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Conservation status, range extension, and call analysis of the Littoral Glassfrog, *Cochranella litoralis* (Ruiz-Carranza and Lynch 1996)

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Abstract.—The little-known glassfrog *Cochranella litoralis* (Ruiz-Carranza and Lynch 1996) is a Vulnerable (VU) species infrequently reported in the literature. Its purported distribution includes the departments of Cauca and Nariño, Colombia, and the provinces of Esmeraldas, Los Ríos, Pichincha, and Santo Domingo de los Tsáchilas, Ecuador. Due to conflicting details regarding its distribution within the literature, we review past records to clarify which localities are valid. We also report two new localities that expand its elevational range to ≤ 407 m and its distribution approximately 175 km south from the previous southernmost locality, present an updated distribution map, and recommend an IUCN Red List status of Endangered (EN) for *C. litoralis*. Lastly, the call of *C. litoralis* is described for the first time, as is that of an Ecuadorian specimen of the widely-distributed *C. granulosa*.

Keywords. Amphibian, Anura, distribution, Ecuador, Endangered, threatened

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Resumen.—La poco conocida rana de cristal *Cochranella litoralis* (Ruiz-Carranza y Lynch 1996) es una especie Vulnerable (VU) con pocos registros en la literatura. Su distribución conocida incluye los departamentos de Cauca y Nariño, en Colombia, y las provincias de Esmeraldas, Los Ríos, Pichincha y Santo Domingo de los Tsáchilas, en Ecuador. Debido a que varias fuentes tienen detalles contradictorios con respecto a su distribución, revisamos los registros para mayor claridad, reportamos dos nuevas localidades que amplían su rango de altitud a ≤ 407 m y su distribución aproximadamente 175 km al sur de la localidad más al sur conocida, presentamos un mapa de distribución actualizado, y recomendamos que el estado de la Lista Roja de la UICN de *C. litoralis* se modifique a En peligro (EN). Por último, se describe por primera vez la llamada de *C. litoralis*, así como la de un ejemplar ecuatoriano de la ampliamente distribuida *C. granulosa*.

Palabras Claves. Anfibio, Anura, distribución, En peligro, amenazada

Introduction

The glassfrog genus *Cochranella* was first proposed over 70 years ago and included 13 species at that time (Taylor 1951). More recently, the genus was revised to resolve its former polyphyly, which reduced its membership to seven taxa (Guayasamin et al. 2009). Five species originally assigned to *Cochranella* were retained as *incertae sedis* within Centroleninae (i.e., "*Cochranella*") due to a lack of molecular data and ambiguous behavioral and morphological characters ("*C.*" *balionota*, "*C.*" *duidaeana*, "*C.*" *megista*, "*C.*" *riveroi*, '*C.*" *xanthocheridia*; Guayasamin et al. 2009). Two of the latter species have since been shown to belong to the genus *Nymphargus* (Guayasamin et al. 2019; Trageser et al. 2021). Currently, eight species are recognized within *Cochranella* (Frost 2024), as well as two putative new species (Guayasamin et al. 2020). Among the lesser known members is the threatened Littoral Glassfrog, *C. litoralis* (Ruiz-Carranza and Lynch 1996). For this species, relatively few observations have been reported, the call and tadpole have yet to be described, and the evolutionary relationships among its congeners are still

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uncertain (Twomey et al. 2014; Guayasamin et al. 2020).

The reported distribution of *C. litoralis* is restricted to lowland Chocoan rainforest below 250 m elevation in extreme southwestern Colombia and northwestern Ecuador (Ruiz-Carranza and Lynch 1996; Ruiz-Carranza et al. 1996; Grant and Morales 2010; IUCN SSC Amphibian Specialist Group 2019; Guayasamin et al. 2020). However, details in the literature regarding the extent of its distribution are ambiguous. While legitimate records have been reported from Nariño Department, Colombia, and Esmeraldas Province, Ecuador (Ruiz-Caranza and Lynch 1996; Guayasamin et al. 2006; Guayasamin et al. 2020; Pinto-Erazo et al. 2020), its distribution is also suggested to include Cauca Department, Colombia, and the Ecuadorian provinces of Los Ríos, Pichincha, and Santo Domingo de los Tsáchilas (Acosta-Galvis 2000; Lynch and Suaréz-Mayorga 2004; IUCN SSC Amphibian Specialist Group 2019; Guayasamin et al. 2020). The latter references appear to have either conflicting data therein or lack corroborating material, or both. As a result, the extent of its known distribution is unclear.

Here, the literature and available material for *C. litoralis* is reviewed to clarify its known distribution and produce an updated distribution map that reflects verifiable localities. In addition, two new localities are reported that extend its known distribution 175 km south-southeast and mark the highest documented elevation, its call is described for the first time, and its extinction risk is reassessed. Lastly, the call of *C. granulosa* is described from a recently documented population in Ecuador (Culebras et al. 2020), as available call analyses of this taxon are based on populations from Costa Rica and Panama (Ibáñez et al. 1999; Kubicki 2007).

