Zootaxa 2161: 47–59 (2009) www.mapress.com/zootaxa/

Copyright © 2009 · Magnolia Press

Article



# A new species of *Noblella* (Amphibia: Strabomantidae) from the western slopes of the Andes of Ecuador

JUAN M. GUAYASAMIN<sup>1</sup> & ANDREA TERÁN-VALDEZ

Museo de Zoología, Escuela de Ciencias Biológicas, Pontificia Universidad Católica del Ecuador, Av. 12 de Octubre y Roca, Aptdo. 17-01-2184, Quito, Ecuador. E-mail: andreateran84@gmail.com <sup>1</sup>Corresponding author. E-mail: jmguayasamin@gmail.com

## Abstract

We describe a new species of *Noblella* from the western slope of the Ecuadorian Andes. The new taxon is distinguished from all other species in the genus by lacking dorsal marks (i.e., interobital bar, scapular and sacral chevrons) and by having a bright orange venter. The new species and *Noblella heyeri* are the only species of *Noblella* reported in the Pacific Andean versant. We provide an osteological description of the new species and a key for the species in *Noblella*.

Key words: Andes, Ecuador, Noblella, osteology, Phyllonastes, Strabomantidae

## Introduction

*Noblella* is a small genus endemic to South America. The genus occurs at elevations of 1250–3450 m in humid habitats in the Andes from Ecuador to central Bolivia, and one species occurs in the Amazonian lowlands of Ecuador, Peru, and extreme western Brazil (Duellman & Lehr in press; this work). Currently, the genus contains nine species: *N. carrascoicola* (De la Riva & Köhler 1998), *N. duellmani* (Lehr, Aguilar & Lundberg 2004), *N. heyeri* (Lynch 1986), *N. lochites* (Lynch 1976), *N. lynchi* (Duellman 1991), *N. myrmecoides* (Lynch 1976), *N. peruviana* (Noble 1921), *N. pygmaea* Lehr and Catenazzi (2009), and *N. ritarasquinae* (Köhler 2000). Until recently, these frogs were in the genus *Phyllonastes*, a name proposed by Heyer (1977) that was placed in the synonymy of *Noblella* by De la Riva *et al.* (2008).

Examination of preserved material from Río Guajalito, a locality on the western slopes of the Ecuadorian Andes, revealed the presence of an undescribed species of *Noblella*. With this discovery, there are two species of *Noblella* on the Pacific slopes of the Andes, *N. heyeri* and the new species described below. Also, in this work, we provide an osteological description of the new species and a key to species in *Noblella*.

## Materials and methods

**Terminology.** Generic and family names are according to the taxonomy proposed by De la Riva *et al.* (2008) and Hedges *et al.* (2008), respectively. Specimens examined are listed in Appendix I and institutional acronyms are those of Frost (2009).

**Morphology.** Morphological measurements were taken with digital calipers to the nearest 0.1 mm, as described by Guayasamin (2004), except for those traits described in parenthesis, and are as follow: (1) snoutvent length (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-nostril distance; (10) snout-eye distance; (11) eye diameter; (12) tympanum diameter; (13) eye-tympanum distance; (14) forearm length; (15) hand length; (16)

Finger-I length (distance from outer-proximal margin of palmar palmar tubercle to tip of Finger I); (17) Finger-II length (distance from outer-proximal margin of palmar tubercle to tip of Finger II). Sexual maturity was determined by the presence of vocal slits in males and by the presence of eggs or convoluted oviducts in females. Techniques for clearing and double-staining specimens with Alcian Blue and Alizarin Red were those of Taylor and Van Dyke (1985). Illustrations were made with the aid of a Wild M3B Heerbrugg stereo dissecting microscope equipped with a camera lucida. Osteological terminology is that of Duellman and Trueb (1986), Fabrezi (1992, 1993), and Trueb (1973, 1993). Character states of the species of *Noblella* included in the key were taken from the original descriptions of species, Duellman and Lehr (in press), and the direct observation of specimens (i.e., *N. coloma, N. heyeri, N. myrmecoides;* Appendix I).

## **Systematics**

## Noblella coloma Guayasamin & Terán, new species

**Holotype.** QCAZ 26307, adult male (Figs. 1, 2), collected from Reserva Florística Río Guajalito (0°14' S, 78°49' W; 1800–2000 m), 3 km NW from Km 59 on the old road from Quito to Santo Domingo, collected by Rubén D. Jarrín on 18 October 2003.

**Paratopotypes.** QCAZ 7277, adult female, collected by Leonora Orejuela on 22 Abril 1995; QCAZ 8701, juvenile female, collected by Santiago Burneo on 15 October 1995; QCAZ 11614, juvenile, collected by Ítalo G. Tapia, date unknown; QCAZ 32702, juvenile, collected by Cristina E. Toapanta on 16 December 2006; QCAZ 6466, sex unknown, collected by George Fletcher on 23 October 1994, cleared-and-stained; QCAZ 7412, sex unknown, collected by Juan M. Guayasamin on 18 June 1995, cleared-and-stained; 40579, juvenile female, collected by Diana Pazmiño on 15 March 2009.

