



## Amphibians of Haut-Ogooué Province, southeastern Gabon

<sup>1,6,\*</sup>Gregory F. M. Jongsma, <sup>2</sup>Elie Tobi, <sup>3</sup>Graham P. Dixon-MacCallum, <sup>4</sup>Abraham Bamba-Kaya, <sup>4</sup>Jean-Aimé Yoga, <sup>4</sup>Jean-Daniel Mbega, <sup>4</sup>Jean-Hervé Mve Beh, <sup>5</sup>Andrea M. Emrich, and <sup>6</sup>David C. Blackburn

<sup>1</sup>New Brunswick Museum, 277 Douglas Avenue, Saint John, NB, CANADA E2K 1E5 <sup>2</sup>Center for Conservation and Sustainability, Smithsonian Conservation Biology Institute, CNG, Gabon Biodiversity Program <sup>3</sup>1756 Cambridge St. Halifax, NS, CANADA, B3H 4A9 <sup>4</sup>Institut de Recherches Agronomiques et Forestières, Libreville, GABON <sup>5</sup>141 Wentworth Ave. Saint John, NB, CANADA, E2L 2S7 <sup>6</sup>Florida Museum of Natural History, University of Florida Gainesville, Florida 32611, USA

**Abstract.**—We provide the most complete inventory to date of amphibians for Haut-Ogooué province in southeastern Gabon. This inventory is based on an 11-day survey conducted in 2015 around two villages, Doumaye and Mboua, near the Gabon-Congo border and a previous survey in Batéké Plateau National Park during 2011. We report 42 species of anuran amphibians (21 genera; 11 families) for Haut-Ogooué including 26 new species records for the province and two new country records for Gabon (*Afrixalus osorioi* and *Hyperolius balfouri*). This work brings the total known amphibian diversity in Gabon to 98 species.

**Résumé.**—Nous fournissons dans cet article, l'inventaire le plus complet des amphibiens de la province du Haut-Ogooué dans le sud-est du Gabon. Cet inventaire se fonde sur des recherches menées durant 11 jours en 2015 autour de deux villages, Doumaye et Mboua, près de la frontière Gabon-Congo et celles menées en 2011 dans le parc national des Plateaux Batéké par Zimkus & Larson (2013). Nous rapportons 42 espèces d'amphibiens (21 genres, 11 familles) pour le Haut-Ogooué dont 26 nouvelles espèces pour la province et trois nouvelles mentions pour le Gabon (*Afrixalus osorioi* et *Hyperolius balfouri*). Ce travail porte à 98 espèces le nombre total connu de la diversité des amphibiens du Gabon.

**Keywords.** Africa, anuran, diversity, frogs, herpetofauna, savanna, forest

**Citation:** Jongsma GFM, Tobi E, Dixon-MacCallum GP, Bamba-Kaya A, Yoga J-A, Mbega J-D, Mve Beh J, Emrich AM, Blackburn DC. 2017. Amphibians of Haut-Ogooué Province, southeastern Gabon. *Amphibian & Reptile Conservation* 11(1) [Special Section]: 1–23 (e144).

**Copyright:** © 2017 Jongsma et al. This is an open-access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits unrestricted use for non-commercial and education purposes only, in any medium, provided the original author and the official and authorized publication sources are recognized and properly credited. The official and authorized publication credit sources, which will be duly enforced, are as follows: official journal title *Amphibian & Reptile Conservation*; official journal website <[amphibian-reptile-conservation.org](http://amphibian-reptile-conservation.org)>.

**Received:** 06 December 2016; **Accepted:** 13 September 2017; **Published:** 20 November 2017

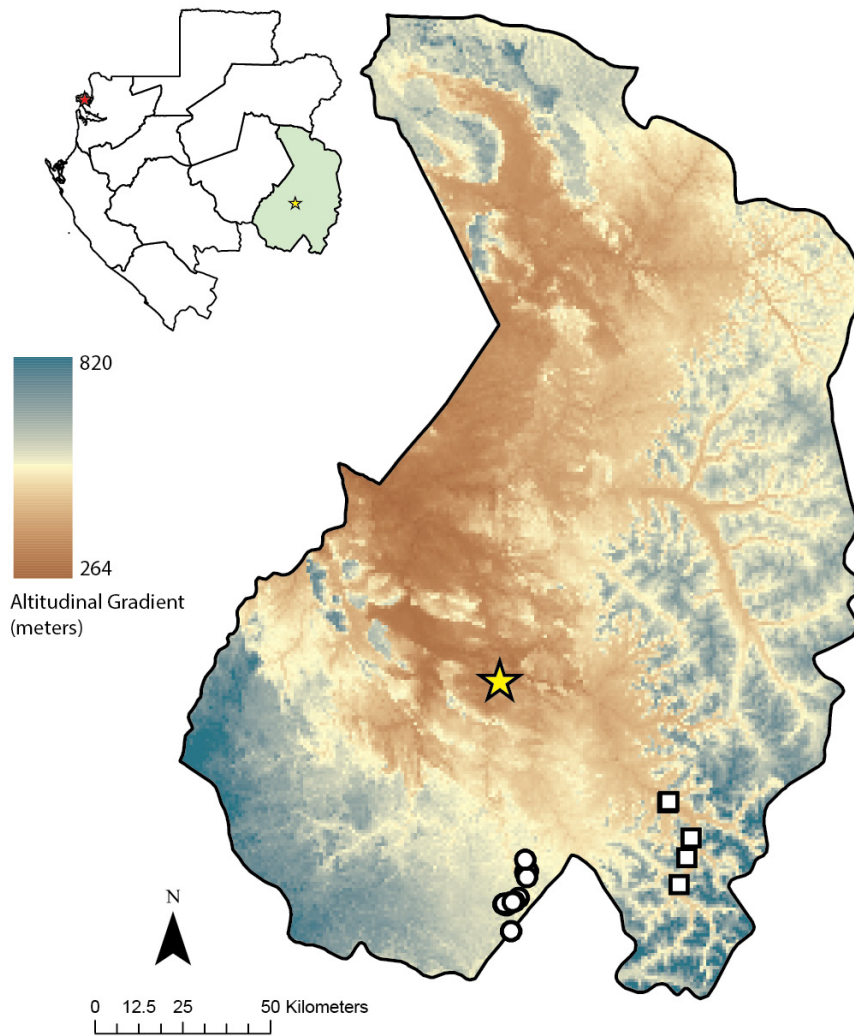
### Introduction

Despite its relative small size, Gabon hosts a number of significant biogeographic features, including the Batéké Plateau, the Ogooué River, and two hypothesized Pleistocene forest refugia (Crystal Mountains and Chaillu Massif). The country is dominated by lowland rainforest, interspersed with a forest-savanna mosaic. Despite topographic diversity and expansive pristine habitat, there is a paucity of research that directly explores the influence and interactions of these features on biodiversity. In part, this is a result of incomplete sampling across most of Gabon. Our report adds to the growing inventory of Gabonese amphibians based on surveys of a region that is underrepresented in natural history collections.

The earliest known amphibian and reptile specimens from Gabon were collected by Charles Eugène Aubry-Lecomte. A French civil servant and keen naturalist,

Aubry-Lecomte made an important collection along the Gabonese coast for the Muséum national d'Histoire naturelle in Paris (Duméril 1856; Beolens et al. 2011). Between 1850 and 1854, he collected the first series of *Cycloderma aubryi* (Duméril 1856) and *Leptopelis aubryi* (Duméril 1856) as well as several new species of birds and plants (Duméril 1856; Beolens et al. 2011). Around the same period (1851–1855), Henry Alexander Ford, an American M.D, was stationed at Baraka Mission in present day Libreville to research malarial fever (Ford 1856). During this time, he collected reptiles for the Academy of Natural Sciences of Philadelphia (now, of Drexel University), including the type series of *Poromera fordii* (Hallowell 1857) and *Gerrhosaurus nigrolineatus* (Hallowell 1857). In 1855, Paul Belloni Du Chaillu became the first westerner to explore the interior of Gabon (Du Chaillu 1861). Funded by the Academy of Natural Sciences of Philadelphia, Du Chaillu collected large series

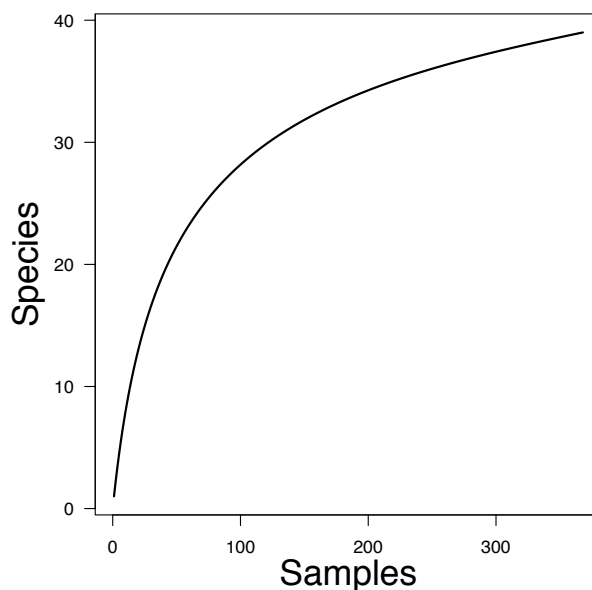
**Correspondence.** \*[gregorjongsma@gmail.com](mailto:gregorjongsma@gmail.com)



**Fig. 1.** Map of Haut-Ogooué province, with the capital Franceville (yellow star). Sample sites from this study are indicated with white circles. White squares denote study site for Zimkus and Larson (2013).

of birds and mammals (including the first intact gorilla specimens) and the type series of *Amnirana albolabris* (Hallowell 1856). At the turn of the 20<sup>th</sup> Century, Ernest Haug, a missionary for the Société des missions évangéliques de Paris, conducted two methodical herpetological inventories approximately 50 km southwest of Lambaréné, Moyen-Ogooué for the Muséum national d'histoire Naturelle de Paris. This resulted in 29 reptile species and 23 frog species (Mocquard 1897, 1902). Herpetological work since the early 1900s has been sporadic but there was an upsurge of inventory work around the beginning of the 21<sup>st</sup> Century (Burger et al. 2004; Burger et al. 2006; Frétey and Blanc 2000; Frétey and Dewynter 1998; Knoepffler 1966, 1974; Lötters et al. 2000; Lötters et al. 2001; Pauwels et al. 2004; Pauwels and Rödel 2007; Zimkus and Larson 2013), and Gabon's known amphibian diversity has increased substantially through these recent efforts.

At the turn of the millennium, the country amphibian total for Gabon was 72 species (Frétey and Blanc 2000). Today, less than two decades later, there are now 96 known amphibian species in Gabon, including 94



**Fig. 2.** Species rarefaction curve based on amphibians encountered in Haut-Ogooué province between April 21<sup>st</sup> to May 1<sup>st</sup>, 2015.





**Fig. 3.** Different habitats sampled in Haut-Ogooué during 2015 field surveys. Lentic habitat in closed forest (A), lotic habitat with closed forest (B, C), lentic habitat at edge of forest (D), lentic habitat in savanna (E), lentic habitat in disturbed open area (F), savanna (G), lentic habitat open forest habitat (H).

frogs and two caecilians (Neil and Jongsma 2016; Evans et al. 2015; Zimkus and Larson 2013; Frétey et al. 2011; Bell et al. 2011; Burger et al. 2006; Pauwels and Rödel 2007; Pauwels 2016). All published amphibian inventories for Gabon are restricted to just six of the 13 national parks (see summary Pauwels and Rödel 2007; Pauwels 2016). However, several recently discovered species were described from outside parks, including *Werneria iboundji* Rödel et al. 2004 and *Leptodactylodon stevarti* Rödel and Pauwels 2003. Zimkus and Larson (2013) car-

ried out the first survey of amphibians in Haut-Ogooué Province in Batéké National Park (BNP) and reported 18 frog species (three unidentified), including four new country records. Our recent survey, presented below, reveals many additional species for the province and two additional species records for Gabon. We hope that our study will serve as a guide to students and researchers undertaking future herpetofaunal work in both Gabon and Haut-Ogooué Province.



## Materials and Methods

Gabon is a small equatorial country (267,667 km<sup>2</sup>) dominated by tropical moist forest (80% total land cover; Lee et al. 2006). The dominant hydrological feature is the Ogooué River basin. There are four seasons: a long rainy season from January to May; a long cold dry season from June to September; a short rainy season from October to December; and a short dry season from December to January. The average annual temperature is 26 °C (Lee et al. 2006).

