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TWO NEW SPECIES OF *ELEUTHERODACTYLUS* (AMPHIBIA: LEPTODACTYLIDAE) FROM THE LOWLANDS AND LOWER CLOUD FORESTS OF WESTERN ECUADOR

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ABSTRACT: *Eleutherodactylus muricatus* sp. nov., an ally of the large, flare-snouted frogs of the *rubicundus* assembly, is named from lowland and lower cloud forest localities in Provincia Pichincha, Ecuador. The new species is smaller than its sympatric allies *E. crenunguis* and *E. latidiscus*. *Eleutherodactylus tenebrionis* sp. nov., is also found in primary lowland and lower cloud forests in west-central Ecuador. It is allied to a species found in the high cloud forests in western Ecuador but differs in color pattern and lacks a calcar and ulnar tubercles.

INTRODUCTION

Approximately 15 species of *Eleutherodactylus* inhabit the Pacific lowlands of Ecuador (Lynch, in press) and perhaps another 40 species are found in the cloud forests of the Pacific versant in the Ecuadorian Andes. Most of these frogs are small organisms (less than 35 mm SVL) but two members of the *rubicundus* assembly [*Eleutherodactylus crenunguis* Lynch and *E. latidiscus* (Boulenger)] are much larger species having long, slender limbs and digits and large emarginate (or notched) digital pads.

Our field work in western Ecuador over the past several years has revealed that *crenunguis* is a frog of the lower cloud forests (800–1500 m) and is not an altitudinal replacement for *latidiscus* (20–1500 m). In the course of this field work two additional species having notched or indented digital pads were found in sympatry

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with both of the larger species. In spite of sharing the notched pads, only one of these species seems allied to the *rubicundus* assembly as defined by Lynch (1979). The other species appears to be most closely allied to a species found in the high cloud forests of western Ecuador (Lynch and Trueb, in press).

The format of the descriptions follows Lynch's long-used style. Abbreviations employed below include the following: SVL — snout-vent length; HW — head width; IOD — interorbital distance; E-N — eye to nostril distance.

Eleutherodactylus muricatus sp. nov.

Holotype: MCZ 94469, an adult male collected at the Río Faisanes where it is crossed by Ecuador Highway 28 (the road from La Palma to Quito via Chiriboga), 14.4 km from the junction with Highway 30 (the Aloag to Santo Domingo de los Colorados road) at La Palma, Provincia Pichincha, Ecuador, 1380 m, on 12 November 1977 by Ken Miyata.

Paratypes. MCZ 92091, 92095, 92100–01, 94848, 97528–31, USNM 211172–74, topotypes; MCZ 97592, Centinela, 14.1 km SE Patricia Pilar by road, Provincia Pichincha, 570 m; MCZ 90337, 94456, 94460, Centro Cientifico Rio Palenque, 47 km S Santo Domingo de los Colorados, Provincia Pichincha, 220 m.

Diagnosis. 1) skin of dorsum smooth with numerous conical tubercles, that of venter feebly areolate; no dorsolateral folds; no anal sheath; 2) tympanum moderately distinct, its length ¼ eye length; 3) snout subacuminate in dorsal view, rounded in lateral profile; canthus rostralis moderately distinct; 4) upper eyelid much wider than IOD, bearing many conical warts: no cranial crests; 5) vomerine odontophores large, triangular in outline, narrowly separated; 6) males with vocal slits, subgular vocal sac; no nuptial pads; 7) first finger shorter than second; all digits bearing broad discs, pads on fingers II–IV, those of III and IV notched; 8) fingers bearing lateral keels; 9) 1–2 small ulnar tubercles; 10) one large conical tubercle on heel; low tubercles along outer edge of tarsus; short inner tarsal fold; 11) two metatarsal tubercles, inner elongate, 10 times size of round, subconical outer; supernumerary plantar tubercles at base of toes; 12) toes bearing lateral fringes, not webbed; toe

