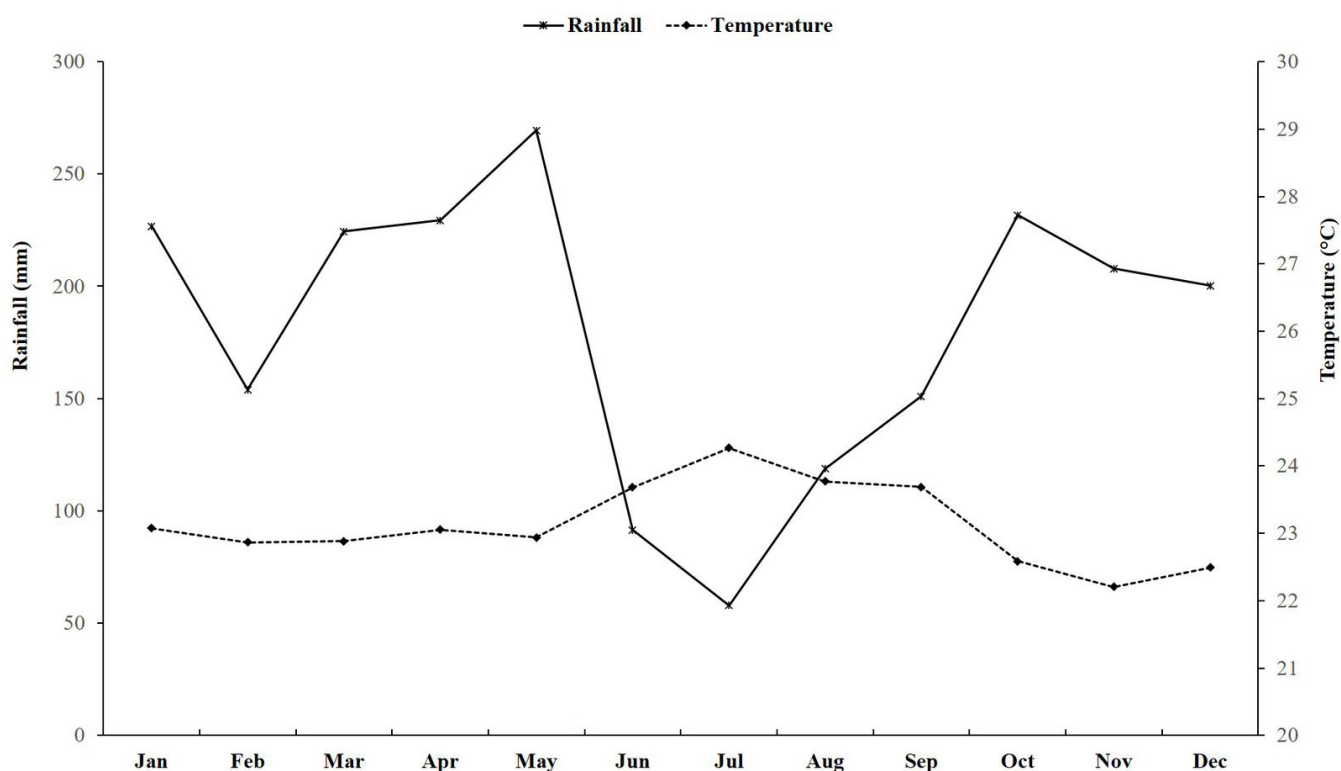


Figura 3. Diagrama climático que muestra la variación de la precipitación y la temperatura a lo largo del año para el área de estudio. Los datos se basan en los registros meteorológicos del período 2014-2019 de la estación climática Berlin, ubicada a 889 m de altitud en el municipio de Samaná, departamento de Caldas, Colombia.

Figure 3. Climate diagram showing the variation in rainfall and temperature throughout the year for the study area. The data is based on the meteorological records of the period 2014-2019 of the Berlin climate station at 889 m a.s.l., in the municipality of Samaná, department of Caldas, Colombia.

succession, such as *Annona tenuiflora* (Annonaceae), *Aniba perutilis*, *Pleurothyrium* sp. (Lauraceae) among others (Díaz-Ayala & Zuluaga-Isaza, 2015).

Collecting methods. The records presented correspond to the results of wildlife monitoring implemented by ISAGEN during the 2014-2022 period in the areas of influence of the Miel I Hydroelectric Power Plant, specifically for the transfer of the Manso River and the Amaní reservoir. To search and capture amphibians and reptiles, we carry out daytime (08:00-12:00 h) and night (18:00-22:00 h) sampling during the dry, rainy and transition seasons. Sampling consisted of active searches freely exploring the sites visited, trying to cover as many microhabitats as possible (bodies of water, vegetation, litter, rocks, soil, fallen logs, etc.) up to an approximate height of 2.5 m, being an inventory of the understory herpetofauna. Some species with cryptic habits, such as caecilians, amphisbaenians,

and fossorial snakes were recorded opportunistically during free runs, usually during or after heavy rains. At the beginning of the monitoring (2014-2017), five field trips were conducted per year, approximately every 2-3 months, while between 2018 and 2022 the frequency increased to 10 trips per year (monthly). Each field trip was conducted by three people. In total, 22 000 person-hours of sampling were invested during the eight years.

Some specimens were collected under specific criteria: species with low representation in the museum collection, individuals found dead in good condition in the field, and those with taxonomic uncertainty. Specimens were sacrificed with 2 % Roxicaine®, later fixed in 10 % formaldehyde solution and preserved in 70 % ethanol, following the protocol of Cortez et al. (2006). The collected specimens were deposited in the herpetological collection of the Natural History Museum of the University of Caldas. (MHN-UCa; Tables 1, 2). This collection was

carried out under research and specimen collection permits No. 164 of 2014 and 1166 of October 9, 2014, granted by the Regional Autonomous Corporation of Caldas (CORPOCALDAS).

The taxonomic nomenclature for amphibians and reptiles follows Frost (2023) and Uetz & Hošek (2023), respectively. To corroborate the taxonomic identifications, we reviewed the original descriptions of the species, as well as specialized taxonomic keys. For amphibians, the works of Cochran & Goin (1970); Lynch & Duellman (1997); Ruiz-Carranza & Lynch (1991, 1995, 1997) and Köhler (2011) were reviewed. For reptiles we reviewed Ayala (1986); Cadle (1992); Peters & Orejas-Miranda (1970); Perez-Santos & Moreno (1988); Kohler (2003) and Passos & Lynch (2010). Additionally, the specimens were reviewed and compared with voucher specimens from the herpetological

collection of MHN-UCa (see Appendix 1 for voucher specimens). For this list, only the collected species and/or those that have photographs of characters that allow their taxonomic identification were included. The threat status of the species followed the categories proposed in the red books of Colombia for amphibians and reptiles (Rueda-Almonacid et al., 2004; Morales Betancourt et al., 2015) and the IUCN (2021).

In order to update the information on the geographic distribution of some species that show expansions in their distribution, maps were created with the help of the QGIS © software. Records of scientific publications were used, in addition to other locations reported in the Biodiversity Information System of Colombia SIB-Colombia (SIB, 2021) and the Global Biodiversity Information Facility (GBIF, 2021) online

Tabla 1. Composición y riqueza de anfibios del bosque subandino del valle del Magdalena medio en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. Las especies consideradas endémicas del valle del río Magdalena están marcadas con una 'X'. Se muestra el estado de conservación según la UICN tanto a nivel global como a nivel nacional (Rueda-Almonacid et al., 2004; IUCN, 2021). Categorías: VU = Vulnerable, NT = Casi Amenazado, LC = Preocupación Menor.

Table 1. Composition and richness of amphibians from the sub-Andean Forest of the middle Magdalena valley in the area of influence of the Miel I Hydroelectric Power Plant, Caldas, Colombia. Species considered endemic from the Middle Magdalena River valley are marked with an 'X'. IUCN Conservation status is shown for both: a global assessment and a national assessment (Rueda-Almonacid et al., 2004; IUCN, 2021). Categories: VU = Vulnerable, NT = Near Threatened, LC = Least Concern.

| | | | Category of threat | |
|------------------------------------------------------------------------------------|---------|--------|--------------------|----------|
| Taxa | Endemic | Figure | Global | National |
| Amphibia (39) | | | | |
| Anura | | | | |
| Centrolenidae (6) | | | | |
| <i>Espadarana prosoblepon</i> (Boettger, 1892) | | 4 A-B | LC | |
| <i>Hyalinobatrachium aureoguttatum</i> (Barrera-Rodríguez and Ruiz-Carranza, 1989) | | 4 C | LC | |
| <i>Hyalinobatrachium tayatoi</i> (Castroviejo-Fisher, Ayarzagüena and Vilá, 2007) | | 4 D | LC | |
| <i>Rulyrana susatamai</i> (Ruiz-Carranza and Lynch, 1995) | X | 4 E | NT | |
| <i>Sachatamia punctulata</i> (Ruiz-Carranza and Lynch, 1995) | X | 4 F | VU | |
| <i>Teratohyla pulverata</i> (Peters, 1873) | | 4 G | LC | |
| Hylidae (8) | | | | |
| <i>Boana boans</i> (Linnaeus, 1758) | | 4 H | LC | |

Tabla 1 (Cont.). Composición y riqueza de anfibios del bosque subandino del valle del Magdalena medio en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. Las especies consideradas endémicas del valle del río Magdalena están marcadas con una 'X'. Se muestra el estado de conservación según la UICN tanto a nivel global como a nivel nacional (Rueda-Almonacid et al., 2004; IUCN, 2021). Categorías: VU = Vulnerable, NT = Casi Amenazado, LC = Preocupación Menor.

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| Taxa | Endemic | Figure | Category of threat | |
|----------------------------------------------------------------------------------------------------------------------------------------|---------|--------|--------------------|----------|
| | | | Global | National |
| <i>Boana platanera</i> (Escalona, La Marca, Castellanos, Fouquet, Crawford, Rojas-Runjac, Giaretta, Señaris, Casrroviejo-Fisher, 2021) | | 4 I | LC | |
| <i>Dendropsophus microcephalus</i> (Cope, 1886) | | 4 J | LC | |
| <i>Dendropsophus ebraccatus</i> (Cope, 1874) | | 4 K-L | LC | |
| <i>Hyloscirtus palmeri</i> (Boulenger, 1908) | | 4 M | LC | |
| <i>Scinax rostratus</i> (Peters, 1863) | | 4 N | LC | |
| <i>Scinax ruber</i> (Laurenti, 1768) | | 4 O | LC | |
| <i>Smilisca phaeota</i> (Cope, 1862) | | 4 P | LC | |
| Microhylidae (1) | | | | |
| <i>Elachistocleis pearsei</i> (Ruthven, 1914) | | 4 Q | LC | |
| Phyllomedusidae (1) | | | | |
| <i>Phyllomedusa venusta</i> Duellman and Trueb, 1967 | | 4 R | LC | |
| Leptodactylidae (5) | | | | |
| <i>Engystomops pustulosus</i> (Cope, 1864) | | 4 S-T | LC | |
| <i>Leptodactylus fragilis</i> (Brocchi, 1877) | | 4 U | LC | |
| <i>Leptodactylus fuscus</i> (Schneider, 1799) | | 4 V | LC | |
| <i>Leptodactylus pentadactylus</i> (Laurenti, 1768) | | 4 W | LC | |
| <i>Leptodactylus savagei</i> Heyer, 2005 | | 4 X | LC | |
| Aromobatidae (1) | | | | |
| <i>Rheobates palmatus</i> (Werner, 1899) | X | 4 Y | LC | |

Tabla 1 (Cont.). Composición y riqueza de anfibios del bosque subandino del valle del Magdalena medio en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. Las especies consideradas endémicas del valle del río Magdalena están marcadas con una 'X'. Se muestra el estado de conservación según la UICN tanto a nivel global como a nivel nacional (Rueda-Almonacid et al., 2004; IUCN, 2021). Categorías: VU = Vulnerable, NT = Casi Amenazado, LC = Preocupación Menor.

