

A new poison frog of the genus *Epipedobates* (Dendrobatoidea: Dendrobatidae) from the north-western Andes of Ecuador

Diego F. Cisneros-Heredia^{1,2,*}, Mario H. Yáñez-Muñoz²

¹*Colegio de Ciencias Biológicas y Ambientales, Universidad San Francisco de Quito. Diego de Robles y Vía Interoceánica, Quito, Ecuador.*

²*Museo Ecuatoriano de Ciencias Naturales, División de Herpetología Calle Rumipamba 341 y Av. de Los Shyris. Casilla Postal 17-07-8976, Quito, Ecuador*

**Autor principal/Corresponding author, e-mail: dcisneros@usfq.edu.ec*

Editado por/Edited by: C. Zambrano, Ph.D.

Recibido/Received: 07/28/2010. Aceptado/Accepted: 10/02/2010.

Publicado en línea/Published on Web: 12/08/2010. Impreso/Printed: 12/08/2010.

Abstract

We describe a new species, *Epipedobates darwinwallacei* sp. nov., from the area of Mindo, on northwestern Ecuador. It inhabits low montane forests in an elevational range of about 1250-1390 m. It differs from all congeneric species by its strong aposematic coloration and tarsal keels. Among species of *Epipedobates*, the new species has been confused with *E. boulengeri* and *E. espinosai*, but it differs from them by its dorsal coloration with bright orange to yellow spots.

Keywords. *Epipedobates darwinwallacei* sp. nov., Pichincha, Mindo, Aposematism, poison frog.

Abstract

Describimos una nueva especie, *Epipedobates darwinwallacei* sp. nov., del área de Mindo en el noroccidente del Ecuador. Habita los bosques montanos bajos en un rango elevacional de 1250-1390 m. Difiere de todas las especies congénicas por su fuerte coloración aposemática y quillas tarsales. Entre las especies de *Epipedobates*, la nueva especie ha sido confundida con *E. boulengeri* y *E. espinosai*, pero difiere de ellas por su coloración dorsal con manchas anaranjadas y amarillas.

Palabras Clave. *Epipedobates darwinwallacei* sp. nov., Pichincha, Mindo, aposematismo, rana venenosa.

Introduction

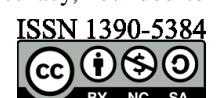
An extensive and detailed phylogenetic revision, based on phenotypic and molecular evidence, recently proposed the creation of the anuran superfamily Dendrobatoidea with two families within it, Aromobatidae and Dendrobatidae [1]. Dendrobatoidea includes some of the most colourful and toxic anurans, commonly called poison frogs or dart-poison frogs. Members of this subfamily are restricted to tropical America, where although widely studied, several species remain undescribed [1, 2]. We are still far from a complete understanding of the evolution, ecology, and biogeography of this clade of amphibians. The genus *Epipedobates*, member of the family Dendrobatidae, currently includes six species distributed across the Pacific lowlands and western Andean slopes of southern Colombia, Ecuador, and northern Peru; i.e. *Epipedobates anthonyi* (Noble), *E. boulengeri* (Barbour), *E. espinosai* (Funkhouser), *E. machalilla*

(Coloma), *E. narinensis* Mueses-Cisneros, Cepeda-Quilindo, and Moreno-Quintero; and *E. tricolor* (Boulenger) [1, 3].

Expeditions to the north-western Andean slopes of the province of Pichincha, Ecuador, conducted independently by Universidad San Francisco de Quito and Museo Ecuatoriano de Ciencias Naturales, resulted in the discovery of a new species of *Epipedobates*, previously confused with *Epipedobates espinosai*, which we are pleased to describe herein.

Methodology

Format of the description, measurements, and terminology follow suggestions presented by Grant et al. [1] and Mueses et al. [5]. We use the widespread numbering of fingers from I to IV. Measurements were taken with a digital calliper (0.05 mm accuracy, rounded to



