

**Catalogue of American Amphibians
and Reptiles 912**

Vargas-Salinas, F., A. M. Ospina-L., J. A. Rios-Soto,
and M. Rivera-Correa. 2017. *Centrolene savagei*.

***Centrolene savagei*
(Ruiz-Carranza and Lynch)
Savage's Cochran Frog**

Cochranella savagei Ruiz-Carranza and Lynch
1991:8. Type locality: [Colombia,] "De-
partamento del Quindío, municipio de
Filandia, vereda El Roble, bosque Reser-
va Bremen, vertiente occidental, Cordil-
lera Central, 4° 39' Latitud N, 75° 40' W
de Greenwich, 2050 m." Holotype, Museo
de Historia Natural, Universidad Nacion-
al de Colombia, Bogotá, ICN 9769, adult
female, collected by P. M. Ruiz-Carranza
on 3 June 1981.

Centrolene savagei: Guayasamin, Castrovie-
jo-Fisher, Trueb, Ayarzagüena, Rada, and
Vilà 2009:26.

CONTENT. No subspecies are recognized.

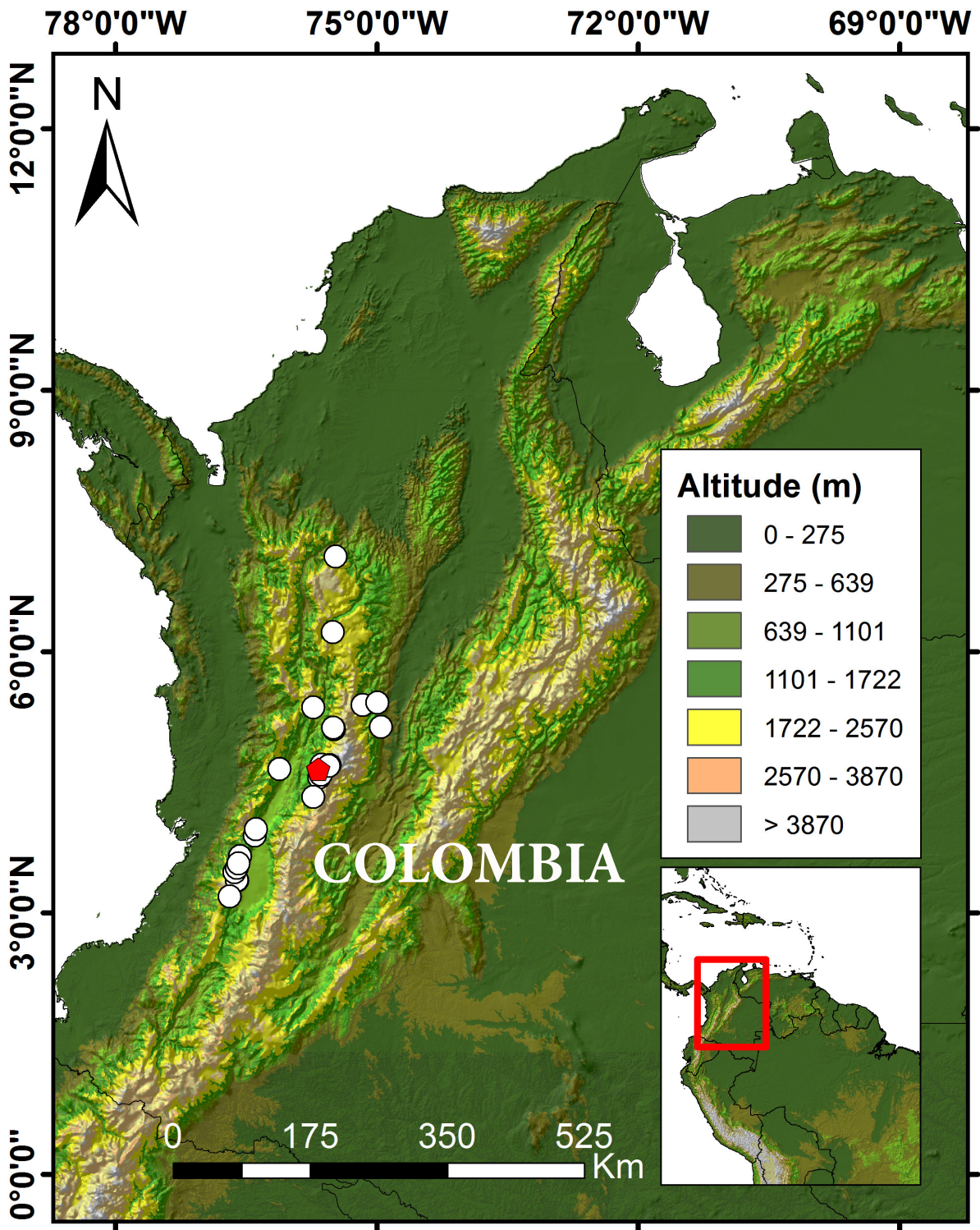
DEFINITION. Individuals of this small glass
frog species exhibit a body size (snout-vent
length, SVL) between 19.0 and 24.2 mm with
adult males smaller than adult females (mean
SVL \pm standard deviation [SD] for 90 males:
21.6 \pm 1.2 mm, range: 19.0–24.2 mm; mean
SVL \pm SD for six females: 24.09 \pm 1.11 mm,
range: 23.3–26.3 mm) (Ruiz-Carranza and
Lynch 1991; Vargas-Salinas et al. 2007; Var-
gas-Salinas et al. 2014; unpublished data). The
following description is based on 17 individ-
uals (two males, 15 females): head wider than
larger and as wide as the body; head width
is 31.0–37.3% of the SVL (mean: 34.2%, SD:
1.747). Head with a short face, rounded in
both dorsal and lateral views; the distance
between eye and nostril is 66.7–95.0% of the
anteroposterior diameter of the eye; loreal
region is straight and widening toward the
superior lip. Nostrils prominent with elipti-



