A new mottled frog of the genus *Eleutherodactylus* (Anura: Leptodactylidae) from Eastern Cuba

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ABSTRACT. A new species of *Eleutherodactylus* (Anura: Leptodactylidae) is described from Eastern Cuba. It is closely related to *Eleutherodactylus planirostris* and *E. ricordi*, but differs from those species in several morphological and acoustical characters.

Key words. Anura, Leptodactylidae, *Eleutherodactylus,* new species, acoustics, Eastern Cuba.

INTRODUCTION

The Parque Nacional Alejandro de Humboldt is one of the most important protected areas in Cuba, located in the Provinces of Holguín and Guantánamo (Eastern Cuba). With an extension of about 70 140 ha, this park contains the most preserved rain forests and fluvial systems of the Island. Twenty-two species of amphibians have been reported from this place, some of them endemic to single localities or reduced areas. In a recent expedition to this National Park, we found a frog very closely related to *Eleutherodactylus planirostris* Cope, and *E. ricordi* Duméril and Bibron, described herein as a new species.

MATERIALS AND METHODS

Measurements were taken with calipers (0.05 mm accuracy) under a scope. Frog calls were recorded with a Sony TCM 59V portable cassette recorder and Sony ECM 220 microphone. The acoustic analyses were made with the use of Canary software version 1.2.4 (Charif *et al*., 1995). Signals were digitized at 22050 Hz and size of 16 bits. Call rate was determined for sequences of 10 calls per individual. Terminology for call parameters follows that proposed by Duellman and Trueb (1986).

Head length was measured from posterior edge of tympanum to snout tip; the head width was taken between articulation of jaws; and interorbital distance was taken at midpoint of upper eyelid. SVL is the abbreviation for snout-vent length. Museum and other zoological collection acronyms used were: MNHNCu, Museo Nacional de Historia Natural de Cuba, Ciudad de La Habana; BSCH, Herpetological Collection of Museo de Historia Natural Tomás Romay, Santiago de Cuba; LMD, senior author field number series.

SYSTEMATICS

Eleutherodactylus simulans, sp. nov

(Figs. 1A, 2A)

Diagnosis. *Eleutherodactylus simulans*, sp. nov., is a small size member of the subgenus *Euhyas* (sensu Hedges, 1989), with adult males attaining a maximum SVL of 17.5 mm, and adult females 23.9 mm. It is closely related to *E. planirostris* and *E. ricordi* by having long arched series of vomerine odontophores, small digital discs, smooth belly (but margins may be shallowly areolated), absence of external vocal sac, and a dorsal pattern of blotches and stripes. From *E. ricordi* (a sympatric mottled species), *E. simulans* sp. nov. differs by its smaller adult size (up to 30.5 mm SVL in females, and 26.7 mm in males of *E. ricordi*); by having lighter belly, iris, dorsum of snout, and sides of head; less "closed" pattern of blotches; and a very different voice (Fig. 2). *E. simulans*, sp. nov, is even more similar to *E. planirostris*; but differs from this species by having a more profuse and contrasting mottled pattern; all individuals have dorsolateral light stripes running among blotches without continuous dark margins; absence of dorsal chevrons and of the triangular figure (present frequently in *E. planirostris*) behind the interorbital bar; lateral folds absent or barely evident (more conspicuously defined in *E. planirostris*); and a quite different voice (see Fig. 2). For comparisons among some call parameters of *E. simulans* sp. nov, *E. planirostris* and *E. ricordi*, see Table 1.

