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Author(s): John D. Lynch

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New Species of Minute Leptodactylid Frogs from the Andes of Ecuador and Peru

JOHN D. LYNCH

School of Biological Sciences, The University of Nebraska, Lincoln, Nebraska 68588, USA

ABSTRACT.—A new species of *Phyllonastes* (*P. heyeri*) is named from the Andean ridges in the Huancabamba Depression in southern Ecuador and northern Peru. A similar species is described as a new species of *Phrynopus* (*P. bagrecito*) from the Andes of Cuzco, Peru. Based on the similarities in skeletons, *Phyllonastes* may share a common ancestry with frogs of the *Phrynopus peruvianus* group. An additional record is provided for *Adelophryne adiastrata* (Amazonas, Colombia).

A suite of minute (adults less than 20 mm SVL) leptodactylid frogs has been described from the lowlands of northern South America and along the eastern Andean flanks in Ecuador (Lynch, 1976; Heyer, 1977; Hoogmoed and Lescure, 1984). Lynch (1976) described the first two as species of the genus *Euparkerella* (previously known only from southeastern Brazil). Heyer (1977) placed these two species in a new genus (*Phyllonastes*) and named another new genus (*Phyzelaphryne*) from Amazonian Brazil. Lynch (1980) treated *Phyzelaphryne miriamae* as a synonym of *Eleutherodactylus nigrovittatus*. Lastly, Hoogmoed and Lescure (1984) revalidated *Phyzelaphryne miriamae* and proposed a new genus with two new species (*Adelophryne*).

At present, all of these minute frogs are placed in the tribe Eleutheradactylini. The five Amazonian species are placed in three genera: *Adelophryne* (*A. adiastrata* and *A. gutturosa*), *Phyllonastes* (*P. lochites* and *P. myrmecoides*), and *Phyzelaphryne* (*P. miriamae*). These small frogs are rather imperfectly known, being separated generically on the basis of (1) presence/absence of vomerine dentition, (2) presence/absence of a tarsal tubercle, (3) digits flattened/round in cross section, and (4) reduction of fourth finger of hand (sometimes with reduction in number of phalanges).

Hoogmoed and Lescure (1984) suggested that *Adelophryne* and *Phyzela-*

phryne might be closely related because each has a peculiar form to the digital pads (lateral grooves not united at tip). They cautioned however that it was difficult to distinguish features that reflect adaptation to a leaf-litter habitat from those that are correlates of achieving very small size from those reflecting relationships. As Hoogmoed and Lescure noted, these frogs are all quite rare and too few specimens are available to permit skeletal preparations. The two new species described here are represented by sufficient material to permit osteological preparations.

MATERIALS AND METHODS

Specimens are identified with a catalogue number and museum abbreviation (following list in Leviton et al., 1980). Measurements were made with dial calipers (under magnification) and recorded to the nearest 0.1 mm. Specimens were cleared and stained (Alizarin and Alcian Blue) using the methods of Dingerkus and Uhler (1977). All drawings were made using a Wild M-5 with a drawing tube attachment. Terminology and measurements follow Lynch (1975).

SYSTEMATICS

Shortly after my description of the first two minute frogs (Lynch, 1976), I found specimens of two other species. One of these was named *Adelophryne adiastrata* by Hoogmoed and Lescure

(1984) but the other remains undescribed.

Adelophryne adiastrata
Hoogmoed and Lescure

This species is known from only four specimens from Yapima, Comisaría Vaupés, Colombia. The fifth specimen found is a juvenile female (LACM 50586) found in leaf-litter at Leticia, Comisaría Amazonas, Colombia, some 570 km south of the type-locality. The oviducts are straight and only slightly enlarged; the ovaries contain only minute, white eggs. The measurements (mm) are as follows: SVL 12.9; tibia length 6.1–6.3; HW 4.2; head length 4.5; chord of head length 5.0; upper eyelid width 1.1–1.1; IOD 1.6; length of tympanum 0.5–0.5; eye length 1.8–1.8; E–N 1.1–1.2.

