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A new frog species (Strabomantidae: *Pristimantis*) from the High Andes of Southeastern Ecuador

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Abstract

We describe *Pristimantis gagliardoi*, a new medium sized (SVL 19.06–33.64 mm) *Pristimantis* species from the Andean forests of southeastern Ecuador. This species is referred to the *P. unistrigatus* group. It differs from other members in the *unistrigatus* group by the presence of large conical tubercles on the eyelid and heel, small conical ulnar and tarsal tubercles, suprascapular dermal ridges, and bronze iris.

Key words: Anura, Strabomantidae, Ecuador, Mazar Reserve, new species, *Pristimantis gagliardoi*, *Pristimantis unistrigatus*

Resumen

Describimos una especie nueva de tamaño medio (SVL 19.06–33.64 mm) de *Pristimantis* de los bosques andinos del sureste de Ecuador. Asignamos la especie al grupo *Pristimantis unistrigatus*. Difiere de otros miembros en el grupo *unistrigatus* por la presencia de tubérculos cónicos grandes en el párpado y en el talón y tubérculos cónicos pequeños en la ulna y el tarso, pliegues dérmicos supraescapulares e iris bronze.

Palabras clave: Anura, Strabomantidae, Ecuador, especie nueva, *Pristimantis gagliardoi*, *Pristimantis unistrigatus*, Reserva Mazar

Introduction

Pristimantis apparently is the most species-rich frog genus in the world, with nearly 427 named species; its distribution and diversity are mainly associated with the Andes (Heinicke *et al*. 2007, Hedges *et al*. 2008). In Ecuador the genus comprises 139 recognized species, 32% of the Ecuadorian frog diversity (Coloma 2005–2008). Estimates of Ecuadorian frog richness suggest that these numbers will keep rising (Ron *et al*. 2006). This increase will certainly be based in the Andes, where most new species are being discovered (Guayasamin *et al*. 2004, 2006; Cisneros-Heredia & McDiarmid 2007). Within *Pristimantis*, the *unistrigatus* group (*sensu* Lynch & Duellman 1997, Duellman & Pramuk 1999, Hedges *et al*. 2008) is the most speciose, comprising 82 ecuadorian representatives. Herein we describe a new species associated to the *unistrigatus* group, based on specimens collected during fieldwork carried out by the authors since February 2004 in the Mazar Reserve, a poorly inventoried area on the eastern slope of the Ecuadorian Andes.

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Material and methods

Specimens were sacrificed in chloretone solution and with 20% benzocaine, fixed in 10% formalin, and preserved in 70% ethanol. We examined comparative specimens from amphibian collections at Museo de Zoología de la Pontificia Universidad Católica del Ecuador (QCAZ) and the Natural History Museum of the University of Kansas (KU) (see Appendix I). Morphological measurements were taken as described by Guayasamin (2004) as follow: (1) SVL; (2) tibia length; (3) foot length; (4) head length; (5) head width; (6) interorbital distance; (7) upper eyelid width; (8) internarial distance; (9) eye to nostril distance; (10) snout to eye distance; (11) eye diameter; (12) tympanum diameter; (13) eye to tympanum distance; (14) radio-ulna length; (15) hand length; and (16) Finger I length. Sexual maturity was determined in females by the presence of eggs and convoluted oviducts. We began our fieldwork in Reserva Mazar in February 2004, aiming to obtain a complete amphibian inventory and set a basis for further natural history and population studies in a region where frog species have diminished or disappeared (Merino-Viteri *et al*. 2005; Coloma *et al*. 2007; Ron *et al*. in press). Between 2004–2007 we conducted bi-annual diurnal and nocturnal visual encounter surveys along transects and trails in the reserve.

Pristimantis gagliardoi Bustamante & Mendelson, new species

Figs. 1–5

Holotype. QCAZ 27103, an adult female (Figs. 1–4) obtained by MRB at La Libertad, Reserva Mazar, (S 02° 32' 47" S, 078° 41' 54.1" W, 2895m). Provincia Cañar, Ecuador, on October 25, 2005.

Paratopotypes. QCAZ 27104, an adult female collected by MRB on 22 October 2005; QCAZ 27568, 27578, 27580–1, adult males, and QCAZ 27577, 27579, two adult females, collected by the authors and Michelle R.Cummer on 26–27 February 2004; QCAZ 29561, an adult male collected by MRB on 16 March 2005; QCAZ 32623, an adult female collected on 20 November 2006 by MRB.