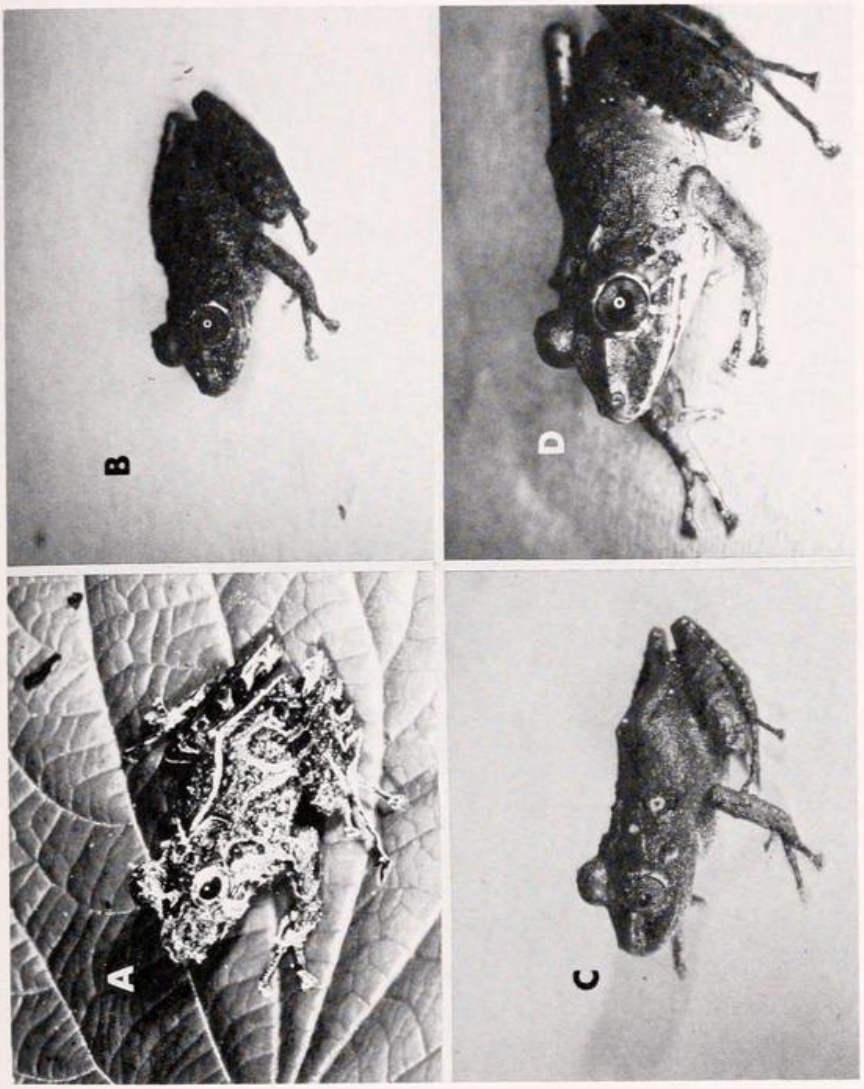

Figure 1. (A) *Eleutherodactylus muricatus*, MCZ 94456, 33.8 mm SVL; (B) *E. tenebrionis*, KU 146171, 36.9 mm SVL; (C) *E. tenebrionis*, KU 179224, 30.6 mm SVL; (D) *E. latidiscus*, KU 131612, 45.1 mm SVL.

pads notched, smaller than those of outer fingers; 13) dorsum brown with black spots; ventral surfaces brown with cream flecks; slightly darker brown chevrons on throat; posterior surfaces of thighs brown; 14) adults from type-locality moderate-sized, males 31.8–40.7 ($\bar{x}$= 36.0, n = 4) mm SVL, one female 46.3 mm SVL; two gravid females from the lowlands (Centinela and Rio Palenque) are only 33.8–36.0 mm SVL.

Eleutherodactylus muricatus is most similar to *E. crenunguis* but differs in coloration (no orange patch on the breast) and in having fewer, larger tubercles on the dorsum (Fig. 1). It is also smaller than *E. crenunguis* (Lynch 1976).

Description. Head as wide as or wider than body, wider than long: HW 37.1–39.9 ($\bar{x}$ = 38.4, n = 7) per cent SVL; snout subacuminate in dorsal view, rounded in lateral profile; nostrils weakly protuberant, directed dorsolaterally; canthus rostralis relatively sharp (swollen), straight or weakly convex; loreal region concave, sloping gradually to lips; lips flared; E-N 80.7–100.0 per cent ($\bar{x}$ = 89.4, n = 7) eye length; upper eyelid 100.0–132.3 per cent ($\bar{x}$ = 119.7, n = 7) IOD, bearing many pungent tubercles; no cranial crests; supratympanic fold moderately distinct, obscuring upper edge of tympanum; tympanum not prominent, round, separated from eye by distance equal twice tympanum length; tympanum length 22.0–27.9 ($\bar{x}$ = 25.1, n = 6) per cent eye length except in MCZ 94456 (small female from Rio Palenque has ratio of 37.5 per cent); postrictal tubercles present, not prominent; choanae round, not concealed by palatal shelf of maxillary arch; vomerine odontophores median and posterior to choanae, large, triangular in outline, separated on midline by distance less than 1/3 an odontophore width, each larger than a choana, bearing 5–12 teeth in a transverse row; tongue longer than wide, its posterior edge notched; posterior 1/3 not adherent to floor of mouth; males with vocal slits posterolateral to tongue, median subgular vocal sac.

