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A herpetological survey of western Zambia

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***Abstract.*—A list of 60 species of amphibians and reptiles found during a six-week survey in western Zambia is presented. Two species of amphibians are newly reported for Zambia: *Amietia chapini* and an undescribed species of *Tomopterna*, previously known to occur in the Democratic Republic of Congo and in Namibia, respectively. Some of the material collected could not be confidently identified to species level because of the taxonomic complexity and uncertainty of some groups (e.g., *Phrynobatrachus*, *Ptychadena*), even with the use of DNA barcoding. This list is a small contribution to the growing knowledge of Zambian and African herpetology.**

Keywords. Amphibians, barcode, checklist, reptiles, Southern Africa, undescribed species

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Introduction

Zambia is a landlocked southern African country considered part of the Zambesiaca area, which also includes Botswana, Malawi, Mozambique, parts of Namibia (Caprivi), and Zimbabwe (Poynton and Broadley 1991). Zambia is located on the main central African plateau where elevations range from 1,200 m to 1,500 m and the vegetation is dominated by *miombo* woodland (Phiri 2005).

Very little has been published on the herpetofauna of Zambia since the first then comprehensive reports from the early 1900's (see reviews in Haagner et al. 2000; Pietersen et al. 2017). Poynton and Broadley's compendium *Amphibia Zambesiaca* (Poynton and Broadley 1985a,b, 1987, 1988, 1991) and Channing (2001) reported on the distribution of Zambian amphibians, while Broadley (1971) presented an initial treatise of the reptiles and amphibians of Zambia, and Broadley et al. (2003) provided an updated atlas and field guide to the snakes of Zambia. Similarly, Haagner et al. (2000) and more recently Pietersen et al. (2017) have made important contributions to Zambian herpetology. Broadley (1991) presents a comprehensive list of reptiles and amphibians from the Mwinilunga District, northwestern Zambia, including records from museum collections dating from 1957. However, except from the extreme north-west (Hillwood Farm), the herpetofauna of western Zambia remains very poorly studied, with only a few regional checklists (e.g., Broadley 1991; Pietersen et al. 2017).

Currently, there are 189 species of reptiles recorded for Zambia according to The Reptile Database (Uetz et al. 2018) and 181 (two crocodile, 10 chelonian, 78 lizard, and 91 snake species) according to Pietersen et al. (2017). The number of amphibian species varies substantially according to different sources. Pietersen et al. (2017) report 86 species of amphibians for Zambia, while AmphibiaWeb (2018) reports 87 species, and a search in the Amphibian Species of the World 6.0 database (ASW; Frost 2018) returns 104 species. This disparity between databases is possibly due to the fact that the ASW includes non-confirmed occurrences. An example is the caecilian *Boulengerula*, which is expected to occur in Zambia based on its known distribution but is as yet unreported there.

Herein I present a checklist of species collected during a six-week herpetological survey in western Zambia.

Materials and Methods

Study site and sampling

The survey was carried out in April and May 2014 encompassing protected as well as non-protected areas of western Zambia (Fig. 1, Table 1). Figure 2 shows the different vegetation types surveyed, comprising *miombo* woodlands (dominated by *Brachystegia* spp.), dry evergreen forests (dominated by *Cryptosepalum* sp.), riverine forests (*mushito*) and grassy wetlands (*dambo*).

During the whole survey period there were only four

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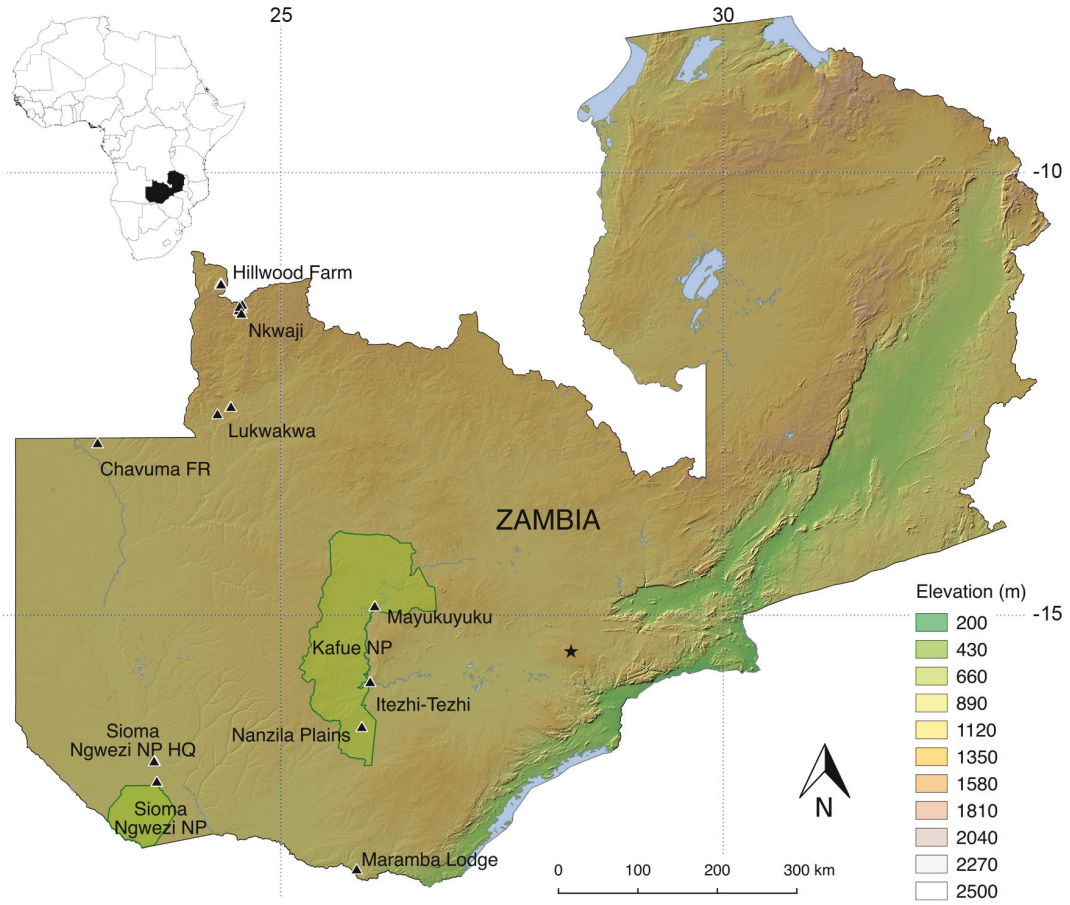

Fig. 1. Map of Zambia showing sites surveyed for herpetofauna. The star indicates the capital (Lusaka).

days of rain and average temperatures were 30 ºC during the day and 15 ºC at night. The main sampling methods were acoustic and visual encounter surveys (diurnal and nocturnal). Entomologists participating in the expedition opportunistically collected some specimens with the use of sweep nets and small pitfall traps (500 ml cups). All specimens collected were euthanized with 20% benzocaine (applied on the skin or in the mouth). Samples of thigh muscles were taken and stored in absolute ethanol before the specimens were fixed in 10% formalin and transferred to 70% industrial methylated spirit for long-term storage. All specimens are deposited in the herpetological collection of the Natural History Museum in London, United Kingdom (see Appendix 1).

Species identification

Identification keys for Amphibia (Channing 2001; Poynton and Broadley 1985a) and Reptilia (Branch 1998; Broadley 1971; Broadley et al. 2003) were used to

Table 1. Localities in Zambia surveyed during this study. Protected areas are indicated by shaded green. NP: National Park; HQ: Headquarters.

Locality	District	Longitude	Latitude	Elevation (m)
Chavuma FR	Chavuma	-13.07006	22.92880	1070
Hillwood Farm	Ikelenge	-11.26316	24.32782	1400
Itezhi-Tezhi, Kafue NP	Itezhi-Tezhi	-15.77340	26.01151	1040
Lukwakwa	Kabompo	-12.66084	24.43697	1150
Livingstone, Maramba Lodge	Livingstone	-17.89120	25.85821	900
Mayukuyuku, Kafue NP	Mumbwa	-14.91533	26.06311	1010
Nanzila Plains, Kafue NP	Itezhi-Tezhi	-16.28138	25.91676	1030
Ngonye Falls Camp	Shangombo	-16.66139	23.57280	930
Nkwaji	Mwinilunga	-11.56567	24.52605	1300
Sioma Ngwezi NP	Shangombo	-16.89873	23.59847	1010
Sioma Ngwezi NP (HQ)	Shangombo	-16.66953	23.56743	1000

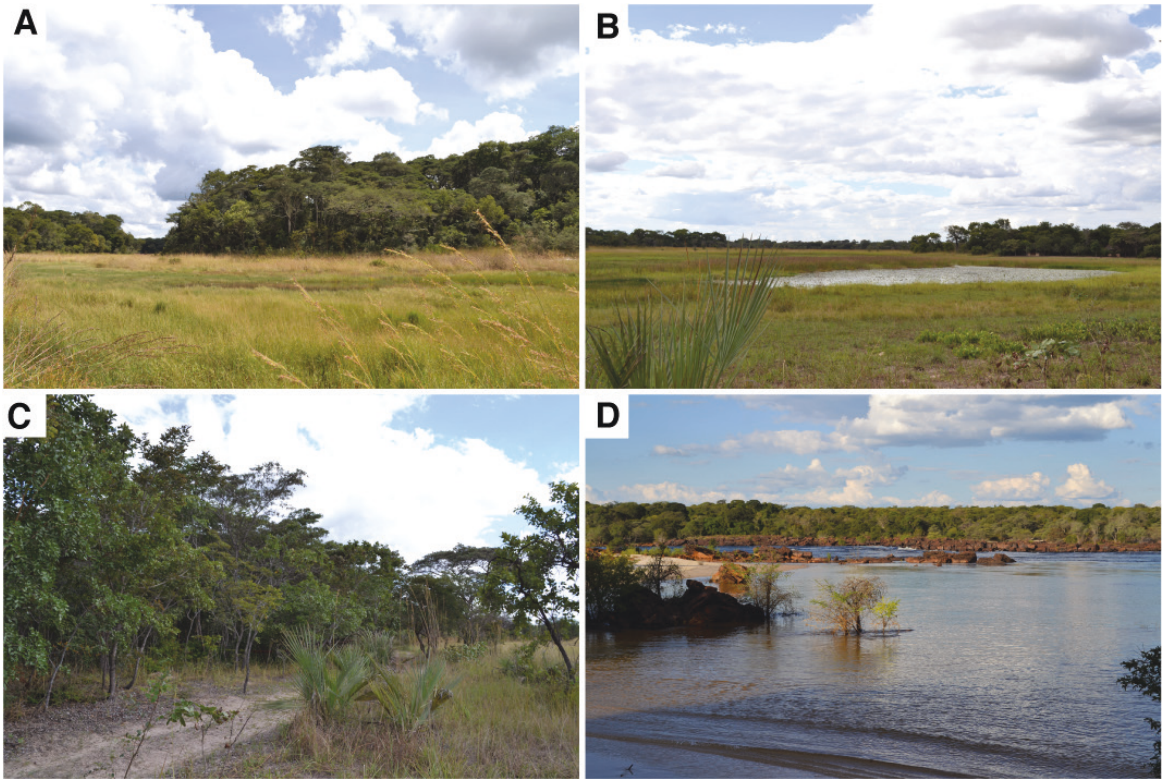

Fig. 2. Habitats surveyed in western Zambia. **(A)** *Dambo* and *Cryptosepalum* dry forest in Lukwakwa, **(B)** *Dambo* in Nanzila Plains, **(C)** *Miombo* woodland in Nanzila Plains, **(D)** Margin of the Zambezi River at Ngonye Falls.

assist with the identification of specimens. Some species identifications presented here are tentative because some groups have complex and difficult taxonomies (e.g., *Hyperolius*, *Hemisus*, *Phrynobatrachus,* and *Ptychadena*). Most samples were barcoded to help species identification (see details below). Despite its known limitations (e.g., Deichmann et al. 2017; Hebert and Gregory 2005; Meier et al. 2006), DNA barcoding is generally, and sometimes very, helpful. The Basic Local Alignment Search Tool (BLAST; Altschul et al. 1990) was used to search the GenBank repository and identify the closest matches for each sample. As there are not many 16S rRNA sequences of Zambian reptiles and amphibians openly available for comparison, percentage of sequence similarity presented here should be interpreted with caution and while taking the possibility of geographic isolation or isolation by distance into account. Private databases were also used for sequence comparisons (D. Portik and B. Zimkus). Snakes were identified primarily using morphological characters.

Genetic analysis

Given the large amount of 16S rRNA sequence data available in GenBank for African amphibians and reptiles, this gene was selected for DNA barcoding. Total genomic DNA was extracted using a Qiagen DNeasy kit (Venlo, Netherlands) following the manufacturer's protocol for purification of total DNA from animal tissues. A fragment (ca. 500 bp) of the 16S rRNA mitochondrial gene was amplified using the primers 16S H3062 (CCGGTTTGAACTCAGATCA) and 16SB FROG (CGCCTGTTACCAAAAACAT) [modified from Palumbi et al. 1991]. Polymerase chain reaction (PCR) was performed using Illustra PuReTaq Ready-To-Go PCR Beads (GE Healthcare Life Sciences) for 35 cycles of 1 minute with annealing temperature at 51 °C. Single strand sequencing reactions and electrophoresis were carried out by the molecular lab team at the Natural History Museum in London, United Kingdom. All sequences generated are available in GenBank under accession numbers MK464267–MK464483.

DNA sequences were trimmed in Geneious v.7 (Kearse et al. 2012) with a maximum of low-quality bases of 20. Uncorrected pairwise distances (p-distances) of the 16S sequences were calculated for some groups in PAUP* (Swofford 2001). For *Phrynobatrachus,* a maximum likelihood (ML) analysis with non-parametric bootstrapping was carried out with RAxML v.8.2 (Stamatakis 2014). The alignment was generated in Geneious using the Auto algorithm of MAFFT v.7 (Katoh et al. 2002), inspected visually and poorly aligned regions were eliminated using the GBlocks Server v.091b (Castresana 2000). Evolutionary models were evaluated using Automated Model Selection (using a Neighbor Joining tree) in PAUP*. The best fitting model (GTR + GAMMA) was selected according to the Akaike Information Criteria (AIC). *Tomopterna marmorata* was used for rooting.

Results

A total of 40 species of amphibians (anurans) belonging to nine families and 13 genera, and 20 species of reptiles from nine families and 17 genera (14 lizards, five snakes, one tortoise) were recorded during this survey (Appendix 1). Among the localities surveyed, Hillwood Farm had the highest species diversity (n=23), followed by Nkwaji (n=15). Different from all other areas surveyed, which are characterized by a combination of *miombo* woodland, *dambo* and/or dry forest, both localities mentioned above have riverine or swamp forest, locally known as *mushitos* (Fig. 2).

Species accounts

All collected specimens and their respective vouchers are listed below. Voucher numbers in bold refer to specimens identified solely based on morphology (i.e., no tissue sample available).

Amphibia

Order Anura

Arthroleptidae

Arthroleptis stenodactylus Pfeffer, 1893
Shovel-footed Squeaker
Material. LUKWAKWA: BMNH 2018.5826, BMNH 2018.5827 (Fig. 3A), BMNH 2018.5828–29; NKWAJI: BMNH 2018.5830. **Comments:** Found in leaf litter in *Cryptosepalum* forest, in *dambo* and at edges of *mushito*. *Arthroleptis stenodactylus* as currently understood is widely distributed from Angola to Tanzania, and from Kenya to South Africa. This taxon clearly represents a species complex, possibly two ecologically distinct forms (see comments in Pickersgill 2007). All specimens listed above have white venters without any dark markings, large inner metatarsal tubercles and a dark line on each side running from the snout over the tympanum to the shoulder. Sequence similarity with *A. stenodactylus* from Malawi is 98% (GenBank accession numbers FJ51098–99).

Arthroleptis xenochirus Boulenger, 1905
Plain Squeaker
Material. LUKWAKWA: BMNH 2018.5811 (Fig. 3B), BMNH 2018.5812–13; HILLWOOD FARM: BMNH 2018.5814–20; NKWAJI: BMNH 2018.5821–25. **Comments:** Specimens were found in leaf litter in *Cryptosepalum* and *mushito*. All specimens have a very small tympanum and relatively large inner metatarsal tubercle (when compared to *A. xenodactyloides*). The closest match on GenBank (94%) is to *A. xenodactyloides* from Malawi (FJ151103). There is no sequence of *A. xenochirus* available for comparison.