Diagnosis. A member of *P. unistrigatus* (*sensu* Lynch and Duellman 1997, as modified by Duellman and Pramuk 1999, Hedges *et al*. 2008,) diagnosed by having (1) skin texture of dorsum shagreen with scattered tubercles, those on venter areolate; (2) tympanic membrane and annulus evident, 29.7–40% of eye length on females and 25.2–32.3% on males, with supratympanic ridge obscuring upper and posterodorsal edges; (3) snout rounded in profile and dorsal views; (4) upper eyelid bearing one large, and several small scattered, conical tubercles; cranial crests absent; (5) dentigerous process of the vomer triangular and narrowly separated, each bearing 4–6 teeth; (6) vocal slits and vocal sac absent in males, nuptial pads present (Fig. 5); (7) first finger shorter than the second, fingers with expanded discs; (8) fingers with lateral fringes; (9) ulnar tubercles small; (10) heel with one enlarged conical tubercle; tarsus with 3–4 tubercles along the outer edge; (11) two metatarsal tubercles prominent, inner oval, about three times the size of the outer subconical tubercle; numerous supernumerary plantar tubercles; (12) toes with lateral fringes; (13) in ethanol, dorsum tan, gray or dark gray, with darker markings (sometimes chevrons or bars) outlined by white or black lines; venter cream to pale cream with darker spots; palmar and plantar surfaces gray, with Fingers I–II, and Toes I–III being the palest; (14) adults medium sized, in males 19.06–24.33 SVL ($\bar{x}$= 22.17 $\pm$ 2.01, n = 6), females 26.83–33.64 SVL ($\bar{x}$ = 30.63 $\pm$ 3.10, n = 5).

We assign this species to the *Pristimantis unistrigatus* group based on the following characters: narrow head (head width 38.5–42.6% of SVL in females and 38.3–41.9% in males); absence of cranial crests; upper eyelid as wide as, or wider than, IOD (75.1–96.9% in females, 96.0–112.0% in males); skin on venter areolate; nuptial pads present; tympanic membrane evident; discs on fingers and toes broad; Finger I shorter than Finger II and toes being unwebbed.

Comparisons. *Pristimantis gagliardoi* may easily be identified by the presence of large, conical tubercles on the eyelids and heels. This species differs from other species in the group that have some degree of development of such tubercles as follows and by the presence/absece of other characters (condition of *P. gagliardoi* in parentheses) (Table 1): *Pristimantis cryptomelas* (Lynch 1979) is the species most similar to *P. gagliardoi*, but differs by having a black coloration on the anterior and posterior sides of thighs, the posterior lower flanks, and the concealed portion of the shank (pale reddish), by having smooth skin (shagreen with scattered distinct tubercles), by lacking a conical tubercle over the eye (present), and by having larger pads on the digits of the hands and feet. *Pristimantis inusitatus* (Lynch & Duellman, 1980) differs by having a green dorsum and white venter (dorsum pale brown with variable dark brown markings, venter cream with variable dark brown reticulations or markings), conical tubercle on upper eyelid (present, but larger in *P. gagliardoi*), snout protruding in profile and subcauminate in dorsal view (rounded in both views). *Pristimantis eriphus* (Lynch & Duellman, 1980) has a straight canthus rostralis (weakly angular), adult females have red iris (bronze) and flanks with white areas and slightly oblique white bars on posterior flanks and hidden surfaces of hind limbs (bars on flanks). *Pristimantis prolatus* (Lynch & Duellman, 1980) has no ulnar tubercles (few conical), vocal slits and vocal sac present in males (absent), Iris is gray brown (bronze), snout in profile nearly truncate and accuimnate in dorsal view (rounded in both views). *Pristimantis nephophilus* (Duellman and Pramuk, 1999) has a few, small tubercles on the posterior eyelid (small tubercles scattered over surface of eyelid, and a single, large, central, conical tubercle), dark brown coloration with cream spots on the posterior thighs (pale reddish), brown coloration on the venter (cream with variable markings), all tubercles on the feet and hands weakly developed (strongly developed), smoother skin, lacking pronounced tubercles (shagreen with scattered distinct tubercles), and discs on the hind digits being slightly smaller than those of fingers (equal in size).

