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ARTÍCULO/ARTICLE SECCIÓN/SECTION B

# A new Andean Toad of the genus *Osornophryne* (Amphibia: Anura: Bufonidae) from northwestern Ecuador, with taxonomic remarks on the genus

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## Abstract

We describe a new species of Andean toad of the genus *Osornophryne* from montane cloud forests of northwestern Ecuador between 2500–2750 m above sea level. The new species is characterized by moderately large size (snout-vent length 32.5–36.0 mm in adult females, 21.1–23.2 mm in adult males), dorsal skin highly rugose with scattered irregular warts, dorsolateral ridges of round or oblong glandular warts, venter with clusters of flattened pustular warts, angular rostrum shaped like a four-sided pyramid protruding in dorsal and lateral views but not forming a proboscis, smooth borders of transverse processes of presacral vertebrae, a dark brown dorsum in life with ochre-brown warts, dorsolateral ridges maroon-brown, and abundant pale salmon spots on the venter. We suggest that it be classified as Endangered under IUCN criteria, because of its small distributional, narrow altitudinal range subjected to habitat loss and fragmentation. We discuss different aspects of taxonomy, natural history, and distribution of the different species of *Osornophryne*. In particular, we comment on the importance of morphological, chromatic, and molecular analyses that take into consideration ontogenic and dimorphic variation among species of *Osornophryne*.

**Keywords.** Anura; Conservation; Distribution; Ecuador; *Osornophryne antisana*; *Osornophryne bufoniformis*; *Osornophryne guacamayo*; *Osornophryne occidentalis* new species; *Osornophryne sumacoensis*; *Osornophryne talipes*; Taxonomy; Variation.

## Abstract

Describimos una nueva especie de sapo Andino del género *Osornophryne* de los bosques montano nublados del noroccidente de Ecuador entre 2500–2700 m sobre el nivel del mar. La nueva especie se caracteriza por su tamaño moderadamente largo (longitud hocico-cloaca 32.5–36.0 mm en hembras adultas, 21.1–23.2 mm en machos adultos), piel del dorso muy rugosa con verrugas irregularmente distribuidas, pliegues dorsolaterales compuestos de verrugas glandulares redondas u oblongas, vientre con agrupaciones de verrugas pustulares aplanadas, hocico angular con forma de una piramide tetragonal proyectado en vistas dorsal y lateral pero sin formar una probóscide; bordes del proceso transverso lisos, dorso de color café oscuro en vida con pliegues dorsolaterales y verrugas café marrón y abundantes puntos salmón palido en el vientre. Esta nueva especie es el único *Osornophryne* conocido que vive en las laderas occidentales de los Andes y recomendamos que sea clasificado como En Peligro bajo los criterios de la UICN debido a su reducido rango de distribución que esta bajo fuerte presión debido a la pérdida de habitat y fragmentación. También discutimos sobre diferentes aspectos de la taxonomía, historia natural y distribución de las diferentes especies de *Osornophryne*. En particular, comentamos sobre la importancia de detallados analisis morfológicos, cromaticos y moleculares que tomen en consideración la variación ontogénica y dimórfica para clarificar el complejo estado de la identidad de algunas especies de *Osornophryne*.

**Palabras Clave.** Anura; Conservación; Distribución; Ecuador; *Osornophryne antisana*; *Osornophryne bufoniformis*; *Osornophryne guacamayo*; *Osornophryne occidentalis* nueva especie; *Osornophryne sumacoensis*; *Osornophryne talipes*; Taxonomía; Variación.

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## Introduction

Toads of the bufonid genus *Osornophryne* Ruiz-Carranza and Hernandez-Camacho are moderately diversified along the Andes from central Colombia to central Ecuador. They inhabit ecosystems with high humidity and cool temperatures between 2100 and 3700 m above sea level, i.e., montane cloud forest, upper montane forest, timberline areas, and paramos. Eight species of *Osornophryne* have been described and seven of them occur in Ecuador: *Osornophryne antisana* Hoogmoed, *O. bufoniformis* (Peracca), *O. cofanorum* Mueses-Cisneros, Yanez-Muñoz & Guayasamin,*O. guacamayo* Hoogmoed, *O. puruanta* Gluesenkamp & Guayasamin, *O. sumacoensis* Gluesenkamp, and *O. talipes* Cannatella [1, 2, 3, 4, 5, 6, 7]. While most Ecuadorian *Osornophryne* have small ranges and some are known only from their type localities, *O. bufoniformis* has been reported from a large area spanning the departments of Cauca, Huila, Nariño, and Putumayo in Colombia and the provinces of Carchi, Imbabura, Pichincha, Sucumbíos, and Tungurahua in Ecuador [1, 2, 3, 4, 5, 6, 8, 9, 10]. Populations assigned to *O. bufoniformis* in Colombia and Ecuador show extensive phenotypic variation, and, although some researchers consider it as a single highly variable taxon [10] other herpetologists have suggested that it is a species complex (T. Grant and D. F. Cisneros-Heredia in [11]). Most Ecuadorian populations referred to *O. bufoniformis* occur in the eastern Andean highlands and slopes over 2700 m, but a widely disjunct population on the northwestern Andean slopes below 2750 m corresponds to an undescribed species of *Osornophryne*, which we describe herein.