FIGURE 1. Male of *Centrolene savagei* from La
Reserva Nacional Forestal Bosque de Yotoco, in
the municipality of Yotoco, department of Valle
del Cauca, Colombia. Photo by Fernando Var-
gas-Salinas.

cal external apertures; no depression present
between nostrils. Canthus rostralis undefined
and concave; small eyes directed anterolater-
ally with an angle of 45 degrees. Eyes do not
protrude to the labial edges from a ventral
perspective. Anteroposterior diameter of the
eye is equivalent to 26–36% of the cephalic
length (mean: 31%, SD: 2.272); width of the
superior eyelids 33–50% of the distance be-
tween the eyes (mean: 45%, SD: 4.969). The
tympanic membrane is large and conspicu-
ous, with the supratympanic fold hiding the
posterior margin of the tympanic ring; the
diameter of tympanic ring is 54–76% of the
ocular diameter (mean: 60%, SD: 6.337). The
medial vocal sac is external and subgular.

A humeral spine is absent; the forearm is
thin with a dermal fold and row of tubercles
extending until the outer margin of Finger IV.
The distal edge of the finger discs are trun-
cate. Fingers I and II are of equal length. Web-
bing is absent between Fingers I and II, vesti-
gial between Fingers II and III, and moderate
between Fingers III and IV. The hind limbs
are thin; metatarsal tubercle is ovoid and dif-
ferentiated, being twice as long as it is wide.
There is a row of tubercles along a dermal fold
in the external edge of the tarsus that extends



MAP. Known geographic distribution of *Centrolene savagei*. Red pentagon indicates the type locality, white dots represent additional localities.

to the base of Toe IV. Discs at the top of toes are smaller than those on hands. The outlines of the discs are truncated to rounded.

Dorsal skin smooth with small white, rounded warts in the trunk and the flanks of the head. Skin on venter and ventral surfaces of the thigh is granular. The cloacal fold is short, in horizontal position, and located at a higher level than the thigh. Granular sub-cloacal area with white granules. Individuals are pale green with white, yellow, and green spots; small blue blotches are usually present as well. Cloacal warts and tarsal tubercles are white. The upper lip has a white line. The iris is gray-yellowish with dark brown reticles. The ventral area exhibits a white color in the parietal peritoneum that extends almost until the liver. The large intestine and pericardium are covered by a white pigmentation. The heart is not visible. Bones are pale green.