I am unable to find any trace of vomerine teeth or odontophores as described for adults by Hoogmoed and Lescure (1984). Otherwise, the individual conforms perfectly to their detailed description. The dorsum is tan with reddish-brown spots forming a reticulation; pale dorsolateral stripes evident within the pattern; side of head brown with white spot below eye and another on lip in front of tympanum; postrictal tubercles white (termed glands by Hoogmoed and Lescure); limbs bear brown transverse bands (2 on forearm, 4 on shank, 3 on tarsus); anterior and posterior surfaces of thighs dark reddish-brown; ventral surfaces dusted with melanophores; throat and chest bear brown spots, forming a reticulum on throat.

A second species was found in 1976 while examining a long series of small dendrobatids from the Andes of southern Ecuador. Although represented by an adult male and adult female, description was deferred in hopes of finding additional material. These small frogs have the round tarsal tubercle used by Heyer (1977) to diagnose *Phyllonastes*. In 1983, David Cannatella asked

me to examine two series of minute frogs which had been collected in the Andes of Peru. The samples included two species, one from Departamento Piura in extreme northern Peru, and the second from Departamento Cuzco in southern Peru. At first glance, these appeared to be minute species of either *Eleutherodactylus* or *Phrynopus*. The specimens from Depto. Piura are conspecific with the frogs from Ecuador and represent an Andean *Phyllonastes*. Those from Depto. Cuzco are clearly congeneric with the frog currently called *Phrynopus peruvianus* (Noble).

These two minute Andean frogs are very similar and, although they are here named as members of different genera, share many features in common. In order to make the descriptions less repetitive, the features in common are given below:

External Features in Common.—Head narrower than body, slightly wider than long; tip of snout extends farther anterior than anterior edge of upper jaw; nostrils not protuberant, directly laterally or dorsolaterally; loreal region sloping abruptly to lips; lips not flared; interorbital region broad, flat; supratympanic fold thick, glandular, not prominent; tympanum concealed (partially or entirely) beneath skin, separated from eye by distance equal to $\frac{2}{3}$ tympanum length; choanae small, round, situated well anterolaterally on palate, partially concealed by palatal shelf of maxillary arch when roof of mouth is viewed from directly above; no vomerine odontophores or teeth; tongue narrow, widest posteriorly, twice as long as wide, lacking posterior notch, posterior $\frac{1}{4}$ – $\frac{1}{3}$ not adherent to floor of mouth; males with large, subgular vocal sacs.

Forearm lacking ulnar tubercles (or 1–2 minute tubercles evident); one palmar tubercle (not bifid), larger than oval thenar tubercle; supernumerary palmar tubercles at bases of fingers II–IV; no discs on finger; no nuptial pads on thumbs of males; no lateral fringes on

fingers; heel lacking tubercles; ventral surface of tarsus bearing tubercle (Fig. 1); two metatarsal tubercles, both prominent and subconical, inner slightly larger and slightly longer than wide; toes lack lateral fringes and webbing.

Internal Features in Common.—Each species has the "S" condition of the *m. adductor mandibulae* and trigeminal nerve (Lynch, 1986). The skulls are very similar (Fig. 2). The principal differences (seen from above) are reflections of how completely the frontoparietals cover the fontanelles (less in *Phyllonastes heyeri*, almost completely in *Phrynopus bagrecito*). The nasals are small and widely separated. No trace of cranial crests is evident. The maxillary arch is complete and the quadratojugals are long and slender. The palatal shelf of the premaxillae is broad and weakly to moderately dissected. The cristae paroticae are short and stocky. The epiotic eminences are low. The occipital condyles are widely separated and not stalked.

The squamosals have narrow otic plates not resting on the cristae paroticae. The squamosomaxillary angles are 50–55°. The zygomatic ramus of the squamosal is shorter than the otic ramus.