Description. Head as wide as body, length greater than width; head length 36.8% (36.4–37.8) of SVL in males, and 38.2% (37.0–39.2) in females; snout subacuminate in dorsal view and in profile, overlapping the lower jaw; snout length 46.2% (43.7–48.7) of head length in males, and 46.2% (44.1–48.6) in females; nostrils weakly protuberant, directed laterally; canthus rostralis rounded and straight in dorsal view; loreal region flat or slightly convex, sloping abruptly to lip; lips not flared; upper eyelids with granules; interorbital distance, 1.2–2.0 (x=1.5) times the upper eyelid, with a shagreened skin; tympanum superficial, with distinct annulus, 47.4% (37.5–58.8) of eye size in males, and 46.5% (40.8–54.8), in females, concealed dorsally by the supratympanic fold and separated from eye by a distance 30.0–61.1% (x=43.1) its own diameter; two enlarged postrictal tubercles posteroventral to tympanum; choanae smaller than digital disc of third finger, round, and slightly concealed by palatal shelf of maxillary arch in ventral view; vomerine odontophores present in two arched large series almost in contact or narrowly separated, each series 3–4 times the diameter of a choana, extending slightly outwards beyond external margin of each choana; tongue oval, not notched behind, posterior two thirds not adherent to floor of mouth; males with sublingual slits; no external vocal sac.

Skin of dorsum shagreened with only few scattered tubercles, becoming smooth in preserved specimens; venter smooth, slightly areolated on posterior edges; posteroventral part of thighs areolated; ventral discoidal folds evident; a well defined vertebral fold; glandular areas inconspicuous, better observed in live frogs; inguinal glands very small, poorly elevated and difficult to see; postfemoral glands narrowly elongated; supraxilary glands not defined, but skin behind supratympanic fold slightly thick; anal opening not extended in sheath; ulnar tubercle minute; palmar tubercle oval, slightly larger than the thenar or about twice its size; thenar tubercle oval, elevated; few rounded supernumerary palmar tubercles; subarticular tubercles of fingers elevated, oval and subconical; barely defined lateral ridge on fingers; fingers III>IV>I>II; digital discs small, about 30–69% the tympanum width; hands 25.7% (23.6–26.8) of SVL in males, and 25.2% (23.9–27.7) in

females; heel with low granules; inner metatarsal tubercle enlarged, 2–2.5 times as large as the outer metatarsal tubercle, oval and protruded anteriorly; supernumerary tubercles small, low and inconspicuous; subarticular tubercles of toes oval and subconical; toes with a barely defined lateral ridge; circunferencial groove bordering distal two thirds of toe pad; heels overlap when flexed legs are held at right angles to sagittal plane; toes IV>III>V>II>I in order of decreasing length. Measurements are summarized in Table 2.

Color in life: body with a dark brown mottled pattern over a light ocraceous-tan background; two light dorsolateral stripes slightly wider at anterior half of body, beginning behind the upper eyelids, running among blotches without a continuous margin; an irregular dark brown interorbital bar, preceded by a lighter area; dorsum of snout with irregular blotches; flanks slightly olive green; extremities mottled, not distinctively cross barred, although some specimens have an evident bar on forearms; thighs dark brown in their anterior and posterior faces; forearms olive green; elbows orange; venter white or slightly fleshy colored; throat and chest white, with scattered brown dots in specimen MNHNCu 868; lower jaw with white dots; a dark brown (almost black) loreal stripe, sometimes fragmented; dark blotches under eyes and upper borders of mouth, alternating with goldy-white dots; supratympanic fold dark brown. Iris with the lower half orange-red and the upper golden yellow.

In alcohol the frogs are contrasting marbled, with black blotches and reticulations over a whitish gray background.

Vocalization. Two males were recorded while actively calling. Advertisement calls are soft "chips", with 1 or 2 notes (x=1.5, N=20) per call. Calls are given at irregular intervals with a low call repetition rate of 6.6-8.8 calls per minute (N=2). In the two- notes call, the first note is usually louder than second. No trills were heard. Simple calls and the first note of two-note calls are similar and single- pulsed. The dominant frequency ranges 2.9–4.2 kHz (x=3.4, N=16), the energy is usually concentrated in the first note (86.6% of sample), that is higher pitched (3.0–4.2 kHz) than second (2.4-3.3 kHz). Call duration: 18.5 ms–1.16 s. First note duration: 18.3–36.8 ms (x=27.1 ms, N=10); second note: 25.8–51.4 ms (x=37.7, N=10). Interval between notes: 827.6 ms–1.1 s (x=982.5 ms, N=10). Interval between calls: 5.5–10.6 s (x=7.7, N=9). Notes repetition rate: 1.7–2.3 (x=1.9) notes per second.

