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Description of a New Species of *Alopoglossus* Boulenger, 1885 from Western Colombia (Gymnophthalmoidea)

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Abstract. We describe and name a new species of *Alopoglossus* (Gymnophthalmoidea: Alopoglossidae) from western Colombia (Departamentos Cauca and Valle del Cauca: Chocó biodiversity hotspot). The new taxon is morphologically similar to *Alopoglossus festae* and *A. viridis,* from which it differs in having, among other things: strongly keeled imbricated temporal scales; strongly keeled scales on dorsum of hand; rhomboid, keeled, and heavily pigmented ventral scales. Specimens of this new taxon have been sitting in museum shelves for several decades (holotype collected over 40 years ago)—thus, we discuss the relevance of biological specimen collection and the importance of reexamination of old museum records, in search of unnamed biodiversity.

Keywords. Alopoglossidae; Biodiversity; Chocó; Emberá; Gymnophthalmidae; Systematics; Taxonomy.

INTRODUCTION

A recent study recognized the morphologically distinct clade composed of *Alopoglossus* Boulenger, 1885 and *Ptychoglossus* Boulenger, 1890 as a full family (Alopoglossidae Goicoechea et al., 2016) instead of a subfamily (Alopoglossinae) of a larger Gymnophthalmidae Fitzinger, 1826 (Goicoechea et al., 2016). Regardless of the taxonomic rank adopted (family or subfamily), the two genera that compose this clade are collectively recognized as a monophyletic group, with a few morphological synapomorphies supporting their relationship (Presch, 1980; Goicoechea et al., 2016). Few morphological characters allow the unambiguous distinction between the two genera, and there have been scattered suggestions that some species may need reallocation to render both genera monophyletic (Ayala and Harris, 1984; Harris, 1994). At any rate, according to Harris (1994), most species can be allocated in one of the two genera on the basis of organization of dorsal scales (laterally imbricated in *Alopoglossus,* parallel sided in *Ptychoglossus*), and in ornamentation of forelimb scales (strongly keeled in *Alopoglossus,* smooth in *Ptychoglossus*).

Alopoglossus is a relatively small genus, including seven formally recognized species—*A. angulatus* (Linnaeus, 1758), *A. atriventris* Duellman, 1973, *A. buckleyi* (O'Shaughnessy, 1881), *A. copii* Boulenger, 1885, *A. festae* Peracca, 1904, *A. lehmanni* Ayala and Harris, 1984, *A. viridiceps* Torres-Carvajal and Lobos, 2014. The genus is distributed through cis- and trans-Andean northern South America. Although a recent review of the taxonomic status of several populations of *Alopoglossus* is available (Köhler et al., 2012), the diversity of the genus is likely underestimated (Torres-Carvajal and Lobos, 2014). During a morphological study of alopoglossids, we stumbled across a few specimens from western (trans-Andean) Colombia that we could not promptly identify. Examination of additional museum specimens, including most type specimens, and the relevant taxonomic literature of the genus, revealed that these specimens represent an unnamed species of *Alopoglossus*.

Herein, we provide a description of known specimens and formalize the recognition of the lineage as a new species. Most type specimens of the new taxon were collected more than 30 years ago; therefore, we discuss the importance of natural history collections and of revising old museum records in search of hidden biodiversity.

MATERIALS AND METHODS

Specimens used in the description or examined for comparisons are deposited in the following institutions: AMNH (American Museum of Natural History, New York, USA); CD-UV (Colección Zoológica de Docencia, Universidad del Valle, Cali, Colombia), KU (University of Kansas, Lawrence, USA); MPEG (Museu Paraense Emilio Goeldi, Belém, Brazil); UMMZ (University of Michigan Museum of Zoology, Ann Harbor, USA); UV-C (Colección de Anfibios y Reptiles, Universidad del Valle, Cali, Colombia).

Scale counts and measurements were taken with the aid of a stereoscope. Measurements were taken with an electronic caliper and recorded to the nearest 0.1 mm. Scale nomenclature follows Harris (1994) with a few observations, as follows: The first chinshield is referred to as postmental and postparietals are referred as occipitals. It is worth noting that scale nomenclature may differ from

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other authors and, thus, differences in scale counts must be evaluated with care. We clarify the following values obtained from specimens: Head length was measured from the posterior end of the last chinshields to the snout. Snout length was measured between the anterior corner of the eye to the snout; temporal region length was measured between the posterior corner of the eye to the tympanum; rows of dorsals were counted form the first row of dorsals to the posterior margin of cloacal plate; and transversal rows of ventrals were counted from first row after the gulars to the last row before the cloacal plate.

Figure 1. Holotype of *Alopoglossus embera* **sp. nov.** AMNH-R 109682.