## Methodology

Examined specimens were preserved in 70% ethanol after fixation in buffered 10% formalin. The following measurements (in mm) were taken with digital calipers: snout–vent length (SVL), greatest width of head (at rictus; =HW), postocular head width (measured just behind the eyes; =HWPO), head length (straight line distance from posterior margin of jaw to tip of rostrum; =HL), interorbital distance (straight-line distance between anterior margins of the orbits; =IOD); internarial distance (IND); eye-nostril distance (from anterior margin of orbit to posterior margin of nostril; EN), horizontal eye diameter (ED), greatest width of upper eyelid (perpendicular to medial axis of skull, =UE), nostril-rostrum distance (from anterior margin of nostril to tip of rostrum; NR); hand length from base of thenar tubercle to tip of third finger (HL3); hand length from base of thenar tubercle to tip of fourth finger (HL4); tibia length (TL), foot length (from base of inner metatarsal tubercle to tip of fourth toe; FL4), foot length (from base of inner metatarsal tubercle to tip of fifth toe; = FL5). Sex of specimens was determined by noting the presence of secondary sexual characters (nuptial pads) and by direct observation of the gonads. Color pattern in life was taken from field notes and color photographs. For the diagnosis, we followed the numbered sequence proposed by Yanez-Muñoz et al. [12] (1) head width/head length ratio; (2) snout form in dorsal and lateral view, including the presence of papillae and proboscis, and the form of the canthus rostralis and loreal area; (3) dorsal skin texture; (4) ventral skin texture; (5) flanks texture; (6) description of dorsal glandular folds; (7) description of hind legs; (8) form and characteristics of hands and feet; (9) dorsal and ventral coloration; (10) SVL range for adult females and males. Classification of vegetation formations in Ecuador follows Sierra's system [13].

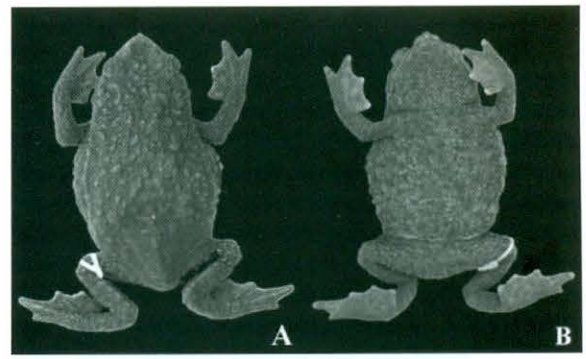


**Figure 1: Holotype of *Osornophryne occidentalis* (DHMECN 3520) in dorsal (A) and ventral (B) views, adult female, SVL = 36.0 mm.**

## Results

### *Osornophryne occidentalis* sp. nov.

*Atelopus bufoniformis* Peracca, 1904 [1] in part; Peters (1973:18–20) [2].
*Osornophryne bufoniformis* (Peracca, 1904) [1] in part; Ruiz-Carranza and Hernandez-Camacho (1976: 124–125) [3]; Cannatella (1986:618–622) [4]; Gluesenkamp (1995: 268–279) [6]; Quiguango (1997:195–209) [14]; Toral et al. (2002:740) [15].

***Holotype:*** DHMECN 3520, adult female (Fig. 1–3), collected on February 2000, near Guarumos, approximately 200 m from the Guarumos guard post on the Nono–Tandayapa road, 11 km WNW of the town of Nono (00°02′*S*, 78°39′*W*, 2550–2600 m), provincia de Pichincha, República del Ecuador, by D.F. Cisneros-Heredia and A. Cardenas.

***Paratypes:*** (4 specimens) ECUADOR: Provincia de Pichincha: adult male (DFCH-USFQ GU036) collected with the holotype. Provincia de Imbabura: Two adult females (QCAZ 9318 and 10141) collected on the farm of F. Rodríguez (00°30′*N*, 78°32′*W*, 2500 m and 2750 m, respectively), W of El Rosario, Cordillera de Toisan, by A. Quiguango et al. in September, 1994. An adult female (QCAZ 36894; Fig. 4) collected on the farm of F. Rodríguez at 2580 m, by A. Gluesenkamp and J. Price on 18 May 1996.

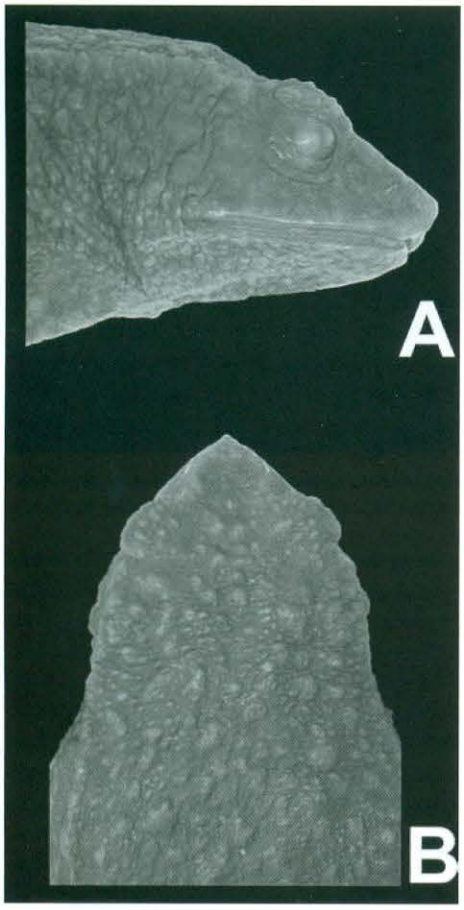


**Figure 2: Head of the holotype of *Osornophryne occidentalis* (DHMECN 3520) in dorsal (A) and lateral (B) views.**

***Referred material:*** (10 juvenile or poorly-preserved specimens) ECUADOR: Provincia de Imbabura: Three males (QCAZ 9319–9321), collected on the farm of F. Rodríguez at 2500 m by A. Quiguango et al. in September, 1994. A juvenile female (QCAZ 36895) collected on the farm of F. Rodríguez at 2580 m on 18 May 1996 by A. Gluesenkamp and J. Price. A juvenile female (KU 132126), collected near La Delicia (00° 22'N, 78° 25'W,
2710 m), Cordillera de Intag [= Cordillera de Toisan]. Provincia de Pichincha: Two juvenile males (FHGO 1907 and 2981) and one female (FHGO 2984), collected near Guantopungo, Parroquia de Yunguilla, buffer-zone of the Maquipucuna Natural Reserve (00° 03'N,
78° 34'W, 2600 m), by K. Taylor on 05 January 1998 and 17 February 1999. A juvenile female (DFCH-USFQ GU034) and a juvenile male (DFCH-USFQ GU035) collected at the type locality in August 2000.