Single notes or the first note of two- note calls show an accentuated frequency modulation, usually beginning higher (3.5–4.3 kHz) and ending lower (2.9–3.1 kHz). Sometimes the second note is harsh (Fig 2A, second call), with a wider frequency band due to sidebands generated by the amplitude modulation nature of signal. In the first call (Fig. 2), the primary note has an inverted U-shaped pattern, while the second is ascendant modulated.

Types. Holotype. MNHNCu 867 (original field number LMD 365), an adult male, CUBA, Arroyo Bueno, La Melba (20(26'28" N, 74(48'48" W), Parque Nacional Alejandro de Humboldt, Holguín Province, collected and recorded by L. M. Díaz and A. Fong, 16.iv.2001. **Paratypes**. Males: MNHNCu 865, 866, 868, and 872; females: MNHNCu 869–871, and 873, with the same data as the holotype; male BSC. H 1228-1230, the same locality, coll. R. Teruel, 20.ix.1997.

Etymology. The Latin name *simulans* means "resembling", and refers to the external resemblance of this species to other known taxa (*E. planirostris* and *E. ricordi*).

Distribution. *Eleutherodactylus simulans* sp. nov, is known only from the type locality.

Table 1. Comparisons between selected parameters of two-note calls of three species of *Eleutherodactylus* (ms=milliseconds, s=seconds). See Discussion for call descriptions of *E. planirostris* and *E. ricordi*. Only ranges are provided, mean values are referred in the text.

Parameters	*E. simulans* sp. nov.	*E. planirostris*	*E. ricordi*
Call repetition rate (calls per minute)	6.6-8.8	15.2-47.3	38.8
Note repetition rate (notes per second)	1.7-2.3	21.2-33.6	19.7-36.5
Call duration (ms, s)	861.5 ms -1.2 s	63.9-94.3 ms	54.7–102.5 ms
Notes duration (ms)			
First note	18.3– 36.8	2.8-16.4	4.4-10.5
Second note	25.8–51.4	6.7-18.5	6.9-13.3
Interval between notes (ms, s)	827.6 ms -1.1 s	34.7–79.7 ms	47.9-88.8 ms

Natural history. Specimens of *Eleutherodactylus simulans* sp. nov, were collected along margins of Arroyo Bueno, a montane stream tributary of the Jaguaní River, that runs crossing the town of La Melba. Frogs were found active between 10:00 and 12:00 pm, over the leaflitter and inside holes of the stream-side talus. Males were heard calling from this habitat or hidden within grass clumps. Vegetation was primarily composed by *Syzigium jambos*, *Ficus* sp., *Carapa guianensis*, *Inga* sp., *Piper aduncum*, ferns (*Blechnum occidentale* and *Thelyptheris* sp.), and mosses. A single specimen (MNHNCu 868) was caught in the morning under a log near the stream. Specimens BSC. H 1228-1230 were collected in a house garden. The following invertebrates were identified in stomach and intestine contents of two specimens of *E. simulans* sp. nov: spiders (*Corinna* sp.), and ants (*Wasmannia auropunctata* and *Odontomachus* sp.). Other anurans calling with *E. simulans* sp. nov were *E. cuneatus, E. ionthus, Bufo taladai*, and *Osteopilus septentrionalis*. In the rain forest bordering Arroyo Bueno, we also collected *E. dimidiatus*, *E. gundlachi*, *E. limbatus*, *E. ricordi*, and *E. toa*.