RESULTS

Alopoglossus embera sp. nov.
(Figs. 1, 2A–D, 3A, 4)

Alopoglossus festae: Castaño-Mora et al., 2004 (part), Castro-Herrera and Vargas-Salinas, 2008 (part), Cardona-Botero et al., 2013 (part).

Holotype (Figs. 1, 2A-D, 3A, 4)

AMNH-R 109682 (field number CWM 11931), an adult female, very well preserved. Collected by Charles W. Myers and John W. Daly, 09 February 1973, at Quebrada Guanguí, upper Río Saija drainage, Departamento del Cauca, Colombia, 100–200 m asl.

Paratypes

AMNH-R 109678–109681, AMNH-R 109683–109684, collected by Charles W. Myers and John W. Daly, February 09–20 1973, at the type locality. UV-C 7231–7232, collected by Bladimir Vasquez and Yesid Solarte, August 12–13 1983, at Camancito, Río Cajambre, Municipality of Buenaventura, Departamento del Valle del Cauca, Colombia (03°27′26.58″N, 77°10′16.58″W; 75 m above sea level [asl]). UV-C 7270, collected by Yesid Solarte, August 18 1983, at Piñuetal, Río Cajambre, Municipality of Buenaventura, Departamento del Valle del Cauca, Colombia (03°27′35.42″N, 77°11′17.88″W; 500 m asl). CD-UV 2457, collected by Jefferson Panche, 11–13 April 2013, at Pianguita, Municipality of Buenaventura, Departamento del Valle del Cauca, Colombia (03°27′35.42″N, 77°11′17.88″W; 0 m asl).

Type locality

The holotype (AMNH-R 109682) and six of the paratypes were collected at Quebrada Guanguí (= Guanguí stream), 0.5 km above its junction with Río Patia (= Patia River), at approx. 100–200 m asl. This is also the type locality of the famous golden poison frog (*Phyllobates terribilis* Myers et al. 1978). In the description of *P. terribilis,* Myers et al. (1978) commented on the locality and mentioned that although it is rarely shown on any maps it does have permanence. We consider the locality as given in Myers et al. (1978), and in the entry into AMNH collection catalog, to be the type locality of *A. embera* **sp nov.** We could not obtain precise geographic coordinates for the Quebrada Guanguí locality, and its placement in our map (Fig. 5) is tentative. We based the placement of the locality on the observations of Myers et al. (1978), according to whom this locality is the same one shown in Myers and Daly (1976: Map 1, Locality E; see also Grant and Myers, 2013: 5, Map 2).

Etymology

The specific name *embera* is used as a noun in apposition and is given in homage of the Emberá People. Emberá is an indigenous ethnicity inhabiting an important biodiversity hotspot, the Chocó-Darién ecoregion, extending from southwest Panama along the entire Colombian Pacific coast to northwest Ecuador. The Emberá are composed of several subgroups that can be readily identified by conspicuous differences in dialect and culture, as well as geographic distribution (Hernandéz, 2001). Human settlements, agriculture, and deforestation are major threats to the Colombian Chocó region. Habitat destruction and degradation in the region endanger not only the Emberá and their cultural heritage, but also a host of animal and plant species, many of which are regional endemics.

Characterization and diagnosis

A species of Alopoglossidae based on the presence of oblique plicae (folds), instead of scale-like papillae, on the surface of the tongue (Harris, 1985). Allocated to *Alopoglossus* based on (1) the presence of keeled scales on forelimb and (2) laterally imbricated, keeled dorsal scales.

The combination of the following characters can be used as a diagnosis for the new taxon: (1) Parietal and interparietals with a pair of well developed ridges on each scale; (2) chinshields in direct contact with gulars,