Bufonidae

Schismaderma carens (Smith, 1848)
Red Toad
Material. CHAVUMA FR: BMNH 2018.5729; ITEZHI-TEZHI: BMNH 2018.5724–28 (Fig. 3C). **Comments:** Specimens were found in *miombo* woodland. This species is widely distributed in Zambia. The BLAST result show 100% sequence similarity with *S. carens* from South Africa (KF665176, AF220913).

Sclerophrys gutturalis (Power, 1927)
Guttural Toad
Material. CHAVUMA FR: **BMNH 2018.5703**; LIVINGSTONE: **BMNH 2018.5702**; LUKWAKWA: BMNH 2018.5705–06, **BMNH 2018.5707**; MAYUKUYUKU: BMNH 2018.5701 (Fig. 3D); NKWAJI: BMNH 2018.5704. **Comments:** This species is found in *miombo* and *Cryptosepalum* forest. These specimens lack the typical red infusions on their thighs, although this could be due to preservation. Specimen identification was confirmed using DNA barcoding (100% sequence similarity with AF220876, from Botswana).

Sclerophrys lemairii (Boulenger, 1901)
Yellow Swamp Toad
Material. HILLWOOD FARM: BMNH 2018.5723; LUKWAKWA: BMNH 2018.5715–22 (Fig. 3E). **Comments:** One male was found in a pond at night and eight individuals were found in *dambo* near the *Cryptosepalum* forest. About six males were calling during the day and two couples were observed in amplexus. The species exhibits dynamic sexual dichromatism, where males undergo a temporary color change (from dark green to bright yellow), depending on the breeding period; females are reddish, especially the parotid glands (Bittencourt-Silva 2014; Conradie and Bills 2017).

Sclerophrys pusilla (Mertens, 1937)
Southern Flat-backed Toad
Material. ITEZHI-TEZHI: BMNH 2018.5709–10; MAYUKUYUKU: BMNH 2018.5708 (Fig. 3F); NKWAJI: BMNH 2018.5711–12. **Comments:** Specimens identification were confirmed using DNA barcoding (100% sequence similarity) and non-morphometric morphological characters following Poynton et al. (2016). Specimens were found in *miombo* woodland.

Hemisotidae

Hemisus cf. *guineensis* Cope, 1865
Guinea Snout-burrower
Material. HILLWOOD FARM: BMNH 2018.5801 (juvenile); LUKWAKWA: BMNH 2018.5800 (Fig. 3G);

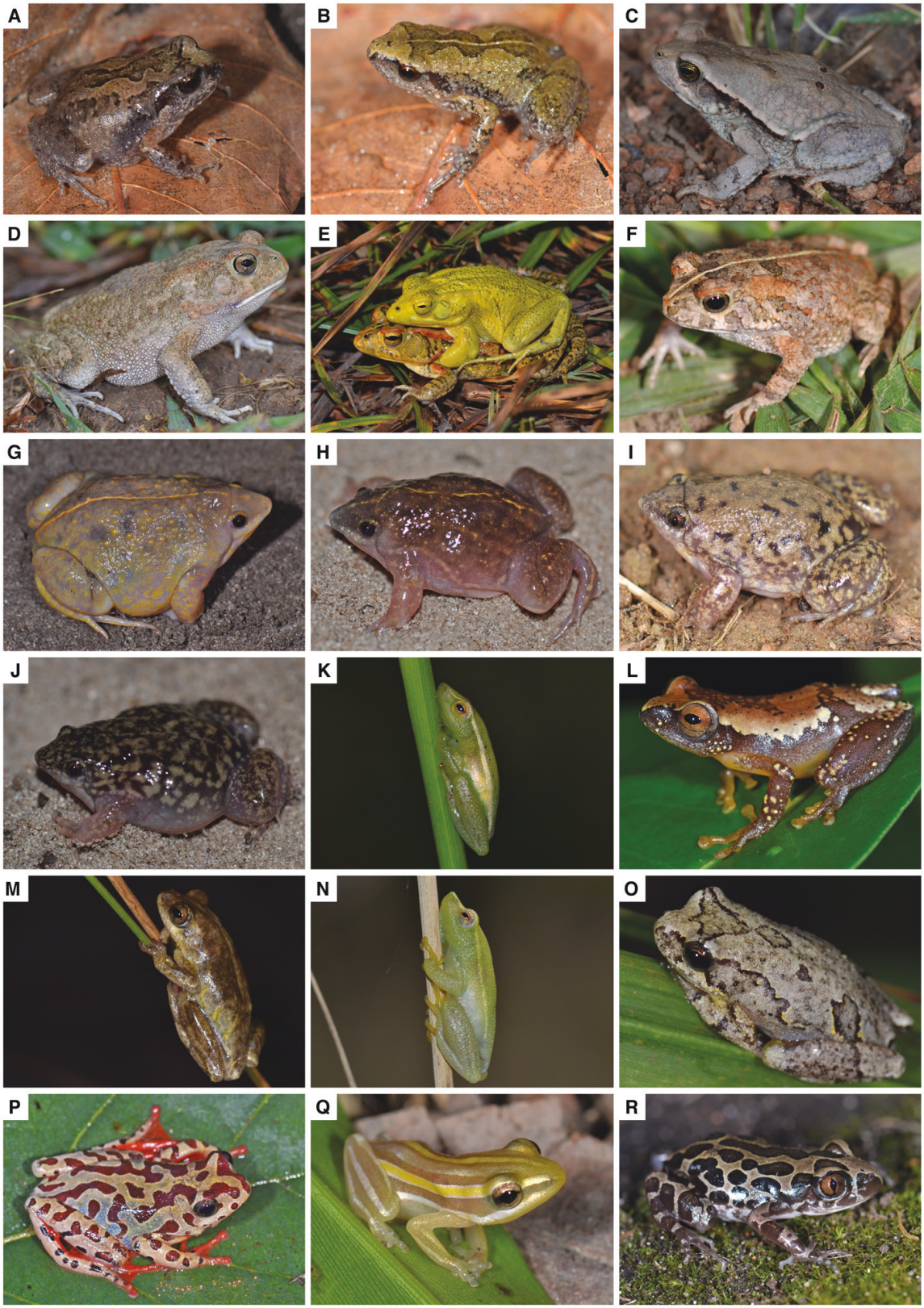

Fig. 3. Amphibians of western Zambia. **(A)** *Arthroleptis stenodactylus* (BMNH 2018.5827), **(B)** *Arthroleptis xenochirus* (BMNH 2018.5811), **(C)** *Schismaderma carens* (BMNH 2018.5728), **(D)** *Sclerophrys gutturalis* (BMNH 2018.5701), **(E)** *Sclerophrys lemairii*, **(F)** *Sclerophrys pusilla* (BMNH 2018.5708), **(G)** *Hemisus* cf. *guineensis* (BMNH 2018.5800), **(H)** *Hemisus* cf. *guineensis* (BMNH 2018.5799), **(I)** *Hemisus marmoratus* (BMNH 2018.5713), **(J)** *Hemisus marmoratus* (BMNH 2018.5714), **(K)** *Hyperolius dartevellei* (BMNH 2018.5681), **(L)** *Hyperolius major* (BMNH 2018.5675), **(M)** *Hyperolius marginatus* (BMNH 2018.5667), **(N)** *Hyperolius nasicus* (BMNH 2018.5666), **(O)** *Hyperolius parallelus* (BMNH 2018.5689), **(P)** *Hyperolius parallelus* (BMNH 2018.5697), **(Q)** *Hyperolius quinquevittatus*, **(R)** *Kassina senegalensis*.

SIOMA NGWEZI NP: BMNH 2018.5799 (juvenile; Fig. 3H). **Comments:** One juvenile (BMNH 2018.5801) was found dead in a pitfall trap set for dung beetles near *mushito*. One large individual (snout-vent length 42.2 mm) from Lukwakwa was found buried in sandy soil under a log between *Cryptosepalum* forest and *dambo*. The specimen from Sioma Ngwezi is a juvenile. The BLAST search shows 95% sequence similarity with *H. guineensis* from the Republic of the Congo (KY080117–19). According to Channing and Broadley (2002), *Hemisus barotseensis*, which is endemic to western Zambia, differs from *H. guineesis* and *H. marmoratus* in body proportions. The presence of a bright yellow vertebral stripe and small yellow spots on the back agree with the description of *H. barotseensis* and it is possible that these specimens are that species. If confirmed, this would represent an extension both north and south from its current known range.

Hemisus marmoratus (Peters, 1854)
Marbled Snout-burrower
Material. MAYUKUYUKU: BMNH 2018.5713 (Fig. 3I); SIOMA NGWEZI NP: BMNH 2018.5714 (Fig. 3J). **Comments:** Juvenile individuals found at night in sandy soil in *miombo* woodland. *Hemisus marmoratus* is widely distributed in sub-Saharan Africa, excluding rainforest, and it mainly inhabits savannahs but can also be found in gallery forests. The BLAST search shows the closest match on GenBank (94%) is *H. marmoratus* (AY531831). Table 2 shows the p-distance for both species of *Hemisus* presented here and highlights a limitation of the use of this measure for species delimitation.

Hyperoliidae

Hyperolius dartevellei Laurent, 1943
Dartevelle's Reed Frog
Material. CHAVUMA FR: BMNH 2018.5681 (Fig. 3K); HILLWOOD FARM: BMNH 2018.5683–84; LUKWAKWA: BMNH 2018.5682. **Comments:** Specimens found in *miombo* woodland and edge of *mushito* basking on vegetation during the day. According to Channing et al. (2013) the snout profile of *H. dartevellei* is truncated instead of shark-like or rounded, but none of the specimens listed above have truncated snouts. However, the BLAST results show 98–99% sequence similarity with samples of *H. dartevellei* from Ikelenge, north-western Zambia (JQ863650, JQ863653, JQ863673, JQ863676–78, JQ863704, JQ863708, JQ863718, JQ863750, JQ863753–54, JQ863756–59, KY080197, KY080199).

Hyperolius kachalolae Schiøtz, 1975
Kachalola Reed Frog
Material. HILLWOOD FARM: BMNH 2018.5676, **BMNH 2018.5677–80**. **Comments:** Juvenile specimens collected during the day on vegetation near a stream in *mushito* forest. In life, the overall coloration was green with a faint canthal and dorsolateral line, consisting of small spots. The green color faded after preservation, although the line is still visible. This agrees with the description provided by Schiøtz (1975). The sequenced individual shows 98% similarity with *H. kachalolae* from northern Zambia (D. Portik, pers. comm.).

Hyperolius major Laurent, 1954
Material. HILLWOOD FARM: BMNH 2018.5675 (Fig. 3L). **Comments:** One male found on top of a leaf (1.5 m from the ground) calling at night. Schiøtz (1999) reports this as a savannah species from north-western Zambia and eastern Democratic Republic of the Congo (DRC), however, this specimen was found in a forest patch (*mushito*). The closest matches from DNA barcoding (97%) are *H. kuligae* and *H. langi* (D. Portik, pers. comm.). Schiøtz (1999) states that these species found in west and central Africa are very similar in morphology and dorsal pattern, and may be conspecific. In contrast, Kohler et al. (2005) treat *H. kuligae* as a western and *H. langi* as an eastern Central African form. However, the color pattern (especially the post orbital marking) differs substantially from Laurent's description of the type material of *H. langi,* whereas this specimen agrees with the morphological description of *H. major* provided by Schiøtz (1999). There is no DNA sequence of *H. major* available for comparison.

Hyperolius marginatus Peters, 1854
Margined Reed Frog
Material. LUKWAKWA: BMNH 2018.5667 (male; Fig. 3M); NANZILA PLAINS BMNH 2018.5668, BMNH 2018.5674 (juveniles). **Comments:** Specimens found near ponds in *miombo* woodland. There is 100% sequence similarity with *H. marginatus* from Zambia (D. Portik, pers. comm.).

Hyperolius nasicus Laurent, 1943
Pointed Long Reed Frog
Material. NANZILA PLAINS BMNH 2018.5666 (Fig. 3N). **Comments:** This single specimen was collected during the day while resting on vegetation ca. 1 m above the ground in *dambo*. The specimen fits the morphological description of the species provided by Channing et al. (2013): when viewed in profile the snout has a shark-like tip, and the first, third, and fifth toes have one phalanx free (or nearly free) of webbing (see Fig. 4), distinguishing it from all the other species. The closest match on GenBank (98–99% sequence similarity) is *Hyperolius inyangae* (JQ863674, JQ863683–84), which is only known from the Eastern Highlands of Zimbabwe and Malawi (Channing et al. 2013). Although Channing et al. (2013) provide accession numbers for the genetic material of *H. nasicus*, no sequences could be found on GenBank under this species name. This could be due to sequence mislabelling and the accession numbers

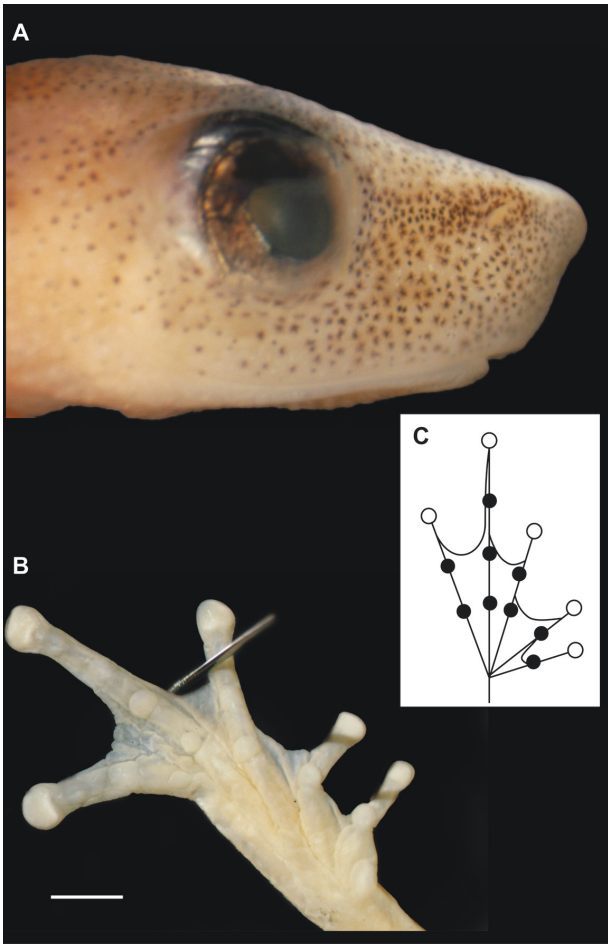

Fig. 4. Details of head profile and webbing of *Hyperolius nasicus* (BMNH 2018.5666). **(A)** Profile of head, **(B)** webbing of right foot, and **(C)** schematic representation of webbing. Scale bar represents 1 mm.

associated with *H. inyangae* may actually be from *H. nasicus*.

Hyperolius parallelus Günther, 1858
Angolan Reed Frog
Material. HILLWOOD FARM: BMNH 2018.5687–88, BMNH 2018.5689 (Fig. 3O), BMNH 2018.5690–94, **BMNH 2018.5695**; NKWAJI: BMNH 2018.5696, BMNH 2018.5697 (Fig. 3P), BMNH 2018.5698–5700. **Comments:** Specimens found near ponds in *miombo* woodland. These specimens show a color variation similar to the *alborufus* group (see Schiøtz 1999). *Hyperolius parallelus* is a taxonomically complex group due to its considerable color polymorphism. According to the BLAST search, the closest match (98% sequence similarity with JQ513623, JQ513626, and JQ513625) is *H. angolensis* from Angola (see Conradie et al. 2012; Frost 2018).

Hyperolius quinquevittatus Bocage, 1866
Five-striped Reed Frog
Material. NKWAJI: **BMNH 2018.5685**–86 (Fig. 3Q). **Comments:** Juveniles collected during the day while resting on vegetation in *mushito*. BLAST results show 99% sequence similarity with *H. quinquevittatus* from Ikelenge, north-western Zambia (GenBank accession number JQ863752).