Haut-Ogooué Province (36,547 km<sup>2</sup>) is located in southeastern Gabon and is composed of three major geological formations: the Chaillu Massif in the southwest, the Franceville Basin in the northwest, and the Batéké Plateau to the east. The Chaillu Massif and Batéké Plateau are unique in Gabon because of their geological histories and contemporary environments. The Chaillu Massif is an ancient formation dating to >2 billion years ago that hosts some of the highest elevation forests in Gabon, including forest refugia (Sosef 1994; Vande weghe 2009). The massif is dominated by forest but also hosts small forest-savanna mosaics around the foothills that originate in the Haut-Ogooué Province. The Batéké Plateau has a sandy substrate and is dominated by large swaths of savanna that are contiguous with plains in southern Africa (Vande weghe 2009). The border of Haut-Ogooué represents the boundary between three major watersheds: the Kouilou-Niari River, the Congo River, and the Ogooué River. We conducted surveys at sites within the Ogooué Basin at the foothills of the Chaillu Massif. Zimkus and Larson (2013) work was based at the Batéké Plateau, also within the Ogooué Basin.

We conducted visual encounter surveys around two villages: Doumaye (02.2402°S, 013.5812°E) on the left side of the Ogooué River, and Mboua (02.1532°S, 013.6398°E) to the right side of the river. Both sites are located in the administrative department of Lekoko in Haut-Ogooué province. The village of Doumaye is dominated by savanna habitat with gallery forest associated with rivers. The habitat around the village of Mboua consists of continuous gallery forest. We spent five survey nights in Doumaye (21–25 April 2015) and six in Mboua (26 April–1 May 2015). We typically worked between 19h00 to 00h00 each night, targeting forested streams and rivers, and small still bodies of water (Fig. 3). Our research in Haut-Ogooué Province focused on six species (*Afraxalus dorsalis*, *Amnirana albolabris*, *Hyperolius olivaceus*, *H. ocellatus*, *Phrynobatrachus africanus*, and *Scotobleps gabonicus*) for a comparative phylogeographic study around the Ogooué River. We captured other amphibians opportunistically.

All species encountered across both sites were photographed alive and swabbed for chytrid fungus (*Batrachochytrium dendrobatidis*; *Bd*). Voucher specimens were euthanized using an aqueous solution of MS-222,

and a sample of liver tissue was removed and stored in RNAlater, before preserving the whole specimen in 10% neutral-buffered formalin. Specimens are deposited at the California Academy of Sciences (CAS) in San Francisco, California, Sam Noble Museum (OMNH) in Norman, Oklahoma, and Gabon's national collection in Yenzi Camp, Gamba, Gabon. We refer to specimens in Gabon's collection using GFMJ field numbers. To determine the extent to which our species sampling was comprehensive, we constructed a rarefaction curve using the rare curve function in the vegan package (Oskansen et al. 2013) for R (R Core Team 2013).

Laboratory work was conducted at the Florida Museum of Natural History (FLMNH) by GFMJ. We extracted genomic DNA from tissues (liver, muscle, or toe clips) using Qiagen DNeasy Kits following their protocol for animals. Using polymerase chain reaction (PCR), we amplified a ~762 base pair (bp) fragment of mitochondrial DNA that encodes part of the mitochondrial ribosomal 16S gene (94 °C 30 s, 52 °C 30 s, 72 °C one min) using 35 cycles and the oligonucleotide primers 16Sc and 16Sd (Moriarty and Cannatella 2004). We used ExoSAP-IT (Affymetrix) to purify all amplified PCR products and then shipped this product for Sanger sequencing at Genewiz Co. All sequences are deposited in GenBank (accession numbers: MF537671–MF537697).

## Species Accounts

### AMPHIBIA – Frogs

#### ARTHROLEPTIDAE

##### *Arthroleptis cf. poecilonotus* (Peters 1863)

**Material:** One (1) specimen. Doumaye: CAS 258166. Fig. 4A.

**Comments:** *Arthroleptis poecilonotus* is a leaf-litter species that is associated with forest habitats but also found in wet savanna and near human habitations. It is widespread across West and Central Africa and is likely composed of several unnamed species (Blackburn 2008). Populations in Central Africa, including eastern Nigeria, Cameroon, Gabon, and Republic of Congo, referred to *A. poecilonotus* are not conspecific with those identified as the same species in western Africa (Blackburn et al. 2010), though no taxonomic changes have yet been made. This species was first reported for Gabon by Mocquard (1902; under *Arthroleptis inguinalis*) near Lambaréné in Moyen-Ogooué province. It has since been found in several national parks including: Batéké NP (Zimkus and Larson 2013), Crystal Mountains NP (Lötters et al. 2001), Ivindo National Park (Frétey and Blanc 2000), Loango NP (Burger et al. 2006), and Lopé NP (Frétey and Blanc 2001).

## Amphibians of southeastern Gabon

**Table 1.** Amphibian species recorded for Haute-Ogooué Province. \*=New provincial record. \*\*=New country record. Habitats include forest (F), open disturbed areas (O), savanna (S), and edge (ED). Microhabitats include leaf litter (LL), arboreal (AR), and aquatic (AQ). Some species lacking microhabitat information were not collected by the authors.

	Doumaye	Mboua	Zimkus and Larson 2013	Habitat	Microhabitat
<b>ARTHROLEPTIDAE</b>					
<i>Arthroleptis cf. poecilonotus</i>	X		X	F	LL
<i>A. cf. sylvaticus</i>		X	X	F	LL
<i>Astylosternus batesi</i> *	X	X		F	LL
<i>Cardioglossa gracilis</i> *	X	X		F	LL
<i>Leptopelis aubryi</i> *	X			O	AR
<i>L. aubryioides</i> *		X		F	AR
<i>L. calcaratus</i> *	X	X		F	AR
<i>L. millsoni</i> *	X	X		F	AR
<i>L. notatus</i> *		X		F	AR
<i>L. ocellatus</i> *	X	X		F	AR
<i>Scotobleps gabonicus</i> *	X	X		F	LL
<b>BUFONIDAE</b>					
<i>Sclerophrys gracilipes</i> *	X	X		F	LL
<i>S. superciliaris</i> *	X			F	LL
<b>CONRAUIDAE</b>					
<i>Conraua crassipes</i> *		X		F	AQ
<b>DICROGLOSSIDAE</b>					
<i>Hoplobatrachus occipitalis</i>	X		X	S	AQ
<b>HYPEROLIIDAE</b>					
<i>Afrivalus dorsalis</i> *	X	X		O	AR
<i>A. osorioi</i> **	X			O	AR
<i>A. quadrivittatus</i>	X		X	O	AR
<i>Cryptothylax greshoffi</i>		X	X	O	AR
<i>Hyperolius adspersus</i>	X		X	S	AR
<i>H. balfouri</i> **	X	X		O	AR
<i>H. bolifambae</i>			X	F	
<i>H. kuligae</i> *		X		F	AR
<i>H. ocellatus</i> *	X	X		F/ED	AR
<i>H. olivaceus</i> *	X			S	AR
<i>H. pardalis</i> *	X	X		S/ED	AR
<i>H. phantasticus</i> *	X			S	AR
<i>Kassina maculosa</i>			X	S	AR
<i>Opisthothylax immaculatus</i> *		X		F	AR
<i>Phlyctimantis leonardi</i> *	X			S	AR
<b>PHRYNOBATRACHIDAE</b>					
<i>Phrynobatrachus africanus</i> *	X	X	X	F	LL
<i>P. horstii (P. ruthbeateae)</i>			X	F	LL
<b>PIPIDAE</b>					
<i>Hymenochirus boettgeri</i>			X	F	AQ
<i>Xenopus pygmaeus</i>			X	F	AQ
<b>PTYCHADENIDAE</b>					
<i>Ptychadena perreti</i>			X	S	
<i>P. taenioscelis</i>			X	S	
<i>P. uzungwensis</i>			X	S	

**Table 1 (continued).** Amphibian species recorded for Haute-Ogooué Province. \*=New provincial record. \*\*=New country record. Habitats include forest (F), open disturbed areas (O), savanna (S), and edge (ED). Microhabitats include leaf litter (LL), arboreal (AR), and aquatic (AQ). Some species lacking microhabitat information were not collected by the authors.

	Doumaye	Mboua	Zimkus and Larson 2013	Habitat	Microhabitat
<b>PYXICEPHALIDAE</b>					
<i>Aubria masako</i> *		X		F	AQ
<b>RANIDAE</b>					
<i>Amnirana albolabris</i>	X	X	X	F	AR
<i>A. amnicola</i> *	X	X		F	AR
<i>A. lepus</i> *	X	X		F	AR
<b>RHACOPHORIDAE</b>					
<i>Chiromantis rufescens</i>		X		F	AR

### ***Arthroleptis cf. sylvaticus* (Laurent 1954)**

**Material:** Six (6) specimens. Doumaye: CAS 258184; GFMJ 1327. Mboua: CAS 258166, 258241–42; OMNH 44767. Fig. 4B.

**Comments:** *Arthroleptis sylvaticus* is a leaf-litter species that is widespread across Central Africa, north of the Congo River and is a complex of several undescribed species. This species is known from the following national parks: Batéké (Zimkus and Larson 2013), Ivindo (Frétey and Blanc 2000), Loango (Burger et al. 2006), Lopé (Frétey and Blanc 2001), and Moukalaba-Doudou (Burger et al. 2004).

### ***Astylosternus batesi* (Boulenger 1900)**

**Material:** Eighteen (18) specimens. Doumaye: CAS 258139, 258151, 258211–12; GFMJ 1240, 1242, 1270, GFMJ 1322–23, 1372. Mboua: CAS 258285–86; OMNH 44768–69; GFMJ 1397, 1461, 1514–15. Fig. 4C, D.

**Comments:** *Astylosternus batesi* is a leaf-litter species that is strongly associated with forested streams. Individuals are best detected by eye-shine at night. This species is distinguishable from the closely related and sympatric species *Scotobleps gabonicus* by its smoother skin. It is known from three national parks: Crystal Mountains NP (Lötters et al. 2001), Ivindo NP (Frétey and Blanc 2000), and Moukalaba-Doudou NP (Burger et al. 2004).

### ***Cardioglossa gracilis* (Boulenger 1900)**

**Material:** Ten (10) specimens. Doumaye: CAS 258182–83, 258197, 258208, 258210; GFMJ 1326. Mboua: CAS 258227, 258251; OMNH 44770–71. Fig. 4E

**Comments:** Male *C. gracilis* are typically found calling from leaf litter within 10 meters of forested streams with sloped sides. Their call is an insect-like click. Males are faithful to their calling sites (GFMJ, pers. obs.); if disturbed, they will vacate the calling site, but

then return to the same spot a short while later. This species was first collected in neighboring Equatorial Guinea by the ornithologist George L. Bates along the Benito River (Boulenger 1900). *Cardioglossa gracilis* is also known from Ivindo NP (Frétey and Blanc 2000) and Moukalaba-Doudou NP (Burger et al. 2004). We also collected voucher specimens from Mitoné village near Lambaréné (000.64375°S, 010.22071°E; CAS 258016) and Madoukou village near Lastoursville (00.86831°S, 12.67244°E; GFMJ 1583).