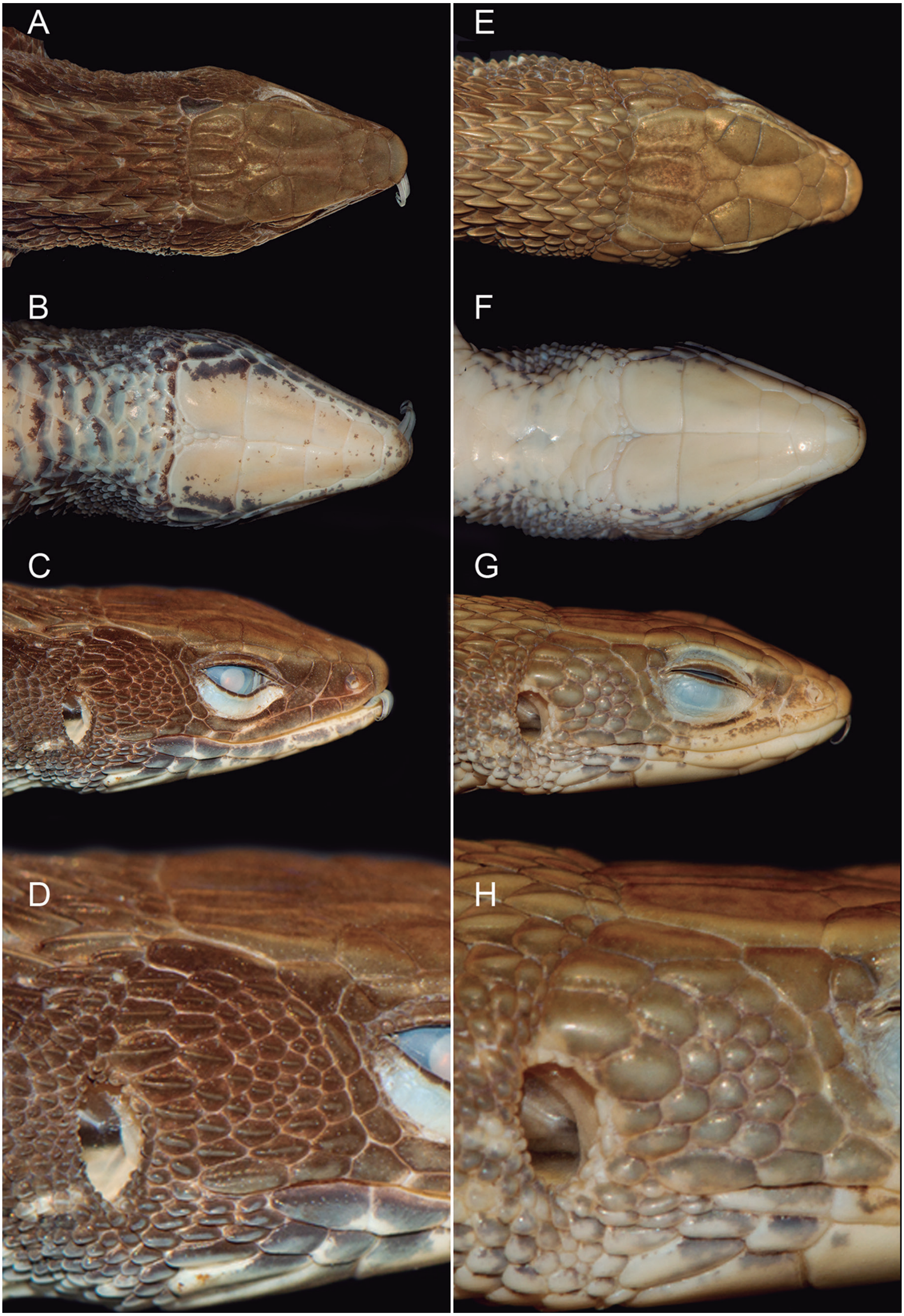

Figure 2. Heads of **(A–D)** *Alopoglossus embera* **sp. nov.** (AMNH-R 109682, holotype), and (**E–H**) *A. festae* (AMNH-R 110610) in dorsal (**A, D**), ventral (**B, E**) and lateral (**C, G**) views. Note the strong keels on temporal scales of *A. embera* **sp. nov.** in **(D)**, usually lacking in *A. festae* **(H)**.

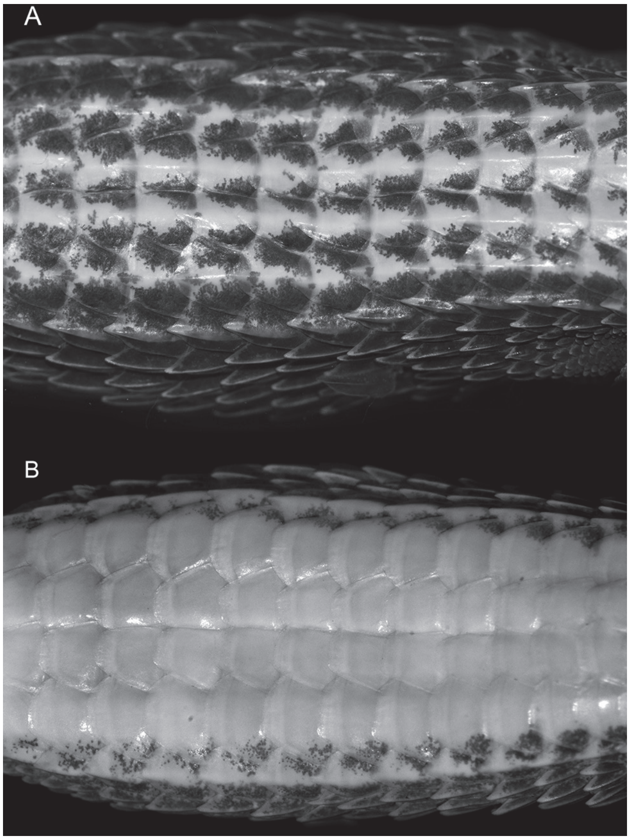

Figure 3. View of ventral scales, at midbody, of **(A)** *Alopoglossus embera* **sp. nov.** (AMNH-R 109682, holotype), and **(B)** *A. festae* (AMNH-R 110610). Note keels on scales of *A. embera* **sp. nov.**, lacking in *A. festae.*

