

First records of *Gastrotheca longipes* (Boulenger, 1882), *Cochranella resplendens* (Lynch and Duellman, 1973) and *Teratohyla midas* (Lynch and Duellman, 1973) for the Allpahuayo-Mishana National Reserve, Peru, with comments on their distribution in the Amazon basin

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Abstract. We report the first records of *Gastrotheca longipes*, *Cochranella resplendens* and *Teratohyla midas* in the Allpahuayo-Mishana National Reserve, Loreto region, Peru. We update the distribution maps of these three species within the Amazon basin, provide information about their natural history, and describe puffing-up body and mouth gaping behaviours in *Gastrotheca longipes*.

Keywords. Anura, Centrolenidae, distribution, Hemiphractidae, Iquitos, Peruvian Amazon

Introduction

The Amazonian lowlands of Loreto region in northern Peru represent one of the most biodiverse areas on the planet along with neighbouring regions in eastern Ecuador and southern Colombia (Bass et al., 2010; Jenkins et al., 2013). Pitman et al. (2013) reported 218 species of amphibians throughout Loreto, and this number has increased with the addition of newly described taxa and new geographic records (e.g., Ortega-Andrade et al., 2015; Ron et al., 2016).

Allpahuayo-Mishana National Reserve is one of the smallest protected areas (58,069.9 ha) in Loreto (SERNANP, 2017). Yet, 83 amphibian and 120 reptile

species are reported in the area (Rivera and Soini, 2002; Rivera-González et al., 2003). Some amphibian and bird species seem to be restricted to white-sand forests, a rare Amazonian phytophysiognomy that exists within the reserve (Álvarez et al., 2013; Rojas et al., 2015). Allpahuayo-Mishana is the only protected area around the growing city of Iquitos (the urban area of the city is only 25 km distant), and plays an important role in preventing urban and agricultural expansion, as well in preserving and raising awareness about the local biodiversity.

Previous herpetological research conducted in Allpahuayo-Mishana resulted in notable records of rare species such as *Rhinella ceratophrys*, *Nyctimantis rugiceps* and *Hemiphractus scutatus* (Rivera and Soini, 2002; Rivera-González et al., 2006). Here, we report for the first time the presence of *Gastrotheca longipes* (Boulenger, 1882), *Cochranella resplendens* (Lynch and Duellman, 1973) and *Teratohyla midas* (Lynch and Duellman, 1973) in the reserve. Additionally, we provide natural history information based on new observations and from the literature, and we update the distribution ranges of these three Amazonian species.

Materials and Methods

We conducted visual encounter surveys (Crump, 1994) in the Allpahuayo-Mishana National Reserve

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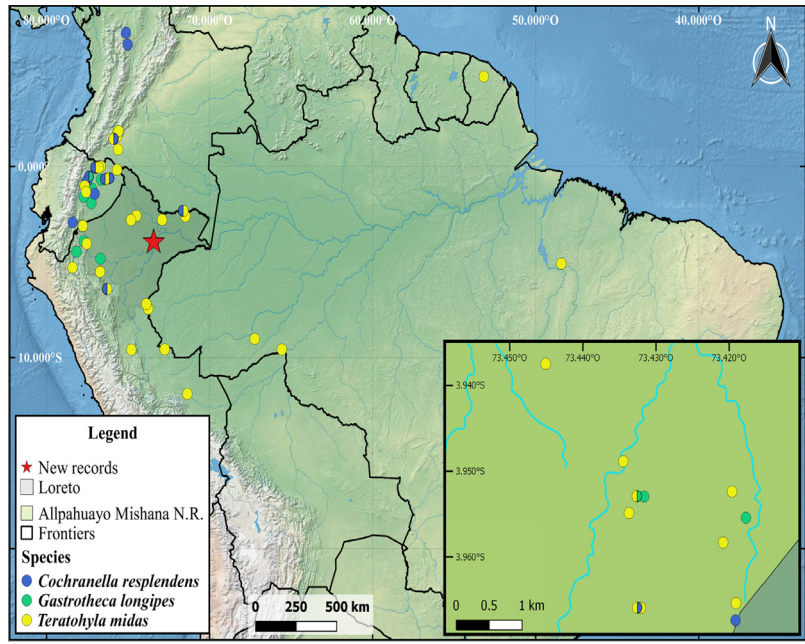


Figure 1. Geographic distribution of *Cochranella resplendens* (blue circles), *Teratohyla midas* (yellow circles) and *Gastrotheca longipes* (green circles). The star represents the new records of these species in Allpahuayo-Mishana National Reserve, in Loreto, Peru. Inset: Location of records within the reserve, most of them between “Paujil” and “Allpahuayo” creeks.

