

Another new cryptic frog related to *Eleutherodactylus varleyi* Dunn
(Amphibia: Anura: Eleutherodactylidae), from eastern Cuba

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ABSTRACT. A new cryptic frog, *Eleutherodactylus beguei* sp. nov., is described from the pine forests of La Muniación, Yateras, Guantánamo Province, Cuba. It is sympatric with *E. feichtingeri*, another recently described grass frog closely related to *E. varleyi*, but differs in morphology, vocalization and DNA sequences of the mitochondrial Cyt-b gene. One female of the new species was found vocalizing in response to a calling male, a behavior that is still poorly documented in anurans. Same male and female were found in axillary amplexus and surrounded by 9 eggs (3.5–3.7 mm in diameter) 5 hours after being isolated in a small container.

Key words: Amphibia, Anura, Eleutherodactylidae, *Eleutherodactylus*, new species, Terrarana, *Euhyas*, West Indies, Guantánamo, female reciprocation calls, eggs.

INTRODUCTION

After a recent review of the geographic variation of the Cuban Grass Frog *Eleutherodactylus varleyi* Dunn, Díaz *et al.* (2012) described *E. feichtingeri*, a cryptic species widely distributed in central and eastern Cuba. The two species differ primarily in tympanum size, supratympanic stripe pattern, and advertisement calls. Species recognition was also supported by genetic and cytogenetic data. One of the authors (SBH) conducted DNA sequence analyses that confirmed the existence of two species at La Muniación, Humboldt National Park. One species is *E. feichtingeri* and the other is a new species that we describe here. Subsequently, in the summer of 2011, LMD collected additional specimens of the new taxon, made recording of vocalizations, and obtained data on ecology and behavior.

MATERIALS AND METHODS

Morphological and bioacoustical measurements were taken as mentioned in Díaz *et al.* (2012). Advertisement and reciprocation calls were defined following Duellman and Trueb (1986). A portion (~800 bp) of the cytochrome b (Cyt-b) mitochondrial gene was sequenced for four species and all molecular methods were identical to those in our previous study (Díaz *et al.*, 2012). Calls were recorded with a Marantz PMD 661 digital sound recorder and a Sennheiser ME 66 microphone. Acoustic signals were digitized at 44 kHz and a sample size of 16 bits.

Bioacoustic analysis was performed with the software BatSound 5.1 (Pettersson Elektronik AB, © 1996–1999). Physical environmental parameters were measured with a Kestrel 3500 Pocket Weather Meter.

The following abbreviations are used: SVL, snout-vent length; MNHNCu, Museo Nacional de Historia Natural de Cuba; MCZ, Museum of Comparative Zoology at Harvard University; AMNH, American Museum of Natural History; LMD, field number series of Luis M. Díaz (specimens deposited in the MNHNCu); SBH, field number series of S. Blair Hedges; CZACC, zoological collection of the Instituto de Ecología y Sistemática, La Habana; BSC.H, herpetological collection of BIOECO (Centro Oriental de Ecosistemas y Biodiversidad), Museo de Historia Natural Tomás Romay, Santiago de Cuba; MFP, Museo Felipe Poej, Facultad de Biología, Universidad de La Habana. Specimens for comparisons are listed in Appendix I.

Eleutherodactylus beguei sp. nov.

Fig. 1A, B

Diagnosis. A very small species of the *Eleutherodactylus gundlachi* species group, *Eleutherodactylus planirostris* species series, and subgenus *Eulybas* (Hedges *et al.* 2008). Males reach 14.2 mm SVL, and the only known female is 15.2 mm SVL. The other members of the species group include *E. feichtingeri*, *E. intermedius*, *E. tetajulia*, and *E. varleyi*. *Eleutherodactylus beguei* sp. nov. is not as robust, stocky, and large-headed as *E. intermedius* and *E. tetajulia*, but tends to have the head as longer as wide (average HL = HW), compared with the more gracile species *E. feichtingeri* and *E. varleyi* (average HL > HW). However, it shares pointed digital tips with the two stocky species (tips rounded in the two gracile species). *Eleutherodactylus intermedius* and *E. tetajulia* also differs from *E. beguei* sp. nov. in having conspicuously reticulated throats, bellies and legs. *Eleutherodactylus beguei* sp. nov. has a very swollen and subtriangular musculus submentalialis, which is inconspicuous and flat in the stocky species (*E. intermedius* and *E. tetajulia*).