Figure 4. Details of the dorsum of right hand of the holotype of *Alopoglossus embera* **sp. nov.** (AMNH-R 109682).

not separated by rows of pregulars; (3) third pair of chinshields always in medial contact (separated by small granules only posteriorly); (4) two longitudinal rows of widened gular scales; (5) dorsals laterally imbricated, lanceolate, strongly keeled; (6) ventrals rhomboid, keeled; (7) temporal scales strongly keeled; (8) scales on dorsal surface of hand strongly keeled; (9) males with two femoral pores; (10) males with eight femoral pores, females with 0–2 pores; (11) pre-cloacal pores absent in both sexes; (12) ventral scales usually heavily pigmented.

Comparisons with other taxa

Alopoglossus embera **sp. nov.** differs from *A. angulatus* by the presence of two longitudinal rows of widened gular scales (absent in *A. angulatus*); temporals strongly keeled (smooth or only slightly keeled in *A. angulatus*); precloacal pores absent (one pore present in male *A. angulatus*); and eight femoral pores in males (> 10 pores in *A. angulatus*). *Alopoglossus embera* **sp. nov.** differs from *A. atriventris* by the absence of enlarged pregular scales (present in *A. atriventris*); third pair of chinshields in contact medially (separated by small granular scales in *A. atriventris*); and the presence of two longitudinal rows of widened gular scales (absent in *A. atriventris*). *Alopoglossus embera* **sp. nov.** differs from *A. buckleyi* in having larger, pointed, slightly imbricated, keeled scales on side of neck (small, granular, juxtaposed, and generally smooth in *A. buckleyi*); temporals strongly keeled (smooth in *A. buckleyi*); ventrals keeled and usually rhomboidal (smooth and usually round in *A. buckleyi*); absence of enlarged pregular scales (present in *A. buckleyi*); third pair of chinshields in broad contact medially (separated by small granular scales in *A. buckleyi*); and absence of precloacal pores (one pore present in males of *A. buckleyi*). *Alopoglossus embera* **sp. nov.** differs from *A. copii* in having rhomboid or lanceolate, tightly juxtaposed scales on lateral neck (conical with free skin between scales in *A. copii*); third pair of chinshields in contact medially (separated by small granular scales in *A. copii*); presence of two longitudinal rows of widened gular scales (absent in *A. copii*); and eight femoral pores in males (> 10 pores in *A. copii*). *Alopoglossus embera* **sp. nov.** differs from *A. festae* in having temporals more strongly keeled (smooth or weakly keeled in *A. festae;* Fig. 2); ventrals keeled (smooth in *A. festae*); ventrals rhomboid, posterior margin acute or mucronated (round or subcircular in *A. festae;* Fig. 3); scale on dorsum of hand sharply keeled (smooth or lightly keeled in *A. festae*); and venter usually heavily pigmented (venter usually pale).

Table 1. Variation in measurements and selected scale counts in the type series of *Alopoglossus embera* **sp. nov.**. Holotype is marked in **bold.** Only adult specimens included.

	AMNH-R	AMNH-R	AMNH-R	AMNH-R	UV-CD	UV-CD	Range
	109682	109683	109684	109687	7270	2457	
Sex	**Female**	Female	Female	Female	Female	Male	
Snout–vent length (mm)	**51.5**	29.1	53.9	39.3	55.3	44.3	29.1–53.9
Head length (mm)	**11.5**	7.8	11.3	9.3	11.2	9.4	7.8–11.5
Head width (mm)	**8.4**	5.3	7.2	6.6	8.1	7.1	5.3–8.4
Snout length (mm)	**4.5**	2.9	4.6	3.6	4.9	3.8	2.9–4.6
Temporal region length (mm)	**4.0**	2.1	4.2	3.1	4.6	3.5	2.1–4.2
Tympanum diameter (mm)	**1.8**	1.1	1.7	1.7	1.7	1.7	1.1–1.8
Fermoral pores	**0**	0	0	0	2	8	8 (M)/0–2 (F)
Rows of dorsals	**29**	25	29	27	32	32	23–32
Transversal rows of ventrals	**17**	16	17	16	16	17	16–17
Infralabials	**6**	5	6	5	5	5	5–6
Subocular	**5**	4	4	5	5	4	4–5
Enlarged Palpebrals	**6**	6	5	7	3	7	3–7
Superciliars	**5**	5	5	5	6	5	5–5
Supraoculars	**4**	4	4	4	3	4	3–4
Scales on cloacal plate	**4**	4	4	4	3	3	3–4
Lamellae under finger IV	**14**	15	14	15	13	13	13–15
Lamellae under toe IV	**17**	18	18	19	19	17	17–19