### *Diagnosis*

(1) head wider than long (Table 1, Fig. 2); (2) snout angular in dorsal and lateral views, shaped like four-sided pyramid; tip of snout protracted into broad, conical protuberance, projecting beyond upper jaw but not forming proboscis; canthus rostralis distinct with elevated glandular canthal ridge, straight in dorsal view,

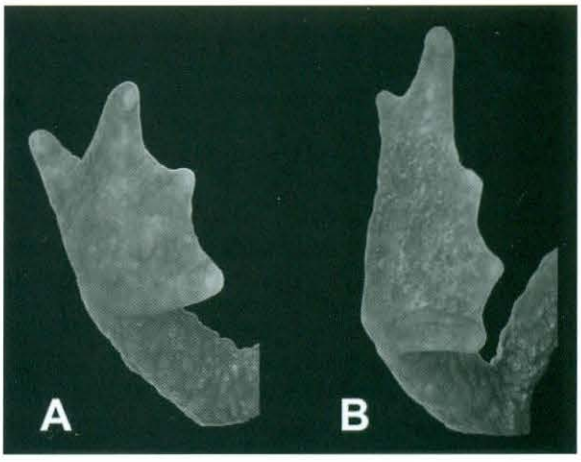


**Figure 3: Hand (A) and foot (B) of the holotype *Osornophryne occidentalis* DHMECN 3520).**

delimiting fairly rectangular, shallow, rugose, tubercular interorbital area (Fig. 2); (3) dorsal skin highly rugose with scattered irregular warts, more dense posteriorly (Figs. 1, 2, 4); (4) ventral skin areolate with clusters of flattened pustular warts; (5) prominent warts on flanks; (6) dorsolateral ridges of round or oblong glandular warts; (7) hind limbs short and stout, when hindlimbs are flexed at right angles to sagittal plane, heels do not touch, and remain widely separated; (8) fingers and toes connected by thick web; fingers III and IV clearly distinct, but just rounded tips of fingers I and II protrude; toes I and II reduced, only rounded tips protrude; Toe III slightly more distinct; Toe IV clearly distinct, well developed, long; toe V reduced but noticeable, rounded tip protrudes at lateral side of Toe IV; (9) dorsal surfaces dark brown in life with warts and dorsolateral ridges ochre-brown, venter maroon-brown with abundant pale salmon spots; (10) moderately large body size (32.5–36.0 mm SVL in adult females, $n = 5$; 21.1–23.2 mm SVL in adult males, $n = 5$).

### *Comparisons*

*Osornophryne occidentalis* is the only species of the genus found in montane cloud forests of western Ecuador. It differs from congeners by the following characters (characters of *O. occidentalis* in parentheses): *O. antisana* has dorsum smooth to shagreen with warts and paravertebral ridges and skin in occipital area relatively smooth (dorsal skin rugose with warts and dorsolateral ridges but without paravertebral ridges, skin of occipital area rugose), tip of snout protracted into fleshy proboscis (tip of snout protracted into broad, conical protuberance, projecting beyond upper jaw but not forming proboscis), and fourth finger and fifth toe shorter and less pointed. *Osornophryne bufoniformis* has snout fairly rounded, broader, less pointed in lateral view, with tip barely pointed (snout angular in lateral view, shaped like four-sided pyramid, with tip of snout protracted into broad, conical protuberance, projected beyond upper jaw but not forming proboscis), canthus rostralis more rounded, less elevated, and curved (canthus rostralis distinct,

| | *Females (n = 5)* Range (Mean ± SD); in mm | *Males (n = 5)* Range (Mean ± SD); in mm |
|---|---|---|
| SVL | 32.5-36.0 (34.5 ± 1.5) | 21.1-23.2 (22.3 ± 0.8) |
| HW/HL | 1.14-1.23 (1.19 ± 0.05) | 1.07-1.12 (1.09 ± 0.02) |
| HW/SVL | 0.32-0.37 (0.034 ± 0.02) | 0.35-0.37 (0.33 ± 0.01) |
| HL/SVL | 0.26-0.32 (0.29 ± 0.03) | 0.33-0.34 (1.09 ± 0.02) |
| IOD/HW | 0.27-0.38 (0.32 ± 0.04) | 0.34-0.38 (0.36 ± 0.02) |
| IOD/HL | 0.33-0.44 (0.38 ± 0.04) | 0.37-0.41 (0.39 ± 0.01) |
| IOD/UE | 1.00-1.46 (1.33 ± 0.18) | 1.26-1.42 (1.33 ± 0.07) |
| IND/IOD | 0.65-1.10 (0.78 ± 0.18) | 0.68-0.78 (0.73 ± 0.04) |
| IND/NR | 1.38-1.87 (1.62 ± 0.20) | 1.43-1.62 (1.53 ± 0.09) |
| EN/HL | 0.16-0.22 (0.19 ± 0.02) | 0.18-0.21 (0.19 ± 0.01) |
| NR/HL | 0.15-0.24 (0.18 ± 0.04) | 0.18-0.19 (0.18 ± 0.01) |
| ED/HL | 0.23-0.31 (0.27 ± 0.03) | 0.22-0.26 (0.24 ± 0.01) |
| ED/IOD | 0.57-0.81 (0.71 ± 0.10) | 0.55-0.67 (0.61 ± 0.05) |
| TL/FL4 | 0.84-1.04 (0.94 ± 0.09) | 0.89-1.15 (0.98 ± 0.11) |
| TL/HL | 0.91-1.26 (1.03 ± 0.14) | 0.87-0.97 (0.91 ± 0.04) |
| TL/SVL | 0.29-0.32 (0.30 ± 0.01) | 0.28-0.32 (0.30 ± 0.01) |