The vomers are minute, being confined to the anterior and medial edges of the choanae (lack dentigerous processes). Palatine bones are present but are not large elements (thinnest in *Phyllonastes heyeri*). The cultriform process of the parasphenoid is widely separated from the palatines (Fig. 2). The median rami of the pterygoids are widely separated from the alary processes of the parasphenoid.

The vertebral column contains eight procoelous presacral vertebrae. The transverse processes are longest on the third and fourth vertebrae. The sacral diapophyses are weakly dilated and deflected posteriorly. The sacrococcygeal articulation is bicondylar. The coccyx lacks transverse processes. The omosternum and sternum are cartilaginous (Fig. 3). The omosternum is elongate

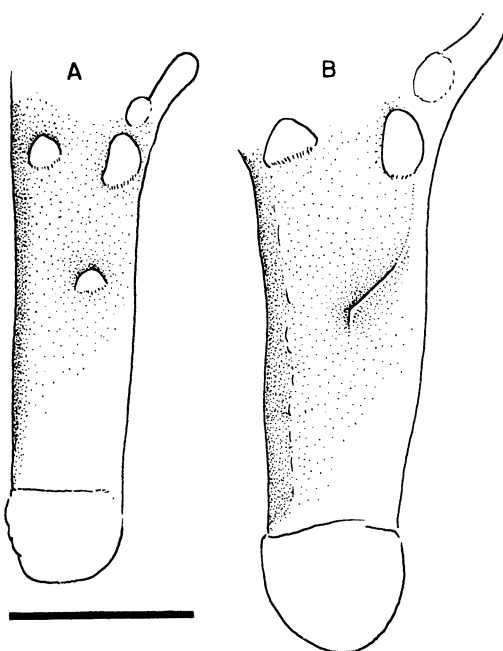


FIG. 1. Ventral views of right tarsi of (A) *Phyllonastes heyeri*, KU 196530, and (B) *Phrynopus bagrecito*, KU 196516, showing form of tarsal tubercles. Scale equals 2 mm.

and dilated anteriorly. The epicoracoidal cartilages are partially fused and overlapping. The posteromedial processes of the hyoid plate are bony, otherwise the hyoid apparatus is cartilaginous (Fig. 3). The hyale are present and large and bear long anterior processes ending in dilated tips. The alary processes of the hyoid plate are evident only as small projections (much smaller than the posterolateral processes of the hyoid plate). The phalangeal formulae are 2-2-3-3 and 2-2-3-4-3.

The genus *Phyllonastes* was established based on the presence of a tarsal tubercle (a derived condition, Heyer, 1977) and some myological traits. The two species named by Lynch (1976) were peculiar among leptodactylids in having only two phalanges in the fourth fingers. The Andean species has three phalanges in the fourth finger. It is here named:

