
PRELIMINARY ASSESSMENT OF THE FROG ASSEMBLAGES FROM SITES ADJACENT TO THREE NATIONAL PARKS IN GABON

JOANNA G. LARSON^{1,2,3} AND BREDA M. ZIMKUS²

¹*Department of Ecology and Evolutionary Biology and Museum of Zoology, University of Michigan, Ann Arbor, Michigan 48109, USA*

²*Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts 02138, USA*

³*Corresponding author; e-mail: jglarson@umich.edu*

Abstract.—We report on preliminary frog inventories from three sites in Gabon that are located in close proximity to three national parks. In the lowland forest surrounding Ossélé Village, located north of Batéké Plateau National Park, we documented 14 species from nine genera and six families. The species assemblage within the area of Ossélé Village was markedly different from what is known in the Batéké Plateau National Park from recent inventory work, likely due to the secondary rainforest located outside of the national park and the savanna grassland interspersed with gallery forest within the protected area. We recorded 10 species from eight genera and five families in the buffer zone of Birougou National Park. From the buffer zone of Minkébé National Park, we documented 16 species from eight genera and six families. The majority of these species are widely distributed in the lowland forests of Central Africa. No amphibian surveys have yet been undertaken within Birougou and Minkébé National Parks, but the information provided by these inventories provides insight into species that are likely present since the habitat in these buffer zones is found in the adjacent protected areas. We examined the similarity of the frog fauna of eight of the 13 national parks in Gabon and Ossélé Village, discovering that the frog community of Batéké Plateau National Park is highly distinct from all other compared areas. Lastly, we provide an updated checklist for frogs from these eight national parks.

Résumé.—Nous rapportons sur des inventaires préliminaires d'grenouilles dans trois sites au Gabon, qui sont situés à proximité directe de trois parcs nationaux. Dans la forêt de plaine environnant le village d'Ossélé, située au nord du Parc National des Plateaux Batéké, nous avons documenté 14 espèces appartenant à neuf genres et six familles. L'assemblage d'espèces dans les environs du village d'Ossélé était nettement différent de ce qui est connu dans le Parc National des Plateaux Batéké sur base d'inventaires récents, probablement à cause de la présence de forêt secondaire située à l'extérieur du parc national au lieu de la savane herbeuse parsemée de forêts-galeries dans l'aire protégée. Nous avons trouvé 10 espèces appartenant à huit genres et cinq familles dans la zone tampon du Parc National des Monts Birougou. Dans la zone tampon du Parc National de Minkébé, nous avons documenté 16 espèces appartenant à huit genres et six familles. La majorité de ces espèces sont largement distribuées dans les forêts de plaine de l'Afrique Centrale. Aucun inventaires des amphibiens n'a encore été entrepris dans les parcs nationaux de Minkébé et Birougou, mais l'information fournie par nos inventaires donne un aperçu de la présence de certaines espèces puisque l'habitat dans ces zones tampons est présent dans ces aires protégées. Nous avons examiné la similitude de la faune des grenouilles entre huit des 13 parcs nationaux au Gabon et le village d'Ossélé, et découvert que la communauté grenouille du parc national des Plateaux Batéké est très distincte de celle de toutes les autres aires protégées comparées. Enfin, nous fournissons une liste mise à jour pour les grenouilles de ces huit parcs nationaux.

Key Words.—Anura; biodiversity; Batéké; Birougou; conservation; Minkébé

INTRODUCTION

African rainforests are recognized for their high biological diversity but have been decimated in recent decades by logging, mining, and slash-and-burn farming (Olson and Dinerstein 1998; Kamdem-Toham et al. 2003; Laurance et al. 2006). The one exception to this unfortunate situation is the Gabonese Republic (Gabon), which has avoided substantial deforestation in part because revenue from the export of natural resources

has minimized plantation agriculture and industrial logging that are common in neighboring countries (Kamdem-Toham et al. 2003). This fact combined with the historically low population density and high degree of urbanization has helped to preserve Gabonese flora and fauna (Laurance et al. 2006).

In 2002, the Gabonese government established 13 national parks (Fig. 1), placing 11% of the land area of the country under strict protection. Additionally, the government designated five kilometers surrounding

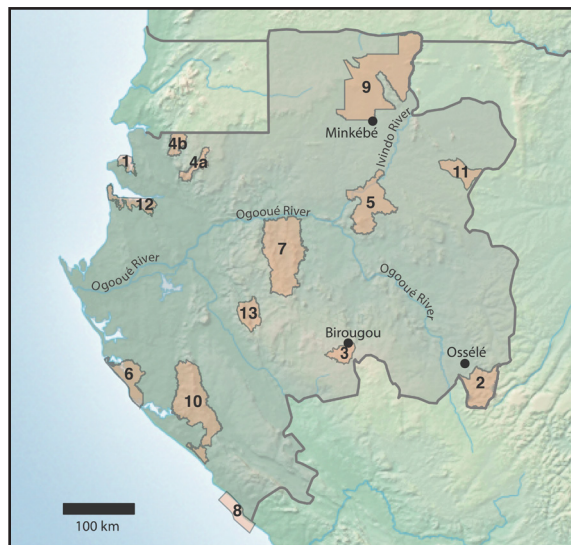


FIGURE 1. Map of Gabon with national parks, not including buffer zones. The three sampled localities indicated by black dots. Blue lines represent rivers. National parks are indicated in orange: (1) Akanda National Park; (2) Batéké Plateau National Park; (3) Birougou National Park; (4) Monts de Cristal National Park (4a: Mbe sector; 4b: Mt Sene sector); (5) Ivindo National Park; (6) Loango National Park; (7) Lopé National Park; (8) Mayumba National Park (park boundaries extend approximately 15 km into the Atlantic Ocean); (9) Minkébé National Park; (10) Moukalaba-Doudou National Park; (11) Mwagna National Park; (12) Pongara National Park; (13) Waka National Park.

each park as a buffer zone in which human activities are restricted. Nevertheless, forested areas of Gabon are facing increased disturbance from illegal mining and logging through government concessions to multinational corporations or illegal activities (Laurance et al. 2006). It is imperative that adequate conservation measures be enacted, and the first step in this process is to thoroughly explore the biodiversity of the country. Pauwels and Rödel (2007) collated and presented all published information on the herpetofauna of protected areas, and Pauwels (2016) recently updated this list to include species described and documented in the interim. Despite the efforts of researchers and support for research from the Agence Nationale des Parcs Nationaux (ANPN), which oversees management of the protected areas, the amphibian fauna of some of the less accessible national parks, such as Birougou and Minkébé, remains unknown.

The purpose of this study was to conduct preliminary batrachofauna inventories from three sites adjacent to three Gabonese national parks: Batéké Plateau National Park, Birougou National Park, and Minkébé National Park. For the latter two sites, study areas were within the buffer zone, and, therefore, this study is the first to report on the amphibian fauna for these protected areas. In this paper, we use the term protected area to indicate the block of land encompassing the national park and

surrounding buffer zone. We provide an annotated list of species that includes observations on microhabitat use, age, and reproductive condition. Additionally, we update the checklist of frog species recorded from eight of the 13 national parks of Gabon and their buffer zones and examine the similarity of the frog fauna in these protected areas, including the three localities that are the subject of this paper.