**Tabla 1: Variation of measurements (in mm) of adult *Osornophryne occidentalis*. See text for abbreviations.**

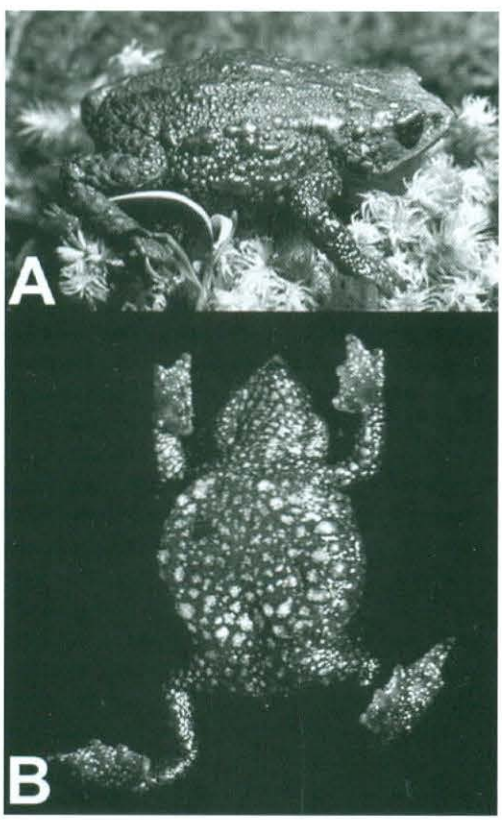


**Figure 4: Dorsal (A) and ventral (B) views of one paratype of *Osornophryne occidentalis* (QCAZ 36894) in life, adult female, SVL = 35.6 mm.**

with elevated glandular canthal ridge, straight in dorsal view), interorbital area poorly defined by low canthus rostralis, fairly smooth (interorbital area fairly rectangular, rugose, tubercular), dorsum sepia or yellow-brown to dark grayish-brown with or without warts and ridges light brown to yellow-brown (dark brown with warts and ridges ochre-brown), venter yellow-brown with yellow pustular warts to venter pinkish-red with tan pustular warts, sometimes with dark brown blotches (venter maroon-brown with irregular clusters of pale salmon pustules), fourth finger and fifth toe shorter less distinct and less pointed, see Hoogmoed (1987: Fig. 9). *Osornophryne guacamayo* has longer limbs, thus when hindlimbs are flexed at right angles to sagittal plane, heels touch or remain close (heels do not touch and remain widely separated), head with prominent bony ridges in posterior part (head covered by warts), dorsal skin tubercular (highly rugose with abundant warts and dorsolateral ridges), Finger III and Toe V elongated, very distinct (Finger III distinct but not elongate, Toe V reduced). *Osornophryne percrassa* has snout truncate with low tip not projecting beyond anterior margin of jaw (snout angular in dorsal and lateral views, shaped like four-sided pyramid, with tip of snout protracted into broad, conical protuberance, projected beyond upper jaw but not forming proboscis), dorsal skin granular with warts but without dorsolateral ridges (dorsum rugose with warts and dorsolateral ridges), venter brown with bold white or yellow stripes or blotches (venter maroon-brown with irregular clusters of pale salmon pustules), and fourth finger and fifth toe shorter less distinct, and less pointed. *Osornophryne sumacoensis* has head rounded in dorsal view (angular in dorsal view), venter blue with black spots in adult females (maroon-brown with clusters of small pale salmon pustules), and transverse process of presacral vertebrae with irregular borders (borders smooth). *Osornophryne talipes* has dorsal skin smooth to shagreen with warts and paravertebral ridges (rugose with warts and dorsolateral ridges but without paravertebral ridges), head that is about as wide as long (head wider than long), tip of snout protracted into highly acuminate fleshy proboscis (tip of snout protracted into broad, conical protuberance, projected beyond upper jaw but not forming proboscis), and Finger IV and Toe V shorter and less pointed. *Osornophryne puruanta*, known only from females from the Puruanta and San Marcos lagoons in eastern Andean Ecuador, differs in having larger females

(SVL 40.5–47.1 mm vs. 32.5-36.0 mm), dorsum relatively smooth with numerous light-colored glandular ridges (rugose with scattered irregular warts), and tip of snout protracted into small proboscis in adult females (fleshy and angular rostrum shaped like four-sided pyramid). A new species from the Paramo del Ángel in northern Andean Ecuador [12], differs from *O. occidentalis* by having dorsal skin granular with scattered large pustules and tubercles and males with proboscis on tip of snout.

### *Description of holotype*

Adult female, SVL = 36.0 mm (Fig. 1), head slightly wider than long, not as wide as adjacent part of body (HW/HL = 1.15, HW/SVL = 0.37, HL/SVL = 0.32), postocular width of head distinctly less than width at corners of jaws (POHW/HW = 0.81), snout distinctly angular in dorsal and lateral view, shaped like four-sided pyramid (Fig. 2), tip of snout protracted into broad, conical protuberance, projecting beyond upper jaw. (NR/EN = 1.33, NR/HL = 0.21, EN/HL = 0.16, ED/HL = 0.25, IOD/UE = 1.46). Nostrils closer to eye than to tip of snout, posterior to margin of upper jaw, just below canthus rostralis in bulbous, slightly elevated, area; nostrils elongated, directed laterally and dorsally; canthus rostralis distinct with elevated glandular canthal ridge, straight in dorsal view, converging anteroventrally to point above nares and sharply and curved anteroventrally in lateral view, forming raised point that extends well past upper jaw in all views, delimiting fairly rectangular, shallow, rugose, tubercular platform in interorbital area. Occipital area rather flat, more rugose and warty than interorbital area; upper eyelid rugose covered by small warts; loreal region with very low warts, sloping steeply to flared upper lips; area between nostrils and base of protuberant tip distinctly concave; pupils rounded; temporal region with numerous, heterogeneous warts; tympanum absent (no vestige found after dissection); parotoid area with glands rounded, slightly triangular covered by warts, externally bordered by low, dorsolateral glandular ridges, sometimes discontinuous as lines of warts, from posteromedial margin of orbits, convergent but not in contact in scapular region.

Dorsal skin highly rugose with abundant warts round and oblong; paravertebral ridges absent; dorsolateral glandular ridges present; temporal area with warts low, fairly uniform, and small; flanks with heterogenous, usually larger, warts on rugose skin; throat and chest distinctly areolate, almost warty especially to the sides; venter distinctly areolate with disperse low formed by clusters of flattened, pustular warts.