### ***Leptopelis aubryi* (Duméril 1856)**

**Material:** Six (6) specimens. Doumaye: CAS 258202, 258260–61; GFMJ 1470–71, 1473. Fig. 4F.

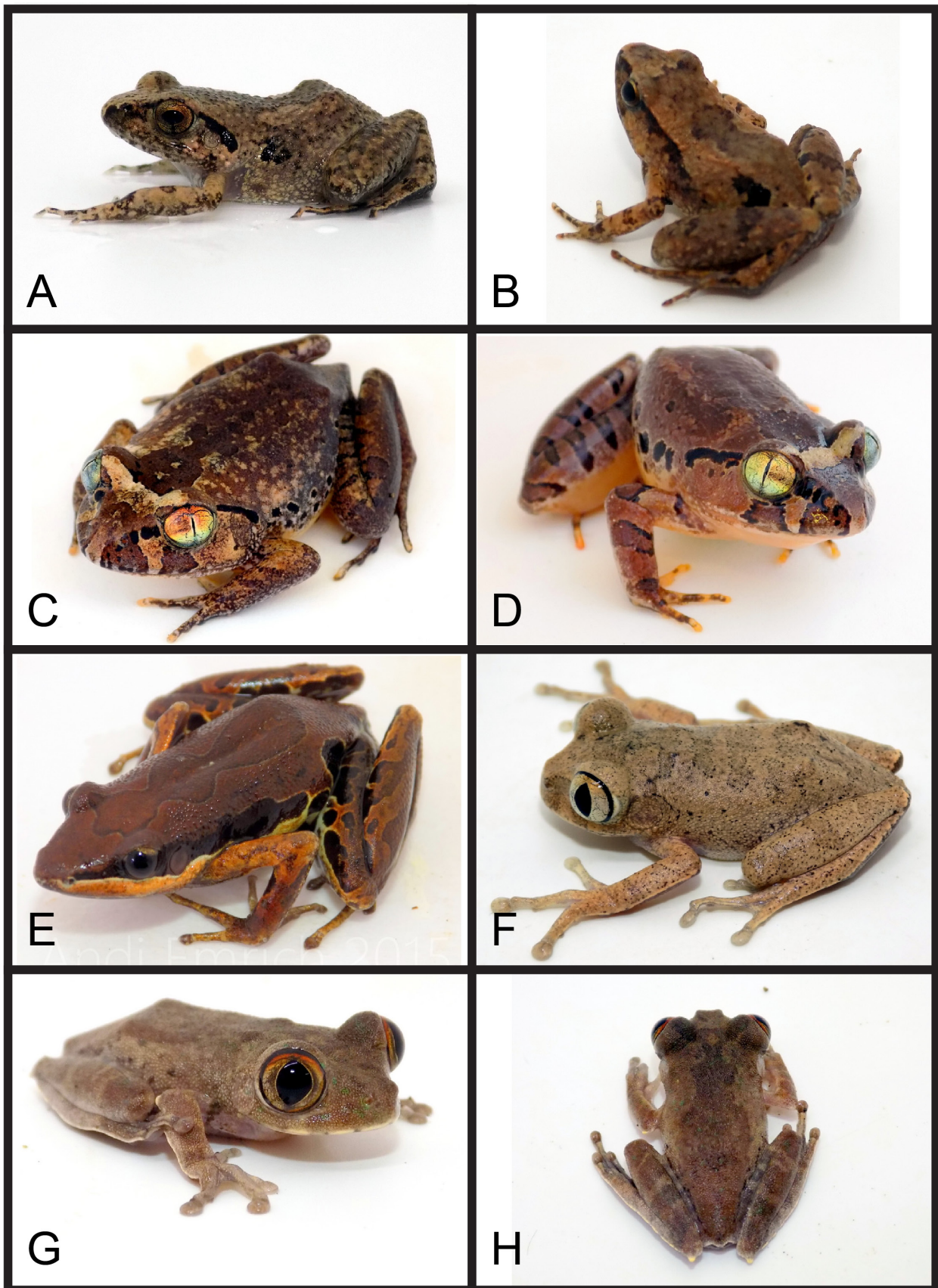
**Comments:** *Leptopelis aubryi* was originally collected by Charles Eugène Aubry-Lecomte in the early 1850s and is among the first amphibians ever collected in Gabon (Duméril 1856). We encountered all individuals in tall grass in ditches and around well pumps in Doumaye. It is a disturbance specialist. In the Plaine Ouanga Reserve in the Gamba Complex of Protected Areas (GCPA) in the Ogooué-Maritime province, one of us (E. Tobi) regularly finds this species on the branches of trees at the edge of forest and in the forest. It is widespread across Central Africa, North of the Congo River. Within Gabon voucher specimens are known from the following national parks: Crystal Mountains NP (Lötters et al. 2001), Ivindo NP (Frétey and Blanc 2000), Loango NP (Burger et al. 2006), Lopé NP (Frétey and Blanc 2001), and Moukalaba-Doudou (Burger et al. 2004).

### ***Leptopelis aubryioides* (Andersson 1907)**

**Material:** One (1) specimen. Mboua: CAS 258234. Fig. 4G, H.

**Comments:** A single individual was encountered near a small forest stream next to a foot path. This species is easily distinguished from similar species by the distinct spurs on its heels and its small size (Amiet 2012). The





**Fig. 4.** *Arthroleptis* cf. *poecilonotus* CAS 258166 (A), *A. sylvaticus* CAS 258184 (B), *Astylosternus batesi* CAS 258139, GFMJ 1240 (C, D), *Cardioglossa gracilis* CAS 258016 (E), *Leptopelis aubryi* 258261 (F), *L. aubryioides* CAS 258234 (G, H).

similar sympatric species, *L. aubryi*, lacks heel spurs and is found in more disturbed habitats. This species is known across Cameroon (Amiet 2012) but few records exist for Gabon. Within Gabon, it is known from: Ivindo NP (Bell et al. 2011), Loango NP (Burger et al. 2006, listed as *L. omissus*), and Lopé NP (Frétey and Blanc 2001 listed as *L. omissus*). We sequenced 16S rRNA of CAS 258234, and confirmed its identification using BLAST (GenBank accession: MF537690; nearest GenBank sequence is KT967084.1; 96% identical).

### ***Leptopelis calcaratus* (Boulenger 1906)**

**Material:** Seven (7) specimens. Doumaye: CAS 258148, 258190–91, 258274, GFMJ 1340. Mboua: CAS 258253–54. Fig. 5A.

**Comments:** *Leptopelis calcaratus* is an arboreal species that is widespread across Central Africa (Cameroon, Gabon, Republic of Congo, and DRC). Within Gabon, it is known from Crystal Mountains NP (Lötters et al. 2001), Ivindo NP (Frétey and Blanc 2000), and Moukalaba-Doudou (Burger et al., 2004). We encountered six of the seven individuals perched in trees above four meters from the ground adjacent to forested streams. It is easily identified by the spur on its heel and larger size than *L. aubryioides*.

### ***Leptopelis millsoni* (Boulenger 1895)**

**Material:** Three (3) specimens. CAS 258147, OMNH 44774. Mboua: CAS 258233. Fig. 5B, C.

**Comments:** We found individuals 1–2.5 m above the ground along forested streams. This species is closely associated with streams. This arboreal species is widespread across Central Africa (Cameroon, Gabon, Republic of Congo, and DRC). Within Gabon, it is known from Crystal Mountains NP (Lötters et al. 2001; Bell et al. 2011), Ivindo NP (Frétey and Blanc 2000; Bell et al. 2011), and Moukalaba-Doudou (Burger et al. 2004). In addition to this new Haut-Ogooué record, we also found this species in Moyen-Ogooué (CAS 257990–91, 258049, 258076, 258119, 258126) and Ogooué-Lolo (CAS 258303) provinces.

### ***Leptopelis notatus* (Peters 1875)**

**Materials:** Five (5) specimens. Mboua: CAS 258230–32, 258283; GFMJ 1405. Fig. 5D–F.

**Comments:** This arboreal species is widespread across Central Africa and we found it near streams 1–2 m above the ground. We encountered three females and two males. The females were all uniformly green, and the males were mottled green and light brown. *Leptopelis notatus* is known from the following national parks: Crystal

Mountains NP (Lötters et al. 2001), Ivindo NP (Frétey and Blanc 2000), and Moukalaba-Doudou (Burger et al. 2004).

### ***Leptopelis ocellatus* (Mocquard 1902)**

**Material:** Nine (9) specimens. Doumaye: CAS 258189, 258196; GFMJ 1337. Mboua: CAS 258252; GFMJ 1422, 1431, 1456–57; OMNH 13751. Fig. 5G.

**Comments:** *Leptopelis ocellatus* is associated with slow rivers and forested swamps. They were found between 10 cm and one m above the ground or water. Across Gabon, this species is known from Ivindo NP (Frétey and Blanc 2000) and Moukalaba-Doudou NP (Burger et al. 2004). We also encountered this species around Junkville, Moyen-Ogooué (CAS 258134–35) and around Ogooué-cinq and Madoukou villages near Lastoursville, Ogooué-Lolo (CAS 258287, 258306, 258316).

### ***Scotobleps gabonicus* (Boulenger 1900)**

**Material:** Twelve (12) specimens. Doumaye: CAS 258149, 258150; GFMJ 1239, 1267–68, 1350, 1367. Mboua: CAS 258228–29; GFMJ 1399, 1401–02. Fig. 5H.

**Comments:** *Scotobleps gabonicus* is found in leaf litter, close to stream edges with sandy to pebbly substrates. While found near streams, we never observed individuals ( $n = 84$  across Gabon) to leap into the water when approached; when detected, it either remains in place or moves in a direction other than the stream. This species appears to prefer clear streams as we did not find it near sections with muddy water. This may suggest that its reproduction and life history are dependent on specific stream qualities, though its tadpoles remain unknown. Adults are best detected at night by eye-shine. *Scotobleps gabonicus* is widespread and common across the lower Guinean forest (Cameroon, Equatorial Guinea, and Gabon; Portik et al. 2017) In Gabon, it is known from Crystal Mountains NP (Lötters et al. 2001), Lopé NP (Frétey and Blanc 2001), Ivindo NP (collected by Bell and Stuart in 2011; NCSM 78914–15), and Moukalaba-Doudou NP (Burger et al. 2004).

## **BUFONIDAE**

### ***Sclerophrys gracilipes* (Boulenger 1899)**

**Material:** Five (5) specimens. Doumaye: CAS 258175. Mboua: CAS 258257, 258282; OMNH 44780; GFMJ 1506. Fig. 6A.

**Comments:** This is a common terrestrial species in lowland forests. All individuals were encountered associated with small to medium-sized, forested streams. This



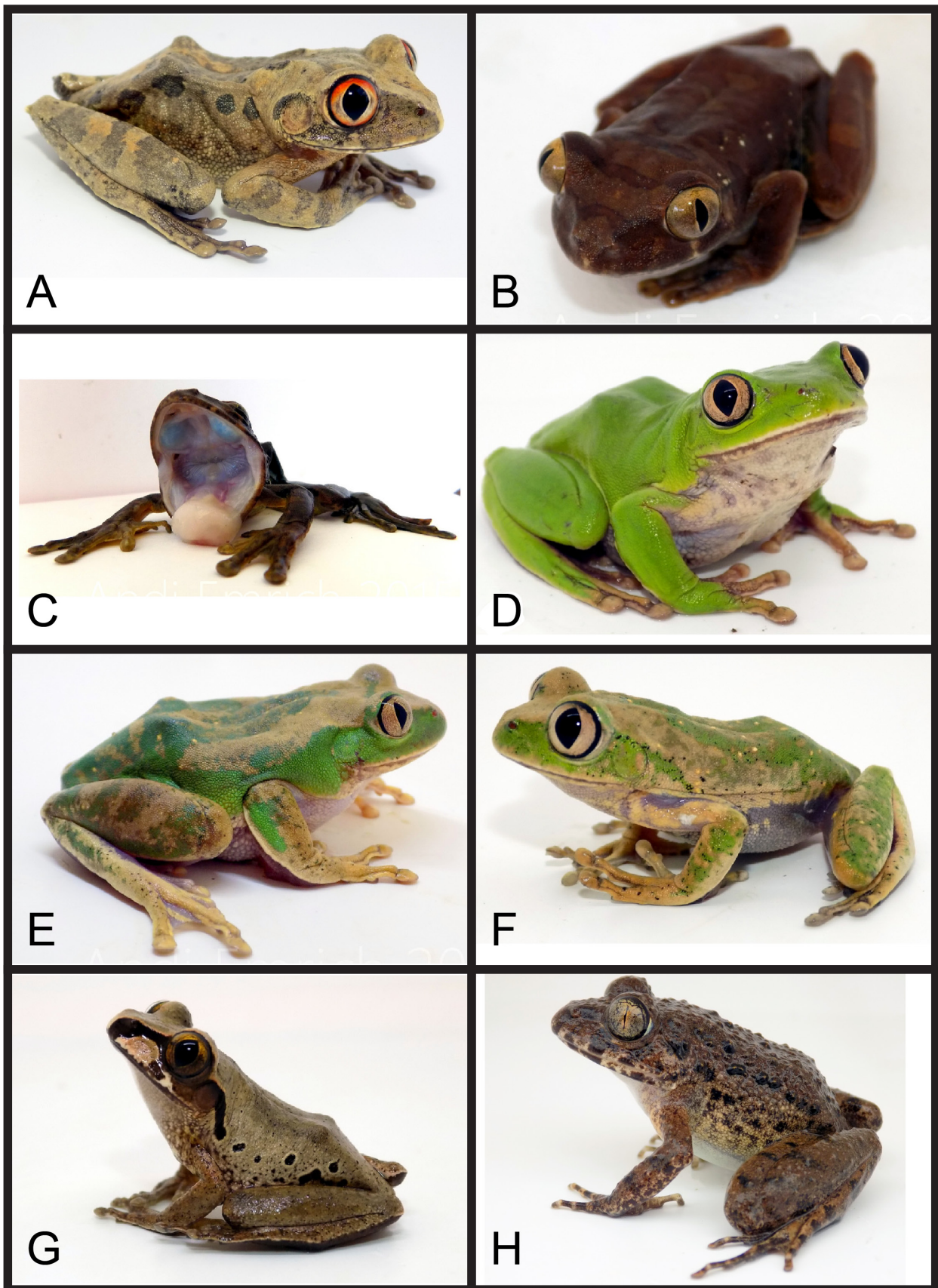


Fig. 5. *Leptopelis calcaratus* CAS 258148 (A), *L. millsoni* CAS 257991, 257990 (B, C), *L. notatus* GFMJ 1495, CAS 258283, 258230 (D–F), *L. ocellatus* GFMJ 1431 (G), *Scotobleps gabonicus* GFMJ 1350 (H).

species is widespread across Central Africa, north of the Congo River. In Gabon, this species is known from Ivindo NP (Frétey and Blanc 2000), Loango NP (Burger et al. 2006), and Moukalaba-Doudou NP (Burger et al. 2004). In 2015 we also collected vouchers in Moyen-Ogooué province near Lambaréné (CAS 257988, 257994) and Ndjolé (CAS 258051, 258096). This species was collected along Onangué Lake in 2013 (by R. Bell and B. Stuart; CAS 254506–10).