The tadpole was described by Díaz-Gutiérrez et al. (2013) based on an individual in developmental stage 39 (Gosner 1960). In that individual, the body is elongate and depressed (wider than high) in lateral view and oval in dorsal view. The total length is 33.1 mm; the body length is 9.8 mm (33.7% of total length), body width is 5.9 mm, and body height is 4.8 mm. Chondrocranial elements are not visible. The snout is truncated in dorsal view and rounded in lateral view. A lateral-line system with neuromasts is evident, mainly in the anterior part of the body, infraorbital line, angular line, and mid-lateral line. The eyes are positioned dorsolaterally; eye diameter is 1.1 mm; interorbital distance is 1.3 mm; eye-snout distance is 3.0 mm. Narial apertures are small, elliptical, and dorsally directed. The distance between nostrils is 2.1 mm. The spiracle, at the posterolateral region of the body, is short and sinistral; diameter of spiracle aperture is 0.7 mm. The spiracle is located slightly below the body midline at 61.6% of the body length. The vent tube is short and medial, free posteriorly, and opens posteriorly; the cloacal tube length is 0.8

mm. Tail length is 23.3 mm (70.4% of total length). Myotomes are visible across the tail. The medial line is straight and visible, separating the dorsal and ventral myotomes. Tail muscle width is 2.9 mm; tail muscle height is 3.0 mm. The dorsal fin begins at the tail-body joint, increases in size at the middle of the tail, and gradually tapers to a rounded tip. The ventral fin originates almost at the base of the tail muscle in the posterior body region; it is slightly arched, and reaches its maximum height throughout the distal two-thirds of the tail. Dorsal fin depth is 1.3 mm; ventral fin depth is 1.1 mm.

The oral disc of the tadpole is directed anteroventrally and is not emarginated; oral disc

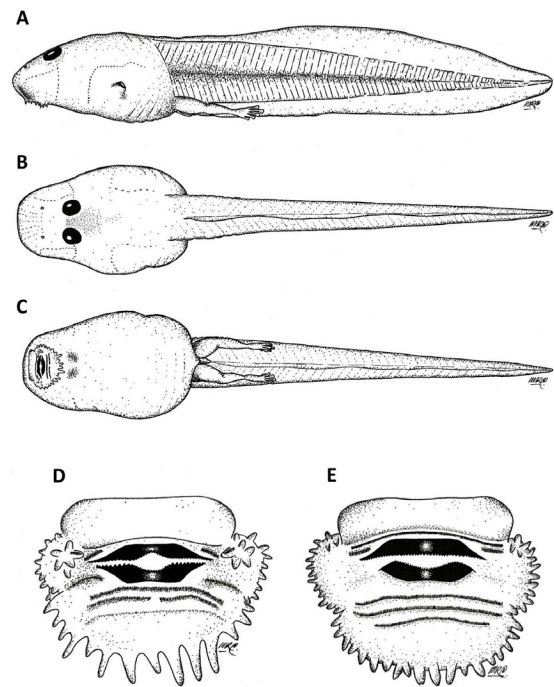


FIGURE 2. Lateral (A), dorsal (B) and ventral (C) views of the tadpole of *Centrolene savagei* at Gosner stage 39 (Gosner 1960); Museo de Herpetología Universidad de Antioquia, Medellín [MHUA]-L 0197-1, total length = 33.1 mm); oral disc at stage 39 (D) and at stage 26 (E). Illustration by Mauricio Rivera-Correa. Reprinted with permission of the journal Zootaxa.

width is 3.0 mm (50.8% of the body width). There are marginal and uni-serial papillae distributed around the oral disc, with the longest papillae mainly on the lower labium; five submarginal papillae are present on each side of the jaw sheath (one papilla with a diminutive tooth row); marginal papillae are interrupted dorsomedially in the anterior labium, forming a wide gap. The upper jaw sheath is completely keratinized with a serrated edge, and with a pronounced arch in the middle. The lower jaw sheath is keratinized, V-shaped, and with a serrated edge. Broad-based serrations are short and oriented straight medially. Labial tooth row formula is 1(1)/2(2); tooth row A-1 is interrupted medially and is located laterally on both sides of the upper jaw sheath, forming a wide gap.