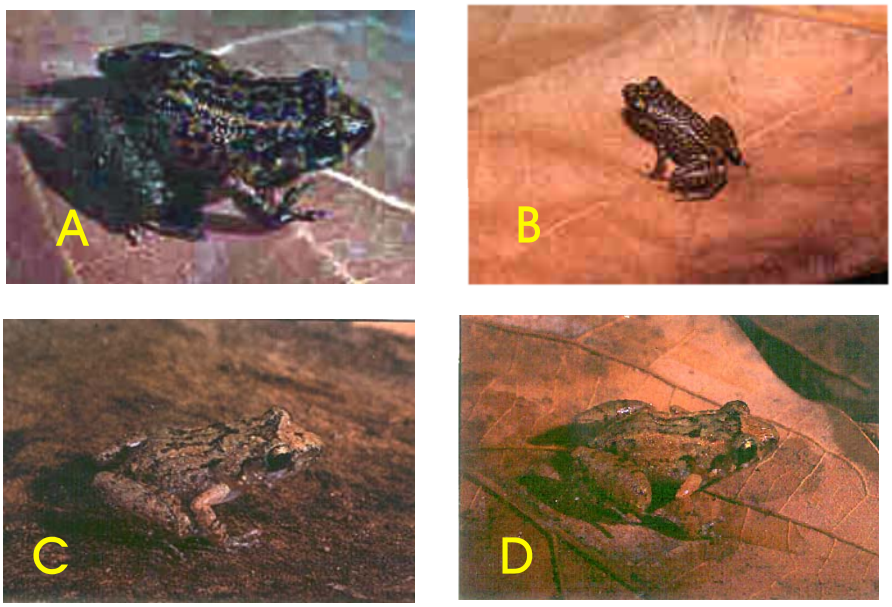

Fig. 1. A, *Eleutherodactylus simulans*, new species (female paratype MNHNCu 870, original field number LMD 370, SVL=22.00 mm); B, *Eleutherodactylus ricordi* (male LMD 346, SVL=22.95 mm); C, *Eleutherodactylus planirostris*, striped pattern (male LMD 372, SVL=18.80 mm); D, *Eleutherodactylus planirostris*, mottled pattern (male LMD 371, SVL= 20.65 mm). Photos A, C and D, by C. Tallet.

DISCUSSION

Eleutherodactylus simulans sp. nov. differs acoustically from *E. planirostris* and *E. ricordi.* The calls of *E. ricordi* have never been described, while those of *E. planirostris* were partially characterized by Estrada and Hedges (1997). For comparisons with *E. simulans*, we describe below the acoustic emissions of these two species, and in Table 1 we summarize the most striking differences between two- note calls of *E. planirostris*, *E. ricordi*, and *E. simulans* (sp. nov). We have not included *E. tonyi* in our comparisson, but call description of this "*planirostris*-like" frog was provided by Estrada and Hedges (1997).

E. ricordi has compound calls (Fig. 2B). Vocalizations are given sporadically or in a continuous sequence of 38.8 calls per minute (N=1) when frog is actively calling. Most frequently emitted calls have two notes and the total call duration ranges 54.7–102.5 ms

(x=82.7, N=21); the second note is longer (x=10.2 ms, range: 6.9–13.3 ms) than first (x=7.8 ms, range: 4.4–10.5 ms) in 81% of sample; the interval between notes ranges 47.9–88.8 ms (x=72.8 ms); notes repetition rate: 19.7–36.5 (x=25.4) notes per second. Single noted calls, having a duration of 7.7–8.0 ms (x=7.9 ms, N=3), may be uttered as introduction to more complex call sequences. Trills with 9–24 notes (x=15.5, N=4) may be intercalated between two or single- noted calls; the duration of such multinote calls ranged 505.2 ms–1.4 s; the trill notes repetition rate is 17.3–21.7 (x=18.8) notes per second. Generally, notes have ascendant frequency modulation or sometimes none. The dominant frequency ranges 2.4–3.9 kHz (x=3.1 kHz, N=10).

E. planirostris also has compound vocalizations (Fig. 2C), with alternated sequences of single noted calls, trills, and two-note calls. Most frequently uttered calls (15.2–47.3 calls per minute, N=2) has two notes and the total call duration ranges 63.9–94.3 ms (x=70.3 ms, N= 15); in 91% of calls measured, the second note is longer (x=13.5 ms, range 6.7–18.5 ms) than first (x=7.2, range 2.8–16.4 ms); the interval between notes is 34.7–79.7 ms (x=54.2 ms); the note repetition rate is 21.2–33.6 (x=29.1) notes per second. A trill of 13 notes and 1.1 s of duration is shown in Fig. 2C; the trill notes repetition rate is 12.7 notes per second. Notes vary in their frequency modulation pattern from no modulation, ascendant modulation (as first notes of trill in Fig. 2C), slightly descendant modulation, to an inverted U-shaped pattern (Fig. 2C). The dominant frequency ranges 1.9–3.5 kHz (x=2.6 kHz, N=15).