**Generic placement.** Duellman (1991), De la Riva *et al.* (2008), and Hedges *et al.* (2008) list the following traits as characteristic of *Noblella:* (1) head narrower than body; (2) tympanic membrane differentiated (except in *N. duellmani*); (3) cranial crests absent; (4) dentigerous processes of vomers absent; (5) "S" condition of adductor muscle; (6) terminal discs on fingers and toes not expanded or slightly expanded; discs and circumferential grooves present distally (except in *N. duellmani*); terminal phalanges narrowly T- shaped; (7) Finger I shorter than, or equal in length to, Finger II; (8) Toe III shorter than Toe V; tips of at least Toes III–IV pointed; (9) subarticular tubercles not protruding; (10) conspicuous tarsal tubercle; (11) dark inguinal spots present (except in *N. duellmani*); (12) small size (SVL < 22 mm). All the traits observed in the new species agree with the diagnosis of *Noblella*; therefore, the placement of *Noblella coloma* in the genus *Noblella* is justified. The only other possibility for the generic placement of the new species is *Barycholos*, a genus endemic to South America that has a close evolutionary and morphological affinity with *Noblella* (Heinicke *et al.* 2007; Hedges *et al.* 2008). However, species in *Barycholos* have vomers with small dentigerous processes (absent in *Noblella*), Finger I longer than II (Finger I shorter than, or equal in length to, Finger II in *Noblella*), and projecting subarticular tubercles (not projecting in *Noblella*).

**Diagnosis.** *Noblella coloma* (Figs. 1, 2) presents the following characteristics: (1) skin of the dorsum finely shagreen; (2) tympanic annulus and membrane clearly visible and differentiated, supratympanic fold covering upper border of tympanum (Fig. 2C); (3) snout rounded in dorsal and lateral view (eye to nostril distance 48.8–58.9% of eye diameter, Fig. 2C); (4) dentigerous processes of vomers absent; (5) fingers not expanded distally; finger tips acuminate; Finger I slightly shorter than Finger II (Fig. 3); nuptial pad not visible; fingers lacking circumferential grooves; (6) distal phalanges T-shaped; phalangeal formula of hands: 2, 2, 3, 3 (Fig. 5); (7) hands with one weakly defined supernumerary tubercle; subarticular tubercles rounded, not prominent; ulnar tubercles absent; (8) one elongated tarsal tubercle (Fig. 3); two prominent metatarsal tubercles; supernumerary plantar tubercles absent; toes slightly expanded and acuminate distally; (9) Toe V shorter than Toe III; distal portions of circumferential grooves present on Toes III–V; (10) phalangeal formula of feet: 2, 2, 3, 4, 3 (Fig. 5); (11) in life, dorsum uniform brown, except for distinctive suprainguinal marks;

flanks with dark brown band that narrows as it approaches groin; venter orange with minute brown and white spots (Fig. 1); (12) in one adult male, SVL 14.6 mm; in one adult female, 16.0 mm.



FIGURE 1. Noblella coloma in life, QCAZ 26307, adult male, holotype. Photos by Luis A. Coloma.



**FIGURE 2.** Color in preservative of *Noblella coloma*, QCAZ 26307, adult male, holotype. Photos by Martín Bustamante.

Noblella coloma differs from all the other species in Noblella by lacking most of the dorsal color marks (i.e., interobital bar, scapular and sacral chevrons; Fig. 2), and by having a bright orange venter (Fig. 1). Additionally, the dorsum of *N. coloma* is shagreen, whereas the dorsum of *N. duellmani* and *N. lynchi* is pustular, and *N. pygmaea* has a tubercular dorsal skin. Noblella coloma is similar to *N. duellmani*, *N. heyeri*, *N. lynchi* and *N. pygmaea* in having three phalanges in Finger IV, in contrast with *N. carrascoicola*, *N. lochites*, *N. myrmecoides*, and *N. ritarasquinae* that have two phalanges in Finger IV. A tympanum is evident in *N. coloma*, *N. heyeri*, *N. lynchi*, *N. myrmecoides*, *N. peruviana*, and *N. pygmaea*, and is absent in *N.* 

duellmani, N. carrascoicola, and N. ritarasquinae. In preservative, N. coloma has a dark throat and a uniform cream venter, whereas the venter is brown with cream mottling in N. duellmani, N lynchi, N. heyeri, and N. carrascoicola (Fig. 6). Comparison of the new species with Noblella peruviana are difficult because of the paucity of information regarding the morphology of the later. All what we know about N. peruviana comes from the brief description provided by Noble (1921) and De la Riva et al. (2008), both based on five specimens collected more than a century ago. Characters mentioned in Noble's original description include: tympanum present, digits pointed with no terminal disks, well-developed and elongated tarsal tubercle, skin feebly granular above and smooth below, dorsal coloration uniform gray brown or with dark brown blotches, and broad band of dark brown extending on each side from the nostril to the lumbar region. Additionally, De la Riva et al. (2008) mentioned that the types of N. peruviana have the tips on Toes II, III and IV distinctively pointed, and that, at least in some paratypes, a black inguinal spot is present. The traits listed above for N. peruviana are present in several other species of the genus; therefore, comparisons are limited. However, Noble (1921) mentioned that, in preservative, the ventral coloration in N. peruviana was reddish brown; in contrast, the ventral coloration of N. coloma is cream. In addition, N. coloma and N. heyeri are the only species in the genus found on the western slopes of the Andes (Table 1); this being a biogeographical criterion that could be useful to distinguish among species.