(Fig. 1) between 2013 to 2018. Voucher specimens were collected using approved protocols under permit (RJN°002-2018-SERNANP-RNAM-JEF) and deposited in the Coleção de Anfíbios do Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul (MCP), Brazil, and in the Colección Referencial de Biodiversidad del Instituto de Investigaciones de la Amazonía (CRBIIAP), Peru. We photographed and measured snout-vent length (SVL) of captured frogs when possible. We geolocated capture points with a GPS Garmin 64s. We reviewed records published in peer reviewed journals and books, and projected their geographical coordinates on a map to confirm their location. We estimated elevations with Google Earth Pro™ 7.3.0.3832 (Google Inc.). We generated the updated distribution map in QGIS Desktop 2.18.9 (QGIS Development Team 2017). Species identities were confirmed by comparison with the original descriptions and other pertinent literature, and with the aid of specialists in Centrolenids and Hemiphractids (see Acknowledgments).

Results

Gastrotheca longipes (Fig. 2, Table 1).—Specimens captured in Allpahuayo-Mishana match diagnostic characteristics noted by Boulenger (1882), Almendáriz and Cisneros-Heredia (2005), and Duellman (2015): skin of skull smooth not ossified, tympanic ring granular, dorsal skin green and that of venter cream, throat and chest yellow, upper lip white, lower lip green, white spot present under the eye and posteriorly to jaw, iris white with brown halftones, bones green, outer edge of heel brown to the tip of the outer toe. One juvenile individual had white spots on dorsum and flanks (where they were more numerous), cream yellow upper lips, white dermal folds on arms and legs, a brown stripe with white dots on dorsal surface of fingers, a single white dot on ventral surface of fingers, throat and chest yellow cream, belly green with creamy yellow spots; discs on fingers green; toes IV – V brown. We observed closed dorsal pouches in a female individual.

We captured three males and one female near forest streams heavily influenced by seasonal rains (i.e., where stream depth exceeded 1.5 meters during the peak of the rainy season). We found the first male