Eleutherodactylus beguei sp. nov. is very similar to *E. feichtingeri* and *E. varleyi* by sharing: (1) small size; (2) pale belly and ventral surface of legs; (3) partially areolate venter; (4) dorsolateral rows of enlarged tubercles; (5) a black stripe crossing the supratympanic fold, surrounding a lower highlighted glandular area; (6) small digital discs; and (7) accentuated polychromatism. It differs from *E. feichtingeri* by having: (1) a smaller adult size (15.2 *versus* 17.4 mm SVL in *E. feichtingeri*); (2) larger tympanum (17–34% of head length in *E. beguei* sp. nov. vs. 8–15% in *E. feichtingeri*); (3) reduced vocal sac when fully distended (*vs.* a large, hemispherical vocal sac distended onto belly in *E. feichtingeri*); and (4) distinct vocalizations typically consisting of one-note chirp calls with an inverted V-shaped frequency pattern of modulation (*versus* a metallic call, with steeply ascending frequency, in *E. feichtingeri*). *Eleutherodactylus beguei* sp. nov. is more similar to *E. varleyi* (nearest known population of this species is ~300 km in straight-line) in the tympanum size, but differs from it by having: (1) a shorter distance between vomerine odontophores and the tip of snout (22–25% of head length in *E. beguei* sp. nov. and 28–32% in *E. varleyi*) and, when mouth is open, head in *E. beguei* sp. nov. looks more rounded than in *E. varleyi* (Fig. 2); (2) a very small vocal pouch during call emissions (*vs.* a well-evident hemispherical vocal sac in *E. varleyi*), that does not fold the gular area when deflated (*versus* folds the gular area in males of *E. varleyi*; Fig. 3); and (3) different one-note advertisement calls (*versus* usually two notes in *E. varleyi*).

Description. Head as wide as long, its length 91–100% (\bar{x} =98%) of SVL; snout subacuminate in dorsal view and in profile, slightly overlapping the lower jaw; snout length 34–42% (\bar{x} =38%) of head length; nostrils suboval, not protuberant, directed laterally, and separated by a distance equivalent to 21–24% (\bar{x} =23%) of head width; canthus rostralis straight in dorsal view, and rounded in profile; loreal region gradually sloping to the labial border; lips not flared; interorbital distance 1.2–1.8 (\bar{x} =1.5) times the upper eyelid width, without enlarged tubercles; eyelid skin with few small granules; loreal area smooth; tympanum superficial, rounded, with distinct annulus, 43–59% (\bar{x} =52%) of eye diameter, separated from

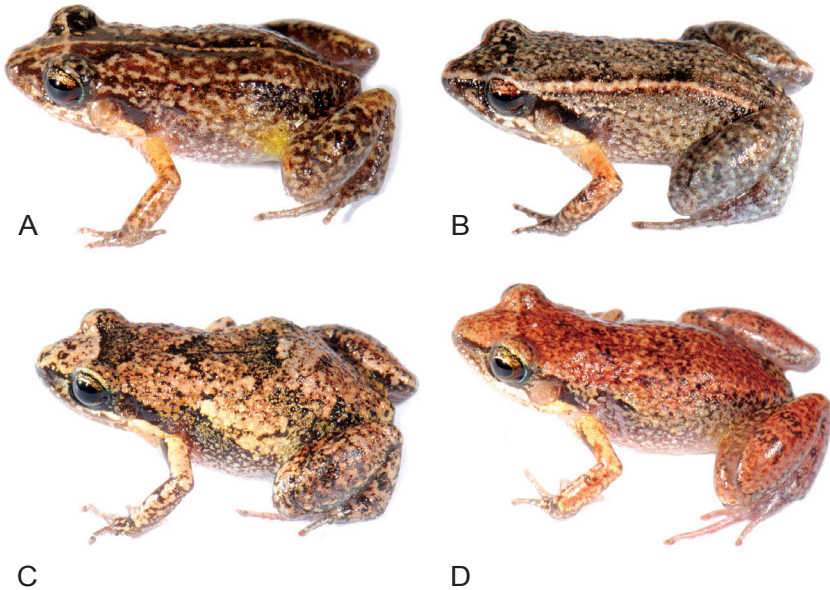


Fig.1. Three related species of Cuban frogs of the genus *Eleutherodactylus*. A-B: *E. bognei* sp. nov. ; (A) adult male (paratype MNHNCu 1265) with a marbled pattern; (B) adult male (paratype MNHNCu 1262) with striped pattern. (C) *E. feichtingeri* (adult male MNHNCu 1280), from La Muniación, Yateras, Guantánamo Province. (D) *E. varleyi* (MNHNCu 1230), from the vicinity of Paso de Lesca, Sierra de Cubitas, Camagüey Province. Photos: Luis M. Díaz.



Fig.2. Distance between vomerine odontophores and the snout tip in: (A) *E. varleyi* (male LMD 251) adult male from Jardín Botánico de Soledad, Cienfuegos; and (B) *E. beguei* sp. nov. (paratype male MNHNCu 1263).