Kassina senegalensis (Duméril and Bibron, 1841)
Bubbling Kassina
Material. CHAVUMA FR: BMNH 2018.5810; HILLWOOD FARM: BMNH 2018.5802–03 (Fig. 3R); NKWAJI: BMNH 2018.5804; SIOMA NGWEZI NP: BMNH 2018.5805–09. **Comments:** Specimens found in

Table 2. Uncorrected pairwise distances (p-distances) for a fragment of the 16S rRNA gene for *Hemisus* spp. Distances between conspecific populations are inside boxes.

	Taxon ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	*Hemisus marmoratus* AY326070	-																
2	*Hemisus marmoratus* DQ283430	0.00	-															
3	*Hemisus marmoratus* AY531831	0.04	0.04	-														
4	*Hemisus marmoratus* KY176997	0.04	0.04	0.00	-													
5	*Hemisus marmoratus* AY948749	0.00	0.00	0.05	0.05	-												
6	*Hemisus marmoratus* KX492610	0.11	0.11	0.13	0.12	0.11	-											
7	*Hemisus marmoratus* KM509138	0.12	0.12	0.15	0.15	0.12	0.07	-										
8	*Hemisus marmoratus* KY176998	0.00	0.00	0.04	0.05	0.01	0.11	0.12	-									
9	*Hemisus marmoratus* BMNH 2018.5713	0.07	0.07	0.07	0.07	0.07	0.14	0.14	0.07	-								
10	*Hemisus marmoratus* BMNH 2018.5714	0.06	0.06	0.07	0.07	0.06	0.14	0.15	0.06	**0.08**	-							
11	*Hemisus guineensis* KY080117	0.12	0.12	0.13	0.13	0.13	0.14	0.15	0.13	0.14	0.15	-						
12	*Hemisus guineensis* KY080118	0.13	0.13	0.14	0.13	0.13	0.15	0.15	0.13	0.14	0.15	0.00	-					
13	*Hemisus guineensis* KY080119	0.12	0.12	0.13	0.13	0.13	0.14	0.15	0.13	0.14	0.15	0.00	0.00	-				
14	*Hemisus guineensis* KY080120	0.12	0.12	0.13	0.13	0.13	0.14	0.15	0.13	0.14	0.15	0.00	0.00	0.00	-			
15	*Hemisus* cf *guineensis* BMNH 2018.5799	0.13	0.13	0.15	0.15	0.14	0.14	0.15	0.14	0.15	0.16	0.05	0.05	0.05	0.05	-		
16	*Hemisus* cf *guineensis* BMNH 2018.5800	0.13	0.13	0.15	0.14	0.14	0.14	0.15	0.14	0.15	0.16	0.05	0.05	0.05	0.05	**0.00**	-	
17	*Hemisus* cf *guineensis* BMNH 2018.5801	0.13	0.13	0.14	0.14	0.13	0.14	0.15	0.13	0.16	0.16	0.05	0.05	0.05	0.05	**0.02**	**0.01**	-

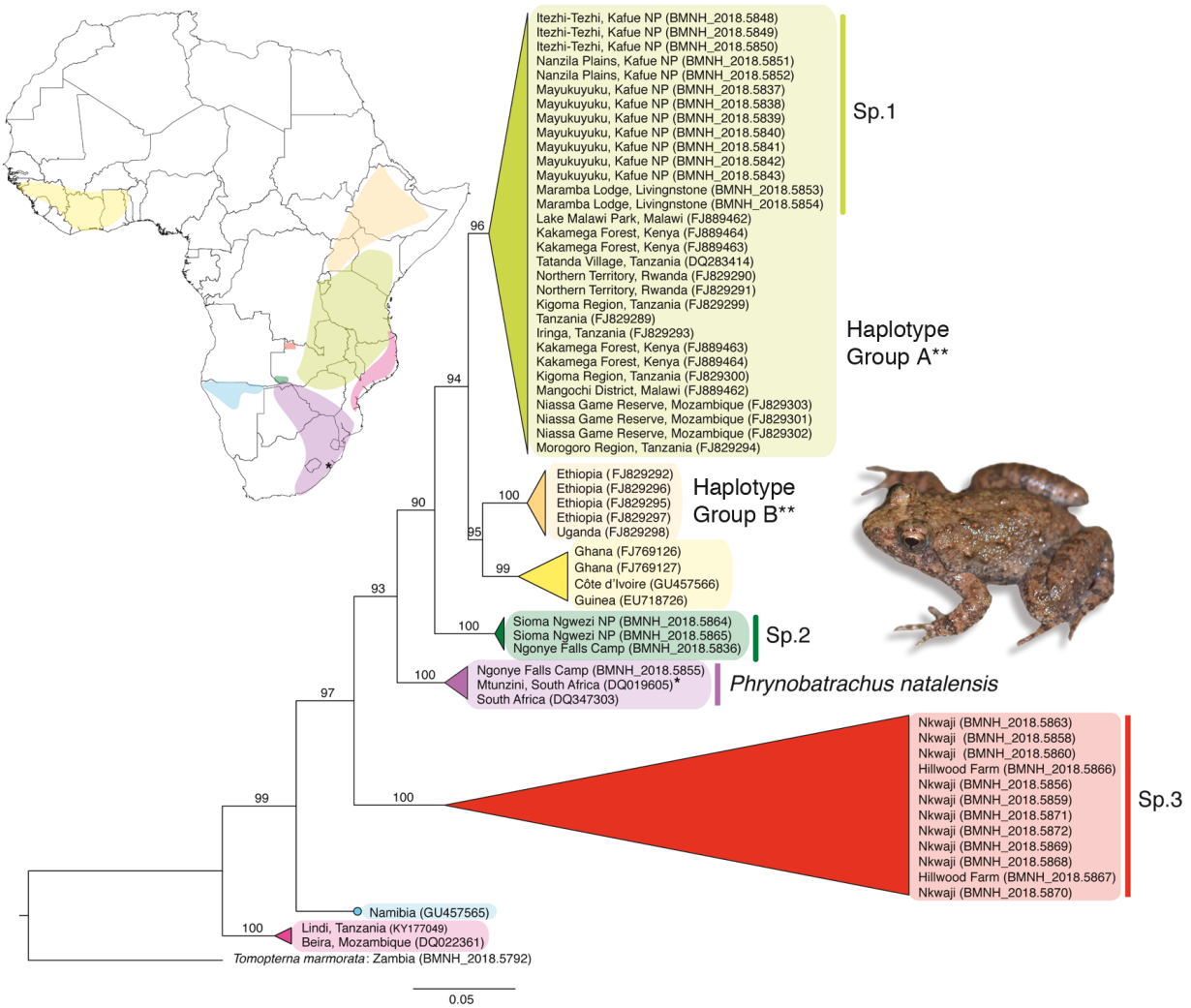

Fig. 5. Maximum likelihood phylogenetic tree inferred from nucleotide sequence data from mitochondrial 16S rRNA of *Phrynobatrachus natalensis*. Numbers above branches are non-parametric bootstrap support values. Specimen vouchers or GenBank accession numbers are shown in parentheses. Colored polygons highlight the clades comprising specimens from this study. (*) Nearest sample from type locality of *Phrynobatrachus natalensis*; (**) Haplotype groups A and B in Zimkus and Schick (2010).

miombo woodland near temporary ponds. All sequences closely match *K. senegalensis* (98%, GenBank accession number AF215445).

Phrynobatrachidae (see Table 3 for inter- and intra-specific p-distances; Fig. 5 shows maximum likelihood tree for this group)

Phrynobatrachus cf. *parvulus* (Boulenger, 1905)
Small Puddle Frog

Material. HILLWOOD FARM: BMNH 2018.5873–78; LUKWAKWA: BMNH 2018.5889 (Fig. 5A); NKWAJI: **BMNH 2018.5882** (juvenile), BMNH 2018.5879–80, **BMNH 2018.5883**–**88**. **Comments:** All specimens were found during the day in *dambo*. Males have a dark throat (BMNH 2018.5882, BMNH 2018.5886–87). While the specimens of *P. mababiensis* listed below have the venter immaculate (creamy), these specimens have the venter white with dark speckles. Additionally, these specimens show a more well-defined band on the thigh (which runs from knee to knee) and, in most specimens, a light line runs along the tibia-fibula and thigh (parallel to the band) and joins a vertebral line above the vent (see Fig. 6A). According to Du Preez and Carruthers (2017), the presence of the latter feature distinguishes *P. parvulus* from *P. mababiensis*. However, this character is present on both species and therefore cannot be used to separate them (see Poynton and Broadley 1985a. Pietersen et al. (2017) report *P. parvulus* for Ngonye Falls, approximately 25 km from Sioma Ngwesi NP, but unfortunately there is no voucher specimen. Poynton and Broadley (1985a) and Marques et al. (2018) provide discussions of the literature on the identifications of *P. mababiensis* and *P. parvulus*. The barcode is very inconclusive given that the closest hits on GenBank (92–95%) include samples of an unidentified species of *Phrynobatrachus* from Gabon (KP247505), one from the Republic of the Congo (KY080354), and *P. keniensis* (JX564885) and *P. scheffleri* (FJ889479), both from Kenya. Poynton and Broadley (1985a) suggest *P. parvulus* tends to be associated more with upland and forest conditions than

Table 3. Uncorrected pairwise distances (p-distances) for the 16S rRNA gene for *Phrynobatrachus* spp. Distances between conspecific populations are inside boxes. Dotted-line box indicates *P. natalensis* group.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	*Phrynobatrachus* cf. *parvulus* BMNH 2018.5873	-													
2	*Phrynobatrachus* cf. *parvulus* BMNH 2018.5874	**0.01**	-												
3	*Phrynobatrachus* cf. *parvulus* BMNH 2018.5880	**0.04**	**0.05**	-											
4	*Phrynobatrachus mababiensis* FJ889461	0.11	0.12	0.12	-										
5	*Phrynobatrachus mababiensis* BMNH 2018.5831	0.11	0.11	0.12	0.00	-									
6	*Phrynobatrachus mababiensis* BMNH 2018.5832	0.11	0.11	0.12	0.00	**0.00**	-								
7	*Phrynobatrachus natalensis* DQ019605	0.14	0.15	0.14	0.14	0.13	0.13	-							
8	*Phrynobatrachus natalensis* BMNH 2018.5855	0.14	0.15	0.14	0.14	0.13	0.13	0.02							
9	*Phrynobatrachus* sp. 1 BMNH 2018.5838	0.16	0.17	0.17	0.17	0.16	0.16	0.07	0.07	-					
10	*Phrynobatrachus* sp. 1 BMNH 2018.5839	0.16	0.17	0.17	0.17	0.16	0.16	0.07	0.0**7**	**0.00**	-				
11	*Phrynobatrachus* sp. 3 BMNH 2018.5856	0.15	0.16	0.15	0.15	0.14	0.14	0.08	0.08	0.09	0.09	-			
12	*Phrynobatrachus* sp. 3 BMNH 2018.5858	0.15	0.16	0.15	0.16	0.15	0.15	0.08	0.09	0.09	0.09	**0.01**	-		
13	*Phrynobatrachus* sp. 2 BMNH 2018.5864	0.17	0.17	0.18	0.17	0.16	0.16	0.06	0.07	0.06	0.05	0.08	0.08	-	
14	*Phrynobatrachus* sp. 2 BMNH 2018.5865	0.17	0.17	0.18	0.17	0.16	0.16	0.06	0.07	0.06	0.05	0.08	0.08	**0.00**	-

P. mababiensis. The localities where these specimens were found are all upland and either inside or near forest, therefore I refer them to *P.* cf. *parvulus*.

Phrynobatrachus mababiensis FitzSimons, 1932
Dwarf Puddle Frog

Material. MAYUKUYUKU: BMNH 2018.5831–32, **BMNH 2018.5881**; NANZILA PLAINS: BMNH 2018.5833; SIOMA NGWEZI NP: BMNH 2018.5834–**35**. **Comments:** All specimens are juveniles and were found in *dambo* both during the day and at night. According to Poynton and Broadley (1985a), it is not easy to distinguish *P. mababiensis* from *P. parvulus* based on external morphology, but they suggest that some characters usually serve to separate them (i.e., labial and subtympanic markings, and shape of tarsal tubercle). The usual well-marked black and white barring on the upper and lower jaws is rather faint on these specimens. Zimkus and Schick (2010) suggest that there is cryptic diversity within the *P. mababiensis* group. The closest match on GenBank is *P. mababiensis* (FJ889461; 99% sequence similarity) from eastern Zambia, which belongs to a population that is sister to the clade containing *P. ukingensis* and *P. ungujae* (see Zimkus and Schick 2010).

Phrynobatrachus natalensis (Smith, 1849)
Snoring Puddle Frog

Material. NGONYE FALLS: BMNH 2018.5855. **Comments:** The overall external morphology resembles *P. natalensis*. The BLAST search shows 98% sequence similarity to *P. natalensis* from Mtunzini, South Africa (DQ347303), which is near Durban, the type locality of *P. natalensis* (see Table 3 and Fig. 5).

Phrynobatrachus sp. 1

Material. ITEZHI-TEZHI: BMNH 2018.5848–50; LIVINGSTONE: BMNH 2018.5853–54; MAYUKUYUKU: BMNH 2018.5837–38 (Fig. 6B), BMNH 2018.5839–42 (Fig. 6C), BMNH 2018.5843, **BMNH 2018.5844–47**; NANZILA PLAINS: BMNH 2018.5851–52. **Comments:** Specimens were found in *dambo*s. One juvenile was found on a beach of the Zambezi River at Ngonye Falls. The closest match on GenBank (99% sequence similarity) is *P. natalensis* DQ283414 from Tanzania (see Fig. 5). Zimkus and Schick (2010) suggest that there are two species of *P. natalensis* in East Africa, and these Zambian populations are more similar to the central and southern populations corresponding to Haplotype group B. It further corresponds to Zimkus et al. (2010) *P. natalensis* Clade E. See further comments in Discussion.

Phrynobatrachus sp. 2

Material. NGONYE FALLS: BMNH 2018.5836; SIOMA NGWEZI NP: BMNH 2018.5864–65. **Comments:** Morphologically, these specimens resemble *P. natalensis* in terms of size, toe webbing and overall color pattern. However, they present silver/white spots around the vent (and ventral part of the thigh in **BMNH 2018.5836**). The closest match on GenBank is *P. natalensis* from Tanzania (95%; DQ283414). Although their range overlaps with the Southern African geographic zone (populations A and B) in Zimkus et al. (2010), these populations form a southern Zambian clade, which is a sister group of the eastern and western African clades (see Fig. 5). These findings allude to further cryptic diversity in the group.