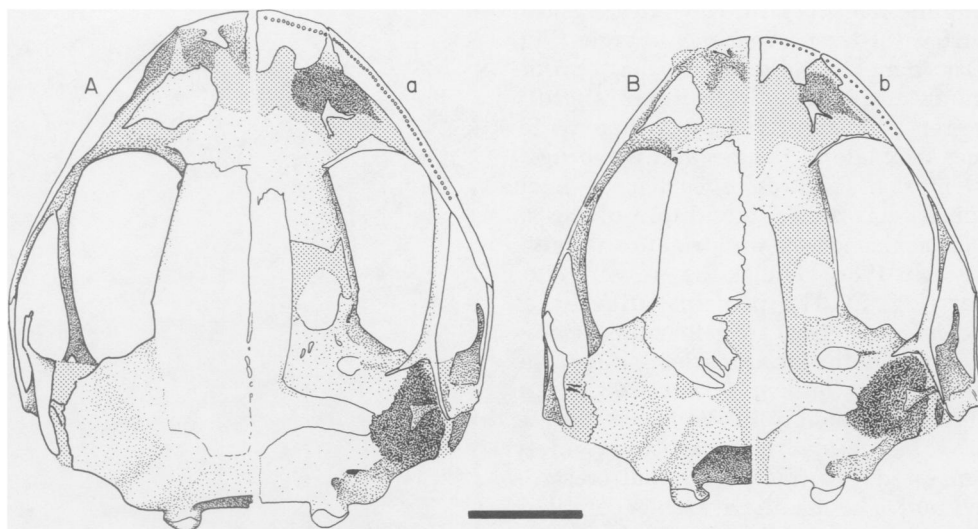


FIG. 2. Hemiskulls of (A, a) *Phrynosopus bagrecito*, KU 196519, and (B, b) *Phyllonastes heyeri*, KU 196531. Dorsal views on left sides (A, B), ventral views on right sides (a, b). Scale equals 2 mm.

PHYLLONASTES HEYERI NEW SPECIES

Holotype.—KU 196529, adult female, taken 33 km SW Huancabamba, Departamento Piura, Peru, 3100 m, on 28 November 1974 by Richard Thomas.

Paratypes.—KU 196530, 196531 (cleared and stained skeleton), LSUMZ 32134, 32169–70, 32173, topotypes. AMNH 16362, 16547, Alamor, Provincia Loja, Ecuador.

Diagnosis.—A species of *Phyllonastes* most similar to *P. myrmecoides* but differing in having three phalanges in the fourth finger, small pads on the fingers, and in lacking papillae on the digital tips. Adults small, males 12.9–14.1 ($\bar{x} = 13.8 \pm 0.2$, $N = 5$) mm SVL, females 13.1–15.9 ($\bar{x} = 14.6 \pm 0.6$, $N = 4$) mm SVL.

Description.—(also see external features in common, above); snout subacuminate in dorsal view (Fig. 4), angularly rounded in lateral profile; HW 32.6–34.9 ($\bar{x} = 34.0$, $N = 5$) % SVL in males, 30.8–33.3 ($\bar{x} = 31.8$, $N = 4$) % in females; canthus rostralis evident but not sharp; loreal region flat; E–N 52.6–66.7 ($\bar{x} = 58.0$, $N = 5$) % eye length in males, 55.6–71.9 ($\bar{x} = 63.8$, $N = 4$) % in

females; no tubercles on upper eyelid; upper eyelid width 61.1–76.5 ($\bar{x} = 67.1$, $N = 9$) % IOD; ventral one-half of tympanum visible through skin, tympanum round, its length 42–50% eye length; long vocal slits lateral to tongue in males; vocal sac large, on posterior one-half of throat and anterior portion of chest.

Very low warts on skin of dorsum (skin sometimes appears to be pitted or dimpled); no dorsolateral or discoidal folds; skin of venter pitted (not areolate); palmar tubercle round; subarticular tubercles distinct, round, pungent; first finger shorter than second; tips of fingers slightly expanded (Fig. 5).

No tubercles along outer edge of tarsus; ventral surface of tarsus with one prominent conical tubercle (Fig. 1); subarticular tubercles round, subconical; tips of digits expanded slightly, forming pads, those on III–V weakly pointed; distal portions of circumferential grooves present on toes III–V (Fig. 5); heels touch when flexed hind legs are held at right angles to sagittal plane; shank 43.4–50.0 ($\bar{x} = 46.2$, $N = 9$) % SVL.