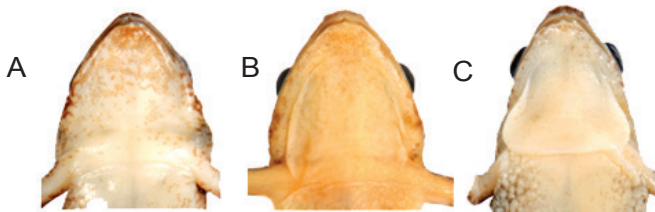


Fig.3. Degree of gular folding as a result of the vocal sac development in males of three closely related Cuban frogs. (A) *E. beguei* sp. nov. (paratype male MNHNCu 1266). (B) *E. varleyi* (male LMD 241), from Jardín Botánico de Cienfuegos. (C) *E. feichtingeri* (male MNHNCu 1280), from La Municipión, Yateras. Photos: Luis M. Díaz.



Fig. 4. Two conditions in the shape of digital discs. (A) *E. beguei* sp. nov. (paratype male MNHNCu 1264), with pointed discs. (B) *E. feichtingeri* (male MNHNCu 1280), with rounded discs. Both photographs were taken of live individuals. Photos: Luis M. Díaz.

eye by a distance equivalent to 0.2–0.7 ($\bar{x}=0.4$) times its own diameter; supratympanic fold distinct; 1 to 6 large postrictal tubercles with glandular features and, when numerous, often one is very enlarged; choanae equivalent in size to the third finger disc diameter, oval, partially overlapped by palatal shelf of the maxillary arch; vomerine odontophores moderate in size, slightly arched, separated from each other by a distance equivalent to 15% of their length, surpassing (in 67% of sample) or not the external margins of choanae; tongue suboval, its posterior half not adherent to floor of mouth; external vocal sac of males very small.

Dorsal skin with granules and tubercles, many of which are arranged in dorsolateral rows. Flanks areolate. Supraxillary, postfemoral, and inguinal glands present, but variably evident; inguinal glands round shaped, and commonly highlighted in yellow. Venter partially areolate, except on chest and throat; anal opening not extended in sheath; inner part of thigh areolate. Palmar tubercle oval, smooth, 1.5 to 2 times longer than thenar tubercle; supernumerary palmar tubercles scarce and enlarged; subarticular tubercles of fingers oval, not very prominent, and rounded in profile. Finger length order: III > IV > II > I; digital discs small, pointed; the third finger disc diameter 16–31% ($\bar{x}=25\%$) of tympanum width; discs are larger in the two outer fingers than on inner ones. Heels without enlarged tubercles; inner metatarsal tubercle narrow and smooth, the same length or 1.4 times longer than the slightly conical outer metatarsal tubercle; supernumerary tubercles flat, scarce, and inconspicuous; subarticular tubercles oval to slightly conical, moderately projected in profile. Toes without defined lateral ridges or basal webbing; circumferential groove bordering the distal half of toe pad; heels touching or barely overlapping each other when flexed legs are held at right angles to sagittal plane; toes length order: IV > III > V > II > I. Hand length 18–21% ($\bar{x}=19\%$) of SVL; foot length 38–41% ($\bar{x}=40\%$) of SVL; thigh length 35–42% ($\bar{x}=39\%$) of SVL; shank length 40–45% ($\bar{x}=43\%$) of SVL; tarsal length 26–28% ($\bar{x}=27\%$) of SVL. Measurements are summarized in Table 1.

Color in alcohol: Overall coloration turns gray to gray-brown. All yellow, green, and red pigments disappeared, but patterns remain.

Color in life: Overall coloration gray-brown to reddish brown, sometimes with a greenish cast. Most individuals (MNHNCu 1263–65, 1269) have small vermiculations or marbling on head, dorsum and hind legs. A dark brown sacral area is usually evident, as well as a dark supra-scapular chevron. Groins yellow. Forearms with a yellowish tone. Some frogs (MNHNCu 1262, 1266–68) with cream to slightly orange dorsolateral stripes. One individual with two wide paravertebral pale stripes. Supratympanic stripe black, having a sharp contrast with an underlying, and conspicuous, pale zone. Two enlarged, somewhat diffuse, dark suprainguinal patches. Legs with fragmented or vaguely evident bands.