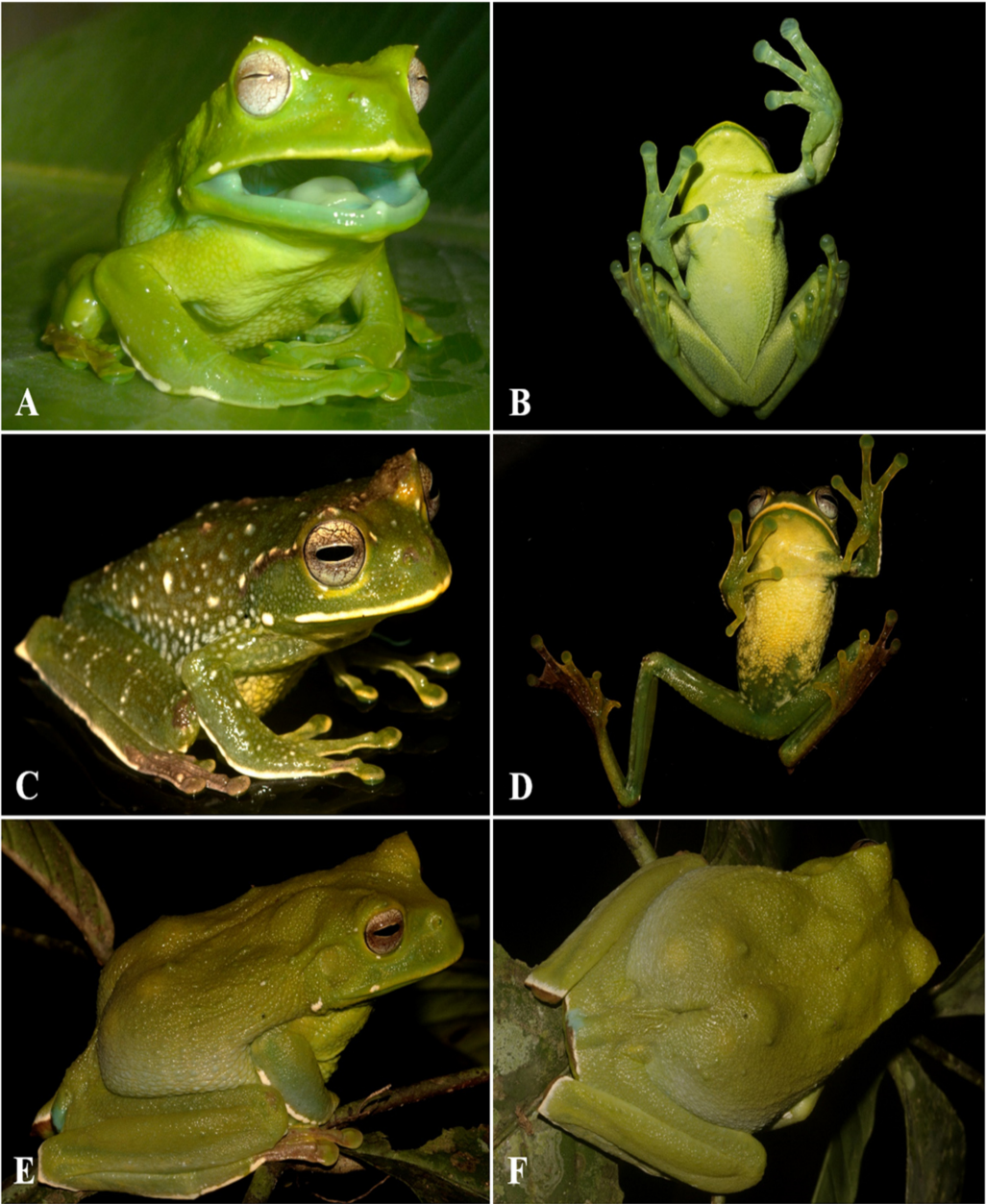


Figure 2. *Gastrotheca longipes* found at Allpahuayo-Mishana National Reserve. (A–B) an unvouchered adult male (SVL: 77.3 mm). (C–D) juvenile (CRBIIAP 1982, SVL: 32.88 mm). (E–F) a female bearing eggs on dorsal pouch (MCP 13954). Photos by G. Gagliardi-Urrutia.

(unvouchered, SVL: 77.3 mm) on 4 May 2013 at 17:35 h. At the time of capture, this male appeared to assume a defence position (appearing “swollen”) and issued a distress call which we did not record. While we were

taking photographs, the individual opened and closed his mouth constantly (Fig. 2A–B). We found a second male (SVL: 76.1 mm, not photographed) on 25 August 2014 at 18:30 h. We found a juvenile (CRBIIAP 1982,

Table 1. Records of *Gastrotheca longipes* in the Amazon basin. Geographical coordinates Datum WGS84.

Locality	Country	Latitude	Longitude	Altitude	Source
Rutuno River, Pastaza Province	Ecuador	-1.916	-77.250	446	Goin (1964)
Sunkuyacu River, Orellana Province	Ecuador	-0.694	-76.670	315	Almendáriz and Cisneros-Heredia (2005)
Tiputini Biological Station, Orellana Province	Ecuador	-0.791	-77.527	838	Almendáriz and Cisneros-Heredia (2005)
Canelos, Pastaza Province	Ecuador	-1.587	-77.734	453	Almendáriz and Cisneros-Heredia (2005)
Chigkan Entse, Cenepa River, Amazonas region	Peru	-4.466	-78.166	662	Almendáriz and Cisneros-Heredia (2005)
near Caterpiza, Caterpiza River, Amazonas region	Peru	-3.916	-77.716	188	Almendáriz and Cisneros-Heredia (2005)
Chichirota, Pastaza Province	Ecuador	-1.166	-77.216	422	Duellman et al. (2006)
Pongo Chimin, Datem del Marañón Province, Loreto region	Peru	-3.112	-77.776	384	Catenazzi and Venegas (2011)
Barranca, upper Marañón River, Loreto region	Peru	-4.832	-76.697	129	Duellman (2015)
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.952	-73.432	130	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.954	-73.417	140	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.952	-73.431	125	This report

SVL: 32.88 mm; Fig. 2C–D) perched on a leaf at 0.40 m height at the margin of the same stream on 4 June 2018. Finally, on 10 June 2018, we found a female with four eggs inside the pouch (MCP 13954, Fig. 2E–F) perched on a branch at 0.80 m near a stream.