Table 1 (Cont.). Composition and richness of amphibians from the sub-Andean Forest of the middle Magdalena valley in the area of influence of the Miel I Hydroelectric Power Plant, Caldas, Colombia. Species considered endemic from the Middle Magdalena River valley are marked with an 'X'. IUCN Conservation status is shown for both: a global assessment and a national assessment (Rueda-Almonacid et al., 2004; IUCN, 2021). Categories: VU = Vulnerable, NT = Near Threatened, LC = Least Concern.

| Taxa | Endemic | Figure | Category of threat | |
|----------------------------------------------------------------------------------------|---------|---------|--------------------|----------|
| | | | Global | National |
| Dendrobatidae (1) | | | | |
| <i>Dendrobates truncatus</i> (Cope, 1861) | X | 4 Z | LC | |
| Bufonidae (3) | | | | |
| <i>Rhaebo haematiticus</i> (Cope, 1862) | | 4 AA | LC | |
| <i>Rhinella horribilis</i> (Wiegmann, 1833) | | 4 AB | LC | |
| <i>Rhinella sternosignata</i> (Günther, 1859) | | 4 AC-AD | LC | |
| Craugastoridae (4) | | | | |
| <i>Craugastor metriosistus</i> Ospina-Sarria, Angarita-Sierra, and Pedroza-Banda, 2015 | X | 4 AE | LC | |
| <i>Pristimantis gaigei</i> (Dunn, 1931) | | 4 AF | LC | |
| <i>Pristimantis taeniatus</i> (Boulenger, 1912) | | 4 AG | LC | |
| <i>Pristimantis viejas</i> (Lynch and Rueda-Almonacid, 1999) | X | 4 AH | LC | |
| Eleutherodactylidae (1) | | | | |
| <i>Diasporus anthrax</i> (Lynch, 2001) | X | 4 AI | VU | |
| Ranidae (1) | | | | |
| <i>Lithobates vaillanti</i> (Brocchi, 1877) | | 4 AJ | LC | |
| Caudata | | | | |
| Plethodontidae (2) | | | | |
| <i>Bolitoglossa lozanoi</i> Acosta-Galvis and Restrepo, 2001 | X | 4 AK-AL | LC | |
| <i>Oedipina</i> sp. | | 4 AM | | |

Tabla 1 (Cont.). Composición y riqueza de anfibios del bosque subandino del valle del Magdalena medio en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. Las especies consideradas endémicas del valle del río Magdalena están marcadas con una 'X'. Se muestra el estado de conservación según la UICN tanto a nivel global como a nivel nacional (Rueda-Almonacid et al., 2004; IUCN, 2021). Categorías: VU = Vulnerable, NT = Casi Amenazado, LC = Preocupación Menor.

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| Taxa | Endemic | Figure | Category of threat | |
|-------------------------------------------|---------|---------|--------------------|----------|
| | | | Global | National |
| Gymnophiona | | | | |
| Caeciliidae (3) | | | | |
| <i>Caecilia</i> sp. | | 9 A-B | | |
| <i>Caecilia subdermalis</i> Taylor, 1968 | X | 9 F-G | LC | |
| <i>Caecilia thompsoni</i> Boulenger, 1902 | X | | LC | |
| Rhinatremitidae (2) | | | | |
| <i>Epicrionops parkeri</i> (Dunn, 1942) | X | 9 C-D-E | VU | |
| <i>Epicrionops</i> sp. | | 9 H-I-J | | |

Tabla 2. Composición y riqueza de reptiles del bosque subandino del valle del Magdalena medio en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. Las especies consideradas endémicas del valle del río Magdalena están marcadas con una 'X'. Se muestra el estado de conservación según la UICN tanto a nivel global como a nivel nacional (IUCN, 2021; Morales-Betancourt et al., 2015). Categorías: CR = En Peligro Crítico, LC = Preocupación Menor, DD = Datos Deficientes.

Table 2. Composition and richness of reptiles from the sub-Andean Forest of the middle Magdalena valley in the area of influence of the Miel I Hydroelectric Power Plant, Caldas, Colombia. Species considered endemic from the Middle Magdalena River valley are marked with an 'X'. IUCN Conservation status is shown for both: a global assessment and a national assessment (IUCN, 2021; Morales-Betancourt et al., 2015). Categories: CR= Critically Endangered; LC = Least Concern, DD = Data Deficient.

| Taxa | Endemic | Figure | Category of threat | |
|--------------------------------------------------------------------|---------|--------|--------------------|----------|
| | | | Global | National |
| Reptilia | | | | |
| Testudines | | | | |
| Kinosternidae (1) | | | | |
| <i>Kinosternon leucostomum</i> (Duméril, Bibron and Duméril, 1851) | | 10 A | LC | |
| Crocodylia | | | | |
| Alligatoridae (1) | | | | |
| <i>Caiman crocodylus</i> (Linnaeus, 1758) | | 10 B | LC | |

Tabla 2 (Cont.). Composición y riqueza de reptiles del bosque subandino del valle del Magdalena medio en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. Las especies consideradas endémicas del valle del río Magdalena están marcadas con una 'X'. Se muestra el estado de conservación según la IUCN tanto a nivel global como a nivel nacional (IUCN, 2021; Morales-Betancourt et al., 2015). Categorías: CR = En Peligro Crítico, LC = Preocupación Menor, DD = Datos Deficientes.

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| Taxa | Endemic | Figure | Category of threat | |
|---------------------------------------------------------|---------|--------|--------------------|----------|
| | | | Global | National |
| Squamata | | | | |
| Lacertilia | | | | |
| Iguanidae (1) | | | | |
| <i>Iguana iguana</i> (Linnaeus, 1758) | | 10 C | LC | |
| Gekkonidae (1) | | | | |
| <i>Hemidactylus frenatus</i> Duméril and Bibron, 1836 | | 10 D | | |
| Phyllodactylidae (1) | | | | |
| <i>Thecadactylus rapicauda</i> (Houttuyn, 1782) | | 10 E-F | LC | |
| Sphaerodactylidae (2) | | | | |
| <i>Gonatodes albugularis</i> (Duméril and Bibron, 1836) | | 10 G-H | LC | |
| <i>Lepidoblepharis xanthostigma</i> (Noble, 1916) | | 10 I | | |
| Scincidae (1) | | | | |
| <i>Mabuya</i> sp. | | 10 J | | |
| Gymnophthalmidae (3) | | | | |
| <i>Bachia bicolor</i> (Cope, 1896) | | 10 L | LC | |
| <i>Cercosaura argulus</i> Peters, 1862 | | 10 M | LC | |
| <i>Loxopholis rugiceps</i> Cope, 1869 | | 10 N | LC | |
| Alopoglossidae (1) | | | | |
| <i>Ptychoglossus</i> aff. <i>festae</i> | | 10 O | | |

Tabla 2 (Cont.). Composición y riqueza de reptiles del bosque subandino del valle del Magdalena medio en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. Las especies consideradas endémicas del valle del río Magdalena están marcadas con una 'X'. Se muestra el estado de conservación según la UICN tanto a nivel global como a nivel nacional (IUCN, 2021; Morales-Betancourt et al., 2015). Categorías: CR = En Peligro Crítico, LC = Preocupación Menor, DD = Datos Deficientes.

Table 2 (Cont.). Composition and richness of reptiles from the sub-Andean Forest of the middle Magdalena valley in the area of influence of the Miel I Hydroelectric Power Plant, Caldas, Colombia. Species considered endemic from the Middle Magdalena River valley are marked with an 'X'. IUCN Conservation status is shown for both: a global assessment and a national assessment (IUCN, 2021; Morales-Betancourt et al., 2015). Categories: CR= Critically Endangered; LC = Least Concern, DD = Data Deficient.

| Taxa | Endemic | Figure | Category of threat | |
|-----------------------------------------------------------|---------|----------|--------------------|----------|
| | | | Global | National |
| Teiidae (3) | | | | |
| <i>Ameiva ameiva</i> (Linnaeus, 1758) | | 10 P | LC | |
| <i>Cnemidophorus lemniscatus</i> (Linnaeus, 1758) | | | LC | |
| <i>Holcosus festivus</i> (Lichtenstein and Martens, 1856) | | 10 Q-R | LC | |
| Diploglossidae (1) | | | | |
| <i>Diploglossus monotropis</i> (Kuhl, 1820) | | 10 S | LC | |
| Polychrotidae (1) | | | | |
| <i>Polychrus marmoratus</i> (Linnaeus, 1758) | | 10 T | LC | |
| Dactyloidae (9) | | | | |
| <i>Anolis auratus</i> (Daudin, 1802) | | 10 U | | |
| <i>Anolis cf. antonii</i> Boulenger, 1908 | X | | | |
| <i>Anolis fuscauratus</i> D'orbigny, 1837 | | 10 V | | |
| <i>Anolis gracilipes</i> Boulenger, 1898 | | 10 W | | |
| <i>Anolis granuliceps</i> Boulenger, 1898 | | | | |
| <i>Anolis limon</i> Velasco and Hurtado-Gómez, 2014 | X | 10 X | | |
| <i>Anolis sulcifrons</i> Cope, 1899 | X | 10 Y | | |
| <i>Anolis tolimensis</i> Werner, 1916 | X | | | |
| <i>Anolis tropidogaster</i> Hallowell, 1856 | | 10 Z | | |
| Corytophanidae (2) | | | | |
| <i>Basiliscus galeritus</i> Duméril, 1851 | | 10 AA-AB | LC | |

Tabla 2 (Cont.). Composición y riqueza de reptiles del bosque subandino del valle del Magdalena medio en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. Las especies consideradas endémicas del valle del río Magdalena están marcadas con una 'X'. Se muestra el estado de conservación según la IUCN tanto a nivel global como a nivel nacional (IUCN, 2021; Morales-Betancourt et al., 2015). Categorías: CR = En Peligro Crítico, LC = Preocupación Menor, DD = Datos Deficientes.

Table 2 (Cont.). Composition and richness of reptiles from the sub-Andean Forest of the middle Magdalena valley in the area of influence of the Miel I Hydroelectric Power Plant, Caldas, Colombia. Species considered endemic from the Middle Magdalena River valley are marked with an 'X'. IUCN Conservation status is shown for both: a global assessment and a national assessment (IUCN, 2021; Morales-Betancourt et al., 2015). Categories: CR= Critically Endangered; LC = Least Concern, DD = Data Deficient.

| Taxa | Endemic | Figure | Category of threat | |
|----------------------------------------------------------------|---------|----------|--------------------|----------|
| | | | Global | National |
| <i>Corytophanes cristatus</i> (Merrem, 1820) | | 10 AC-AD | LC | |
| Amphisbaenia | | | | |
| Amphisbaenidae (1) | | | | |
| <i>Amphisbaena fuliginosa</i> Linnaeus, 1758 | | 10 K | LC | |
| Serpentes | | | | |
| Leptotyphlopidae (1) | | | | |
| <i>Trilepida macrolepis</i> (Peters, 1858) | | 11 A | LC | |
| Anomalepididae (1) | | | | |
| <i>Anomalepis</i> sp. | | 11 B | | |
| Boidae (3) | | | | |
| <i>Boa constrictor</i> Linnaeus, 1758 | | 11 C | | |
| <i>Corallus annulatus</i> (Cope, 1875) | | 11 D | LC | |
| <i>Corallus batesii</i> (Gray, 1860) | | 11 E | LC | |
| Viperidae (1) | | | | |
| <i>Bothrops asper</i> (Garman, 1883) | | 11 F | LC | |
| Elapidae (2) | | | | |
| <i>Micrurus dumerilii</i> Jan, 1858 | | 11 G | LC | |
| <i>Micrurus mipartitus</i> (Duméril, Bibron and Duméril, 1854) | | 11 H | LC | |

Tabla 2 (Cont.). Composición y riqueza de reptiles del bosque subandino del valle del Magdalena medio en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. Las especies consideradas endémicas del valle del río Magdalena están marcadas con una 'X'. Se muestra el estado de conservación según la IUCN tanto a nivel global como a nivel nacional (IUCN, 2021; Morales-Betancourt et al., 2015). Categorías: CR = En Peligro Crítico, LC = Preocupación Menor, DD = Datos Deficientes.