Trills have been reported as possible territorial calls in other species related to *E. planirostris* (Díaz and Estrada, 2000). We stimulated males of *E. simulans* sp. nov. in the field with call playbacks, and they never produced trills or other complex calls. However, two note calls were broadcasted more frequently during such experiments.

Eastern mottled frogs of the rock/cave ecomorph (*sensu* Hedges, 1989), such as *E. thomasi* and *E. bresslerae*, differ from *E. simulans* sp. nov by their larger size, distinct habitus, coloration and pattern, and more developed digital discs (see Schwartz, 1959; 1960, for original descriptions and illustrations of these species, and Schwartz and Henderson, 1991, for distribution maps).

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Table 2. Variation in some morphological measurements of *Eleutherodactylus simulans* sp. nov. First value is the mean; the range in parenthesis.

Characters	Males (N= 5)	Females (N= 4)	Holotype (Male)
Snout – vent length	16.7 (14.1–18.7)	22.7 (21.3-23.9)	17.5
Head width	5.8 (5.0-6.4)	8.6 (8.2-8.7)	6.4
Head length	6.1 (5.1-6.8)	8.7 (8.3-8.9)	6.4
Snout length	2.8 (2.2-3.1)	4.0 (3.7-4.3)	3.1
Upper eyelid width	1.2 (1.1-1.4)	1.5 (1.3-1.7)	1.4
Interorbital distance	1.7 (1.4-2.2)	2.4 (2.1-2.6)	1.6
Tympanum width	1.2 (0.9-1.5)	1.5 (1.4-1.7)	1.1
Tympanum heigth	1.3 (1.0-1.6)	1.7 (1.6-1.8)	1.4
Internarial distance	1.6 (1.4-1.8)	2.3 (2.1-2.3)	1.5
Thigh length	7.7 (6.5-8.3)	10.7 (10.4-11.0)	8.3
Shank length	7.9 (6.8-8.6)	10.8 (10.4-11.2)	8.4
Tarsal length	5.1 (4.4-5.5)	6.9 (6.4-8.0)	5.5
Foot length	7.8 (6.3-9.0)	10.4 (10.2-10.8)	8.6
Hand length	4.3 (3.3-4.7)	5.7 (5.1-6.1)	4.7
Eye – tympanum distance	0.5 (0.3-0.5)	0.6 (0.6-0.7)	0.5
Eye diameter	2.4 (2.2-2.5)	3.3 (3.1-3.5)	2.5
Eye – naris distance	1.6 (1.2-1.7)	2.4 (2.3-2.6)	1.6
Fingertip (III) width	0.5 (0.3-0.7)	0.8 (0.7-1.0)	0.6
Toetip (IV) width	0.6 (0.5-0.7)	0.7 (0.2-0.8)	0.6

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Appendix I. Specimens examined for comparisons.

Eleutherodactylus planirostris. **Pinar del Río**: MNHNCu 475, Pan de Guajaibón; MNHNCu 471, Sierra de Faustino, La Güira; MNHNCu 608, San Andrés; LMD 215, Sabanas Llanas, Alturas de Pizarras del Sur. **Ciudad de La Habana**: MNHNCu 468–469, interior garden of Capitolio Nacional, Centro Habana; LMD 373, 374, 377, and 378, garden of a house in Vedado. **Isla de la Juventud**: LMD 63, Sierra de Casas; MNHNCu 837 and 840, La Jungla de Jones. **Matanzas**: LMD 371–372, Cueva de la Pluma, Corral Nuevo. **Sancti Spiritus**: LMD 89, Topes de Collantes, Sierra del Escambray. **Holguín**: MNHNCu 684-686, 15 km SW Motel Pinares de Mayarí (325 m a.s.l); MNHNCu 750, Loma de la Mensura, Pinares de Mayarí. **Guantánamo**: MNHNCu 67, Playa Majiana, Baracoa; MNHNCu 644. **Granma**: MNHNCu 749, Camarón Grande; LMD 283, La Sierrita, B. Masó.