### ***Sclerophrys superciliaris* (Boulenger 1888)**

**Material:** One (1) specimen. Doumaye: GFMJ 1314. Fig. 6B, C.

**Comments:** One individual was brought to our camp by a local civil servant, Eric Dipanda, who found the toad on the main dirt road running through Doumaye (02.23373°S, 013.60008°E). This is the first provincial record and most southern record for the species (Barej et al. 2011), although Frétey and Blanc (2000) reports the species from the Republic of Congo without precise locality information. It is best detected by its bright eye-shine in the dark (DCB, pers. obs.).

### **CONRAUIDAE**

#### ***Conraua crassipes* (Buchholz and Peters 1875)**

**Material:** Two (2) specimens. Mboua: CAS 258277–78. Fig. 6D, E.

**Comments:** *Conraua crassipes* is closely associated with forested small tributaries of the Ogooué River. Individuals were found in shallow muddy substrate near the banks and detected by their eye-shine. This species is known from the following national parks: Crystal Mountains (Lötters et al. 2001), Ivindo (Frétey and Blanc 2001), Lopé (Frétey and Blanc 2000), and Moukalaba-Doudou (Burger et al. 2004). In 2015, we also encountered this species near Lambaréné (CAS 257993, 258019), Ndjolé (CAS 258084), Junkville (CAS 258122–23), and Lastoursville (CAS 258317).

### **DICROGLOSSIDAE**

#### ***Hoplobatrachus occipitalis* (Günther 1858)**

**Material:** Three (3) specimens. Doumaye: CAS 258174; OMNH 44786; GFMJ 1294. Fig. 6F.

**Comments:** This highly aquatic species is associated with permanent bodies of water in savanna habitat and tolerant of disturbance (Guibé and Lamotte 1958; Rödel 2000). We encountered this species at pristine savanna lakes as well as disturbed permanent pools in the village of Bafounou. This species is widely distributed across

Africa, from Senegal to Ethiopia and south to Zambia and Angola (Rödel 2000). Within Gabon, *H. occipitalis* is known from: Batéké NP (Zimkus and Larson 2013), Crystal Mountains NP (Lötters et al. 2001), and Loango NP (Burger et al. 2006). It is also known from the following areas: Ivindo, Rougier Gabon Forestry Concession (NCSM 78971–74) and from the Ouanga Plains, Basse-Banio in Nyanga province (USNM 580613–17).

### **HYPEROLIIDAE**

#### ***Afrixalus dorsalis* (Peters 1875)**

**Material:** Five (5) specimens. Doumaye: CAS 258200, 258201, 258240, 258284; GFMJ 1353. Fig. 6G.

**Comments:** *Afrixalus dorsalis* is a disturbance specialist, and we found individuals concentrated near village water pumps, calling from tall grasses. This species was found in sympatry with *Leptopelis aubryi*. Its identification is based on the key by Frétey et al. (2011), including the brown mediodorsal band that widens and spreads towards the eyelids (see Fig. 6G). *Afrixalus dorsalis* is known from the following national parks: Ivindo, Lopé (Frétey and Blanc 2000, 2001), Loango, Moukalaba-Doudou (Burger et al. 2004, 2006).

#### ***Afrixalus osorioi* (Ferreira 1906)**

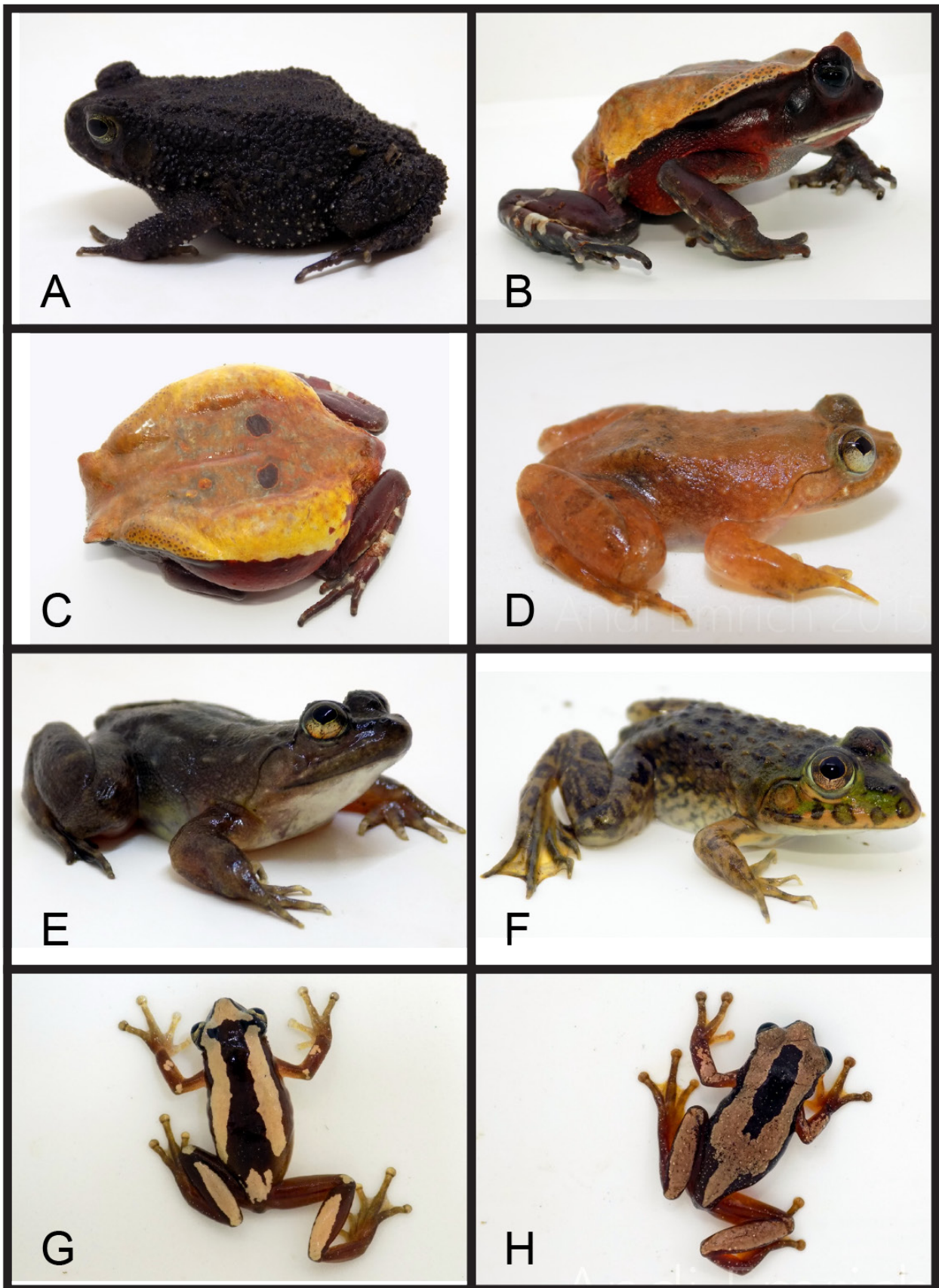
**Material:** Twenty one (21) specimens. Doumaye: CAS 258160, 258161, 258262–70; OMNH 44788; GFMJ 1356–58, 1475–78, 1531–32. Fig. 6H, Fig. 7A, B.

**Comments:** *Afrixalus osorioi* is similar in appearance and habitat preference to *A. dorsalis*, but distinguished from that species by its distinct advertisement call. *Afrixalus osorioi* is known from Angola, Republic of Congo, Democratic Republic of Congo, Kenya, and Uganda. These specimens represent the first country records for Gabon. This species inhabits bushland habitat. It has a unique pattern that helps distinguish it from other Gabonese *Afrixalus*, typically with a rectangular dark dorsal spot and a narrow light dorsal pattern extends to the anus (Schiotz 1999). Laurent (1982) mentions that this pattern does not vary within populations; however, we encountered some variation, including individuals that possessed no dark rectangle at all (Fig. 6, 7). The identification of these specimens was confirmed by comparing DNA sequence data for 16S ribosomal RNA from these specimens to another identified sample (K. Charles and D. Portik, unpubl. data; CAS 256140).

#### ***Afrixalus quadrivittatus* (Werner 1908)**

**Material:** Three (3) specimens. Doumaye: CAS 258271–72, GFMJ 1492. Fig. 7C.





**Fig. 6.** *Sclerophrys gracilipes* CAS 258282 (A), *Sclerophrys superciliaris* GFMJ 1314 (B, C), *Conraua crassipes* ORB 97 (D, E), *Hoplobatrachus occipitalis* CAS 258278 (F), *Afrixalus dorsalis* ORB 140 (G) *A. osorioi* GFMJ 1356 (H).

**Comments:** This species is found in open grassy habitat. In Doumaye, we found individuals in a flooded area near the football stadium (02.23300°S, 13.60305°E), calling from within bunches of grasses between 10–50 cm above the ground or shallow water. At this site, *A. quadrivittatus* is sympatric with *A. osorioi*, *Hoplobatrachus occipitalis*, and *Phlyctimantis leonardi*. This species is known from Batéké NP (Zimkus and Larson 2013). We sequenced 16S rRNA of CAS 258271 and GFMJ 1492, and confirmed their identification using BLAST (GenBank accession: MF537696–97; nearest GenBank sequence is KF178889.1; 99% identical).

### ***Cryptothylax greshoffi* (Schilthuis 1889)**

**Material:** Eleven (11) specimens. Mboua: CAS 258214–216; OMNH 44789–90; GFMJ 1430, 1442–46. Fig. 7D.

**Comments:** We found *C. greshoffi* in open grassy habitat bordered by forest at a dammed section of the stream where locals did laundry. At night, individuals were found calling within the vegetation surrounding the water, ranging from 5 to 100 cm above the water. This species is known from Ivindo NP (Frétey and Blanc 2001) and Batéké Plateau NP (Zimkus and Larson 2013).

### ***Hyperolius adpersus* (Peters 1877)**

**Material:** Twelve (12) specimens. Doumaye: CAS 258167–69, 258332–33, 258170; GFMJ 1303–06. Fig. 7E–G.

**Comments:** We found *H. adpersus* in open, natural savanna habitat. Individuals called in high densities from grasses in and at the edge of shallow ponds. This species was previously considered a part of the *Hyperolius nasutus* complex (Channing et al. 2013). This species is known from Batéké Plateau NP, Loango NP (Burger et al. 2006), Moukalaba-Doudou NP (Burger et al. 2004), and Pongara NP (Pauwels 2016). It is also known from Libreville (Gratwick et al. 2011).

### ***Hyperolius balfouri* (Werner 1908)**

**Material:** Four (4) specimens. Doumaye: CAS 258171–73; GFMJ 1307. Fig. 8E.

**Comments:** We encountered this species at one site, a pond in savanna habitat near Doumaye (Fig. 3). It was found in open savanna calling from the edge of a pool. *Hyperolius adpersus* also occurred at this same site. This is a new country record for Gabon. It is distinguishable from other Gabonese species based on its green dorsolateral lines and the presence of a vertebral stripe (Fig. 8). The nearest known population is 715-km north in Cameroon (Amiet 2012) and represented by the subspecies *H. b. viridistriatus*. However, based on our

16S sequence data, this is more closely related to populations in East Africa, including ~2,180 km east in Mabira, Uganda (CAS 256187). We sequenced the 16S rRNA of CAS 258171–73 and GFMJ 1307 (GenBank accession: MF537676–79), and confirmed their identification using an unpublished dataset (Portik; 100% identical to CAS 256187).

### ***Hyperolius kuligae* (Mertens 1940)**

**Material:** Four (4) specimens. Doumaye: CAS 258238–39, 258247, GFMJ 1418. Fig. 8F, G.

**Comments:** These individuals were found within closed forest on vegetation surrounding a still section of river that was dammed for manioc fermentation. The males exhibited a bright yellow coloration at night, which helps distinguish it from similar species like *H. platyceps* (Amiet 2012). This species is known from Ivindo NP (Bell et al. 2011), Loango NP (Burger et al. 2006), and Moukalaba-Doudou (Burger et al. 2004).

### ***Hyperolius ocellatus* (Günther 1858)**

**Material:** Ten (10) specimens. Doumaye: CAS 258142, 258176–77, GFMJ 1246, 1248. Mboua: CAS 258237, GFMJ 1411, 1414–15, 1417. Fig. 8H, 9A–C.