Phrynobatrachus sp. 3

Material. HILLWOOD FARM: **BMNH 2018.5866–67** (Fig. 6D); NKWAJI: BMNH 2018.5856–**57**, BMNH 2018.5858–60, **BMNH 2018.5861** (Fig. 6E), **BMNH 2018.5862**–63; **BMNH 2018.5868–69** (Fig. 6F), **BMNH 2018.5870–72**. **Comments:** All specimens

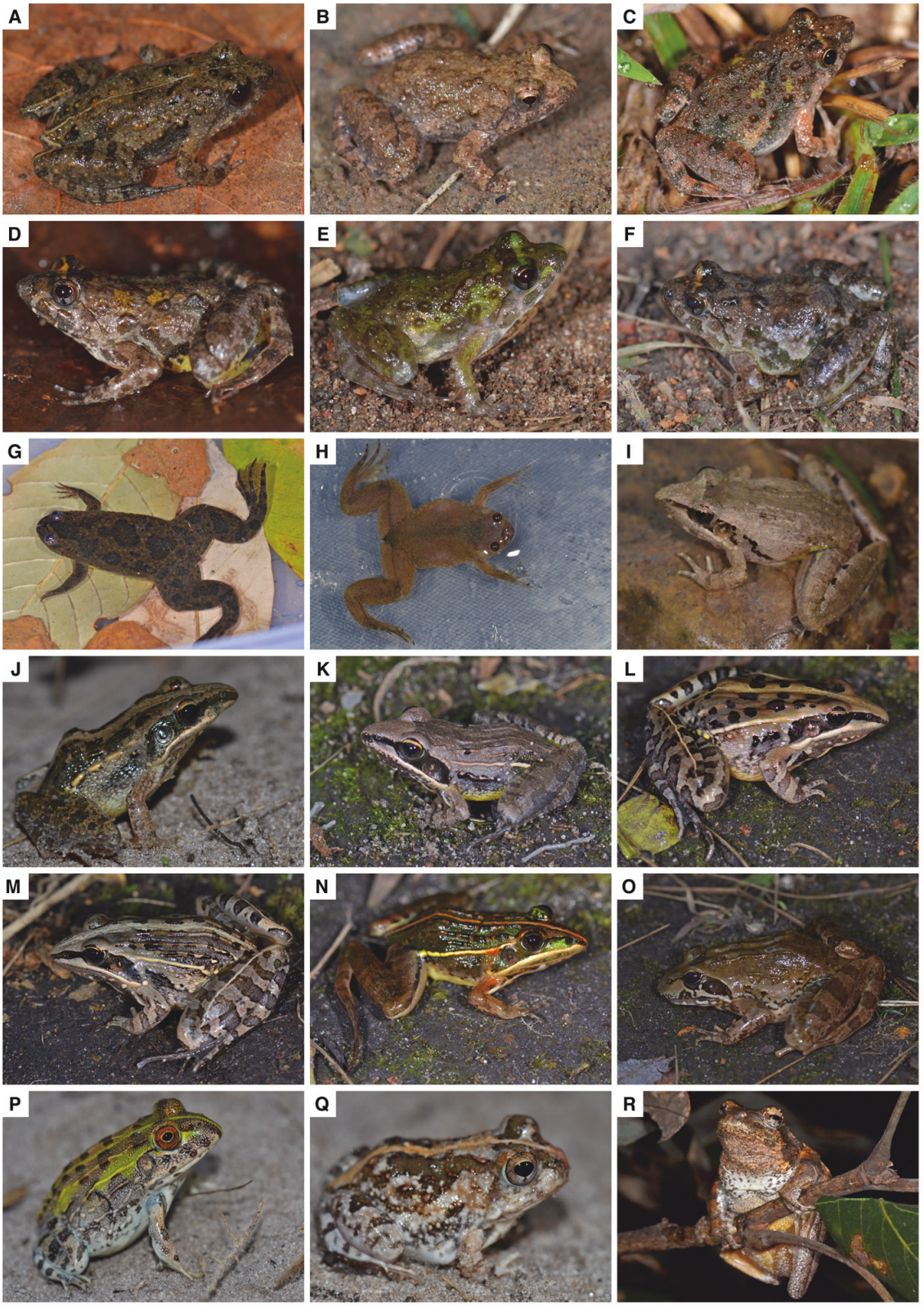

Fig. 6. Amphibians of western Zambia. **(A)** *Phrynobatrachus* cf. *parvulus* (BMNH 2018.5889), **(B)** *Phrynobatrachus natalensis* (BMNH 2018.5838), **(C)** *Phrynobatrachus natalensis* (BMNH 2018.5842), **(D)** *Phrynobatrachus* sp. 1 (BMNH 2018.5867), **(E)** *Phrynobatrachus* sp. 1 (BMNH 2018.5861), **(F)** *Phrynobatrachus* sp. 1 (BMNH 2018.5869), **(G)** *Xenopus poweri* (BMNH 2018.5659), **(H)** *Xenopus pygmaeus*, **(I)** *Ptychadena anchietae* (BMNH 2018.5730), **(J)** *Ptychadena* cf. *mossambica* (BMNH 2018.5759), **(K)** *Ptychadena porosissima* (BMNH 2018.5766), **(L)** *Ptychadena porosissima* (BMNH 2018.5769), **(M)** *Ptychadena porosissima* (BMNH 2018.5770), **(N)** *Ptychadena taenioscelis* (BMNH 2018.5785), **(O)** *Amietia chapini* (BMNH 2018.5664), **(P)** *Pyxicephalus* cf. *adspersus* (BMNH 2018.5791), **(Q)** *Tomopterna* sp. (BMNH 2018.5797), **(R)** *Chiromantis xerampelina* (BMNH 2018.5798).

are morphologically similar to *P. natalensis,* however the BLAST search shows sequence similarity with *P. natalensis* from South Africa (GenBank accession number DQ347303) varying between 90–91% (see Fig. 5). These populations form a northern Zambian clade, sister to southern, western, and eastern African clades. Further investigation is needed to resolve the taxonomical status of this group.

Pipidae

Xenopus poweri Hewitt, 1927
Power's Clawed Frog
Material. HILLWOOD FARM: BMNH 2018.5654–**58**; NKWAJI: BMNH 2018.5659 (Fig. 6G). **Comments:** Specimens collected from a pond in *miombo* area. The BLAST search shows 99% sequence similarity with *X. poweri* from Ikelenge, north-western Zambia (GenBank accession number KP345253). Furman et al. (2015) removed this name from the synonymy of *X. petersii* and reassigned the West African populations of *X. laevis* to this species.

Xenopus pygmaeus Loumont, 1986
Bouchia Clawed Frog
Material. HILLWOOD FARM: BMNH 2018.5651–52 (Fig. 6H), BMNH 2018.5653. **Comments:** Species identification was based on their relatively small size and the presence of a fourth claw. Specimens were found in a small pool formed in a car track next to a riverine forest (*mushito*). Recently, Wagner et al. (2013) presented the first record of *Xenopus pygmaeus* for Zambia, representing a significant range extension (about 1,300 km). This species belongs to the *fraseri* subgroup and it was previously known to have its southernmost distribution in the northern part of the DRC. The DNA barcode corroborates the morphological identification (99% sequence similarity with KF738291).

Ptychadenidae

Ptychadena anchietae (Bocage, 1868)
Anchieta's Ridged Frog
Material. ITEZHI-TEZHI: BMNH 2018.5735–**36**; MAYUKUYUKU: **BMNH 2018.5730**–31 (Fig. 6I), **BMNH 2018.5732–34**. **Comments:** Specimens collected near water in *miombo* woodland. The closest match (99%) is *P. anchietae* (AY517610) from Tanzania.

Ptychadena grandisonae Laurent, 1954
Grandison's Ridged Frog
Material. NKWAJI: BMNH 2018.5737–43. **Comments:** Two juveniles and four males found in a pond in *miombo*. This series fits the description for *P. grandisonae* in Poynton and Broadley (1985a). The results of the BLAST search show that the closest match (98%) is *Ptychadena* sp. (GenBank accession number KF178892) from Gabon.

Ptychadena cf. *guibei*
Material. MAYUKUYUKU: BMNH 2018.5764; SIOMA NGWEZI NP: BMNH 2018.5765. **Comments:** Specimens identified following the key in Poynton and Broadley (1985a). Foot length of BMNH 2018.5765 is slightly less than half the body length and thus, according to the key, this specimen would be *mossambica* or *cotti* (i.e. *schillukorum*). The BLAST result shows 96% sequence similarity with *P. porosissima* (KY177058) from Kenya. There is no sequence of *P. guibei* available for comparison.

Ptychadena mapacha Channing, 1993
Mapach Ridged Frog
Material. MAYUKUYUKU: BMNH 2018.5772 (male). **Comments:** Specimen collected near water in *miombo* woodland. Following Poynton and Broadley (1985a), this specimen should be assigned to *P. cotti*, now a synonym of *P. schillukorum*. However, this specimen also fits the description of *Ptychadena mapacha* (not included in the key), except for the white spots on the posterior face of the tibia and a thin tibial line that are present in the holotype (CAS 160535). The closest match (89%) is *P. porosissima* (GenBank accession number KY177058) from Kenya, and the sequence similarity with *P. schillukorum* (KY177060) is 82%. There is no sequence of *P. mapacha* available for comparison. Although *P. schillukorum* is listed in the AmphibiaWeb database as occurring in Zambia, there is no reference to the literature confirming this claim. Pietersen et al. (2017) provided an unconfirmed record of *P. mapacha* for Sioma Ngwesi. This record represents the northernmost record of this species.

Ptychadena cf. *mossambica* (Peters, 1854)
Mozambique Ridged Frog
Material. ITEZHI-TEZHI: **BMNH 2018.5753**, BMNH 2018.5754–57; MAYUKUYUKU: BMNH 2018.5763; SIOMA NGWEZI NP: **BMNH 2018.5758**–59 (Fig. 6J), BMNH 2018.5760, **BMNH 2018.5761**. **Comments:** The key in Poynton and Broadley (1985a) points to *P. mossambica*, except for the skin folds that are not continuous in these specimens. The authors note that *P. mossambica* shows an east-west cline in size and degree of webbing, where material from western Zambia tends to be smaller (maximum SVL 28.9 mm) than the series from Mozambique (maximum SVL 52.5 mm). The average SVL of this series is 34 mm. Most specimens have a pair (sometimes two) of large dark blotches on the scapular region. The closest match on GenBank (93–94%) is *Ptychadena* cf. *mossambica* from coastal Tanzania (KY177057). These specimens may be referrable to *P. mapacha* Channing, 1993, for which there is no available sequence data. *Ptychadena mapacha*

has recently been recorded in Ngonye Falls, south-west Zambia by Pietersen et al. (2017), confirming Channing's (2001) prediction about its distribution.

Ptychadena nilotica (Seetzen, 1855)
Nile Grass Frog
Material. LIVINGSTONE: BMNH 2018.5781; NANZILA PLAINS: BMNH 2018.5773–**76**, BMNH 2018.5777–80. **Comments:** Specimens collected at night near water in *miombo* woodland. Sequence similarity with *P. nilotica* is 98% with KF027211 and 99% with KX836515 from the DRC. For further discussion about this species see Dehling and Sinsch (2013) and Zimkus et al. (2016).

Ptychadena obscura (Schmidt and Inger, 1959)
Material. HILLWOOD FARM: BMNH 2018.5766–67 (Fig. 6K), BMNH 2018.5768. **Comments:** These small specimens (SVL ranges from 21.8 to 22.8 mm) fit the description of *P. obscura* in Poynton and Broadley (1985a). The specimens have a pair of dark marks on the scapular region. The results of the BLAST search show higher similarity (97–98%) to *P. broadleyi* (GenBank accession number MH300600–02). This is an unexpected finding considering that *P. broadleyi* is only known to occur in the Mulanje Mountain and the Zomba Plateau, in Malawi. These specimens from Zambia have a light triangle on the snout distinguishing them from *P. broadleyi*. Hence, the barcoding results should be interpreted with caution.

Ptychadena oxyrhynchus (Smith, 1849)
Sharp-nosed Grass Frog
Material. HILLWOOD FARM: BMNH 2018.5783; NANZILA PLAINS: BMNH 2018.5782. **Comments:** Specimens collected near water in *miombo* woodland. Sequence similarity with *P. oxyrhynchus* from Kwambonambi, South Africa (GenBank accession number AF215403) is 99%.

Ptychadena porosissima (Steindachner, 1867)
Three-striped Grass Frog
Material. HILLWOOD FARM: BMNH 2018.5769 (Fig. 6L), BMNH 2018.5770 (Fig. 6M), BMNH 2018.5771. **Comments:** This species, common in *miombo* woodland near water bodies, was present in large numbers at Hillwood Farm. Sequence similarity with *P. porosissima* (GenBank accession number KF027212) from Rwanda is 98%.

Ptychadena cf. *taenioscelis* Laurent, 1954
Stripe-legged Grass Frog
Material. HILLWOOD FARM: BMNH 2018.5784–86 (Fig. 6N). **Comments:** Adult specimens found in pond. These specimens have been identified using the key in Poynton and Broadley (1985a). The closest match on GenBank (95%) is *P. taenioscelis* from the Republic of the Congo (GenBank accession number KY080397). Perret (1979) assigned records of *taenioscelis* from west and central Africa to *pumilio* Boulenger. There seems to be some confusion in the literature regarding the taxonomy of these species, and a review of the group is needed.

Ptychadena upembae (Schmidt and Inger, 1959)
Upemba Ridged Frog
Material. HILLWOOD FARM: BMNH 2018.5750–52 (last number is a juvenile); NKWAJI: BMNH 2018.5744–46 (juveniles), BMNH 2018.5747–49 (last number is a juvenile); SIOMA NGWEZI NP: **BMNH 2018.5762**. **Comments:** Following the key in Poynton and Broadley (1985a), this series should be assigned to *Ptychadena upembae*. The BLAST search shows that the closest match (96%) is *Ptychadena* aff. *porosissima* (GenBank accession number DQ525940) from Tanzania, but it is important to note that there is no sequence of *P. upembae* available for comparison.

Pyxicephalidae

Amietia chapini (Noble, 1924)
Chapin's River Frog
Material. HILLWOOD FARM: BMNH 2018.5660–61, **BMNH 2018.5662**–63, **BMNH 2018.5664** (Fig. 6O), BMNH 2018.5665. **Comments:** Specimens found near streams in *miombo* woodland. The result of the BLAST search shows that *A. chapini* is the closest match to the specimens collected at Hillwood Farm (sequence similarity with *A. chapini* of 96–98%). All specimens have long legs (tibiofibula ~0.6 of snout-vent length), as noted by Noble (1924). I note that the specimens described as *A. chapini* by Channing et al. (2016) differ from the specimens listed above in coloration – the latter being darker. If these specimens are confirmed to be *A. chapini*, this will be the first record of this species for Zambia, but their presence in Zambia is not surprising considering the proximity (ca. 380 km) between the currently known populations from southern DRC (Kundelungu National Park) and Hillwood Farm.

Pyxicephalus cf. *adspersus* Tschudi, 1838
Giant Bullfrog
Material. SIOMA NGWEZI NP: BMNH 2018.5787–91 (Fig. 6P). **Comments:** All individuals collected are juveniles. Hence, identification is tentative and based on the geographic range of the species. The BLAST shows 95% sequence similarity to *Pyxicephalus* cf. *adspersus* (DQ347304) and *P. edulis* (DQ022366).

Tomopterna marmorata (Peters, 1854)
Marbled Sand Frog
Material. LIVINGSTONE: BMNH 2018.5792. **Comments:** Juvenile found in a small pond at night. Skin of dorsum and venter is smooth; venter is pale

Table 4. Uncorrected pairwise distances (p-distances) for the 16S rRNA gene for *Tomopterna* spp. Distances between conspecific populations are inside boxes.

		1	2	3	4	5	6	7	8	9	10	11
1	*Tomopterna* sp. "Shankara" AY255095	-										
2	*Tomopterna* sp. BMNH 2018.5793	**0.01**	-									
3	*Tomopterna* sp. BMNH 2018.5794	**0.01**	**0.00**	-								
4	*Tomopterna* sp. BMNH 2018.5795	**0.01**	**0.00**	**0.00**	-							
5	*Tomopterna* sp. BMNH 2018.5796	**0.01**	**0.00**	**0.00**	**0.00**	-						
6	*Tomopterna* sp. BMNH 2018.5797	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	-					
7	*Tomopterna delalandii* DQ283403	0.06	0.06	0.05	0.05	0.05	0.05	-				
8	*Tomopterna damarensis* KX869909	0.07	0.06	0.06	0.06	0.06	0.06	0.02	-			
9	*Tomopterna cryptotis* JX564898	0.06	0.06	0.06	0.06	0.06	0.06	0.03	0.02	-		
10	*Tomopterna marmorata* BMNH 2018.5792	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.05	0.06	-	
11	*Tomopterna marmorata* AY255084	0.08	0.08	0.07	0.07	0.07	0.07	0.06	0.05	0.06	0.00	-

with a few dark markings under the throat; tympanum indistinguishable; undivided sub-articular tubercle on first finger. The closest match on GenBank (100%) is *Tomopterna marmorata* (AY255084) from Zambia.

Tomopterna sp.
Material. SIOMA NGWEZI NP: BMNH 2018.5793–97 (Fig. 6Q). **Comments:** All individuals are juveniles and were found at night close to a light-trap set to collect beetles. The main morphological characters of these specimens are: dorsal and ventral skin smooth; immaculate venter; presence of a ridge below tympanum; tympanum indistinguishable; and undivided sub-articular tubercle on first finger. The closest match on GenBank (99%) is *Tomopterna* sp. "Shankara" (AY255095), an undescribed species from Namibia (Dawood et al. 2002). Table 4 shows the p-distances among the closest matches from GenBank.