Materials and Methods

Field work was conducted at two separate sites. The first site was Los Laureles, Cotopaxi Province, Ecuador, where sampling efforts were conducted in March 2017 and March 2019. This area is characterized by a mosaic of cleared plots of land for agriculture and human settlements, with relatively small pockets of secondary forest. The second site was a fragmented forest near Cristobal Colón Quininde, Esmeraldas Province, Ecuador, where sampling was conducted in August 2021. The habitat consists of ca. 1.4 km² of secondary forest, with the northern end adjoining the Río Canandé. Large forest clearings are present to the east, south, and west. Patches of cleared forest are also present north of the Río Canandé, although intact mature forest is more prominent in this area and the protected forest of Reserva Biológica Río Canandé lies only about 3 km to the northwest, and Estación Biológica Jevon is just to the northeast of the forest fragment. The plot of forest sampled was recently purchased to serve as a future rescue center and sanctuary for the Critically Endangered Ecuadorian Brown-headed Spider Monkey (*Ateles f. fusciceps*), and sampling of the biodiversity was conducted to generate a preliminary list of the taxa present in the forest.

Sampling was conducted using visual encounter surveys along trails and streams located within mature forest, disturbed forest, forest edge, and adjacent cleared areas, as well as agricultural plots. A Garmin 64s GPS receiver using WGS84 datum was used to collect geographic coordinates. Animals were verified as *Cochranella litoralis* using the diagnostic characters described in Ruiz-Carranza and Lynch (1996) and Guayasamin et al. (2020). Diagnostic photographs were taken of live specimens and submitted as vouchers to the digital repository at Centro Jambatu de Investigación y Conservación de Anfibios, San Rafael, Ecuador (CJ). Animals were returned to the exact location of capture after image and data collection, and released either the same night of capture or immediately at sunset the following evening to minimize stress. Field work was conducted under permit numbers 0013-18 IC-FAU-DNB/MA and MAE-ARSFC-2019-0163, authorized by the Ministerio del Ambiente del Ecuador, and carried out in accordance with the guidelines for the use of live amphibians and reptiles in field and lab research (Beaupre et al. 2004) compiled by the American Society of Ichthyologists and Herpetologists, the Herpetologists' League, and the Society for the Study of Amphibians and Reptiles.

To assess and validate past records, we performed a search of the literature pertaining to *C. litoralis* as well as various databases containing unpublished specimens or locality information. The literature search was conducted by entering key words from its taxonomic history into Google Scholar (i.e., "*Centrolene litoralis*," "*Centrolene litorale,*" and "*Cochranella litoralis*"). Public-sourced and museum databases that were assessed include: Museo de Zoología, Pontificia Universidad Católica del Ecuador, Quito, Ecuador (QCAZ; https://bioweb.bio/faunaweb/amphibiaweb/); Instituto de Ciencias Naturales, Universidad Nacional de Colombia, Bogotá, Colombia (ICN; http://www.biovirtual.unal.edu.co/en/collections/search/amphibians/); VertNet (https://portal.vertnet.org); CalPhotos (https://calphotos.berkeley.edu); iNaturalist (https://www.inaturalist.org); and HerpMapper (https://www.herpmapper.org). Confirmed localities were considered those that included a referenced specimen(s) or a combination of geographic coordinates and corroborating media. Extinction risk was assessed using the IUCN (2012) guidelines. Estimates for extent of occurrence (EOO) and area of occupancy (AOO) were calculated using the software GeoCAT (Bachman et al. 2011), following IUCN guidelines (IUCN 2022).

Bioacoustics. Call recordings for *C. litoralis* and *C. granulosa* were accessioned in the digital repository at Centro Jambatu de Investigación y Conservación de Anfibios, San Rafael, Ecuador (CJ). Call analyses for *C.*

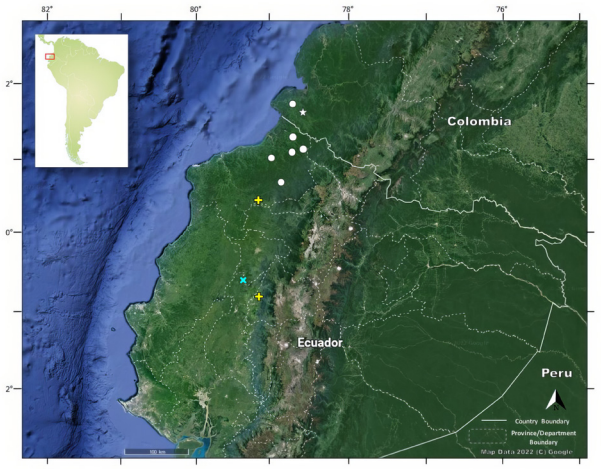

Fig. 1. Distribution map of *Cochranella litoralis*. White circles indicate verifiable localities reported in the literature; the white star denotes the type locality; the blue X marks the iNaturalist observation from the Río Palenque Research Center, Los Ríos; and yellow plus symbols indicate new records reported herein.

litoralis are based on four recordings of a single male (voucher CJ12588; call records: ec.cj.aud.26, ec.cj.aud.28–30) obtained by JC on 16 March 2019 between 0400–0430 h after light rain. The recordings were taken at Los Laureles, Cotopaxi, Ecuador within an abandoned banana plantation next to a small patch of secondary forest. That area frequently floods after rains and has a small, shallow creek with slow moving water. One recording was made with an iPhone 7 in MPEG-4 format with a sampling rate of 44.1 kHz and 24-bits resolution. The other three were made with a Tascam DR-05 recorder in WAV format with a sampling rate of 44.1 kHz and 16-bits resolution. The iPhone 7 was placed approximately 3.5 m from the calling male and the Tascam DR-05 recorder was placed less than 0.5 m away.