Advertisement calls (Fig. 5A). The call of *Eleutherodactylus beguei* sp. nov. typically consists of a short, one-note, call (65% of all sampled calls) that sounds like a chirp. Less frequently, it is a two-note (31%) or three- or four-note call (4%). Three males were recorded and their vocalizations were analyzed. One-note calls commonly increase and decrease sharply in frequency (inverted V). Calls are uttered at a low rate (3–7 calls/minute) with a duration of 19–26 milliseconds ($\bar{x}=22$, $n=30$). In each call, the maximum amplitude is gradually reached in 6–13 milliseconds ($\bar{x}=10$ milliseconds), which is normally the middle part (31–59%) of each signal. The interval between calls is 12.7–21.1 seconds ($\bar{x}=17.7$ seconds, $n=30$) and the dominant frequency is 3.5–3.9 kHz ($\bar{x}=3.7$ kHz, $n=30$). In the two-note calls ($n=9$), the first note has a duration of 22–28 milliseconds ($\bar{x}=25$), and the second one 19–30 milliseconds ($\bar{x}=24$). The note interval is 222–1146 milliseconds ($\bar{x}=623$ milliseconds). The first note

Table 1. Morphological measurements (mm) of *Eleutherodactylus beguei* sp. nov., *E. feichtingeri*, and *E. varleyi*. Values are means and ranges (in parentheses).

	<i>E. beguei</i> n. sp.			<i>E. feichtingeri</i>	<i>E. varleyi</i>
	Males N=8	Female N=1	Holotype	Males N=40	Males N=40
Snout-vent length	13.1 (12.3–14.2)	15.2	13.0	14.7 (13.3–17.4)	14.1 (12.2–18.5)
Head length	4.8 (4.5–5.5)	5.3	4.8	5.2 (4.6–5.9)	5.4 (4.6–7.0)
Head width	4.8 (4.7–5.0)	5.3	4.8	4.9 (4.4–5.8)	5.1 (4.2–6.6)
Snout length	1.8 (1.6–2.0)	2.1	2.0	2.1 (1.8–3.0)	2.1 (1.8–3.0)
Upper eyelid width	1.0 (0.9–1.2)	1.2	1.0	0.9 (0.8–1.2)	1.1 (0.8–1.4)
Interocular distance	1.4 (1.3–1.5)	1.5	1.3	1.7 (1.3–2.1)	1.5 (1.2–2.4)
Internarial distance	1.1 (1.0–1.2)	1.2	1.1	1.2 (1.0–1.5)	1.2 (1.0–1.5)
Tympanum width	0.9 (0.8–1.0)	1.8	0.9	0.6 (0.4–0.7)	1.1 (0.8–1.7)
Tympanum height	0.9 (0.8–1.2)	1.1	0.9	0.7 (0.3–1.0)	1.2 (1.0–1.6)
Thigh length	5.1 (4.5–5.5)	5.9	5.4	5.6 (4.7–6.5)	5.8 (4.7–7.5)
Shank length	5.6 (5.3–5.8)	6.4	5.5	5.9 (4.9–7.0)	6.1 (5.5–8.3)
Tarsal length	3.6 (3.3–3.8)	4.0	3.6	3.8 (3.1–4.6)	4.0 (3.4–5.0)
Foot length	5.3 (4.7–5.7)	6.2	5.1	5.9 (4.7–7.3)	5.9 (5.1–8.3)
Hand length	2.6 (2.3–2.8)	3.0	2.4	2.8 (2.3–3.5)	3.0 (2.3–3.9)
Eye-tympanum distance	0.4 (0.3–0.5)	0.4	0.3	0.4 (0.3–0.6)	0.4 (0.1–0.7)
Eye diameter	1.8 (1.6–1.9)	1.9	1.8	1.8 (1.6–2.1)	1.8 (1.4–2.8)
Eye-naris distance	1.1 (1.0–1.3)	1.4	1.3	1.2 (1.0–1.5)	1.4 (1.1–2.0)
Finger disc (III) width	0.2 (0.1–0.3)	0.2	0.1	0.3 (0.2–0.4)	0.3 (0.2–0.4)
Toe disc (IV) width	0.2 (0.1–0.3)	0.3	0.2	0.4 (0.3–0.5)	0.4 (0.2–0.5)