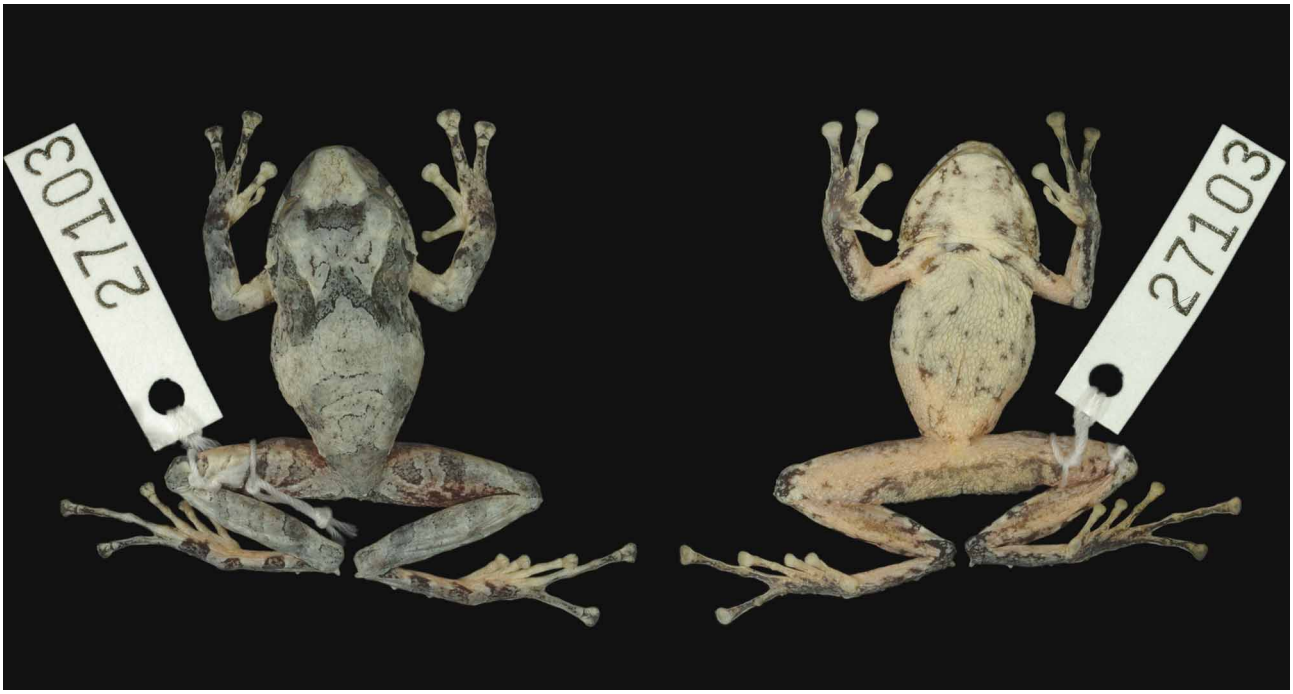

FIGURE 1. Dorsal (left) and ventral (right) views of *Pristimantis gagliardoi* in preservative; holotype, adult female (QCAZ 27103), SVL = 32.49 mm.

Description of the holotype. Head slightly wider than long, head length 85% of head width (Fig. 1); snout relatively short (snout to eye distance 15.1% of SVL), rounded in dorsal view and in profile (Figs. 1–2); eye to nostril 92.7% length of eye; nostrils not protuberant, directed anterolaterally; canthus rostralis weakly

angular; loreal region concave; lips not flared; interorbital area flat, broader than upper eyelid (upper eyelid width 85.9% of interorbital distance); upper eyelid with distinct conical fleshy tubercle situated centrally on outer margin of eyelid; cranial crests absent; supratympanic fold weak, but partially obscuring upper margin of tympanic annulus and tympanum; side of head nearly vertical; tympanic annulus distinct; tympanic membrane weakly pustular, not thickened; length of tympanic annulus 40% length of eye; postrictal tubercles large, subconical, situated ventral and posteroventral to tympanic annulus; skin on head finely granular; choanae very small, oval, not concealed by palatal shelf of maxillary; vomerine odontophores oblique, posteromedial to choanae, oval in outline, about 3–4x size of choana, separated medially by distance less than width of odontophore, each bearing 4 teeth; tongue wider than long, its posterior border bilobbed, posterior half not adherent to floor of mouth.