The call analysis of *C. granulosa* is based on seven recordings (ec.cj.aud.27, ec.cj.aud.31–36) taken from two males obtained by JC on 16 March 2019 between 0315–0340 h after light rain, and on 17 March 2019 between 2100–2115 h after light rain. The recordings were taken at Los Laureles, Cotopaxi, Ecuador, as reported by Culebras et al. (2020). The recordings were made with a Tascam DR-05 recorder in WAV format with a sampling rate of 44.1 kHz and 16-bits resolution. Recordings were made approximately 5 m from the calling male.

The Avisoft-SASLab Pro "Spectrogram tool" was used to analyze and filter the audio recordings. High resolution waveform, spectrogram, and power spectrum figures were generated using the R package Seewave (v2.2.1; Suer et al. 2008). To remove the background noise and facilitate the measurement of temporal and spectral parameters, a "Band Filter" was applied between 3,000–6,000 Hz and a "Noise Reduction" of 60 dB, with a threshold of -60 dB. The measurements were generated using Kaleidoscope Pro 5 software with the "Analyze View" tool, with a spectrogram configuration window of a 512-sample window size and 512 FFT size. The parameters assessed, as defined by Köhler et al. (2017), were dominant frequency (frequency with the most energy), bandwidth (difference between the upper and lower frequencies) and call duration (length of a note).

Results

Cochranella litoralis (Ruiz-Carranza and Lynch, 1996)

New record. Adult male from Los Laureles, Cotopaxi, Ecuador (0°51'18.2232" S, 79°11'25.926" W, 407 m; Fig. 1), 16 March 2019 at 0400 h; Christophe Pellet and Jaime Culebras leg.; photo voucher CJ12588 (Fig. 2); uncollected. The specimen was observed calling shortly after a light rain, perched on a leaf 4.5 m high within an abandoned banana plantation adjacent to secondary forest. Other males have been observed at this same location, the first being on 19 February 2017 at 2100 h. Males of *Hyalinobatrachium tatayoi* have also been observed calling nearby.

New record. Adult male, 20.6 mm snout-urostyle length (SUL), recorded from a fragmented forest adjacent to Cristobal Colón Quininde, Esmeraldas, Ecuador (0.45213°N, 79.14919°W, 178 m; Fig. 1); 21 August 2021 at 2310 h; Ross Maynard and Sebastian Kohn leg.; photo vouchers CJ12587a–d (Fig. 2); uncollected. The male was observed in a clearing 3 m from the forest edge, calling on the upper surface of a leaf within sparse herbaceous vegetation, perched 1.0 m high. Slow, shallow water was channeled just below the vegetation due to steady rain earlier that evening, which was flowing towards a small stream (about 2–3 m wide and 0.5 m deep) a few meters away. Two additional males were heard calling nearby, one from just within the forest and the other also in the clearing near the forest edge, however their exact locations were not observed. Other glassfrogs recorded along the stream adjacent to where the *C. litoralis* was observed, but from within the secondary forest, were *Sachatamia ilex* and *Teratohyla spinosa*.

Distribution. A review of the literature yielded seven verified localities for *C. litoralis*: two localities from Colombia in extreme southwest Nariño Department, and five localities in Esmeraldas Province, Ecuador (Table 1; Fig. 1). The purported localities in Cauca, Colombia, and in Los Ríos, Pichincha, and Santo Domingo de los Tsáchilas, Ecuador, are either unverified or were reported in error (see **Discussion**). Nonetheless, a search of public-sourced and museum databases identified an additional locality from Los Ríos Province, Ecuador, at the Río Palenque Research Center in August 2021 (http://iNaturalist.org/observations/90596035; D. Weaver and E. Osterman, pers. comm.). Since the coordinates of the holotype provided by Ruiz-Carranza and Lynch (1996) are imprecise, the placement of the type locality on the map is approximated (Fig. 1). The new record from Los Laureles, Cotopaxi,

Table 1. Localities of *Cochranella litoralis* that are verifiable from deposited specimen(s), geographic coordinates, or corroborating media. PUCE = Museo de Zoología, Pontificia Universidad Católica del Ecuador, Quito, Ecuador (https://bioweb.bio/faunaweb/amphibiaweb/); ** denotes an elevation that was acquired from Google Earth based on the coordinates provided.