Limbs short, stout, covered with conical, rounded, and flat warts; when hindlimbs are flexed at right angles to sagittal plane, heels do not touch, and remain widely separated (TL/HW = 0.80, TL/HL = 0.91, TL/FL4 = 0.84, TL/SVL = 0.29); palmar and plantar surfaces tuberculate; cloacal opening directed ventrally at end of short cloacal tube.

Fingers with thick webbing, forming platform with tubercular ventral surface; fingers III and IV clearly distinct (HaL4/HaL3 = 0.91), but just rounded tips of fingers I and II protrude (Fig. 3); all fingers depressed with rounded tips; dorsal surfaces of hands covered by warts, wrist without transverse grooves; length of fingers III > IV > II > I; toes connected by thick webbing, forming platform with tubercular ventral surface; toes I and II reduced, only rounded tips protrude; Toe III slightly more distinct; Toe IV clearly distinct, well developed, long; Toe V reduced but noticeable, rounded tip protrudes at lateral side of Toe IV (FL5/FL4 = 0.78; Fig. 3). Phalangeal formula of hand 2-2-3-3, phalangeal formula of foot 2-2-3-4-3, tips of terminal phalanges slightly expanded. Anterior and posterior margins of transverse processes of presacral vertebrae smooth.

### *Coloration in life*

Dorsum and dorsal surfaces of limbs dark brown, including most dorsal warts; some warts, canthal ridge, tip of snout, and dorsolateral ridges dark ochre-brown; venter maroon-brown, with abundant pale salmon spots, each composed of several pustular warts; ventral surfaces of limbs maroon-brown with small clusters of white and pale salmon pustular warts; throat with fewer, smaller pale salmon warts; palmar and plantar surfaces brown with purplish-maroon tint and scattered pale pink tubercles; iris black, heavily flecked with gold; palpebrum translucent brown.

### *Coloration in preservative*

Dorsum and dorsal surfaces of limbs dark brown; most warts, canthal ridge, tip of snout, and dorsolateral ridges ochre-brown; dorsal surfaces of hands and feet ochre-brown with dark irregular spots; venter and ventral surfaces of limbs dark brown background with abundant ochre-brown pustular warts; throat and chest with smaller ochre-brown warts; palmar and plantar surfaces tan brown with darker shadows; iris dark, palpebrum translucent brown (Fig. 1).

### *Measurements*

Holotype data is followed by measurements of adult females (F, $n = 5$) and adult males (M, $n = 5$) in parenthesis (range, mean $\pm$ SD): SVL 36.0 mm; greatest head width 13.3 mm (F: 10.9–13.3, 11.9 $\pm$ 1.0; M: 7.8–8.5, 8.1 $\pm$ 0.3); postocular head width 10.7 mm; head length 11.6 mm (F: 9.0–11.6, 10.0 $\pm$ 1.2; M: 7.0–7.8, 7.5 $\pm$ 0.3); interorbital distance 5.1 mm (F: 3.0–5.1, 3.8 $\pm$ 0.8; M: 2.7–3.1, 2.9 $\pm$ 0.1); internarial distance 3.3 mm (F: 2.5–3.3, 2.9 $\pm$ 0.1; M: 2.0–2.2, 2.1 $\pm$ 0.1); eye-nostril distance 1.8 mm (F: 1.7–2.0, 1.9 $\pm$ 0.1; M: 1.3–1.6, 1.4 $\pm$ 0.1); horizontal eye diameter 2.9 mm (F: 2.1–2.9, 2.7 $\pm$ 0.3; M: 1.7–1.9, 1.8 $\pm$ 0.1); greatest width of upper eyelid 3.5 mm (F: 2.4–3.5, 2.9 $\pm$ 0.4; M: 1.9–2.4, 2.2 $\pm$ 0.2); nostril-rostrum distance 2.4 mm (F: 1.4–2.4, 1.8 $\pm$ 0.4; M: 1.3–1.5, 1.4 $\pm$ 0.1); hand length to third finger 8.5 mm; hand length to fourth finger 7.7 mm; tibia length 10.6 mm (F: 9.4–11.3, 10.3 $\pm$ 0.8; M: 6.6–7.0,

6.8 ± 0.2); foot length to fourth finger 12.6 mm (F: 9.2–12.6, 11.0 ± 1.6; M: 5.9–7.9, 7.0 ± 0.8); foot length to fifth finger 9.8 mm.

### *Variation*

Detailed information of body proportions is presented in Table 1. *Osornophryne occidentalis* exhibits sexual size dimorphism. Adult males are smaller than adult females, and show smaller head width/head length and head length/SVL ratios; these ratios do not overlap, however, our sample sizes are small and we will postpone a more detailed study of sexual dimorphism (Tables 1). Males have dorsal warts more densely packed posteriorly, ventral pustular warts bearing multiple coni, and protuberance on the tip of the snout slightly broader but never forms a proboscis. Gross morphological features are relatively invariant. Dorsal skin is highly rugose in all specimens, regardless of age or sex. Lips are flared or slightly flared in adults, but not flared in juveniles. Dorsal coloration in all specimens is similar to holotype, but ventral background coloration varies from maroon-brown to black and the ventral pustular warts vary from white to pale salmon to pale blue. Palmar and plantar coloration varies from brown to reddish brown to purplish-maroon. Tips of the digits vary from dark brown to reddish brown. Males have a ventrally directed cloacal tube, but some specimens have the cloaca opening posteriorly at the upper level of the thighs rather than ventrally at the end of a cloacal tube. The presence of ventrally directed cloacal tubes has been overlooked in most species descriptions because they are highly flexible and can retract depending on the position of the individual, due to preservation artifacts or ontogenic changes— juveniles seem to have shorter cloacal tubes ([16], A.G. Gluesenkamp personal observation)..