MATERIALS AND METHODS

Sampling and collection methods.—The first author conducted fieldwork at the end of the rainy season in May and June 2013. Students and researchers from the Central African Biodiversity Alliance, an international partnership that seeks to develop an integrated framework for conserving central African biodiversity under climate change, provided field assistance. At all sites, we conducted visual searches of habitat, including potential hiding spots, during the day and at night. We also conducted acoustic encounter searches at night. In subsequent sections we provide descriptions of fieldwork localities and site-specific methods. We photographed captured animals prior to euthanizing them using topical benzocaine and preserving them in 10% neutral buffered formalin. After fixation, we stored specimens in 70% ethanol. From every voucher specimen we took a liver or muscle tissue sample and preserved it in 95% ethanol. We deposited voucher specimens and tissue samples at the Museum of Comparative Zoology (Harvard University). We also deposited photographs of a single individual that was not vouchered in the same institution as a Herp Observation.

Study sites.—(1) Ossélé Village, Haut-Ogooué Province; 1°51.318'S, 13°51.245'E; 380 m elevation. Ossélé, a small village with approximately 10 inhabitants, lies along an unpaved road that connects Franceville and Lekoni (Fig. 1). The village is located 2 km north of the northern border of the Batéké Plateau National Park buffer zone, which is marked by the Mpassa River. This natural barrier also marks the start of the transition from rainforest to savanna ecosystem that dominates Batéké Plateau National Park. By contrast, the area around Ossélé Village is characterized by lowland, secondary rainforest, and is at the very eastern edge of the contiguous rainforest block that extends over much of Gabon. A group of five people conducted visual searches for five nights in the forests and along streams near Ossélé between 12 and 17 May 2013. Search periods lasted approximately 4 h each and generally were conducted from 2000–2400. A group of four people additionally conducted five searches of the same areas in the mornings from 0900–1200. These searches covered an area of approximately 24 ha.

Additionally, we installed 12 pitfall buckets with plastic drift fencing, and checked approximately every 12 h. We henceforth call this field site Ossélé (Site 1).

(2) Birougou National Park Buffer Zone, Ogooué-Lolo Province; 1°37.659'S, 12°21.783'E; 727 m. Birougou National Park, named for Mount Birougou (975 m), is located in south-central Gabon within the Chaillu Massif and occupies approximately 690 km² (Fig. 1). The Chaillu Massif has long been recognized for its plant diversity (Wilks 1990) and recently has been identified as having high species richness for reptiles (Pauwels et al. 2002). Carbon isotope analysis of soil organic carbon indicates that the Birougou Mountains have been continuously covered in rainforest vegetation since the Holocene climate optimum, serving as a refugium for Congo Basin flora and fauna (Pietsch and Gautam 2013).

The field site was approximately 7 km southeast from Popa Village within the buffer zone of the national park (Fig. 1). We conducted visual searches in secondary forest and along streams over three days and four nights (25–29 May 2013) across an area of roughly 24 ha. A group of three people performed the night searches from approximately 2000–2400 and five people conducted the morning searches from 0900–1300. We also used 12 pitfall buckets and plastic drift fencing that we checked approximately every 12 h. We henceforth call this site Birougou (Site 2).

(3) Minkébé National Park Buffer Zone, Ogooué-Ivindo Province; 1°9.271'N, 12°41.955'E; 500 m. Covering 7,570 km², Minkébé National Park is the largest of all Gabonese parks and is part of the Northwest Congolian Lowland Forest ecoregion (Olson et al. 2001; Fig. 1). A variety of habitats are found within this protected region, including herbaceous swamps, seasonally flood forests, and inselberg forests.

The field site was approximately 65 km northwest of Makokou on the Oua River, a tributary of the Ivindo River located in the buffer zone of the park (Fig. 1). We completed inventory work between 11 and 19 June 2013. We used a camp established by ecoguards of the national park agency (Agence Nationale des Parcs Nationaux; ANPN), who regularly patrol for illegal poachers. We searched for frogs in approximately 16 ha of swamps and seasonally flooded forest (dry phase) surrounding the site for six days and nights, as well as one night along the Oua River via canoe. A group of five people conducted eight night searches, each lasting 4 h (2000–2400). During eight morning searches, a group of three people searched from 0900–1100. We henceforth call this site Minkébé (Site 3).

DNA barcoding and species identification.—We confirmed identification of specimens by DNA barcoding approximately 550 bp of the 16S rRNA

gene. This fragment of mitochondrial DNA has been recognized as a reliable means of identifying amphibians (Vences et al. 2005; Smith et al. 2008). Amplification followed standard conditions and used the following primers of Palumbi et al. (1991): 16Sa-L (5'-CGCCTGTT-TATCAAAAACAT-3') and 16Sb-H (5'-CCGGTCTGAACTCAGATCACGT-3'). We verified PCR products using electrophoresis on a 1.5% agarose gel stained with GelRed™ DNA stain (Biotium, Fremont, California, USA) and then purified products with ExoSAP-IT® (Affymetrix, Santa Clara, California, USA). We compared sequences generated using an automated DNA sequencer (ABI PRISM 3730xl) to genetic data available on GenBank using standard nucleotide-nucleotide BLAST searches (Benson et al. 2004), as well as to each other. Using MUSCLE (Edgar 2004), we created alignments with sequences generated for this study and those identified as having the highest similarity in GenBank and then calculated percent pairwise uncorrected molecular distances using Geneious R9.1 (<http://www.geneious.com> [Accessed 13 January 2017]; Kearse et al. 2012).

Biogeographical patterns.—We compared the anuran communities of eight of the 13 national parks in Gabon (Fig. 1) and the area around Ossélé Village using information compiled from the literature (Pauwels 2016) and novel presence data from this study; see Appendix for the community data matrix used in analyses. With non-transformed occurrence records, we calculated binary Bray-Curtis dissimilarity indices using the vegan package (Oksanen et al. 2015) implemented in R 3.2.2 (R Core Team 2016). To visualize the results, we constructed a dendrogram using unweighted pair group method with arithmetic mean (UPGMA) with the dissimilarity matrix as input.

RESULTS AND DISCUSSION

Community analysis and biogeographical patterns.—We recorded 13 species in seven genera and six families from Ossélé, 11 species in eight genera and five families from Birougou, and 16 species in nine genera and six families from Minkébé. We found that most of our encounters occurred in terrestrial habitats, including leaf litter or low vegetation, as opposed to aquatic habitats, such as streams or rivers (Table 1). The community matrix in the Appendix includes species that have been recorded since the last synthesis (Pauwels 2016) and updates the taxonomy and identifications of published records to reflect the current understanding of Central African frog diversity.

We calculated the dissimilarity between protected areas of Gabon and Ossélé Village (Table 2) and visualized the patterns with a dendrogram (Fig. 3).

Larson and Zimkus.—Frog assemblages of three protected areas in Gabon.

TABLE 1. Anuran species collected at three sites in Gabon with site of record and the microhabitat where collected: (1) temporary puddle; (2) pitfall trap in forest; (3) forest floor; (4) forest vegetation; (5) forest stream; (6) Oua River (vegetation); (7) Oua River (edge).

