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# A NEW SPECIES OF *OSORNOPHRYNE* (ANURA: BUFONIDAE) FROM VOLCÁN SUMACO, ECUADOR WITH NOTES ON OTHER MEMBERS OF THE GENUS

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ABSTRACT: A new species of the Andean genus *Osornophryne* is described from the cloud forests of Volcán Sumaco in central Ecuador. This species can be distinguished from all other members of the genus by the combination of its unique ventral coloration, rugose skin, and pustular dorsal ridges. Individuals of two other species of *Osornophryne*, *O. guacamayo* and *O. antisana*, were encountered at the same locality. I discuss some aspects of the microhabitat preferences and diets of these toads. Morphometric comparisons and notes on the status of digital reduction in the genus are included.

*Key words:* Bufonidae; *Osornophryne sumacoensis*; New species; Volcán Sumaco; Provincia Napo; Ecuador; Cloud forests; Andes; Digital reduction

RUIZ-CARRANZA and Hernández-Camacho (1976) erected the bufonid genus *Osornophryne* to include two species of small, Andean toads: *Osornophryne percrassa* Ruiz-Carranza and Hernández-Camacho and *Atelopus bufoniformis* (Peracca). Since then, three more species of *Osornophryne* have been described: *Osornophryne talipes* Cannatella, *O. antisana* Hoogmoed, and *O. guacamayo* Hoogmoed. This genus is distinguished from other bufonid genera by the combination of the presence of six presacral vertebrae with fusion of the atlas and the first trunk vertebra, wide variation in the phalangeal configuration of the hands and feet, and inguinal amplexus. Species of *Osornophryne* are found in páramo, subparamo, and cloud forest and generally seem to be terrestrial with some exceptions. Individ-

uals of species of *Osornophryne* have been encountered in swampy areas, rocky crevices and gravel stream beds, under rocks and dead vegetation, as well as in terrestrial and arboreal bromeliads (Cannatella, 1986*a*; Hoogmoed, 1987; Ruiz-Carranza and Hernández-Camacho, 1976). During field work in the cloud forests of Volcán Sumaco, workers from the University of California at Davis and from Pontificia Universidad Católica del Ecuador discovered specimens of three species of *Osornophryne*: *O. antisana*, *O. guacamayo*, and a previously undescribed species. Specimens were collected in August 1992 between 2100 m and 2860 m elevation. The majority of specimens were collected near a small crater lake 5 km east of the summit of Volcán Sumaco. In this paper, I describe the new species from Volcán Sumaco, compare it to the other described species, and present statistical data to support the recognition of six taxa within the genus. I also report observations on phalangeal formulae within the genus.

## Materials and Methods

Measurements are in millimeters and were made using calipers. I followed the procedure used by Cannatella (1986*a*), except that I did not include femur length. Abbreviations are as follow: SVL = snout-vent length; TIB = tibia length; FOOT = length of foot from base of inner metatarsal tubercule to tip of 4th toe; HWID = greatest width of head; WLEN = length of head from posterior margin of jaw to tip of rostrum; IOD = interorbital distance; IND = internarial distance; E–N = distance from anterior margin of orbit to posterior margin of nostril; EDIA = diameter of eye; N–R = distance from anterior margin of nostril to tip of rostrum; EWID = widest width of upper eyelid measured perpendicular to medial axis of skull; AGG = Andrew G. Gluesenkamp field numbers; QCAZ = Museo de Zoologia, Departamento de Ciencias Biologicas, Pontificia Universidad Católica del Ecuador; UCD = University of California, Davis. I used SAS 6.03 (SAS, 1988) to perform a principle component analysis, discriminant analysis, jackknife classification, and a description of canonical variates in order to quantify morphological differences and overlap among the species. Specimens examined are listed in Appendix I. X-rays were examined using an illuminated table and a loupe. Any phalangeal element visible on a radiograph was counted, regardless of size. Limbs with curled digits which made viewing of phalanges impossible were not included in phalangeal counts.

*Osornophryne* ***sumacoensis*** sp. nov.

*Holotype.*—QCAZ 4570, adult female, collected at 2500 m on slope of crater 5 km east of summit of Volcán Sumaco (00°35'S, 77°37'W), Provincia Napo, Ecuador on 31 July 1992 by Andrew G. Gluesenkamp.

*Paratypes.*—QCAZ 4571, a subadult female collected 3.5 km east of the summit of Volcán Sumaco, same data as for holotype and QCAZ 4572, a subadult female collected 4.5 km east of the summit on 1 August 1992 by Andrew G. Gluesenkamp.

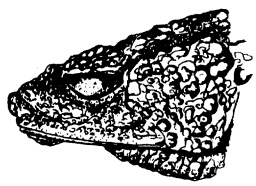
*Measurements of holotype.*—Measurements are followed by those of the two paratypes in parentheses. SVL 33.4 (32.0, 32.1), TIB 9.5 (8.9, 7.6), FOOT 10.4 (10.2, 8.0), HWID 11.7 (11.2, 11.9), HLEN 11.1 (10.5, 10.9), IOD 3.9 (3.7, 3.5), IND 3.0 (2.9, 3.3), E–N 2.2 (2.1, 2.1), EDIA 3.2 (2.9, 2.9), N–R 2.2 (2.1, 2.1), EWID 2.3 (2.5, 2.4); TIB/SVL 0.28 (0.28, 0.24); HWID/HLEN 1.05 (1.06, 1.09); HLEN/SVL 0.33 (0.33, 0.34); HWID/SVL 0.35 (0.35, 0.37).