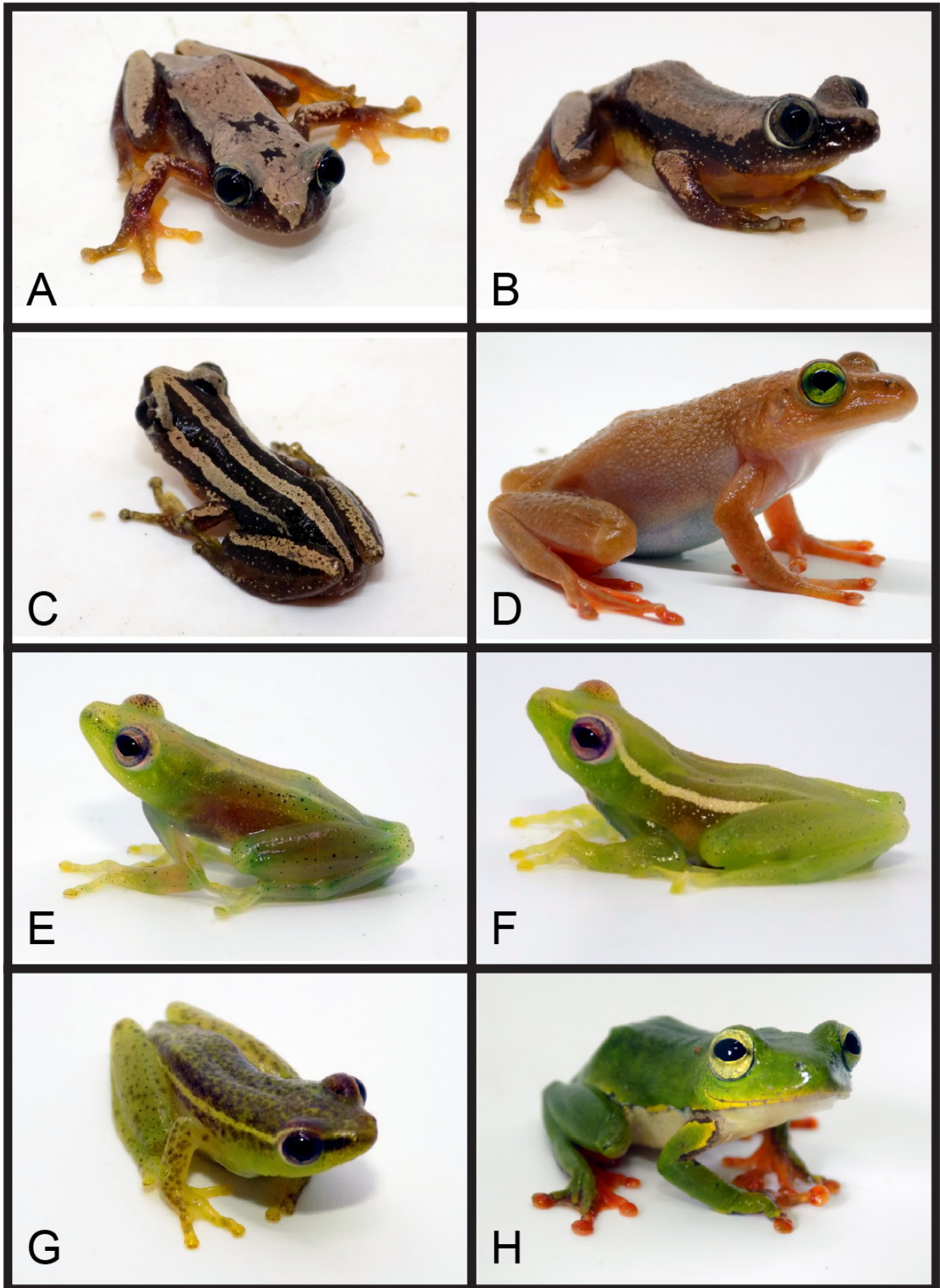
**Comments:** This dichromatic species is found in the forest or at the forest-edge, typically on leaves 1–2 m above the ground and near slow sections of streams. Males are green with light dorsolateral stripes and a pale triangle on the snout that is diagnostic of the species. Females range in coloration from silvery grey to red with black spots (Schlötz 1999; Amiet 2012). *Hyperolius ocellatus* is widespread and common across Central Africa, including Gabon. To date, it is known from four national parks: Ivindo (Bell et al. 2011), Loango (Burger et al. 2006), Moukalaba-Doudou (Burger et al. 2004), and Crystal Mountains (Bell et al. 2011). It was also encountered near Mitoné (CAS 258083; -0.641950 10.217420) and Ndjolé (CAS 257997; -0.193950, 10.784770) in Moyen-Ogooué, and from Basse-Bania department in Nyanga province (USNM 558547; -3.23331, 10.619).

### ***Hyperolius olivaceus* (Peters 1876)**

**Material:** Ten (10) specimens. Doumaye: CAS 258158–59; GFMJ 1489–91. Mboua: CAS 258217–18; GFMJ 1380–82. Fig. 7H.

**Comments:** This disturbance specialist is common across Gabon. This species was until recently considered a subspecies of the very widespread *Hyperolius cinnamomeoventris*. However, it was recently elevated based on molecular, ecological, and phenotypic data (Bell et al. 2017). It is known from Loango (Burger et





**Fig. 7.** *Afrixalus osorioi* CAS 258270, CAS 258161 (A, B), *A. quadrivittatus* GMFJ 1492 (C), *Cryptothylax greshoffi* OMNH 44789 (D), *Hyperolius adspersus* CAS 258168, 2583332, GMFJ 1304 (E–G), *H. olivaceus* CAS 258159 (H).

al. 2006), Moukalaba-Doudou (Burger et al., 2004), and from Libreville (Gratwick et al. 2011). We encountered individuals around artificial bodies of water in grasses and palm fronds, but never within closed canopy forests. We sequenced 16S rRNA from GFMJ 1489–91 and confirmed their identification using BLAST (GenBank accession: MF537693–95; closest GenBank sequence is MF376266; 100% identical).

### ***Hyperolius pardalis* (Laurent 1948)**

**Material:** Twenty (20) specimens. Doumaye: CAS 258162, 258203–06, OMNH 44794–99, GFMJ 1281, 1363. Mboua: CAS 258219–20, GFMJ 1447–51. GFMJ Fig. 9D–H.

**Comments:** We encountered *H. pardalis* in disturbed areas. One female was found on a tent, where we camped in a field in Doumaye. All other individuals were encountered in vegetation next to a small fish pond, adjacent to a forested stream. Of 17 males encountered, two males demonstrated the F-phase representing 11.8% of the male population sampled (Fig. 6 D–H). This species can be distinguished from the similar species *Hyperolius bolifambae* by its distinct vocal sac, which is pearl-white posterior to the gular gland (Amiet 2012). In Gabon, *Hyperolius pardalis* is known from Crystal Mountains NP (Lötters et al. 2001), Rabi-Toucan (Burger et al. 2006), and Ivindo NP (Frétey and Blanc 2001).

### ***Hyperolius phantasticus* (Boulenger 1899)**

**Materials:** Three (3) specimens. Doumaye: CAS 258163–65. Fig. 10A–C.

**Comments:** *Hyperolius phantasticus* was found in small trees next to a large savanna pond, 2–2.5 meters above the ground. In the Plaine Ouanga Reserve in the Gamba Complex of Protected Areas, this species was found in shrubs close to or next to savanna ponds. This species is known from Crystal Mountains NP (Lötters et al. 2001; Bell et al. 2011) and Loango NP (Burger et al. 2006). We sequenced 16S rRNA of CAS 258165 and confirmed its identification using BLAST (GenBank accession: MF537674; closest BLAST sequence is FJ594099; 97% identical).

### ***Opisthoxylax immaculatus* (Boulenger 1903)**

**Material:** One (1) specimen. Mboua: CAS 258235. Fig. 10D.

**Comments:** This monotypic genus is distinguished from other Hyperoliidae by the combination of its vertical pupils, rough skin, and orange color (Schlötter 1999). The males have large gular glands and non-descendible

vocal sacs (Schlötter 1999). This arboreal species builds foam nests (Amiet 1991). This species was encountered at night on a stem one m above the ground, between a forested stream and an elephant wallow. In Gabon, it is known from Ivindo NP (Bell et al. 2011) and Rabi-Toucan (Burger et al. 2006). We sequenced 16S rRNA of this individual and confirmed its identification using BLAST (GenBank accession: MF537682; the most similar GenBank sequence is KX492629; 98% identical).

### ***Phlyctimantis leonardi* (Boulenger 1906)**

**Material:** Three (3) specimens. Doumaye: CAS 258209, 258273; GFMJ 1369. Fig. 10E, F.

**Comments:** This large hyperoliid frog was encountered in shrubs or trees, 1–2 m above the ground and near still bodies of water in open habitat. In Gabon, *P. leonardi* is common and widespread. It is known from the following national parks: Crystal Mountains (Lötters et al. 2001), Ivindo, Lopé (Frétey and Blanc 2000, 2001), Loango, and Moukalaba-Doudou (Burger et al. 2004, 2006). It is also known from Basse-banio, Nyanga (USNM 580612; -3.0876, 10.4285), Junkville (CAS 258130–31; -0.051710, 11.166210), and near Ndjolé, (CAS 258063–65; -0.18482, 10.77727) in Moyen-Ogooué.

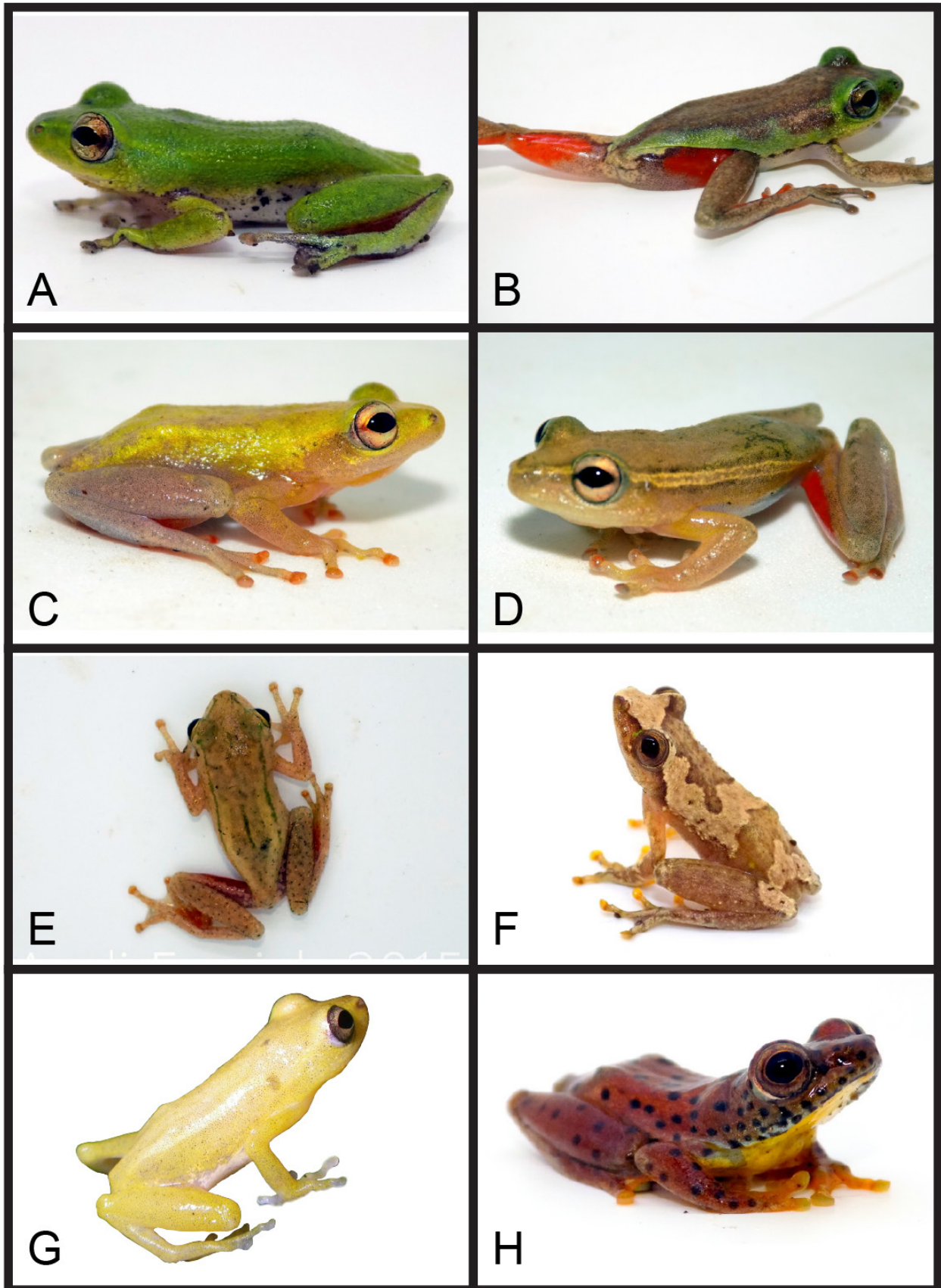
## **PHRYNOBATRACHIDAE**

### ***Phrynobatrachus africanus* (Hallowell 1868)**

**Material:** Thirteen (13) specimens. CAS 258187–88, GFMJ 1332–34. Mboua: CAS 258222, 258243, 1425, 1427–28, 1463–65. Fig. 11 D–E.