**Description of holotype.** Adult male (QCAZ 26307); head as long as wide; snout round in dorsal and lateral views (Fig. 2C); canthus rostralis straight; loreal region concave; upper eyelid about 50% of interorbital distance; eye-nostril distance 59% of eye diameter; tympanum visible almost completely, tympanic membrane well differentiated from surrounding skin; supratympanic fold covering upper border of tympanum. Dentigerous processes of vomers absent. Skin of dorsum finely shagreen; venter smooth; ulnar tubercles absent; palmar tubercle oval, about 1.5x the size of thenar tubercle; one supernumerary tubercle weakly marked; proximal subarticular tubercles large, rounded; fingers not expanded distally, finger tips slightly acuminate (Fig. 3), circumferential grooves absent; relative lengths of fingers I < II < IV < V.

One prominent tarsal tubercle on ventral surface of tarsus (Fig. 3); metatarsal tubercles conspicuous, similar size, longer than broad; proximal subarticular tubercles visible, distal subarticular tubercles inconspicuous; no supernumerary plantar tubercles. Toes slightly expanded and acuminate distally; distal portions of circumferential grooves present on Toes III–V; relative lengths of toes I < II < V < III < IV. For measurements of the type series (mm) see Table 2.



FIGURE 3. Ventral view of hand and foot of Noblella coloma, QCAZ 26307, adult male, holotype.

Species	Distribution	Elevation	Source	
carrascoicola	Bolivia: Cloud forests along the northeastern Andean slopes from Chapare, Departamento Cochabamba, eastward to Provincia Caballero, Departamento Santa Cruz.	1850–2700 m	De la Riva and Köhler (1998); Köhler (2000)	
coloma	Ecuador: Western slope of the Andes, Provincia Pichincha, Reserva Florística Río Guajalito (0°14' S, 78°49' W).	1800–2000 m	This work	
duellmani	Peru: Eastern slope of the Andes, Departamento Pasco, Distrito Paucartambo, Cillapata (approximately 1.5 km NNE of Auquimarca; 10°43'52" S, 75°42'48" W).	2900 m	Lehr et al. (2004)	
heyeri	Ecuador, Peru: Andes of northern Peru (33 km SW of Huancabamba) and southern Ecuador (Provincia de Loja).	2000–3100 m	Lynch (1986), this work	
lynchi	Peru: Western crest of the Cordillera Central, Departamento Amazonas, Provincia Chachapoyas, east slope of Abra Chinchillo, 42 km N of Balsas (06°49' S, 77°54' W).	2870 m	Duellman (1991)	
lochites	Ecuador: Amazonian slopes of central and southern Andes, Cordillera del Cóndor, and Cordillera de Cutucú (Provincias Pastaza, Zamora Chinchipe, and Morona Santiago).	900–1700 m	Lynch (1976); Duellman and Lynch (1988); Almendáriz (1997); Reynolds and Icochea (1997); Cisneros-Heredia and Reynolds (2007); Duellman and Lehr (2009)	
myrmecoides	Western Amazon basin including southeastern Colombia (Leticia), eastern Ecuador (Provincias Orellana, Zamora Chinchipe), northeastern and southeastern Peru (Departmentos Loreto, San Martin, Huánuco, Cusco, Madre de Dios), Bolivia (Departmentos Cochabamba, La Paz), and western Brazil (Amazonas).	100–1200 m	Lynch (1976); Hoogmoed and Lescure (1984); Rodríguez and Cadel (1990); Rodríguez <i>et al.</i> (1993); Alonso and Dallmeier (1999); Doan and Arizábal (2002); Lehr <i>et al.</i> (2004); Lynch (2005); Reichle <i>et al.</i> (2004); Cisneros-Heredia and Reynolds (2007); this work	
peruviana	Peru: Andean Amazonian slopes; Inca Mine, Santo Domingo, Departamento de Puno. Type locality "Juliaca" is in error.	ca. 1690 m	Noble (1921); De la Riva <i>et al.</i> (2008); Duellman and Lehr (2009)	
pygmaeae	Peru: Cusco Region, Provincia de Paucartambo, Distrito de Cosñipata, Upper Cosñipata Valley.	3025–3190 m	Lehr and Catenazzi (2009)	
ritarasquinae	Bolivia: Western slopes of the Andes, Departamento Cochabamba, Provincia Chapare, known only from the type locality (31 km on the old road from Paractito vía Palmar to Cochabamba, 17°6′50″ S, 65°34′19″ W) in the lower montane rainforest of the Río San Mateo valley.	1250 m	Köhler (2000)	

TABLE 1. Distribution of species in the genus Noblella.