Cochranella resplendens (Fig. 3, Table 2).—Specimens captured and photographed match the diagnostic characteristics provided by Lynch and Duellman (1973): snout round in dorsal view and sloping in lateral view, dorsal colouration dark green with scattered white spots, dermal folds present on the outer edge of hand, arm, foot, tarsus and around the heel, anal fold u-shaped, parietal and visceral peritoneum

white, humeral spine absent, heart not visible through skin in life.

We captured three individuals, two of which were found along a forest stream and a third near a small temporary pond fed by stream water. We found an adult male (unvouchered, SVL: 27.7 mm; Fig. 3A–B) on 16 March 2015 at 14:15 h perched on a branch 1.4 m above the ground. The vegetation of the area was composed of large trees (canopy reaching 15–25 meters), lianas and shrub vegetation on white sandy-clay soil. We found another male (MCP 13953, SVL: 23.48 mm; Fig. 3C–D) and a female with eggs (CRBIIAP 1969, SVL: 25.89 mm) perched on a leaf 0.5 m from the ground on 13 March 2018 at 23:00 h.

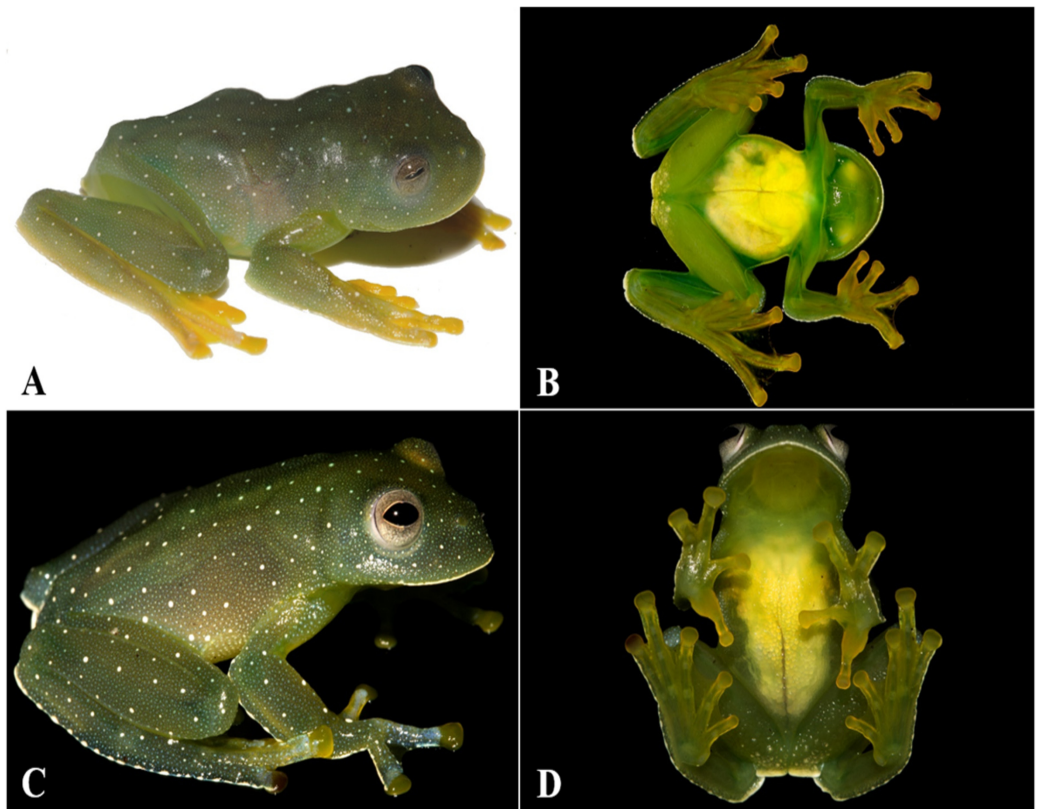


Figure 3. *Cochranella resplendens* found in Allpahuayo-Mishana National Reserve. (A–B) an unvouchered adult specimen (SVL: 27.7 mm). (C–D) an adult male (MCP 13953, SVL: 23.48 mm). Note intraspecific variation on dermal folds on legs and arms, and in colouration of hands and feet. Photos by G. Gagliardi-Urrutia.