	Site			Microhabitat						
	Ossélé	Birougou	Minkébé	1	2	3	4	5	6	7
Arthroleptidae										
<i>Arthroleptis adelphus</i>		X	X		X		X			
<i>Arthroleptis cf. poecilonotus</i>	X	X				X		X		
<i>Arthroleptis sylvaticus</i> complex	X		X			X		X		
<i>Arthroleptis variabilis</i>			X			X				
<i>Astylosternus batesii</i>	X	X				X				
<i>Cardioglossa gracilis</i>		X				X				
<i>Cardioglossa leucomystax</i>			X			X				
<i>Leptopelis boulengeri</i>			X				X			
<i>Leptopelis notatus</i>	X		X				X			
<i>Leptopelis ocellatus</i>		X					X			
Bufonidae										
<i>Sclerophrys camerunensis</i>			X			X				
<i>Sclerophrys gracilipes</i>	X	X			X	X		X		
<i>Sclerophrys pusilla</i>	X			X						
<i>Nectophryne afra</i>			X				X			
<i>Nectophryne batesii</i>	X						X			
Hyperoliidae										
<i>Hyperolius bolifambae</i>		X						X		
<i>Hyperolius cinnamomeoventris</i>			X						X	
<i>Hyperolius ocellatus</i>	X	X					X	X		
<i>Hyperolius tuberculatus</i>			X						X	
Ranidae										
<i>Amnirana albolabris</i>	X	X	X				X	X		
<i>Amnirana amnicola</i>	X	X	X				X			
<i>Amnirana lepus</i>			X							X
Phrynobatrachidae										
<i>Phrynobatrachus africanus</i>	X							X		
<i>Phrynobatrachus auritus</i>	X		X			X	X			
<i>Phrynobatrachus</i> sp. 1		X						X		
Ptychadenidae										
<i>Ptychadena aequiplicata</i>	X		X			X				
<i>Ptychadena mascareniensis</i>	X			X						
<i>Ptychadena perreti</i>			X							X
Total	14	10	16							

Batéké Plateau National Park is recovered as highly distinct from all other areas included in the analysis. The other regions are grouped into two clusters with Birougou and Ossélé grouping together and Ivindo, Minkébé, Lopé, Loango, and Moukalaba-Doudou forming the other cluster.

Even though Ossélé Village is not part of a protected area in Gabon, it is adjacent to the buffer zone of Batéké

Plateau National Park. The transition from the lowland rain forest that is characteristic of most of Gabon to the arid and sandy plains of Batéké Plateau is quite abrupt, and Ossélé is situated within the forest at this boundary. The results presented in this study indicate that this abrupt environmental shift is mirrored by a large turnover in frog diversity (Fig. 3). Despite the physical proximity of the two areas, the two anuran faunas are

highly distinct (Table 2). Species found near Ossélé are generally forest species (Table 1), whereas those recorded in Batéké Plateau National Park are typical savanna or farmbrush species (Zimkus and Larson 2013). This study confirms the findings of Zimkus and Larson (2013) that Batéké Plateau with the only extensive, true savanna habitat in Gabon has a unique frog fauna compared to the rest of Gabon and deserves additional investigation into its herpetofauna.

Other biogeographical patterns were more surprising, such as the grouping of Birougou and Ossélé, because the latter is in lowland forest whereas the field site in Birougou is at higher elevation. Another unexpected result was that the anuran fauna of Ivindo was more similar to Loango and Moukalaba-Doudou than to Minkébé because Ivindo and Minkébé appear to be more comparable in terms of environment (lowland forest) in contrast to the savanna forest mosaics of Loango and Moukalaba-Doudou. We were unsurprised by the similarity of Loango and Moukalaba-Doudou because these protected areas are in close proximity to each other (Fig. 1) and have similar environments along the Atlantic coast.

Arthroleptidae

Arthroleptis

The genus *Arthroleptis* contains 47 species, all of which are direct developers. Of these species, 14 were described in the past 15 years (Frost 2017. Amphibian Species of the World. Available from <http://research.amnh.org/herpetology/amphibia/index.html> [Accessed 15 May 2017]) and recognized diversity is expected to rise due to ongoing research (International Union for the Conservation of Nature [IUCN] 2017).

Arthroleptis adelphus Perret 1966. Voucher specimens: MCZ A-149125–149132. Sites 2, 3. We collected this species in Minkébé (GenBank No. KX289618) and Birougou (GenBank No. KX289619). Its documented range stretches from southern Cameroon to southeastern Gabon and east into northern Republic of Congo (Burger et al. 2006; IUCN 2017). The proximity of Birougou National Park to the border of the Republic of Congo makes it likely that *A. adelphus* is also found in the southern part of that country. All of the individuals from Minkébé were sitting on vegetation at approximately 0.5 m from the ground; two were gravid females (Fig. 2A). We caught the single specimen from Birougou in a pitfall trap in secondary forest.

Arthroleptis cf. poecilnotus Peters 1863. Voucher specimens: MCZ A-149142, 149156–149157. Sites 1, 2. In using the cf. designation, we follow Pauwels and Rödel (2007) who suggested that populations in Gabon are distinct from the nominotypical ones in West Africa.

This distinction has been supported by molecular studies (Blackburn 2008, 2010), which indicate populations referred to as *A. poecilnotus* represent a species complex that requires additional investigation. We collected individuals of this species from leaf litter and pitfall traps in Birougou (Table 1). In the area surrounding Ossélé Village, we collected animals from the edges of a sandy stream during night searches (Table 1). Genetic sequences indicate that individuals from the two sites are conspecific with individuals previously collected from Batéké National Park identified as *A. cf. poecilnotus* (Zimkus and Larson 2013).

Arthroleptis sylvaticus complex (Laurent 1954). Voucher specimens: MCZ A-149134, 149143, 149151–149152. Sites 1, 3. Populations referred to as *Arthroleptis sylvaticus* are found from southern Cameroon through the Republic of Congo and across northern Democratic Republic of Congo, but the name represents multiple cryptic species (IUCN 2017). Our genetic data strongly supports the presence of at least three distinct lineages within the samples we collected; however, we assign all of these individuals to the *A. sylvaticus* complex based upon morphology, pending a revision of the group (David Blackburn, pers. comm.). In Ossélé Village, we found two divergent lineages (min p-distance = 12.5%). We encountered these individuals in forest leaf litter and along the banks of a sandy stream during night searches (Table 1). In the leaf litter at Minkébé (Fig. 2B, C) we found individuals that were distinct from both of the lineages found at Ossélé (min p-distances = 18.5% and 20%). Despite these deep divergences, we chose to treat them as a single species in our biogeographical analyses given that it is impossible to assign previous records of *A. sylvaticus* to one of these lineages without genetic information.

Arthroleptis variabilis Matschie 1893. Voucher specimens: MCZ A-149122, 149124. Site 3. We collected individuals from the leaf litter within Minkébé (Fig. 2D, E; GenBank No. KX289620, KX289621). This is a common species in lowland and montane forests across Central Africa (Blackburn et al. 2009) and has been reported from six other protected areas of Gabon (Pauwels and Rödel 2007; Pauwels 2016).

Astylosternus

This genus of large-bodied frogs is endemic to sub-Saharan Africa and currently contains 12 described species (Frost 2017. *op. cit.*). They are notable in having claw-shaped terminal phalanges on toes II–V that can pierce the skin and be used defensively (Blackburn et al. 2008).