**Comments:** The distantly related genera *Phrynobatrachus* and *Arthroleptis* have often proved difficult for field researchers to distinguish. The most reliable diagnostic feature is the presence of a tubercle roughly in the middle of the tarsus in *Phrynobatrachus* in addition to both an inner and outer metatarsal tubercle (Zimkus and Blackburn 2008). *Phrynobatrachus africanus* is a common forest species found in the leaf litter and easily identified by its rugose skin, yellow legs, and in males both a large flat nuptial pad and odontoid processes. We also encountered individuals with red legs in sympatry with the yellow-legged individuals (Fig. 11), but these morphotypes were confirmed as conspecific using 16S rRNA sequences (100% similarity). It is widely distributed across Gabon and known from Ivindo NP (Frétey and Blanc 2001), Loango NP (Burger et al. 2006), Lopé (Frétey and Blanc 2000), and Moukalaba-Doudou (Burger et al. 2004). We sequenced 16S rRNA of CAS 258243, GFMJ 1332–34, 1425, 1427–28 and confirmed their identifications using BLAST (GenBank accession: MF537671–73, MF537675, MF537680–81, MF537685–





**Fig. 8.** *Hyperolius olivaceus* GFMJ 1381, CAS 258218, GFMJ 1181, CAS 258108 (A–D), *H. balfouri* GFMJ 1307 (E), *H. kuligae* CAS 358247 (F, G), *H. ocellatus* CAS 258177 (H).

89, MF537691; most similar to GenBank sequence GU457531; 93% identical).

***Phrynobatrachus horsti* (Rödel, Burger, Zassi-Boulou, Emmrich, Penner, and Barej 2015)**

**Material:** One (1) specimen. GFMJ 1332.

**Comments:** We encountered a single adult individual in leaf litter in the forest. Rödel et al. (2015) proposed that this species occurs in Batéké Plateau NP and that Zimkus and Larson (2013) misidentified *P. ruthbeateae*, which is endemic to Cameroon (Rödel et al. 2012). We sequenced 16S rRNA of GFMJ 1332 and confirmed their identifications using BLAST (GenBank MF537676; most similar sequence on GenBank is KR827534; 99% identical).

**PYXICEPHALIDAE**

***Aubria masako* (Ohler and Kazadi 1990)**

**Material:** One (1) specimen. Mboua: CAS 258250.

**Comments:** We collected a single male individual from a muddy pool adjacent to a forested stream in Mboua. Typical of this species, the individual was skittish and required multiple search events over two nights to capture successfully. *Aubria masako* is widespread in Central Africa, including specifically the Congo Basin (Ohler and Kazadi 1990). This individual was identified based on 16S rRNA (GenBank MF537692; most similar to GenBank sequence is KU560021; 99% identical).

**RANIDAE**

***Amnirana albolabris* (Hallowell 1856)**

**Material:** Nine (9) specimens. Doumaye: CAS 258140, 258146, GFMJ 1260–61. Mboua: CAS 258248–49, GFMJ 1436–37, 1504. Fig. 10G.

**Comments:** *Amnirana albolabris* is typically found on vegetation (~0.2–1.5 m above the ground) near still water within the forest, for example around manioc fermentation sites or elephant wallows. Individuals are easily spotted by eye-shine. The type series of this species was collected by Du Chaillu between 1855 or 1856 north of the Ogooué River in Gabon (Du Chaillu, 1861; Hallowell 1856). This species is common and widespread across Central Africa, and within Gabon it is known from Batéké Plateau NP (Zimkus and Larson 2013), Mayumba NP (USNM 2013), Loango NP (Burger et al. 2006), Lopé NP, Ivindo NP, (Frétey and Blanc 2000, 2001), and Moukalaba-Doudou (Burger et al. 2004). There are also records from Lac Oguémoué (CAS 254595–98; -1.1001600, 10.02999983), Mitone (CAS 257980; -0.641950, 10.217420), Junkville (CAS

258116; -0.062160, 11.15870), and near Ndjolé (CAS 258085; -0.193950, 10.784770).

***Amnirana amnicola* (Perret 1977)**

**Material:** Eight (8) specimens. Doumaye: CAS 258179–81, 258192, GFMJ 1247, 1262. Mboua: CAS 258244. Fig. 10H, Fig. 11A.

**Comments:** We frequently encountered this species near slow sections of forested streams on stems 1–2 m above the ground. *Amnirana amnicola* is often found sympatry with the morphologically similar and related species *A. albolabris* from which it is distinguishable by less webbing between the toes (Perret 1977). This species is known from Crystal Mountains NP (Lötters et al. 2001), Ivindo NP (Frétey and Blanc 2001), and Moukalaba-Doudou NP (Burger et al. 2004).

***Amnirana lepus* (Andersson 1903)**

**Material:** Fifteen (15) specimens. Doumaye: CAS 258143–45, GFMJ 1250–52, 1255–57. Mboua: CAS 258224–26, 258279–81, GFMJ 1394. Fig. 11B, C.

**Comments:** This large arboreal species is commonly found along forested streams at night on vegetation 0.5–1.5 meters above the ground. A single individual was encountered on a rock in the center of a stream. *Amnirana lepus* releases a pungent sour odor when captured, which smells like vinegar. H-W Herрман observed other species kept in the same container with *A. lepus* from western Cameroon died (HWH, pers. comm.). This is possibly due to the presence of peptides (Daly et al. 2004). This species is known from Ivindo NP (Frétey and Blanc 2001), Moukalaba-Doudou (Burger et al. 2004), and near Ndjolé (CAS 258115; -0.193950, 10.784770).

**RHACOPHORIDAE**

***Chiromantis rufescens* (Günther 1869)**

**Material:** One (1) specimen. Mboua: CAS 258245. Fig. 11H.

**Comments:** Similar to *C. rufescens* encountered elsewhere in Gabon, we encountered this single male individual near small, temporary pools in the forest. This species is typically found on branches 1–3 m above the ground and is widespread across West and Central Africa. Within Gabon, *C. rufescens* is known from six national parks: Crystal Mountains (Bell et al. 2011), Ivindo (Frétey and Blanc 2001), Loango (Burger et al. 2006), Lopé (Frétey and Blanc 2000), Moukalaba-Doudou (Burger et al. 2004), and Batéké Plateau NP (Zimkus and Larson 2013).



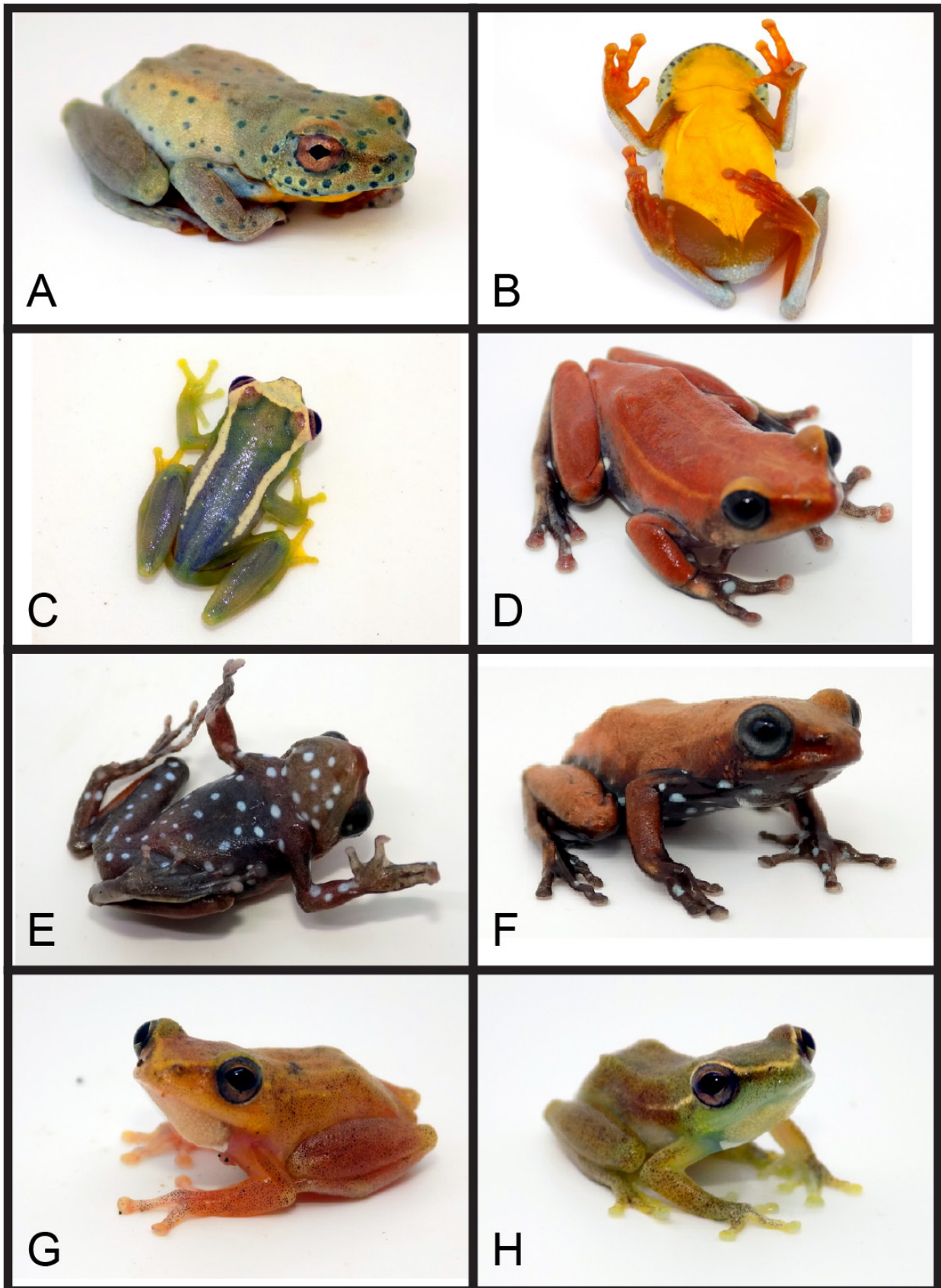
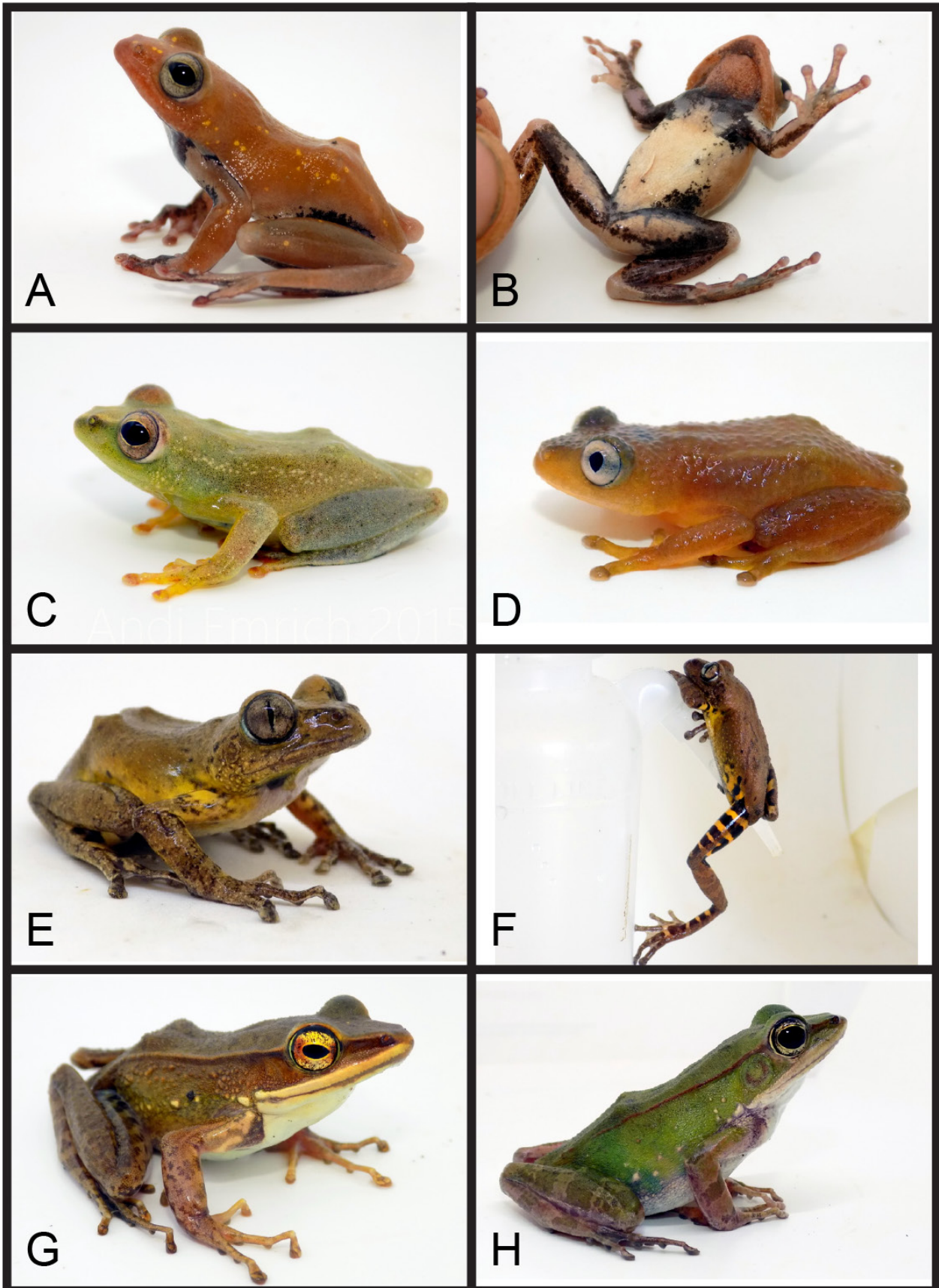
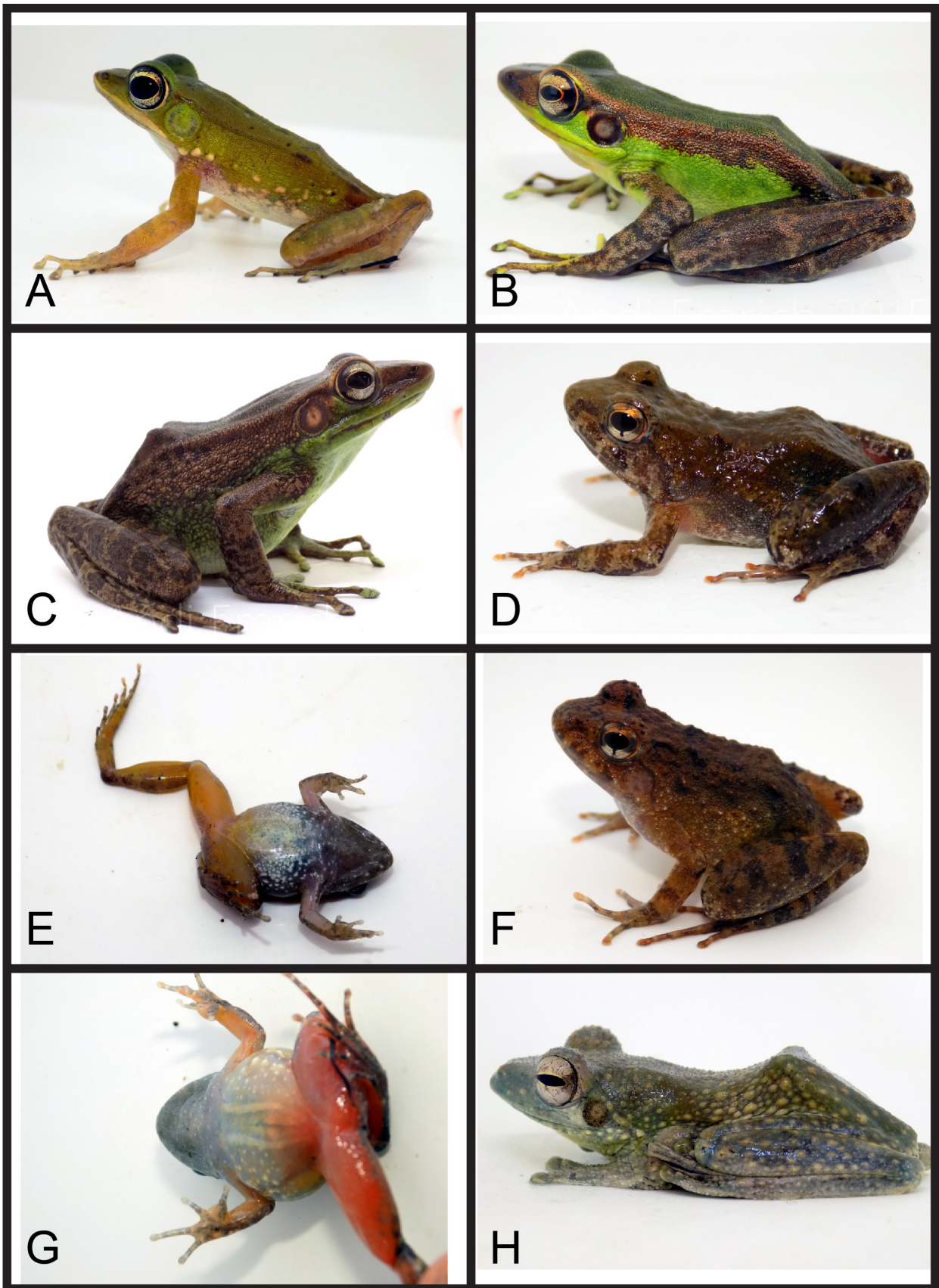