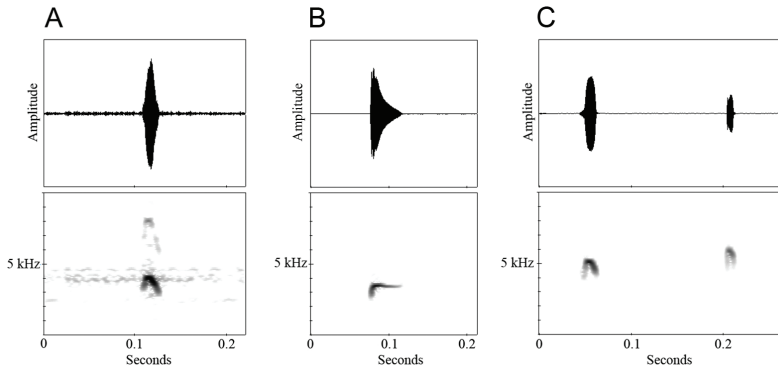
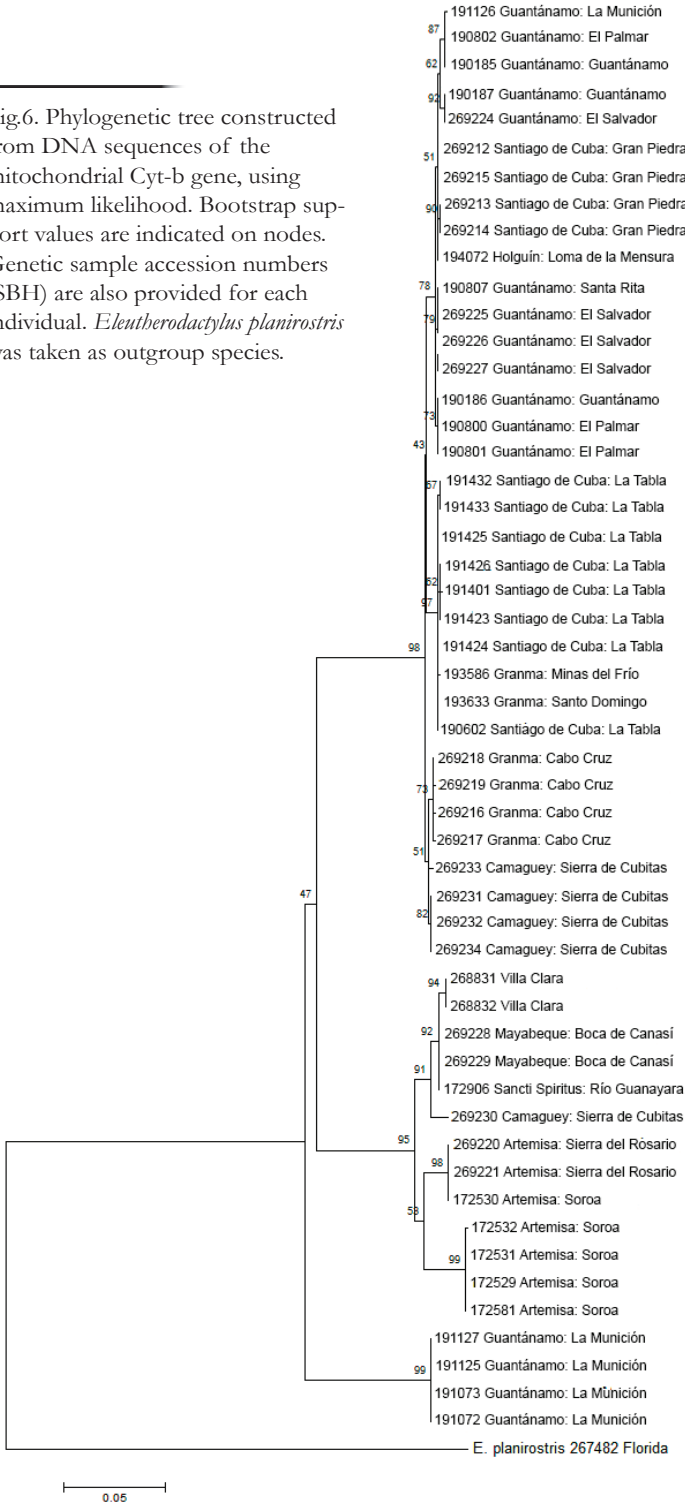


Fig. 5. Oscillograms (above) and sonograms (below) of the most-frequently produced advertisement calls of three closely related species. Sonograms were generated with a Fast Fourier transform (FFT) of 512 points, using Hanning windows. (A) Single note call of *Eleutherodactylus beguei* sp. nov., type locality, air temperature 23°C. (B) *E. feichtingeri*, Gran Piedra, Santiago de Cuba, 20.6°C. (C) *E. varleyi*, Jardín Botánico Nacional, La Habana, 21.4°C.

Fig.6. Phylogenetic tree constructed from DNA sequences of the mitochondrial Cyt-b gene, using maximum likelihood. Bootstrap support values are indicated on nodes. Genetic sample accession numbers (SBH) are also provided for each individual. *Eleutherodactylus planirostris* was taken as outgroup species.



E. feichtingeri

E. varleyi

E. beguei n. sp.

dominant frequency is 3.2–5.1 kHz (\bar{x} =3.8 kHz) and the second note dominant frequency is 3.5–4.4 kHz (\bar{x} = 3.7 kHz). The two-note calls also have an inverted V-shape or decline in frequency. Calls were recorded at a temperature of 23–24°C and relative humidity of 85%.