### *Distribution and natural history*

*Osornophryne occidentalis* is currently known from four localities on the western slopes of the Cordillera Occidental of northwestern Ecuador, between 2500 m and 2750 m (Fig. 5). Its presence in southern Colombia is plausible, but no specimens are known even from the northernmost Ecuadorian province of Carchi. The two localities in the province of Imbabura are less than 20 km apart in the Cordillera de Toisan, a mountain range part of the Cordillera Occidental of the Andes of Ecuador. The two localities in the province of Pichincha are 13 km apart in the Cordillera de Mindo, and 40 km from the localities in Imbabura.

*Osornophryne occidentalis* inhabits primary and old-secondary montane cloud forests, usually with dense canopy and understory, abundant arboreal and terrestrial epiphytes, and dense leaf litter. Specimens collected at the type locality were found in secondary forest dominated by small trees up to 10 m tall covered with abundant epiphytes such as orchids, anthuriums, bromeliads, and ferns. Similar conditions were observed at Cordillera de Toisan, except that forest was primary and

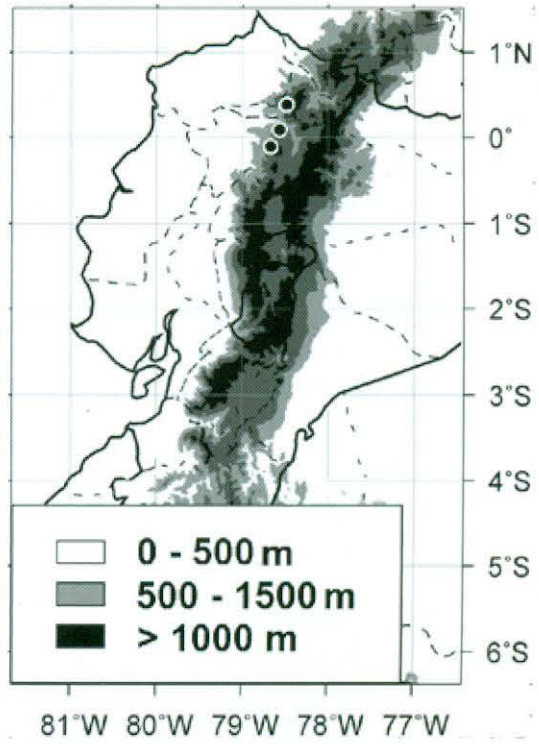


**Figure 5: Schematic map of Ecuador showing the distribution of *Osornophryne occidentalis* (circles); from south to north: near Guarumos, type locality; Guantopungo; and the northernmost circle marks La Delicia and F. Rodríguez's farm. Precise locations can be visualized in Google Earth by downloading the supporting online material available at <http://www.cisneros-heredia.org/osornophryne/occidentalis.kmz>**

its canopy up to 25 m tall. *Osornophryne occidentalis* has been collected under leaf litter or root mats, on moss-covered floor, and in terrestrial and arboreal bromeliads during day and early afternoon (J. D. Lynch field data, D.F. Cis-neros-Heredia and A.G. Gluesenkamp personal observation).

*Osornophryne occidentalis* may have clustering behavior; adult female holotype and the topotypic paratype were collected together on leaf litter and moss at the base of an arboreal bromeliad (1 m above the floor). Possible clustering behavior has also been observed in *O. antisana* (several individuals collected under a log, L. A. Coloma personal communication, A. G. Gluesenkamp personal observation), *O. bufoniformis* (several individuals collected in and under terrestrial bromeliads, M. H. Yanez-Muñoz personal communication, A. G. Gluesenkamp personal observation), and in *O. sumacoensis* (two males found together underneath a dead bromeliad, A. G. Gluesenkamp personal observation).

### *Etymology*

The specific epithet, a noun in opposition, of this new species refers to its unique distribution in the montane cloud forests on the western slope of Cordillera Occidental of the Andes of Ecuador.

### *Suggested common name*

Western Andean Plump Toad

### *Conservation status*

We suggest that *Osornophryne occidentalis* be classified as Endangered by IUCN criteria, EN B1ab(i,ii,iii,iv), 2ab(i,ii,iii,iv). Although several specimens have been collected at most known localities and habitat quality varies from primary to secondary vegetation, the range of this species is small (extent of occurrence = 555 $km^2$; Fig. 5) and confined to a rather narrow altitudinal band (2500–2750 m a.s.l.). Populations in the Cordillera de Toisan are within the buffer zone of the Cotacachi-Cayapas Ecological Reserve, but they are severely threatened by habitat loss and fragmentation due to uncontrolled expansion of the agricultural frontier and unsustainable extraction of natural resources [17]. At least one population (La Delicia) may be already extinct due to extreme habitat destruction (recent expeditions have failed finding additional specimens). Various areas across the Cordillera de Toisan are conceded for mining exploration [17]. Direct and indirect environmental impacts of mining operations may affect populations of *O. occidentalis* (e.g., habitat transformation and fragmentation, soil pollution). Populations in the Cordillera de Mindo have enjoyed apparently better conservation conditions, with many areas highly inaccessible, protected by several private reserves, or part of two protected forests: Mindo-Nambillo and Cuenca Alta del Río Guayllabamba [17]. However, they are also impacted by habitat loss and fragmentation. The area is crossed by the recently-constructed oil pipeline "Oleoducto de Crudos Pesados" that opened access for illegal colonization of areas that were previously inaccessible [17].

### *Taxonomic remarks on some Osornophryne*

Knowledge about the morphology, ecology, behavior, breeding biology, and other evolutionary and biological aspects of the natural history of *Osornophryne* is extremely scarce because few individuals have been observed in the field or deposited in museums. However, instead of being ecologically rare, most *Osornophryne* seem to be difficult to find due to their habits (at least some species are semi-fossorial) and few survey efforts concentrated in their preferred habitats (M. H. Yanez-Muñoz personal communication). Under the right ecological circumstance it seems that some species of *Osornophryne* may attain large densities; for example *O.* cf. *bufoniformis* was reported as the most common species at some localities in the Llanganates National Park [18] and more than 60 specimens were rescued after the flooding of 130 ha for the Salve-Faccha dam (M.H. Yanez-Muñoz personal communication).