Locality / Coordinates	Specimen / Voucher #	Year(s) observed	Source
Colombia, Nariño, Tumaco, La Guayacana / 1°49.8'N, 78°46.2'W, 100 m	ICN 13821	1985	Ruiz-Carranza and Lynch 1996
Colombia, Nariño, Tumaco, Universidad Nacional de Colombia, Sede Tumaco / 1°36'22.1"N, 78°43'48.16"W, 17 m **	--	2015, 2016, 2020	Pinto-Erazo et al. 2020; iNaturalist.org
Ecuador, Esmeraldas, Tsejpu, Río Zapallo / 0°42'0"N, 78°54'0"W, 150 m	EcoC 141	?	Grant and Morales 2004; Cisneros-Heredia and McDiarmid 2007
Ecuador, Esmeraldas, Río Cachabí, 2 km NE on San Lorenzo-Lita Rd / 1°01'59.9" N, 78°46'0" W, 200 m	DHMECN 3198	2005	Guayasamin et al. 2006
Ecuador, Esmeraldas, stream near Durango / 1°2'49.2"N, 78°37'4.8"W, 220 m	QCAZ 27693	2004	PUCE; Guayasamin et al. 2020
Ecuador, Esmeraldas, Pichiyacu, Comunidad Chachi, Río Cayapas / 0°54'29.16"N, 78°59'52.8"W, 200 m	QCAZ 31705	1996	PUCE; Guayasamin et al. 2020
Ecuador, Esmeraldas, Tundaloma Lodge / 1°10'43.248"N, 78°44'58.92"W, 74 m	QCAZ 57041; MZUTI 3481	2014	PUCE; Guayasamin et al. 2020
Ecuador, Los Ríos, Centro Científico Río Palenque / 0°35'17.47"S, 79°21'44.95"W, 170 m	--	2021	iNaturalist.org
Ecuador, Esmeraldas, Cristobal Colón Quininde / 0°27'7.668"N, 79°8'57.084"W, 178 m	CJ12587a–d	2021	This study
Ecuador, Cotopaxi, Los Laureles / 0°51'18.2232"S, 79°11'25.926"W, 407 m	CJ12588	2017, 2019	This study

expands the elevational range from near sea level to 407 m asl, and extends the known distribution of *C. litoralis* by abount 175 km south-southeast from the previous southernmost locality at Tsejpu, Río Zapallo, Esmeraldas.

Extinction risk. Despite the new records, the extinction risk for *C. litoralis* remains relatively high. With the additional localities reported herein, and assuming each of the seven localities where the species had previously been reported represent extant populations, the extent of occurrence (EOO) of the species is about 8,308 km² and the area of occupancy (AOO) is 40 km². However, the only other reported observations over the past decade are from Tundaloma Lodge, Esmeraldas, Ecuador in 2014 (Guayasamin et al. 2020) and Tumaco, Nariño, Colombia, in 2015, 2016, and 2020 (Table 1; IUCN SSC Amphibian Specialist Group 2019; Pinto-Erazo et al. 2020; iNaturalist.org). Except for the latter locality in Colombia, whether there have been subsequent sampling efforts for *C. litoralis* at the remaining localities in Esmeraldas Province, Ecuador is unclear. Although the status of these subpopulations cannot be verified at this time, we suspect that there has been recent and ongoing decline in the extent and quality of its habitat, given that northwest Ecuador has been a hotspot of deforestation over the past three decades (Sierra 2013; Kleeman et al. 2022). Logging and agriculture are the main drivers of deforestation in the region, which have resulted in severely fragmented forests throughout its range. As a result of these ongoing pressures, *C. litoralis* is currently known only from threat-defined locations (*sensu* IUCN 2012, 2022). While the observations reported here are the first to suggest that the species can tolerate altered habitat adjacent to forest, at least to some degree, the natural history and habitat requirements of the species remain poorly understood. Accordingly, and like the recent threat assessment for its national status in Ecuador (Ortega-Andrade et al. 2021), we recommend a global threat status of Endangered (EN) for *C. litoralis* following IUCN criteria B2ab(iii).

Call analysis. The call of *C. litoralis* consists of a short, single tonal note (Fig. 3). The call duration was 88.51–177.17 ms ($\bar{x}$ = 132.84 ± 44.33; N = 4), the dominant frequency ranged from 5,210–5,304 Hz ($\bar{x}$ = 5,257 ± 47; N = 4), and the call bandwidth ranged from 738–1,729 Hz ($\bar{x}$ = 1,265 ± 527; N = 4).

Compared to the available call descriptions of other species in the genus, *C. nola* and *C. mache* have similar call structures and parameter metrics. While *C. nola* exhibits a simple, non-pulsed note with comparable metrics (call duration: $\bar{x}$ = 95 ms ± 11.97, dominant frequency: $\bar{x}$ = 5,460 Hz ± 221; Lötters and Köhler 2000; Köhler et al.