Molecular phylogeny. The tree obtained from the Cyt-b sequences (Fig. 6) shows that *E. beguei* sp. nov. *Eleutherodactylus feichtingeri* and *E. varleyi* form three different clades that support the genetic recognition of the new species.

Holotype. MNHNCu 1261, adult male from the pine forests of La Muniación (20°24'06"N, 75°02'14"W), Humboldt National Park, Municipality of Yateras, Guantánamo Province, 678 m, collected 24 July 2011 by Luis M. Díaz and Gerardo Begué.

Paratypes. Paratopotype males (n=7): MNHNCu 1262–1268; female (n=1): MNHNCu 1269. Collected 24–26 July 2011, by the same collectors. SBH 191127, 2 km north of La Muniación, Municipality of Yateras, Guantánamo Province, 730 m, collected 22 June 1990 by S. Blair Hedges.

Distribution. *Eleutherodactylus beguei* sp. nov. is only known from the vicinity of La Muniación, in the southwestern limit of the Humboldt National Park, Municipality of Yateras, Guantánamo Province, Cuba, but it may have a wider distribution on the Meseta del Guaso and elsewhere.



Fig. 7. Distribution map of *Eleutherodactylus varleyi* (triangles), *E. feichtingeri* (circles), and *E. beguei* sp. nov. (star).

Etymology. We take pleasure in naming this new species after Gerardo Begué Quiala, one of the most outstanding specialists on the biodiversity of the Humboldt National Park and longtime enthusiastic collaborator.

Natural History. The type-locality of *E. beguei* sp. nov. is in a region of pine (*Pinus caribaea*) forests (Fig. 8). Males were found sporadically calling from 2200 to 0300 hours in each of the two collecting nights (24–26 July 2011). Vocalizing individuals were located: (1) on the ground, (2) on horizontal leaf of a small bush about 30 cm above ground (Fig. 8A), (3) 1.2 m height in the forked branch of a small bush, (4) on a fallen trunk about 5 cm in diameter (Fig. 8B), and (5) hidden among dense pine needles of fallen branches. Once we obtained recordings of the male's calls, other males were easily located because they responded to playbacks. A gravid female (MNHNCu 1269) was found about 25 cm from a calling male (MNHNCu 1263) on the ground, as she emitted soft reciprocation chirping calls (Fig. 9). Only one female call was recorded with adequate quality for analysis: duration 16 milliseconds; dominant frequency 2.9 kHz. The female

call has two well-defined harmonics (at 5.9 and 8.9 kHz), and is similar to male calls in having the inverted V-shaped frequency pattern. Male and female were placed in a collecting container and five hours later they were found in axillary amplexus and surrounded by 9 ivory white eggs (lot MNHNCu 1270) of 3.5–3.7 mm in diameter (Fig. 8C). One fully yolked egg remained inside the female, preserved before laying it, giving a clutch size of 10 for that individual.

DISCUSSION

The discovery of *E. beguei* sp. nov. increases to six the number of species within the *E. gundlachi* species group (*sensu* Hedges *et al.*, 2008). However, recent evidences (SBH in preparation) suggest changes in the former classification, because *E. gundlachi* is actually related to the *E. luteolus* species group. Therefore, the recognition of an *E. varleyi* species group is valid to include *E. beguei* sp. nov., *E. feichtingeri*, *E. varleyi*, *E. intermedius* and *E. tetajulia* based on the available genetic and/or morphological data. Rodríguez *et al.* (2011) stated that *E. adelus*, another grass frog previously placed in the *E. gundlachi* species group based on shared morphological traits with *E. varleyi*, is genetically close to *E. pezopectrus*, a big rock-dwelling frog and the only member of the *E. pezopectrus* species group following the classification of Hedges *et al.* (2008). Very divergent morphologies have evolved among phylogenetically related species, or convergences occur between more distant lineages. This situation made the taxonomy of this genus very confused until recent reviews using DNA sequences (Hedges *et al.*, 2008). But even with the most advanced tools, methodological mistakes yield contradictory results.

There are characters other than those mentioned in the diagnosis of *Eleutherodactylus beguei* sp. nov. that show interesting tendencies but overlap among species or are difficult to measure in a useful way. For example, post-femoral glands tend to be more conspicuously swollen and highlighted in coloration in *E. varleyi* than in *E. beguei* sp. nov., in which they are only vaguely evident. The marbling pattern of *E. beguei* sp. nov. (Fig. 1) has not been observed to be as accentuated in any known population of *E. varleyi* or *E. feichtingeri*. *Eleutherodactylus feichtingeri* and *E. varleyi* have a black bar running along the inner side of arms, but this pattern is usually less conspicuous, fragmented, or even absent in *E. beguei* sp. nov. Besides the herein showed photographs of *E. beguei* sp. nov., a color photo of this species already was published as "*Eleutherodactylus varleyi*" (Hedges *et al.*, 2008: fig. 68).