Alopoglossus embera **sp. nov.** differs from *A. lehmanni* by the absence of a well-defined collar fold (present in *A. lehmanni*); third pair of chinshelds in contact medially (separated by gulars in *A. lehmanni*); dorsals lanceolate and imbricated (hexagonal and parallel in *A. lehmanni*); scales on flanks similar to dorsals (discrete zone of granular scales in *A. lehmanni*); absence of enlarged postparietals (present in *A. lehmanni*); four transverse rows of ventrals (10 in *A. lehmanni*); ventrals rhomboid (rectangular in *A. lehmanni*); and absence of precloacal pores (one pore present in *A. lehmanni*). *Alopoglossus embera* **sp. nov.** differs from *A. viridiceps* by the absence of enlarged pregular scales (present in *A. viridiceps*); absence of longitudinal stripe from mouth commissure to shoulder (present and distinct in *A. viridiceps*); and presence of two femoral pores on each side of males (single femoral pore in *A. viridiceps*).

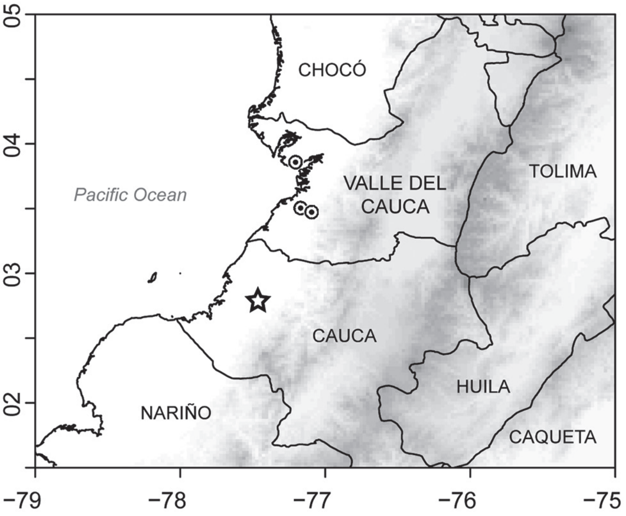

Figure 5. Known localities of *Alopoglossus embera* **sp. nov.**. Star = Quebrada Guanguí, Departamento del Cauca (type locality). Dot = Two nearby localities in Departamento del Valle del Cauca (see text for details).

Description of holotype

Measurements and scale counts of the holotype are given in Table 1. Rostral hexagonal, much wider than long; visible from above; in broad contact with frontonasal, anterior margin of nasal, and first supralabial. Frontonasal pentagonal, wider than long; in contact with nasals laterally, and with prefrontals posteiorly. Two prefontals; each irregularly pentagonal; in contact with first two supraocularls laterally, and with frontal posteriorly. Frontal irregularly hexagonal, much longer than wide, wider anteriorly and narrower posteriorly; in contact with second and third supraoculars laterally, and frontoparietals posteriorly. Two frontoparietals; each irregularly pentagonal; in contact with third and fourth supraoculars laterally, and with interparietal and parietals posteriorly. Interparietal nearly pentagonal, with parallel lateral margins. Parietals hexagonal, as long as interparietal; in broad lateral contact with interparietal (inner side) and with a postocular and an enlarged temporal (outer side); in broad contact with posterior margins of frontoparietals and fourth supraocular anteriorly. Interparietal and parietals forming an undulated margin posteriorly, followed by a small row of lanceolate scales (postparietals). All scales on dorsal head juxtaposed. Interparietal and parietals with a pair of well developed ridges each; ridges extend through frontoparietals and prefrontals, although they are much less developed than thos in parietals; postparietals keeled; all other dorsal head scales smooth.