Rhacophoridae

Chiromantis xerampelina Peters, 1854
African Grey Treefrog
Material. MAYUKUYUKU: BMNH 2018.5798 (Fig. 6R). **Comments:** This is a widespread species found in *miombo* woodland. One adult individual found at night on a tree near the campsite.

Reptilia

Order Squamata

Agamidae

Agama armata Peters, 1855
Northern Ground Agama
Material. NGONYE FALLS CAMP: BMNH 2018.2751 (Fig. 7A). **Comments:** One juvenile found basking on a log by the Zambezi River. Sequence similarity is 98% with *A. armata* ZFMK 84990 (GenBank accession number GU128447).

Chamaeleonidae

Chamaeleo dilepis Leach, 1819
Flap-necked Chameleon
Material. CHAVUMA FR: BMNH 2018.2755 (Fig. 7B), BMNH 2018.2756. **Comments:** Specimens were found in *miombo* woodland on shrubs above 1 m. There are currently seven subspecies in this group and based on their distributions, these specimens represent *C. dilepis quilensis* (Uetz et al. 2018). Sequence similarity is 99% with *Chamaeleo dilepis* from Matema, Tanzania (GenBank accession number AY927272).

Gekkonidae

Hemidactylus mabouia (Moreau de Jonnès, 1818)
Common Tropical House Gecko
Material. ITEZHI-TEZHI: BMNH 2018.2742, **BMNH 2018.2740**; NANZILA PLAINS: BMNH 2018.2741. **Comments:** Common species found in a variety of habitats, including heavily degraded ones, though not found in forests. The closest matches from GenBank are *Hemidactylus mercatorius* (AY863034) and *H. mabouia* (AY863038), both showing 94% sequence similarity.

Lygodactylus chobiensis Fitzsimons, 1932
Chobe Dwarf Gecko
Material. ITEZHI-TEZHI: BMNH 2018.2743 (female; Fig. 7C), **BMNH 2018.2744** (male) **Comments:** Specimens found on tree-trunks in *miombo*. Identification follows the key provided by Broadley (1971). The rostral is excluded from the nostril and the male has dark forward-directed chevron marks on the throat. The female is yellow and white underneath (Fig. 7D). The closest match from GenBank (95% sequence similarity)

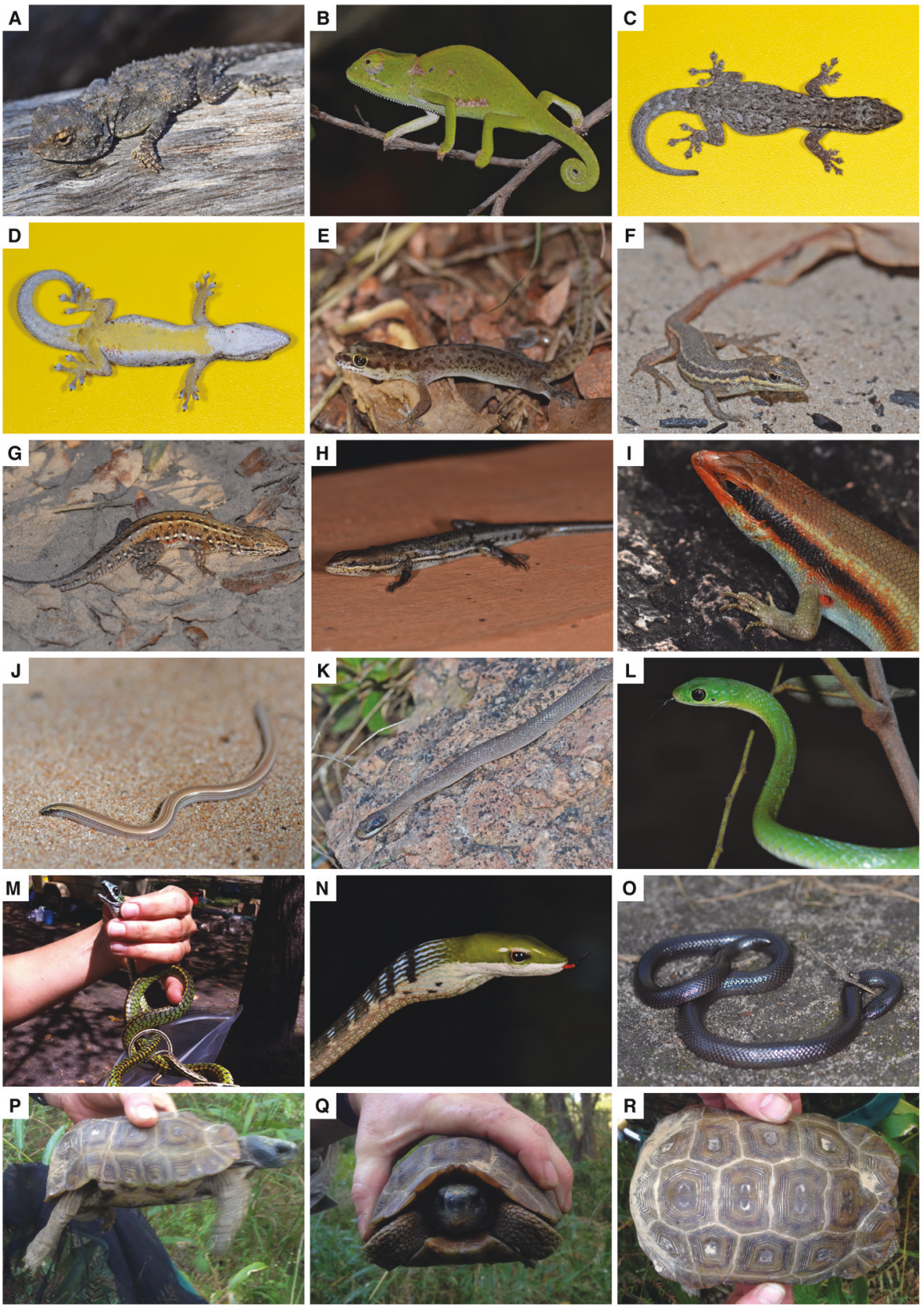

Fig. 7. Reptiles of western Zambia. **(A)** *Agama armata* (BMNH 2018.2751), **(B)** *Chamaeleo dilepis* (BMNH 2018.2755), **(C)–(D)** *Lygodactylus chobiensis* (BMNH 2018.2743), **(E)** *Pachydactylus punctatus*, **(F)** *Ichnotropis capensis* (BMNH 2018.2750), **(G)** *Meroles squamulosus* (BMNH 2018.2753), **(H)** *Trachylepis* cf. *albopunctata* (BMNH 2018.2765), **(I)** *Trachylepis varia* (BMNH 2018.2769), **(J)** *Typhlacontias rohani* (BMNH 2018.2761), **(K)** *Crotaphopeltis hotamboeia* (BMNH 2018.2776), **(L)** *Philothamnus hoplogaster* (BMNH 2018.2775), **(M)** *Rhamnophis aethiopissa ituriensis* (BMNH 2018.2772), **(N)** *Thelotornis kirtlandii* (BMNH 2018.2760), **(O)** *Atractaspis congica* (BMNH 2018.2274), **(P)–(R)** *Kinixys spekii*.

is *Lygodactylus chobiensis* from Zimbabwe (GenBank accession number GU593456).

Lygodactylus angolensis Bocage, 1896
Angola Dwarf Gecko
Material. NKWAJI: BMNH 2018.2767 (male), BMNH 2018.2766 (female). **Comments:** Specimens were identified following the key provided by Broadley (1971). In both specimens, the mental has a pair of lateral clefts, resulting from fusion with a large postmental. The male has nine preanal pores, which distinguish it from *L. bradfieldi*. The closest match from GenBank (90% sequence similarity) is *Lygodactylus* sp. from East Africa (GenBank accession numbers GU593448–50).

Pachydactylus punctatus Peters, 1854
Speckled Thick-toed Gecko
Material. ITEZHI-TEZHI: BMNH 2018.2757, BMNH 2018.2758 (Fig. 7E), **BMNH 2018.2759**. **Comments:** Specimens found at night in dry leaf litter in *miombo* woodland. All specimens have the dorsum covered with sub-uniform granules. The closest matches from GenBank (93% sequence similarity) are *Pachydactylus punctatus* (AF449120) and *P. scherzi* (AY123379). As the latter is only known from Namibia (Bauer and Branch 1995), I assign these specimens to *P. punctatus*.

Gerrhosauridae

Gerrhosaurus bulsi Laurent, 1954
Laurent's Plated Lizard
Material. HILLWOOD FARM: BMNH 2018.2754. **Comments:** One juvenile collected by the farm scouts in dry *miombo*. The BLAST search shows the closest match (98%) as *Gerrhosaurus bulsi* from Angola (KF717381). Broadley (1971, 1991) referred the population of *Gerrhosaurus* from Ikelenge (north-western Zambia) to *multilineatus* but this was later contested by Haagner et al. (2000). Bates et al. (2013) consider *G. bulsi* a valid species and discuss the taxonomic problems regarding *G. multilineatus*.

Lacertidae

Ichnotropis capensis (Smith, 1838)
Cape Rough-scaled Lizard
Material. CHAVUMA FR: BMNH 2018.2746; LUKWAKWA: **BMNH 2018.2749**, BMNH 2018.2747; NANZILA PLAINS: BMNH 2018.2750, **BMNH 2018.2748** (Fig. 7F); SIOMA NGWEZI NP: BMNH 2018.2745. **Comments:** All specimens are juveniles and were found in *miombo* woodland. Sequence similarity is 99% with *I. capensis* from Katima Mulilo, Namibia (GenBank accession number JX962898).

Meroles squamulosus (Peters, 1854)
Savanna Lizard
Material. NANZILA PLAINS: BMNH 2018.2753 (Fig. 7G); SIOMA NGWEZI NP: BMNH 2018.2752. **Comments:** Two adult males found in *miombo*. Sequence similarity is 96% with *Meroles* (*Ichnotropis*) *squamulosus* from Laela, Tanzania (GenBank accession number JX962897).

Scincidae

Panaspis cf. *wahlbergi* (Smith, 1849)
Snake-eyed Skink
Material. CHAVUMA FR: BMNH 2018.2738, **BMNH 2018.2739**. **Comments:** Specimens found during the day in leaf litter. The closest match from GenBank (98%) is *Panaspis* sp. (KU236726), from Katanga, DRC. Medina et al. (2016) provide a molecular phylogeny of this genus, which suggests that there is cryptic diversity within *P. wahlbergi*.

Trachylepis cf. *albopunctata* (Bocage, 1867)
Angolan Variable Skink
Material. ITEZHI-TEZHI: BMNH 2018.2762; MAYUKUYUKU: BMNH 2018.2765 (Fig. 7H), **BMNH 2018.2763**. **Comments:** Specimens found during the day. The BLAST search shows 99–100% sequence similarity with sequences from *T. varia* clade B (accession numbers MG605651–59), which was recently assigned to *Trachylepis* cf. *albopunctata* by Marques et al. (2018).

Trachylepis damarana (Peters, 1870)
Damara Skink
Material. SIOMA NGWEZI NP (HQ): BMNH 2018.2764. **Comments:** Morphologically similar to *T. varia* group. However, both its distribution and sequence similarity (99%) match *T. damarana* (see Weinell and Bauer 2018).

Trachylepis wahlbergii (Peters, 1869)
Wahlberg's Striped Skink
Material. ITEZHI-TEZHI: BMNH 2018.2769 (Fig. 7I); LUKWAKWA: **BMNH 2018.2768**, BMNH 2018.2770; NKWAJI: BMNH 2018.2771. **Comments:** Specimens found during the day on rocks (Itezhi-Tezhi), *dambo* (Lukwakwa), and inside a tree trunk at Nkwaji. According to Broadley (2000) these specimens fall in the distribution range of *T. wahlbergii*. The most similar sequence from GenBank is *T. wahlbergii* from Zambia (99%, accession number DQ234810).

Typhlacontias rohani Angel, 1923
Rohan's Blind Dart Skink
Material. SIOMA NGWEZI NP (HQ): BMNH 2018.2761 (Fig. 7J). **Comments:** One specimen was found buried in sand and collected by Errol Pietersen. The closest match on GenBank (90%) is *T. punctatissimus* (DQ316889). There is no sequence of *T. rohani* available

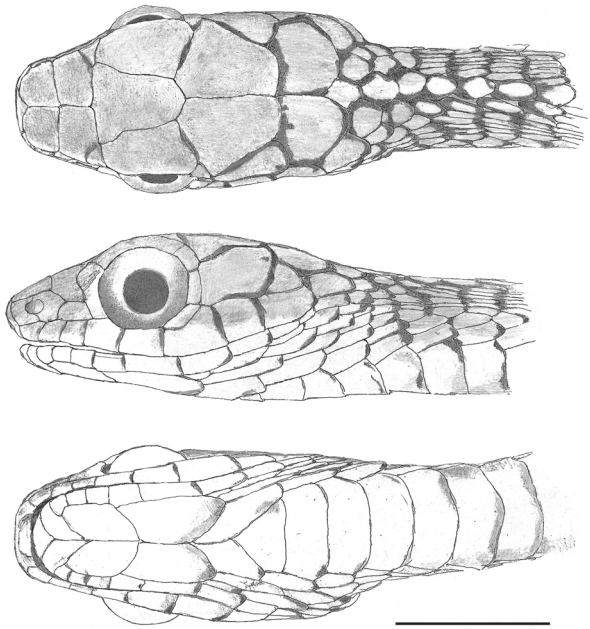

Fig. 8. Drawings of *Rhamnophis aethiopissa ituriensis* (BMNH 2018.2772). Head and anterior of body in dorsal, left lateral, and ventral views. Scale bar 10 mm. *Drawings by Ed Wade.*

for comparison.

Colubridae

Crotaphopeltis hotamboeia (Laurenti, 1768)
White-lipped Herald Snake
Material. ITEZHI-TEZHI: **BMNH 2018.2776** (Fig. 7K); HILLWOOD FARM: BMNH 2018.2773; SIOMA NGWEZI NP: BMNH 2018.2777. **Comments:** All individuals collected are juveniles and were found at night in *miombo* woodland near rocks. The most similar sequence on GenBank is *C. hotamboeia* from Malawi (99%, accession number AY611816).

Philothamnus hoplogaster (Günther, 1863)
Green Water Snake
Material. NANZILA PLAINS: BMNH 2018.2775 (Fig. 7L). **Comments:** Specimen found while eating tadpoles and juveniles of *Kassina* sp. in a temporary pond during the day. This species is similar to other *Philothamnus* but usually smaller (Marais 2004). The closest match on GenBank (99%) is *P. hoplogaster* from Mozambique (accession number FJ913484).

Rhamnophis aethiopissa ituriensis (Schmidt 1923)
Large-eyed Green Tree Snake
Material. HILLWOOD FARM: BMNH 2018.2772 (Fig. 7M; Fig. 8). **Comments:** Specimen found in leaf litter of riverine forest during the day. Broadley (1991) provided the first record of this species for Zambia. Based on distribution, this form represents the subspecies *R. a. ituriensis* from Niapu in the DRC (see Eimermacher 2012).

Thelotornis kirtlandii (Hallowell, 1844)
Forest Vine Snake
Material. HILLWOOD FARM: **BMNH 2018.2760** (Fig. 7N). **Comments:** One juvenile was found at night resting on green vegetation in riverine forest (*mushito*). Species was identified using the key in Broadley (2001) and the following characters were observed: top of the head, including temporal region, is uniform green; rostral and nasals are strongly recurved onto top of snout; supralabials are white with small green spots.

Lamprophiidae

Atractaspis congica Peters, 1877
Congo Stiletto Snake
Material. HILLWOOD FARM: BMNH 2018.2274 (Fig. 7O). **Comments:** One relatively large specimen found in moist leaf litter inside a patch of *mushito* at night. Broadley and Blaylock (2013): 232 expanded the description of *A. bibronii* to accommodate the condition of 19 midbody scales of *A. congica* (19–21 scales at midbody). This specimen exhibits erratic counts of 19+17, the latter count predominating after the 84th ventral.

Order Testudines

Testudinidae

Kinixys spekii Gray, 1863
Speke's Hinge-back Tortoise
Comments: One specimen (Figs. 5P–R) was found in *mushito* at Nkwaji. The carapace was hinged between the 7th and 8th marginals. The specimen was photographed and released.