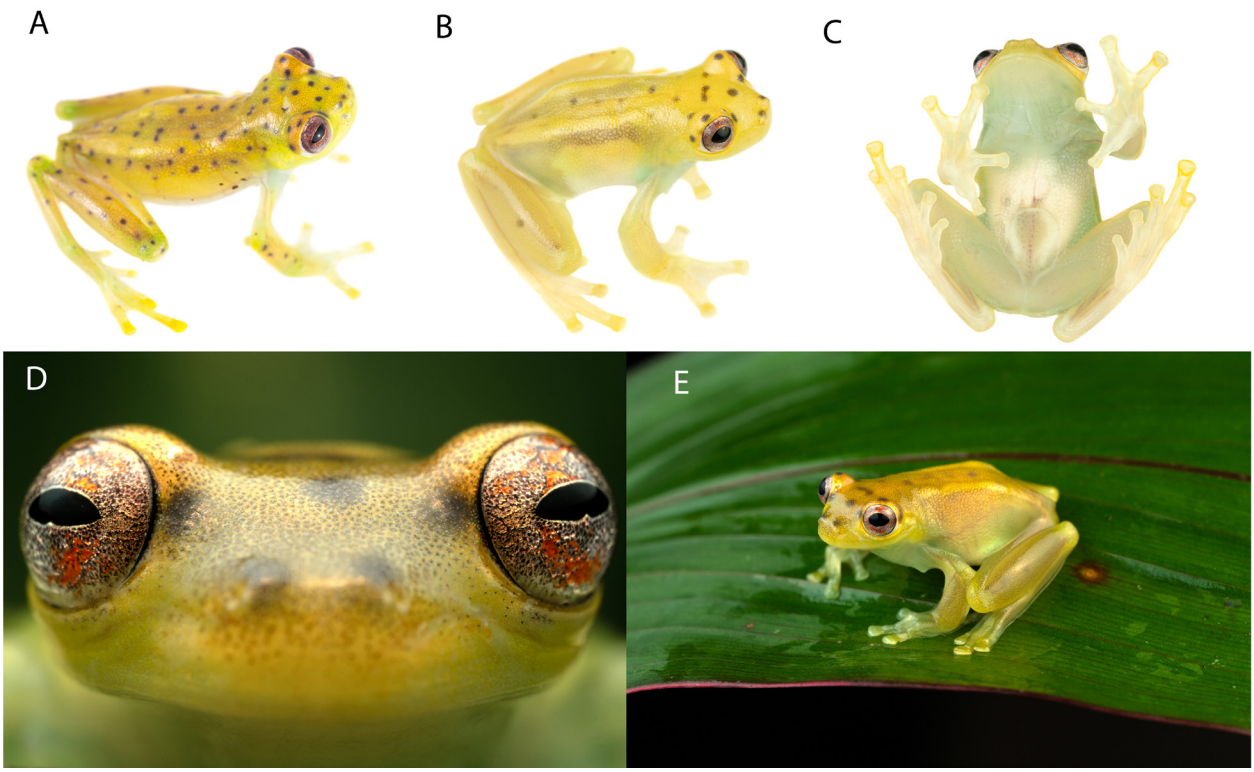

Fig. 2. Dorsal and ventral aspects of *Cochranella litoralis* in life. **(A)** Adult male, CJ12588, from Los Laureles, Cotopaxi, Ecuador. **(B–E)** Adult male, CJ12587a–d, from Cristobal Colón Quininde, Esmeraldas, Ecuador. Photos by: *Jaime Culebras* (**A**)*; Ross J. Maynard* (**B–E**).