Teratohyla midas (Fig. 4, Table 3).—Diagnostics characteristics of captured specimens matched the description provided by Lynch and Duellman (1973): snout truncate in dorsal and lateral view, iris silvery bronze with black reticulations, chest white, skin on venter coarsely areolate, dorsal skin shagreened without warts or spicules, dorsal colouration green with yellow spots, parietal peritoneum white, visceral peritoneum white, heart not visible through skin, arms and legs lacking dermal folds, hands and feet dull greenish yellow, humeral spine absent in males, bones green.

We found about 10 individuals during surveys. On 4 May 2013, we found an adult (unvouchered, Fig. 4A–B) on a branch 0.5 m above the ground. On 4 June 2017, we heard two males calling, and captured one (CRBIIAP 2099, SVL: 17.9 mm; Fig. 4C–D) on a leaf at 1.80 m above the stream. We also photographed an adult male in calling activity (Fig. 4E) and an egg clutch

(Fig. 4F) with 13 tadpoles at developmental stage 17–19 (Gosner, 1960) on the same day. On 02 February 2018, we captured three adults (MCP 13950, SVL: 17.4 mm; MCP 13951, SVL: 16.9, CRBIIAP 2101, SVL: 20.3 mm).

Discussion

Gastrotheca longipes was previously known to occur from 250 to 1,020 m a.s.l. in Amazonian Ecuador and Peru (Almendáriz and Cisneros-Heredia, 2005; Duellman et al., 2006; Catenazzi and Venegas, 2012; Duellman, 2015). Our records in Allpahuayo-Mishana National Reserve extend the lower boundary of the species' elevational range to 125 m a.s.l. Our records also stretch the species' geographical range 508 km eastward, and adds a third known locality for the species in Loreto. *Gastrotheca longipes* might be

Table 2. Records of *Cochranella resplendens* in the Amazon basin. Geographical coordinates Datum WGS84.

Locality	Country	Latitude	Longitude	Altitude	Source
Santa Cecilia, Sucumbios Province	Ecuador	-0.080	-76.990	339	Lynch and Duellman (1973)
Pozo Garza, Oryx, Pastaza Province	Ecuador	-1.433	-77.05	312	Cisneros-Heredia and McDiarmid (2005)
Tiputini Biological Station, Orellana Province	Ecuador	-0.616	-76.166	257	Cisneros-Heredia and McDiarmid (2005)
Viejo de Sumaco, Orellana Province	Ecuador	-0.533	-77.416	948	Cisneros-Heredia and Meza-Ramos (2007)
Tiputini Biological Station, Orellana Province	Ecuador	-0.791	-77.527	300	Cisneros-Heredia and Meza-Ramos (2007)
Napinaza River, Morona Santiago Province	Ecuador	-2.926	-78.406	1100	Terán-Valdez et al. (2009)
Microcuenca La Resaca, Municipality of Belén de Los Andaquíes, Caquetá departament	Colombia	1.439	-75.890	482	Malambo et al. (2013)
Stream near the village of San Jose in the Cainarachi valley near Tarapoto, San Martín region	Peru	-0.642	-76.291	518	Twomey et al. (2014)
Quebrada Bufeo, Putumayo Province, Loreto region	Peru	-2.330	-71.607	124	Chávez and Mueses-Cisneros (2016)
Finca El Chaquiral, vereda El Retiro, Municipality de Anorí, Antioquia region	Colombia	6.988	-75.130	1699	Molina-Zuluaga et al. (2017)
El Eden, vereda San Antonio, Municipality de Alejandría, Antioquia region	Colombia	6.367	-75.027	1309	Molina-Zuluaga et al. (2017)
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.966	-73.418	129	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.965	-73.431	131	This report

distributed throughout the Amazon basin (Blackburn and Duellman, 2013), but records are very rare because this marsupial frog inhabits the forest canopy and is rarely observed in the forest understory (Almendáriz and Cisneros-Heredia, 2005; Guayasamin et al., 2006). The distress behaviour of the male we captured and photographed has been termed “puffing-up body” and “mouth gapping” (Toledo et al., 2011), and has been observed in others Hemiphractids species (Lourenço-de-Moraes et al., 2016). Our observation constitutes the first report of such behaviours in *G. longipes*.

