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PENSOFT

First record of *Boana maculateralis* (Caminer & Ron, 2014) and *Boana tetete* (Caminer & Ron, 2014) (Anura, Hylidae) in Colombia

Andrés Rymel Acosta-Galvis,[1] Carlos A. Lasso,[2] Mónica A. Morales-Betancourt[2]

1 Subdirección de Investigaciones, Colecciones Biológicas, Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Carrera 8 # 15-08, Claustro de San Agustín, Villa de Leyva, Boyacá, Colombia. **2** Programa Ciencias Básicas de la Biodiversidad, Instituto de Investigación de Recursos Biológicos Alexander von Humboldt, Calle 28A # 15-09, Bogotá, D.C., Colombia.
Corresponding author: Andrés Rymel Acosta-Galvis, aacosta@humboldt.org.co

Abstract
This is the first report demonstrating that *Boana tetete* and *B. maculateralis* occur in the Colombian Amazon Basin. These specimens were identified previously as *Boana fasciata*; however, morphology and current distribution records show that the specimens were misidentified. These new records extend the known distribution of the *B. tetete* 630 km north from nearest locality in the Ecuadorian Amazon and 420 km for *B. maculateralis*. An updated map of current distribution and ecoregional areas in Amazonian is provided.

Key words
Amazonian; *Boana calcarata–fasciata* complex; new records; morphology; museum specimens.

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Introduction

The genus *Boana* Gray, 1825 consists of 92 species distributed throughout Central and South America (Frost 2017). Amazonian frogs of the *Boana calcarata–fasciata* species complex currently consist of 8 formally described species: *B. alfaroi* (Caminer & Ron, 2014); *B. almendarizae* (Caminer & Ron, 2014); *B. calcarata* (Troschel, 1848); *B. dentei* (Bokermann, 1967); *B. fasciata* (Günther, 1858); *B. maculateralis* (Caminer & Ron, 2014); *B. steinbachi* (Boulenger, 1905); and *B. tetete* (Caminer & Ron, 2014) (Caminer and Ron 2014, Carvalho et al. 2017). Also, at least 5 unconfirmed candidate species have been reported (Funk et al. 2011, Caminer and Ron 2014).

The taxonomic status of populations in the *calcarata–fasciata* species complex in Colombia has not been evaluated; only 2 species are currently recognized: *B. calcarata* and *B. fasciata* (Acosta 2017). Four specimens of *Boana* deposited in reference collections of Amphibian collection of the Alexander von Humboldt Biological Resources Research Institute (IAvH-Am) were preliminarily identified as *B. fasciata*. However, diagnostic characters described in the taxonomic revision by Caminer and Ron (2014) indicate that those Colombian specimens are not that species. This revised identification is also consistent with the geographical distribution of *B. fasciata*, which is restricted to southern Ecuador and northern Peru (Caminer and Ron 2014). Morphological examination of the specimens indicate that they belong to *B. tetete* and *B. maculateralis*. Herein we document those records, which are the first known occurrences of both species for Colombia.

Methods

Specimens were collected using the active manual capture method along a terrestrial transect associated with riparian habitat. Specimens were euthanized using a solution of Clorethone and fixed in 10% formalin, then transferred and stored in 70% ethanol. Voucher specimens are deposited in the amphibian collection of the Alexander von Humboldt Biological Resources Research Institute (IAvH-Am), Villa de Leyva, Boyacá Department, Colombia. The specimens were identified using the original species' descriptions of the *Boana calcarata–fasciata* species complex (Caminer and Ron 2014). Morphometric measurements were made with digital calipers (nearest 0.01 mm) for adult specimens following Caminer and Ron (2014). An updated occurrence map of *B. tetete* and *B. maculateralis* in the Amazonian region, based on collection data, was generated using Arc-GIS version 10.2.1. Specimens were collected under permits issued to the Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH) (Decree 1376 of 2013).

Results

Boana tetete (Caminer & Ron 2014)
Figure 1

New record. Colombia: Department of Amazonas: Municipality of Puerto Nariño, La Lupuna stream (or Caño La Lupuna), at La Hacienda, near the Loretoyacu river (03°46′9.2″ S, 070°22′42.6″ W, 98 m above sea level, Fig. 5) 28 September 2017, CAL and MAMB collectors (IAvH-Am-14856).

This specimen is the first record of *B. tetete* in Colombia. The nearest previously known record is from San Jacinto, Loreto region, Peru (Caminer and Ron 2014), which is about 630 km away (Fig. 5).