DIAGNOSIS. Diagnostic characters of *Centrolene savagei* are: presence of vomerine teeth; individuals with pale green bones in life; extension of the parietal peritoneum almost to the liver; pale green coloration with white and green spots; webbing formula in fingers II ($2^+ - 2\frac{1}{2}$)–($3\frac{1}{3} - 3\frac{2}{3}$) III ($2\frac{1}{3} - 2\frac{1}{2}$)–($2 - 2\frac{1}{3}$) IV; webbing formula of toes I ($1\frac{1}{3} - 1\frac{1}{2}$)– 2^+ II $1 - (2 - 2\frac{1}{3})$ III ($1 - 1\frac{1}{2}$)–($2 - 2\frac{1}{3}$) IV ($2 - 2\frac{1}{3}$)–1 V; rounded snout when viewed dorsally; smooth dorsal skin with low, rounded, and white warts; a thin row of tubercles along the outer margins of the hand, forearm, tarsus, and foot; absence of a humeral spine; presence of a large and rounded tympanum; absence of nuptial excrescences.

PHYLOGENETIC RELATIONSHIPS. *Centrolene savagei* was assigned originally to the genus *Cochranella* by Ruiz-Carranza and Lynch (1991), based solely on morphological characters such as the absence of a humeral spine. Questions about the homology of the humeral spine and its implications for a monophyletic *Cochranella*, and the possible synonymy with *Centrolene* were discussed by Frost et al. (2006). Subsequently, *savagei* was assigned to the genus *Centrolene* based on an

extensive revision of the systematics of Centrolenidae using nuclear genes (c-myc exon 2, RAG1, POMC) and mitochondrial genes (12S, 16S, ND1) (Guayasamin et al. 2009). *Centrolene savagei* is morphologically similar to *Centrolene daidaleum* (Ruiz-Carranza and Lynch 1991); the two species were recovered as sister species in different phylogenetic hypotheses constructed with molecular evidence (Castroviejo-Fisher et al. 2014; Catenazzi et al. 2012; Dugo-Cota et al. 2015; Guayasamin et al. 2008, 2009; Hutter et al. 2013; Pyron and Wiens 2011).

PUBLISHED DESCRIPTIONS. Descriptions of *Centrolene savagei* and taxonomic reviews of the family Centrolenidae were published by Cisneros-Heredia and McDiarmid (2007), Guayasamin et al. (2008, 2009), and Ruiz-Carranza and Lynch (1991). Observations of breeding behavior, mating pattern and parental care were presented by Vargas-Salinas et al. (2007, 2014). Antipredatory behaviors were described by Escobar-Lasso and Rojas-Morales (2012). The tadpole, advertisement call, and courtship call of *Centrolene savagei* were described by Díaz-Gutiérrez et al. (2013), Rios-Soto et al. (2017), and Vargas-Salinas et al. (2014). Spanish language species accounts were published by Bolívar-G. et al. (2013) and Palacio Baena et al. (2006).

The advertisement call was described in detail by Díaz-Gutiérrez et al. (2013) and is as follows, based on 238 calls recorded by 23 males. The call consists of 1–3 ‘peep’ notes that last 16.65 ± 2.98 ms (range = 10–22 ms); consecutive notes are separated by silent intervals of 348.77 ± 33.67 ms (range = 302–442 ms). Mean call duration is 0.501 ± 0.26 s (range = 0.018–1.057 s). Call rate is 0.112 ± 0.03 calls/s (range = 0.061–0.198 calls/s). The dominant frequency of the call is 6.214 ± 0.334 kHz (range = 5.822–7.211 kHz). The maximum sound pressure level of the advertisement call, measured at 50 cm in front of two males, reached 75.4 and 78.6 dB, respec-

tively. A separate description of the courtship call in *Centrolene savagei* was published by Rios-Soto et al. (2017) and Vargas-Salinas et al. (2014).