Discussion

This is a non-comprehensive list of the herpetofauna of western Zambia. The survey was conducted shortly after the general breeding season for amphibians and reptiles in this part of the world, and consequently most specimens collected are juveniles. For the same reason, most species were not active, which made the search for them more challenging. However, some species of amphibians were active during the survey. *Phrynobatrachus* were heard calling during the day and at night, and at least ten males of *Sclerophrys lemairii* were calling during the day in Lukwakwa (see Bittencourt-Silva 2014). The presence of juveniles of *Ichnotropis capensis* and adults of *Meroles squamulosus* in sympatry is explained by their staggered life cycles (see Broadley 1967, 1979).

DNA barcoding is an important tool for identifying candidate species. However, there are a number of caveats. For instance, for amphibians, Vences et al. (2005a) propose a tentative 16S rRNA threshold at 5% for interspecific sequence divergence but also

highlight the broad overlap of intra- and interspecific divergence values (see Vences et al. 2005b, p. 1,865) that complicates the establishment of threshold values. Using DNA barcoding alone can potentially lead to simplistic diagnoses of putative species. Another issue with DNA barcoding relates to the taxonomic accuracy of public DNA databases (e.g., GenBank, BOLD, EMBL). Misidentified sequences are not uncommon (Bridge et al. 2003; Vilgalys 2003), which reinforces the importance of vouchering all sequences deposited. Table 2 shows that the intra-specific p-distances within *H. marmoratus* are considerably large in some cases. This could be partly due to geographic distances, given that the specimens are from Ghana, Guinea-Bissau, Kenya, and Tanzania. A taxonomic review of this group is clearly necessary. Nonetheless, genetic data may be crucial in cases where species are genetically different but morphologically largely conserved. An example is the mongrel frogs from Mozambique and Malawi, which have ca. 5% interspecific divergences but are in general phenotypically indistinguishable (Conradie et al. 2018).

Some of the taxa reported here could not be assigned to currently recognized species based on DNA barcoding and/or external morphology. For instance, based on p-distances, some of the *Phrynobatrachus* specimens represent putative new species (Table 3). Zimkus and Schick (2010) suggest that there are at least two species currently identified as *Phrynobatrachus natalensis* in East Africa, and another two clades are reported from western and southern Africa (Zimkus et al. 2010). The phylogeny presented here indicates that there may be more species of this group in western Zambia (see Fig. 5). Species identified here as *P.* cf. *parvulus* may be a new species. These results corroborate the conclusions of Zimkus and Schick (2010) and Zimkus et al. (2010) that a taxonomic review of the genus *Phrynobatrachus* is needed. Similarly, the *Tomopterna* population found in Sioma Ngwezi NP could represent an undescribed species (Table 4) previously reported from Namibia (see Dawood et al. 2002). These taxa deserve further investigations by specialists. It is often the case that original species descriptions lack diagnostic details, including illustration of characters, and/or type material may be lost or in poor condition, all of which can contribute to inconclusive or even incorrect species identification. Additional datasets (e.g., bioacoustics, ecology) often provide important information and can solve some of these taxonomic conundrums.

The genus *Ptychadena* currently comprises 56 species, some (possibly many) representing species complexes (e.g., Zimkus et al. 2016). Nineteen species have been reported in Zambia (see genus account in Frost 2018), eleven of which were recorded during this survey. The lack of an updated key to the *Ptychadena* of Zambia makes the species identification process challenging. Similarly, barcoding is not helpful when there are no reference sequences available. A search of GenBank for 16S sequences of *Ptychadena* shows that 41% of currently recognized species are not represented, and 22% of the sequences available are either pending confirmation or identified only to genus. The taxonomy of this group is clearly in need of attention.

Except for a few areas—on the extreme north-west of the country and along the Zambezi river—most of Zambia remains poorly studied. Recently, Channing and Willems (2018) described a new species of *Ptychadena* from the northern part of the country, and a new cryptic species of *Polemon* (Squamata: Lamprophiidae) described from the DRC and Uganda is likely to occur in Zambia (Portillo et al. 2019). The list of species provided here adds new points to the map of the Zambian herpetofauna.

The herpetofauna of Zambia is mostly contained in the Zambezian biogeographical core, with only the south-western region forming part of the South African core (*sensu* Linder et al. 2012). Not surprisingly, many species found during this survey also occur in the DRC (e.g., Channing et al. 2016), Angola (Conradie et al. 2016) and Namibia (Dawood et al. 2002), including *Amietia chapini*, recorded here for the first time from Zambia. Four species of amphibians that Pietersen et al. (2017) expected to occur near Ngonye Falls are now confirmed to occur at Sioma Ngwezi NP (*Kassina senegalensis*, *Phrynobatrachus mababiensis*, *Ptychadena porosissima*, and *Pyxicephalus adspersus*). The still very incomplete knowledge of the Zambian herpetofauna remains the main obstacle to our understanding of its biogeography and the conservation statuses of its constituent species.

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Literature Cited

Altschul SF, Gish W, Miller W, Myers EW, Lipman DJ. 1990. Basic local alignment search tool. *Journal of Molecular Biology* 215: 403–410.

AmphibiaWeb. 2018. Available: https://amphibiaweb.

org. [Accessed: 17 July 2018].

Bates MF, Tolley KA, Edwards S, Davids Z, Da Silva JM, Branch WR. 2013. A molecular phylogeny of the African plated lizards, genus *Gerrhosaurus* Wiegmann, 1828 (Squamata: Gerrhosauridae), with the description of two new genera. *Zootaxa* 3750: 465–493.

Bauer AM, Branch WR. 1995. Geographic variation in western populations of the *Pachydactylus punctatus* complex (Reptilia: Gekkonidae). *Tropical Zoology* 8: 69–84.

Bittencourt-Silva GB. 2014. Notes on the reproductive behaviour of *Amietophrynus lemairii* (Boulenger, 1901) (Anura: Bufonidae). *Herpetology Notes* 7: 611–614.

Branch WR. 1998. *Field Guide to the Snakes and other Reptiles of Southern Africa*. Struik, Cape Town, South Africa. 399 p.

Bridge PD, Roberts PJ, Spooner BM, Panchal G. 2003. On the unreliability of published DNA sequences. *New Phytologist* 160: 43–48.

Broadley DG. 1967. The life cycles of two sympatric species of *Ichnotropis* (Sauria: Lacertidae). *African Zoology* 3: 1–2.

Broadley DG. 1971. *The Reptiles and Amphibians of Zambia*. The Puku, Number 6. Kenya Litho, Nairobi, Kenya. 143 p.

Broadley DG. 1979. A field study of two sympatric annual lizards (genus *Ichnotropis*) in Rhodesia. *African Zoology* 14: 133–138.

Broadley DG. 1991. The herpetofauna of northern Mwinilunga District, northwestern Zambia. *Arnoldia Zimbabwe* 9: 519–538.

Broadley DG. 2000. A review of the genus *Mabuya* in southeastern Africa (Sauria: Scincidae). *African Journal of Herpetology* 49: 87–110.

Broadley DG. 2001. A review of the genus *Thelotornis* A. Smith in eastern Africa, with the description of a new species from the Usambara Mountains (Serpentes: Colubridae: Dispholidini). *African Journal of Herpetology* 50(2): 53–70.

Broadley DG, Blaylock R. 2013. *Snakes of Zimbabwe and Botswana*. Edition Chimaira, Frankfurt am Main, Germany. 387 p.

Broadley DG, Doria C, Wigge J. 2003. *Snakes of Zambia: An Atlas and Field Guide*. Edition Chimaira, Frankfurt am Main, Germany. 280 p.

Castresana J. 2000. Selection of conserved blocks from multiple alignments for their use in phylogenetic analysis. *Molecular Biology and Evolution* 17: 540–552.

Channing A. 2001. *Amphibians of Central and Southern Africa*. Comstock Publishing Associates, Ithaca, New York, USA. 470 p.

Channing A, Broadley DG. 2002. A new snout-burrower from the Barotse floodplain (Anura: Hemisotidae: *Hemisus*). *Journal of Herpetology* 36: 367–372.

Channing A, Willems F. 2018. A new grass frog with rupicolous tadpoles from northern Zambia (Anura: Ptychadenidae). *Zootaxa* 4462: 349–366.

Channing A, Hillers A, Lötters S, Rödel M-O, Schick S, Conradie W, Rödder D, Mercurio V, Wagner P, Dehling JM. 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: 301–350.

Channing A, Dehling JM, Lötters S, Ernst R. 2016. Species boundaries and taxonomy of the African river frogs (Amphibia: Pyxicephalidae: *Amietia*). *Zootaxa* 4155: 1–76.

Conradie W, Bills R. 2017. Wannabe Ranid: Notes on the morphology and natural history of the Lemaire's Toad (Bufonidae: *Sclerophrys lemairii*). *Salamandra* 53: 439–444.

Conradie W, Branch WR, Measey GJ, Tolley KA. 2012. A new species of *Hyperolius* Rapp, 1842 (Anura: Hyperoliidae) from the Serra da Chela mountains, south-western Angola. *Zootaxa* 3269: 1–17.

Conradie W, Bills R, Branch WR. 2016. The herpetofauna of the Cubango, Cuito, and lower Cuando river catchments of south-eastern Angola. *Amphibian & Reptile Conservation* 10(2) [Special Section]: 6–36 (e126).

Conradie W, Bittencourt-Silva GB, Farooq HM, Loader SP, Menegon M, Tolley KA. 2018. New species of Mongrel Frogs (Pyxicephalidae: *Nothophryne*) for northern Mozambique inselbergs. *African Journal of Herpetology* 67: 61-85.

Dawood A, Channing A, Bogart JP. 2002. A molecular phylogeny of the frog genus *Tomopterna* in southern Africa: examining species boundaries with mitochondrial 12S rRNA sequence data. *Molecular Phylogenetics and Evolution* 22: 407–413.

Dehling JM, Sinsch U. 2013. Diversity of *Ptychadena* in Rwanda and taxonomic status of *P. chrysogaster* Laurent, 1954 (Amphibia, Anura, Ptychadenidae). *ZooKeys* 356: 69–102.

Deichmann JL, Mulcahy DG, Vanthomme H, Tobi E, Wynn AH, Zimkus BM, McDiarmid RW. 2017. How many species and under what names? Using DNA barcoding and GenBank data for west Central African amphibian conservation. *PLoS ONE* 12: e0187283.

Eimermacher TG. 2012. Phylogenetic systematics of Dispholidine colubrids (Serpentes: Colubridae). Ph.D. Dissertation, The University of Texas at Arlington, Arlington, Texas, USA. 109 p.

Frost DR. 2018. Amphibian sSpecies of the World: an online reference. Version 6.0. American Museum of Natural History, New York, New York, USA. Available: http://research.amnh.org/vz/herpetology/amphibia/index.php [Accessed: 10 November 2018].

Furman BLS, Bewick AJ, Harrison TL, Greenbaum E, Gvoždík V, Kusamba C, Evans BJ. 2015. Pan-African phylogeography of a model organism, the African

clawed frog *Xenopus laevis*. *Molecular Ecology* 24: 909–925.

Haagner GV, Branch WR, Haagner AJF. 2000. Notes on a collection of reptiles from Zambia and adjacent areas of the Democratic Republic of the Congo. *Annals of the Eastern Cape Museum* 1: 1–25.

Hebert PDN, Gregory TR. 2005. The promise of DNA barcoding for taxonomy. *Systematic Biology* 54: 852–859.

Katoh K, Misawa K, Kuma K, Miyata T. 2002. MAFFT: a novel method for rapid multiple sequence alignment based on fast Fourier transform. *Nucleic Acids Research* 30: 3,059–3,066.

Kearse M, Moir R, Wilson A, Stones-Havas S, Cheung M, Sturrock S, Buxton S, Cooper A, Markowitz S, Duran C, et al. 2012. Geneious Basic: an integrated and extendable desktop software platform for the organization and analysis of sequence data. *Bioinformatics* 28: 1,647–1,649.

Kohler J, Scheelke K, Schick S, Veith M, Lotters S. 2005. Contribution to the taxonomy of hyperoliid frogs (Amphibia: Anura: Hyperoliidae): advertisement calls of twelve species from East and Central Africa. *African Zoology* 40: 127–142.

Linder HP, de Klerk HM, Born J, Burgess ND, Fjeldså J, Rahbek C. 2012. The partitioning of Africa: statistically defined biogeographical regions in sub-Saharan Africa. *Journal of Biogeography* 39: 1,189–1,205.

Marais J. 2004. *A Complete Guide to the Snakes of Southern Africa*. Struik Nature, Cape Town, South Africa. 740 p.

Marques MP, Ceríaco LMP, Blackburn DC, Bauer AM. 2018. Diversity and distribution of the amphibians and terrestrial reptiles of Angola. Atlas of historical and bibliographic records (1840–2017). *Proceedings of the California Academy of Sciences* 65(Supplement 1): 1–501.

Medina MF, Bauer AM, Branch WR, Schmitz A, Conradie W, Nagy ZT, Hibbitts TJ, Ernst R, Portik DM, Nielsen SV. 2016. Molecular phylogeny of *Panaspis* and *Afroablepharus* skinks (Squamata: Scincidae) in the savannas of sub-Saharan Africa. *Molecular Phylogenetics and Evolution* 100: 409–423.

Meier R, Shiyang K, Vaidya G, Ng PKL. 2006. DNA barcoding and taxonomy in Diptera: a tale of high intraspecific variability and low identification success. *Systematic Biology* 55: 715–728.

Noble GK. 1924. Contributions to the herpetology of the Belgian Congo based on the collection of the American Museum Congo Expedition, 1909-1915. Part 3, Amphibia. *Bulletin of the American Museum of Natural History* 49(2): 147–347.

Palumbi SR, Martin A, Romano S, McMillan WO, Stice L, Grabowski G. 1991. The Simple Fool's Guide to PCR. Version 2.0. Privately published document compiled by S. Palumbi. Department of Zoology, University of Hawaii, Honolulu, Hawaii, USA.

Perret JL. 1979. Remarques et mise au point sur quelques espèces de *Ptychadena* (Amphibia, Ranidae). *Bulletin de la Société Neuchâteloise des Sciences Naturelles* 102: 5–21.

Phiri P. 2005. *A Checklist of Zambian Vascular Plants*. SABONET, Pretoria, South Africa. 169 p.

Pickersgill M. 2007. *Frog Search, Results of Expeditions to Southern and Eastern Africa*. Frankfurt Contributions to Natural History. Editions Chimaira, Frankfurt am Main, Germany. 574 p.

Pietersen DW, Pietersen EW, Conradie W. 2017. Preliminary herpetological survey of Ngonye Falls and surrounding regions in south-western Zambia. *Amphibian & Reptile Conservation* 11(1) [Special Section]: 24–43 (e148).

Portillo F, Branch WR, Tilbury CR, Nagy ZT, Hughes DF, Kusamba C, Muninga WM, Behangana M, Greenbaum E. 2019. A cryptic new species of *Polemon* (Squamata: Lamprophiidae, Aparallactinae) from the Miombo woodlands of Central and East Africa. *Copeia* 107: 22–36.

Poynton JC, Broadley DG. 1985a. Amphibia Zambesiaca 2. Ranidae. *Annals of the Natal Museum* 27: 115–181.

Poynton JC, Broadley DG. 1985b. Amphibia Zambesiaca 1. Scolecomorphidae, Pipidae, Microhylidae, Hemisidae, Arthroleptidae. *Annals of the Natal Museum* 26: 503–553.

Poynton JC, Broadley DG. 1987. Amphibia Zambesiaca 3. Rhacophoridae and Hyperoliidae. *Annals of the Natal Museum* 28: 161–229.

Poynton JC, Broadley DG. 1988. Amphibia Zambesiaca 4. Bufonidae. *Annals of the Natal Museum* 29: 447–490.

Poynton JC, Broadley DG. 1991. Amphibia Zambesiaca 5. Zoogeography. *Annals of the Natal Museum* 39: 221–277.

Poynton JC, Loader SP, Conradie W, Roedel M-O, Liedtke HC. 2016. Designation and description of a neotype of *Sclerophrys maculata* (Hallowell, 1854), and reinstatement of *S. pusilla* (Mertens, 1937) (Amphibia: Anura: Bufonidae). *Zootaxa* 4098: 73–94.