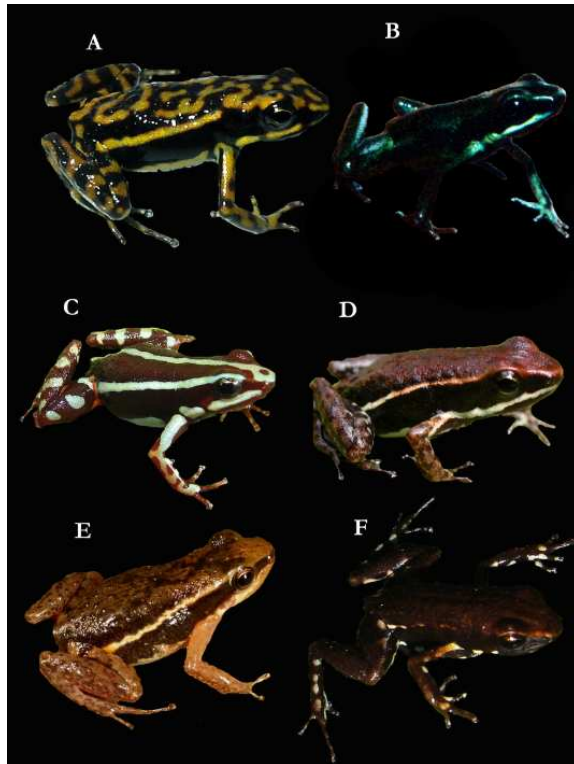


Figure 1: Some species of *Epipedobates* for comparison with (A) *Epipedobates darwinwallacei* sp. nov. (holotype); (B) *E. narinensis*; (C) *E. anthonyi*; (D) *E. boulengeri*; (E) *E. machalilla*; (F) *E. espinosai*.

the nearest 0.1 mm). Colour in life was taken from field notes and photographs. The new species was compared with published descriptions and museum specimens (Appendix I) deposited in the Museo Ecuatoriano de Ciencias Naturales, División de Herpetología, Quito (DHMECN) and Universidad San Francisco de Quito (DFCH-USFQ). Sex and maturity were determined by direct examination of the gonads. Specimens were euthanized using regular toothache pain-relief gel containing 20% benzocaine, fixed in 10% formalin, and preserved in 75% ethanol.

Epipedobates darwinwallacei sp. nov.

Phyllobates boulengeri: Silverstone, 1976: 29 (in part).

Epipedobates sp. F: Santos et al. (2003: Table 1), Graham et al. 2004.

Epipedobates espinosai: [1]: 221 (in part).

Holotype

DHMECN 5854, adult female collected at Saragoza-Río Cinto (78°45'15.7"W, 00°07'44.1"S, 1390 m), on the Lloa-Mindo old road, provincial de Pichincha, República del Ecuador, by Mario Yáñez-Muñoz and Salomón Ramírez J. on 16 September 2008.

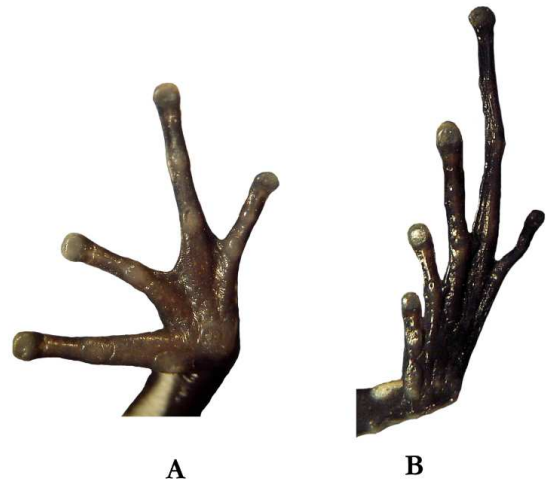


Figure 2: Hand and foot of *Epipedobates darwinwallacei* sp. nov. (holotype).

Paratypes

DHMECN 5849–53, 5855–56, adult females with same data as holotype. DFCH-USFQ 3408–3410, adult females, 3411 adult male, Hostería El Carmelo de Mindo, c. 1 km from the town of Mindo (78°46'W, 00°03'S, c. 1250 m), provincia de Pichincha, Ecuador.

Referred specimens

Additional Ecuadorian specimens (not seen by us) referred by Silverstone [6: 29] to *Phyllobates boulengeri*, from Tandapi, Río Blanco, and San Miguel de Los Colorados, province of Pichincha; by Santos et al. [7] as *Epipedobates* sp. F, from Mindo, province of Pichincha; and by Grant et al. [1] as *Epipedobates espinosai* from "Santo Domingo de los Colorados, Bypass Road".