ILLUSTRATIONS. **Color photographs** of the venter of a female were published by Bolívar-G. et al. (2013); color photographs of calling and non-calling males were presented by Bolívar-G. et al. (2013), Castro-Herrera et al. (2007), Díaz-Gutiérrez et al. (2013), Guayasamin et al. (2009), Halliday (2016), Palacio Baena et al. (2006), Stuart et al. (2008); color photographs of amplexus and courtship behavior were published by Vargas-Salinas et al. (2014); color photographs of egg attendance by males were published by Bolívar-G. et al. (2013), Rivera-Correa (2013), Rojas-Morales et al. (2011), and Vargas-Salinas et al. (2014). A color picture of a male in anti-predatory position behavior was published by Escobar-Lasso and Rojas-Morales (2012). A series of color drawings and photographs showing courtship behavior, amplexus, oviposition, and parental care were presented by Vargas-Salinas et al. (2014). **Black-and-white photographs** of males caring for egg clutches were presented by Vargas-Salinas et al. (2007). **Black-and-white illustrations** of tadpole morphology were published by Díaz-Gutiérrez et al. (2013) and black-and-white drawings and photographs of anatomical features of adults were published by Palacio Baena et al. (2006) and Ruiz-Carranza and Lynch (1991).

DISTRIBUTION. *Centrolene savagei* is endemic to Colombia and is found on leaves between 0.5–5 m height alongside streams in both undisturbed and disturbed forests. This species has been recorded between 1440 and 2410 m in the central and western Andes of Colombia in the departments of Antioquia, Caldas, Quindío, Risaralda, Tolima, and Valle del Cauca. Detailed data about elevational distribution range in each of those Colombian departments were published by Bolívar-G.

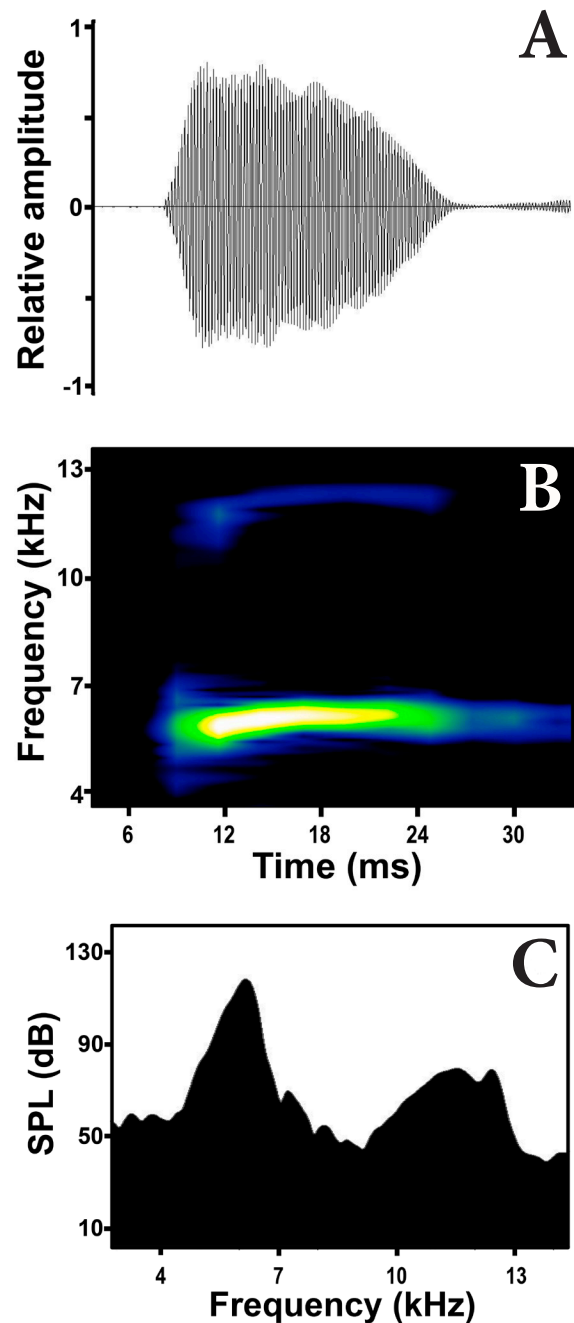


FIGURE 3. Oscillogram (A), spectrogram (B), and power spectrum (C) of the one note advertisement call of *Centrolene savagei*; dB = decibels; kHz = kilohertz; ms = milliseconds; SPL = sound pressure level. Snout-vent length of recorded male is 22.59 mm, temperature of male is 16.6° C. Recorded at Filandia, Central Andes of Colombia. Adapted from Díaz-Gutiérrez et al. (2013).