Fig. 9. *Hyperolius ocellatus* CAS 258142, GFMJ 1184 (A–C), *H. pardalis* GFMJ 1281, CAS 258204, OMNH 44797, CAS 258162 (D–H).



**Fig. 10.** *Hyperolius phantasticus* CAS 258165, 358163 (A–C), *Opisthoxylax immaculatus* CAS 258235 (D), *Phlyctimantis leonardi* CAS 258237, 2558071 (E, F), *Amnirana albolabris* ORB 291 (G), *A. amnicola* CAS 258244 (H).





**Fig. 11.** *Amnirana amnicola* CAS 258224 (A) *A. lepus* CAS 258144, 258224 (B, C), *Phrynobatrachus africanus* CAS 258223, GFMJ 1389 (D, E, F, G), *Chiromantis rufescens* GFMJ 1095 (H).

## Results and Discussion

Haut-Ogooué Province contains a rich diversity of amphibians but remains understudied in spite of its interesting geological history (Batéké Plateau, Chaillu Massif, Franceville Basin) and pristine savanna-forest mosaic habitat. Further inventory work will no doubt reveal more amphibian diversity. We encountered 34 amphibian species, 26 of which are new provincial records and two of which are new records for Gabon (*Afrivalus osorioi* and *Hyperolius balfouri*). These results bring the known amphibian diversity of the Haut-Ogooué province to 42 species and 98 species for Gabon. Several of our records also represent significant range extensions (>100 km from nearest known record). Our record of *Hyperolius balfouri* represents a 725-km distribution expansion south of its known distribution (nearest voucher, MHNG 1559 from Obala, Central province, Cameroon). Other range extensions include *Leptopelis calcaratus* (315 km S; nearest voucher is NCSM 77692, Ivindo NP), *Scotobleps gabonicus* (275 km SE; nearest voucher NCSM 78915, Ogooué-Ivindo province), *Sclerophrys superciliaris* (320 km S, nearest locality is Makokou, Ogooué-Ivindo province), *Hyperolius kuligae* (275 km S; nearest voucher is CUMV 15570, Ogooué-Ivindo province), *H. pardalis* (310 km SE; nearest locality is Ivindo NP), and *Amnirana amnicola* (310 km SE; nearest voucher is MCZ A-139750, Ivindo NP). Laurent (1951) reported *Hyperolius steindachneri* from Franceville, Gabon. If confirmed, this record represents an 870 km extension to the north for this species and brings the total known diversity of Haut-Ogooué province to 43 species. Having not examined this specimen, we refrain from including it in the list presented here. The rarefaction curve for amphibians suggest that we are nearing the true species diversity at our sampling sites, though we anticipate that uncommon species remain to be discovered in this area (Fig. 2).

This article represents the first attempt to characterize amphibian diversity in Haut-Ogooué province in southeastern Gabon. The most amphibian-diverse province in Gabon is the Ogooué-Maritime with 77 species (Burger et al. 2004; Burger et al. 2006). Haut-Ogooué province is comparable in overall amphibian diversity to Ogooué-Ivindo, which has 46 known amphibian species (Burger et al. 2004), and Moyen-Ogooué, which has 41 species (Mocquard 1902; Pauwels 2016; specimens at the California Academy of Sciences, unpubl.). Based on GBIF data, Estuaire province has 31 known species, Ogooué-Lolo has 17, and Nyanga has 14. Other provinces have never been surveyed for amphibians (Ngounié and Woleu-Ntem). We believe that further surveys in Haut-Ogooué that focus on higher elevation sites and savannas will increase the known diversity of amphibian for this underexplored province.

**Acknowledgements.**—We thank the Centre National

de la Recherche Scientifique et Technologique (CENAREST, permit #AR008/15/CSAR) for providing scientific permits and the Direction de la Faune et de la Chasse for providing an export permit. For logistical support, we thank The Nature Conservancy (Marie-Claire Paiz) and the Smithsonian Institute (Lisa Korte). We are indebted to Glen Ratel and Marie Coupé for hosting us in Libreville. Thanks to Daniel M. Portik for helping identify hyperoliid species, including the new country record *A. osorioi*. We thank Jordana Abugattas for assistance with molecular genetics labwork. For assistance in the field we thank Freye Pavel for always getting us safely to our destination and keeping us fed once there. We are indebted to Chief Dipanda Guillaume and his family (Doumaye) and to Chief Michel Ngari (Mboua) for their hospitality, warmth and knowledge. Marius Burger and Olivier S.G. Pauwels provided valuable revisions on this article. Edward L. Stanley helped make Figure 1. And finally, we thank our local guides (Julien Yinga, Crepin and Blaise) that never led us astray during our nocturnal quests for frogs. This project was supported by the NSF grant (#1202609) to DCB and funding by Shell Gabon and the Smithsonian Conservation Biology Institute for ET.

## Literature Cited

- Amiet J-L. 1991. Images d'Amphibiens camerounais. IV. Les constructeurs de nids. *Alytes* 9(3): 71–77.
- Amiet J-L. 2012. *Les Rainettes du Cameroun (Amphibiens Anoures)* [The Hylid Frogs of Cameroon]. La Nef des Livres, Saint-Nazaire, France. 591 p., 785 color photos, 1,500+ b/w line drawings, color distribution maps.
- Barej MF, Schmitz A, Menegon M, Hillers A, Hinkel H, Böhme W, Rödel M-O. 2011. Dusted off—the African *Amietophrynus superciliaris*-species complex of giant toads. *Zootaxa* 2772: 1–32.
- Bell RC, Garcia AVG, Stuart BL, Zamudio KR. 2011. High prevalence of the amphibian chytrid pathogen in Gabon. *Ecohealth* 8: 116–120.
- Bell RC, Parra JL, Badjedjea G, Barej MF, Blackburn DC, Burger M, Channing A, Dehling JM, Greenbaum E, Gvoždík V, Kielgast J, Kusamba C, Lötters S, McLaughlin PJ, Nagy ZT, Rödel M-O, Portik DM, Stuart BL, VanDerWal J, Zassi-Boulou AG, Zamudio KR. 2017. Idiosyncratic responses to climate-driven forest fragmentation and marine incursions in reed frogs from Central Africa and the Gulf of Guinea Islands. *Molecular Ecology* 26(19): 5,223–5,244.
- Beolens B, Watkins M, Grayson M. 2013. *The Eponym Dictionary of Amphibians*. Pelagic Publishing, Exeter, United Kingdom. 244 p.
- Blackburn DC. 2008. Biogeography and evolution of body size and life history of African frogs: Phylogeny of squeakers (*Arthroleptis*) and long-fingered