Identification. *Boana tetete* is a small frog (SVL 31.1–45.8 mm) that can be distinguished from other species of the *B. calcarata–fasciata* complex (i.e. *B. alfaroi*, *B. calcarata, B. dentei, B. fasciata, B. maculateralis*, and *B. steinbachi)* by the following set of morphological characters (Caminer and Ron 2014, Carvalho et al. 2017): small tubercle present on heel (Fig. 2) (calcar large and triangular in *B. maculateralis* and *B. calcarata*; small and conical in *B. fasciata*); larger tympanum (relative tympanum diameter/SVL = 0.08 vs 0.06 in *B. alfaroi*); supernumerary tubercles on the hands not prominent or abundant (Fig. 3) (prominent and abundant in *B. steinbachi*; Caminer and Ron 2014: 28); and hidden surfaces of thighs (Fig. 4) and flanks with dark brown irregular spots (dark brown blotches in *B. maculateralis* (Fig. 4), but black transverse stripes in thighs in *B. dentei* sensu Bokermann (1967) and dark brown vertical bars in *B. calcarata* and *B. fasciata*).

Natural history. The specimen of *B. tetete* (IAvH-Am-14856, SVL = 33.6 mm, TD = 2.97 mm, TD/SVL = 0.08, Fig. 1) was collected during a rainy night between 21:00–22:00 h, the individual was found perched on shrubby vegetation about 1 m high on the margins of La Lupuna stream in a secondary forest associated with low hills. La Lupuna stream, a tributary of the Loretoyacu river (black water), is 1.5 m wide, 20 cm deep, and with clear waters (pH = 5.3; conductivity = 27uS/cm; total dissolved solids = 15 ppm; temperature = 29 °C).

Boana maculateralis (Caminer & Ron 2014)
Figure 1

New records. Colombia: Department of Amazonas: Municipality of Leticia, Amacayacu National Natural Park (03°48′25.10″ S, 070°18′11.7″ W, 80 m above sea level, Fig. 5), 9 September 1987, Oscar Pinto collector (IAvH-Am-4518, SVL= 38.12 mm). Department of Meta: Sierra de la Macarena National Natural Park, northern limit of the Amazon basin at the mouth of Caño Cabra (02°25′26.34″ N, 073°04′18.4″ W, 196 m above sea level, Fig. 5), collected by José Vicente Rueda Almonacid on 1983 (adult males, IAvH-Am-2391 and IAvH-Am-2417, SVL= 34.41 and 36.44 mm respectively).

These specimens represent the first records for Colombia of *B. maculateralis* from two distant localities in the Amazon basin (Fig. 5). The closest previously known records are from Río Napo, La Primavera sector, Orellana province, Ecuador (Caminer and Ron 2014), which are 420 km and 824 km from the Sierra of Macarena and Amacayacu National Natural Park, respectively (Fig. 5).

Identification. *Boana maculateralis* is a small frog (SVL 31.8–55.3 mm) that can be distinguished from other species by the following set of morphological characters (Caminer and Ron 2014): calcar large and triangular (Fig. 2) (calcar absent, only small tubercle present in *B. alfaroi* and *B. tetete*; small and conical in *B. fasciata*); supernumerary tubercles on the hands not prominent or abundant (Fig. 3) (prominent and abundant in *B. steinbachi*); hidden surfaces of thighs (Fig. 4) and flanks with dark brown blotches (dark brown irregular spots in *B. alfaroi* and *B. tetete*; thighs with black transverse stripes in *B. dentei* sensu Bokermann 1967 and with dark brown vertical bars in *B. calcarata* and *B. fasciata*).

Discussion

With this report of 2 additional species of *Boana* in Colombia, the number of species is increased to 23. Our finding of misidentified museum specimens points to the need to pursue exhaustive revision of material identified as *B. calcarata* and *B. fasciata* in Colombian collections, which will help better determine the geographic range of *B. tetete* and *B. maculateralis*. In Colombia, the *Boana calcarata–fasciata* species complex may also include *B. alfaroi* and other undescribed candidate species.