Skin of dorsum smooth but bearing many warts, most numerous on lower back (where skin is tuberculate); many elongate, subconical warts on flanks; no dorsolateral folds; no anal sheath; skin posterior and posterolateral to anus areolate but also bearing conical warts; skin of throat areolate, that on other ventral surfaces smooth with very feeble areolations; discoidal folds well anteriad to groin; one or two small ulnar tubercles; palmar tubercle bifid, larger

than oval thenar tubercle; several prominent supernumerary palmar tubercles; subarticular tubercles round, pungent; fingers bear lateral keels; all digits with pads, that of thumb scarcely wider than digit below pad, on II twice as wide, on III–IV three times as wide (wider than tympanum); pads of fingers III–IV notched apically; discs on all pads broader than long; fingers long, first slightly shorter than second; thumb of male lacking nuptial pad or swelling.

Numerous tubercles on heel, one large conical tubercle (not a calcar); low tubercles along outer edge of tarsus; short fold at base of inner metatarsal tubercle which is three times as long as wide, 10 times size of round, subconical outer metatarsal tubercle; supernumerary plantar tubercles at bases of each toe; subarticular tubercles longer than wide, pungent; toes bearing distinct lateral fringes, broad discs, expanded pads; pads notched apically, smaller than those of outer fingers; heels of flexed hind limbs broadly overlap; shank 54.7–62.2 per cent ($\bar{x}$ = 58.4, n = 7) SVL.

Brown above with black spots enclosing tubercles; bars evident on thighs but remainder of pattern (limbs, labial bars, canthal-supratympanic stripe, dorsal chevrons, etc.) only suggested by black spots; venter brown with cream flecks and small spots; inverted brown chevrons on chin and throat; undersides of limbs and groin brown with cream flecks; anterior and posterior surfaces of thighs brown with cream flecks. In small individuals, ground color gray and with evident shank bars (narrow and oblique), labial bars, and canthal-supratympanic stripe.

In life, *E. muricatus* from the type locality are pale to dark brown with black rings around large tubercles; flanks paler brown with yellowish wash; venter dark purplish-brown with yellow-brown mottling; iris gold flecked with black. Lowland specimens lack the black rings around the tubercles; the venter is a muddy yellow mottled with dark brown; the lower flanks, groin, and underside of the limbs have a purplish-brown wash; the iris is copper. The above color descriptions apply to daytime patterns; at night all individuals are much paler in dorsal coloration, ranging from pale buff to olive brown, but the various markings remain intact.

Measurements of holotype (in mm). SVL 32.3; shank 20.1; HW 12.5; head length 11.6; upper eyelid 2.9; IOD 2.9; tympanum length 1.0; eye length 4.3; E-N 3.9.

Etymology. The specific epiphet is derived from the Latin, meaning spiny, in reference to the pungent tubercles on the dorsum and upper eyelid.

Variation. The two adult females from low elevations (MCZ 94456 from Río Palenque, 220 m, and MCZ 97592 from Centinela, 570 m) are much smaller than the only adult female from the type-locality. They are also peculiar (Fig. 1) in having prominent vertebral stripes which are yellow-cream to buffy orange in life. All of the material from the lower elevations has venters more pale than the topotypic material; in life the ventral surfaces of the topotypic population are predominantly brown with some yellowish mottling while those of the low elevation populations are predominantly yellowish with brown mottling. The lowland populations also have more prominent tubercles on the eyelids and dorsum. All of these differences are rather minor and probably represent slight geographical or altitudinal variation. We are taking a conservative approach in assigning all of these specimens to the same taxon; further work may well prove we have confused two species.