Eleutherodactylus ricordi. **Holguín**: LMD 341, sorroundings of Arroyo Bueno, La Melba; LMD 340, 346 and 347, Arroyo Prieto, La Melba. **Guantánamo**: MNHNCu 402-403, Monte Líbano, Meseta del Guaso; MNHNCu 400, Arroyón, San Antonio del Sur; LMD 29 and 34, Piedra La Vela, Ojito de Agua. **Santiago de Cuba**: MNHNCu 349, La Isabelica, Gran Piedra; MNHNCu 41, La Emajagua, Guamá, Sierra Maestra.

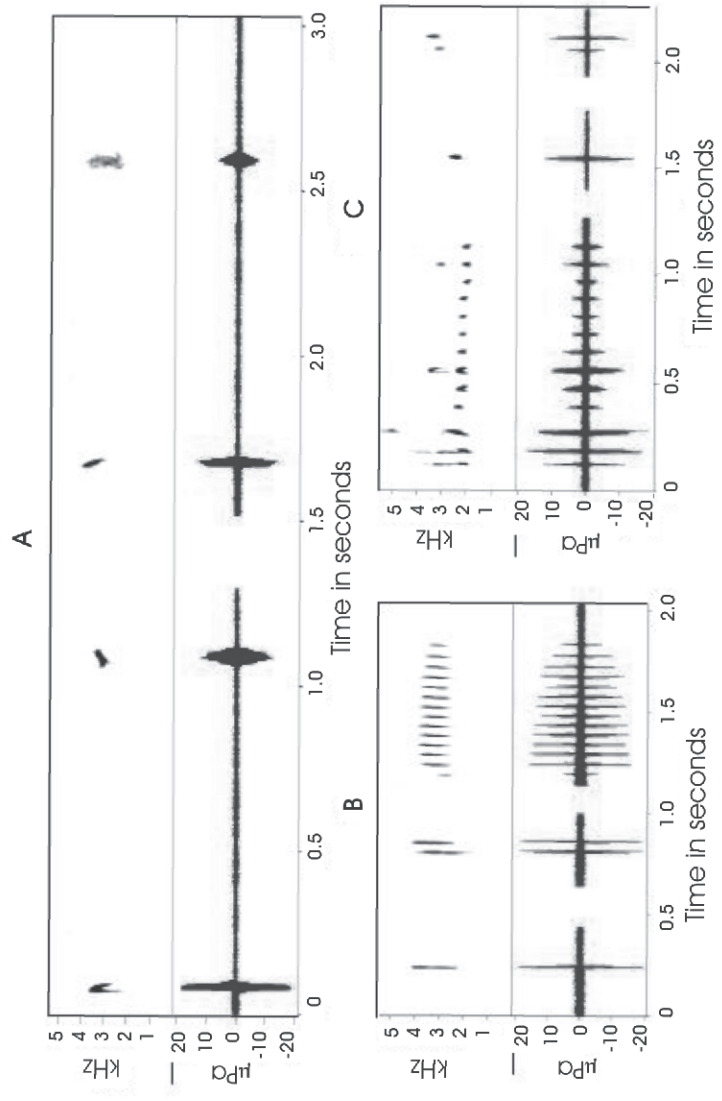

Fig. 2. Sonograms and oscillograms of three different frog calls. A, two-note calls of *Eleutherodactylus simulans*, sp. nov. (holotype, air temperature 19-20°C, 12: 30 am); B, three calls of *Eleutherodactylus ricordi* from sorroundings of Arroyo Bueno, La Melba, Holguín (voucher specimen LMD 341, air temperature 28°C, 12: 35 pm): (1) trill, (2) single-note call, and (3) two-notes call; C, *Eleutherodactylus planirostris* from Vedado, Ciudad de La Habana (voucher