In preservative, dorsum pale reddish-

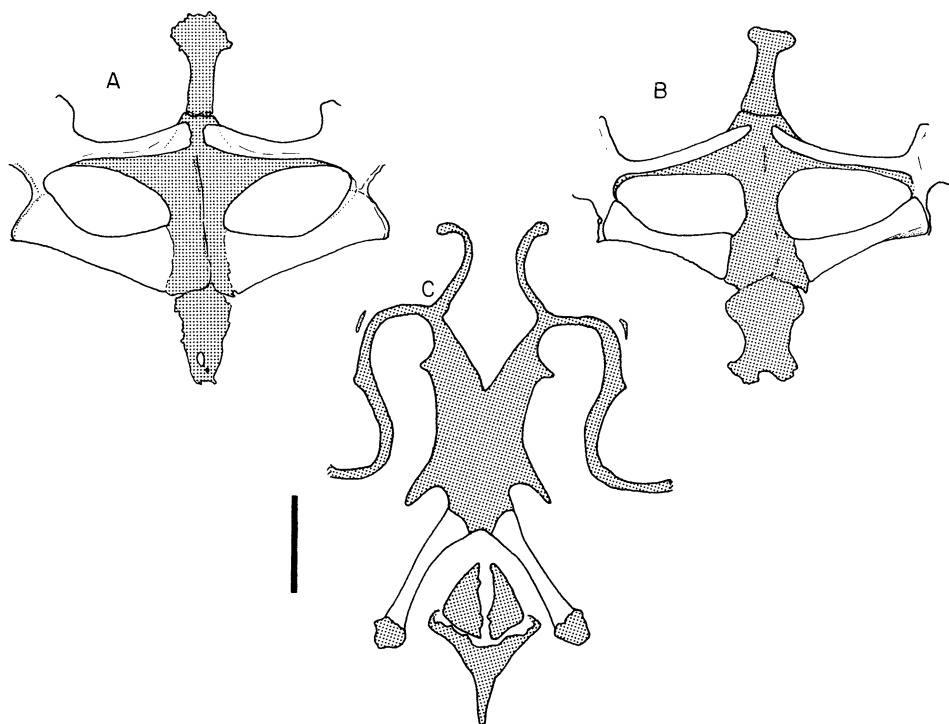


FIG. 3. Ventral views of pectoral girdles of (A) *Phrynopus bagrecito*, KU 196519, and (B) *Phyllonastes heyeri*, KU 196531, and dorsal view of hyolaryngeal skeleton (C) of *Phrynopus bagrecito*, KU 196519. Cartilage is stippled. Scale equals 1 mm.

brown with brown interorbital bar, scapular and sacral chevrons, and suprainguinal spots (Fig. 4); anal patch brown; posterior surfaces of thighs cream speckled with brown; faint bars on shanks (normally evident only along outer edge of shank); brown on side of head—continuing as dark brown band onto flanks and narrowing as it approaches groin; cream flecks on upper lip and lower flanks; forelimbs partially banded; throat and venter brown with cream flecks; undersides of limbs paler brown (less dense brown stippling).

Measurements of Holotype (in mm).—SVL 14.4; shank 6.8; HW 4.6; upper eyelid width 1.2; IOD 1.9; eye length 1.6; E-N 1.2.

Etymology.—Named for W. Ronald Heyer, who proposed that these small frogs constituted a genus of leaf-litter dwellers.

Remarks.—*P. heyeri* shows no evidence of reduction of the fourth finger (Fig. 5) except that there is no distal subarticular tubercle. Its fingers are essentially "normal" (contrast with those of *P. lochites*, see Lynch, 1976:50). The terminal phalanges of the fingers are in the form of a T but the lateral projections are short. The terminal phalanges of the toes are T-shaped but with long lateral projections.

With the description of *P. heyeri*, the genus *Phyllonastes* can no longer be defined on the basis of reduction of the fourth finger or of the phalangeal formula. The relationships of this genus and its species remain obscure. This obscurity is accentuated by the observation that *P. heyeri* is very similar (osteologically) to some frogs of the genus *Phrynopus*. The pectoral girdles are similar, the hyolaryngeal skeletons are