Due to insufficient knowledge on the morphological and chromatic variation of *Osornophryne*, identification has been troublesome. *Osornophryne guacamayo* has been reported from four localities in Ecuador and two recent localities in Colombia (i.e., Ecuador: Cordillera de Los Guacamayos—type-locality, Sumaco volcano and Reventador volcanoes, and the Amazonian slopes of Antisana volcano; Colombia: Vereda Vichoy, Valle de Sibundoy; D. Lombeida personal communication, D.F. Cisneros-Heredia, personal observation, [5, 16, 10, 19]; Appendix 1). However, some specimens reported from Colombia differ from Ecuadorian populations in the dorsal skin texture and body size and more than one taxa may be involved (M. H. Yanez-Muñoz and D. F. Cisneros-Heredia personal observation).

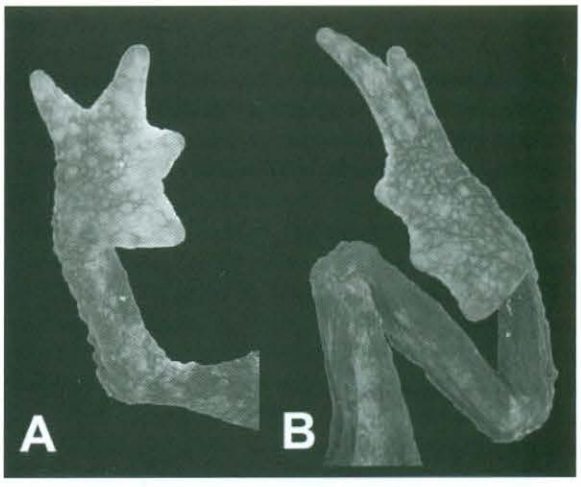


**Figure 6: Hand (A) and foot (B) of *Osornophryne guacamayo* (FHGO 1458).**

*Osornophryne antisana* occurs on the paramos and highlands on the eastern Andes and has been reported from five localities in Ecuador and a recent locality from Colombia (i.e., Ecuador: Antisana volcano—type locality, Sumaco volcano, Cordillera de los Llanganates and Vía Salcedo-Oriente, and Guandera; Colombia: Pasto; [5, 6, 10, 20]). Specimens from Guandera and surroundings (i.e., La Angelina) are very similar to the holotype of *O. antisana* and we agree that they seem to belong to the species. All other records correspond to misidentifications or uncertain records.

Gluesenkamp [6] reported *O. antisana* from the Sumaco volcano based on two adult males and a subadult female (QCAZ 4573–75), but subsequent morphological and molecular analysis showed that they were erroneously identified and correspond to *O. sumacoensis* (A. Gluesenkamp unpublished data). The irregular borders of the transverse process in both sexes and blue venter of females are the best diagnostic characters of *O. sumacoensis* [6]. When first studied, the specimens from Sumaco were sufficiently similar to Hoogmoed's [5] description of *O. antisana*, but knowledge of ontogenic change and sexual dimorphism in *Osornophryne* was little known at that time; now it is recognized that juveniles and males have generalized morphologies and species specific morphologies are most apparent in adult females ([16], D. F. Cisneros-Heredia and A. G. Gluesenkamp personal observation). Gluesenkamp [6] also reported *Osornophryne antisana* from Cordillera de los Llanganates, Tungurahua, Ecuador; but a female from Llanganates was identified as *O. bufoniformis* by Hoog-

moed [5], and Ortíz and Morales [18] reported the population from Llanganates as *O. bufoniformis*. Further studies are needed to determine the identity of the *Osornophryne* from Llanganates.

When Hoogmoed [5] described *Osornophryne antisana*, he considered it was closely related and rather alike *O. talipes*. Mueses [10] reported *O. antisana* and *O. talipes* for the first time from Colombia. He pointed out that his specimen of *O. antisana* did not coincide with the original description of the species [5] or with notes by Gluesenkamp ([6], based on true *O. antisana* specimens), but it was similar to the figure presented by Gluesenkamp ([6]: Fig. 1.D, based on misidentified *O. sumacoensis* as mentioned above). Mueses [10] provided a redescription of *O. antisana* based on his Colombian specimen (ICN 12264). Yet, some characters used by Mueses [10] were attributed to *O. talipes* by Hoogmoed [5]. In general, most diagnostic characters presented by Mueses [10] and Hoogmoed [5] to differentiate *O. antisana* from *O. talipes* are highly variable due to sexual dimorphism and ontogenic changes and are easily affected by preservation (e.g., condition of the proboscis and cloacal tube, head width vs. head length, and extension of nuptial pads). However, three characters suggest that *O. antisana* and *O. talipes* are different taxa: (1) body size: *O. talipes* has larger SVL (adult males 23.8–24.3 mm) than *O. antisana* (adult male 18.6 mm) and this difference is expected to be greater in females; (2) snout form: *O. talipes* has a longer snout than *O. antisana* due to a much longer loreal region; (3) dorsal skin texture and coloration: *O. talipes* has a smooth dorsum with elevated and distinctly-colored glandular ridges, whereas *O. antisana* has a smooth to shagreen dorsal skin with flat and mostly indistinct glandular ridges. Based on descriptions provided by Mueses [10] and the examination of some Colombian specimens, we consider that the Colombian specimen (ICN 12264) referred to *O. antisana* does not belong to that species and may correspond to an undescribed taxon. Definitive conclusions about the identity of the phenetically similar populations occurring in southeastern Colombia and northeastern Ecuador and their association with the names *antisana* and *talipes* will require careful examination of type-material and additional fresh topotypic material to understand intraspefic variation. A molecular approach would likely be useful in elucidating relationships among problematic populations. We emphasize the importance of understanding individual, ontogenic and sexual variation in *Osornophryne*. It is important to remember species-specific morphologies are better expressed in adult females while juveniles and males have generalized morphologies.