Four supraoculars, first the smallest, followed by fourth, third, and second. Five superciliars. Nasal divided; longer than wide; irregularly pentagonal (trapezoid); in contact with rostral anteriorly, frontonasal and prefrontal dorsally, first and second supralabials ventrally, loreal and frenocular posteriorly; nostril opening on lower portion of nasal, touching adjacent first supralabial. Loreal rectangular, slightly taller than wide. Frenocular irregularly pentagonal, in point contact with nasal (not in contact with any supralabial). Four suboculars, the second very elongate (nearly four times the length of the others). Posterior subocular in contact with a single postocular. Lower eyelid translucent, with four lower palpebrals; upper border of eyelid pigmented. Six supralabials; third the longest (at least three times longer than any other); one postsupralabial. Temporals irregularly polygonal and of variable size; anterior temporals smaller than posterior temporals; distinctly keeled; almost entirely juxtaposed, with minor imbrication on larger posterior scales. Tympanum recessed; tympanic membrane not pigmented. All lateral head scales except temporals juxtaposed and smooth.

Mental trapezoidal with round anterior margin; postmental heptagonal, in contact with first two infralabials laterally and first pair of chinshields posteriorly. Five infralabials, third longest. Three pairs of chinshields; first two in broad contact medially and in contact with infralabials; second in point contact with the sublabial on its posterolateral margin; third in medial contact anteriorly, separated by small granules posteriorly; chinshields in direct contact with gulars. All scales on ventral head juxtaposed and smooth.

Gulars strongly imbricated; roughly organized in six rows; first row formed by scales subequal in size, followed by four rows in which two medial scales are conspicuously broader than others. Gulars mostly smooth with round or mucronate (slightly pointed) posterior edges; those on flanks lanceolate and keeled. Collar with five scales; medial three enlarged, smooth, and with round posterior margin; flanking scales lanceolate and keeled.

Scales on nape similar to dorsals; lanceolate, strongly imbricated, and distinctly keeled. Scales on lateral neck irregularly shaped, generally granular and juxtaposed anteriorly, slightly pointed and imbricated posteriorly; mostly keeled, except those in anteroventral region, which are keeled and smooth.

Scales on dorsal and lateral parts of midbody equal; lanceolate, strongly keeled and imbricated; organized in transversal rows; 29 rows counted from first after the postparietal to posterior margin of the cloacae. Ventrals mucronate; lightly keeled and imbricated; organized in transversal rows; 17 longitudinal rows counted from collar to cloacal plate; four transversal rows. Cloacal plate formed by four scales, all longer than wide. Cloacal and femoral pores absent.

Scales on tail mucronate, imbricated, keeled (more sharply on dorsal than ventral scales), organized in longitudinal and transversal rows.

Scales on forelimbs mostly rhomboidal or lanceolate, mucronate, imbricated, strongly keeled; granular and smooth on posterior surface of arm; scales on dorsal surface of hands rhomboidal, imbricated, mucronate and keeled (Fig. 4), on dorsal surface of fingers rectangular, smooth, on undersurface of hand granular, juxtaposed, not smooth. Subdigital lamellae of fingers single, rectangular, smooth. Fourteen subdigital lamellae under fourth finger (on both sides).

Scales on hindlimbs mostly rhomboidal or lanceolate, mucronate, imbricated, strongly keeled; granular and smooth on posterior surface of thigh. Scales on dorsal surface of feet rhomboidal, imbricate, mucronate and keeled; on dorsal surface of fingers rectangular, smooth; on undersurface of hand granular, juxtaposed, not smooth. Subdigital lamellae of toes like those of feet. Seventeen subdigital lamellae under fourth toe (left side).

Color of the holotype in preservative

Variation in scale counts and measurements among type specimens are given in Table 1. Dorsum of head, body, limbs, and tail brown with pale dorsolateral stripes extending from loreal region over the eyes (superciliar scales and lateral margins of supraoculars) towards midbody (not reaching forelimb). Lateral surfaces of head, body, and tail brown. Undersurface of head cream with dark pigmentation on most parts of mental, infralabials, posterolateral portion of second chinshields, lateral portion of third chinshields, and entire sublabial. Pigmentation sparser on postmental, first pair of chinshields, and medial portions of second and third chinshields. Gular region heavily pigmented (pigments concentrated on anterior margin of gular scales. Ventrals pale with dark brown pigmentation concentrated on anterolateral region of scales. Cloacal plate pale with scattered dark brown pigments. Undersurface of forelimb brown; undersurface of hindlimb and tail heavily pigmented.

Variation in type series

Only one confirmed adult male is present in the type series (CD-UV 2457). This specimen has eight femoral pores on the right side (left side damaged) and lacks pre-cloacal pores. Another specimen (UV-C 7270, female) does have two femoral pores on each side and also lacks pre-cloacal pores. All remaining specimens are female or juvenile and lack femoral and pre-cloacal pores. Most specimens have either three or four supraoculars, whereas a single specimen (UV-C 7231) has only two supraoculars on one the left side (three on the right). The density of pigmentation on ventral surfaces of the body varies conspicuously. Most paratypes have a pattern very similar to that of holotype but some specimens have a cream venter, almost lacking pigments or are only slightly pigmented (AMNH-R 109684; CD-UV 2457).