*Diagnosis.*—Head rounded in dorsal and lateral views with pointed tip extending beyond upper jaw. Canthus rostralis pustular, raised: pustular ridge along outer margin of upper eyelid. Lips flared. Tympanum absent. Six presacral vertebrae, atlas fused with first. Dorsolateral, mid-dorsal, and parasaggital ridges pustular. Skin warty with interspersed tubercles; skin of trunk more tuberculate dorsally than ventrally. Venter in life blue with black spots. Hands and feet palmate. Phalangeal formula of hands: 1-2-3-3 or 1-2-3-2, that of feet: 1-2-2-4-1, 1-2-2-4-2, or 1-2-3-4-2.

*Osornophryne sumacoensis* can be distinguished from all other members of the genus by its unique ventral coloration.

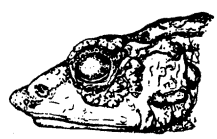
**A** *Osornophryne sumacoensis*

**B** *Osornophryne sumacoensis*



**C** *Osornophryne sumacoensis*

**D** *Osornophryne antisana*



**E** *Osornophryne antisana*

FIG. 1.—*Osornophryne sumacoensis*, holotype, QCAZ 4570, adult female, SVL = 33.4: (A) dorsal, (B) ventral, (C) lateral aspect of the head. *O. antisana*, QCAZ 4575, adult female, SVL = 23.3: (D) dorsal, (E) lateral aspect of the head.

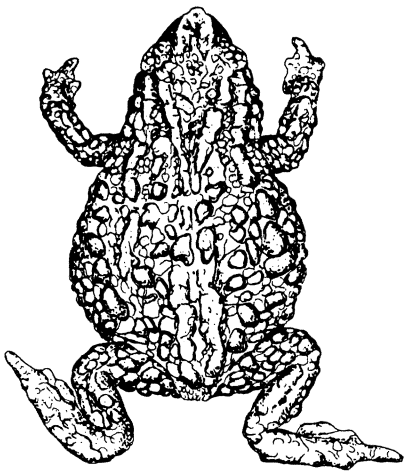
TABLE 1.—Measurements of morphological characters in *Osornophryne*.

| | *antisana* (*n* = 5) | | *bufoniformis* (*n* = 15) | | *guacamayo* (*n* = 16) | | *percrassa* (*n* = 3) | | *sumacoensis* (*n* = 3) | | *talipes* (*n* = 2) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD | $\bar{x}$ | SD |
| SVL | 21.52 | 3.65 | 29.04 | 6.53 | 25.62 | 9.62 | 29.20 | 5.90 | 32.50 | 0.78 | 26.90 | 3.54 |
| TIB | 6.48 | 1.27 | 7.29 | 2.12 | 8.06 | 3.07 | 7.40 | 1.37 | 8.67 | 0.97 | 7.20 | 0.57 |
| FOOT | 6.82 | 1.75 | 9.05 | 1.92 | 10.72 | 4.76 | 6.50 | 4.19 | 9.53 | 1.33 | 8.55 | 0.92 |
| HEADW | 7.94 | 1.31 | 9.58 | 2.07 | 8.66 | 2.98 | 10.33 | 2.20 | 11.60 | 0.36 | 8.05 | 0.50 |
| HEADL | 7.10 | 1.38 | 8.92 | 2.01 | 8.50 | 2.95 | 8.57 | 1.20 | 10.83 | 0.31 | 7.95 | 0.35 |
| IOD | 2.58 | 0.64 | 3.09 | 0.81 | 2.79 | 0.96 | 2.97 | 0.50 | 3.70 | 0.20 | 2.70 | 0.57 |
| IND | 2.06 | 0.56 | 2.02 | 0.48 | 2.19 | 0.64 | 2.20 | 0.30 | 3.07 | 0.21 | 2.10 | 0.57 |
| EN | 1.16 | 0.57 | 1.39 | 0.32 | 1.66 | 0.52 | 1.27 | 0.32 | 2.13 | 0.07 | 1.45 | 0.50 |
| ED | 2.30 | 0.47 | 1.57 | 0.28 | 1.63 | 0.50 | 1.53 | 0.51 | 2.40 | 0.10 | 1.80 | 0.57 |
| NR | 1.46 | 0.15 | 1.35 | 0.33 | 1.43 | 0.47 | 1.50 | 0.17 | 2.13 | 0.07 | 1.55 | 0.50 |
| EW | 1.78 | 0.35 | 1.77 | 0.39 | 2.01 | 0.69 | 1.87 | 0.25 | 2.40 | 0.10 | 1.95 | 0.64 |
| HWHL | 1.12 | 0.06 | 1.08 | 0.06 | 1.02 | 0.04 | 1.20 | 0.10 | 1.07 | 0.02 | 1.01 | 0.02 |
| HLSVL | 0.33 | 0.01 | 0.31 | 0.02 | 0.34 | 0.02 | 0.30 | 0.02 | 0.33 | 0.01 | 0.30 | 0.05 |