Table 2 (Cont.). Composition and richness of reptiles from the sub-Andean Forest of the middle Magdalena valley in the area of influence of the Miel I Hydroelectric Power Plant, Caldas, Colombia. Species considered endemic from the Middle Magdalena River valley are marked with an 'X'. IUCN Conservation status is shown for both: a global assessment and a national assessment (IUCN, 2021; Morales-Betancourt et al., 2015). Categories: CR= Critically Endangered; LC = Least Concern, DD = Data Deficient.

| Taxa | Endemic | Figure | Category of threat | |
|---------------------------------------------------------------------|---------|--------|--------------------|----------|
| | | | Global | National |
| Colubridae (33) | | | | |
| <i>Atractus obtusirostris</i> | | 11 I | DD | |
| <i>Chironius carinatus</i> (Linnaeus, 1758) | | 11 J | DD | |
| <i>Chironius grandisquamis</i> (Peters, 1869) | | 11 K | LC | |
| <i>Chironius exoletus</i> (Linnaeus, 1758) | | 11 L | LC | |
| <i>Clelia clelia</i> (Daudin, 1803) | | 11 M-N | LC | |
| <i>Dendrophidion bivittatus</i> (Duméril, Bibron and Duméril, 1854) | | | LC | |
| <i>Dendrophidion boshelli</i> Dunn, 1944 | X | 11 O | CR | CR |
| <i>Dendrophidion percarinatum</i> (Cope, 1893) | | 11 P | LC | |
| <i>Drymarchon melanurus</i> (Duméril, Bibron and Duméril, 1854) | | 11 Q | LC | |
| <i>Erythrolamprus epinephelus</i> (Cope, 1862) | | 11 R | LC | |
| <i>Imantodes cenchoa</i> (Linnaeus, 1758) | | 11 S | LC | |
| <i>Imantodes inornatus</i> (Boulenger, 1896) | | 11 T | LC | |
| <i>Leptodeira septentrionalis</i> (Kennicott, 1859) | | 11 U | LC | |
| <i>Leptophis ahaetulla</i> (Linnaeus, 1758) | | | LC | |
| <i>Mastigodryas boddaerti</i> (Santzen, 1796) | | 11 V | LC | |
| <i>Ninia atrata</i> (Hallowell, 1845) | | 11 W | LC | |
| <i>Oxybelis brevirostris</i> (Cope, 1861) | | 11 X | LC | |
| <i>Oxyrhopus occipitalis</i> (Wied-Neuwied, 1824) | | 11 Y | LC | |
| <i>Oxyrhopus petolaris</i> (Linnaeus, 1758) | | 11 Z | LC | |

Tabla 2 (Cont.). Composición y riqueza de reptiles del bosque subandino del valle del Magdalena medio en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. Las especies consideradas endémicas del valle del río Magdalena están marcadas con una 'X'. Se muestra el estado de conservación según la IUCN tanto a nivel global como a nivel nacional (IUCN, 2021; Morales-Betancourt et al., 2015). Categorías: CR = En Peligro Crítico, LC = Preocupación Menor, DD = Datos Deficientes.

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| Taxa | Endemic | Figure | Category of threat | |
|-----------------------------------------------------------------------|---------|--------|--------------------|----------|
| | | | Global | National |
| <i>Phrynonax shropshirei</i> (Barbour and Amaral, 1924) | | | LC | |
| <i>Phrynonax poecilonotus</i> (Günther, 1858) | | | LC | |
| <i>Pliocercus euryzonus</i> Cope, 1862 | | 11 AA | LC | |
| <i>Rhadinaea decorata</i> (Günther, 1858) | | 11 AB | LC | |
| <i>Rhinobothryum bovallii</i> (Andersson, 1916) | | 11 AC | LC | |
| <i>Scaphiodontophis annulatus</i> (Diménil, Bibron and Diménil, 1854) | | | LC | |
| <i>Sibon nebulatus</i> (Linnaeus, 1758) | | 11 AD | LC | |
| <i>Spilotes pullatus</i> (Linnaeus, 1758) | | 11 AE | LC | |
| <i>Stenorrhina degenhardtii</i> (Berthold, 1846) | | 11 AF | LC | |
| <i>Tantilla alticola</i> (Boulenger, 1903) | | 11 AG | LC | |
| <i>Tantilla melanocephala</i> (Linnaeus, 1758) | | 11 AH | LC | |
| <i>Urotheca fulviceps</i> (Cope, 1886) | | 11 AI | LC | |
| <i>Urotheca lateristriga</i> (Berthold, 1859) | | 11 AJ | LC | |
| <i>Xenodon rabdocephalus</i> (Wied-Neuwied, 1824) | | | LC | |

database, supported by museum specimens. Subsequently, the Extent of Occurrence (EOO) of these species was calculated and compared with that reported for each of them, according to the IUCN red list (2021). This analysis was carried out through the creation of a triangulation network between the locations of the known localities, for which the create TIM tool was used, which generates a network between the points, based on Delaunay's triangulation principles (Guiot-Gaitán & Londoño-Giraldo, 2005).

RESULTS

Amphibians

A total of 39 amphibian species were recorded, belonging to 26 genera, 14 families and three orders (Anura, Caudata, Gymnophiona) (Figs. 4-9). The Anura order was the most diverse with 11 families (Aromobatidae, Bufonidae, Centrolenidae, Craugastoridae, Dendrobatidae, Eleutherodactylidae, Hylidae, Microhylidae, Leptodactylidae, Phyllomedusidae, and Ranidae), 22 genera and 32 species. The order Caudata recorded one family

(Plethodontidae), two genera and two species, and the order Gymnophiona two families (Caeciliidae and Rhinatrematidae), two genera and five species were recorded. Among all the registered families, Hylidae presented five genera and eight species, being the most representative at the species level, adding 20.5 % of the total richness (Fig. 4). Among the results, the record of 11 endemic species from the Magdalena River valley stands out (Table 1). In addition, three species are classified as vulnerable (VU) and one species as near threatened (NT) according to the IUCN (2021).

New amphibian records

Oedipina sp. (Fig. 4AM)

New record. Two individuals in the municipality of Samaná, Corregimiento Berlín, Media Cuesta sector, 700 m a.s.l. and Quebrada La Piscina, 826 m a.s.l. (MHN-UCa-A 1028).

Remarks. The cryptic salamander *Oedipina* sp. at present is poorly known in Colombia and scarcely represented in scientific collections (Acosta-Galvis et al., 2020). Although its taxonomic determination was only possible up to the genus level, it is not certain to which species complex it belongs. However, this record represents the first evidence of the presence of the genus in the department of Caldas, thus providing a new locality for this group (Fig. 5).

Epicrionops parkeri (Dunn, 1942) (Fig. 9C-E).

New record. A new locality and extension in the range of distribution for this species in Colombia is discovered; registering in the municipality of Samaná, Corregimiento Berlin, Vereda Piedra Verdes, Media Cuesta sector, 818 m a.s.l. (MHN-UCa-A 1248).

Remarks. A species of caecilian, which is very little known due to its burrowing and semi-aquatic habits. The presence of *E. parkeri* constitutes the southernmost locality known for it and, in addition, its first record for the department of Caldas, which extends its distribution range by 51 km to the southeast (Fig. 6). According to the IUCN (2019b), apparently, there is no significant expansion in its extent of occurrence (5839.3 km²), since here we report an EOO of 5835.2 km². This is because it was not possible to obtain the spatial information of the northernmost record of the species, which appears in the IUCN polygon.

Hyalinobatrachium aureoguttatum (Barrera & Ruiz, 1989) (Fig. 4C)

New record. The glass frog is registered in the municipality of Norcasia, Quebrada Soto, 624 m a.s.l. (MHN-UCa-A 802).

Remarks. A male individual is recorded vocalizing on an herbaceous leaf at the first time for the department of Caldas, including a new locality and expanding its distribution range, 48 km to the southeast of its closest known locality, in the department of Antioquia (Fig. 7). However, there are no significant changes in its extent of occurrence (IUCN, 2020a).

Teratohyla pulverata (Peters, 1873) (Fig. 4G).

New record. The glass frog is recorded perched on a herbaceous leaf at the edge of the creek, for the first time in the municipality of Samaná, Vereda Montebello, quebrada Negra, 560 m a.s.l. (MHN-UCa-A 1272).

Remarks. This constitutes a new locality for the species, expanding its distribution range by approximately 30 km linear to the southwest of its closest known locality, south of the department of Antioquia (Fig. 8).

Reptiles. In total, 70 species of reptiles were recorded, belonging to 50 genera, 21 families and three orders (Crocodylia, Squamata, Testudines; Fig. 10). The order Squamata was the most diverse with 19 families, 48 genera and 68 species. One family (Alligatoridae) and one species were recorded for the order Crocodylia, as well as for the order Testudines (Kinosternidae; Table 2; Fig. 10A-B). Among all the registered families, Colubridae was the most rich with 24 genera and 33 species, being the richest in species with 47.1 % of the total (Fig. 11I-AJ). Five species are endemic to Colombia (7.7 %) and according to the IUCN red lists of threatened species, one has deficient DD data and one is critically endangered CR (IUCN, 2021; Table 2).

New reptile records

Atractus obtusirostris (Werner, 1916) (Fig. 11I)

New record. The land snake was observed for the first time in the department of Caldas, in the municipality of Samaná, Corregimiento Berlín Portal de Salida in “Quebrada La Piscina” sector.