Cochranella resplendens was known from 11 localities in the Andean and lowland Amazon forests of Peru, Ecuador and Colombia, with an elevational range from 190 to 1,699 m a.s.l. (Lynch and Duellman, 1973;

Cisneros-Heredia and McDiarmid, 2005; Cisneros-Heredia and Meza-Ramos, 2007; Torres-Gastello et al., 2007; Terán-Valdez et al., 2009; Malambo et al., 2013; Twomey et al., 2014; Chávez and Mueses-Cisneros, 2016; Molina-Zuluaga et al., 2017). Our record extends the species’ known distribution 345 km southwest and represents the third geographic record of the species for Peru, the second for the Loreto region and the first inside a protected area. Previous records have been made in areas close to streams within primary forests and mature secondary forest (Chávez and Mueses-Cisneros, 2016), which are similar in structure to those where we found our individuals. One of the specimens found during surveys, had small and scattered spots, small dermal folds on legs and arms, and yellow hands

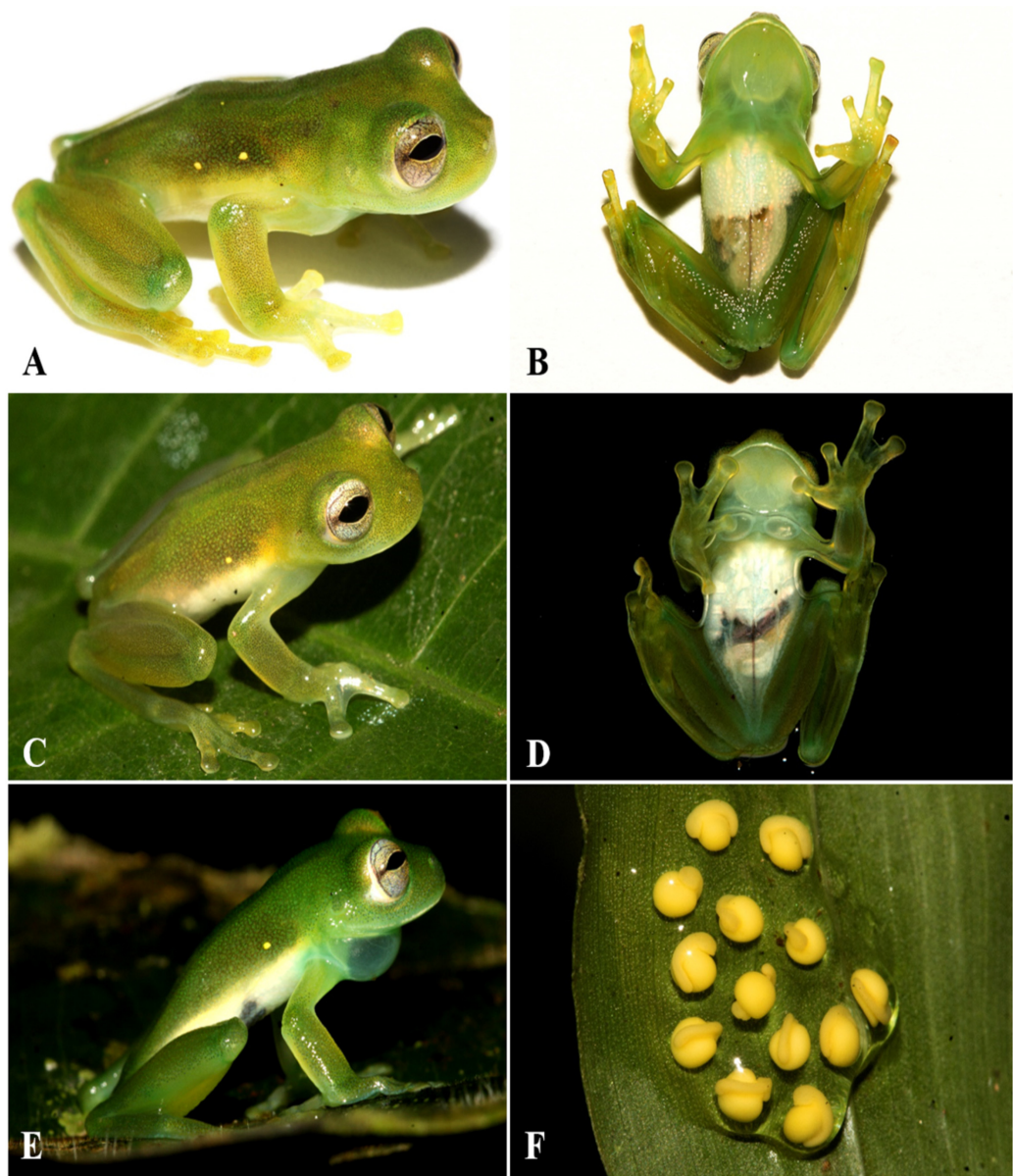


Figure 4. *Teratohyla midas* found in Allpahuayo-Mishana National Reserve, in Loreto, Peru. (A–B) an unvouchered adult specimen. (C–D) male (CRBIIAP 2099, SVL: 17.9 mm). (E) an unvouchered adult male in calling activity. (F) egg clutch containing 13 embryos at developmental stages 17–19 (Gosner, 1960). Photos A–B by E.J. Rios-Alva; C–F by G. Gagliardi-Urrutia.

and feet. Based on available publications, this pattern is within the range of intraspecific colour variation of the species. Malambo et al. (2013) reported one individual with green hands and feet, and with small and scattered spots on dorsum. Molina-Zuluaga et al. (2017) reported one individual with green legs and two individuals with yellow colouration on the hands and feet, in addition to variation in the length and width of dermal folds on arms and legs. Combined, these reports suggest *C. resplendens* to be polychromatic, and future studies

Table 3. Records of *Teratohyla midas* in the Amazon basin. Geographical coordinates Datum WGS84.

Locality	Country	Latitude	Longitude	Altitude	Source
Santa Cecilia, Napo Province	Ecuador	-0.05	-76.983	339	Lynch and Duellman (1973)