TABLE 1. Character states in similar *Pristimantis* species associated to the *unistrigatus* group.

Character	*P. cryptomelas*	*P. eriphus*	*P. inusitatus*	*P. nephophilus*	*P. prolatus*	*P. gagliardoi*
SVL males	28.2–30.2	18.1–25.2	-	-	13.7–18.4	19.1–24.3
SVL females	38.6	25.8–29.0	24.0–24.4	24.6–34.0	20.8–24.1	26.8–33.6
Canthus rostralis	Rounded	Straight (weakl concave)	Sharp	Weakly angular (barely concave)	Moderately sharp	Weakly angular
Snout in profile	Rounded	Round	Protruding	Rounded	Nearly truncate	Rounded
Snout in dorsal view	Sub acuminate	Round	Sub acuminate	Rounded	Acuminate	Rounded
Eyelid	Bearing tubercles	Bearing one conical tubercle	Bearing a conical tubercle	With small tubercles posteriorly	Bearing one pungent tubercle	Distinct conical, fleshy
Ulnar tubercles	Prominent	Conical to subconical	Conical	Few, round to subconical	Not present	Few conical

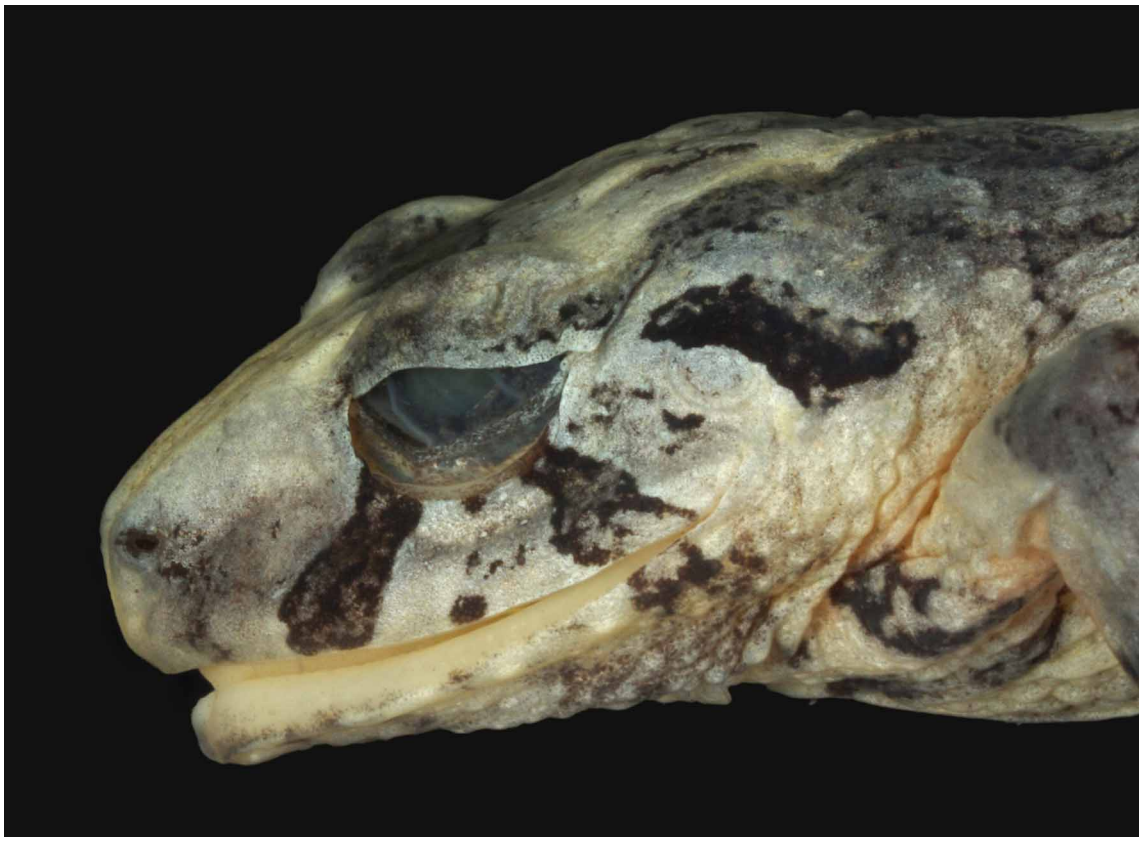

FIGURE 2. Lateral view of the head holotype of *Pristimantis gagliardoi*, holotype, adult female (QCAZ 27103).