Vocalizations of *Eleutherodactylus beguei* sp. nov. are clearly different from those of *E. varleyi* and *E. feichtingeri* (see Díaz *et al.*, 2012). Calls of *E. beguei* sp. nov. are somewhat similar to those of other distantly related species of the subgenus *Enhyas*, such as *E. zugi* and *E. klinikowskii* (see Díaz and Cádiz, 2008). Sonograms and bioacoustical data of the advertisement calls of *E. feichtingeri* and *E. varleyi* (see Fig. 5B and C) have been used repeatedly to differentiate among species by Díaz *et al.* (2003; 2012) and Díaz and Cádiz (2008). A direct reference to species sound recordings is available in Díaz and Cádiz (2008). We were unable to measure call intensity in the field but, definitely, the typical single-noted advertisement calls of *E. feichtingeri* are distinctively louder and metallic, and can be heard from a greater distance (more than 50 meters), than the soft calls of *E. beguei* sp. nov., which are difficult to hear from 10 meters. During observations in the wild, *E. feichtingeri* at La Muniçión was calling at a very higher rate (in the range of 21–42 calls per minute; Díaz *et al.*, 2003, 2012) than *E. beguei* sp. nov., under the same weather conditions. This represents a substantial difference between the species, especially as data for both were collected during breeding activity. Additionally, there is a strong tendency in *E. feichtingeri* to reach maximum call amplitude at the beginning of

each signal (first 7–50%, $x=16.6\%$; Díaz *et al.*, 2012), whereas in *E. beguei* sp. nov. that point is attained at 31–59% ($x=49\%$) of call duration. *Eleutherodactylus varleyi* also has a higher call rate (17–35 calls per minute; Díaz *et al.*, 2003) than *E. beguei* sp. nov. In the typical two-note calls of *E. varleyi*, notes are spaced at 118–217 millisecond intervals (Díaz *et al.*, 2003), whereas in the less-frequently emitted two-note calls of *E. beguei* sp. nov. this interval is two to five times longer. Dominant frequency of calls is similar in *E. beguei* and *E. feichtingeri*, but emissions tend to be higher pitched in *E. varleyi* (mean values usually 4.5 to 5.6 kHz in most populations; Díaz *et al.*, 2003, 2012; Cádiz, 2008). Our findings of vocal variation are not likely to be influenced by temperature differences, because we recorded most calls of *E. beguei* sp. nov., *E. feichtingeri* and *E. varleyi* within a similar thermal range.

Estrada (1987) and Díaz *et al.* (2003) reported clutch sizes of 3 and 4 eggs for *Eleutherodactylus varleyi* and *E. adelus*, respectively. Small clutch sizes, of 5–6 eggs, were also reported by Estrada (1992) and Estrada and Hedges (1996) for *E. intermedius* and *E. tetajulia*. However, the clutch size of *E. beguei* sp. nov. exceeds this number, which is quite unexpected considering the small size of the adult female and the diameter of eggs. The female's call before ovoposition is quite unusual in anurans, and was first reported for Cuban species in *E. guanahacabibes* (Díaz and Estrada, 2000). This behavior might be widespread in other *Euhyas*.

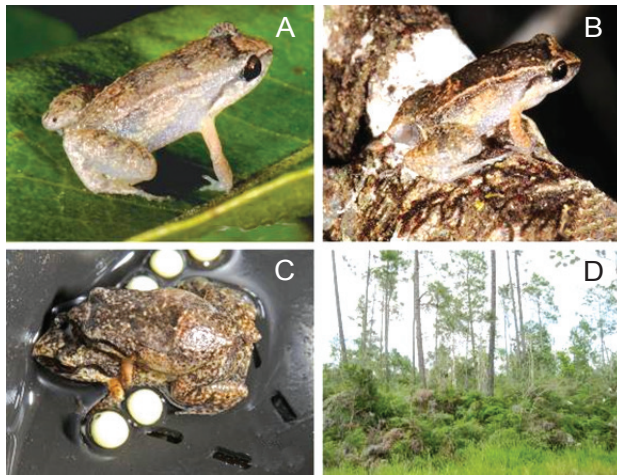


Fig.8. *Eleutherodactylus beguei* sp. nov. (A) Paratype male MNHNCu 1268, perching on horizontal leaf from which it was calling. (B) Paratype male MNHNCu 1267, calling from the bifurcation of a fallen branch. (C) Amplexing pair inside a small transporting container (paratype male MNHNCu 1263 and female MNHNCu 1269) with just-laid eggs. (D) Pine forest, with ferns, shrubs and grasses, at the type locality in La Muniación, Yateras, Guantánamo, Cuba.