**Color of holotype in alcohol.** Dorsum grayish brown to brown with dark brown inguinal spots; scapular and sacral chevrons absent. Sides of head uniform black continuous posteriorly onto flanks; labial bars absent; each flank with a wide longitudinal dark brown stripe that narrows posteriorly. Forearms and hind limbs with well-defined dark brown marks (Fig. 2). Throat dark brown; venter cream with minute dark spots (visible under magnification).

**Coloration in life.** Dorsum orange-brown, with a thin dark brown middorsal stripe and dark brown inguinal spots; interobital bar and scapular and sacral marks absent. Venter orange with minute white and brown spots (Fig. 1). Sides of head dark brown; flanks with dark brown stripe that narrows posteriorly. Iris dark brown with orange ring around pupil (based on photographs of QCAZ 32702, holotype, by Luis A. Coloma).

**Variation.** Throat cream (QCAZ 32702) or cream with minute brown spots visible under magnification (QCAZ 11614). There is no evident sexual dimorphism. For measurements see Table 2.

	7277	26307	8701	40579	11614	32702
Sex	Adult female	Adult Male	Juv. Female	Juv. female	Juvenile	Juvenile
SVL	16.03	14.55	12.61	11.28	10.26	10.65
Tibia length	7.23	6.73	6.18	6.13	5.09	5.69
Foot length	7.30	6.31	6.10	5.78	4.36	5.46
Head length	5.09	4.51	4.29	4.17	3.44	3.66
Head width	5.01	4.31	4.21	4.04	3.46	3.58
Interorbital distance	2.01	1.71	1.82	1.60	1.50	1.46
Upper eyelid width	1.04	0.86	1.07	0.91	0.89	0.88
Internarial distance	2.08	1.80	1.76	1.57	1.42	1.38
Eye to nostril distance	1.15	1.02	0.87	0.81	0.72	0.67
Snout to eye distance	2.10	1.92	1.95	1.79	1.50	1.61
Eye diameter	1.96	1.72	1.75	1.61	1.32	1.37
Tympanum diameter	1.08	0.75	0.58	0.66	0.42	0.58
Eye to tympanum distance	0.47	0.46	0.31	0.34	0.50	0.41
Forearm length	3.63	3.63	3.17	2.76	2.48	2.79
Hand length	2.59	2.89	2.37	2.62	2.44	2.48
Finger I length	1.76	1.96	1.66	1.64	1.64	1.77
Finger II length	1.80	2.11	1.76	1.73	1.76	1.86

TABLE 2. Measurements of the type s	series (in mm) of Noblella coloma
-------------------------------------	-----------------------------------

**Osteology.** The following osteological description of *Noblella coloma* is based on a cleared-and-double stained individual (QCAZ 6466, SVL = 14.1 approximately; Figs. 4, 5). The specimen lacks information regarding its sex, but because of its SVL we assume that it could be an adult or subadult male or juvenile female. Drawings of hand and foot are based on QCAZ 7412.

**Cranium.** *Shape and proportions.* The skull is widest posterior to the orbit at the level of the articulation of the maxilla with the quadratojugal (Fig. 4); at this level, the skull is as wide as long. The rostrum is short, accounting for less than a quarter (17%) of the medial length of the skull. At the level of midorbit, the width of the braincase is about 35% of the greatest width of the skull and 38% of the medial skull length.

*Neurocranium*. The anterior neurocranium comprises large olfactory capsules, which are cartilaginous, and the anterior part of the braincase. The medial walls of the nasal capsules are narrowly separated, with the internasal septum apparently being composed of a thin plate of cartilage between the capsule walls; a minute, ossified septomaxilla is present, but obscured by the staining of the anterior nasal capsule cartilages (Fig. 4).

The cartilaginous planum antorbitale has a slight anterolateral orientation in dorsal and ventral aspects. Ventrally, the planum is invested by a simple, thin and relatively long neopalatine (Fig. 4). The distal end of the neopalatine is clearly separated from the maxilla; the medial end articulates with the sphenethmoid (Fig. 4).

The braincase and otic capsules are moderately ossified. Ventrally, the bony sphenethmoid is not fused medially (Fig. 4). There is a moderately broad separation between the sphenethmoid and prootics, within which the optic fenestra lies (Fig. 4). The optic fenestra lies in cartilage, except for its posterior margin that is formed by the prootic bone. Dorsally and ventrally, the exoccipitals are separated from each other and from the prootics (Fig. 4). The contralateral prootics are completely separated from each other; each one bears a relatively long prootic foramen, and two small foramina, the oculomotor and trochlear. The frontoparietal fontanelle is partially exposed medially between the frontoparietal (Fig. 4).

Dorsally, the otic capsule is well ossified, and bears a moderately broad, cartilaginous crista parotica. The epiotic eminences are prominent; the anterior eminence is slightly longer than the posterior and the angle

between the two arms is approximately 90°. Ventrally, the lateral wall of the otic capsule is cartilaginous. The cartilaginous operculum lies posteriorly adjacent to the pars interna plectri of the stapes in the fenestra ovalis, which is formed entirely in cartilage. The pars media plectri is a long, slender, ossified element that extends anterolaterally beneath the crista parotica and behind the palatoquadrate and ventral ramus of the squamosal to terminate in the club-shaped cartilaginous pars externa plectri located in the middle of the incomplete tympanic annulus (Fig. 4).