Astylosternus batesi Boulenger 1900. Voucher specimens: MCZ Cryo-2322, MCZ A-149158–149162. Sites 1, 2. We collected multiple individuals of this

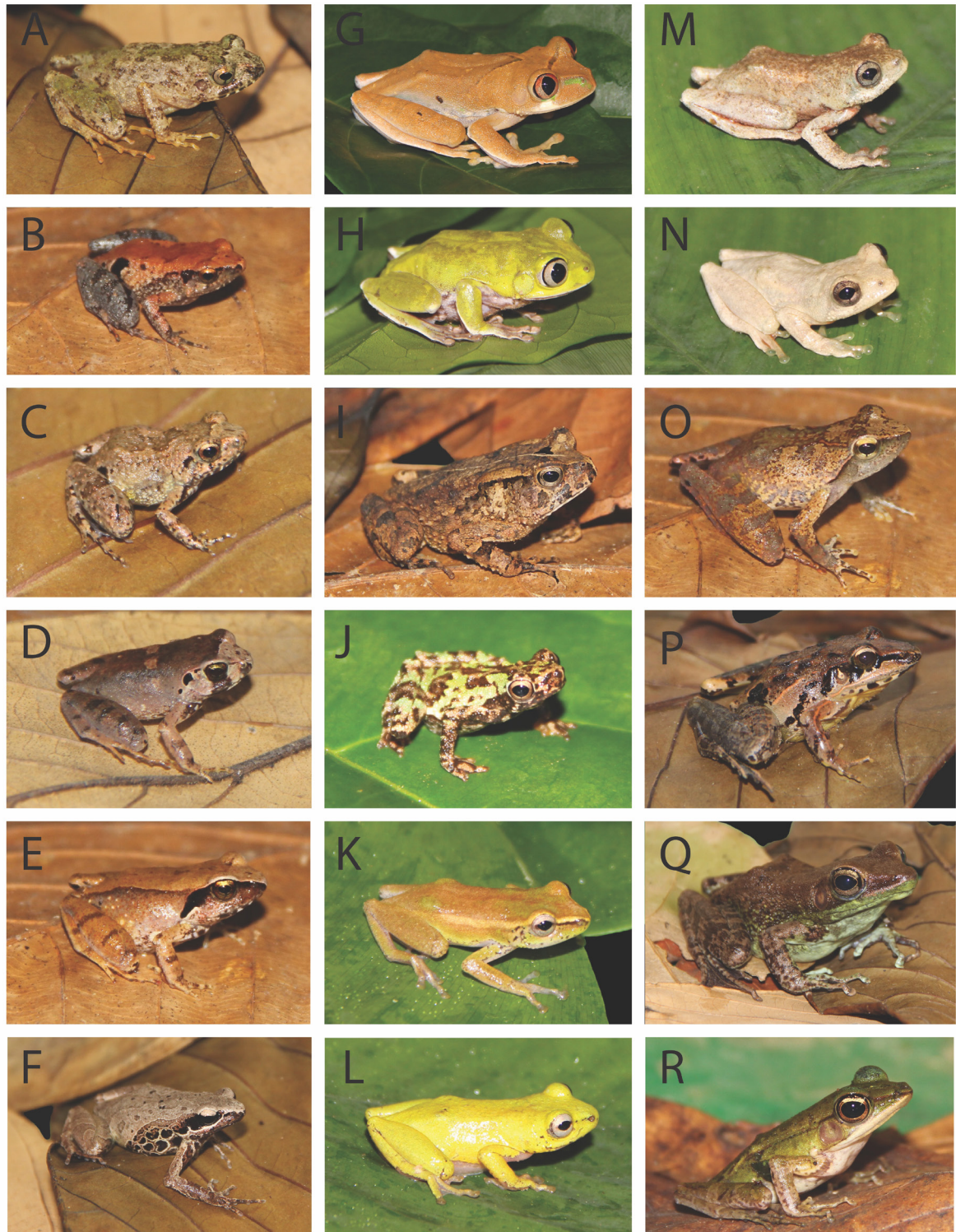


FIGURE 2. Frogs collected in Minkébé National Park Buffer Zone; (A) *Arthroleptis adelphus*; (B) *Arthroleptis sylvaticus* complex, male; (C) *Arthroleptis sylvaticus* complex, female; (D) *Arthroleptis variabilis*; (E) *Arthroleptis variabilis*; (F) *Cardioglossa leucomystax*; (G) *Leptopelis boulengeri*; (H) *Leptopelis notatus*; (I) *Sclerophrys camerunensis*; (J) *Nectophryne afra*; (K) *Hyperolius cinnamomeoventris*, male; (L) *Hyperolius cinnamomeoventris*, female; (M) *Hyperolius tuberculatus*, male; (N) *Hyperolius tuberculatus*, female; (O) *Phrynobatrachus auritus*; (P) *Ptychadena aequiplicata*; (Q) *Hylarana lepus*; (R) *Hylarana amnicola*. (Photographed by Joanna G. Larson).

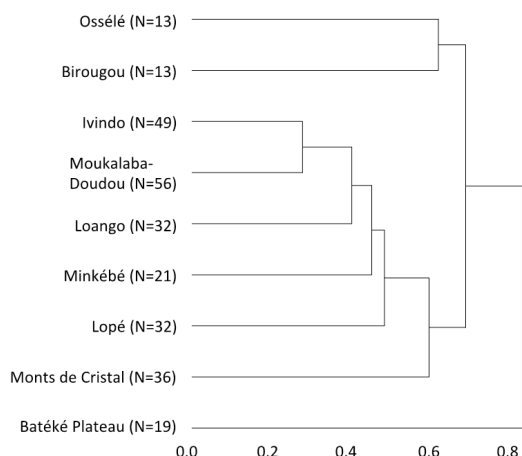


FIGURE 3. Dendrogram based on the anuran species of eight Gabonese protected areas (national parks with the buffer zones) and Ossélé Village, using the Bray-Curtis dissimilarity index on the X-axis. The number of species from each protected area is noted in parentheses.

large arthroleptid in the leaf litter of forests surrounding Ossélé (GenBank No. KX289622) and within Birougou (GenBank No. KX289623). The species is found in southern Cameroon and throughout Gabon and Equatorial Guinea, and its range extends into western Republic of Congo (IUCN 2017).

Cardioglossa

The genus is distributed across West and Central Africa and currently has 19 species (IUCN 2017; Frost, 2017. *op. cit.*). The common name for species in the genus is long-fingered frogs due to the very elongate third fingers of males. We recorded two species of *Cardioglossa*.

Cardioglossa gracilis Boulenger 1900. Voucher specimen: MCZ A-149163. Site 2. We collected a

single animal from Birougou that was found in leaf litter near the edge of a swamp in a montane valley (Table 1; GenBank No. KX260261).

Cardioglossa leucomystax Boulenger 1903. Voucher specimen: MCZ A-149164. Site 3. We collected a single adult specimen from leaf litter of secondary forest in Minkébé (Fig. 2F; GenBank No. KX260262). The species is distributed within rainforest from Nigeria to southeastern Central African Republic and northeastern Democratic Republic of Congo, throughout Gabon and the Republic of Congo, and south to the region of the mouth of the Congo River (Frost, 2017. *op. cit.*).

Leptopelis

The genus *Leptopelis* contains 53 described species of large treefrogs (Frost, 2017. *op. cit.*). The taxonomy of the genus remains unresolved with the recent description of many new species (e.g., Portillo and Greenbaum 2014a, 2014b), discovery of numerous cryptic lineages (Portillo et al. 2015), and significant revisions of species groups (Gvoždík et al. 2014). There are 10 species known to occur in Gabon (IUCN 2017), and this field work identified three.

Leptopelis boulengeri Werner 1898. Voucher specimens: MCZ A-149198 (juvenile), 149199. Site 3. This species is widely distributed across Central Africa but is found only in dense rainforest (IUCN 2017). We collected an adult and a juvenile of this species (Fig. 2G) from vegetation approximately 1 m above ground during night searches in Minkébé (Table 1; GenBank No. KX260263).

Leptopelis notatus Peters 1875. Voucher specimens: MCZ A-149197, 149200. Sites 1, 3. We collected a gravid female from the banks of a shallow, sandy stream near Ossélé Village within secondary forest (GenBank No. KX260265) and a second adult from Minkébé, where it was perched on a sapling at approximately 1.5

TABLE 2. Dissimilarity in frog diversity between selected protected areas in Gabon and the study sites presented in this paper, as measured by Bray-Curtis dissimilarities. A value of 1 indicates no overlap in the frog species community and 0 indicates complete overlap. Each entry is for the named protected area, which includes the national park and buffer zone, with the exception of Ossélé, which refers to a village situated in unprotected forest.