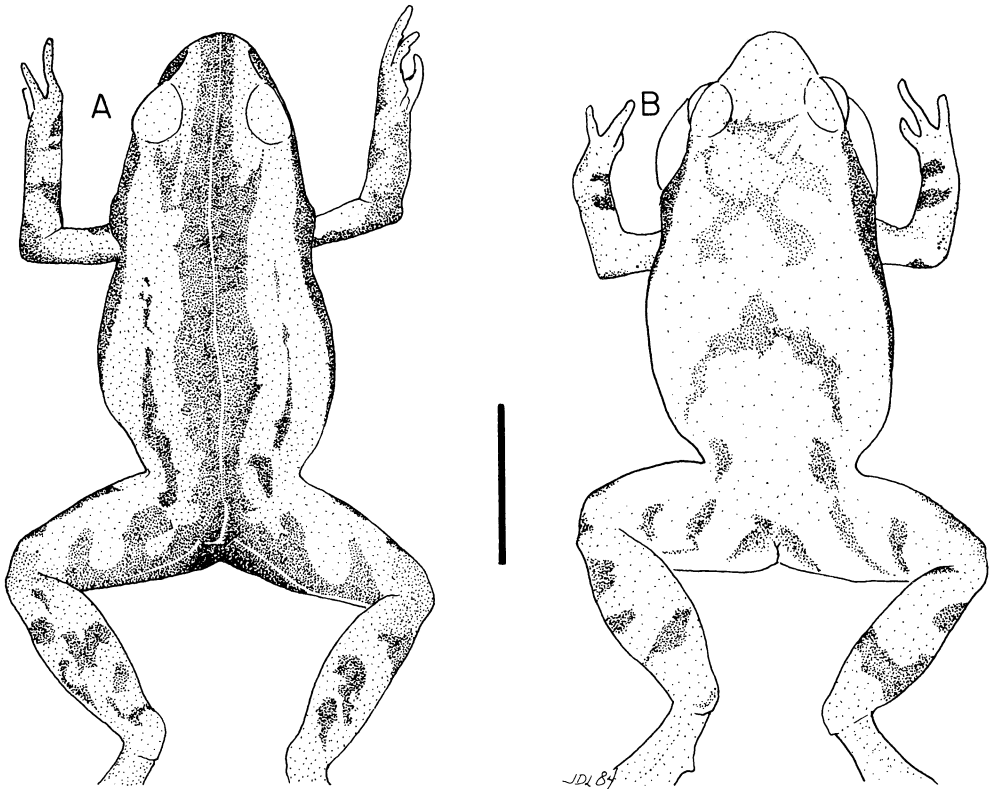


FIG. 4. Dorsal patterns of (A) *Phrynopus bagrecito*, LSUMZ 32153, and (B) *Phyllonastes heyeri*, LSUMZ 32169. Scale equals 5 mm.

identical, and the skulls are remarkably similar (Figs. 2–3). It may prove to be the case that the frogs here placed in the *peruvianus* group of *Phrynopus* are more closely related to *Phyllonastes* than to other species placed in *Phrynopus*.

The genus *Phrynopus* contains 15–16 species distributed throughout the Andes of Colombia, Ecuador, Peru, and Bolivia (Cannatella, 1984; Lynch, 1975). Lynch (1975) recognized the *peruvianus* group for a single species found in southern Peru. A second species is now available from a nearby cordillera; it is here named:

PHRYNOPUS BAGRECITO NEW SPECIES

Holotype.—KU 196512; adult female, one of a series taken at the Río Marcapata below Marcapata, Departamento

Cuzco, Peru, ca. 2740 m, on 16 October 1974 by R. and K. R. Thomas.

Paratypes.—KU 196513–26 (196519, 196522 are cleared and stained skeletons), LSUMZ 32150–64, topotypes. KU 196527–28, LSUMZ 32167–68, Hacienda Huyro between Huayopata and Quillabama, Departamento Cuzco, Peru, ca. 1830 m.