Remarks. Adults of *E. crenunguis* and *E. latidiscus* are seldom encountered. No adult females of *E. crenunguis* have been found, although juvenile females to 41.3 mm have been examined, and adult males range in size from 35.0 to 49.2 mm SVL. Very few adults of *E. latidiscus* are available even though juveniles are often quite common. Three males with vocal slits are 43.9–50.0 mm SVL and four females having convoluted oviducts are 49.7–64.5 mm SVL. Both of these frogs are considerably larger than the sympatric *E. muricatus.*

Natural History. Eleutherodactylus muricatus from the type-locality have been collected on streamside vegetation within 1.5 m of the water surface. Several specimens were taken on logs just above water level, but the majority were perched on large leaves adjacent to the stream. For a description of the type-locality see Miyata (in press). Individuals are found in low density on most nights at this locality.

The lowland specimens have all been taken from primary forest or, in the case of the Centinela specimen, from very recently eut primary forest. The Rio Palenque specimens were taken from low vegetation in forest with a dense canopy on rainless nights.

Eleutherodactylus muricatus appears to have a spotty distribution, somewhat analogous to that seen in other anurans in this region (Lynch 1977). *E. muricatus* has not been collected at the Río Orito, a locality very close to the type locality, despite several visits by field parties from the University of Kansas. More field work is needed to confirm the spottiness of the distribution.

Eleutherodactylus tenebrionis

Holotype: MCZ 90326, an adult male collected at the Hotel Tinalandia, 16 km E Santo Domingo de los Colorados by road, Provincia Pichincha, Ecuador, 800 m, on 6 August 1975 by Ken Miyata.

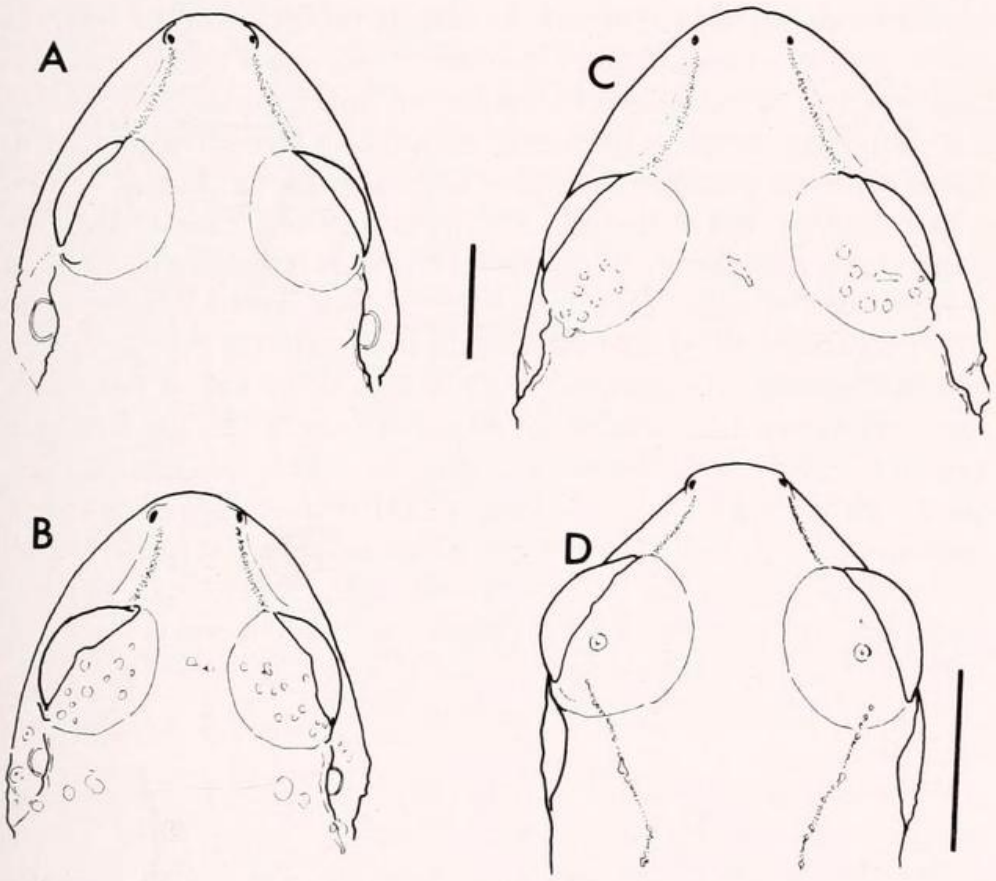

Figure 2. Outlines of heads of western Ecuador *Eleutherodactylus*. (A) *E. crenunguis*, MCZ 92099; (B) *E. muricatus*, MCZ 92095; (C) *E. latidiscus*, cotype, BM 98.4.28.109; (D) *E. tenebrionis*, MCZ 92081. Scale for A–C is between figs. A and C; that for D is to its right. Scales equal 5 mm.