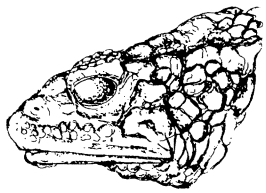
*Osornophryne sumacoensis* can be further distinguished from *O. antisana* (Fig. 1) by its highly tuberculate skin (smooth in *O. antisana*) and raised, pustular canthus rostralis (not so in *O. antisana*). In addition, *O. sumacoensis* is significantly larger than *O. antisana* (Table 1). *Osornophryne sumacoensis* differs from *O. bufoniformis* (Fig. 2) in having a more pointed rostrum, larger choannae and a granular loreal region. The transverse widths of the diapophyses on presacral vertebrae II–VI are reduced posteriorly in *O. sumacoensis* but they are roughly equal in width in *O. bufoniformis*. *Osornophryne sumacoensis* differs from *O. guacamayo* (Fig. 2) by having more rugose but less tuberculate skin, and pustular ridges on the dorsum. *Osornophryne sumacoensis* also lacks the attenuated limbs and digits characteristic of *O. guacamayo*. *Osornophryne sumacoensis* differs from *O. percrassa* (Fig. 3) in having a more pointed snout, highly rugose skin, and a tapered diapophysis configuration (wider anteriorly). *Osornophryne sumacoensis* differs from *O. talipes* (Fig. 3) in having a more rounded head in dorsal and lateral views and a tuberculate dorsum.

*Description of holotype.*—Widest point of head narrower than widest point of body; head rounded in dorsal and lateral views with pointed, fleshy rostrum extending beyond upper jaw; prominent glandular ridge on canthus rostralis from anterior margin of orbit to tip of rostrum; nostrils directed laterally, flared; internarial region concave; skin of upper eyelid tubercular with pustular ridge along outer margin; eyes not projecting beyond outline of head in dorsal view, upper eyelid narrower than IOD; lips flared; choannae oval, widely separated; tongue twice as long as wide, oval; skin of head with prominent warts laterally from temple to groin; glandular parasaggital ridge extending from posterior margin of orbit posteriorly, continuous with dorsolateral ridges; skin of dorsum of body tubercular with prominent, glandular, mid dorsal ridge and scattered areolate warts; dorsolateral ridges fragmented into large pustular warts posteriorly; six presacral vertebrae; diapophyses flat, transverse width of diapophyses reduced posteriorly; III > IV > VI > V > II (diapophyses absent on presacral I, which is fused with the atlas); skin of venter rugose with scattered, large warts; skin on throat more granular than belly; all surfaces of limbs tuberculate; hands and feet palmate; length of fingers: III > IV > II > I; toes: IV > III > V > II > I; phalangeal formula of hand: 1-2-3-3, phalangeal formula of foot: 1-2-3-4-2; palmar and planter surfaces beaning numerous low callosities; thenar, palmar, inner metatarsal and outer metatarsal tubercles inconspicuous; ventral surface of distal end of each digit bearing small, rounded knob.