Du Preez L, Carruthers V. 2017. *Frogs of Southern Africa: A Complete Guide*. Struik Nature, Cape Town, South Africa. 519 p.

Schiøtz A. 1975. *Treefrogs of Eastern Africa*. Steenstrupia, Copenhagen, Denmark. 232 p.

Schiøtz A. 1999. *Treefrogs of Africa*. Andreas S. Brahm, Frankfurt am Main, Germany. 350 p.

Stamatakis A. 2014. RAxML version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. *Bioinformatics* 30: 1,312–1,313.

Swofford DL. 2001. PAUP*: Phylogenetic Analysis Using Parsimony (and other methods) 4.0.b5. Sinauer Associates, Sunderland, Massachusetts, USA.

Uetz P, Freed P, Hošek J. 2018. *The Reptile Database*.

Available: http://www.reptile-database.org [Accessed: 15 February 2019].

Vences M, Thomas M, Bonett RM, Vieites DR. 2005a. Deciphering amphibian diversity through DNA barcoding: chances and challenges. *Philosophical Transactions of the Royal Society B: Biological Sciences* 360: 1,859–1,868.

Vences M, Thomas M, van der Meijden A, Chiari Y, Vieites DR. 2005b. Comparative performance of the 16S rRNA gene in DNA barcoding of amphibians. *Frontiers in Zoology* 2: 1–12.

Vilgalys R. 2003. Taxonomic misidentification in public DNA databases. *New Phytologist* 160: 4–5.

Wagner P, Wilms TM, Rödder D, Schmitz A. 2013. A great leap–the first record of *Xenopus pygmaeus* (Anura: Pipidae) from south of the Congo Basin. *Salamandra* 49: 206–210.

Weinell JL, Bauer AM. 2018. Systematics and phylogeography of the widely distributed African skink *Trachylepis varia* species complex. *Molecular Phylogenetics and Evolution* 120: 103–117.

Zimkus BM, Schick S. 2010. Light at the end of the tunnel: insights into the molecular systematics of East African puddle frogs (Anura: Phrynobatrachidae). *Systematics and Biodiversity* 8: 39–47.

Zimkus BM, Rödel MO, Hillers A. 2010. Complex patterns of continental speciation: Molecular phylogenetics and biogeography of sub-Saharan puddle frogs (*Phrynobatrachus*). *Molecular Phylogenetics and Evolution* 55: 883–900.

Zimkus BM, Lawson LP, Barej M, Barratt CD, Channing A, Dash KM, Dehling JM, Du Preez L, Gehring P-S, Greenbaum E, et al. 2016. Leapfrogging into new territory: How Mascarene ridged frogs diversified across Africa and Madagascar to maintain their ecological niche. *Molecular Phylogenetics and Evolution* 106: 254–269.

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Appendix 1. List of amphibians and reptiles found in western Zambia, including species vouchers, GenBank accession numbers, and locality information. Museum acronym: BMNH – Natural History Museum, London, United Kingdom. GPS datum WGS-84.

Species	Voucher ID	Field ID	GenBank	Locality	Latitude	Longitude	Altitude
AMPHIBIA: ANURA							
Arthroleptidae							
Arthroleptis stenodactylus	BMNH 2018.5826	SL 2109	MK464479	Lukwakwa	-12.66084	24.43697	1063
Arthroleptis stenodactylus	BMNH 2018.5827	SL 2121	MK464478	Lukwakwa	-12.66084	24.43697	1063
Arthroleptis stenodactylus	BMNH 2018.5828	SL 2123	MK464477	Lukwakwa	-12.66084	24.43697	1063
Arthroleptis stenodactylus	BMNH 2018.5829	SL 2128	MK464476	Lukwakwa	-12.66084	24.43697	1063
Arthroleptis stenodactylus	BMNH 2018.5830	SL 2221	MK464475	Nkwaji	-11.57728	24.53960	1291
Arthroleptis xenochirus	BMNH 2018.5814	SL 2145	MK464471	Hillwood Farm	-11.26316	24.32782	1356
Arthroleptis xenochirus	BMNH 2018.5815	SL 2146	MK464470	Hillwood Farm	-11.26316	24.32782	1356
Arthroleptis xenochirus	BMNH 2018.5816	SL 2147	MK464469	Hillwood Farm	-11.26316	24.32782	1356
Arthroleptis xenochirus	BMNH 2018.5817	SL 2148	MK464468	Hillwood Farm	-11.26316	24.32782	1356
Arthroleptis xenochirus	BMNH 2018.5818	SL 2152	MK464467	Hillwood Farm	-11.26690	24.31666	1308
Arthroleptis xenochirus	BMNH 2018.5819	SL 2153	MK464466	Hillwood Farm	-11.26690	24.31666	1308
Arthroleptis xenochirus	BMNH 2018.5820	SL 2246	MK464465	Hillwood Farm	-11.26690	24.31666	1308
Arthroleptis xenochirus	BMNH 2018.5811	SL 2122	MK464474	Lukwakwa	-12.66084	24.43697	1063
Arthroleptis xenochirus	BMNH 2018.5812	SL 2124	MK464473	Lukwakwa	-12.66084	24.43697	1063
Arthroleptis xenochirus	BMNH 2018.5813	SL 2125	MK464472	Lukwakwa	-12.66084	24.43697	1063
Arthroleptis xenochirus	BMNH 2018.5821	SL 2200	MK464464	Nkwaji	-11.60592	24.55448	1244
Arthroleptis xenochirus	BMNH 2018.5822	SL 2201	MK464463	Nkwaji	-11.60592	24.55448	1244
Arthroleptis xenochirus	BMNH 2018.5823	SL 2202	MK464462	Nkwaji	-11.60592	24.55448	1244
Arthroleptis xenochirus	BMNH 2018.5824	SL 2203	MK464461	Nkwaji	-11.60592	24.55448	1244
Arthroleptis xenochirus	BMNH 2018.5825	SL 2204	MK464460	Nkwaji	-11.60592	24.55448	1244
Bufonidae							
Sclerophrys gutturalis	BMNH 2018.5703	SL 2102		Chavuma FR	-13.07006	22.92880	1073
Sclerophrys gutturalis	BMNH 2018.5705	SL 2108	MK464294	Lukwakwa	-12.66084	24.43697	1063
Sclerophrys gutturalis	BMNH 2018.5706	SL 2107	MK464293	Lukwakwa	-12.74275	24.28436	1101
Sclerophrys gutturalis	BMNH 2018.5707	SL 2111		Lukwakwa	-12.66084	24.43697	1063
Sclerophrys gutturalis	BMNH 2018.5702	SL 2069	MK464296	Maramba Lodge, Livingstone	-17.89120	25.85821	900
Sclerophrys gutturalis	BMNH 2018.5701	SL 2025	MK464297	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Sclerophrys gutturalis	BMNH 2018.5704	SL 2190	MK464295	Nkwaji	-11.60592	24.55448	1244
Sclerophrys lemairii	BMNH 2018.5723	SL 2245		Hillwood Farm	-11.26690	24.31666	1308
Sclerophrys lemairii	BMNH 2018.5715	SL 2112		Lukwakwa	-12.66084	24.43697	1063
Sclerophrys lemairii	BMNH 2018.5716	SL 2113		Lukwakwa	-12.66084	24.43697	1063
Sclerophrys lemairii	BMNH 2018.5717	SL 2114		Lukwakwa	-12.66084	24.43697	1063
Sclerophrys lemairii	BMNH 2018.5718	SL 2115		Lukwakwa	-12.66084	24.43697	1063
Sclerophrys lemairii	BMNH 2018.5719	SL 2116		Lukwakwa	-12.66084	24.43697	1063
Sclerophrys lemairii	BMNH 2018.5720	SL 2117		Lukwakwa	-12.66084	24.43697	1063
Sclerophrys lemairii	BMNH 2018.5721	SL 2118		Lukwakwa	-12.66084	24.43697	1063
Sclerophrys lemairii	BMNH 2018.5722	SL 2119		Lukwakwa	-12.66084	24.43697	1063
Sclerophrys pusilla	BMNH 2018.5709	SL 2047	MK464291	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Sclerophrys pusilla	BMNH 2018.5710	SL 2053	MK464290	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Sclerophrys pusilla	BMNH 2018.5708	SL 2012	MK464292	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Sclerophrys pusilla	BMNH 2018.5711	SL 2189	MK464289	Nkwaji	-11.60592	24.55448	1244

Appendix 1 (continued). List of amphibians and reptiles found in western Zambia, including species vouchers, GenBank accession numbers, and locality information. Museum acronym: BMNH – Natural History Museum, London, United Kingdom. GPS datum WGS-84.

Species	Voucher ID	Field ID	GenBank	Locality	Latitude	Longitude	Altitude
Sclerophrys pusilla	BMNH 2018.5712	SL 2191	MK464288	Nkwaji	-11.60592	24.55448	1244
Schismaderma carens	BMNH 2018.5729	SL 2105	MK464298	Chavuma FR	-13.07006	22.92880	1073
Schismaderma carens	BMNH 2018.5724	SL 2048	MK464303	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Schismaderma carens	BMNH 2018.5725	SL 2049	MK464302	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Schismaderma carens	BMNH 2018.5726	SL 2050	MK464301	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Schismaderma carens	BMNH 2018.5727	SL 2051	MK464300	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Schismaderma carens	BMNH 2018.5728	SL 2052	MK464299	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Hemisotidae							
Hemisus cf. *guineensis*	BMNH 2018.5801	SL 2252	MK464449	Hillwood Farm	-11.26690	24.31666	1308
Hemisus cf. *guineensis*	BMNH 2018.5800	SL 2110	MK464450	Lukwakwa	-12.66084	24.43697	1063
Hemisus cf. *guineensis*	BMNH 2018.5799	SL 2091	MK464451	Sioma Ngwezi NP	-16.89873	23.59847	1009
Hemisus marmoratus	BMNH 2018.5713	SL 2018	MK464448	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Hemisus marmoratus	BMNH 2018.5714	SL 2090	MK464447	Sioma Ngwezi NP	-16.89873	23.59847	1009
Hyperoliidae							
Hyperolius dartevellei	BMNH 2018.5681	SL 2098	MK464446	Chavuma FR	-13.07006	22.92880	1073
Hyperolius dartevellei	BMNH 2018.5683	SL 2139	MK464444	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius dartevellei	BMNH 2018.5684	SL 2140	MK464443	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius dartevellei	BMNH 2018.5682	SL 2127	MK464445	Lukwakwa	-12.66084	24.43697	1063
Hyperolius kachalolae	BMNH 2018.5676	SL 2138	MK464442	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius kachalolae	BMNH 2018.5677	SL 2149	MK464441	Hillwood Farm	-11.26316	24.32782	1356
Hyperolius kachalolae	BMNH 2018.5678	SL 2180	MK464440	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius kachalolae	BMNH 2018.5679	SL 2243	MK464439	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius kachalolae	BMNH 2018.5680	SL 2244	MK464438	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius major	BMNH 2018.5675	SL 2159	MK464437	Hillwood Farm	-11.27444	24.32444	1416
Hyperolius marginatus	BMNH 2018.5667	SL 2126	MK464436	Lukwakwa	-12.66091	24.42943	1100
Hyperolius marginatus	BMNH 2018.5668	SL 2063	MK464435	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Hyperolius marginatus	BMNH 2018.5674	SL 2064	MK464434	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Hyperolius nasicus	BMNH 2018.5666	SL 2056	MK464433	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Hyperolius paralellus	BMNH 2018.5687	SL 2133	MK464432	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius paralellus	BMNH 2018.5688	SL 2136	MK464431	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius paralellus	BMNH 2018.5689	SL 2137	MK464430	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius paralellus	BMNH 2018.5690	SL 2141	MK464429	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius paralellus	BMNH 2018.5691	SL 2142	MK464428	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius paralellus	BMNH 2018.5692	SL 2150	MK464427	Hillwood Farm	-11.26316	24.32782	1356
Hyperolius paralellus	BMNH 2018.5693	SL 2161	MK464426	Hillwood Farm	-11.27444	24.32444	1416
Hyperolius paralellus	BMNH 2018.5694	SL 2179	MK464425	Hillwood Farm	-11.26690	24.31666	1308
Hyperolius paralellus	BMNH 2018.5695	SL 2184		Hillwood Farm	-11.26690	24.31666	1308
Hyperolius paralellus	BMNH 2018.5696	SL 2224	MK464424	Nkwaji	-11.50420	24.56456	1386
Hyperolius paralellus	BMNH 2018.5697	SL 2225	MK464423	Nkwaji	-11.50420	24.56456	1386
Hyperolius paralellus	BMNH 2018.5698	SL 2220	MK464422	Nkwaji	-11.60592	24.55448	1244
Hyperolius paralellus	BMNH 2018.5699	SL 2240	MK464421	Nkwaji	-11.53906	24.55262	1336
Hyperolius paralellus	BMNH 2018.5700	SL 2241	MK464420	Nkwaji	-11.53906	24.55262	1336
Hyperolius quinquevittatus	BMNH 2018.5685	SL 2216	MK464419	Nkwaji	-11.53906	24.55262	1336

Appendix 1 (continued). List of amphibians and reptiles found in western Zambia, including species vouchers, GenBank accession numbers, and locality information. Museum acronym: BMNH – Natural History Museum, London, United Kingdom. GPS datum WGS-84.

Species	Voucher ID	Field ID	GenBank	Locality	Latitude	Longitude	Altitude
Hyperolius quinquevittatus	BMNH 2018.5686	SL 2217		Nkwaji	-11.53906	24.55262	1336
Kassina senegalensis	BMNH 2018.5810	SL 2106	MK464406	Chavuma FR	-13.07006	22.92880	1073
Kassina senegalensis	BMNH 2018.5802	SL 2129	MK464414	Hillwood Farm	-11.26690	24.31666	1308
Kassina senegalensis	BMNH 2018.5803	SL 2130	MK464413	Hillwood Farm	-11.26690	24.31666	1308
Kassina senegalensis	BMNH 2018.5804	SL 2223	MK464412	Nkwaji	-11.50420	24.56456	1386
Kassina senegalensis	BMNH 2018.5805	SL 2073	MK464411	Sioma Ngwezi NP	-16.89873	23.59847	1009
Kassina senegalensis	BMNH 2018.5806	SL 2074	MK464410	Sioma Ngwezi NP	-16.89873	23.59847	1009
Kassina senegalensis	BMNH 2018.5807	SL 2075	MK464409	Sioma Ngwezi NP	-16.89873	23.59847	1009
Kassina senegalensis	BMNH 2018.5808	SL 2076	MK464408	Sioma Ngwezi NP	-16.89873	23.59847	1009
Kassina senegalensis	BMNH 2018.5809	SL 2087	MK464407	Sioma Ngwezi NP	-16.89873	23.59847	1009
Phrynobatrachidae							
Phrynobatrachus cf. *parvulus*	BMNH 2018.5873	SL 2157	MK464397	Hillwood Farm	-11.26316	24.32782	1356
Phrynobatrachus cf. *parvulus*	BMNH 2018.5874	SL 2162	MK464396	Hillwood Farm	-11.27444	24.32444	1416
Phrynobatrachus cf. *parvulus*	BMNH 2018.5875	SL 2163	MK464395	Hillwood Farm	-11.26316	24.32782	1356
Phrynobatrachus cf. *parvulus*	BMNH 2018.5876	SL 2164	MK464394	Hillwood Farm	-11.26316	24.32782	1356
Phrynobatrachus cf. *parvulus*	BMNH 2018.5877	SL 2165	MK464393	Hillwood Farm	-11.26316	24.32782	1356
Phrynobatrachus cf. *parvulus*	BMNH 2018.5878	SL 2166	MK464392	Hillwood Farm	-11.26316	24.32782	1356
Phrynobatrachus cf. *parvulus*	BMNH 2018.5889	SL 2120	MK464389	Lukwakwa	-12.66084	24.43697	1063
Phrynobatrachus cf. *parvulus*	BMNH 2018.5879	SL 2208	MK464391	Nkwaji	-11.56594	24.52659	1311
Phrynobatrachus cf. *parvulus*	BMNH 2018.5880	SL 2210	MK464390	Nkwaji	-11.56594	24.52659	1311
Phrynobatrachus cf. *parvulus*	BMNH 2018.5882	SL 2205		Nkwaji	-11.56594	24.52659	1311
Phrynobatrachus cf. *parvulus*	BMNH 2018.5883	SL 2234		Nkwaji	-11.56567	24.52605	1263
Phrynobatrachus cf. *parvulus*	BMNH 2018.5884	SL 2235		Nkwaji	-11.56567	24.52605	1263
Phrynobatrachus cf. *parvulus*	BMNH 2018.5885	SL 2236		Nkwaji	-11.56567	24.52605	1263
Phrynobatrachus cf. *parvulus*	BMNH 2018.5886	SL 2237		Nkwaji	-11.56567	24.52605	1263
Phrynobatrachus cf. *parvulus*	BMNH 2018.5887	SL 2238		Nkwaji	-11.56567	24.52605	1263
Phrynobatrachus cf. *parvulus*	BMNH 2018.5888	SL 2239		Nkwaji	-11.56567	24.52605	1263
Phrynobatrachus mababiensis	BMNH 2018.5831	SL 2010	MK464388	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus mababiensis	BMNH 2018.5832	SL 2011	MK464387	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus mababiensis	BMNH 2018.5881	SL 2015		Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus mababiensis	BMNH 2018.5833	SL 2065	MK464386	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Phrynobatrachus mababiensis	BMNH 2018.5834	SL 2080	MK464385	Sioma Ngwezi NP	-16.89873	23.59847	1009

Appendix 1 (continued). List of amphibians and reptiles found in western Zambia, including species vouchers, GenBank accession numbers, and locality information. Museum acronym: BMNH – Natural History Museum, London, United Kingdom. GPS datum WGS-84.