Panguana, Huánuco region	Peru	-9.583	-74.8	405	Toft and Duellman (1979)
Pakitza, Madre de Dios region	Peru	-11.9	-71.366	345	Morales and McDiarmid (1996)
Tiputini Biodiversity Station, Orellana Province	Ecuador	-0.616	-76.166	190	Cisneros-Heredia and McDiarmid (2005)
Yasuní Scientific Station, Orellana Province	Ecuador	-0.666	-76.400	230	Cisneros-Heredia and McDiarmid (2005)
Puerto Misahualli, Napo Province	Ecuador	-1.033	-77.666	400	Cisneros-Heredia and McDiarmid (2005)
Oglán River, Pastaza Province	Ecuador	-1.333	-77.583	600	Cisneros-Heredia and McDiarmid (2005)
Alto Mazan, Loreto region	Peru	-2.586	-74.492	134	Catenazzi and Bustamante (2007)
Alto Nanay, Loreto region	Peru	-2.806	-74.825	153	Catenazzi and Bustamante (2007)
Pisorié Setsa'cco, between Aguarico and Pisorié rivers, Dureno	Ecuador	-0.001	-76.671	278	Yáñez-Muñoz and Chimbo (2007)
Totoa Nai'qui, Dureno	Ecuador	-0.0513	-76.796	298	Yáñez-Muñoz and Chimbo (2007)
Güepicillo, Sucumbíos	Ecuador	-0.177	-75.675	225	Yáñez-Muñoz and Venegas (2008)
Crique Grand Leblond, French Guyana	Guyana French	4.700	-53.183	76	Kok and Castroviejo-Fisher (2008)
Boca do Acre, Amazonas state	Brazil	-9.026	-67.236	151	França and Venâncio (2010)
Regional Conservation Area "Maijuna", Las Piedras river, Loreto region	Peru	-2.792	-72.917	163	von May and Venegas (2010)
Choro, Yaguas National Park, Putumayo Province, Loreto region	Peru	-2.610	-71.485	160	von May and Mueses-Cisneros (2011)
Pongo Chinim, Datem del Marañón Province, Loreto region	Peru	-3.113	-77.776	385	Catenazzi and Venegas (2012)
Quebrada Kampankis, Condorcanqui Province, Amazonas region,	Peru	-4.043	-77.541	1336	Catenazzi and Venegas (2012)
Municipality of Solita, Caquetá departament	Colombia	0.883	-75.616	219	Osorno et al. (2011)
Mâncio Lima: Serra do Divisor National Park: Igarapé Ramon	Brazil	-7.450	-73.766	276	Melo-Sampaio and de Oliveira (2013)
Municipality of Sao Pedro da Água Branca	Brazil	-5.085	-48.429	159	Pontes and Mattedi (2013)
Municipality of Porto Velho, Vista Alegre do Abuna, Rondônia state	Brazil	-9.576	-65.570	149	Melo-Sampaio and de Oliveira (2013)

Table 3. Continued.