Remarks. The record obtained constitutes the easternmost locality known for this species. In this work, we report a population of the species in department of Caldas to 266 km from the northernmost known locality for *A. obtusirostris*, furthermore is located 130 km from the southernmost locality,

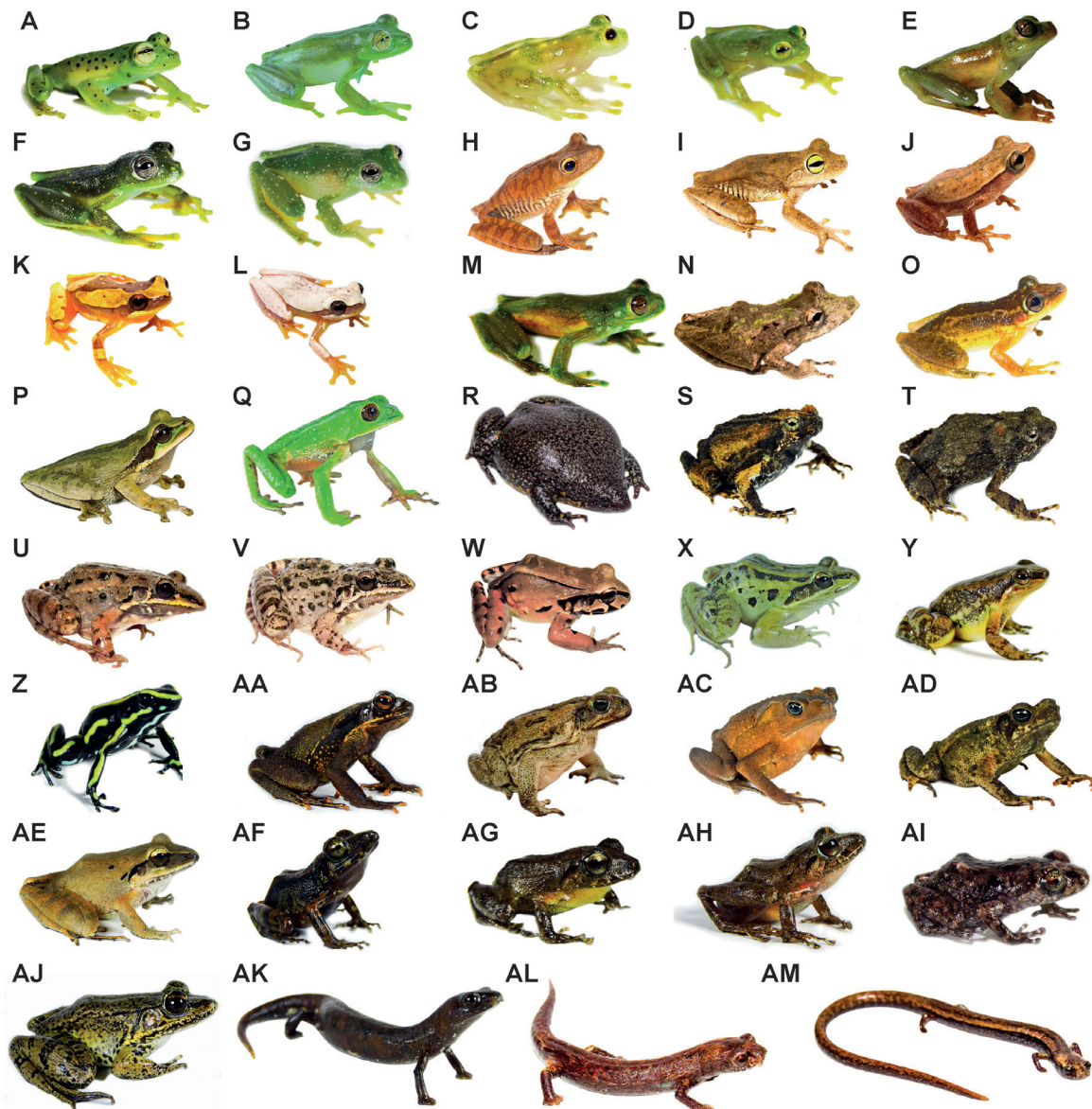


Figure 4. Amphibian species of the orders Anura and Caudata, present in the area of influence of the Miel I Hydroelectric Power Plant, Caldas, Colombia. (A-B) *Espadarana prosoblepon*; (C) *Hyalinobatrachium aureoguttatum*; (D) *Hyalinobatrachium tayato*; (E) *Rulyrana susatamai*; (F) *Sachatia punctulata*; (G) *Teratohyla pulverata*; (H) *Boana boans*; (I) *Boana platanera*; (J) *Dendropsophus microcephalus*; (K-L) *Dendropsophus ebraccatus*; (M) *Hylascirtus palmeri*; (N) *Scinax rostratus*; (O) *Scinax ruber*; (P) *Smilisca phaeota*; (Q) *Phyllomedusa venusta*; (R) *Elachistocleis pearsei*; (S-T) *Engystomops pustulosus*; (U) *Leptodactylus fragilis*; (V) *Leptodactylus fuscus*; (W) *Leptodactylus pentadactylus*; (X) *Leptodactylus savagei*; (Y) *Rheobates palmatus*; (Z) *Dendrobates truncatus*; (AA) *Rhaebo haematiticus*; (AB) *Rhinella horribilis*; (AC-AD) *Rhinella sternosignata*; (AE) *Craugastor metriosistis*; (AF) *Pristimantis gaigei*; (AG) *Pristimantis taeniatus*; (AH) *Pristimantis viejas*; (AI) *Diasporus anthrax*; (AJ) *Lithobates vaillanti*; (AK-AL) *Bolitoglossa lozano*; (AM) *Oedipina* sp.

Figura 4. Especies de anfibios de los órdenes Anura y Caudata presentes en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. (A-B) *Espadarana prosoblepon*; (C) *Hyalinobatrachium aureoguttatum*; (D) *Hyalinobatrachium tayato*; (E) *Rulyrana susatamai*; (F) *Sachatia punctulata*; (G) *Teratohyla pulverata*; (H) *Boana boans*; (I) *Boana platanera*; (J) *Dendropsophus microcephalus*; (K-L) *Dendropsophus ebraccatus*; (M) *Hylascirtus palmeri*; (N) *Scinax rostratus*; (O) *Scinax ruber*; (P) *Smilisca phaeota*; (Q) *Phyllomedusa venusta*; (R) *Elachistocleis pearsei*; (S-T) *Engystomops pustulosus*; (U) *Leptodactylus fragilis*; (V) *Leptodactylus fuscus*; (W) *Leptodactylus pentadactylus*; (X) *Leptodactylus savagei*; (Y) *Rheobates palmatus*; (Z) *Dendrobates truncatus*; (AA) *Rhaebo haematiticus*; (AB) *Rhinella horribilis*; (AC-AD) *Rhinella sternosignata*; (AE) *Craugastor metriosistis*; (AF) *Pristimantis gaigei*; (AG) *Pristimantis taeniatus*; (AH) *Pristimantis viejas*; (AI) *Diasporus anthrax*; (AJ) *Lithobates vaillanti*; (AK-AL) *Bolitoglossa lozano*; (AM) *Oedipina* sp.

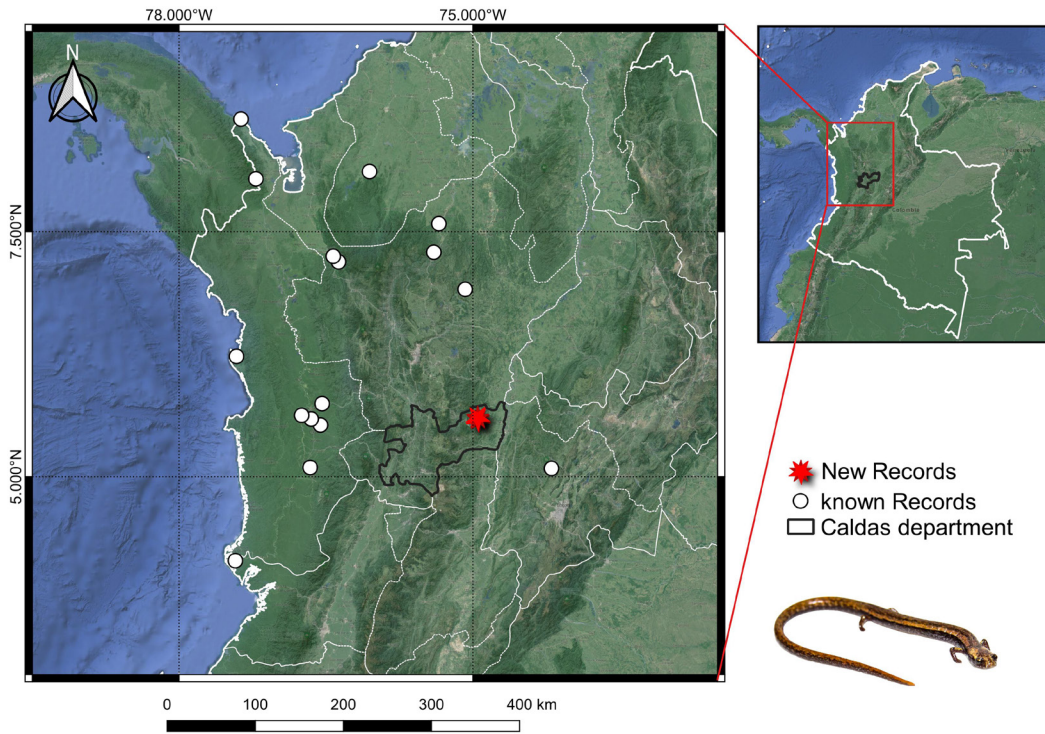


Figure 5. Location of known records of the genus *Oedipina* for Colombia. The white dots represent the known records for the genus and the red star represents the new record for the department of Caldas.

Figura 5. Ubicación de los registros conocidos del género *Oedipina* en Colombia. Los puntos blancos representan los registros conocidos para el género y la estrella roja representa el nuevo registro para el departamento de Caldas.

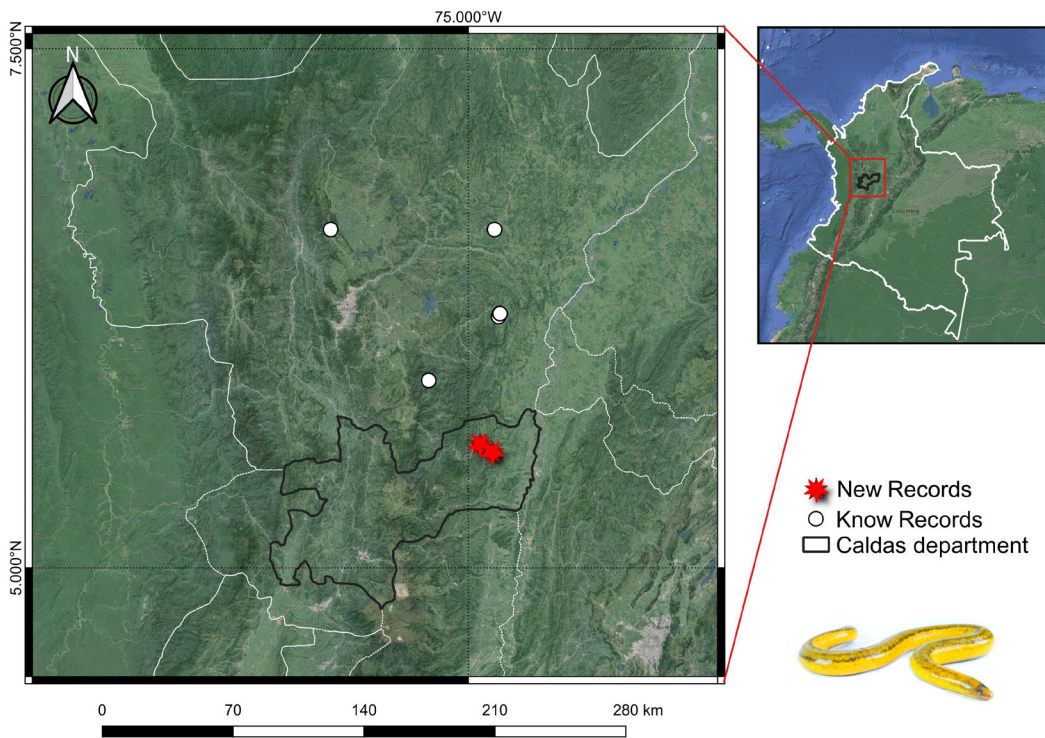


Figure 6. Location of known records for *Epicrionops parkerii* in Colombia. The white dots represent the known records for the species and the red star represents the new record for the department of Caldas.