Dorsum of head, body, and limbs with scattered subconical tubercles becoming larger and more abundant on lateral surfaces; dermal ridge from posteromedial edge of eyelid to scapular region; dorsolateral folds absent; flanks granular; cloacal sheath absent; enlarged tubercles in cloacal region present, moderately developed; skin on throat granular; skin on venter areolate; discoidal fold not evident; forearm slender; radio-ulna length 25% of SVL; ulnar tubercles few, round to subconical; thenar tubercle ovoid, about 3x size of bifid subpalmar tubercle; supernumerary tubercles few, large subconical; subarticular prominent, subconical; hand length longer than radioulna length 33.1% of SVL; Fingers II–IV bearing narrow lateral fringes; relative lengths of fingers I < II < IV < III; disc on thumb slightly expanded; discs on Fingers II–IV extensively expanded, truncate, less than twice width of digits; Finger I having ventral pad defined by circumferential groove, absent on other fingers (Fig. 3).

FIGURE 3. (A) Right hand of *Pristimantis gagliardoi*; (B) right foot of *Pristimantis gagliardoi*. Holotype, adult female (QCAZ 27103).

Hind limbs relatively slender; tibia length 52.9% of SVL; foot length 95.3% of tibia length; heel bearing small, subconical tubercle; outer edge of tarsus bearing three large subconical tubercles; inner metatarsal tubercle flat, ovoid, about 3x subconical outer metatarsal tubercle; supernumerary plantar tubercles prominent, round or subconical; subarticular tubercles round, not conical; toes bearing narrow lateral fringes, most

developed on Toes IV–V; relative length of toes I < II < III < V < IV; webbing absent; discs on toes equal in size to discs on fingers; tip of Toe V extending to distal edge of distal subarticular tubercle on Toe IV; tip of Toe III not extending to that tubercle (Fig. 3).

Coloration of holotype. In life: Dorsum tan with brown bars outlined by thin black lines, suprascapular region with a dark brown W mark corresponding to suprascapular dermal ridges; dark brown interorbital bar; brown cloacal region. Dorsal surfaces of limbs tan with brown and dark brown bars. Dorsum of hands and feet with black blotches, more abundant towards distal portions of fingers and toes. Flanks tan with black blotches. Axial region and groin pink with brown blotches. Hidden parts of venter and forelimbs pink with brown blotches. Ventral surfaces of tarsus and outer toes dark brown. Yellow belly with dark brown spots, yellowish throat with brown blotches. Two dark brown blotches in ventral scapular region. Venter of hands dark brown, inner fingers (I and II) pale brown; black bars originating below eye and extending towards the lip. Iris bronze with black reticulations (Fig. 4).

FIGURE 4. Dorsolateral (A) and ventral (B) views of *Pristimantis gagliardoi* in live; holotype, adult female (QCAZ 27103), SVL = 32.49 mm.

In preservative: Dorsum gray with darker interorbital bar and a W over scapular region; dorsal surfaces of proximal forelimbs dull cream, distal forelimbs dull gray with darker markings; dorsal surfaces of Fingers I

and II pale cream, Fingers III and IV pale gray with dark gray markings and paler discs; dorsal surfaces of thighs pinkish gray with darker blotches; shanks gray with darker bars, tarsus gray with darker markings, Toes IV and V same color, Toes I–III cream. Dorsum of tympanum with black markings; gray loreal, canthal, and upper labial regions with black markings. Venter tan with dark gray spots, pale cream throat with gray markings; venter of proximal forelimbs pinkish becoming darker on ulna and outer fingers, inner fingers cream; ventral hindlimbs pinkish with brown markings, on tarsus and Toes IV and V becoming dark grey, and Toes I–III cream (Fig. 1).