Distribution (Fig. 5)

Alopoglossus embera **sp. nov.** is known only from the Colombian Chocó region, with a few scattered records in the Departamento del Cauca (type locality) and Departamento del Valle del Cauca. Given that the region is poorly sampled with respect to its biodiversity, it is likely that this species occurs more widely.

Remarks

Two of the paratypes (UV-C 7230, 7231) of *A. embera* **sp. nov.** were previously referred to *A. festae* by Castaño-Mora et al. (2004), Castro-Herrera and Vargas-Salinas (2008), and Cardona-Botero et al. (2013).

DISCUSSION

Alopoglossus embera **sp. nov.** is the eighth recognized species of the genus *Alopoglossus,* as currently defined. Given the character-states it shares with *A. festae* and *A. viridis,* we hypothesize a close phylogenetic relationship between *A. embera* **sp. nov.** and those two taxa. At least one potential morphological synapomorphy supporting the relationship of the three taxa can be immediately identified—the presence of a double longitudinal row of widened gular scales (absent in all other *Alopoglossus* and *Ptychoglossus*). Torres-Carvajal and Lobos (2014) suggested a phylogenetic split between cis- and trans-Andean taxa, which is consistent with our hypothesis. This relationship is, however still at the speculative stage and needs to pass an explicit phylogenetic test. Moreover, *A. lehmanni,* also found on the Pacific side of the Andes, has never been included in any phylogenetic analysis and has a strikingly different morphology from the other three trans-Andean taxa.

Historically, a number of additional species and subspecies have been recognized in *Alopoglossus*—at least four names are currently recognized as junior synonyms of *A. angulatus* (*Leposoma carinicaudatum* Cope, 1876; *Alopoglossus amazonius* Ruthven, 1924; *Alopoglossus copii surinamensis* Brongersma, 1946; *Alopoglossus andeanus* Ruibal, 1952). A recent systematic review of the genus (Köhler et al., 2012) did not find enough evidence to recognize any of those as names as valid species. In contrast, the recent discoveries of *A. viridiceps* (Torres-Carvajal and Lobos, 2014) and *A. embera* **sp. nov.** suggests that the diversity in the genus might be underestimated. The use of refined morphological analyses, hemipenis characters, and genetic data have revealed astonishing numbers of cryptic species across many Gymnophthamoidea clades (Nunes et al., 2012; Recoder et al., 2014; Torres-Carvajal et al., 2016), and perhaps the addition of data from alternative sources (in addition to pholidosis and morphometrics) will prove useful in identifying additional diversity within *Alopoglossus*. Torres-Carvajal and Lobos (2014) indicated that more detailed systematic studies of *A. festae* and species of *Alopoglossus* east of the Andes in Ecuador based on extensive sampling are underway. Additional studies including a broader sample of the widespread species *A. angulatus* and *A. atriventris* might also prove to be fruitful in revealing hidden species.

The importance of natural history collections for long-term biodiversity assessments

Recent taxonomic studies have largely shifted towards barcode initiatives and phylogenetic species delimitation methods, both of which rely heavily on the use of DNA sequences and the collection of fresh specimens and tissue samples. This effort has produced extremely relevant contributions and accelerated the discovery of unnamed diversity throughout the globe. However, it is also extremely important that historical collections (many of which predate the practice of tissue sample collection) be surveyed and the morphological features of specimens for which taxonomic revisions are available be reexamined. As noted by Peloso (2010), many of the world's unnamed species are not cryptic, but are instead "strikingly distinct and easily diagnosable; all we need is to find them, whether in the field or in old jars sitting in museum shelves." This is an accurate description of what happened in the case of *Alopoglossus embera* **sp. nov.**. The species was discovered during the study of museum specimens collected more than four decades ago. A large fraction of the preserved specimens that now compose the type series of *A. embera* **sp. nov.** have been sitting on the shelves of the American Museum of Natural History since they were collected by Drs. Charles Myers and John Daly in 1973. Further examination of specimens at the collections of Universidad del Valle revealed additional specimens of the new species, some of them collected more than 30 years ago. These findings further stress the importance of scientific collections in documenting species diversity in the long term.

Taxonomy is a continuous science and our ability to recognize (or better yet, define) the limits between species is ever-evolving, either by the appearance of additional evidence (e.g., more specimens, additional characters) or new techniques (e.g., CT-scanning, electron microscopy, refined statistical analyses). Therefore, the reevaluation of collection specimens is constantly revealing unexpected novelties from specimens previously thought to be part of common taxa.