Figura 6. Ubicación de los registros conocidos de *Epicrionops parkerii* en Colombia. Los puntos blancos representan los registros conocidos para la especie y la estrella roja representa el nuevo registro para el departamento de Caldas.

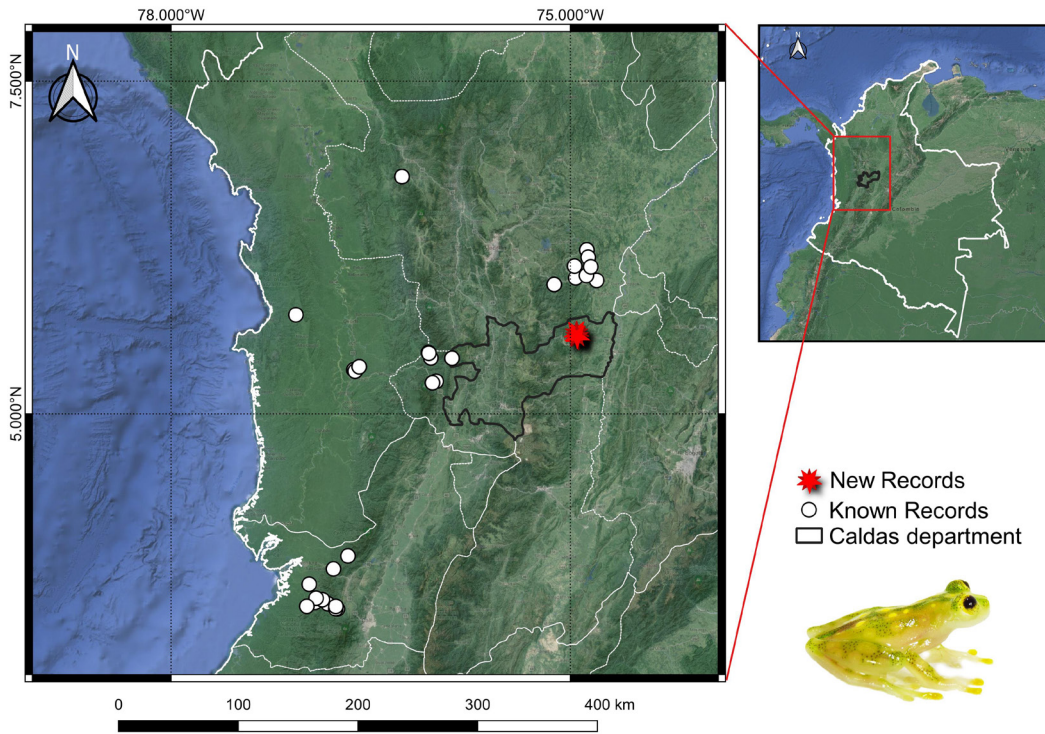


Figure 7. Location of known records for *Hyalinobatrachium aureoguttatum* in Colombia. The white dots represent the known records for the species and the red star represents the new record for the department of Caldas.

Figura 7. Ubicación de los registros conocidos de *Hyalinobatrachium aureoguttatum* en Colombia. Los puntos blancos representan los registros conocidos para la especie y la estrella roja representa el nuevo registro para el departamento de Caldas.

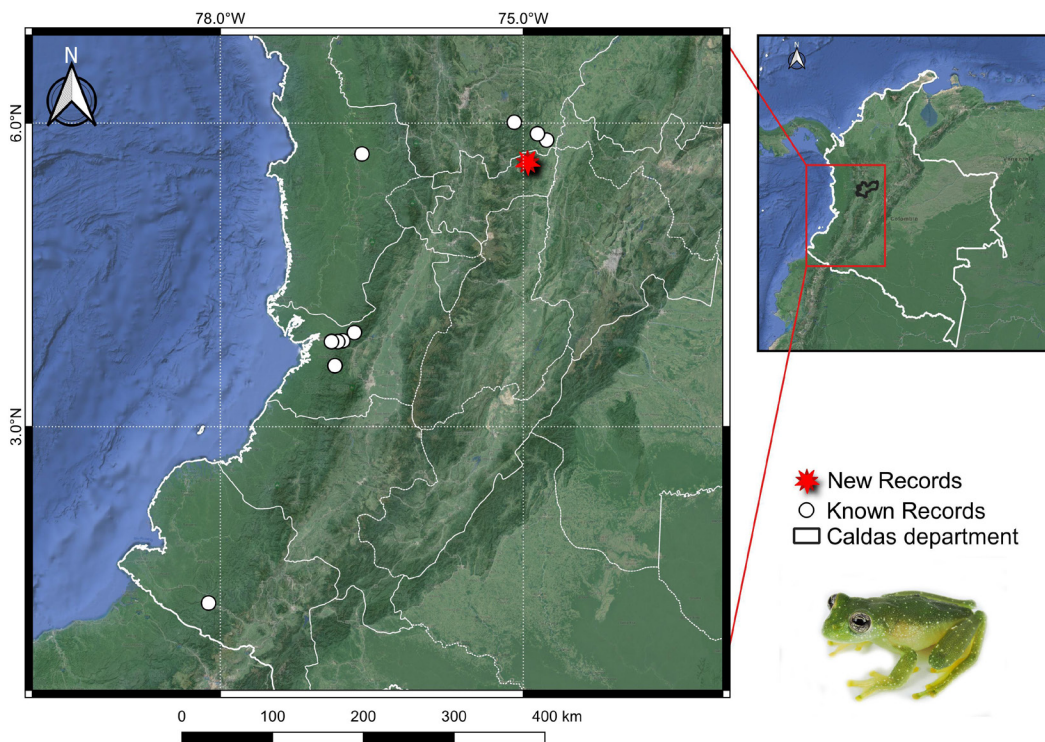


Figure 8. Location of known records for *Teratohyla pulverata* in Colombia. The white dots represent the known records for the species and the red star represents the new record for the department of Caldas.

Figura 8. Ubicación de los registros conocidos de *Teratohyla pulverata* en Colombia. Los puntos blancos representan los registros conocidos para la especie y la estrella roja representa el nuevo registro para el departamento de Caldas.



Figure 9. Amphibian species of the order Gymnophiona present in the area of influence of the Miel I Hydroelectric Power Plant. (A-B) *Caecilia* sp.; (C-D-E) *Epicrionops parkeri*; (F-G) *Caecilia subdermalis*; (H-I-J) *Epicrionops* sp.

Figura 9. Especies de anfibios del orden Gymnophiona presentes en el área de influencia de la Central Hidroeléctrica Miel I. (A-B) *Caecilia* sp.; (C-D-E) *Epicrionops parkeri*; (F-G) *Caecilia subdermalis*; (H-I-J) *Epicrionops* sp.

filling the distribution gap between the north and south of the middle Magdalena River Valley basin (see Fig. 12).

New record. The emerald boa was observed for the second time for the department in the municipality of Samaná, Corregimiento Berlin, Media Cuesta sector at 925 m a.s.l.

Corallus batesii (Gray, 1860) (Fig. 11E)

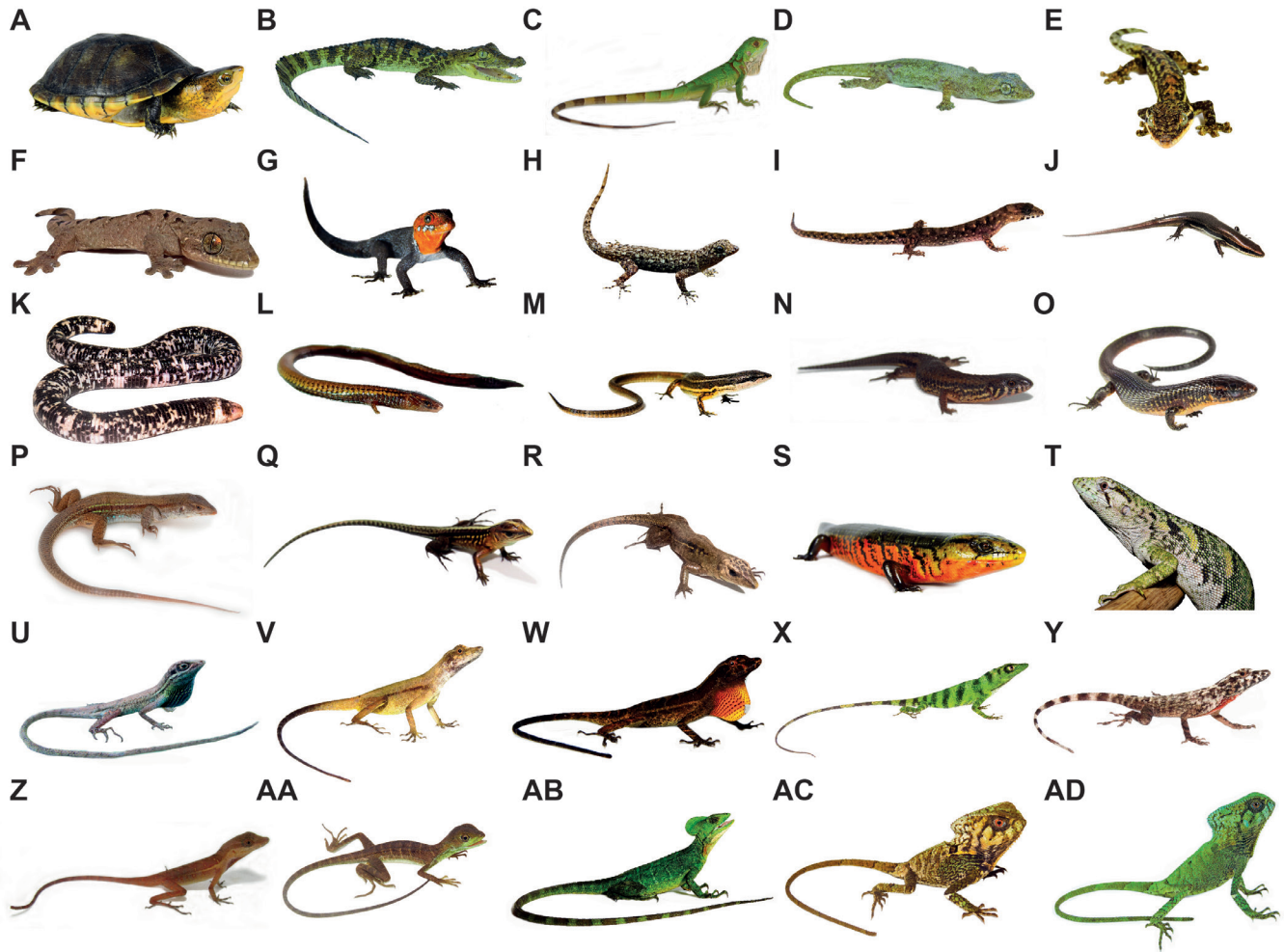


Figure 10. Reptile species of the Testudines and Crocodylia suborders and the Lacertilia suborder present in the area of influence of the Miel I Hydroelectric Power Plant, Caldas, Colombia. A) *Kinosternon leucostomum*; B) *Caiman crocodilus*; C) *Iguana iguana*; D) *Hemidactylus frenatus*; E-F) *Thecadactylus rapicauda*; G) *Gonatodes albogularis* (male); H) *Gonatodes albogularis* (female); I) *Lepidoblepharis xanthostigma*; J) *Mabuya mabouya*; K) *Amphisbaena fuliginosa*; L) *Bachia bicolor*; M) *Cercosaura argulus*; N) *Loxopholis rugiceps*; O) *Ptychoglossus aff. festae*; P) *Ameiva ameiva*; Q-R) *Holcosus festivus*; S) *Diploglossus monotropis*; T) *Polychrus marmoratus*; U) *Anolis auratus*; V) *Anolis fuscoauratus*; W) *Anolis gracilipes*; X) *Anolis limon*; Y) *Anolis sulcifrons*; Z) *Anolis tropidogaster*; AA) *Basiliscus galeritus* (juvenile); AB) *Basiliscus galeritus* (adult); AC) *Corytophanes cristatus* (juvenile); AD) *Corytophanes cristatus* (adult).