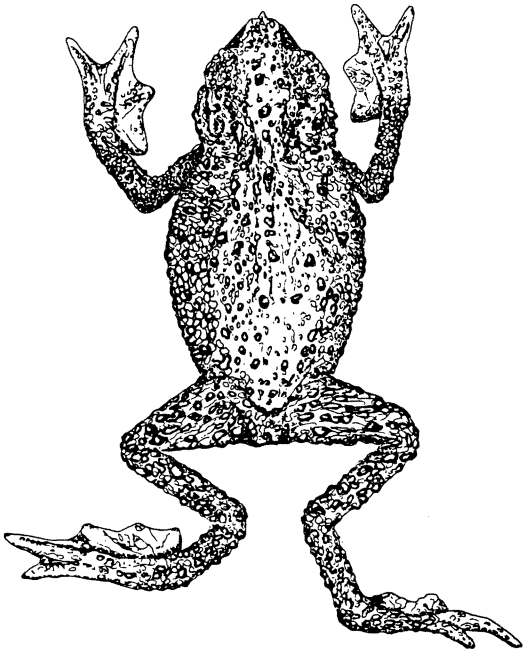
*Color in life.*—Dorsum and limbs blu-



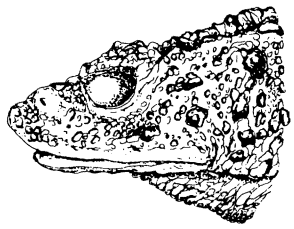
**A** *Osornophryne bufoniformis*



**B** *Osornophryne bufoniformis*

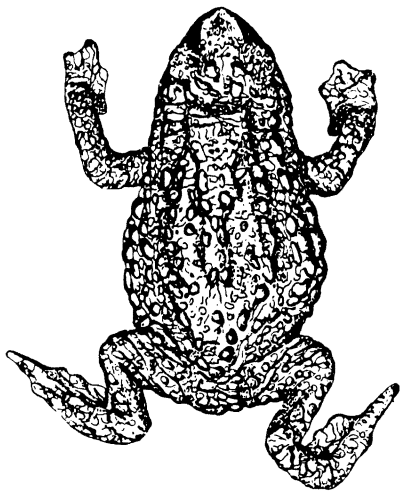


**C** *Osornophryne guacamayo*

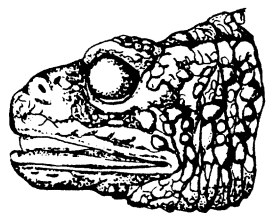


**D** *Osornophryne guacamayo*

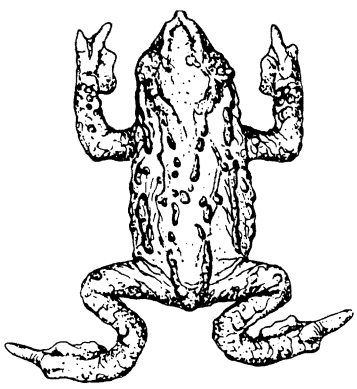
FIG. 2.—*Osornophryne bufoniformis*. KU 117880, adult female, SVL = 34.8: (A) dorsal, (B) lateral view of head. *O. guacamayo*, QCAZ 4580, adult female, SVL = 38.2: (C) dorsal, (D) lateral view of head.



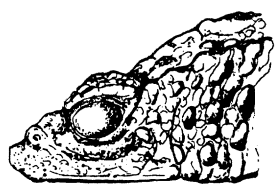
A *Osornophryne percrassa*



B *Osornophryne percrassa*



C *Osornophryne talipes*



D *Osornophryne talipes*

FIG. 3.—*Osornophryne percrassa*, MCZ 100558, adult female, SVL = 33.0: (A) dorsal, (B) lateral view of head. *O. Talipes*, KU 131798, adult male, SVL = 24.4: (C) dorsal, (D) lateral view of head.

ish-black, venter blue with black spots; palmar and planter surfaces yellowish red; iris black, heavily flecked with dull gold.

*Color in preservative.*—Dorsum black, venter bluish-gray with black spots; palmar and plantar surfaces yellowish gray.

*Etymology.*—Named for the type locality, Volcán Sumaco, on the Amazonian versant of the Andes, Provincia Napo, Ecuador. The specific epithet *sumacoensis* is used as an adjective.

*Distribution and ecology.*—*Osornophryne sumacoensis* is known only from cloud forest around a small crater lake at 2500 m on the eastern slopes of Volcán Sumaco (Fig. 4). The surrounding forest is

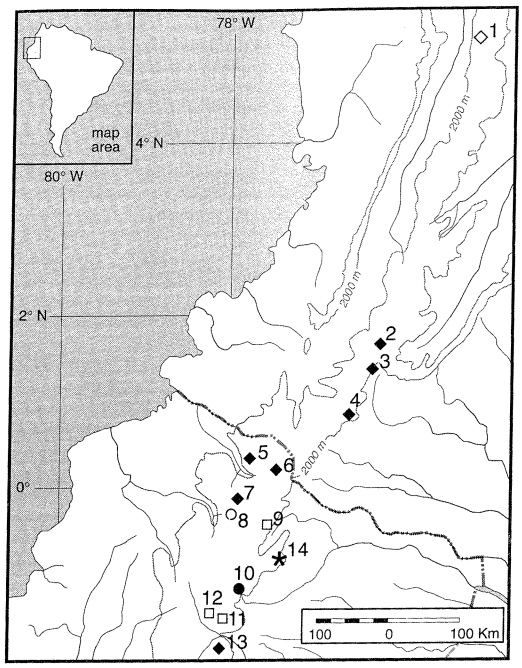



FIG. 4.—Distribution of the genus of *Osornophryne* in Colombia and Ecuador (adapted from Cannatella, 1986*b*, and Hoogmoed, 1987). Open diamond: *O. percrassa*, closed diamonds: *O. bufoniformis*, open circle: *O. talipes*, closed circle: *O. guacamayo*, open squares: *O. antisana*, star: *O. sumacoensis*. (1) Páramo de Herveo; (2) Páramo de Puracé; (3) Páramo de las Papas; (4) Pasto; (5) Páramo del Angel; (6) El Pún (= El Carmelo) and Santa Barbara; (7) La Delicia; (8) Nudo de Mojanda; (9) Volcán Antisana; (10) Cordillera de los Guacamayos; (11) Páramos Dellangantes; (12) vía Salcedo-Oriente; (13) Cerros Llanganati; (14) Volcán Sumaco.

made up of bamboo (*Bambusa* sp.), *Ficus*, and other trees up to 20 m tall. There is an abundance of bromeliads, orchids, and other epiphytes in the area (see Hanrahan and Pereira, 1989, for a floral list). In contrast to other localities where *Osornophryne* has been found, there are no exposed rocks, and the few streams in the area lack gravel beds.