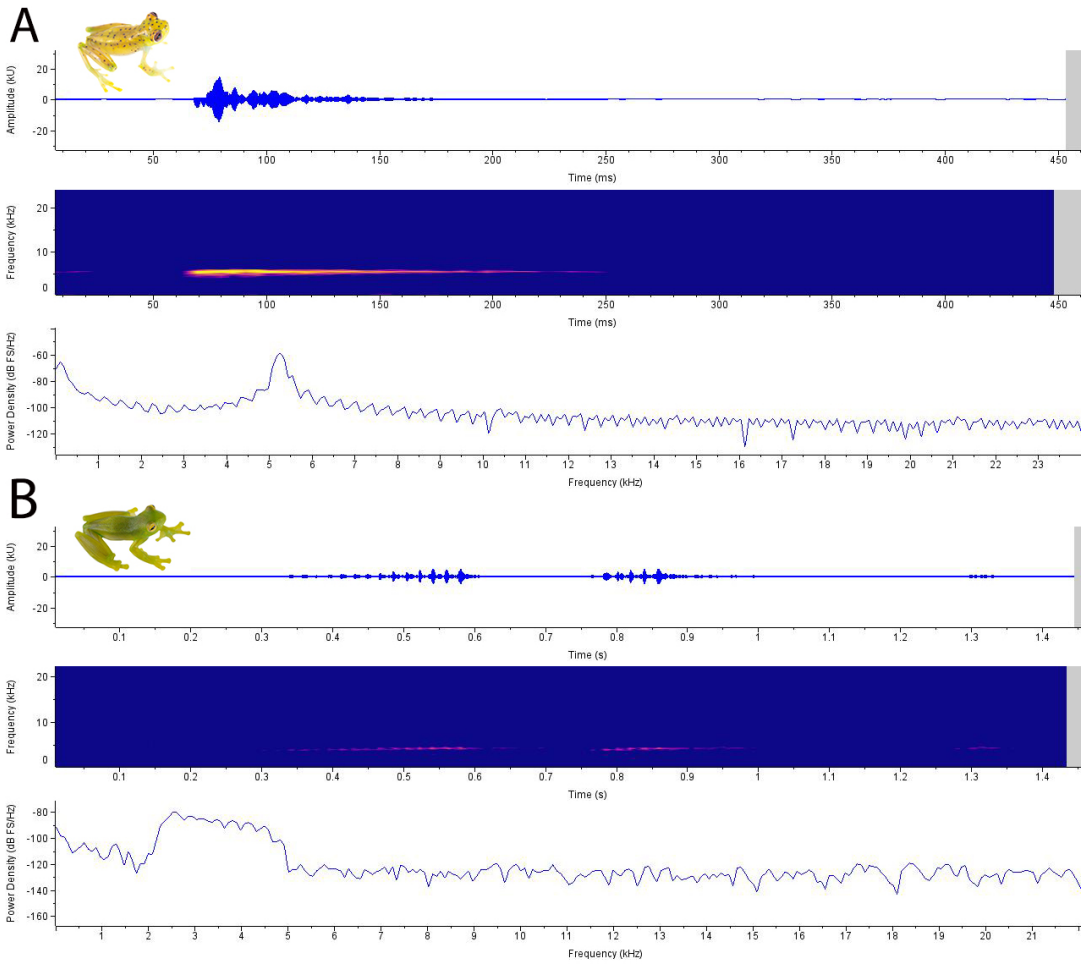

Fig. 3. Audio spectrogram (top), oscillogram (middle), and power spectrum (bottom) of an adult male *Cochranella litoralis* from Los Laureles, Cotopaxi, Ecuador **(A)**, and an adult male *C. granulosa* from Jardín de los Sueños, Cotopaxi, Ecuador **(B)**.

2006), *C. mache* has a call with two pulsed notes, a call duration of $\bar{x}$ = 38 ms ± 8, and a dominant frequency of $\bar{x}$ = 5,410.2 Hz ± 17.9 (Ortega-Andrade et al. 2013). Other *Cochranella* spp. that have described calls, such as *C. granulosa* (Fig. 3), have pulsed notes.

The call metrics measured from seven call recordings of *C. granulosa* observed at Jardín de los Sueños, Cotopaxi, Ecuador are as follows. Calls consisted of 1–4 notes ($\bar{x}$ = 2.34), with 8–15 pulses per note; the first notes in multi-note calls are more pulsated than subsequent notes (first note: $\bar{x}$ = 15 ± 2 pulses; second note: $\bar{x}$ = 12 ± 2 pulses; third note $\bar{x}$ = 8 ± 5 pulses); call duration was 150–1,437 ms ($\bar{x}$ = 790 ms ± 640); single-note duration varied from 130–260 ms, with the first note generally being longer than subsequent notes, similar to the calls of individuals from Costa Rica (Ibáñez et al. 1999; Kubicki 2007). The note interval was 45.49–179.31 ms ($\bar{x}$ = 112 ± 66.91), and the dominant frequency was measured at 3,943–4,119 Hz ($\bar{x}$ = 4,031 ± 88). Comparable metrics can be found in *C. guayasamini*, as it also exhibits a high-pitched, pulsed trill with two notes, with the first note having substantially more pulses than the second note (Twomey et al. 2014). Similar to the lack of phenotypic variation observed between populations of *C. granulosa* in Ecuador and Central America (Culebras et al. 2020), call variation also appears to be minimal.

Discussion

Although information for *C. litoralis* remains limited, this study contributes new locality records and the first call analysis of this species, as well as that of *C. granulosa* from Ecuador. Our observation from Los Laureles, Cotopaxi, and the observation identified in the iNaturalist database from the Río Palenque Research Center, Los Ríos, are the first verified records outside of either Nariño Department, Colombia, or Esmeraldas Province, Ecuador. Other works that suggest its distribution includes Cauca Department, Colombia, and the Ecuadorian provinces of Pichincha, Santo Domingo de los Tsáchilas, and Los Ríos seem to do so in error or cannot be confirmed. Acosta-Galvis (2000) was the first to report the species from Cauca, but this was a mistake when citing the original description by Ruiz-Carranza and Lynch (1996). Lynch and Suaréz-Mayorga (2004) inexplicably report Guapi, Cauca as the species'

only locality in Colombia, while omitting the type locality of La Guayacana, Nariño. Considering that there appears to be no evidence to support that locality, we suspect the former error led to the latter. The most recent Red List assessment for *C. litoralis* also includes the Guapi locality, but the uncertainty of that locality is acknowledged (IUCN SSC Amphibian Specialist Group 2019). Notably, the only observations of *C. litoralis* from Colombia since it was described were reported from adjacent to the type locality in Nariño (Pinto-Erazo et al. 2020), whereas no localities have been reported from Cauca.

The available information for populations within Ecuador is also confusing. The Red List assessment states that *C. litoralis* is known from the provinces of Esmeraldas, Santo Domingo de los Tsáchilas, and Los Ríos, however, the range map and extent of occurrence (EOO) exclude the latter two provinces (IUCN SSC Amphibian Specialist Group 2019). Although it is unclear why these provinces are mentioned, Cisneros-Heredia and McDiarmid (2007) suggested that two specimens collected in 1979 from the Río Palenque Research Center, Los Ríos, represent an undescribed taxon that is morphologically similar to *C. litoralis*. That locality lies on the border of Los Ríos and Santo Domingo de los Tsáchilas, which may have led to the confusion. Cisneros-Heredia and McDiarmid (2007) posit that the Río Palenque specimens are distinguishable from *C. litoralis* based on a difference in iris coloration—unique red marks and reticulations as opposed to a salmon iris—but such variation is evident in images of *C. litoralis* throughout much of its known distribution, including from the vicinity of the Río Palenque Research Center (Fig. 2; iNaturalist.org; Cisneros-Heredia and McDiarmid 2007; Guayasamin et al. 2020). Therefore, we believe it is unlikely that the specimens from the Río Palenque Research Center are distinguishable from *C. litoralis*, and, if true, that the taxon has been observed at this site in January 1979 and August 2021 (https://www.inaturalist.org/observations/90596035; https://collections.nmnh.si.edu/search/herps/; Cisneros-Heredia and McDiarmid 2007).