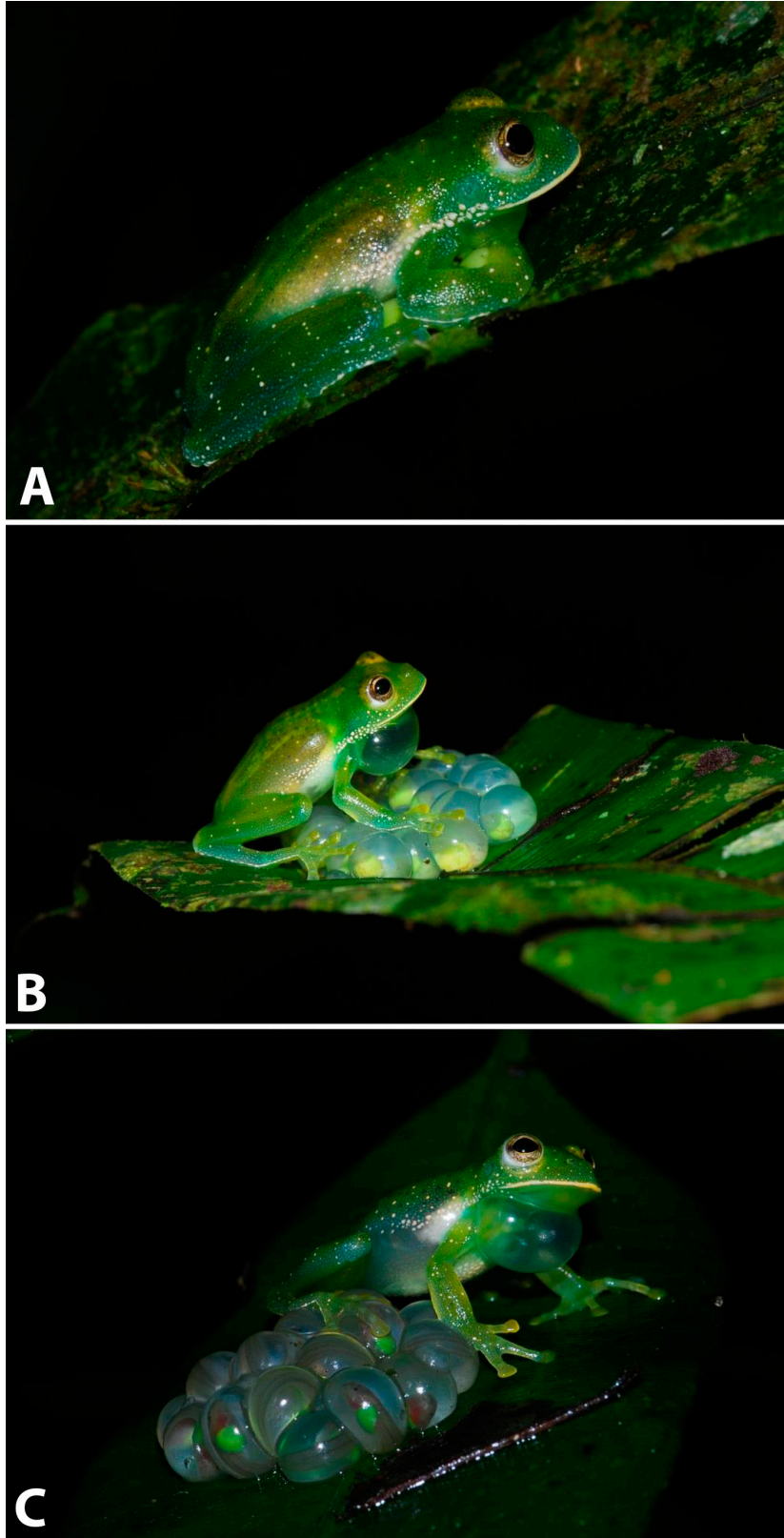


FIGURE 4. Development of embryos and egg attendance by the father. (A) Egg brooding after ovoposition. (B) The father begins calling several days after ovoposition. (C) A male can stay beside the egg clutch until embryos are near to hatching. Note change in color of embryos. Photos by Fernando Vargas-Salinas.