The increase in awareness about biological conservation, stricter permitting regulations, and recent advocates for the general avoidance of collection, continue to generate healthy debates over the importance and relevance of lethal collecting of specimens. We argue that even common species should always be collected in reasonable amounts, especially when surveys are conducted in remote sites, because we never know if one will ever be able to return to a locality. Even if one does return to a locality, it might look quite different and much of the biodiversity might be absent (Coloma et al., 2007; Coloma et al., 2010). Recent claims by some colleagues that biological collection should be avoided, or minimized, is extremely prejudicial to taxonomy (Minteer et al., 2014; Pape, 2016; Gutiérrez and Pine, 2017). As an example, the majority of the specimens of *A. embera* **sp. nov.** were labeled as *Alopoglossus festae,* a common species in Colombia and Ecuador, and potentially sympatric with *A. embera* **sp. nov.** Hence, some of these specimens (UV-C 7231, 7270) have been already referenced in scientific papers as *A. festae* (Castaño-Mora et al., 2004; Castro-Herrera and Vargas-Salinas, 2008; Cardona-Botero et al., 2013). Had the collectors of the new taxon dismissed these specimens as nothing more than additional records of *A. festae* and released the animals, the species would still be unknown to science and might never have been discovered. In another, rather extreme, example Coloma et al. (2010) named five new species of harlequin toads (Bufonidae Gray, 1825: *Atelopus* Duméril and Bibron, 1841) and suggested that four of them might already be extinct—*Atelopus ardila* (holotype from 1984, oldest reported specimens from 1965); *At. orcesi* (all known specimens collected in 1988); *At. pastuso* (holotype 1980; oldest reported specimens from 1968); *At. podocarpus* (holotype from 1994, oldest reported specimens from 1977). The recognition of all of these species was only possible due to the availability of well-preserved museum specimens collected several decades before their actual "discoveries."

We agree that it may be impossible to define a general policy or guideline as to what defines reasonable collecting, i.e., collecting 10 adult specimens of any given population of *Alopoglossus* might seem reasonable, but collecting 10 mature specimens of *Eunectes murinus* Linnaeus, 1758 will likely impact the population. Nonetheless, we generally concur with colleagues who have explicitly expressed that the collection of biological specimens is, and will continue to be, an essential tool for most areas of biology, especially taxonomy (Culley, 2013; Krell and Wheeler, 2016; Rocha et al., 2016).

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APPENDIX 1

Specimens examined for comparisons

Alopoglossus angulatus (*n* = 2). SURINAM: **Brokopondo:** Brownsberg Nature Park, AMNH-R 119395. BRAZIL: **Mato Grosso:** Vila Murtinho, UMMZ 56853 (holotype of *Alopoglossus amazonius:* examined from photographs).

Alopoglossus atriventris (*n* = 2). COLOMBIA: **Departamento Putumayo:** Aprox. 10 km (airline) south of Mocoa, AMNH-R 106634 (*paratype*). ECUADOR: **Provincia Napo,** Lago Agrio, KU 126783 (holotype: examined from photographs).

Alopoglossus buckleyi (*n* = 4). ECUADOR: **Provincia Morona-Santiago:** Cusuime, Río Cusuime, 60 km airline southeast of Macas, AMNH-R 113762–113764; **Provincia Canelos,** BMNH 1946.8.31.66 (holotype: examined from photographs in Ávila-Pires, 1995).

Alopoglossus copii (*n* = 2). ECUADOR: **Napo:** UMMZ177888. PERU: **Loreto:** 1.5 km north of Teniente Lopez, KU 222169.

Alopoglossus festae (*n* = 9). ECUADOR: **Provincia Pichincha:** Rio Baba, 5–10 km southwestern of Santo Domingo de los Colorados, AMNH-R 110608; **Provincia El Oro:** Santa Elena, AMNH-R 21855; Pasage, AMNH-R 21856; Santa Rosa, AMNH-R 21995; 3 km east of Pasaje, AMNH-R 110609; 10 km southeast of Machala, AMNH-R 112998–112999; **Provincia Guayas:** Bucay, AMNH-R 21956; 3 km north of Naranjal, AMNH-R 110610; Naranjal, AMNH-R 23429.

Alopoglossus lehmanni (*n* = 1). COLOMBIA: **Departamento Valle del Cauca,** Lower Rio Calima, FMNH 165199 (holotype).

Alopoglossus viridiceps (*n* = 1). ECUADOR: **Provincia Pichincha:** Nanegal, Santa Lucia Cloud Forest Reserve, QCAZ 10670 (holotype, examined from photographs in Torres-Carvajal and Lobos (2014)).