Guayasamin et al. (2020) provide five localities with referenced vouchers and geographic coordinates for *C. litoralis* from Ecuador (see subsections "Specimens examined" and "Localities from the literature" therein). These data conflict with the localities depicted in the associated distribution map in both geographic position and number of localities, so we view these localities from the map as either unconfirmed or reported in error (Guayasamin et al. 2020). Guayasamin et al. (2020) also informally mentioned the presence of *C. litoralis* at Jardín de los Sueños, Cotopaxi, presumably based on an observation uploaded to the iNaturalist database by one of the authors of this paper (CP). However, and as we report herein, the observations from this area are not from the latter site, but instead from the nearby site of Los Laureles, Cotopaxi.

Considering that the conservation status of *C. litoralis* is primarily based on distribution data (IUCN SSC Amphibian Specialist Group 2019), our review of past localities along with the new records reported here provides an updated basis from which its extinction risk can currently be assessed. Like prior reports of this species, our observations are not from within protected areas. Nonetheless, the observation from Los Laureles, Cotopaxi, was made about 2 km from the private reserve of Jardín de los Sueños, and is the second substantial range extension of a glassfrog discovered from the area (Culebras et al. 2020). Although the observation from Cristobal Colón Quininde, Esmeraldas, is only 3 km south of Reserva Biológica Río Canandé, there have surprisingly been no observations of *C. litoralis* documented there, although this area has been fairly well sampled (Mite et al. 2013).

Overall, the call analyses we provide improve our understanding of the natural history of these taxa, and can benefit efforts in field detection and studies of their respective species boundaries. Nonetheless, these glassfrogs remain poorly understood and there is little data to inform population trends either locally or across their known distributions. Future efforts are needed to fill these knowledge gaps, especially in light of the ongoing, broad-scale declines in the forest ecosystems from which they are known (Sierra 2013; Kleeman et al. 2022).

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Literature Cited

Acosta-Galvis AR. 2000. Ranas, Salamandras y Caecilias (Tetrapoda: Amphibia) de Colombia. *Biota Colombiana* 1(3): 289–319.

Bachman S, Moat J, Hill AW, de la Torre J, Scott B. 2011. Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool. In: Editors, Smith V, Penev L. e-Infrastructures for Data Publishing in Biodiversity Science. *Zookeys* 150: 117–126. (Version BETA).

Beaupre SJ, Jacobson ER, Lillywhite HB, Zamudio K. 2004. *Guidelines for Use of Live Amphibians and Reptiles in Field and Laboratory Research.* American Society of Ichthyologists and Herpetologists, Lawrence, Kansas, USA. 43 p.

Cisneros-Heredia DF, McDiarmid RW. 2007. Revision of the characters of Centrolenidae (Amphibia: Anura: Athesphatanura), with comments on its taxonomy and the description of new taxa of glassfrogs. *Zootaxa* 1572: 1–82.

Culebras J, Angiolani-Larrea FN, Tinajero-Romero J, Pellet C, Yeager J. 2020. First record and notable range extension of the glass frog *Cochranella granulosa*

(Taylor, 1949) (Anura, Centrolenidae) found in Ecuador. *Herpetology Notes* 13: 353–355.

Frost DR. 2024. Amphibian Species of the World: an Online Reference. Version 6.1. Available: https://amphibiansoftheworld.amnh.org/index.php. [Accessed: 4 September 2022].

Grant T, Morales M. 2010. *Cochranella litoralis*. The IUCN Red List of Threatened Species 2010: e.T54923A11225350.

Guayasamin JM, Cisneros-Heredia DF, Yánez-Muñoz MH, Bustamante MR. 2006. Notes on geographic distribution. Amphibia, Centrolenidae, *Centrolene ilex*, *Centrolene litorale*, *Centrolene medemi*, *Cochranella albomaculata*, *Cochranella ametarsia*. Range extensions and new country records. *Check List* 2: 24–25.

Guayasamin JM, Castroviejo-Fisher S, Trueb L, Ayarzagüena J, Rada M, Vilà C. 2009. Phylogenetic systematics of glassfrogs (Amphibia: Centrolenidae) and their sister taxon *Allophryne ruthveni*. *Zootaxa* 2100: 1–97.

Guayasamin JM, Cisneros-Heredia DF, McDiarmid RW, Peña P, Hutter CR. 2020. Glassfrogs of Ecuador: diversity, evolution, and conservation. *Diversity* 12(6): 222.

Ibáñez DR, Rand AS, Jaramillo A. 1999. *Los Anfibios del Monumento Natural Barro Colorado, Parque Nacional Soberanía y* Áreas *Adyacentes*. Editorial Mizrachi y Pujol, Santa Fe de Bogotá, Colombia. 187 p.