Locality	Country	Latitude	Longitude	Altitude	Source
Sucre, Municipality de Florencia	Colombia	1.781	-75.651	950	Malambo et al. (2013)
El corregimiento de Santo Domingo, Municipality de Florencia	Colombia	1.558	-75.668	295	Malambo et al. (2013)
En la microcuenca La Resaca, Municipality de Belén de los Andaquíes	Colombia	1.439	-75.890	482	Malambo et al. (2013)
San José, San Martín region	Peru	-6.420	-76.291	531	Twomey et al. (2014)
Pongo de Rentema, Amazonas region	Peru	-5.295	-78.406	556	Twomey et al. (2014)
Alto Cachiyacu, Loreto region	Peru	-5.516	-76.717	216	Venegas et al. (2014)
"Sierra del Divisor" National Park, Contamana Province, Loreto region	Peru	-7.204	-73.882	274	Melo-Sampaio and de Souza (2015)
Quebrada Bufo, Putumayo Province, Loreto region	Peru	-2.330	-71.607	124	Chávez and Mueses-Cisneros (2016)
Puesto de Control y Vigilancia, La Novia River, Ucayali region	Peru	-9.9882	-70.7081	260	Padial et al. (2016)
Sepahua River, Ucayali region	Peru	-11.05002	-72.45307	356	Padial et al. (2016)
3.8 km south of Puerto Breu, Ucayali region	Peru	-9.566	-72.755	268	Padial et al. (2016)
Community Natural Reserve "El Manantial", Florencia, Caquetá department	Colombia	1.847	-75.584	427-493	Rodríguez-Cardoso et al. (2016)
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.965	-73.431	133	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.937	-73.445	138	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.957	-73.420	123	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.952	-73.432	130	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.954	-73.433	125	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.951	-73.419	135	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.948	-73.434	131	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.964	-73.418	131	This report
"José Álvarez Alonso" Biological Station, Allpahuayo-Mishana National Reserve, Loreto	Peru	-3.965	-73.4315	131	This report

should be evaluated whether different colour morphotypes are associated with particular geographic regions.

Teratohyla midas is regarded as a common species with a broad distribution in northern South America, altitudinally ranging from 76 to 1,336 m a.s.l. Most geographic records were reported from Peru, Ecuador and Colombia, with a few records in Brazil and French Guiana (Table 3, Fig. 1). The species is likely to be found in the Amazonian forests of Bolivia and other localities in the Amazon basin where it has not yet been detected. During our surveys we recorded individuals calling and in amplexus on the riparian vegetation along forest streams at different times of the year. Reproductive activity increases considerably during the rain. For example, in a survey on 04 June 2017, we heard numerous and intense vocalizations along a 3 km-long stretch of a water stream, during and after a rain storm. The activity continued, with lower intensity along the following days. It seems that the species has a gregarious behaviour during reproduction, because many males can be found in nearby areas (Díaz-Ricarte *et al.*, 2016). Contrary to the report by Díaz-Ricarte *et al.* (2016), we found egg clutches attached to the backs of leaves, including palm leaves, always hanging above water streams. We believe that the site and position of egg clutches is not fixed reproductive trait in *T. midas*, as it has been described for several other glassfrog species (Vockenhuber *et al.*, 2008; Delia *et al.*, 2010; Rojas-Morales and Escobar-Lasso, 2013).

With these three new records, the number of amphibian species registered within the Allpahuayo-Mishana National Reserve is increased to 86. This protected area covers a diversity of ecosystems that includes white-sand forests, forest growing over clay forests and seasonally flooded forests, which have yet to be thoroughly surveyed. Therefore, we expect further work to reveal new records of amphibians and reptiles in the area.

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