Paratypes: MCZ 88890, 90325, 90327–29, 92079–81, 94712, topotypes; KU 179224–27, Santo Domingo de los Colorados, Provincia Pichincha, 580 m; KU 179228–30, 2 km E, 1 km S Santo Domingo de los Colorados, Provincia Pichincha, 600 m; MCZ 97596–97, USNM 211176, Centinela, 14.1 km SE Patricia Pilar by road, Provincia Pichincha, 570–600 m; KU 146171, 165874–77, MCZ 94864–65, 94867, 98164–66, USNM 211175, Centro Cientifico Río Palenque, 47 km S Santo Domingo de los Colorados by road, Provincia Pichincha, 170–220 m.

Diagnosis. 1) Skin of dorsum smooth with occasional tubercles, that of venter areolate; no dorsolateral folds; no anal sheath; 2) tympanum distinct, round, its length 1/4–2/5 eye length; 3) snout round in dorsal view, truncate in lateral profile; canthus rostralis distinct; 4) interorbital space narrower than upper eyelid; low cranial crests in females; small tubercle on upper eyelid; 5) vomerine odontophores elevated, triangular in outline, narrowly separated; 6) males with vocal slits; males lack nuptial pads on thumb; 7) first finger shorter than second; all digits bearing broad discs on expanded pads, pads of fingers III–IV largest, emarginate, those of I–II smaller, rounded apically; 8) fingers lack lateral fringes; 9) no ulnar tubercles; 10) small tubercles on heel, none on knee or tarsus; 11) two metatarsal tubercles, inner oval, 4 times size of flat outer; low supernumerary tubercles at bases of toes II–IV; 12) toes lack lateral fringes; discs broader than long on weakly emarginate pads, pads smaller than those on fingers; 13) brown above with little indication of pattern (Fig. 1); venter cream with extensive brown reticulation; undersides of limbs brown with cream flecks; anterior and posterior surfaces of thighs brown with small cream flecks; in life, iris blue; 14) adults moderate-sized, males 20.8–26.8 ($\bar{x} = 23.8 \pm 0.9$, $n = 16$) mm SVL, females 30.6–36.9 ($\bar{x} = 33.8 \pm 1.6$, $n = 7$) mm SVL.

Eleutherodactylus tenebrionis has no close relatives known to us except for an undescribed species from the upper cloud forests (2000–2700 m) in Provincias Imbabura and Pichincha, Ecuador (Lynch and Trueb, in press) which differs from *E. tenebrionis* in having prominent conical tubercles on the forearm, tarsus, and upper eyelid and a calcar on the heel.

Description. Head as wide as or wider than body, wider than

long; HW 37.0–41.4 per cent ($\bar{x}$ = 39.3, n = 23) SVL; snout round in dorsal view, truncate in lateral profile; E-N in males 72.0–84.8 per cent ($\bar{x}$ = 77.9, n = 16) eye length, in females 75.9–87.0 ($\bar{x}$ = 82.9, n = 7); nostrils protuberant, directed laterally; canthus rostralis distinct, weakly concave; loreal region concave, sloping abruptly in males and gradually in females to lips; lips not flared (Fig. 2); upper eyelid 110.3–165.7 per cent ($\bar{x}$ = 125.8, n = 23) IOD, bearing 1–2 small conical tubercles; adult females have low cranial crests (not evident in smaller frogs); lower 3/4 of tympanum distinct, upper edge hidden by diffuse supratympanic fold; tympanum separated from eye by almost its length; tympanum length in males 25.0–35.0 per cent ($\bar{x}$ = 29.4, n = 16) eye length, in females 29.6–38.5 ($\bar{x}$ = 32.9, n = 7); small postrictal tubercles present; skin on rest of head smooth; choanae longer than wide, not concealed by palatal shelf of maxillary arch; vomerine odontophores median and posterior to choanae, pungent, triangular in outline, bearing 5–7 teeth in a transverse row, separated on midline by a space equal to 1/3–1/2 of odontophore width; odontophores nearly as large as a choana; tongue longer than wide, its posterior border notched, posterior 1/5 not adherent to floor of mouth; male with vocal slits.