**FIGURE 4.** Skull of *Noblella coloma*, QCAZ 6466, in dorsal (*upper left*), ventral (*upper right*), and lateral (*bottom*) views.

*Dorsal investing bones.* Dorsal investing bones are poorly developed. The nasals are thin and widely separated from one another; they cover a large area of the nasal capsules dorsally. The frontoparietals are well-developed bones, separated medially, and separated from the prootics. The frontoparietal bears a lamina perpendicularis, the vertical component forming the dorsolateral edge of the braincase (Fig.4).

*Ventral investing and palatal bones.* Owing to the thinness of the bone, the posterior margin of the parasphenoid is difficult to determine accurately. The cultriform process (ca. 39% the width of the braincase) extends anteriorly reaching about the midlength of the sphenethmoid (Fig. 4). The anterior end of the process is tapered; the parasphenoid is separated from the neopalatines. The lateral margins of the process are approximately parallel; anteriorly, the margins converge gradually towards one another and make contact with the medial margin of the sphenoid. The parasphenoid alae are moderately long (about equal to the width of the cultriform process), slightly posterolaterally oriented, and distally truncate beneath the midwidth of the otic capsules. A posteromedial process is present, but distinctly separated from the margin of the foramen magnum (Fig. 4).

The small vomers are broadly separated from one another medially. Each is composed of an arcuate bone bordering the medial and small portions of the anterior and posterior margins of the choana. The prechoanal and postchoanal ramus are slightly expanded anteriorly; the dentigerous process is absent (Fig. 4).

The neopalatines are thin and underlie the plana antorbitalae, covering the posterior surfaces and dorsomedial surfaces of these structures (Fig. 4). The bones are unornamented, straight, and articulate with the sphenethmoid; each neopalatine is separated from the maxilla.

*Maxillary arcade.* The maxillary arcade bears teeth on the premaxillae and maxillae. The maxillae are in close proximity to the quadratojugals, but have no contact (Fig. 4). The partes palatinae of the maxillae are narrow and barely evident. The premaxilla bears prominent partes palatinae; the posterolateral palatinae process is more robust than the posteromedial process (Fig. 4). There is a simple, juxtaposed articulation between the anterior end of the maxilla and the premaxilla. The pars facialis of the maxilla is well developed anteriorly, having a preorbital process that covers the planum antorbitale along the lateral aspect of the olfactory capsule (Fig. 4).

*Suspensory apparatus.* The triradiate pterygoid bears a curved anterior ramus that is oriented anterolaterally toward the maxilla, with which it has an area of close proximity. The pterygoid is separated from the maxilla by the pterygoid cartilage, which lies along the medial margin of the maxilla in the orbital region. The medial and posterior rami of the pterygoid are about equal in length; however, the medial ramus is more robust than the posterior. The edge of the medial ramus overlaps the lateral edge of the ossified margin of the prootic.

The squamosal is T-shaped; the otic ramus is much more longer than the zygomatic ramus (otic ramus 3 x the length of the zigomatic ramus). The otic ramus overlaps a large area of the crista parotica. The ventral ramus invests the lateral surface of the palatoquadrate, and articulates with the quadratojugal (Fig. 4).

## Postcranium

*Vertebral column.* There are eight presacral vertebrae (Fig. 5). Presacral I is notably shorter than the posterior presacrals, and Presacral III is relatively longer than the other presacral vertebrae. All of the presacrals are non-imbricate. The vertebral profile in increasing order of overall width is: I < across VIII < VII = VI < V = II < IV < III.

Presacral I lacks a transverse process. The transverse processes of Presacral II have a slightly anterolateral orientation, Presacrals III–VI have a posterolateral orientation and Presacrals VII and VIII have an anterolateral orientation. The bony sacral diapophysis is not broadly expanded, and its width is about the same along all the bone. The leading edge of the diapophyses is straight and slightly orientated posterolaterally, whereas the posterior margin is concave, and also oriented posterolaterally. The urostyle is long, slender, and about equal length of the presacral portion of the vertebral column. The bone has a bicondylar articulation with the sacrum, and bears a prominent dorsal crest throughout most of its length (Fig. 5).

*Pectoral girdle.* The prezonal portion is represented by a short cartilaginous omosternum. The clavicles are oriented anteromedially, with the medial tips distinctly separated from one another and located at about the same level of the anterolateral end of the clavicle that articulates with the scapula. The coracoid is stout, with the glenoidal and sternal ends about equally expanded. The midshaft width is about 13% the length of the coracoid, and about 41% the width of the expansion of the sternal end of the bone. The pectoral fenestra is oval and about two times as wide as it is deep. The scapula is long with a prominent pars acromialis that is not separated from the pars glenoidalis. The clavicle is 75% the length of the scapula. The suprascapula is mineralized, with the ossified cleithrum apparent as a slender bone along the leading edge of the suprascapular blade and with an expansion of its proximal end. The sternum is mineralized and narrowly separated from the epicoracoid (Fig. 5).