However, the lack of genetic data, live specimens, and vocalizations are some clear limitations when studying old museum specimens, and Caminer and Ron (2014)

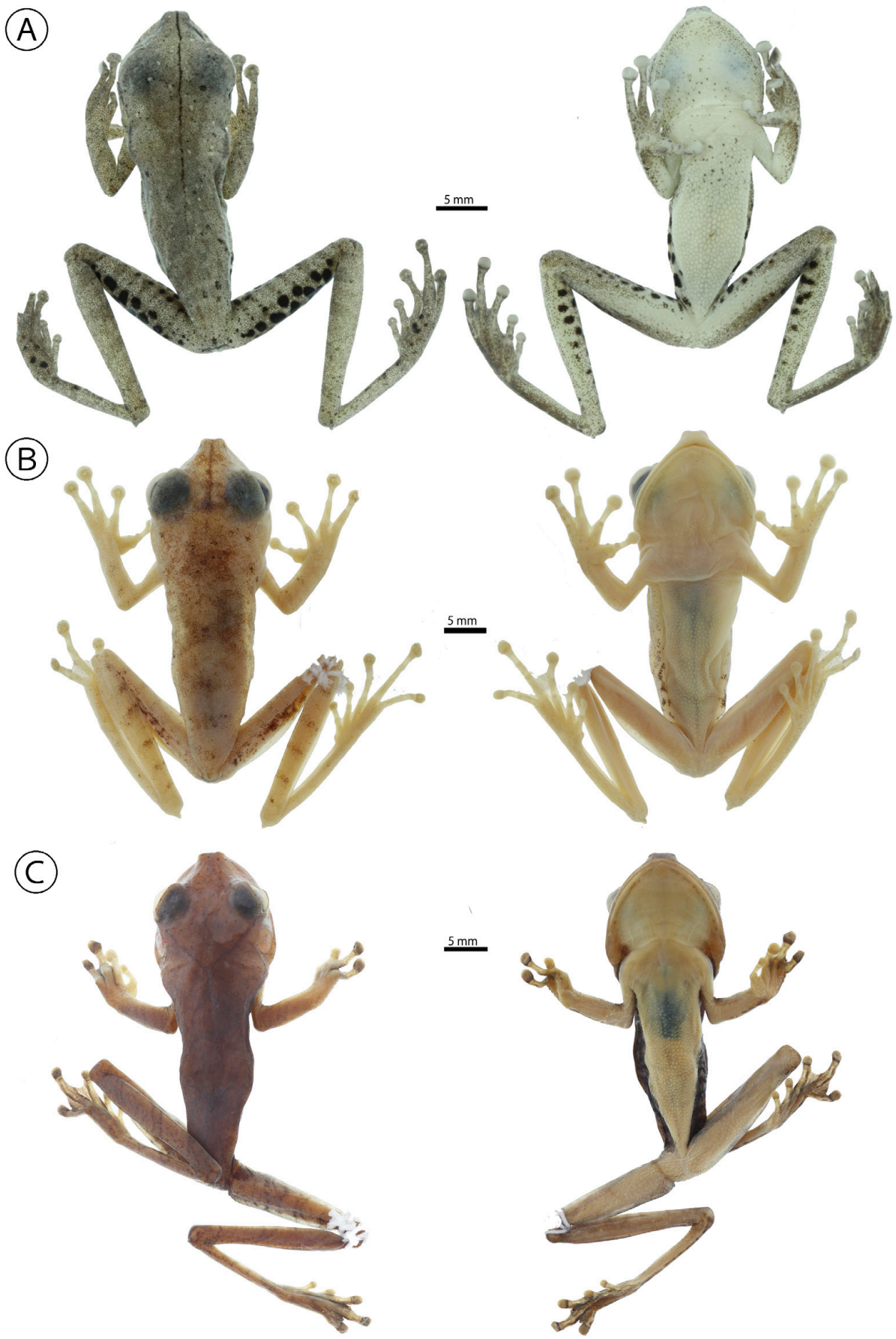


Figure 1. Dorsal (left) and ventral (right) views of species of *Boana calcarata-fasciata* complex in Colombia. **A.** *B. tetete* (IAvH-Am-14856, SVL 33.6 mm) from Caño La Lupuna, Amazonas department. **B.** *B. maculateralis* (IAvH-Am-2417, SVL 36.4 mm) from Caño Cabra, Meta department. **C.** *B. maculateralis* (IAvH-Am-4518, SVL 38.12 mm) from Amacayacu National Natural Park, Amazonas department. (Photographs: Andrés Acosta.)