Figura 10. Especies de reptiles de los subórdenes Testudines y Crocodylia, y del suborden Lacertilia presentes en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. A) *Kinosternon leucostomum*; B) *Caiman crocodilus*; C) *Iguana iguana*; D) *Hemidactylus frenatus*; E-F) *Thecadactylus rapicauda*; G) *Gonatodes albogularis* (macho); H) *Gonatodes albogularis* (hembra); I) *Lepidoblepharis xanthostigma*; J) *Mabuya mabouya*; K) *Amphisbaena fuliginosa*; L) *Bachia bicolor*; M) *Cercosaura argulus*; N) *Loxopholis rugiceps*; O) *Ptychoglossus aff. festae*; P) *Ameiva ameiva*; Q-R) *Holcosus festivus*; S) *Diploglossus monotropis*; T) *Polychrus marmoratus*; U) *Anolis auratus*; V) *Anolis fuscoauratus*; W) *Anolis gracilipes*; X) *Anolis limon*; Y) *Anolis sulcifrons*; Z) *Anolis tropidogaster*; AA) *Basiliscus galeritus* (juvenil); AB) *Basiliscus galeritus* (adulto); AC) *Corytophanes cristatus* (juvenil); AD) *Corytophanes cristatus* (adulto).



Figure 11. Reptile species of the Serpentes suborder present in the area of influence of the Miel I Hydroelectric Power Plant, Caldas, Colombia. (A) *Trilepida macrolepis*; (B) *Anomalepis* sp.; (C) *Boa constrictor*; (D) *Corallus annulatus*; (E) *Corallus batesii*; (F) *Bothrops asper*; (G) *Micrurus dumerilii*; (H) *Micrurus mipartitus*; (I) *Atractus obtusirostris*; (J) *Chironius carinatus*; (K) *Chironius grandisquamis*; (L) *Chironius exoletus*; (M) *Clelia clelia* (juvenile); (N): *Clelia clelia* (adult); (O) *Dendrophidion boshelli*; (P) *Dendrophidion percarinatum*; (Q) *Drymarchon melanurus*; (R) *Erythrolamprus epinephelus*; (S) *Imantodes cenchoa*; (T) *Imantodes inornatus*; (U) *Leptodeira septentrionalis*; (V) *Mastigodryas boddaerti*; (W) *Ninia atrata*; (X) *Oxybelis brevirostris*; (Y) *Oxyrhopus occipitalis*; (Z) *Oxyrhopus petolaris*; (AA) *Pliocercus euryzonus*; (AB) *Rhadinaea decorata*; (AC) *Rhinobothryum bovallii*; (AD) *Sibon nebulatus*; (AE) *Spilotes pullatus*; (AF) *Stenorrhina degenhardtii*; (AG) *Tantilla alticola*; (AH) *Tantilla melanocephala*; (AI) *Urotheca fulviceps*; (AJ) *Urotheca lateristriga*.

Figura 11. Especies de reptiles del suborden Serpentes presentes en el área de influencia de la Central Hidroeléctrica Miel I, Caldas, Colombia. A) *Trilepida macrolepis*; (B) *Anomalepis* sp.; (C) *Boa constrictor*; (D) *Corallus annulatus*; (E) *Corallus batesii*; (F) *Bothrops asper*; (G) *Micrurus dumerilii*; (H) *Micrurus mipartitus*; (I) *Atractus obtusirostris*; (J) *Chironius carinatus*; (K) *Chironius grandisquamis*; (L) *Chironius exoletus*; (M) *Clelia clelia* (juvenile); (N): *Clelia clelia* (adult); (O) *Dendrophidion boshelli*; (P) *Dendrophidion percarinatum*; (Q) *Drymarchon melanurus*; (R) *Erythrolamprus epinephelus*; (S) *Imantodes cenchoa*; (T) *Imantodes inornatus*; (U) *Leptodeira septentrionalis*; (V) *Mastigodryas boddaerti*; (W) *Ninia atrata*; (X) *Oxybelis brevirostris*; (Y) *Oxyrhopus occipitalis*; (Z) *Oxyrhopus petolaris*; (AA) *Pliocercus euryzonus*; (AB) *Rhadinaea decorata*; (AC) *Rhinobothryum bovallii*; (AD) *Sibon nebulatus*; (AE) *Spilotes pullatus*; (AF) *Stenorrhina degenhardtii*; (AG) *Tantilla alticola*; (AH) *Tantilla melanocephala*; (AI) *Urotheca fulviceps*; (AJ) *Urotheca lateristriga*.

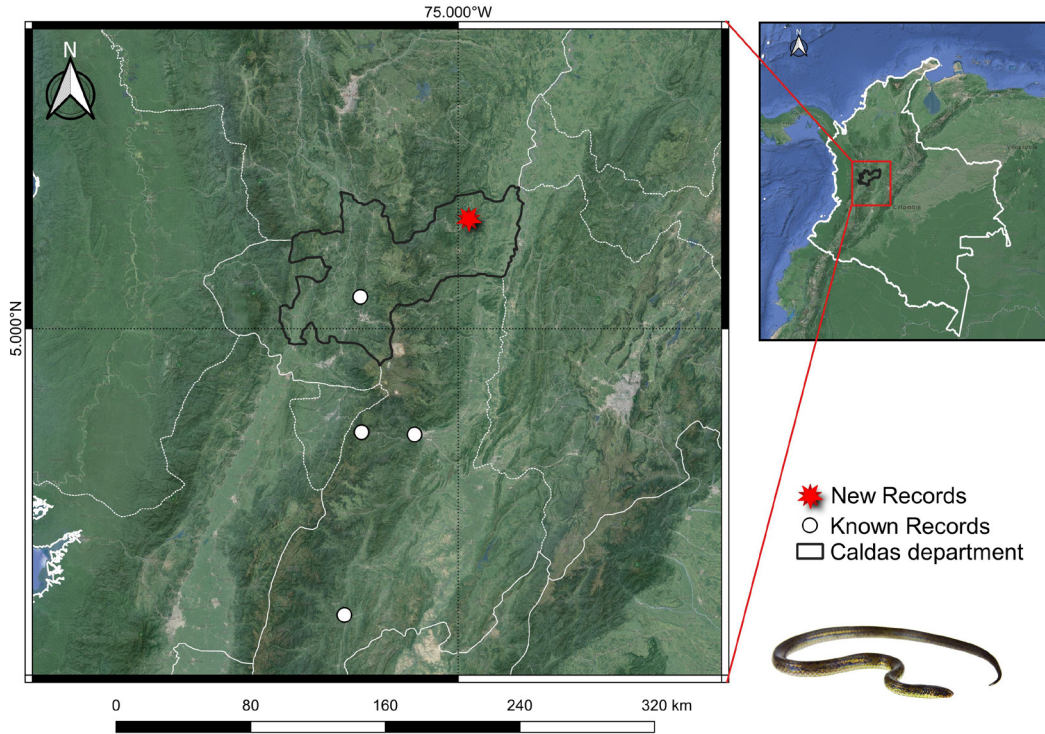


Figure 12. Location of known records for *Atractus obtusirostris* in Colombia. The white dots represent the known records for the species and the red star represents the new record for department of Caldas.

Figura 12. Ubicación de los registros conocidos de *Atractus obtusirostris* en Colombia. Los puntos blancos representan los registros conocidos para la especie y la estrella roja representa el nuevo registro para el departamento de Caldas.

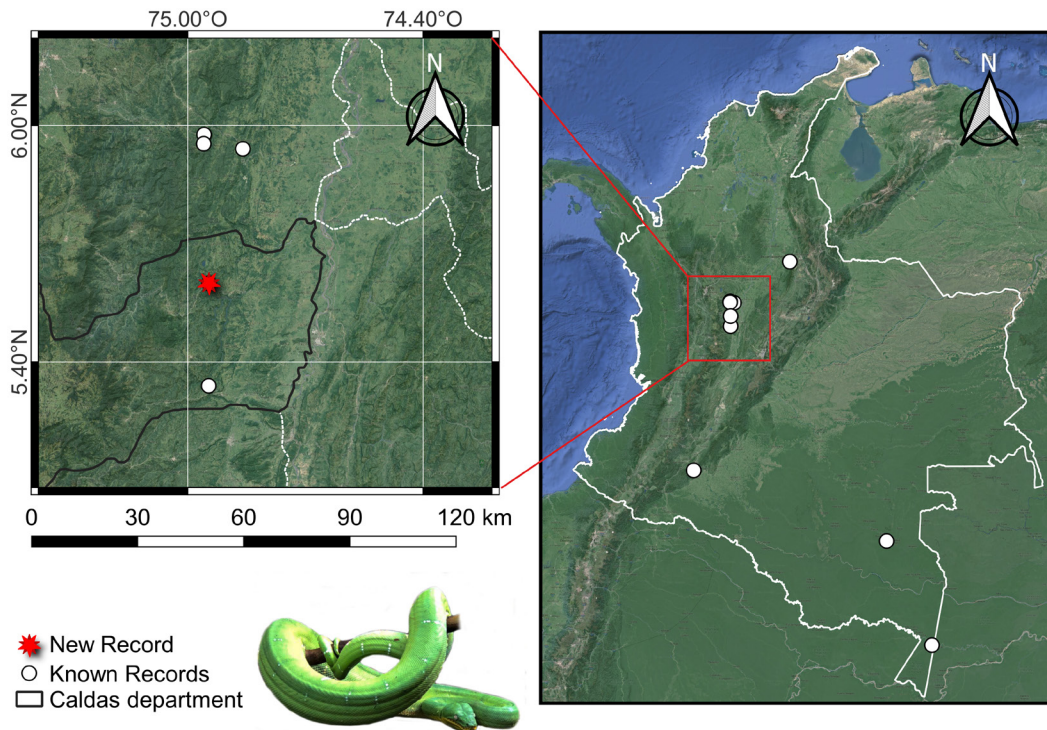


Figure 13. Location of known records for *Corallus batesii* in Colombia. The white dots represent the known records for the species and the red star represents the second record for the department of Caldas.

Figura 13. Ubicación de los registros conocidos de *Corallus batesii* en Colombia. Los puntos blancos representan los registros conocidos para la especie y la estrella roja representa el segundo registro para el departamento de Caldas.

Remarks. The observed specimen has prominent lateral spots, but no middorsal stripe connecting the dorsal triangles. The record obtained is located 29 km north and 39.8 km south

with respect to the department of Caldas, filling a distributional gap between the northern and southern localities of the middle valley of the Magdalena River (see Fig. 13).