*Pelvic girdle.* The long, slender ilial shafts bear conspicuous dorsolateral crests. The ilial prominence is broad and low; the pubes is cartilaginous. The round acetabulum is ossified (Fig. 5).

*Manus and pes.* The phalangeal formulae for the hand and foot are standard: 2-2-3-3 and 2-2-3-4-3, respectively. In increasing order of length, the order of the digits on the hand is: I < IV < II < III, and that of the foot is: I-II-V-III-IV. The carpus is composed of a radiale, ulnare, Element Y, Carpal 1, and a large postaxial element assumed to represent a fusion of Carpals 2, 3, and 4 (Fig. 5). The prepollex is composed of one small, proximal bone and an elongated distal cartilage. The terminal phalanges are T-shaped. The tarsus is

composed of two tarsal elements, presumably Tarsal 1 and Tarsal 2 + 3. In a ventral view, three sesamoids (of about equal size) are covering the proximal end of the metatarsals III–IV. The prehallux is represented by a bony, rounded basal element associated with a distal cartilaginous element (Fig. 5).

**Etymology.** The specific name *coloma* is a patronym for Luis Aurelio Coloma in recognition of his continual efforts in studying and protecting amphibians, and mentoring students (us included). The specific epithet is used as a substantive in apposition.



**FIGURE 5.** Postcranial osteology of *Noblella coloma*. (A) Vertebral column in dorsal view, cartilage is in gray, QCAZ 6466. (B) Pectoral girdle in ventral view, QCAZ 6466. (C) Pelvic girdle in lateral view, QCAZ 6466. (D) Hand in dorsal view, QCAZ 7412. (E) Foot in dorsal view, QCAZ 7412. (E) Foot in ventral view, QCAZ 7412. (E) Foot in ventral view, QCAZ 7412. (E) Foot in gray; stippling on cartilage denotes mineralization. Scale bar = 1 mm.



**FIGURE 6.** Color pattern of *Noblella heyeri* and *N. myrmecoides.* (**A**, **B**) Dorsal and lateral views of *N. heyeri*, QCAZ 22501, SVL 12.9 mm; (**C**, **D**) ventral view of *N. heyeri*, QCAZ 22501 (left) and 24875 (right; SVL 13.9 mm); (**E**, **F**) dorsal view of *N. myrmecoides*, QCAZ 27266 (left; SVL 14.3 mm) and 24877 (right; SVL 16.0 mm); (**G**) ventral view of *N. myrmecoides* QCAZ 24877.

**Distribution and conservation.** *Noblella coloma* is known only from the type locality, Reserva Florística Río Guajalito (0°14' S, 78°49' W; 1800–2000 m), 3 km NW, by path, from Km 59 on the Quito-Chiriboga-

Santo Domingo road (Fig. 7). All individuals of *N. coloma* have been found active on leave litter during the day. The type locality of *Noblella coloma* is included in the Bosque de Neblina Montano (Montane Cloud Forest) according to the classification proposed by Valencia *et al.* (1999). *Noblella coloma* only is known from the type locality, within a private reserve. During the last 15 years, several groups of biology students have been visiting this reserve. As a result, only eight specimens have been collected, suggesting that the species is rare and/or very difficult to locate. Following the IUCN (2001) criteria, we consider *N. coloma* as data deficient.

**Remarks.** Species of *Noblella* share several morphological characteristics, thereby making this group easy to identify and, likely, monophyletic. Potentially derived traits present in most species of *Noblella* include pointed toes and conspicuous tarsal tubercle (Fig. 3). The thin neopalaties, reduced vomers, and lack of fusion among several bones (sphenethmoid, exoccipitals, prootics) could also be derived traits related to the small size of *Noblella*.

Given that all species except the Amazonian *N. myrmecoides* are endemic to the Andes (Table 1), the most likely scenario is that this group originated in the Andes and later dispersed to the Amazon basin. The recent phylogeny of Hedges *et al.* (2008) places the only sampled species of *Noblella* (*N. lochites*) as the closest relative of *Barycholos*.



FIGURE 7. Map showing the location of Reserva Florística Río Guajalito, type locality of Noblella coloma.

## Key

Traits that are characteristic of *Noblella* and usually absent in other anurans are small size (SVL < 22 mm), terminal phalanges narrowly T- shaped, fingers and toes not expanded laterally or only slightly expanded, and tips of at least Toes III–IV pointed. This key includes all described species of *Noblella*, except *N. peruviana*, for which little information is available (Noble 1921; Duellman & Lehr in press) and some characters states are in conflict (e.g., tympanum, tarsal tubercle; De la Riva *et al.* 2008). Color and pattern variation of *N. heyeri* and *N. myrmecoides* is shown if Figure 6; color pattern of *N. coloma* is in Figures 1 and 2. An electronic version of this key is available at: http://www.puce.edu.ec/zoologia/vertebrados/amphibiawebec/ claves/claves/NoblellaEsp.html.