	Loango	Moukalaba-Doudou	Monts de Cristal	Lopé	Birougou	Minkébé	Ivindo	Batéké Plateau	Ossélé
Loango	0								
Moukalaba-Doudou	0.341	0							
Monts de Cristal	0.647	0.522	0						
Lopé	0.438	0.455	0.647	0					
Birougou	0.689	0.739	0.755	0.822	0				
Minkébé	0.434	0.455	0.684	0.472	0.647	0			
Ivindo	0.457	0.276	0.459	0.556	0.645	0.457	0		
Batéké Plateau	0.765	0.787	0.891	0.843	0.812	0.9	0.794	0	
Ossélé	0.644	0.681	0.755	0.644	0.615	0.529	0.645	0.812	0

m from the ground (Table 1; Fig. 2H; GenBank No. KX260266). This is a common species across Central Africa and can be found in a variety of habitat types (IUCN 2017). Although we did not record this species from Birougou, it is expected to occur within the park because it is documented in the surrounding area. In fact, in some communities around the Chaillu Massif, *L. notatus* is burned and the ashes are believed to improve the performance of soccer goalkeepers (Pauwels et al. 2003).

Leptopelis ocellatus Mocquard 1902. Voucher specimen: MCZ A-149201. Site 2. We collected a juvenile individual in Birougou from vegetation in secondary forest (GenBank No. KX260264). The ocellated forest treefrog is a widespread species found in southern Cameroon southward to Republic of Congo and east to central Democratic Republic of Congo (Frost. 2017. *op. cit.*).

Bufonidae

Sclerophrys

Sclerophrys is a monophyletic group of true toads endemic to the African continent (Frost et al. 2006; Ohler and Dubois 2016). There are currently 45 species in this genus (Frost. 2017. *op. cit.*).

Sclerophrys camerunensis Parker 1936. Voucher specimens: MCZ A-149106–149112. Site 3. We collected this medium-large toad from leaf litter in secondary forest in Minkébé (Fig. 2I). This is a distinctive species with conical tubercles on the sides of the body and a relatively smooth anterior half of the dorsum (GenBank No. KX260257).

Sclerophrys gracilipes Boulenger 1899. Voucher specimens: MCZ A-149113–149120. Sites 1, 2. In Ossélé and Birougou, we collected adult animals along stream banks in secondary forest (Table 1; GenBank No. KX260258–KX260260). *Sclerophrys gracilipes* is a medium-sized toad found in lowland forests throughout the Central Africa rainforest belt (IUCN 2017).

Sclerophrys pusilla Mertens 1937. Voucher tissue: MCZ Cryo-2317. Site 1. We collected this large-bodied species in close proximity to houses within Ossélé Village after a rainstorm (Table 1). This species is morphologically similar to *S. regularis*; we based species determination on the flat and not well-defined parotid glands and confirmed using DNA barcoding (GenBank No. KX260256; Poynton et al. 2016). This species has a large range from southern Cameroon east to Ethiopia and south into northern South Africa (IUCN 2017).

Nectophryne

African tree toads are diminutive, arboreal bufonids with extensively webbed hands and feet. We recorded both of the species that are known to occur in Gabon.

Nectophryne afra Buchholz and Peters 1875. Voucher specimen: MCZ A-149202. Site 3. During a night search in secondary forest of Minkébé, we collected an adult from vegetation at approximately 1 m from the ground (Fig. 2J; GenBank No. KX260254). This species occurs from southwestern Nigeria east through southern Cameroon to Gabon and northeastern Democratic Republic of Congo (IUCN 2017).

Nectophryne batesii Boulenger 1913. Voucher specimen: MCZ A-149203. Site 1. *Nectophryne batesii* can be distinguished from *N. afra*, the only other congeneric species, by the shape of the rostrum. The former has a short, oblique snout in contrast to the curved, prominent one of *N. afra* (Frétey et al. 2012). We encountered a single *N. batesii* sitting on vegetation along a path in secondary forest near Ossélé Village (Table 1; GenBank No. KX260255). This species shares a similar geographic distribution with *N. afra* (IUCN 2017).

Hyperoliidae

Hyperolius

There are currently 141 described species within the genus *Hyperolius*, making it the most speciose genus of African frogs (Frost. 2017. *op. cit.*). Due to a lack of reliable external diagnostic traits, including significant intraspecific color and pattern variation, the taxonomy of the genus remains poorly defined (Schick et al. 2010). We recorded four species of the genus *Hyperolius* within the three sites inventoried.

Hyperolius bolifambae Mertens 1938. MCZ Herpetology Observations 14 (<http://mczbase.mcz.harvard.edu/guid/MCZ:HerpOBS:14>). Site 2. The Bolifamba Reed Frog was recently reported from Ivindo National Park (Bell et al. 2011) in central Gabon and Batéké Plateau National Park (Zimkus and Larson 2013) in southeastern Gabon. We photographed an individual in phase F (Schiotz 1999) from Birougou but did not capture it. This site, at 727 m, is a new elevational record for the species, which has previously only been reported from below 600 m (IUCN 2017).

Hyperolius cinnamomeoventris Bocage 1866. Voucher specimens: MCZ A-149187–149189, 149194–149195. Site 3. A very widespread species, found across Central Africa and into East Africa, *H. cinnamomeoventris* is adaptable and found in a variety

of habitats (IUCN 2017). During night searches, we collected adult males and females (Fig. 2K, L) from vegetation near the Oua River in Minkébé (GenBank No. KX289624, KX289625).

Hyperolius ocellatus Günther 1858. Voucher specimen: MCZ A-149196, 149227. Sites 1, 2. We collected one individual in F phase (Schjötz 1999) from low vegetation along a shallow, sandy stream in secondary forest near Ossélé (Table 1) and a very young juvenile in J phase (Schjötz 1999) in Birougou (GenBank No. KX260267). This species is widely distributed from southern Nigeria to the enclave of Cabinda, Angola, and possibly as far east as Uganda. This species is likely distributed throughout Gabon's lowland forests (Frost. 2017. *op. cit.*).

Hyperolius tuberculatus Mocquard 1897. Voucher specimens: MCZ A-149190–149193. Site 3. The rainforest reed frog has a similar distribution to *H. ocellatus* (Frost. 2017. *op. cit.*) and is also considered to be a farmbrush species (IUCN 2017). We collected multiple adult individuals from vegetation near the Oua River in Minkébé (Table 1; Fig. 2M, N) during night searches (GenBank No. KX260268–KX260270).

Phrynobatrachidae

Phrynobatrachus

With 89 species currently recognized (Frost. 2017. *op. cit.*), *Phrynobatrachus* is one of the most speciose sub-Saharan genera. There are currently seven described species believed to occur in Gabon: *P. africanus*, *P. auritus*, *P. batesii*, *P. cornutus*, *P. horsti*, *P. mayokoensis*, and *P. ogoensis* (Frétey et al. 2012; Frost. 2017. *op. cit.*; IUCN 2017; Rödel et al. 2015; this study, see Appendix for discussion). We recorded three species of *Phrynobatrachus* within the three field sites.

Phrynobatrachus africanus Hallowell 1858. Voucher specimen: MCZ A-149204, Cryo 2330. Site 1. We collected two adult *P. africanus* along the banks of a sandy stream in secondary forest near Ossélé (Table 1). Males of this species are distinct due to enlarged odontoids (tooth-like processes) in the lower jaw. This species is currently known from western, central, and southern Cameroon, Equatorial Guinea, Gabon, southern Congo, and southwestern Central African Republic (IUCN 2017).