## Discussion

*Osornophryne* is a bufonid genus diagnosed by the absence of the alary and posterolateral processes of the hyoid plate, absence of the columella and tympanum, quadratojugal reduced in size, pectoral girdle firmisternal with complete fusion of epicoracoid cartilages, six presacral vertebrae, coccyx with greatly expanded lateral processes fused to sacral diapophyses, phalangeal formula variable, palmate hands and feet with extensive webbing between digits, cloaca situated on a ventrally-directed tube in both sexes in most species, amplexus inguinal, large and unpigmented eggs terrestrially deposited [3, ?]. *Osornophryne* is the only bufonid genus that lacks the alary process of the hyoid and the only Neotropical genus with six presacral vertebrae [21]. It is distinctive among Neotropical bufonids in having hands and feet connected by thick webbing forming a fleshy platform from which in some cases only the tips of the fingers and toes protrude.

*Osornophryne guacamayo* has the most recognizable discrete fingers and toes among the genus (Fig. 6), while *O. antisana* and *O. bufoniformis* have hands and feet where fingers and toes are hardly differentiated ([5]: Fig. 7 and 9, D. F. Cisneros-Heredia and A. G. Gluesenkamp personal observation). *Osornophryne occidentalis* shows intermediate condition, where fingers (particularly the fifth) and toes are recognizable but still forming a thick platform (Fig. 3). Ruiz-Carranza and Hernández-Camacho [3] suggested the morphology of hands and feet of *O. bufoniformis* and *O. percrassa* (i.e., extensively webbed digits forming a massive platform) was an adaptation towards terrestrial habits. Hoogmoed [5] suggested that the microhabitats reported for the types of *O. guacamayo* and *O. antisana* refuted that hypothesis and suggested the inverse tendency. The type series of *O. guacamayo* was collected on "moss in rock crevices" and Hoogmoed [5] hypothesized that the species was adapted for locomotion in saxicolous microhabitats. The microhabitat reported for the holotype of *O. antisana* was an arboreal bromeliad ([5], based on a letter written by the donor not the collector of the specimen). Subsequent research has revealed that *O. guacamayo* is more arboreal than terrestrial, although it can occupy both microhabitats ([6, 16] D. F. Cisneros-Heredia personal observation); and that *O. antisana* and *O. bufoniformis* live in semi-fossorial and terrestrial conditions, being common towards the center of terrestrial bromeliads and beneath them (data for more than 50 specimens recently collected, M. H. Yanez-Muñoz personal communication). The report of *O. antisana* inside an arboreal bromeliad is either an unusual event or an error of the donor whom described the general situation for different frogs collected with *O. antisana* rather than its specific microhabitat. The occupation of both terrestrial and arboreal habitats by *O. occidentalis*, a species with discernible digits, seems to support the hypothesis that more arboreal species have more discernible digits while more terrestrial taxa have more compact hands and feet.

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***Appendix 1: Material examined***

*Osornophryne antisana*: ECUADOR: Vía Salcedo-Oriente, 3500-3600 m (QCAZ 1647-49, 9322); near La Angelina, ca. 3200 m (QCAZ 10047); Represa Salve Faccha, 3400-3500 m (DHMECN 0801-0831). *Osornophryne bufoniformis*: ECUADOR: 15 km ESE El Carmelo (USNM 193537); 1 km NW of Santa Barbara (USNM 193538); Santa Barbara, 2650 m (KU 189945, QCAZ 11472). COLOMBIA: Paramo Puracé, Laguna San Rafael (KU 144113-15, USNM 322775); Puracé, 3450 m (KU 145036-37); 23 km E Puracé, 3275 m (KU169134-35); 26 km E Puracé, 3180 m (KU 169136); 12 km E Pasto, 3050 m (KU 169137, 169139-40). *Osornophryne guacamayo*: ECUADOR: Cordillera de los Guacamayos, ca. 2200 m (QCAZ 1268-69, 2735, 3266, 3274, 3908, 7387, 8940, 9310-11, 9313-15, 13939-40); Volcan Sumaco, 2500 m (QCAZ 4576-84); Volcan Reventador (QCAZ 9314, FHGO 1458-60); Sierra Azul (QCAZ 4121, 4889, 7402). *Osornophryne occidentalis*: ECUADOR: near Guarumos (DHMECN 3520 - holotype, DFCH-USFQ GU036 - paratype, DFCH-USFQ GU034, GU035); Cordillera de Toisan (QCAZ 10141, 9318, 36894 - paratypes, 9319-21, 36895, KU 132126); near Guantopungo (FHGO 1907, 2981, 2984). *Osornophryne percrassa*: COLOMBIA: out of Manizales, on old road to Nevado de Ruiz (USNM 153125); Paramo de Herveo, E slope Cordillera Central (USNM 200467). Tolima, Cajamarca, km 111-112 carretera Cajamarca-Calarca (La Línea), 3040-3080 m (ICN 10015-23); Herveo, 3100 m (ICN 01922, 01924-25, 02624-25). *Osornophryne puruanta*: ECUADOR: Laguna de Puruanta, Cordillera de Pimampiro, 3000 m (QCAZ 11471, 7684-85); Laguna de San Marcos, 3400 m (QCAZ 13271, 13320, EPN 7081-83). *Osornophryne sumacoensis*: ECUADOR: Volcan Sumaco, 2500 m (QCAZ 4570 - holotype, QCAZ 4571-72 - paratypes, 4573-75). *Osornophryne talipes*: ECUADOR: Nudo de Mojanda, 3400 m (KU 131797 - holotype, KU 131798 - paratype). *Osornophryne* cf. *talipes*: COLOMBIA: Pasto, Hacienda La Marquesa, 3400-3450 m (ICN 12264); Parque Nacional Natural Puracé, 2880 m (ICN 07568, 07572); carretera Pasto-Volcan Galeras, 3630 m (ICN 12252-53, 12255, 12262-63). *Osornophryne* sp.: ECUADOR: Volcan Chiles, 3252 m (QCAZ 735, 9316-17). Estación Científica Los Encinos, 3600 m (DHMECN 2166-71). Km 51 vía Tulcan-Maldonado, 3252 m (QCAZ 9316). 23 km SW Tulcan (QCAZ 9316).

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