Diagnosis

Epipedobates (SVL 13.0–19.5 mm in 11 females, SVL 16.6 in one male), Finger I longer than Finger II; Finger III swollen in adult males; basal webbing between toes II, III, and IV; short metatarsal fold; finely-granular dorsal skin; dorsum black with bright orange to yellow spots in life; length of oblique lateral stripe partial and structure varies from solid to formed by series of spots; ventrolateral line formed by series of interconnected spots to solid; throat dark with pale medial longitudinal stripe or spot; venter dark with large orange spotting; tarsal keel straight or weakly curved extending proximolateral from preaxial edge of inner metatarsal tubercle or short, tuberclelike, transversely across tarsus, not extending from metatarsal tubercle.

Epipedobates darwinwallacei differs from all congeneric species by its coloration and tarsal keels. *Epipedobates anthonyi* and *E. tricolor* have dorsal and oblique lateral stripes light and solid, inguinal and posterior calf region orange, tarsal keel large and strongly curved. *Epipedobates machalilla* differs by the dorsum pale olive brown with dark brown marking, oblique lateral stripe solid

	Sex	SVL	HL	HW	IOD	EW	ED	IND	TD	TL	FL	HdL	FAL
MECN 5849	F	18,7	7,0	6,2	2,2	1,7	2,3	1,8	1,2	8,3	7,4	5,5	3,8
MECN 5850	F	13,0	5,8	4,1	1,4	1,1	1,8	1,3	0,7	6,1	5,8	2,7	2,7
MECN 5851	F	19,7	7,4	6,0	2,5	1,7	2,9	1,7	1,4	8,7	9,1	5,8	5,2
MECN 5852	F	16,8	7,7	5,5	2,1	1,3	2,2	1,6	1,1	8,7	8,3	3,9	4,1
MECN 5853	F	16,4	6,5	5,1	1,6	1,3	2,3	1,4	1,0	7,7	7,9	3,6	4,0
MECN 5854	F	19,5	7,7	6,9	2,2	1,1	3,0	2,0	1,1	8,8	8,7	5,3	4,5
MECN 5855	F	18,5	6,3	5,4	1,5	1,4	2,4	1,6	1,2	8,2	8,4	5,3	4,1
MECN 5856	F	15,8	6,7	5,2	4,5	1,0	2,6	1,7	1,1	8,3	8,3	4,5	3,8
DFCH-USFQ 3408	F	18,5	6,8	6,2	2,2	1,5	2,3	1,8	1,2	8,2	7,1	5,3	3,7
DFCH-USFQ 3409	F	17,4	6,5	6,0	2,0	1,6	2,2	1,5	1,1	7,6	8,2	4,9	3,9
DFCH-USFQ 3410	F	16,5	7,1	5,1	1,7	1,2	2,4	1,6	1,0	8,3	8,0	4,0	3,9
DFCH-USFQ 3411	M	16,6	7,0	5,2	1,7	1,3	2,4	1,5	1,0	8,1	7,9	3,7	4,0

Tabla 1: Measurements of the type series of *Epipedobates darwinwallacei* sp. nov. in mm. Abbreviations: SVL = Snout-vent length, HL = head length, HW = head width, IOD = interocular distance, EW = eye width, ED = eye diameter, IND = internarial distance, TD = tympanum diameter, TL = tibia length, FL = foot length, HdL = hand length, FAL = forearm length. Female = F, male = M.

and complete, inguinal and posterior calf regions yellow or yellowish-orange, tarsal keel large and strongly curved. *Epipedobates boulengeri* has a dorsum uniformly dark brown to dark red, lateral oblique stripe complete and solid, solid labial stripe, venter whitish-blue with dark spotting / reticulation / marbling, tarsal keel large and strongly curved. *Epipedobates espinosai* has a dorsum copper-brown to dark red with lateral oblique and labial stripes formed by a series of spots and incomplete, venter dark with whitish-blue, blue, or turquoise spotting / reticulation, tarsal keel large and strongly curved. *Epipedobates narinensis* differs by its dorsum uniformly green with lateral oblique and labial stripes complete, tarsal keel large and strongly curved, venter light-green with dark reticulation/marbling.