Phrynobatrachus auritus Boulenger 1900. Voucher specimens: MCZ A-149205–149213, 149394–149418, 149465–149480. Sites 1, 3. We found all of the animals collected within Ossélé Village sitting on vegetation in secondary forest at an average 0.5 m from the ground. Specimens collected in Minkébé (Fig. 2O) were similarly located or were found within the leaf litter (Table 1).

We commonly encountered this species during day and night searches in Minkébé, but only found it at night in Ossélé. It is a common species in primary, secondary, and riparian forests from southeastern Nigeria and southern Cameroon, east to eastern Democratic Republic of Congo, western Uganda and Rwanda, and south to Gabon and possibly the Cabinda Enclave of Angola (IUCN 2017).

Phrynobatrachus sp. Voucher specimens: MCZ A-149214 (gravid female), 149215–149216. Site 2. We collected three conspecific individuals of a small *Phrynobatrachus* that show strong morphological similarity to the type description of *P. hylaïos*. Additionally, the elevation and habitat types of Birougou and the type locality of *P. hylaïos* in Cameroon (Foulassi, Sangmelima, 710 m) are similar (Perret 1959). However, *Phrynobatrachus hylaïos* is only known from the Adamawa Plateau in central Cameroon to southern Cameroon and western Republic of Congo (Frost. 2017. *op. cit.*), and genetic data that can be reliably attributed to this species is not available for comparison. In addition, comparison of sequence data from MCZ A-149214 and data available for all other species of *Phrynobatrachus* resulted in a minimum p-distance of 4.7%. In light of these factors, we have chosen not to assign a name to these specimens until additional morphological and molecular data are available.

Ptychadenidae

Ptychadena

There are currently 51 species in the genus *Ptychadena*, although preliminary molecular analyses suggest that there are many cryptic species (Frost. 2017. *op. cit.*; Zimkus et al. 2017; Breda M. Zimkus, unpubl. data). Six species have been recorded in Gabon (*P. aequiplicata*, *P. aff. mascareniensis*, *P. perreti*, *P. pumilio*, *P. taenioscelis*, and *P. uzungwensis*). However, records assigned to *P. taenioscelis* could refer to *P. pumilio* (Frost. 2017. *op. cit.*; IUCN 2017), and Deichmann et al. (2017) found that *P. pumilio* is likely a species complex. We follow Pauwels (2016) in reporting *Ptychadena* diversity from selected Gabonese parks (Appendix) and caution that ongoing study of the genus will likely lead to changes. We record three species from sites 1 and 3.

Ptychadena aequiplicata Werner 1898. Voucher specimens: MCZA-149218, 149219–149221. Sites 1, 3. This species was very common in the secondary forest surrounding our field site in Minkébé (Fig. 2P). We collected a single individual from the forest near Ossélé Village (Table 1). Preliminary molecular analyses of the genus *Ptychadena* reveal multiple lineages identified as

P. aequiplicata; examination of type material is needed to determine which lineage should remain identified as *P. aequiplicata* (Breda M. Zimkus, unpubl. data).

Ptychadena aff. *mascareniensis* Duméril and Bibron 1841. Voucher specimen: MCZ A-149223. Site 1. We collected an adult from a puddle formed from rain in tire tracks near houses in Ossélé Village (Table 1). *Ptychadena mascareniensis* sensu stricto is restricted to Madagascar, the Seychelles, and the Mascarenes; the unnamed species within the *P. mascareniensis* complex are restricted to sub-Saharan Africa (Vences et al. 2004; Measey et al. 2007; Zimkus et al. 2017). This specimen falls within the lineage identified as *P. aff. mascareniensis* D (OTU6), which is distributed across the Congo Basin and is currently also known from Cameroon, Republic of Congo, Democratic Republic of Congo, Kenya, and Uganda (Zimkus et al. 2017).

Ptychadena perreti Guibé and Lamotte 1958. Voucher specimen: MCZ A-149222. Site 3. We collected a single individual of this species from a docked dugout canoe along the banks of the Oua River in Minkébé (Table 1). This species ranges from southern Cameroon and Gabon south to southwestern Congo, east through southwestern Central African Republic to northeastern Democratic Republic of Congo (IUCN 2017). *Ptychadena perreti* was identified in Batéké Plateau National Park from 16S data extracted from a tadpole (GenBank No. MF085556; Zimkus and Larson 2013), but it should be noted some of the material (larva and juvenile) originally attributed to this species has been reidentified as *P. sp.* (GenBank No. KF 178892).

Ranidae

Amnirana

The genus *Amnirana* has recently been removed from synonymy with *Hylarana* by Oliver et al. (2015), where it had been placed by Che et al. (2007). It currently contains 12 sub-Saharan Africa species with the exception of *A. nicobariensis*, which is found in Southeast Asia (Frost 2017. *op. cit.*). Other recent work on this clade suggests that there is undescribed cryptic diversity (Jongsma et al. 2018). We recorded all three of the currently described species known to occur in Gabon.

Amnirana albolabris Hallowell 1856. Voucher specimens: MCZA-149166, 149181, Cryo 2324. Sites 1, 2, 3. At site 1, we found individuals on vegetation along a stream in secondary forest. At sites 2 and 3, animals were sitting on vegetation that was approximately 0.5 m off the ground and was not near a stream or other water body (Table 1; GenBank No. KX289626–28). This is a widespread species found throughout Central Africa to Kenya, Uganda, and western Tanzania (Frost 2017. *op.*

cit.). Populations in West Africa that have previously been assigned to *H. albolabris* are a cryptic species that is sister to *A. fonensis* (Jongsma et al. 2018).

Amnirana amnicola Perret 1977. Voucher specimens: MCZ A-149165, 149170, 149172. Sites 1, 2, 3. As with *Amnirana albolabris*, we found this species at all three sites sitting on low vegetation (Fig. 2R; GenBank No. KX289629–31).

Amnirana lepus Andersson 1903. Voucher specimen: MCZ A-149184. Site 3. We collected one large individual of this species during a night search in Minkébé (Fig. 2Q). The animal was found sitting on a log in the Oua River, approximately 1 m from the bank (Table 1; GenBank No. KX241478). Jongsma et al. (2018) found that populations in the Republic of Congo likely represent a cryptic species when compared to populations in Gabon and Cameroon. The nominotypical *A. lepus* is found in southern Cameroon, Equatorial Guinea, Gabon, and Democratic Republic of Congo (Frost 2017. *op. cit.*; Jongsma et al. 2018).

GENERAL DISCUSSION

This study presents the first published data on the frog fauna of the Minkébé and Birougou protected areas, as well as from along the border of the Batéké Plateau protected area. No surveys had yet been undertaken within Birougou and Minkébé National Parks due to their remote locations, but our results indicate that these sites have interesting frog communities that merit further research. For example, in only 4 d, we recorded 11 species in eight genera and five families from Birougou. However, fieldwork was conducted at the end of the rainy season when many frogs have become inactive and difficult to find. Therefore, the species lists given here should be considered preliminary and likely incomplete due to the short duration of the fieldwork and the time of year. In addition, our inventories for Birougou and Minkébé were restricted to a single locality in the buffer zone without any sampling in the interior of either park. Given the similarity in habitat type of these parks and their respective buffer zones, it is reasonable to infer that the faunal composition of the parks is similar to that of their respective buffer zone. This makes it less likely that large turnovers in the frog assemblage, such as that seen between Ossélé and Batéké Plateau, would occur within Birougou or Minkébé. Nevertheless, we recommend additional surveys in other parts of these protected areas, especially the core of the national parks, to further improve understanding of frog diversity.