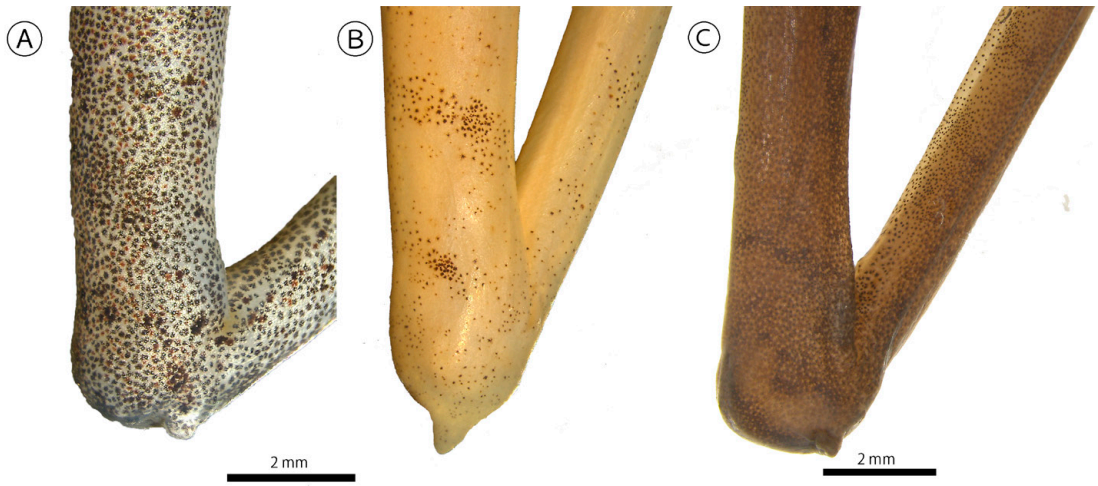


Figure 2. Dorsal view of calcar of the species of *Boana calcarata–fasciata* complex in Colombia. **A.** *B. tetete* (IAvH-Am-14856) from Caño La Lupuna, Amazonas department. **B.** *B. maculateralis* (IAvH-Am-2417) from Caño Cabra, Meta department. **C.** *B. maculateralis* (IAvH-Am-4518, SVL 38.12 mm) from Amacayacu National Natural Park, Amazonas department. (Photographs: Andrés Acosta.)

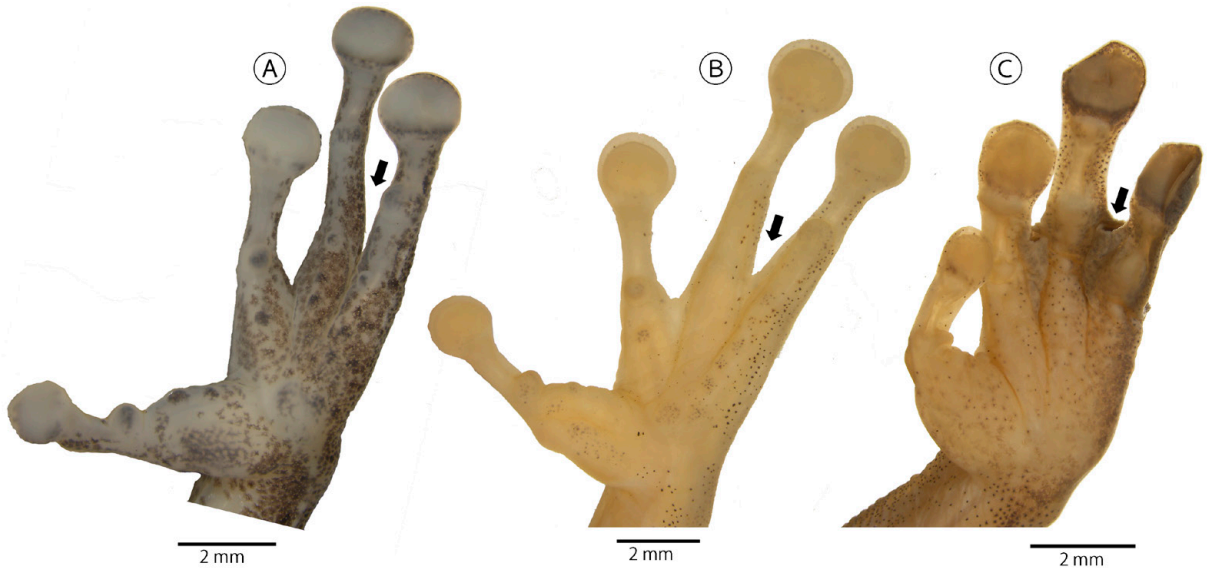
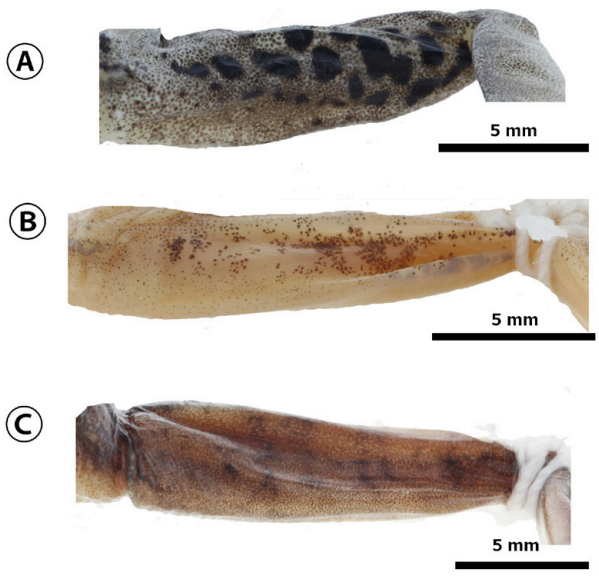