Description of the holotype

Dorsal surfaces of head and body finely granular; post-trical tubercles absent; ventral skin smooth; cloacal tubercles absent. Snout slightly beyond anterior border of mandible; snout projected in lateral view, slightly rounded in dorsal view; nares not visible dorsally; tympanic membrane concealed under skin, tympanic annulus weakly apparent on its anteroventral part, tympanic fold absent; *canthus rostralis* rounded or poorly defined; loreal region slightly concave.

Fingers relative length III>I>II>IV; Finger III not swollen in female holotype. Thenar tubercle flat but noticeable, rounded and located on external border at base of thumb; palmar tubercle large, flat and rounded; one subarticular tubercle well-defined on fingers I and II, and two on fingers III and IV; distal tubercles poorly defined and less-protuberant; lacking webbing among fingers; supernumerary tubercles absent; fingers with lateral fringes.

Toes relative length IV>III>V>II>I; toes with lateral fringes, with basal webbing between toes II, III, and IV; inner metatarsal tubercles oval; outer metatarsal tubercle rounded and prominent; subarticular tubercles prominent, one on toes I and II, two on toes III and V, and three on toe IV; quilla tarsal finamente curvo, extendiéndose desde el tubérculo metatarsal interno. Tarsal keel straight or weakly curved extending proximolateral from preaxial edge of inner metatarsal tubercle.

Colour in life

Dorsal background black to dark brown with bright yellow to orange spots (sometimes forming reticulations), and bright yellow to orange partial oblique lateral stripe. Ventrolateral line formed by yellow spots. Throat dark with yellow pale medial longitudinal stripe. Venter dark with large orange spotting.

Colour in preservative.

Dark dorsal background with cream spots (sometimes forming reticulations), and cream partial oblique lateral stripe. Ventrolateral line formed by cream spots. Throat dark with cream pale medial longitudinal stripe. Venter dark with large cream spotting.

Variation

Measurements of the type series are presented in Table 1. Most features are conservative in their morphology, the largest variation being observed in the tarsal keel, which is straight or weakly curved and extending proximolateral from preaxial edge of inner metatarsal tubercle; or short, tuberclelike, transversely across tarsus, not extending from metatarsal tubercle. Swollen third finger in males. Chromatic variation is most evident in the structure of the oblique lateral stripe that varies from solid to formed by series of spots; dorsal colouration varies in size and intensity of orange (cream in preservative) spots; in some specimens the spots of some specimens are reduced, not forming a reticulum, while in other the spots get fused forming a medial line; throat may have just a median line or additional spots; flanks vary having yellow (cream in preservative) spots to uniformly dark (the last one if the most common condition).

Distribution and natural history

Epipedobates darwinwallacei occurs on the western slopes of the Cordillera Occidental of the Andes in north-western Ecuador, at known elevations of 1250–1390 m. It was found on the floor by day, on abandoned pastures near forest borders, inside *Guadua* patches, secondary and primary forest, always next to or inside slow-flowing marshes and streams. Individuals were seen moving actively among the grass and leaf litter, and sometimes (especially when chased) they would jump into water.