Diagnosis.—A species of the *Phrynopus peruvianus* group differing in having shagreened skin on dorsum, that of venter areolate, in having subconical tubercles, in having the thumb shorter than the second finger; dorsum striped shades of brown, venter white to cream with some brown mottling. Adults small, males 13.8–16.3 (\bar{x} = 15.2 \pm 0.1, N = 20) mm SVL, females 14.4–18.6 (\bar{x} = 16.9 \pm 0.4, N = 13) mm SVL.

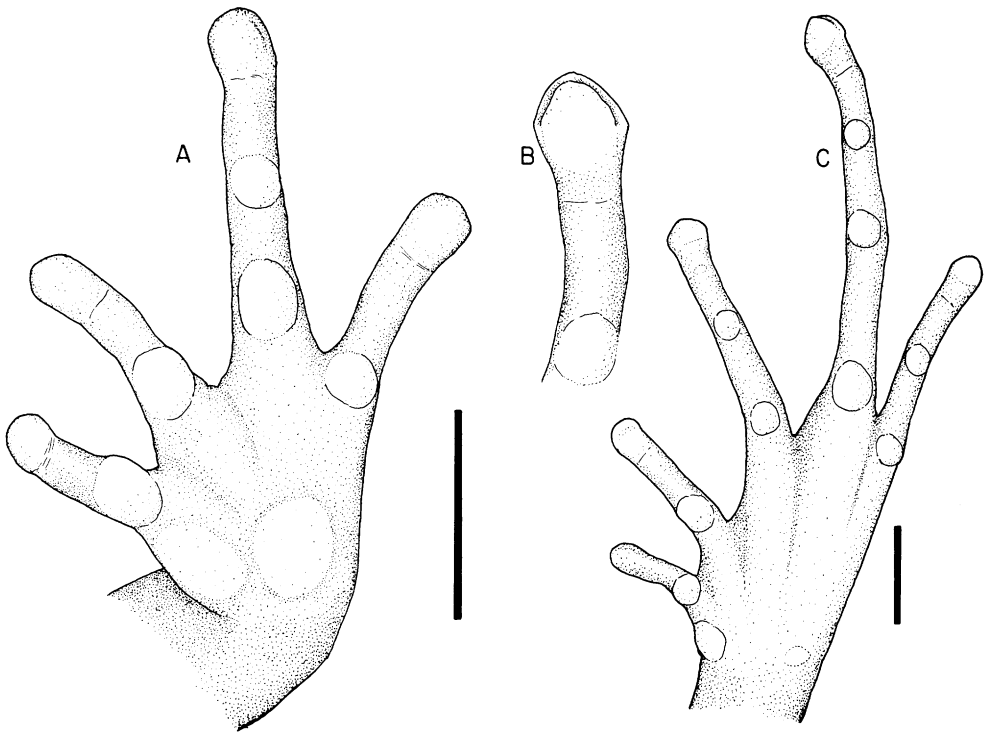


FIG. 5. Hand (A), fourth toe (B), and foot (C) of *Phyllonastes heyeri*, AMNH 16547. Scales equal 1 mm (that for A and B same).

Description.—(also see external features in common, above); snout subovoid in dorsal view, round in lateral profile (not protruding); HW 31.4–36.8 (\bar{x} = 33.3, N = 23) % SVL; canthus rostralis evident but not sharp nor pronounced; E–N 61.1–70.6 (\bar{x} = 65.7, N = 10) % eye length in males, 64.7–73.7 (\bar{x} = 70.4, N = 13) % in females; loreal region flat; a minute tubercle on each upper eyelid; upper eyelid width 68.4–93.8 (\bar{x} = 82.0, N = 23) % IOD; anteroventral one-half of tympanum visible through skin, its length approximately 30–40% eye length; vocal sac distended on posterior one-half of throat and on chest.

Skin of dorsum shagreened but becoming more coarse on lower back; skin on throat smooth, that on venter areolate although individual granulations not distinct; skin on shanks shagreened with larger round warts superimposed; no trace of dorsolateral folds; palmar

tubercle subtriangular in outline (not round); subarticular tubercles subconical, round, distal one on IV scarcely evident; digital tips not expanded; first finger shorter than second.