- frogs (*Cardioglossa*) estimated from mitochondrial data. *Molecular Phylogenetics and Evolution* 49(3): 806–826.
- Blackburn DC, Gvoždik V, Leaché AD. 2010. A new squeaker frog (Arthroleptidae: *Arthroleptis*) from the mountains of Cameroon and Nigeria. *Herpetologica* 66: 335–348.
- Boulenger GA. 1900. A list of batrachians and reptiles of the Gaboon (French Congo), with descriptions of new genera and species. *Proceedings of the Zoological Society of London* 1900: 433–456.
- Burger M, Branch WR, Channing A. 2004. Amphibians and reptiles of Monts Doudou, Gabon: Species turnover along an elevational gradient. Pp. 145–186 In: *Monts Doudou, Gabon: A Floral and Faunal Inventory with Reference to Elevational Variation*. Editor, Fisher BL. California Academy of Sciences, San Francisco, California, USA. 295 p. California Academy of Sciences, Memoirs 28.
- Burger M, Pauwels OSG, Branch WR, Tobi E, Yoga J-A, Mikolo E-N. 2006. An assessment of the amphibian fauna of the Gamba complex of protected areas, Gabon. Pp. 297–308 In: *Gamba, Gabon: Biodiversity of an Equatorial African Rainforest*. Alonso A, Lee ME, Cambell P, Pauwels OSG, Dallmeier F. (Editors). Biological Society of Washington and National Museum of Natural History, Washington, D.C., USA. 436 p. *Bulletin of the Biological Society of Washington* (Washington) 12.
- Channing A, Hillers A, Lötters S, Rödel M, Schick S, Conradie W, Rödder D, Mercurio V, Wagner P, Dehling JM, Du Preez LH. 2013. Taxonomy of the super-cryptic *Hyperolius nasutus* group of long reed frogs of Africa (Anura: Hyperoliidae), with descriptions of six new species. *Zootaxa* 3620(3): 301–350.
- Daly JW, Noimai N, Kongkathip B, Kongkathip N, Wilham JM, Garraffo HM, Kaneko T, Spande TF, Nimit Y, Nabhitabhata J, Chan-Ard T. 2004. Biologically active substances from amphibians: Preliminary studies on anurans from twenty-one genera of Thailand. *Toxicon* 44(8): 805–815.
- Du Chaillu PB. 1861. *Exploration and Adventure in Equatorial Africa*. Harper and Brothers Publishers, New York, New York, USA. 565 p.
- Duméril AHA. 1856. Note sur les reptiles du Gabon. *Revue et Magasin de Zoologie Pure et Appliquée* 2(8): 553–562.
- Evans BJ, Carter TF, Greenbaum E, Gvoždik V, Kelley DB, McLaughlin PJ, Pauwels OSG, Portik DM, Stanley EL, Tinsley RC, Tobias ML, Blackburn DC. 2015. Genetics, morphology, advertisement calls, and historical records distinguish six new polyploid species of African clawed frog (*Xenopus*, Pipidae) from West and Central Africa. *PLoS ONE* 10: e0142823.
- Ford HA. 1856. *Observations on the Fevers of the Western Coast of Africa*. Edward O. Jenkins, New York, New York, USA. 61 p.
- Frétey T, Blanc CP. 2000. Liste des amphibiens d’Afrique centrale: Cameroun, Congo, Gabon, Guinée-Equatoriale, République Centrafricaine, République Démocratique du Congo, São Tomé et Príncipe. *Les dossiers de l’ADIE, Série Bio-diversité* 2: 1–39.
- Frétey T, Blanc CP. 2001. Inventaire systématique des amphibiens anoures du centre du Gabon. *Bulletin de la Société Zoologique de France* 126: 375–390.
- Frétey T, Dewynter M. 1998. Amphibiens anoures de la Forêt des Abeilles (Gabon). *Journal of African Zoology* 112: 171–184.
- Gossmann V, Lötters S, Obame F, Böhme W. 2002. Zur Herpetofauna Gabuns – Teil II: Kommentierte Artenliste der gefundenen Reptilien, Bemerkungen zur Artenvielfalt. *Herpetofauna* 24(136): 19–33.
- Guibé J, Lamotte M. 1958. La réserve naturelle intégrale du Mont Nimba. XII. Batraciens (sauf *Arthroleptis*, *Phrynobatrachus* et *Hyperolius*). *Mémoires de l’Institut Fondamental d’Afrique Noire* (A) 53: 241–273.
- Gratwicke B, Alonso A, Elie T, Kolowski J, Lock J, Rotzel N, Sevin J, Fleischer RC. 2011. *Batrachochytrium dendrobatidis* not detected on amphibians from two lowland sites in Gabon, Africa. *Herpetological Review* 42(1): 69.
- Hallowell E. 1856. Notes on Reptilia in the collection of the Museum of the Academy of Natural Sciences. *Proceedings of the Academy of Natural Sciences of Philadelphia* 8: 146–153.
- Hallowell E. 1858 “1857.” Notice on a collection of reptiles from the Gaboon country, West Africa, recently presented to the Academy of Natural Sciences of Philadelphia, by Dr. Henry A. Ford. *Proceedings of the Academy of Natural Sciences of Philadelphia* 9: 48–72.
- Knoepffler LP. 1966. Faune du Gabon (Amphibiens et Reptiles). I. Ophidiens de l’Ogooué- Ivindo et du Woleu N’tem. *Biologia Gabonica* 2(1): 3–23.
- Knoepffler LP. 1974. Faune du Gabon (Amphibiens et Reptiles). II.-Crocodyles, chéloniens et sauriens de l’Ogooué-Ivindo et du Woleu N’tem. *Vie Milieu* 24(1): 111–128.
- Knoepffler L-P. 1976. Food Habits of *Aubria subsigilata* in Gaboon (Anura: Ranidae). *Zoologica Africana* 11(2): 369–371.
- Laurent RF. 1951. Catalogue des rainettes africaines (genres *Afrixalus* et *Hyperolius*) de la collection du Museum National d’Histoire Naturelle de Paris. *Belgian Journal of Zoology/ Annales de la Société Royale Zoologique de Belgique* 82: 23–50.
- Laurent RF. 1982. Le genre *Afrixalus* (Hyperoliidae) en Afrique Centrale. *Koninklijk Museum voor Midden-Afrika Tervuren Belgie Annalen Zoologische Wetenschappen* 235: 1–58.
- Lee ME, Alonso A, Dallmeier F, Campbell P, Pauwels OSG. 2006. The Gamba Complex of Protected

- Areas: An illustration of Gabon's Biodiversity. Pp. 229–242 In *Gamba, Gabon: Biodiversity of an Equatorial African Rainforest*. Alonso A, Lee ME, Cambell P, Pauwels OSG, Dallmeier F. (Editors). Biological Society of Washington and National Museum of Natural History, Washington, D.C., USA. 436 p. *Bulletin of the Biological Society of Washington* (Washington) 12.
- Lötters S, Gossmann V, Obame F. 2000. Erfassung der diversität der amphibien und reptilien Gabuns. *Ela-phe* (Berlin) 8: 63–66.
- Lötters S, Gossmann V, Obame F, Böhme W. 2001. Zur Herpetofauna Gabuns Teil I: Einleitung, Untersuchungsgebiet und Methodik, kommentierte Artenliste der gefundenen Froschlurche. *Herpetofauna* 23(133): 19–34.
- Mocquard F. 1897. Sur une collection de reptiles recueillie par M. Haug, à Lambaréné. *Bulletin de la Société Philomathique de Paris*. Series 8, 9: 6–20.
- Mocquard F. 1902. Sur les reptiles et batraciens de l'Afrique orientale anglaise, du Gabon et de la Guinée française (région de Kouroussa). *Bulletin du Museum National d'Histoire Naturelle* (Paris) 8: 404–417.
- Ohler A, Kazadi M. 1990 “1989.” Description d'une nouvelle espèce du genre *Aubria* Boulenger, 1917 (Amphibiens, Anoures) et redescription du type d'*Aubria subsigillata* (A. Duméril, 1856). *Alytes* (Paris) 8: 25–40.
- Oksanen J, Blanchet G, Kindt R, Legendre P, Minchin PR, O'Hara RB, Simpson GL, Solymos P, Henry M, Stevens H, Wagner H. 2013. *Vegan: Community Ecology Package*. R package version 2.0-7. Available: <http://CRAN.R-project.org/package=vegan> [Accessed: 14 December 2015].
- Pauwels OSG, Rödel M-O. 2007. Amphibians and national parks in Gabon, western Central Africa. *Herpetozoa* 19: 135–148.
- Portik DM, Leaché A, Rivera D, Hirschfeld M, Barej M, Burger M, Rödel M-O, Blackburn DC, Fujita MK. 2017. Evaluating mechanisms of diversification in a Guineo-Congolian forest frog using demographic model selection. *Molecular Ecology* 26(19): 5,245–5,263.
- R Core Team. 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available: <http://www.R-project.org/> [Accessed: 16 Decmeber 2015].
- Rödel M-O. 2000. *Herpetofauna of West Africa: Amphibians of the West African Savanna*. Volume 7. Edition Chimaira, Frankfurt am Main, Germany. 332 p.
- Schiøtz A. 1999. *Treefrogs of Africa*. Edition Chimaira, Frankfurt am Main, Germany. 350 p.
- Sosef MSM. 1994. *REFUGE BEGONIAS: Taxonomy, phylogeny and historical biogeography of Begonia in relation to glacial rain forest refuges in Africa*. Wageningen Publishers, Wageningen, Gelderland, Netherlands. 308 p.
- Vandeweghe JP. 2009. *The Batéké Plateaux*. Wildlife Conservation Society, New York, NY, USA. 272 p.
- Vandeweghe JP, Christy P, DuCrocq M, Lee M, Vandeweghe GR, Pauwels OSG. 2016. *Biodiversité des parcs nationaux et réserves du Gabon*. 2. Espèces, écosystèmes et populations. Agence Nationale des Parcs Nationaux, Libreville, Gabon. 384 p.
- Zimkus BM, Blackburn DC. 2008. Distinguishing features of the sub-Saharan frog genera *Arthroleptis* and *Phrynobatrachus*: A short guide for field and museum researchers. *Breviora* 513: 1–12.
- Zimkus BM, Larson JG. 2013. Assessment of the amphibians of Batéké Plateau National Park, Gabon, including results of chytrid pathogen tests. *Salamandra* 49(3): 159–170.



**Gregory F.M. Jongsma** is a Ph.D. student at the Florida Museum of Natural History at the University of Florida, USA. He received a B.S. from Acadia University (2010) and a M.S. from San Francisco State University (2014). For his dissertation he is taking a comparative phylogeographic approach to explore the diversification of frogs in Central Africa. He is seeking sponsorship from Régab and Vache Qui Rit to help sustain the team during future field work in Gabon.



**Elie Tobî** has been working with the Smithsonian Institution's, Gabon Biodiversity Program since 2001. He has been involved in the Monitoring and Assessment of Biodiversity in the Gamba Complex of Protected Areas. He conducted the amphibian assessment before the Loubomo-Moungagara National Road construction in South West Gabon and did recommendations to avoid and or mitigate the road construction impact on amphibian populations. He is also involved in the monitoring of Nile Crocodile nesting in the Gamba area. Elie manages an important zoological reference collection in Africa (123,000 specimens of mammals, birds, fish, reptiles, amphibians, and arthropods). He is leading environmental education and awareness programs with schools and workers of hydrocarbon companies to reduce human/animals incidents, conflicts, and impacts.



## Amphibians of southeastern Gabon



**Graham P. Dixon-MacCallum** developed his love for herpetology over the summer before his third year at Acadia University while working for a travelling snake show in Ontario. After graduation he worked bird jobs to pay the bills but always kept an eye to the ground (and in the trees) for all things scaled or slimy. He returned officially to the world of herpetology while completing a master's degree on garter snake habitat use at the University of Victoria, British Columbia. He misses wading through elephant wallows in Gabon in search of frogs. Graham currently works in the Centre for Conservation Research at the Calgary Zoo, in Calgary, Alberta.



**Abraham Bamba-Kaya** has been employed since 2015 at Institut de Recherche Agronomique et Forestiere. His research interests include aquatic biodiversity, conservation, and investigating amphibian declines. He has participated in expeditions of assessments and surveys of amphibians in various localities in Gabon.



**Jean-Aimé Yoga** is a researcher at the National Center for Scientific and Technological Research (CENAREST) of Gabon. He has a special interest in herpetology and has been involved in several projects since 2005. He helped with monitoring and assessing biodiversity at the Rabi site for amphibians and reptiles (Smithsonian Institution Project). He was the first to collect *Ramphotylops braminus* (Snakes: Typhlopidae) from Gabon.



**Jean-Daniel Mbega** is the head researcher at the Laboratory of Hydrobiology and Oenology of the National Center based at Institut de Recherches Agronomiques et Forestières (IRAF/CENAREST). Jean Daniel has made several important contributions to our knowledge about the freshwater fish of Gabon. In 2008, the National Assembly of Gabon presented Dr. Mbega the gold medal for his published *Identification Guide of the Fishes of the Lower Ogooué Basin*.



**Jean Hervé Mvé Beh** is a researcher at the Laboratory of Hydrobiology and Oenology of the National Center for Scientific and Technological Research (CENAREST) of Gabon. There are nearly twenty-two experiments on projects on freshwater fish in Gabon and brackish fish in Gabon. He participates in several projects with a focus on taxonomy, biology, and conservation. He participated in the development of the IUCN report on marine fish in the eastern Atlantic. Jean Hervé is currently working on a project on the role of mangroves in the Akanda National Park as a nursery for species of commercial interest landed by artisanal fisheries. It has just contributed to a project financed by TNC Gabon and to the study of the baselines of the fish populations of the sites proposed for the hydropower project. Jean Hervé is a member of the scientific society Gilbert.



**Andi Emrich** fostered a love for amphibians as a small child in Canada but re-invigorated the spark after working with Greg Jongsma on his research in Ecuador in 2007. After moving to San Francisco, Andi got involved at the California Academy of Sciences, volunteering her time in the mammalogy collections. She now works for the Florida Organic Growers in Gainesville, Florida but hopes to get back in the field on another amphibian adventure soon.



**David C. Blackburn** is the Associate Curator of Herpetology at the Florida Museum of Natural History at the University of Florida, USA. He received a BA from the University of Chicago (2001) and a Ph.D. from Harvard University (2008). His research focuses on the diversity and evolution of frogs. He hopes to one day see the following strange frogs alive in the field: *Calyptocephalella gayi*, *Conraua beccarii*, *Myobatrachus gouldii*, and *Triprrion petastatus*.