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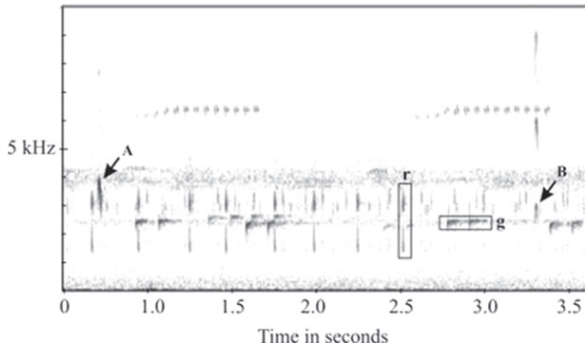


Fig.9. Male advertisement call (A) and female reciprocation call (B) of *Eleutherodactylus beguei* sp. nov. Advertisement calls of sympatric arboreal *Eleutherodactylus* also appear in the sonogram: *E. ronaldi* (r) and *E. guant-anamera* (g).

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APPENDIX I. Specimens examined for comparisons

Eleutherodactylus varleyi (N=119).— **Pinar del Río Province**: LMD 231, 232, 240–245, Loma del Espejo, Alturas de Pizarras del Sur, km 41 Carretera de Luis Lazo; MNHNCu 613, Cueva Cheta, Majagua Canteras; LMD 432, Mil Cumbres, Sierra del Rosario; AMNH 59834, 4.4 mi NW San Vicente; AMNH 61937–44, 5.6 mi NW San Vicente. **Artemisa Province**: MNHNCu 1233–1234, and MFP 11521–11523, Estación Ecológica Las Terrazas, Sierra del Rosario; MNHNCu 1239, Río Bayate, Reserva de la Biosfera Sierra del Rosario, Sierra del Rosario. MNHNCu 1235–1236, Campismo La Chorrera, Artemisa. **La Habana Province**: CZACC jar 309 (a single specimen without number), Atabey, Playa. **Mayabeque Province**: MNHNCu 250, Madruga; LMD 276–278, Peñas Blancas; MNHNCu 1237–1238, Boca de Canasí, Santa Cruz del Norte. **Isla de la Juventud**: CZACC jar 311 (18 specimens without individual numbers), Hotel Colony, Siguanea; AMNH 63292–63308, Nueva Gerona. **Villa Clara Province**: LMD 247–248, Placetás; AMNH 61950, 8 mi S Manicaragua; MNHNCu 1235–1236, Cayo Alto, Reserva Ecológica Sabanas de Santa Clara. **Cienfuegos Province**: LMD 251–269, Jardín Botánico de Cienfuegos; MCZ 10601 (Holotype), Soledad (=Jardín Botánico de Cienfuegos); AMNH 92430–92453, Soledad (=Jardín Botánico de Cienfuegos). **Camagüey Province**: MNHNCu 1230–1232, Paso de Lesca, Sierra de Cubitas.

Eleutherodactylus feichtingeri (N= 75).— **Camagüey Province**: MNHNCu 1181 (Holotype)–1189, Paso de Lesca, Sierra de Cubitas, Cubitas. **Sancti Spiritus Province**: MNHNCu 1212, surroundings of Hotel Zaza, Río Zaza. **Granma Province**: MNHNCu 1194–1211, Marea de Limones, Niquero, Cabo Cruz; BSC.H 659, 2 km W de Los Muertos, Alegría de Pío, Niquero. **Santiago de Cuba Province**: MNHNCu 1213–1217, Gran Piedra, Sierra Maestra; MNHNCu 1218–1219, surroundings of Santiago de Cuba airport; BSC.H 2476–2480, La Tabla, Tercer Frente; BSC.H 3176, surroundings of Paso la Mina, 4.5 km S of Cruce de los Baños, Tercer Frente; BSC.H 2671–2674, gardens of Hotel Sierramar, Sevilla, Guamá; BSC.H 2342–2345, El Olimpo, 4km WNW of Gran Piedra; BSC.H 3156–3157, Providencia, 13.5 km WSW from El Caney, Santiago de Cuba; BSC.H 3271, 1.2 km NNW of Nuevo Mundo, main road to La Caoba, San Luis. **Guantánamo Province**: MNHNCu 1220–1226, City of Guantánamo, crossroad to El Salvador; MNHNCu 330, Arroyón, San Antonio del Sur; MNHNCu 1227–1229, San Rafael; MNHNCu 1280, La Municipación, Yateras; MNHNCu 1281, La Máquina, Maisí.