Figure 3. Ventral view of hands of the species of *Boana calcarata–fasciata* complex in Colombia. **A.** *B. tetete* (IAvH-Am-14856) with basal webbing on the fingers. **B.** *B. maculateralis* (IAvH-Am-2417) from Caño Cabra, Meta department, with basal webbing on the fingers. **C.** *B. maculateralis* (IAvH-Am-4518) from Amacayacu National Natural Park, Amazonas department, with basal webbing on the fingers, except fingers III and IV (see arrow). (Photographs: Andrés Acosta.)



noted that the limited number of distinctive morphological characters between *B. alfaroi* and *B. tetete* may result in the misidentification of museum specimens. Our identifications rely on morphological characters exclusively. We used the ratio between TD and SVL to differentiate *B. alfaroi* and *B. tetete*. Nevertheless, the identification of *B. maculateralis* based on the available morphological characters leads to conclusive diagnosis of this species, although other features (e.g. degree of webbing between fingers III and IV; Fig. 3) might raise doubts and guide

◂ **Figure 4.** Posterior thigh of the species of *Boana calcarata–fasciata* complex in Colombia. **A.** *B. tetete* (IAvH-Am-14856) with dark brown irregular spots. **B.** *B. maculateralis* (IAvH-Am-2417) from Caño Cabra, Meta department, with dark brown blotches. **C.** *B. maculateralis* (IAvH-Am-4518) from Amacayacu National Natural Park, Amazonas department, with dark brown blotches. (Photographs: Andrés Acosta.)