IUCN SSC Amphibian Specialist Group. 2019. *Cochranella litoralis*. The IUCN Red List of Threatened Species 2019: e.T54923A49367704.

IUCN Standards and Petitions Committee. 2022. *Guidelines for Using the IUCN Red List Categories and Criteria. Version 15.1*. Prepared by the Standards and Petitions Committee, International Union for the Conservation of Nature, Gland, Switzerland. 114 p.

Kleeman J, Zamora C, Villacis-Chiluisa AB, Cueca P, Koo H, Noh JK, Fürst C, Thiel M. 2022. Deforestation in continental Ecuador with a focus on protected areas. *Land* 11(268): 1–26.

Köhler J, John A, Böhme W. 2006. Notes on amphibians recently collected in the Yungas de La Paz region, Bolivia. *Salamandra* 42(1): 21–27.

Köhler J, Jansen M, Rodriguez A, Kok PJ, Toledo LF, Emmrich, M, Vences M. 2017. The use of bioacoustics in anuran taxonomy: theory, terminology, methods, and recommendations for best practice. *Zootaxa* 4251(1): 1–124.

Kubicki B. 2007. *Ranas de Vidrio de Costa Rica/Glass Frogs of Costa Rica*. Editorial INBio, Santo Domingo de Heredia, Costa Rica. 304 p.

Lötters S, Köhler J. 2000. *Cochranella nola* (Anura: Centrolenidae): natural history notes, distribution, and advertisement call. *Herpetological Natural History* 7(1): 79–81.

Lynch JD, Suarez-Mayorga A. 2004. Catálogo de anfibios en el Chocó Biogeográfico. Pp. 654–668 In: *Colombia Diversidad Biótica IV, El Chocó Biogeográfico/ Costa Pacífica. Volumen I*. Editor, Orlando Rangel C. Universidad Nacional de Colombia, Bogota, Colombia. 862 p.

Mite MAM, Yánez-Muñoz MH, Meza-Ramos PA, Reyes-Puig MA. 2013. Reserva Biológica Río Canandé. Entre los últimos relictos de bosque húmedo Tropical en la Costa. In: *Herpetofauna en* Áreas *Prioritarias para la Conservación: el Sistema de Reservas Jocotoco y Ecominga*. Serie de Publicaciones del Museo Ecuatoriano de Ciencias Naturales, Monografia 6. MECN, Fundación para la Conservación Jocotoco, Fundación Ecominga, Quito, Ecuador. 392 p.

Ortega-Andrade HM, Rojas-Soto O, Paucar C. 2013. Novel data on the ecology of *Cochranella mache* (Anura: Centrolenidae) and the importance of protected areas for this Critically Endangered glassfrog in the Neotropics. *PLoS ONE* 8(12): e0081837.

Ortega-Andrade HM, Blanco MR, Cisneros-Heredia DF, Arévalo NG, Vargas-Machuca KGL, Sánchez-Nivicela JC, Armijos-Ojeda D, Andrade JFC, Reyes-Puig C, Riera ABQ, et al. 2021. Red List assessment of amphibian species of Ecuador: a multidimensional approach for their conservation. *PLoS ONE* 16(5): e0251027.

Pinto-Erazo MA, Calderón-Espinosa ML, Medina-Rangel GF, Galeano MÁM. 2020. Herpetofauna de dos municipios del suroeste de Colombia. *Biota Colombiana* 21(1): 41–57.

Ruiz-Carranza PM, Lynch JD. 1996. Ranas Centrolenidae de Colombia IX. Dos nuevas especies del suroeste de Colombia. *Lozania Acta Zoológica Colombiana* 30(68): 1–11.

Ruiz-Carranza PM, Ardila-Robayo MC, Lynch JD. 1996. Lista actualizada de la fauna de Amphibia de Colombia. *Revista de la Academia Colombiana de Ciencias Exactas, Físicas, y Naturales* 20(77): 365–415.

Sierra R. 2013. *Patrones y Factores de Deforestación en el Ecuador Continental, 1990–2010, y un Acercamiento a los Próximos 10 Años*. Conservación Internacional Ecuador / Forest Trends, Quito, Ecuador. 45 p.

Suer J, Augin T, Simonis C. 2008. Seewave, a free modular tool for sound analysis and synthesis. *Bioacoustics* 18(2): 213–226.

Taylor EH. 1951. Two new genera and a new family of tropical American frogs. *Proceedings of the Biological Society of Washington* 64: 33–40.

Trageser SJ, Maynard RJ, Culebras J, Kohn S, Quezada A, Guayasamin JM. 2021. Phylogenetic position of the glassfrog "*Cochranella*" *megista* (Anura: Centrolenidae) and first records for Ecuador. *Phyllomedusa* 20: 27–35.

Twomey EM, Delia J, Castroviejo-Fisher S. 2014. A review of northern Peruvian glassfrogs (Centrolenidae), with the description of four new remarkable species. *Zootaxa* 3851: 1–87.

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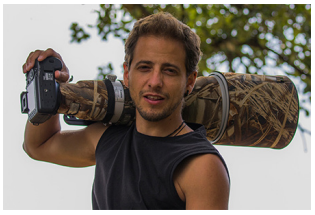

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