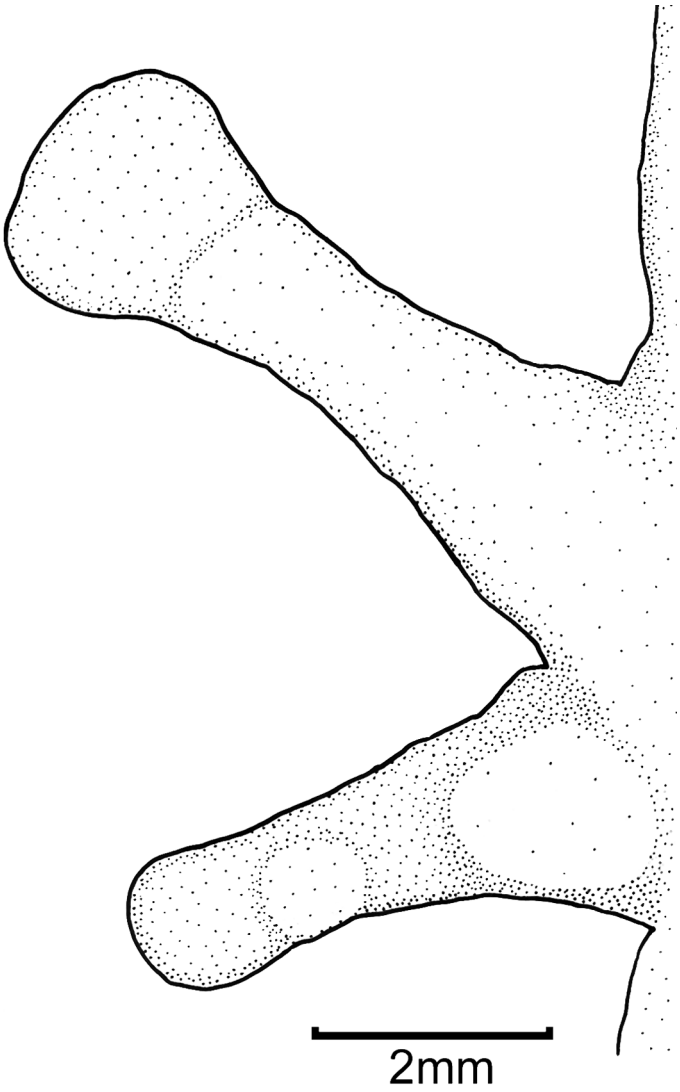

FIGURE 5. Nuptial pad on Finger I of a *Pristimantis gagliardoi* male (QCAZ 27580).

Measurements of holotype. SVL = 32.49; tibia length = 17.19; foot length = 16.38; head length = 10.84; head width = 12.75; interorbital distance = 4.03; upper eyelid width = 3.46; internarial distance = 2.79; eye to nostril distance = 3.57; snout to eye distance = 5.06; eye diameter = 3.85; tympanum diameter = 1.54; eye to tympanum distance = 1.40; radioulna length = 8.12; hand length = 10.78; and Finger I length = 5.13.

Variation. Variation in measurements and proportions among additional specimens are presented in Tables 2 and 3. Variation of coloration in life: QCAZ 27570: Dorsum with cream and pale brown bars outlined by thin black lines; flanks cream with bars originating on the dorsum; dorsum of limbs showing the same pattern as the body; groin and hidden surfaces of thighs colorless; venter cream; iris bronze with a brown medial stripe; upper lip with vertical brown and cream bars; QCAZ 27104: Dorsum tan with brown blotches outlined

by thin black lines; flanks brown with diagonal bars becoming greenish toward the dorsum; dorsum of forelimbs with brown and greenish bars; tarsus tan with brown bars; dorsum of arms tan with brown blotches; dorsum of hands and feet with black blotches present on outer fingers; groin, armpit, and hidden parts of thighs pale pink with brown blotching; throat tan with brown blotching; venter of limbs tan with dark brown blotching with outer fingers and toes darker; black bars originating below eye and extending towards the lip. Iris bronze with black reticulations; QCAZ 27434: Same pattern as QCAZ 27104 but having diagonal green bars extending from the dorsum onto the hidden surfaces of thighs; groin and armpit are orange.

TABLE 2. Measurements (in mm) of adults of *Pristimantis gagliardoi*. Range, mean SD are given. SVL = snout–vent length.