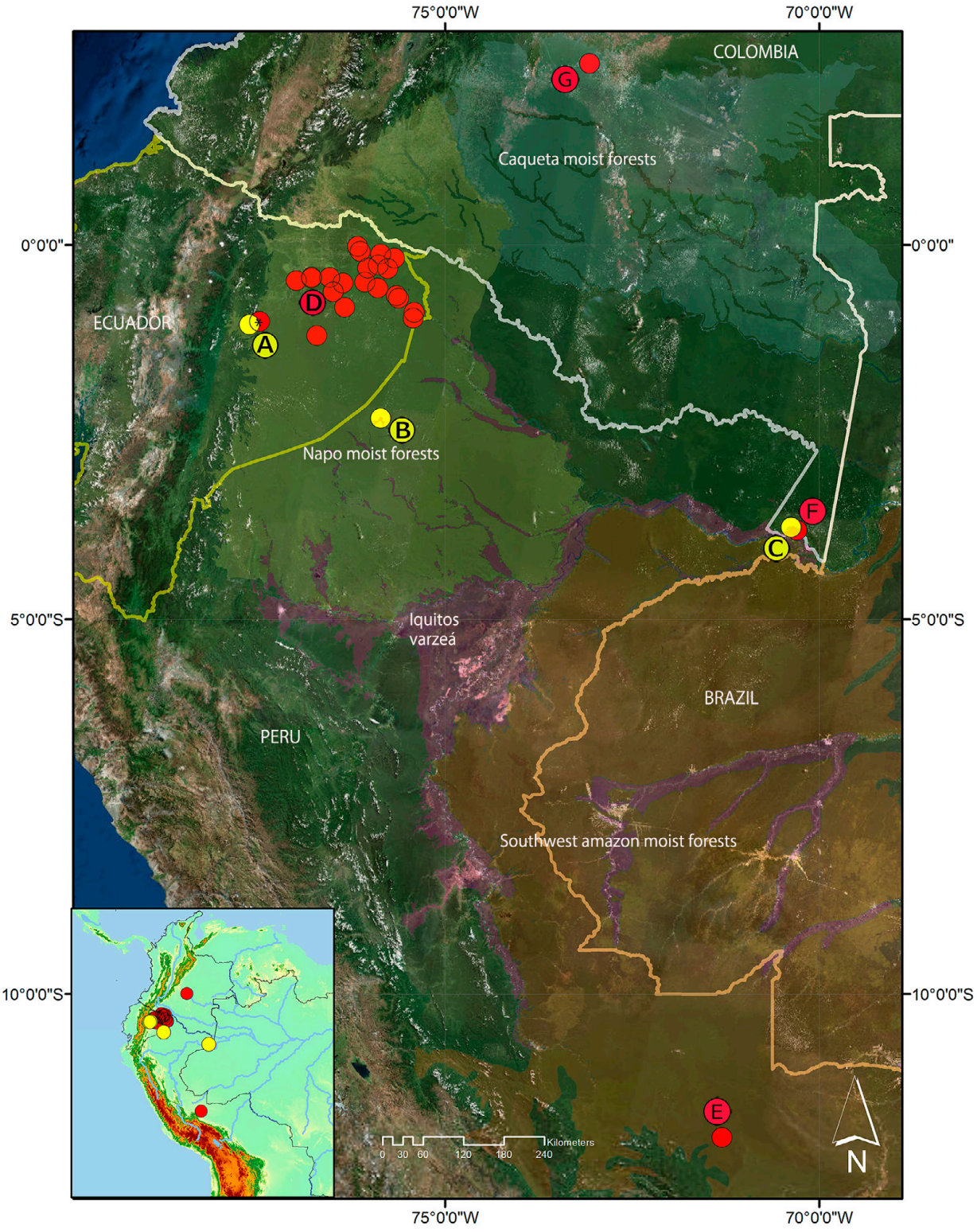


Figure 5. Current geographical distribution of *Boana tetete* (yellow dots) in the Amazonian basin. A) Previous Ecuadorian localities published in the original description (*type locality) (Caminer and Ron 2014). B) Peruvian locality reported in San Jacinto, Region of Loreto (Caminer and Ron 2014). C) New record IAvH-Am-14856 from Caño (Creek) La Lupuna, afferent to Loretoyacu River, Puerto Nariño Municipality in Colombia. Current geographical distribution of *B. maculateralis* in Amazonian basin (red dots). D) Previous Ecuadorian localities published in the original description (*type locality) (Caminer and Ron 2014). E) Peruvian locality reported in Manu National Park, Region of Madre de Dios (Caminer and Ron 2014). F) New record (IAvH-Am-4518) from Amacayacu National Natural Park (Amazonas Department, Colombia). G) New records (IAvH-Am-2391 and IAvH-Am-2417) from Caño Cabra (Meta Department, Colombia).

the exploration of candidate species in Colombian populations.

Boana tetete was originally described from 3 localities in Ecuador and Peru (Caminer and Ron 2014), with records located in the Tropical Moist Broadleaf Forest biome. In addition to this biome, ecoregional criteria (Olson et al. 2001) confirm that *B. tetete* occupies the Napo Moist Forests and Iquitos Varzeá ecoregions; there is the possibility that the range of this species extends to other ecoregions in the Amazonian basin (Fig. 5).

In contrast, *B. maculateralis* was previously reported from 24 localities in Ecuador and Peru (Caminer and Ron 2014). This species has a widespread distribution within the Amazon basin and was previously known from the Tropical Moist Broadleaf Forests biome and 3 ecoregions (Napo Moist Forests, Iquitos Varzeá, and Southwest Amazon Moist Forests). The record from Macarena extends this species' range into the Caquetá Moist Forests ecoregion (Fig. 5).

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Authors' Contributions

ARA identified and photographed the specimen; ARA and CAL wrote the manuscript and reviewed the manuscript text; CAL and MAMB collected the specimen and ecological data.

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