Skin of dorsum essentially smooth but some small, low, flat warts on lower back (in a few examples these warts are pungent) and a few tiny warts scattered on back; no dorsolateral folds; flanks become areolate, areolation continuing onto venter; throat smooth; discoidal folds present; no anal sheath; no ulnar tubercles; palmar tubercles bifid (outer lobe the smaller), as large as or smaller than oval thenar tubercle; if present, supernumerary palmar tubercles flat, indistinct; subarticular tubercles relatively low, round; fingers lacking lateral fringe or keel; all fingers bearing broader than long discs; pad smallest on I, intermediate on II, largest on III and IV; pad of III as large as tympanum; pads on III and IV feebly emarginate; II longer than I; males lack nuptial pads.

No tubercles on knee or tarsus; 1–2 small tubercles on heel; inner metatarsal tubercle twice as long as wide, outer 1/4 (or less) size of inner, flat; supernumerary plantar tubercles low, at bases of toes II–IV; subarticular tubercles longer than wide, not conical; toes lack lateral fringes, bearing broad discs on expanded, feebly emarginate pads (toe pads smaller than those on outer fingers); heels of flexed hind legs overlap; shank of males 52.8–62.5 ($\bar{x}$ = 57.9, n = 16) per cent SVL, of females 52.2–59.7 ($\bar{x}$ = 56.1, n = 7).

Brown above with diffuse dark brown or black scapular "W", supratympanic stripe, interorbital bar, and indefinite sacral chevron; canthal stripe, labial bars, anal triangle brown, not distinct; limb bars brown, nearly transverse on shanks, about as wide as interspaces; flanks pale brown (cream invasion of brown); venter cream with dense fine brown reticulation; some cream flecks on limbs, fewest on underside of shank; throat and breast heavily stippled with brown (relative to venter); anterior and posterior surfaces of thighs (and groin) brown with small cream flecks.

In life, *E. tenebrionis* is burnt umber with black and dull golden flecks above; the venter is gray with gray-brown mottling. The iris is gray-blue. At night they tend to be a much paler yellowish-tan dorsally with prominent black spots in the shoulder region.

Measurements of Holotype (in mm). SVL 26.4; shank 15.0; HW 10.8; head length 10.4; upper eyelid 3.0; IOD 2.6; tympanum length 1.4; eye length 4.4; E-N 3.3.

Etymology. The specific epiphet is derived from the Latin, meaning a lover of darkness, in reference to the restriction of *E. tenebrionis* to primary forest.

Natural History. Eleutherodactylus tenebrionis is restricted to primary forest, where it is most frequently found at night on low vegetation along stream courses. The lowland rain forests in western Ecuador which this species inhabits are characterized by full canopies and relatively sparse understories. Epiphytes are especially prominent in these wet forests, and some of the lowland forests appear superficially like cloud forest. Much of this region is covered with clouds during the dry season which encourages this lush growth even though annual rainfall is only moderately heavy (Dodson and Gentry 1978).

The preference of *E. tenebrionis* for streamside vegetation appears to be real and not a sampling bias. One of us (KM) has spent considerable time working study plots in primary forest at Rio Palenque located on top of a plateau and lacking any streams and has never encountered *E. tenebrionis* there. Along the small creeks elsewhere in the Rio Palenque forest they are encountered regularly, if not commonly. The specimens from Centinela likewise all came from along a small forest stream rather than from the primary ridgetop forest or the recently cleared hillside forest. At Tinalandia

occasional individuals were found perched on low vegetation within 2 m of the ground along a hillside about 30 m above stream level, but this area at 800 m elevation is more mesic than the lower localities.

Discussion

The flared lips and long snouts of *E. crenunguis, E. latidiscus, E. muricatus,* and *E. rubicundus* are in marked contrast to the condition seen in *E. tenebrionis* (Fig. 2). All of these species share the narrow IOD, a relatively uncommon trait among *Eleutherodactylus* (Fig. 2). Low cranial crests are present in most of these species (except *E. muricatus*) but are generally evident only in adult females. These traits are also exhibited by *E. cruentus* (Peters), a species sometimes confused with *E. latidiscus* which may be allied to *E. crenunguis* and *E. latidiscus* (Lynch 1976). As noted by Lynch (in press) only *E. crenunguis, E. latidiscus,* and *E. rubicundus* of the *rubicundus* assembly have emarginate digital pads. We can now add *E. muricatus* to this list but we are not convinced that these four species are more closely related to one another than any is to the other two known species of the assembly. The weakly emarginate digital pads of *E. tenebrionis* are not convincing evidence of its relationship with the *rubicundus* assembly; its snout physiognomy suggests that it is allied elsewhere.

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