Character	females *n* = 5	males *n* = 5
SVL	26.83–33.64 (30.63 ± 3.10)	19.06–24.33 (22.17 ± 2.01)
Tibia length	15.23–18.17 (16.68 ± 1.29)	10.98–14.97 (12.70 ± 1.50)
Foot length	13.21–17.05 (15.23 ± 1.86)	9.22–13.04 (11.16 ± 1.46)
Head length	9.82–11.43 (10.70 ± 0.60)	6.76–9.05 (7.87 ± 0.85)
Head width	10.71–13.34 (12.22 ± 1.00)	7.73–10.19 (9.02 ± 0.94)
Interorbital distance	3.20–4.03 (3.51 ± 0.33)	2.18–2.85 (2.60 ± 0.28)
Upper eyelid width	2.46–3.46 (3.25 ± 0.39)	2.32–2.83 (2.65 ± 0.22)
Radioulna length	2.58–2.91 (2.81 ± 0.14)	1.83–2.64 (2.23 ± 0.29)
Eye to nostril distance	2.43–3.58 (3.23 ± 0.34)	2.01–2.83 (2.33 ± 0.31)
Snout to eye distance	4.52–5.75 (5.10±0.51)	3.31–4.55 (3.85 ± 0.45)
Eye diameter	3.45–4.12 (3.78 ± 0.27)	2.40–3.00 (2.83 ± 0.24)
Tympanum diameter	1.04–1.54 (1.25 ± 0.19)	0.70–0.80 (0.76 ± 0.03)
Eye to tympanum distance	1.32–1.75 (1.51± 0.17)	1.10–1.35 (1.18 ± 0.10)
Radio-ulna length	6.92–8.50 (7.83 ± 0.65)	5.26–6.94 (5.85 ± 0.66)
Hand length	8.43–10.78 (9.38 ± 1.00)	5.92–7.48 (6.56 ± 0.68)
Finger I length	3.95–5.13 (4.73 ± 0.54)	2.91–3.80 (3.27 ± 0.34)

TABLE 3. Ranges of morphological proportions (in percentages) of adults of *Pristimantis gagliardoi.* SVL = snout–vent length.

Character	females (n = 5)	males (n =5)
Tibia length/ SVL	51.7–57.5	53.8–61.5
Foot length/SVL	47.5–50.4	47.7–51.4
Foot length/tibia length	85.6–95.3	84.0–92.5
Head width/SVL	38.5–42.6	38.3–41.9
Head length /SVL	33.4–37.8	34.6–37.2
Head length/ head width	85.0–91.7	84.0–92.1
Eye–to–nostril distance/eye diameter	79.5–92.7	72.0–97.9
Upper eyelid width/IOD	75.1–96.9	96.0–112.0
Radioulna length/SVL	24.4–26.6	25.1–28.5
Hand length/radioulna length	103.2–132.7	101.5–125.9
Finger I Length/hand length	46.9–58.2	41.8–66.0

Etymology. The specific name is a noun in the genitive case and is a patronym for Ron Gagliardo, dedicated collaborator in both research and conservation programs involving Neotropical amphibians. Gagliardo has been important in promoting amphibian research, environmental education, but especially for supporting the establishment of captive breeding programs for the threatened Ecuadorian frogs.

Distribution and ecology. *Pristimantis gagliardoi* is known only from La Libertad, Reserva Mazar (S 02 32' 47" S, 078 41' 54.1" W, 2895m), Provincia Cañar, Ecuador. This site, a small farm, is located on the western versant of the Ecuadorian Andes in Bosque de neblina montano (Montane cloud forest) and Bosque siempreverde montano alto (Evergreen montane forest) according to Valencia *et al*. (1999) (Fig. 6). The species has been found on leaves and branches at heights varying from 0.40–1.50 m above ground ($\bar{x}$ = 0.775 m), mainly in secondary forests (12 of 16 individuals), and on vegetation over very small stream (2 of 16) and in primary forest (1 of 16). During our visits (six field trips since February 2004) to La Libertad, *P. gagliardoi* showed seasonal activity. During the wettest months we found it in primary and secondary forest as well as along small streams. In drier months (October and November) we found it along streams. An adult female (QCAZ 32623) obtained on 20 November, 2006, contained mature eggs in the oviducts. *Pristimantis gagliardoi* occurs sympatrically with *Gastrotheca pseustes*, *Hyloxalus vertebralis*, *P. orestes*, *P. pycnodermis*, *P. riveti* and an undescribed *Pristimantis* species.