All specimens were found under leaf litter by day. Other anurans present included *Osornophryne antisana*, *O. guacamayo*, several species of hylids (including *Hyla staufferorum* Duellman and Coloma), *Eleutherodactylus croceoinguinis* Lynch, *E. elassodiscus* Lynch, *E. trachyblepharis* (Boulenger), and several apparently undescribed species of *Eleutherodactylus*. The stomach contents of the holotype and paratypes included isopods and Coleoptera. Stomach contents of *O. guacamayo* consisted primarily of Coleoptera, formicids, Araneida, and Apocrita; *O. antisana* contained remains of Coleoptera as well as Araneida, Acarina, formicids, salpugids, and Homoptera. Ruiz-Carranza and Hernández-Camacho (1976) reported finding the remains of curculionid beetles (Coleoptera) in the stomachs of *Osornophryne percrassa*.

*Remarks.*—The type locality is a conical, volcanic crater approximately 15 km due north of the village of Guagua Sumaco. The village of Guagua Sumaco can be reached by the Archidona-Coca road which passes south of Volcán Sumaco. From the village, a trail leads directly north for 7 km to another, smaller community called Pacto Sumaco. This resettlement community is located within the boundaries of the 100,045 ha protected forest which contains the entire Sumaco site (Long, 1992). A trail by which the volcano and cinder cone can be reached leads north from this point. The cone is referred to by locals as Guagua Sumaco. I refer to the cone and the lake inside of it as Lago Sumaco in order to avoid confusion.

*Notes on other species.*—Of the other species of *Osornophryne* encountered on Volcán Sumaco, *O. guacamayo* was by far the most common. Individuals of this species were collected by day and by night. They were most common on large leaves (0.5–1 m above the ground) at night. They also occurred in bromeliads up to at least 5 m above the ground by day and night. At night, individuals often were found active on the trunks of large trees and on exposed roots. Three individuals were walking on open ground by day. Many individuals had aposematic coloration in the form of yellow venters and bold, yellow, dorsolateral stripes.

*Osornophryne guacamayo* was encountered in the greatest density and in a variety of microhabitats immediately adjacent to the lake. No individuals were encountered off of the slopes of the cone itself. Other species of *Osornophryne* were uncommon around the lake and were col-

lected at distances from the lake where no *O. guacamayo* was found. The population of *Osornophryne guacamayo* described in this paper exists at the highest elevation known for the species.

*Osornophryne guacamayo* has long limbs and frequently climbs trees and shrubs. Hoogmoed (1987) suggested that the peculiar hands and feet of *O. guacamayo* could be adaptations for locomotion in rocky and mossy crevices. I agree that the attenuated limbs and long, flexible digits are probably adaptations to a life of climbing. However, my field observations lead me to believe that they are more arboreal than saxicolous. *Osornophryne guacamayo* collected at the type locality (Hoogmoed, 1987) in the Cordillera de los Guacamayos may be at the edge of its range and therefore in habitat less than optimal for the species. This notion is supported by the fact that few specimens have been encountered at the rocky and mossy type locality; yet dozens were found in the cloud forest habitat of Volcán Sumaco.

Three individuals of *Osornophryne antisana* were collected at the east end of the ridge surrounding Lago Sumaco. Two subadult males were discovered by day in what appeared to be an amplectant (aggressive?) grasp when they were raked out from under leaf litter. An adult female was collected by day at 2860 m in leaf litter. All three individuals had small, ventrally directed cloacal tubes like that described by Hoogmoed (1987). *Osornophryne antisana* was previously unknown below 3600 m (Hoogmoed, 1987). The lowest elevation at which any *Osornophryne* (*O. guacamayo*) was collected on Volcán Sumaco is approximately 2100 m.

*Morphometric comparisons.*—To quantify morphological overlap and differences, I conducted a multivariate morphometric analysis of all species of *Osornophryne*. Because the species differ in adult size (Table 1) and the sample had both adults and subadults, I removed size from the analysis and examined size-independent shape variation and overlap among species. To do this, I performed a principal component analysis on 11 morphological characters of 43 specimens representing all six species (Fig. 5). The first component had equal, positive loadings of all characters and accounted for 78.34% of the total variance (Table 2). I interpreted PC I as a size component and eliminated it from the remaining analyses. I then performed a discriminant analysis using individual scores on PC II through PC XI to examine species overlap based on size-independent shape variables. The first three canonical variates are responsible for the most variation (93.78%) among the groups (Table 3). Generalized squared distances between all species demonstrate the relatively close similarities between *Osornophryne bufoniformis* and *O. guacamayo* and between *O. antisana* and *O. sumacoensis* (Table 4). However, even among these species discrimination was virtually complete. Only a single specimen of *O. bufoniformis* (KU 144113) was misclassified in a jackknife classification procedure based solely on size-independent, external characters (Table 5). Distances between the species reflect phenotypic similarity and are not intended to describe an actual phylogeny.

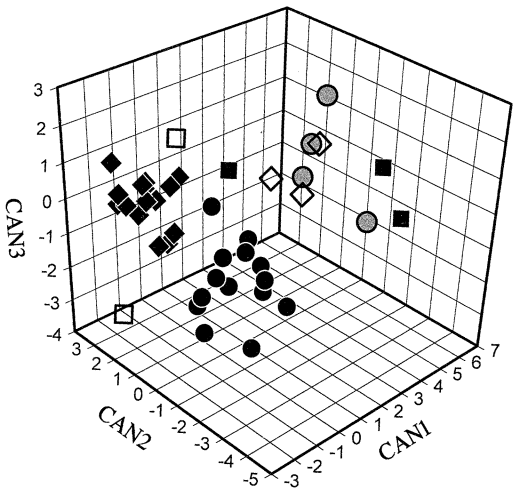



FIG. 5.—Plot of cannonical variants I–III derived by discriminant function analysis of 11 morphological characters for 43 specimens of *Osornophryne*. *O. antisana* = open circles, *O. bufoniformis* = closed circles, *O. guacamayo* = closed diamonds, *O. percrassa* = closed squares, *O. sumacoensis* = open diamonds, *O. talipes* = open squares.