The protected areas that we inventoried are highly relevant to conservation efforts in Gabon and the region. Minkébé is home to the largest population of forest elephants (*Loxodonta cyclotis*) in Africa (WCS 2005) and is now the epicenter of the ivory poaching

crisis (Blake et al. 2007; Wasser et al. 2015). Similarly, bushmeat poachers threaten many species present in the region that includes Ossélé Village. Although these two areas have not been altered by deforestation or farming, their large mammal populations have suffered heavy losses in the past decade, which have direct and indirect consequences for the ecosystem (e.g., Brodie et al. 2009). In contrast, the Birougou protected area has had minimal human disturbance in the recent past (Gautam and Pietsch 2012) and is less likely to have suffered human-mediated losses in faunal diversity. Despite the differences in disturbance, the frog communities of Ossélé and Birougou are more similar to each other than to any other protected area in the country, which could indicate that frogs exhibit a degree of resiliency to this type of human impact.

Ongoing investigation into the frog diversity of Gabon continues to elucidate local, regional, and even the country species list (Jongsma et al. 2017), highlighting the importance of such work. As the composition of frog communities in Gabon and Central African rain forests becomes clearer, it is also evident that knowledge about habitat usage, diet, and reproductive biology of these species is still limited and often inferred from congeners rather than due to direct observation. Data such as these are critical to improving our understanding of the environmental requirements and biogeographical history of species that in turn improves inferences, such as extinction risk assessments. We recommend that increased focus be directed at studying the ecology of these species. As mining for precious metals and logging are becoming more important sources of revenue for Gabon, there is an increased urgency to understand how these ecosystems function without significant anthropogenic disturbance. Not only will this knowledge aid in conservation planning for Gabon, but also for similar ecoregions in other countries (Kamdem-Toham et al. 2003). Lastly, we suggest that more rigorous methodologies such as historical biogeography and environmental niche modeling be conducted on speciose genera, such as *Arthroleptis*, *Phrynobatrachus*, and *Ptychadena*, to more fully understand patterns of species distribution of these groups in Gabon.

Acknowledgments.—We thank Flore Koumba Pambo (Centre National de la Recherche Scientifique et Technologique, CENAREST) and Kath Jeffery (Agence Nationale des Parcs Nationaux, ANPN) for assistance with research permits (AR0013/13 and AE130014), as well as the Gabonese Direction de la Faune et de la Chasse for export permits. For invaluable logistical support, we thank Frank Lepemangoye (Conservator, Birougou), Frank Bibang Bingomo (Conservator, Minkébé), and Joseph Okouyi (Senior Warden, ANPN).

We are very grateful to the Central African Biodiversity Alliance, Université des Sciences et Techniques de Masuku (USTM), villagers of Ossélé, particularly Hilaire Ontsana, the villagers of Popa, and the ecoguards of Minkébé National Park for assistance in the field. We extend gratitude to David Blackburn for assistance with the identification of specimens. We also thank C. Scott Walker of the Harvard Map Collection for assistance with the map used in Figure 1, and Pascal Title, who assisted with the translation of the abstract into French. This fieldwork and research was funded by grants from the Museum of Comparative Zoology (Harvard University), Museum of Zoology (University of Michigan), and Rackham Graduate School (University of Michigan) to JGL.

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Larson and Zimkus.—Frog assemblages of three protected areas in Gabon.



JOANNA G. LARSON is a Graduate Student in the Ecology and Evolutionary Biology Department and Museum of Zoology at the University of Michigan, Ann Arbor, USA. She is studying the evolution of diet in frogs using high-throughput sequencing technology. She received her B.A. from Harvard University, Cambridge, Massachusetts, USA. (Photographed by Pascal O. Title).



BREDA M. ZIMKUS is the Cryogenics Collections Manager for Genetic Resources at the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA. She received her B.A. from Boston University, Boston, Massachusetts, USA, and Ph.D. from Harvard University. She is interested in the biodiversity, biogeography, phylogenetics, and conservation of African amphibians. Her research integrates a broad range of techniques, including fieldwork, taxonomy, and molecular systematics, to interpret patterns of speciation and diversity. (Photographed by Joanna G. Larson).

Herpetological Conservation and Biology

APPENDIX. In this binary community matrix, a value of one indicates that the species has been recorded from the designated protected area or locality and a value of zero indicates that it has not been recorded. For all localities, except Ossélé, faunal data from the national park and buffer zone were pooled to examine the diversity of the entire protected area. Ossélé is a village located in unprotected forest.

	Loango	Moukalaba- Doudou	Monts de Cristal	Lopé	Birougou	Minkébé	Ivindo	Batéké Plateau	Ossélé
Arthroleptidae									
<i>Arthroleptis adelphus</i>	1	1	0	1	1	1	1	0	0
<i>A. poecilonotus</i>	1	0	1	1	1	0	1	1	1
<i>A. sylvaticus</i> complex	1	1	0	1	0	1	1	1	1
<i>A. taeniatus</i>	0	0	0	1	0	0	0	0	0
<i>A. variabilis</i>	0	1	1	0	0	1	1	0	0
<i>Astylosternus batesi</i>	0	1	1	0	1	0	1	0	1
<i>Cardioglossa elegans</i>	0	0	1	0	0	0	0	0	0
<i>C. gracilis</i>	0	1	0	0	1	0	1	0	0
<i>C. gratiosa</i>	1	1	0	0	0	0	0	0	0
<i>C. leucomystax</i>	1	1	1	1	1	1	0	0	0
<i>Leptopelis aubryi</i>	1	1	1	1	0	0	1	0	0
<i>L. aubryioides</i>	1	0	0	1	0	0	0	0	0
<i>L. boulengeri</i>	1	1	0	0	1	1	1	0	0
<i>L. brevirostris</i>	0	0	1	0	0	0	1	0	0
<i>L. calcaratus</i>	0	1	1	0	0	0	1	0	0
<i>L. crystallinoron</i>	0	0	1	0	0	0	0	0	0
<i>L. millsoni</i>	0	1	1	0	0	0	1	0	0
<i>L. notatus</i>	0	1	1	0	0	1	1	0	1
<i>L. ocellatus</i>	0	1	0	0	0	0	1	0	0
<i>L. rufus</i>	0	1	1	0	0	0	0	0	0
<i>L. zebra</i>	0	0	1	0	0	0	1	0	0
<i>Leptodactylodon blanci</i>	0	1	0	1	0	0	0	0	0
<i>L. stevarti</i>	0	0	1	0	0	0	0	0	0
<i>Scotolepis gabonicus</i>	0	1	1	1	0	0	0	0	0
<i>Trichobatrachus robustus</i>	0	1	1	0	0	0	0	0	0
Bufoidea									
<i>Nectophryne afra</i>	1	1	1	1	0	1	1	0	0
<i>N. batesii</i>	0	1	1	1	0	0	1	0	1
<i>Sclerophrys camerunensis</i>	1	1	0	1	0	1	1	0	0
<i>S. gracilipes</i>	1	1	0	0	1	1	1	0	1
<i>S. latifrons</i>	0	1	0	1	0	0	0	0	0
<i>S. pusilla</i>	0	1	0	1	0	1	0	0	1
<i>S. regularis</i>	0	1	0	1	0	0	0	1	0
<i>S. superciliaris</i>	0	0	1	0	0	0	1	0	0
<i>S. tuberosa</i>	0	1	0	0	0	0	1	0	0
<i>Werneria iboundji</i>	0	0	0	1	0	0	0	0	0
Conrauidae									
<i>Conraua crassipes</i>	0	1	1	1	0	0	1	0	0
Discroglossidae									
<i>Hoplobatrachus occipitalis</i>	1	1	1	0	0	0	0	1	0

Larson and Zimkus.—Frog assemblages of three protected areas in Gabon.