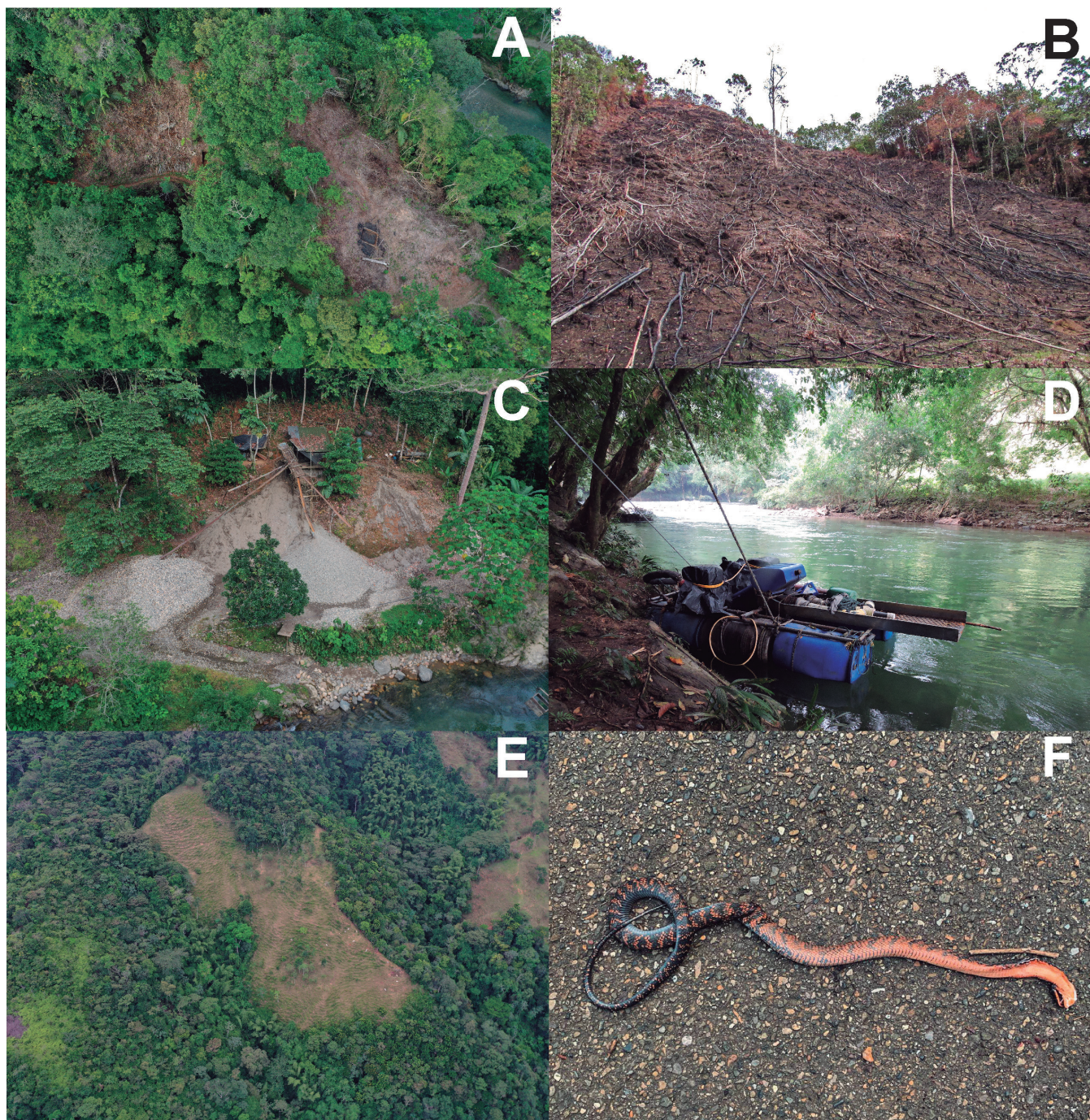


Figure 14. Main threats in the area of influence of the Manso diversion dam. (A) Selective felling of native forest; (B) Burning of secondary vegetation for the production of artisanal charcoal; (C) Subsistence mining; (D) Gold mining; (E) Transformation of the landscape from forests to pastures; (F) Ophidiofauna run over.

Figura 14. Principales amenazas en el área de influencia de la presa de derivación Manso. (A) Tala selectiva de bosque nativo; (B) Quema de vegetación secundaria para la producción de carbón artesanal; (C) Minería de subsistencia; (D) Minería de oro; (E) Transformación del paisaje de bosques a pastizales; (F) Atropellamiento de ofidiofauna.

DISCUSSION

This work presents the first compilation about the diversity of amphibians and reptiles in the forests of the Miel I Hydroelectric Power Plant, and it is a representative sample of the herpetofauna diversity from the eastern department of Caldas, counting more than 100 species of amphibians and reptiles. This geographic area is of special interest due to the high species richness and proportion of endemic species, particularly in the strip of Andean forests above 1500 m a.s.l. (Lynch & Rueda-Almonacid, 1998; Rueda-Almonacid, 2000; Lynch & Suárez-Mayorga, 2002). In the basal and sub-Andean belt, between 250-1000 m a.s.l., the composition of amphibians and reptiles shows a high zoogeographical affinity with other areas of the MMRV (see Moreno-Arias et al., 2008; Vargas-Salinas & Aponte, 2016; Restrepo et al., 2017) and the Colombian Pacific (Lynch et al., 1997; Acosta-Galvis et al., 2006; Rojas-Morales, 2012; Díaz-Ayala et al., 2015; Rojas-Morales et al., 2018), supporting the biogeographical proposal of Hernández-Camacho et al. (1992a, 1992b) and replicated by Morrone (2014), when defining the Chocó-Magdalena biogeographical province. Morrone et al. (2022) proposed the Magdalena Province as a different unit from Chocó and the herpetofauna of the Magdalena river agrees with this proposal, because although there is a high affinity with the Chocó and the Caribbean, the endemism in this basin is also high for some groups. Something interesting when looking at the herpetofauna of eastern Caldas and Antioquia is that the sub-Andean and Andean forests may represent a biogeographic district in itself, distinct from the western flank of the Eastern Cordillera in Santander, Boyacá. The biogeographic proposal of Hernández-Camacho et al. (1992b) is very accurate, but it awaits validation with current information on the country's biodiversity.

The 39 registered amphibian species represent 4.4 % of the amphibian species currently known for Colombia (Acosta-Galvis, 2023), of which 11 species (28.2 %) are endemic to the middle basin of the Magdalena River (Table 1). Most of the species recorded present distribution patterns associated with the humid tropical forests and sub-Andean forests of the eastern flank of the Central Cordillera (e.g., *Diasporus anthrax*, *Epicrionops parkeri*, *Rheobates palmatus*, *Rulyrana susatamai*, *Sachatamia punctulata* and *Pristimantis viejas*). The distribution of the other endemic species extends to the tropical humid forests in the middle valley of the Magdalena River: *Bolitoglossa lozanoi*, *Caecilia thompsoni* and *Craugastor metriosistus* or the lowlands of the Caribbean region and the foothills of the Sierra Nevada de Santa Marta (*Dendrobates truncatus*). Although, *Cecilia subdermalis*

presents a distribution pattern in the Colombian central massif and in the central and western mountain ranges.

The 70 species of reptiles represent 10.7 % of the total Colombian reptile species (Uetz et al., 2023). Among the reptiles that were recorded, five species (7.1 %) are endemic to Colombia: *Anolis limon* and *Dendrophidion boshelli* are distributed exclusively in the humid forests of the middle valley of the Magdalena River (Velasco and Hurtado-Gómez, 2014; Rojas-Morales et al., 2019). This represents one of the only confirmed records of this critically endangered taxon, more than 70 years after its description (Dunn, 1944). *Anolis limon* is a species described several years ago (see Velasco & Hurtado-Gómez, 2014), this would constitute the second locality known for the Department of Caldas. On the other hand, *A. antonii*, *A. sulcifrons* and *A. tolimensis*, reach wider distributions elevation wise, throughout the Andean and sub-Andean forests (500–2000 m a.s.l.) in the basin of this same river (IUCN, 2021; Uetz et al., 2023).

Among the registered amphibians, the discovery of the glass frog *H. aureoguttatum* stands out, which was previously known in the Andean, sub-Andean and tropical humid forests of the western slope of the Western Cordillera, in the departments of Valle del Cauca, Risaralda, Chocó and Antioquia, between 45–1780 m a.s.l. (Bernal & Lynch, 2008; Solis et al., 2010). This would constitute the second known record for the middle valley of the Magdalena River, being the first for the Department of Caldas. The salamander genus *Oedipina* contains only two species in South America (García-Paris & Wake 200; McCranie et al., 2008; Köhler, 2011) and is mainly distributed in the Pacific lowlands of Colombia and Ecuador (Brame & Wake 1963; Acosta-Galvis et al., 2019); recently, Ovalle-Pacheco et al. (2019) reported a specimen of the *Oedipina* species “complex” for the Department of Boyacá, in the middle valley of the Magdalena River (Acosta-Galvis et al., 2020). These salamanders are a rare taxonomic group (McCranie et al., 2008) and are poorly represented in biological collections from South America, and the number of individuals in Colombia is limited, it does not exceed 20 specimens (Acosta-Galvis et al., 2020). This is because there is current taxonomic chaos in both *O. parvipes* and *O. complex*, apparently composed of multiple cryptic species that need further study to clarify an appropriate taxonomic status (García-Paris & Wake, 2000; McCranie et al., 2008).

Lozano's salamander *B. lozanoi* and *S. punctulata* are the only species in this study included as vulnerable at the national level (Resolution 1912 of 2017 of the Ministry of Environment and Sustainable Development of Colombia). Among the rest of the registered species, five amphibian species are under some degree



of threat, according to the criteria of the IUCN (2021; Table 1). *Diasporus anthrax*, *S. punctulata* and *E. parkeri* are categorized as vulnerable, that is, they face a moderate risk of extinction or population deterioration in the medium term. Habitat loss and fragmentation are likely to pose a threat to both species, due to overgrazing, agriculture, and mining activities (IUCN, 2017b, 2019a). *Rulyrana susatamai* is categorized as almost threatened with extinction (IUCN, 2017a).

The recorded caecilians have a wide distribution from sea level to 2300 m. The only species with a distribution from sea level is *Caecilia thompsoni*, while the highland caecilians (1000 – 2300 m a.s.l.) recorded are *C. subdermalis* and *E. parkeri*. In addition, there is a very particular record of a specimen of the genus *Epicrionops*, which appears to be a postlarval individual (the grooves in the gular region are not visible and the caudal fin is well developed). For this species there is a young specimen deposited in the scientific collection of the Institute of Natural Sciences (ICN-41234), which was found in the municipality of Norcasia, Caldas at 600 m a.s.l. (Lynch, 1999). It has a laterally compressed and sharp tail, similar to the specimen found in this study (Fig. 9 H-J) (MHN-UCa-A 1742) and in the same locality Norcasia, Caldas, Montebello village at 800 m a.s.l.. Although the available data is minimal, it could be the same species. However, understanding of the natural history of the species that make up this genus is limited, primarily due to their underground burrowing habits. Furthermore, there are limitations to the study of these organisms, due to the lack of adequate methodologies and insufficient efforts in sampling and identifying their habitats. That is why the records presented in this document are based on chance discoveries.

Among the registered reptiles, the finding of *A. obtusirostris* stands out, it is a snake with fossorial habits that inhabits the sub-Andean forests associated with the water masses that run from the eastern slope of the Central Mountain Range between 1200 m and 2200 m a.s.l., but they are also found in plant formations at lower elevations of the central mountain range and the middle valley of the Magdalena River (Passos & Lynch, 2010; Böhm et al., 2015), registering an individual at 800 m a.s.l.. Although there is a record for the southwest of the department, this is the first documented record of the species. Likewise, we report the finding of a tree boa *C. batesii*, this would constitute the second record for Caldas and the sixth confirmed record for the species outside the Amazon River basin (see Fig. 13), these being the only documented records for the species north of the Colombian Andes (Renjifo & Lundberg, 1999; Daza-R & Henderson, 2005). According to Henderson et al. (2009) suggests a possible dispersion through an Andean corridor between the

central mountain range and the eastern mountain range in the middle valley of the Magdalena River. Although the populations of northwestern Colombia are probably assigned to *C. batesii*, there are morphological variations in these that could represent a different species, so further studies and molecular data would be needed to clarify an appropriate taxonomic status.