et al. (2013). However, records in the municipality of Falan, department of Tolima (Gallego et al. 2008; Guayasamin et al. 2009) may correspond to another species (Marco Rada; personal communication).

PERTINENT LITERATURE. Published references to this species are listed by topic: **advertisement and courtship call** (Díaz-Gutiérrez et al. 2013; Rios-Soto et al. 2017; Vargas-Salinas et al. 2014), **antipredatory behavior in adults** (Escobar-Lasso and Rojas-Morales 2012), **breeding behavior, mating pattern, and parental care** (Crump 1995; Ospina-L. et al. *in press*; Ruiz-Carranza and Lynch 1991; Vargas-Salinas et al. 2007, 2014; Wells 2007), **conservation status** (Bolívar et al. 2004; Halliday 2016; Stuart et al. 2008), **geographic distribution** (Acosta-Galvis 2000, Bernal and Lynch 2008; Cadavid et al. 2005; Duellman 1993; Gallego et al. 2008; Palacio Baena et al. 2006; Rojas-Morales et al. 2011; Rueda-Almonacid 2000; Ruiz-Carranza and Lynch 1997; Ruiz-Carranza et al. 1996; Stuart et al. 2008), **morphology of adults and tadpoles** (Cisneros-Heredia and McDiarmid 2007; Díaz-Gutiérrez et al. 2013; Ruiz-Carranza and Lynch 1991), **popular press books** (Halliday 2016), **taxonomy, systematics, and phylogenetic relationships** (Castroviejo-Fisher et al. 2014; Frank and Ramus 1995; Frost 2017; Glaw et al. 1998, 2000a, 2000b; Guayasamin et al. 2008, 2009; Hutchins et al. 2003; Hutter et al. 2013; Pyron and Wiens 2011; Wrobel 2004).

REMARKS. Unpublished genetic diversity for mitochondrial markers in some populations of *Centrolene savagei* suggest that there could be cryptic taxa within this species (Marco Rada, personal communication). Future analyses that include different lines of evidence will help to elucidate the taxonomic limits of the species.

ETYMOLOGY. The specific epithet *savagei* is a tribute to the recognized herpetologist

Dr. Jay M. Savage for his great contributions to the knowledge about Centrolenidae.

COMMENTS. Experimental studies with several species of Centrolenidae frogs show that parental care in glass frogs is mainly to hydrate the eggs and reduce the mortality by desiccation (Delia et al. 2013, 2014; Vockenhuber et al. 2009). Given that the embryos are visible through their transparent-jelly egg coverings, this hypothesis would be relatively easy to test in *Centrolene savagei*. In this species, larger males have higher probabilities to mate than smaller males (Vargas-Salinas et al. 2014); the increased mating success of larger males seems most strongly correlated to a mechanism of endurance related to rivalry competition (intrasexual selection) rather than to female choice (intersexual selection) based on egg fertilization efficiency or parental care quality (Ospina-L. et al. *in press*). Additionally, males are commonly observed attending egg clutches from ovoposition until hatching (Vargas-Salinas et al. 2014). At present, it is unknown whether males of *Centrolene savagei* adjust their parental effort according to environmental conditions as reported for other glass frogs (Delia et al. 2013, 2014), an important point in the context of global climatic change.

ADDITIONAL VERNACULAR NAMES. Rana de cristal (Ospina-L. et al. *in press*; Vargas-Salinas et al. 2014).

ACKNOWLEDGMENTS. Some of the distributional records for the municipality of Salento, department of Quindío were provided by Carlos M. Gómez. Geographical distribution map was made with the help of Carlos A. Londoño-G. Thanks to the journal Zootaxa for allowing us to replicate some images.

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