APPENDIX (CONTINUED). In this binary community matrix, a value of one indicates that the species has been recorded from the designated protected area or locality and a value of zero indicates that it has not been recorded. For all localities, except Ossélé, faunal data from the national park and buffer zone were pooled to examine the diversity of the entire protected area. Ossélé is a village located in unprotected forest.

	Loango	Moukalaba- Doudou	Monts de Cristal	Lopé	Birougou	Minkébé	Ivindo	Batéké Plateau	Ossélé
Hemisotidae									
<i>Hemisus perreti</i>	1	1	0	0	0	0	0	0	0
Hyperoliidae									
<i>Acanthixalus spinosus</i>	0	1	0	0	0	0	1	0	0
<i>Afrixalus dorsalis</i>	1	1	0	1	0	0	1	0	0
<i>A. laevis</i>	0	0	0	0	0	0	1	0	0
<i>A. paradorsalis</i>	0	0	1	0	1	0	1	0	0
<i>A. quadrivittatus</i>	0	1	1	0	0	0	1	1	0
<i>Alexteroon hysiphonus</i>	0	0	0	1	0	0	0	0	0
<i>A. obstetricans</i>	0	1	0	0	0	0	0	0	0
<i>Cryptothylax greshoffi</i>	0	0	0	0	0	0	1	1	0
<i>Hyperolius adspersus</i>	1	1	0	0	0	0	0	1	0
<i>H. bolifambae</i>	0	0	0	0	1	0	1	1	0
<i>H. cinnamomeoventris</i>	1	1	0	1	0	1	1	0	0
<i>H. guttulatus</i>	1	1	0	0	0	0	0	0	0
<i>H. kuligae</i>	1	1	0	0	0	0	1	0	0
<i>H. mosaicus</i>	0	0	1	0	0	0	0	0	0
<i>H. ocellatus</i>	1	1	1	0	1	0	1	0	1
<i>H. pardalis</i>	0	0	1	0	0	0	1	0	0
<i>H. phantasticus</i>	1	0	1	0	0	0	0	0	0
<i>H. platyceps</i>	1	1	0	0	0	0	0	0	0
<i>H. tuberculatus</i>	1	1	1	0	0	1	1	0	0
<i>H. sp. 1</i>	0	0	0	0	0	0	0	1	0
<i>H. sp. 2</i>	0	0	0	0	0	0	0	1	0
<i>H. sp. 3</i>	0	0	0	0	0	0	0	1	0
<i>Kassina maculosa</i>	0	0	0	0	0	0	0	1	0
<i>Kassina sp.</i>	0	1	0	0	0	0	0	0	0
<i>Opisththylax immaculatus</i>	0	0	0	0	0	0	1	0	0
<i>Phlyctimantis leonardi</i>	1	1	1	1	0	1	1	0	0
Petroedetidae									
<i>Petroedetes cf. johnstoni</i>	0	1	0	0	0	0	1	0	0
<i>P. palmipes</i>	0	0	1	0	0	0	0	0	0
<i>P. aff. parkeri</i>	0	0	1	0	0	0	0	0	0
<i>P. vulpiae</i>	0	0	1	1	0	0	0	0	0
Phrynobatrachidae									
<i>Phrynobatrachus africanus</i>	1	1	0	1	0	1	1	0	1
<i>P. auritus</i>	1	1	1	1	0	1	1	0	1
<i>P. batesii*</i>	0	0	0	0	0	0	1	0	0
<i>P. cornutus</i>	1	1	0	1	0	0	0	0	0
<i>P. horsti</i>	0	1	0	0	0	0	0	1	0
<i>P. sp. 1</i>	0	0	0	0	1	0	0	0	0

Herpetological Conservation and Biology

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	Loango	Moukalaba- Doudou	Monts de Cristal	Lopé	Birougou	Minkébé	Ivindo	Batéké Plateau	Ossélé
<i>P. sp. 2**</i>	0	0	0	1	0	0	0	0	0
Pipidae									
<i>Hymenochirus boettgeri</i>	1	1	0	0	0	0	1	1	0
<i>Xenopus mellotropicalis</i>	1	1	1	1	0	0	1	0	0
<i>X. parafraseri***</i>	1	1	0	0	0	0	1	0	0
<i>X. pygmaeus</i>	0	0	0	0	0	0	0	1	0
Ptychadenidae									
<i>Ptychadena aequiplicata</i>	1	1	0	1	0	1	1	0	1
<i>P. aff. mascareniensis</i>	0	0	0	0	0	0	0	0	1
<i>P. perreti</i>	0	1	0	1	0	1	1	0	0
<i>P. pumilio</i>	0	0	0	1	0	0	0	0	0
<i>P. sp.</i>	0	0	0	0	0	0	0	1	0
<i>P. taenioscelis</i>	0	0	0	0	0	0	0	1	0
<i>P. uzungwensis</i>	0	0	0	0	0	0	0	1	0
Pyxicephalidae									
<i>Aubria subsgillata</i>	0	1	0	0	0	0	1	0	0
Ranidae									
<i>Amnirana albolabris</i>	1	1	0	1	1	1	1	1	1
<i>A. amnicola</i>	0	1	1	0	1	1	1	0	0
<i>A. lepus</i>	0	1	0	0	0	1	1	0	0
Rhacophoridae									
<i>Chiromantis rufescens</i>	1	1	1	1	0	1	1	0	0

* Rödel et al. (2015) states that the presence of *Phrynobatrachus batesii* has not been confirmed in Gabon. We follow Pauwels (2016) in maintaining the record of *Phrynobatrachus batesii* from Ivindo National Park.

** This record is based on a specimen originally identified as *Phrynobatrachus ogoensis* (Larson and Zimkus 2015). We re-assign this specimen because of the recent description of *Phrynobatrachus mayokoensis* (Rödel et al. 2015). The specimen had high genetic similarity (mean uncorrected pairwise distance = 1.34%) to *P. mayokoensis*; however, the specimen, which was not examined for the description of *P. mayokoensis*, differs in some key morphological traits. Unlike *P. mayokoensis*, which is described as having a triangular black pattern originating on the pectoral region and pointing toward the throat and pectoral region (Rödel et al. 2015), the specimen attributed to *P. ogoensis* by Larson and Zimkus (2015) has dark blotches on white, but no clear pattern. Another key characteristic of *P. mayokoensis* is the presence of a large red blotch (coloration fades to pale in preservative) bordered by a black line on the antero-dorsal part of the femur (Rödel et al. 2015). The specimen in question has a pale area on the thigh, which could have been red in life, but there is not a photograph of the specimen before preservation to verify this. It should also be noted that the pale area is not bordered with a black line.

***A revision of the *Xenopus* genus described several new species, including *X. parafraseri*, and re-identified specimens collected in Ivindo National Park from *X. fraseri* to this new species (Evans et al. 2015). However, it is not clear whether *Xenopus* from Loango and Moukalaba-Doudou should be attributed to *X. parafraseri* or *X. allofraseri*, which was also described in the same revision (Evans et al. 2015). The latter species is described as occurring in forests along the Atlantic Coast in Cameroon and the Democratic Republic of Congo, which makes it likely that the species also occurs in the intervening Gabonese coast where Loango and Moukalaba-Doudou are located. We update the taxonomy here to reflect the confirmed presence of *X. parafraseri* in Gabon, but note that additional species, such as *X. allofraseri*, may be present and further investigation is needed in regards to coastal populations.