TABLE 2.—Character loading and percentage of the explained variance for principal components (PC) 1–11.

| | PC I | PC II | PC III | PC IV | PC V | PC VI | PC VII | PC VIII | PC IX | PC X | PC XI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SVL | 0.312 | −0.259 | −0.338 | −0.060 | −0.213 | 0.135 | 0.310 | −0.068 | 0.144 | 0.346 | 0.639 |
| TIB | 0.304 | −0.267 | 0.287 | −0.175 | −0.138 | 0.441 | −0.631 | −0.318 | 0.079 | −0.068 | 0.027 |
| FOOT | 0.277 | −0.366 | 0.478 | 0.183 | 0.617 | −0.094 | 0.230 | 0.128 | 0.239 | −0.060 | 0.086 |
| HEADW | 0.322 | −0.136 | −0.326 | −0.124 | −0.150 | 0.110 | 0.220 | 0.166 | 0.170 | −0.763 | −0.186 |
| HEADL | 0.329 | −0.204 | −0.140 | −0.088 | −0.092 | −0.013 | 0.122 | 0.048 | 0.130 | 0.514 | −0.719 |
| IOD | 0.307 | −0.026 | −0.403 | 0.323 | 0.410 | 0.132 | −0.145 | −0.093 | −0.650 | −0.009 | −0.023 |
| IND | 0.315 | 0.220 | −0.135 | 0.169 | −0.039 | −0.307 | −0.523 | 0.588 | 0.247 | 0.082 | 0.152 |
| EN | 0.288 | 0.174 | 0.407 | 0.598 | −0.519 | 0.067 | 0.226 | −0.004 | −0.189 | −0.039 | −0.029 |
| ED | 0.242 | 0.682 | 0.106 | −0.268 | 0.248 | 0.518 | 0.195 | 0.119 | 0.086 | 0.101 | 0.017 |
| NR | 0.306 | 0.343 | −0.093 | 0.031 | 0.093 | −0.477 | −0.016 | −0.682 | 0.268 | −0.078 | −0.002 |
| EW | 0.305 | −0.0145 | 0.289 | −0.588 | −0.122 | −0.401 | 0.072 | 0.123 | −0.521 | −0.021 | 0.093 |
| % total variance | 78.34 | 7.99 | 4.86 | 2.71 | 1.74 | 1.35 | 1.03 | 0.87 | 0.72 | 0.22 | 0.16 |

TABLE 3.—Character loading and percentage of explained variance for canonical variates (CAN) 1–3.

| | CAN1 | CAN2 | CAN3 |
|---|---|---|---|
| PRIN2 | 0.617 | 0.173 | 0.112 |
| PRIN3 | −0.592 | 0.405 | −0.009 |
| PRIN4 | 0.376 | 0.632 | 0.045 |
| PRIN5 | −0.012 | −0.044 | 0.449 |
| PRIN6 | 0.254 | −0.066 | −0.260 |
| PRIN7 | 0.151 | −0.377 | 0.612 |
| PRIN8 | −0.129 | −0.081 | −0.077 |
| PRIN9 | 0.100 | 0.087 | −0.019 |
| PRIN10 | 0.112 | −0.419 | 0.552 |
| PRIN11 | −0.013 | 0.262 | −0.176 |
| % total variance | 62.18 | 25.26 | 6.35 |

## DISCUSSION

Cannatella (1986*b*) placed the genera *Atelopus* Duméril and Bibron, *Frostius* Cannatella, and *Osornophryne* in a monophyletic group based on consideration of several internal and external morphological characters (excluding phalangeal count). Cannatella (1986*a*) and Hoogmoed (1987) distinguished the genus *Osornophryne* from the other members of the *Atelopus-Frostius-Osornophryne* clade partly because of its palmate hands and feet (extensive webbing and reduced phalangeal formulae in some species). In anurans, the ancestral phalangeal formula in the hand is 2-2-3-3 (digits I–IV, respectively) and 2-2-3-4-3 in the foot (Duellman and Trueb, 1985). *Atelopus* and *Frostius* both have the ancestral formula in the hand and foot (Cannatella, 1986*b*).