Recently, Morales-Betancourt et al. (2015) evaluated the conservation status of Colombian reptiles and found that 43 species are currently under one of three threat categories (e.g., Vulnerable VU, Endangered EN, Critically Endangered CR). *Dendrophidion boshelli* was categorized as a Critically Endangered B1ab(iii) species (Caicedo et al., 2017), because the estimated extent of occurrence is less than 100 km², its distribution is severely fragmented, and there is a continuous decline in extent and quality of its habitat (Caicedo-Portilla & Lynch 2015; Rojas-Morales et al., 2019). Currently, information on the distribution of *D. boshelli* is insufficient, and it is possible that this species has a broader distribution along the middle valley of the Magdalena River, encompassing the moist lowland and premontane forests of the Cordilleras Oriental and Central de Colombia.

Rojas-Morales et al. (2019) identified the area adjacent to the Manso River in Caldas as a locality with good habitat conditions that allow the presence of endemic and threatened vertebrate species. In this locality, it is evident that the vegetation upstream of the Manso River transfer belongs to a mature forest in an advanced stage of succession. The composition includes tree vegetation with a canopy height greater than 30 m located on the banks of permanent watercourses, a stratified canopy structure with vegetation in the understory and plant associations with a predominance of palms is observed. Currently, the natural forests in the area of influence of the project are threatened by the fragmentation and loss of habitat caused by various factors, such as selective logging for the sale of native woods, the manufacture of artisanal charcoal, subsistence mining, gold mining, the pasture of forests, the running over of ophidofauna and the establishment of agricultural crops (Andrade et al., 2013; Garzón & Gutiérrez, 2013; Restrepo et al., 2016) (Fig. 14A-F).

Finally, the results of this work show that the activities of reforestation and delimitation of intangible areas, with the consequent recovery of structural connectivity between the forests of the Miel I Hydroelectric Power Plant, have allowed the herpetofauna to remain diverse, evidencing an increase in the richness of amphibian and reptile species from 102 to 109 species in the last decade and an important change in the vegetation cover in the area of influence in the last 30 yr (see Andrade et al., 2013). During the nine years that monitoring activities have been

implemented a total of 5948 individuals have been recorded, for amphibians (5129 records) and reptiles (819 records). Hence, the records presented in this work indicate that continued sampling efforts over extended periods of time are essential to have an approximation about the composition of herpetofauna in tropical ecosystems. As new areas are subject of herpetological research and species composition becomes better known, recording “rare” elements demographically (*sensu* Rabinowitz, 1981) produces a more robust data set.

In comparison with similar field studies of herpetofauna inventories in hydroelectric power plants, different results have been obtained (see da Silva jr, 1993; Suárez & Alzate, 2014; Restrepo et al., 2017), with the highest species richness values being found in forests of the Miel I Hydroelectric Power Plant. However, recent studies from Serranía de Las Quinchas, in the MMRV, present a list of 51 species of amphibians (Ovalle-Pacheco et al., 2019).

Therefore, it is vital to understand that the spatial distribution of a species is extremely important to assess its conservation status and suggest possible decisions to be made. In short, knowledge of the distribution of species provides basic information on the areas in which efforts can be concentrated for the implementation of management and recovery plans for wild species and populations. Worldwide, particularly in the developing world, the development of hydroelectricity production occurs together with the rise in ecosystem/biodiversity conservation efforts in watersheds (Guo et al., 2007). This interweaving creates the need for a functional relationship between hydroelectricity production and ecosystem/biodiversity conservation.

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APPENDIX

Appendix 1. Voucher specimens of amphibians and reptiles from the sub-Andean Forest of the middle Magdalena valley in the area of influence of the Miel I Hydroelectric Power Plant, Caldas, Colombia.

Apéndice 1. Especímenes voucher de anfibios y reptiles del bosque subandino del Valle medio del Magdalena, en el área de influencia de la planta hidroeléctrica Miel I, Caldas. Colombia.

Amphibians

Anura. Aromobatidae: *Rheobates palmatus* (MHN-UCa-A 374, 375, 383, 698, 801, 837, 839, 840, 841); Bufonidae: *Rhaebo haematiticus* (MHN-UCa-A 302, 311, 319, 321, 392, 1066); *Rhinella horribilis* (MHN-UCa-A 1069); *Rhinella sternosignata* (MHN-UCa-A 275, 298, 299, 300, 301, 371, 729); Craugastoridae: *Craugastor metriosistus* (MHN-UCa-A 1090, 1168, 1169); *Pristimantis gaigei* (MHN-UCa-A 923, 924, 1070, 1088, 1207); *Pristimantis taeniatus* (MHN-UCa-A 1170, 1191); *Pristimantis viejas* (MHN-UCa-A 1192, 1208); Eleutherodactylidae: *Diasporus anthrax* (MHN-UCa-A 763); Centrolenidae: *Espadarana prosoblepon* (MHN-UCa-A 844, 845, 1074, 1077); *Hyalinobatrachium aureoguttatum* (MHN-UCa-A 802); *Hyalinobatrachium tayatoi* (MHN-UCa-A 696); *Rulyrana susatamai* (MHN-UCa-A 702); *Sachatamia punctulata* (MHN-UCa-A 308, 312, 804); *Teratohyla pulverata* (MHN-UCa-A 1272); Hylidae: *Boana boans* (MHN-UCa-A 739, 740, 1017, 1018, 1019, 1020, 1021, 1022, 1023, 1024, 1025, 1027, 1190, 1244); *Boana platanera* (MHN-UCa-A 295, 386, 1076, 1082); *Dendropsophus microcephalus* (MHN-UCa-A 277, 278, 379); *Dendropsophus ebraccatus* (MHN-UCa-A 693, 695); *Hyloscirtus palmeri* (MHN-UCa-A 444); *Scinax rostratus* (MHN-UCa-A 457, 838); *Scinax ruber* (MHN-UCa-A 442); *Smilisca phaeota*

(MHN-UCa-A 62, 303, 394); Phyllomedusidae: *Phyllomedusa venusta* (MHN-UCa-A 106); Leptodactylidae: *Engystomops pustulosus* (MHN-UCa-A 1087); *Leptodactylus fragilis* (MHN-UCa-A 318); *Leptodactylus fuscus* (MHN-UCa-A 378, 385, 446); Dendrobatidae: *Dendrobates truncatus* (MHN-UCa-A 403, 736, 1075); Ranidae: *Lithobates vaillanti* (MHN-UCa-A 279, 282, 345, 912).

Caudata. Plethodontidae: *Bolitoglossa lozanoi* (MHN-UCa-A 323, 329, 370, 380, 382, 397, 705, 771, 842, 1085, 1086, 1247); *Oedipina* sp. (MHN-UCa-A 1028).

Gymnophiona. Caeciliidae: *Caecilia* sp. (MHN-UCa-A 1205); *Caecilia subdermalis* (MHN-UCa-A 1206); *Caecilia thompsoni* (MHN-UCa-A 339, 700, 806, 807, 1065, 1204); Rhinatrematidae: *Epicrionops parkeri* (MHN-UCa-A 1248); *Epicrionops* sp. (MHN-UCa-A 1742).

Reptiles

Squamata

Lacertilia. Phyllodactylidae: *Thecadactylus rapicauda* (MHN-UCa-R 247); Sphaerodactylidae: *Lepidoblepharis xanthostigma* (MHN-UCa-R 97, 127, 128, 145, 148, 244, 456); Scincidae: *Mabuya* sp. (MHN-UCa-R 85, 151, 460); Gymnophthalmidae: *Bachia bicolor* (MHN-UCa-R 156, 298); Alopoglossidae: *Ptychoglossus aff. Festae* (MHN-UCa-R 510, 608); Teiidae: *Ameiva ameiva* (MHN-UCa-R 508); *Cnemidophorus lemniscatus* (MHN-UCa-R 86); *Holcosus festivus* (MHN-UCa-R 260, 261, 267); Diploglossidae: *Diploglossus monotropis* (MHN-UCa-R 230, 246); Dactyloidae: *Anolis cf. Antonii*

(MHN-UCa-R 538), *Anolis fuscoauratus* (MHN-UCa-R 289, 408); *Anolis gracilipes* (MHN-UCa-R 131); *Anolis granuliceps* (MHN-UCa-R 124, 125); *Anolis limon* (MHN-UCa-R 308, 360, 410); *Anolis tolimensis* (MHN-UCa-R 302); Corytophanidae: *Basiliscus galeritus* (MHN-UCa-R 89, 275); *Corytophanes cristatus* (MHN-UCa-R 143).

Serpentes. Leptotyphlopidae: *Trilepida macrolepis* (MHN-UCa-R 507); Anomalepididae: *Anomalepis* sp. (MHN-UCa-R 359); Boidae: *Corallus annulatus* (MHN-UCa-R 286); Viperidae: *Bothrops asper* (MHN-UCa-R 92, 138, 141, 142, 154, 175, 299, 399, 365, 597); *Micrurus dumerilii* (MHN-UCa-R 357, 415); *Micrurus mipartitus* (MHN-UCa-R 214, 284, 285); Colubridae: *Atractus obtusirostris* (MHN-UCa-R 356); *Chironius grandisquamis* (MHN-UCa-R 155, 405, 406, 428, 454, 605); *Chironius exoletus* (MHN-UCa-R 400); *Clelia clelia* (MHN-UCa-R 174); *Dendrophidion boshelli* (MHN-UCa-R 239, 263, 271); *Dendrophidion percarinatum* (MHN-UCa-R 176, 276); *Imantodes*

cenchoa (MHN-UCa-R 150, 273, 292, 573); *Imantodes inornatus* (MHN-UCa-R 262); *Leptodeira septentrionalis* (MHN-UCa-R 84, 98, 279, 305, 452); *Leptophis ahaetulla* (MHN-UCa-R 407); *Ninia atrata* (MHN-UCa-R 603); *Oxybelis brevirostris* (MHN-UCa-R 149); *Oxyrhopus occipitalis* (MHN-UCa-R 282); *Oxyrhopus petolarius* (MHN-UCa-R 90, 250, 268, 287, 522); *Phrynonax shropshirei* (MHN-UCa-R 252, 574, 606); *Pliocercus euryzonus* (MHN-UCa-R 144, 278); *Rhadinaea decorata* (MHN-UCa-R 152, 427); *Rhinobothryum bovallii* (MHN-UCa-R 238, 306); *Scaphiodontophis annulatus* (MHN-UCa-R 253, 270); *Sibon nebulatus* (MHN-UCa-R 342, 453, 498); *Spilotes pullatus* (MHN-UCa-R 277); *Stenorrhina degenhardtii* (MHN-UCa-R 146, 264, 265, 310, 571); *Tantilla alticola* (MHN-UCa-R 237, 248); *Tantilla melanocephala* (MHN-UCa-R 254, 272, 570); *Urotheca fulviceps* (MHN-UCa-R 234, 283); *Urotheca lateristriga* (MHN-UCa-R 152, 266); *Xenodon rabdocephalus* (MHN-UCa-R 94, 358).