1.	Tympanum absent	2
-	Tympanum present	4
2.	Dorsal skin pustular, flanks and dorsum similarly colored, inguinal spots absent, Finger IV with 3 phalanges	
	N. duelln	nani

-	Dorsal skin shagreen or smooth, dark brown flanks contrasting with a lighter dorsum, inguinal spots present, Finger IV with 2 phalanges
3.	Pale dorsolateral band present, discs on toes expanded and ending in terminal papillaeN. ritarasquinae
-	Pale dorsolateral band absent, discs on toes slightly expanded and lacking terminal papillae N. carrascoicola
4.	Dorsal skin tubercular; maximum reported SVL < 12.5 mm in adult males and femalesN. pygmaea
-	Dorsal skin smooth or shagreen; maximum SVL > 12.5 mm
5.	Flanks and dorsum similarly colored
-	Flanks with well-defined dark brown stripe that narrows as it approaches the groin, contrasting with much lighter
	dorsal coloration7
6.	Low dorsolateral folds present, dorsal skin pustular, Finger IV with 3 phalangesN. lynchi
-	Dorsolateral folds absent, dorsal skin shagreen or smooth, Finger IV with 2 phalangesN. lochites
7.	Dorsum with dark interorbital bar, scapular marks, sacral marks, inguinal spots, and/or middorsal stripe8
-	Dorsal coloration uniform, lacking marks except for distinct inguinal spots; tips of toes not expanded and lacking
	papillae; Finger IV with 3 phalanges; in preservative, throat brown and venter cream; in life, orange venter
	N. coloma
8.	Tips of toes expanded (in Toe IV, width of disk 127-193% of width of digit at the level of distal subarticular tuber-
	cle) and with papillae; Finger IV with 2 phalanges; in preservative, throat brown, venter cream with brown reticula-
	tion
-	Tips of toes not expanded or slightly expanded (in Toe IV, width of disk < 145% of width of digit at the level of dis-
	tal subarticular tubercle) and lacking papillae; Finger IV with 3 phalanges; in preservative, throat and venter cream
	to dark brown with cream flecks N. heyeri

### Acknowledgements

For their comments on previous versions of this article we thank Ignacio de la Riva, William E. Duellman, and José Manuel Padial. This work was supported by grants from the Secretaría Nacional de Ciencias y Tecnología del Ecuador (PIC08-0000470) and JRS Biodiversity Foundation. Luis A. Coloma and R. Martín Bustamante provided photographs of the species in life and preservative.

## References

- Almendáriz, A. (1997) Overview of the herpetofauna of the western slopes of the Cordillera del Cóndor. In: Schulenberg,
  T.S. & Awbrey, K. (Eds), The Cordillera del Cóndor region of Ecuador and Peru: A biological assessment.
  Conservation International, Washington, D.C., pp. 80–82.
- Alonso, A. & Dallmeier, F. (Eds) (1999) Biodiversity assessment and monitoring of the lower Urubamba region, Perú: Pagoreni well site, assessment and training. SI/MAB Series No. 3. Smithsonian Institution / Man and Biosphere Biodiversity Program, Washington, D.C.
- Cisneros-Heredia, D.F. & Reynolds, R.P. (2007) New records of Phyllonastes Heyer, 1977 from Ecuador and Peru. *Herpetozoa*, 19, 184–186.
- De la Riva, I., Chaparro, J.C. & Padial, J.M. (2008) The taxonomic status of *Phyllonastes* Heyer and *Phrynopus peruvianus* (Noble) (Lissamphibia, Anura): resurrection of *Noblella* Barbour. *Zootaxa*, 1685, 67–68.
- De la Riva, I. & Köhler, J. (1998) A new minute leptodactylid frog, genus *Phyllonastes*, from humid montane forests of Bolivia. *Journal of Herpetology*, 32, 325–329.
- Doan, T.M. & Arizábal, W. (2002) Microgeographic variation in species composition of the herpetofaunal communities of Tambopata region, Peru. *Biotropica*, 34, 101–117.
- Duellman, W.E. (1991) A new species of leptodactylid frog, genus Phyllonastes, from Peru. Herpetologica, 47, 9-13.
- Duellman, W.E. & Lehr, E. (in press) *Terrestrial-breeding frogs (Strabomantidae) in Peru*. Natur und Tier Verlag, Münster, Germany, 382 pp.
- Duellman, W.E. & Lynch, J.D. (1988) Anuran amphibians from the Cordillera de Cutucú, Ecuador. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 140, 125–142.
- Duellman, W.E. & Trueb, L. (1994) *Biology of Amphibians*. Johns Hopkins University Press, Baltimore and London, 670 pp.
- Fabrezi, M. (1992) El carpo de los anuros. Alytes, 10, 1-29.
- Fabrezi, M. (1993) The anuran tarsus. Alytes, 11, 47-63.