Two observations suggest that a reduced phalangeal formula is not a diagnostic character for *Osornophryne*. McDiarmid (1971) reported a single specimen of *Atelopus* with a phalangeal formula in the foot of 1-2-3-4-3 as well as several cases of intraspecific variation in phalangeal formula where some individuals possessed a formula of 1-2-3-3 in one or both hands. Additionally, Hoogmoed (1987) studied X-rays of *Osornophryne guacamayo* and noted that the species has a reduced phalangeal formula in the hand (1-2-3-3) and the foot (1-1-2-4-3). However, my X-rays indicate that *Osornophryne guacamayo* does not exhibit such a reduction in phalangeal formulae of the hand and foot,

TABLE 4.—Generalized squared distances between species of *Osornophryne*.

| | *bufoniformis* | *antisana* | *talipes* | *percrassa* | *sumacoensis* | *guacamayo* |
|---|---|---|---|---|---|---|
| *bufoniformis* | 0 | 51.3 | 26.2 | 17.5 | 55.4 | 11.1 |
| *antisana* | 51.3 | 0 | 34.8 | 43.6 | 13.4 | 60.3 |
| *talipes* | 26.2 | 34.8 | 0 | 39.7 | 50.9 | 21.2 |
| *percrassa* | 17.5 | 43.6 | 39.7 | 0 | 50.4 | 34.3 |
| *sumacoensis* | 55.4 | 13.4 | 50.9 | 50.4 | 0 | 68.7 |
| *guacamayo* | 11.1 | 60.3 | 21.2 | 34.3 | 68.7 | 0 |

although some of the terminal phalanges of the inner fingers and toes in *O. guacamayo* are reduced to small but discrete nodules (Table 6). Ruiz-Carranza and Hernández-Camacho (1976) reported a phalangeal formula 2-2-3-2 in the hand and 2-2-3-4-3 in the foot of *Osornophryne percrassa*. I observed a formula of 1-2-3-2 in the hand and 1-2-2-4-1 in the foot in all specimens of *Osornophryne percrassa* examined (Table 6). Reduced phalangeal formulae are not phylogenetically informative because of the plasticity of this character within this genus. Phalangeal reduction and unique foot structures occur elsewhere in neotropical bufonid genera (*Crepidophryne* Savage and Kluge, *Dendrophryniscus* Jiménez de la Espalda, and *Oreophrynella* Boulenger) and are considered taxonomically important. I agree with Cannatella (1986*b*) and Hoogmoed (1987) that *Osornophryne*, *Atelopus*, and *Frostius* should not be subsumed under a single genus *Atelopus*. Characters in *Osornophryne* which differentiate it from *Atelopus* and *Frostius* include the presence of bony lateral expansions of the coccyx (Cannatella, 1986*b*), a reduction in the number of presacral vertebrae, and a robust shoulder girdle with fused epicoracoid cartilages (Hoogmoed, 1987). Both *Frostius* and *Atelopus* possess derived characters not shared by other members of the clade. The current placement emphasizes the distinctiveness of the three genera.

Specimens of *Osornophryne antisana*, *O. bufoniformis*, and *O. sumacoensis* that I have examined display some polymorphism in the phalangeal configuration of the foot (Table 6). These data in general agree with observations by Alberch and Gale (1985) and Hoogmoed (1987) who presented the following phalangeal formula for the feet of *O. bufoniformis* and *O. percrassa*: 1-2-3(2)-4-1(2) (underline indicates digit that has lost skeletal elements). *Osornophryne antisana* also has a significantly reduced phalangeal formula in the foot. *Osornophryne talipes* has an even more reduced phalangeal formula. "Rules" for trends in phalangeal reduction in anurans were proposed by Alberch and Gale (1985). Briefly stated, their rules are as follows. (1) In all species that have lost only one phalange, the loss always occurs in the first toe. (2) When two digits display phalangeal losses, they are always Digits I and V. (3) If three toes are affected by loss or reduction, they are Digits I, V and either II (in *Didynamipus*) or III (in *Osornophryne* and *Crepidophryne* Savage and Kluge).

In species of *Osornophryne* that have

TABLE 5.—Resubstitution summary using linear discriminant function.

| | Number of observations classified into group: | | | | | | |
|---|---|---|---|---|---|---|---|
| From group | *bufoniformis* | *antisana* | *talipes* | *percrassa* | *sumacoensis* | *guacamayo* | Total |
| *bufoniformis* | 14 | 0 | 0 | 0 | 0 | 1 | 15 |
| *antisana* | 0 | 5 | 0 | 0 | 0 | 0 | 5 |
| *talipes* | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| *percrassa* | 0 | 0 | 0 | 3 | 0 | 0 | 3 |
| *sumacoensis* | 0 | 0 | 0 | 0 | 3 | 0 | 3 |
| *guacamayo* | 0 | 0 | 0 | 0 | 0 | 15 | 15 |

TABLE 6.—Phalangeal formulae in the genus *Osornophryne*. The number of individuals observed with each configuration is listed in parentheses. This number is underlined if polymorphism occurs within an individual(s).