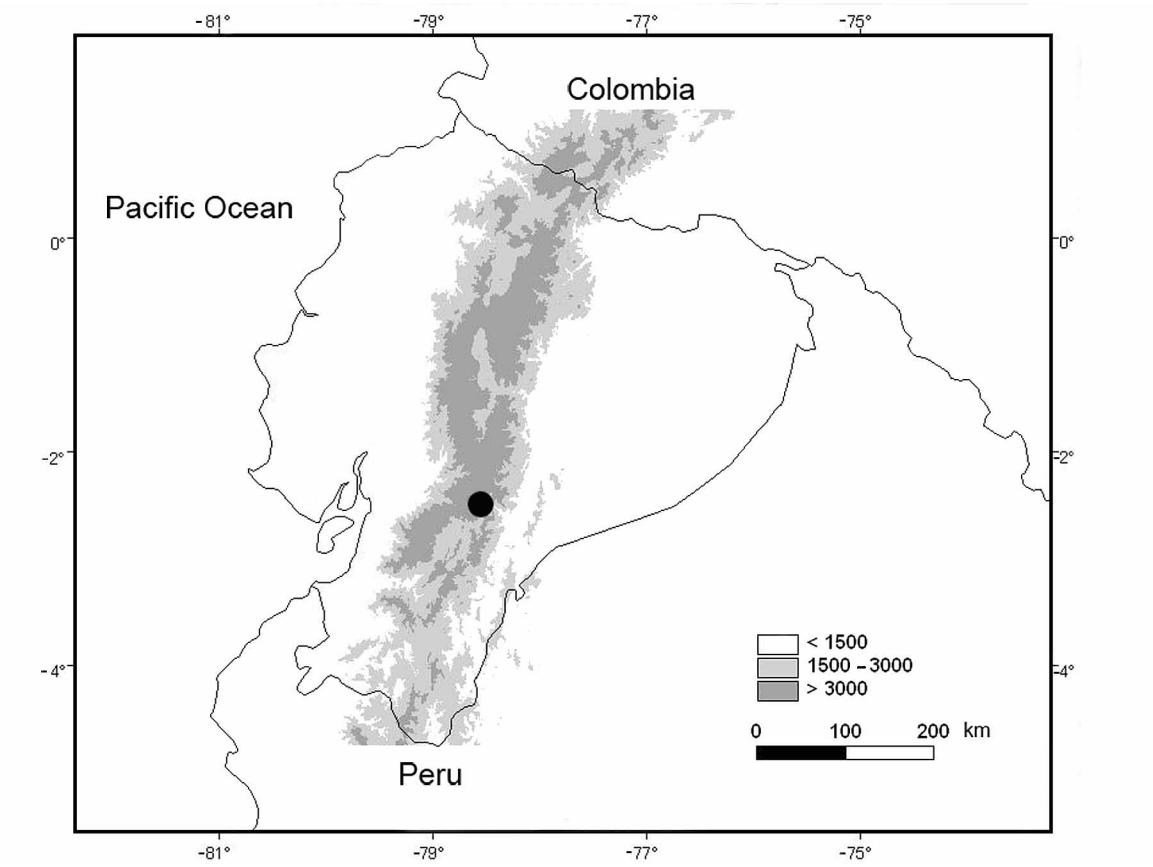

FIGURE 6. Map of Ecuador showing the type locality of *Pristimantis gagliardoi*.

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Appendix I. Specimens examined

Pristimantis cryptomelas:
Ecuador: Zamora-Chinchipe: 15 km E Loja, 2700m (KU 141993); Morona-Santiago: Rio Piuntza, 1910m (KU 147039); Loja: 7 km N San Lucas, 2840m (KU 177735).

Pristimantis eriphus:
Ecuador, Napo, Yanayacu Biological Station 2000m (QCAZ 30952–53, 32703–07).

Pristimantis inusitatus:
Ecuador, Napo, Yanayacu Biological Station,2000m (QCAZ 16199,16124, 19091–98, 22285–86, 23120–21,26058, 32710–12).

Pristimantis nephophilus:
Peru: San Martin: Rioja: E slope Abra Pardo de Miguel, 1980m (KU 212305, 212317).

Pristimantis prolatus:
Ecuador, Sucumbíos, Cascada de San Rafael, 1350m (QCAZ 22203–06, 34967, 36690; Sucumbíos, Río Azuela, 1700m (QCAZ 16115).