No distinct tubercles along outer edge of tarsus (adjacent skin on dorsal surfaces is granular and this texture extends onto surfaces of heel and outer edge of tarsus); tarsal tubercle sickle-shaped (Fig. 1); toes lacking pads and discs; shank 38.9–44.7 (\bar{x} = 41.2, N = 23) % SVL.

In preservative, the dorsum is creamy-brown with darker brown lateral (flank) bands and a mid-dorsal band; flank bands continue across anterior surfaces of thighs; pale areas between brown bands partially divided (posteriorly) by narrow band extending from level of sacrum to above groin (Fig. 4); forelimb pale brown with diffuse darker mottling; top of thigh brown but posterior

surfaces slightly more pale except in vicinity of vent (dark brown); shank brown with diffuse darker marbling; a thin cream vertebral stripe present in many individuals (Fig. 4), divided at vent and extended ventrolaterally across thighs to lower edge of thigh behind knee; throat, chest, undersides of arms and legs dirty cream to yellowish-cream with diffuse brown mottling; venter white with some brown blotching extending downward from lower flanks and just posteromedial to axillae. KU 196524 and LSUMZ 32155 have three brown bands but the central one is faint. LSUMZ 32156 lacks the central band and has a nearly cream dorsum sharply set off from the dark brown flanks. In LSUMZ 32164, the brown blotching extending onto venter forms a loose reticulation giving the impression of a frog with cream spots on a brown venter.

Measurements of Holotype (in mm.).—SVL 18.3; shank 7.6; HW 5.9; upper eyelid width 1.5; IOD 1.8; eye 1.8; E-N 1.3.

Etymology.—Spanish, meaning small catfish. The name is used as a noun in apposition and is a nickname for my colleague, David Cannatella.

Natural History.—All males except LSUMZ 32168 (a juvenile 9.0 mm SVL) have distended vocal sacs. Females appear to have been ready to deposit eggs. This species was apparently in its breeding season in August and October 1974 when the series was collected.

Remarks.—The skull of *P. bagrecito* is nearly identical to that of *P. peruvianus* (see Lynch, 1975:26). The only differences I find between them involve the sizes of the vomers (smaller in *P. bagrecito*), of the palatines (less extensive in *P. bagrecito*), and the relative lengths of the zygomatic and otic rami of the squamosals (otic longer in *P. bagrecito*).

The sternum (Fig. 3) is broad and lacks posterolateral lobes (identical to that seen in *P. peruvianus*). The terminal phalanges are intermediate between the knobbed and T-shaped conditions (Lynch, 1975:5).

DISCUSSION

The descriptions of *Phyllonastes heyeri* and *Phrynopus bagrecito* bring to seven (or eight, counting *P. peruvianus*) the number of "minute leptodactylids" known from South America (common name after Hoogmoed and Lescure, 1984). All species show considerable evidence of epicoracoidal fusion. For the present, this trait is taken to be a consequence of small size rather than evidence of relationship. The species of the *Phrynopus peruvianus* group and those of the genus *Phyllonastes* lack vomerine teeth and odontophores whereas the species of *Adelophryne* and *Phyzelaphryne* have both, at least as adults; all of these frogs are equally small. The systematic utility of this trait is limited because other species of *Phrynopus* have the same states but a distinct underlying osteology (Lynch, 1975); this similarity is ambiguous and derives from simplification (Heyer, 1977).

The osteological similarity between *Phyllonastes* and the frogs of the *Phrynopus peruvianus* group suggests that either the skulls are of limited value (possibly reflecting consequences of small size and/or adaptations to microhabitat) or that these animals are closely related. Until material is available for osteological study of *Adelophryne* and *Phyzelaphryne*, we will not be able to decide if either genus is also closely related to the Napoan and Andean species.

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