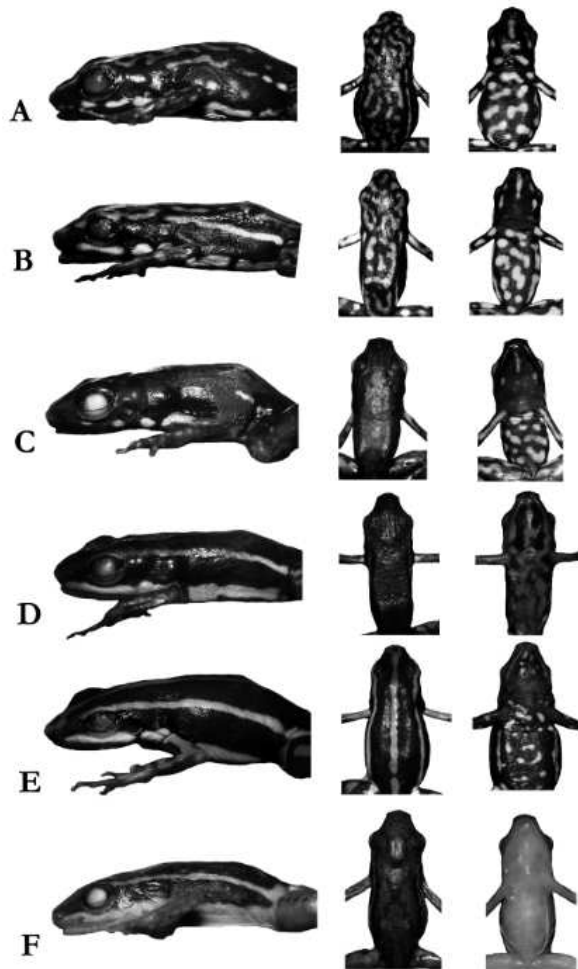


Figure 3: Lateral (left), dorsal (central), and ventral (right) views of some species of *Epipedobates* for comparison with (A and B) *Epipedobates darwinwallacei* sp. nov.: (C) *E. espinosai*; (D) *E. boulengeri*; (E) *E. anthonyi*; (F) *E. machalilla*.

At night, some specimens (probably sleeping) were found perching on leaves of herbs 5 cm over the floor, close to streams. *Epipedobates darwinwallacei* was found microsympatric with *Pristimantis achatinus*, *Dendropsophus carnifex*, and *Leptodactylus ventrimaculatus*.

Etimology

The specific epithet of this new species is a patronym for Charles Darwin and Alfred Russel Wallace, the two British naturalists that independently proposed the processes of natural selection as a key mechanisms of evolution [4]. Their work are not only the foundation of modern biology and reshaped our understanding and development of life sciences, but is responsible for the acceptance of a secular explanation of the world, revolutionising our thinking about the past, present, and future, and the role of humans within it. "Almost every component in modern human's system is somehow affected by one or another of their conceptual contributions. There can be no doubt that the thinking of every modern human has been profoundly affected by their philosophical thought" (Mayr [8]).

Etimology Remarks

Epipedobates darwinwallacei was previously confused with *E. boulengeri* and *E. espinosai*. However, both species are clearly different. The status of *E. espinosai* is controversial, but a recently discovered population near the type-locality of the species seems to correspond to *E. espinosai*, further information will be published elsewhere.

Appendix 1: Additional examined material *Epipedobates boulengeri*: USFQ-ACRL 002, 011, 015, 029, 031, 033, 043, 063-64, 068-72, 074, 084-85, 087-88, 101, 108, 110, 114, 118-9, 129, 135, 144, 158-9, 169-171, 173, 175, 184, 188. *Epipedobates espinosai*: DHMECN 04367. *Epipedobates machalilla*: DFCH-USFQ 0365-367.

References

- [1] Grant, T., Frost, D., Caldwell, J., Gagliardo, R., Haddad, C., Kok, P., Means, D., Noonan, B., Schargel, W., and Wheeler, W. 2006. "Phylogenetic systematics of dart-poison frogs and their relatives (amphibia: Athesphatana: Dendrobatidae)". *Bulletin of the American Museum of Natural History*. 299, 1-269.
- [2] Lötters, S., Jungfer, K., Hekel, F., and Schmidt, W. 2007. "Poison frogs". *Biology, species & captive husbandry*.
- [3] Frost, D. 2010. "Amphibian species of the world: an online reference". *American Museum of Natural History*. 6-18.
- [4] Darwin, C. and Wallace, A. 1858. "On the tendency of species to form varieties; and on the perpetuation of varieties and species by natural means of selection". *Proceedings of the Linnean Society of London*. 3, 46-50.
- [5] Mueses-Cisneros, J. J., Cepeda Quilindo, B., Moreno-Quintero, V. 2008. "Una nueva especie de *Epipedobates* (Anura: Dendrobatidae) del sur-occidente de Colombia". *Papéis Avulsos de Zoologia São Paulo*. 48 (1), 1-10.
- [6] Silverstone, P. A. 1976. "A revision of the poisson-arrow frogs of the genus *Phyllobates* Bibron in Sagra (Family Dendrobatidae)". *Natural History Museum of Los Angeles County Science Bulletin*. 27, 1-53.
- [7] Santos, J. C., Coloma, L. A., Cannatella, D. C. 2003. "Multiple, recurring origins of aposematism and diet specialization in poison frogs". *Proceedings of the National Academy of Sciences*. 100, 12792-12797.
- [8] Mayr, E. 2001. "The Philosophical Foundations of Darwinism". *Proceedings of the American Philosophical Society*. 145 (4), 488-495.