| | *antisana* | *bufoniformis* | *guacamayo* | *percrassa* | *sumacoensis* | *talipes* |
|---|---|---|---|---|---|---|
| Hand (I–IV) | 1-2-3-2 (3)<br>1-2-3-3 (1)<br>2-2-3-2 (1) | 1-1-3-3 (1)<br>1-2-3-2 (14)<br>1-2-3-3 (3)<br>2-2-3-2 (2)<br>2-2-3-3 (4) | 2-2-3-3 (12) | 1-2-3-2 (4) | 1-2-3-2 (1)<br>1-2-3-3 (3) | 1-2-3-2 (2) |
| Foot (I–V) | 1-2-2-4-2 (3)<br>1-2-2-4-1 (1) | 1-1-2-4-1 (1)<br>1-1-2-4-2 (4)<br>1-2-2-3-1 (1)<br>1-2-2-4-1 (3)<br>1-2-2-4-2 (2)<br>1-2-3-4-2 (3)<br>2-2-2-4-2 (2) | 2-2-3-4-3 (12) | 1-2-2-4-1 (4) | 1-2-2-4-1 (1)<br>1-2-2-4-2 (2)<br>1-2-3-4-2 (2) | 1-1-2-4-1 (2) |

undergone digital reduction, Toe V is always reduced, Toe I is almost always reduced, and Toe III is frequently reduced. Toes II and IV are reduced in some cases as well. I have not seen any examples of a single digit being reduced in *Osornophryne*. Two specimens of *O. bufoniformis* have phalangeal formulae of 2-2-2-4-2. These are the only examples that I have seen of two digits being affected by the loss of phalangeal elements in *Osornophryne* that do not follow the rules proposed by Alberch and Gale. All cases of digital reduction occurring in three digits follow the rules proposed by Alberch and Gale (1985). It may be necessary to examine more individuals possessing intermediate states in order to determine the exact pathway by which a given phalangeal configuration has arisen in adult frogs. Observations of the development of the limb bud in these frogs may also provide answers to this problem.

## RESUMEN

Se describe una nueva especie del género andino *Osornophryne* de los bosques nublados del Volcán Sumaco en Ecuador central. Esta especie puede distinguirse de otras del género por el combinación de su coloración ventral, piel arrugada y cordoncillos dorsales y pustulados. Individuos de dos otras especies de *Osornophryne, O. guacamayo* y *O. antisana,* fueron en la misma localidad. Se discute unos de los aspectos de la ecología de estos sapos. Incluyo unas comparaciones morfometricas y notas respecto a la condición de reducción digital en este grupo.

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## APPENDIX I

*Material Examined*

*Osornophryne antisana.* Ecuador: Napo: Volcán Sumaco, SE of summit, QCAZ 4573, 4574, 4575. Napo: vía Salcedo-Oriente, 3500–3600 m, eastern slopes, QCAZ 411. Tungurahua: Páramos dellangantes, QCAZ 1648.

*Osornophryne bufoniformis.* Ecuador: Departamento de Carchí; Santa Barbara, 2650 m, KU 189945; Páramo del Angel, 23 km SW Tulcán, KU 117880. Imbabura: Cordillera de Intag, La Delicia, KU 132126. USNM 322774–5. Provincia Napo; Santa Barbara, USNM 193537–193540. Colombia: Departamento de Cauca: Municipio Paez, carretera al paramo de Santo Domingo, 3200–3300, Pedro M. Ruiz coll. 28.x.1972, MCZ 100559; Paramo Purace, Laguna San Raphael, 3200 m, KU 144113–144114; Purace, 3450 m, KU 145036–45037; 23 km E. of Purace, 3275 m, KU 169134–169135. Departamento de Narino; 12 km E. of Pasto, 3050 m, KU 169137, 169139–169140.

*Osornophryne guacamayo.* Ecuador: Napo: Volcán Sumaco, SE of summit, QCAZ 4576–4584, AGG (AGG numbers are deposited in QCAZ) 191, 193, 216, 219, 230, 238–240, 242, 247, 250, 253, 256, 257.

*Osornophryne percrassa.* Colombia: Departamento de Tolima: Herveo, 3100 m Pedro M. Ruiz coll. 28.i.1972. MCZ 100558. USNM 151325, 322776–7.

*Osornophryne sumacoensis.* Ecuador: Napo: Volcán Sumaco, SE of summit, 2500 m, QCAZ 4570–4572.

*Osornophryne talipes.* Ecuador: Imbabura: north slope of Nudo de Mojanda, 3400 m, KU 131798. Colombia: Departamento de Cauca: 26 km E. of Purace, 3180 m, KU 169136.

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# A NEW SPECIES OF *HYLODES* FROM SOUTHEASTERN BRAZIL (AMPHIBIA: LEPTODACTYLIDAE)

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ABSTRACT: A new species of leptodactylid frog is described from the Serra das Cabras in São Paulo, southeastern Brazil. The new species is a member of the *Hylodes lateristrigatus* group and is characterized by its small size and high number of notes per call. Descriptions of the tadpole and advertisement call and information on natural history are provided.

*Key words:* Anura; Leptodactylidae; Hylodinae; Advertisement call; New species; Southeastern Brazil; Tadpole

THE rheophilic frogs of the genus *Hylodes* are restricted to the Atlantic Forests in Brazil, with the only known exception being *H. otavioi* from the riparian forests in rocky fields at the Serra do Cipó, Minas Gerais, Brazil (Sazima and Bokermann, 1982).

In the genus *Hylodes,* there are 15 species currently recognized in four groups: one in the *H. glaber* group, nine in the *H. lateristrigatus* group, one in the *H. mertensi* group, and four in the *H. nasus* group (Duellman, 1993; Frost, 1985; Izecksohn and Gouvêa, 1983). The *Hylodes lateris-*