- Frost, D.R. (2009) Amphibian Species of the World: an Online Reference. Version 5.3 (12 February, 2009). Electronic Database accessible at <a href="http://research.amnh.org/herpetology/amphibia/">http://research.amnh.org/herpetology/amphibia/</a>>.
- Guayasamin, J.M. (2004) A new species of *Eleutherodactylus* (Anura: Leptodactylidae) from the lowlands of northwestern Ecuador. *Herpetologica*, 60, 103–116.
- Hedges, S.B., Duellman, W.E. & Heinicke, P. (2008) New world direct-developing frogs (Anura: Terrarana): molecular phylogeny, classification, biogeography, and conservation. *Zootaxa*, 1737, 1–182.
- Heyer, W.R. (1977) Taxonomic notes on frogs from the Madeira and Purus rivers, Brazil. *Papéis Avulsos de Zoologia*, São Paulo, 8, 141–162.
- Hoogmoed, M.S. & Lescure, J. (1984) A new genus and two new species of minute leptodactylid frogs from Northern South America, with comments upon *Phyzelaphryne* (Amphibia: Anura: Leptodactylidae). Zoologische Mededelingen Leiden, 58, 85–115.
- IUCN (2001) IUCN Red list categories and criteria: version 3.1. Available from http://www.iucnredlist.org/static/ categories\_criteria\_3\_1 (accessed 12 May 2009).
- Köhler, J. (2000) A new species of *Phyllonastes* Heyer from the Chapare region of Bolivia, with notes on *Phyllonastes* carrascoicola. Spixiana, 23, 47–53.
- Lehr, E., & Catenazzi, A. (2009) A new species of minute Noblella (Anura: Strabomantidae). Copeia, 1, 148-156
- Lehr, E., Aguilar, C. & Lundberg, M. (2004) A new species of *Phyllonastes* from Peru (Amphibia, Anura, Leptodactylidae). *Journal of Herpetology*, 38, 214–218.
- Lynch, J.D. (1976) Two new species of frogs of the genus *Euparkerella* (Amphibia: Leptodactylidae) from Ecuador and Perú. *Herpetologica*, 32, 48–53.
- Lynch, J.D. (1986) New species of minute Leptodactylid frogs from the Andes of Ecuador and Peru. *Journal of Herpetology*, 20, 423–431.
- Lynch, J.D. (2005) Discovery of the richest frog fauna in the world An exploration of the forests to the North of Leticia. *Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales*, 113, 581–588.
- Noble, G.K. (1921) Five new species of Salientia from South America. American Museum Novitates, 29, 1-7.
- Reichle, S., Aguayo, R. & Cortez, C. (2004) Geographic distribution: *Phyllonastes myrmecoides*. Herpetological Review, 35, 283.
- Reynolds, R.P. & Icochea, M.J. (1997) Amphibians and reptiles of the upper Rio Comainas, Cordillera del Cóndor. In: Schulenberg, T.S. & Awbrey, K. (Eds), The Cordillera del Cóndor region of Ecuador and Peru: A biological assessment. Conservation International, Washington, D.C., pp. 82–86.
- Rodríguez, L.O. & Cadle, J.E. (1990) A preliminary overview of the herpetofauna of Cocha Cashu, Manu National Park, Peru. *In*: Gentry, A.H. (Ed), *Four Neotropical rainforests*. Yale University Press, New Haven, pp. xiii–627.
- Rodriguez, L.O., Córdova, J.H. & Icochea, J. (1993) Lista preliminar de los anfibios del Perú. *Museo de Historia Natural Universidad Mayor de San Marcos*, 45, 1–22.
- Taylor, W.R. & Van Dyke, G.C. (1985) Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study. *Cybium*, 9:107–119.
- Trueb, L. (1973) Bones, frogs, and evolution. Pp. 79–108. In J. L. Vial (Ed.), Evolutionary Biology of the Anurans. University of Missouri Press, Columbia, U.S.A.
- Trueb, L. (1993) Patterns of cranial diversity among the Lissamphibia. *In* Hanken, J. & Hall, B. K. (Eds.), *The Skull: Patterns of Structural and Systematic Diversity, Vol.* 2. Chicago University Press, Chicago, pp. 255–343.

## **APPENDIX I. Specimens examined**

- *Noblella coloma*: Ecuador: <u>Pichincha</u>: Reserva Ecológica Río Guajalito (0°14' S, 78°49' W; 1800–2000 m), QCAZ 7277, 7412, 8701, 11614, 26307, 32702.
- Noblella heyeri: Ecuador: Loja-Zamora road, 2385 m, QCAZ 31470, 31471, 31473; Zamora-Huaico, 2000 m, QCAZ 22501; Loja-Valladolid road, Hacienda Cachivalu, 2044 m, QCAZ 24875; Dos puentes-Río Malacatus road, 2260 m, QCAZ 24876.
- *Noblella myrmecoides*: Ecuador: Zamora Chinchipe: nearby Panguintza, 853 m, QCAZ 27250–54, 33009, 33012; 1 km N of Panguintza, 831 m, QCAZ 27309–13; 1 km W of Panguintza on the Zamora–Zumbi road (3°53'48.61" S, 78°48'38.7" W), QCAZ 24877; 2 km W of Panguintza, on the Zamora–Zumbi road, 800 m, QCAZ 30605–07; 11 km S of Yantzaza, 853 m, QCAZ 27259–75.