Species	Voucher ID	Field ID	GenBank	Locality	Latitude	Longitude	Altitude
Phrynobatrachus mababiensis	BMNH 2018.5835	SL 2081		Sioma Ngwezi NP	-16.89873	23.59847	1009
Phrynobatrachus natalensis	BMNH 2018.5848	SL 2045	MK464377	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Phrynobatrachus natalensis	BMNH 2018.5849	SL 2046	MK464376	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Phrynobatrachus natalensis	BMNH 2018.5850	SL 2054	MK464375	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Phrynobatrachus natalensis	BMNH 2018.5853	SL 2066	MK464372	Maramba Lodge, Livingstone	-17.89120	25.85821	900
Phrynobatrachus natalensis	BMNH 2018.5854	SL 2067	MK464371	Maramba Lodge, Livingstone	-17.89120	25.85821	900
Phrynobatrachus natalensis	BMNH 2018.5837	SL 2016	MK464384	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5838	SL 2017	MK464383	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5839	SL 2026	MK464382	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5840	SL 2027	MK464381	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5841	SL 2033	MK464380	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5842	SL 2034	MK464379	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5843	SL 2037	MK464378	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5844	SL 2028		Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5845	SL 2029		Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5846	SL 2030		Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5847	SL 2031		Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Phrynobatrachus natalensis	BMNH 2018.5851	SL 2055	MK464374	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Phrynobatrachus natalensis	BMNH 2018.5852	SL 2057	MK464373	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Phrynobatrachus sp.1	BMNH 2018.5866	SL 2143	MK464364	Hillwood Farm	-11.26316	24.32782	1356
Phrynobatrachus sp.1	BMNH 2018.5867	SL 2144	MK464363	Hillwood Farm	-11.26316	24.32782	1356
Phrynobatrachus sp.1	BMNH 2018.5856	SL 2195	MK464369	Nkwaji	-11.60592	24.55448	1244
Phrynobatrachus sp.1	BMNH 2018.5857	SL 2196		Nkwaji	-11.60592	24.55448	1244
Phrynobatrachus sp.1	BMNH 2018.5858	SL 2197	MK464368	Nkwaji	-11.60592	24.55448	1244
Phrynobatrachus sp.1	BMNH 2018.5859	SL 2198	MK464367	Nkwaji	-11.60592	24.55448	1244
Phrynobatrachus sp.1	BMNH 2018.5860	SL 2199	MK464366	Nkwaji	-11.60592	24.55448	1244
Phrynobatrachus sp.1	BMNH 2018.5861	SL 2211		Nkwaji	-11.56594	24.52659	1311
Phrynobatrachus sp.1	BMNH 2018.5862	SL 2219		Nkwaji	-11.56567	24.52605	1263
Phrynobatrachus sp.1	BMNH 2018.5863	SL 2232	MK464365	Nkwaji	-11.56567	24.52605	1263
Phrynobatrachus sp.1	BMNH 2018.5868	SL 2206	MK464362	Nkwaji	-11.56594	24.52659	1311
Phrynobatrachus sp.1	BMNH 2018.5869	SL 2207	MK464361	Nkwaji	-11.56594	24.52659	1311
Phrynobatrachus sp.1	BMNH 2018.5870	SL 2209	MK464360	Nkwaji	-11.56594	24.52659	1311
Phrynobatrachus sp.1	BMNH 2018.5871	SL 2231	MK464359	Nkwaji	-11.56567	24.52605	1263
Phrynobatrachus sp.1	BMNH 2018.5872	SL 2233	MK464358	Nkwaji	-11.56567	24.52605	1263
Phrynobatrachus sp.2	BMNH 2018.5836	SL 2071	MK464357	Ngonye Falls Camp	-16.66139	23.57280	929
Phrynobatrachus sp.2	BMNH 2018.5864	SL 2095	MK464356	Sioma Ngwezi NP	-16.89873	23.59847	1009
Phrynobatrachus sp.2	BMNH 2018.5865	SL 2096	MK464355	Sioma Ngwezi NP	-16.89873	23.59847	1009
Phrynobatrachus sp.3	BMNH 2018.5855	SL 2072	MK464370	Ngonye Falls Camp	-16.66139	23.57280	929
Pipidae							
Xenopus poweri	BMNH 2018.5654	SL 2173	MK464274	Hillwood Farm	-11.26690	24.31666	1308
Xenopus poweri	BMNH 2018.5655	SL 2174	MK464273	Hillwood Farm	-11.26690	24.31666	1308
Xenopus poweri	BMNH 2018.5656	SL 2175	MK464272	Hillwood Farm	-11.26690	24.31666	1308

Appendix 1 (continued). List of amphibians and reptiles found in western Zambia, including species vouchers, GenBank accession numbers, and locality information. Museum acronym: BMNH – Natural History Museum, London, United Kingdom. GPS datum WGS-84.

Species	Voucher ID	Field ID	GenBank	Locality	Latitude	Longitude	Altitude
Xenopus poweri	BMNH 2018.5657	SL 2176	MK464271	Hillwood Farm	-11.26690	24.31666	1308
Xenopus poweri	BMNH 2018.5658	SL 2177		Hillwood Farm	-11.26690	24.31666	1308
Xenopus poweri	BMNH 2018.5659	SL 2222	MK464270	Nkwaji	-11.50420	24.56456	1386
Xenopus pygmaeus	BMNH 2018.5651	SL 2134	MK464269	Hillwood Farm	-11.26690	24.31666	1308
Xenopus pygmaeus	BMNH 2018.5652	SL 2135	MK464268	Hillwood Farm	-11.26690	24.31666	1308
Xenopus pygmaeus	BMNH 2018.5653	SL 2156	MK464267	Hillwood Farm	-11.26690	24.31666	1308
Ptychadenidae							
Ptychadena anchietae	BMNH 2018.5735	SL 2040	MK464344	Itezhi-Tezhi, Kafue NP	-15.7734	26.01151	1036
Ptychadena anchietae	BMNH 2018.5736	SL 2039		Itezhi-Tezhi, Kafue NP	-15.7734	26.01151	1036
Ptychadena anchietae	BMNH 2018.5730	SL 2019		Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Ptychadena anchietae	BMNH 2018.5731	SL 2020	MK464345	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Ptychadena anchietae	BMNH 2018.5732	SL 2022		Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Ptychadena anchietae	BMNH 2018.5733	SL 2023		Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Ptychadena anchietae	BMNH 2018.5734	SL 2024		Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Ptychadena grandisonae	BMNH 2018.5737	SL 2214	MK464318	Nkwaji	-11.5042	24.56456	1386
Ptychadena grandisonae	BMNH 2018.5738	SL 2215		Nkwaji	-11.5042	24.56456	1386
Ptychadena grandisonae	BMNH 2018.5739	SL 2226	MK464317	Nkwaji	-11.5042	24.56456	1386
Ptychadena grandisonae	BMNH 2018.5740	SL 2227	MK464316	Nkwaji	-11.5042	24.56456	1386
Ptychadena grandisonae	BMNH 2018.5741	SL 2228	MK464315	Nkwaji	-11.5042	24.56456	1386
Ptychadena grandisonae	BMNH 2018.5742	SL 2229	MK464314	Nkwaji	-11.5042	24.56456	1386
Ptychadena grandisonae	BMNH 2018.5743	SL 2230	MK464313	Nkwaji	-11.5042	24.56456	1386
Ptychadena cf. *guibei*	BMNH 2018.5764	SL 2035	MK464324	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Ptychadena cf. *guibei*	BMNH 2018.5765	SL 2079	MK464323	Sioma Ngwezi NP	-16.89873	23.59847	1009
Ptychadena mapacha	BMNH 2018.5772	SL 2014	MK464312	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Ptychadena cf. *mossambica*	BMNH 2018.5754	SL 2042	MK464342	Itezhi-Tezhi, Kafue NP	-15.7734	26.01151	1036
Ptychadena cf. *mossambica*	BMNH 2018.5755	SL 2043	MK464341	Itezhi-Tezhi, Kafue NP	-15.7734	26.01151	1036
Ptychadena cf. *mossambica*	BMNH 2018.5756	SL 2044	MK464340	Itezhi-Tezhi, Kafue NP	-15.7734	26.01151	1036
Ptychadena cf. *mossambica*	BMNH 2018.5757	SL 2038	MK464339	Itezhi-Tezhi, Kafue NP	-15.7734	26.01151	1036
Ptychadena cf. *mossambica*	BMNH 2018.5763	SL 2021	MK464336	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Ptychadena cf. *mossambica*	BMNH 2018.5758	SL 2088		Sioma Ngwezi NP	-16.89873	23.59847	1009
Ptychadena cf. *mossambica*	BMNH 2018.5759	SL 2089	MK464338	Sioma Ngwezi NP	-16.89873	23.59847	1009
Ptychadena cf. *mossambica*	BMNH 2018.5760	SL 2094	MK464337	Sioma Ngwezi NP	-16.89873	23.59847	1009
Ptychadena cf. *mossambica*	BMNH 2018.5761			Sioma Ngwezi NP	-16.89873	23.59847	1009
Ptychadena cf. *mossambica*	BMNH 2018.5753	SL 2041		Itezhi-Tezhi, Kafue NP	-15.7734	26.01151	1036
Ptychadena nilotica	BMNH 2018.5781	SL 2068	MK464327	Maramba Lodge, Livingstone	-17.8912	25.85821	900
Ptychadena nilotica	BMNH 2018.5773	SL 2058	MK464332	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Ptychadena nilotica	BMNH 2018.5774	SL 2059	MK464331	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Ptychadena nilotica	BMNH 2018.5775	SL 2061	MK464330	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Ptychadena nilotica	BMNH 2018.5776	SL 2062		Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Ptychadena nilotica	BMNH 2018.5777	SL 2278	MK464329	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Ptychadena nilotica	BMNH 2018.5778	SL 2279		Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Ptychadena nilotica	BMNH 2018.5779	SL 2280	MK464328	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Ptychadena nilotica	BMNH 2018.5780	SL 2281		Nanzila Plains, Kafue NP	-16.28138	25.91676	1032

Appendix 1 (continued). List of amphibians and reptiles found in western Zambia, including species vouchers, GenBank accession numbers, and locality information. Museum acronym: BMNH – Natural History Museum, London, United Kingdom. GPS datum WGS-84.

Species	Voucher ID	Field ID	GenBank	Locality	Latitude	Longitude	Altitude
Ptychadena obscura	BMNH 2018.5768	SL 2155	MK464322	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena obscura	BMNH 2018.5766	SL 2131	MK464311	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena obscura	BMNH 2018.5767	SL 2132	MK464310	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena oxyrhynchus	BMNH 2018.5783	SL 2250	MK464325	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena oxyrhynchus	BMNH 2018.5782	SL 2060	MK464326	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Ptychadena porosissima	BMNH 2018.5769	SL 2158	MK464321	Hillwood Farm	-11.27531	24.31977	1340
Ptychadena porosissima	BMNH 2018.5770	SL 2168	MK464320	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena porosissima	BMNH 2018.5771	SL 2248	MK464319	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena cf. *taenioscelis*	BMNH 2018.5784	SL 2169	MK464335	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena cf. *taenioscelis*	BMNH 2018.5785	SL 2171	MK464334	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena cf. *taenioscelis*	BMNH 2018.5786	SL 2172	MK464333	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena upembae	BMNH 2018.5750	SL 2154	MK464348	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena upembae	BMNH 2018.5751	SL 2170	MK464347	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena upembae	BMNH 2018.5752	SL 2251	MK464346	Hillwood Farm	-11.2669	24.31666	1308
Ptychadena upembae	BMNH 2018.5744	SL 2192	MK464354	Nkwaji	-11.60592	24.55448	1244
Ptychadena upembae	BMNH 2018.5745	SL 2193	MK464353	Nkwaji	-11.60592	24.55448	1244
Ptychadena upembae	BMNH 2018.5746	SL 2194	MK464352	Nkwaji	-11.60592	24.55448	1244
Ptychadena upembae	BMNH 2018.5747	SL 2212	MK464351	Nkwaji	-11.56594	24.52659	1311
Ptychadena upembae	BMNH 2018.5748	SL 2218	MK464350	Nkwaji	-11.53906	24.55262	1336
Pyxicephalidae							
Amietia chapini	BMNH 2018.5660	SL 2186	MK464482	Hillwood Farm	-11.26690	24.31666	1308
Amietia chapini	BMNH 2018.5661	SL 2185	MK464481	Hillwood Farm	-11.26690	24.31666	1308
Amietia chapini	BMNH 2018.5662	SL 2178		Hillwood Farm	-11.26690	24.31666	1308
Amietia chapini	BMNH 2018.5663	SL 2183	MK464480	Hillwood Farm	-11.26690	24.31666	1308
Amietia chapini	BMNH 2018.5664	SL 2151		Hillwood Farm	-11.26690	24.31666	1308
Amietia chapini	BMNH 2018.5665	SL 2167		Hillwood Farm	-11.26690	24.31666	1308
Pyxicephalus cf. *adspersus*	BMNH 2018.5787	SL 2077	MK464309	Sioma Ngwezi NP	-16.89873	23.59847	1009
Pyxicephalus cf. *adspersus*	BMNH 2018.5788	SL 2082	MK464308	Sioma Ngwezi NP	-16.89873	23.59847	1009
Pyxicephalus cf. *adspersus*	BMNH 2018.5789	SL 2083	MK464307	Sioma Ngwezi NP	-16.89873	23.59847	1009
Pyxicephalus cf. *adspersus*	BMNH 2018.5790	SL 2084	MK464306	Sioma Ngwezi NP	-16.89873	23.59847	1009
Pyxicephalus cf. *adspersus*	BMNH 2018.5791	SL 2097	MK464305	Sioma Ngwezi NP	-16.89873	23.59847	1009
Tomopterna marmorata	BMNH 2018.5792	SL 2070	MK464287	Maramba Lodge, Livingstone	-17.89120	25.85821	900
Tomopterna sp.	BMNH 2018.5793	SL 2078	MK464286	Sioma Ngwezi NP	-16.89873	23.59847	1009
Tomopterna sp.	BMNH 2018.5794	SL 2085	MK464285	Sioma Ngwezi NP	-16.89873	23.59847	1009
Tomopterna sp.	BMNH 2018.5795	SL 2086	MK464284	Sioma Ngwezi NP	-16.89873	23.59847	1009
Tomopterna sp.	BMNH 2018.5796	SL 2092	MK464283	Sioma Ngwezi NP	-16.89873	23.59847	1009
Tomopterna sp.	BMNH 2018.5797	SL 2093	MK464282	Sioma Ngwezi NP	-16.89873	23.59847	1009
Rhacophoridae							
Chiromantis xerampelina	BMNH 2018.5798	SL 2036	MK464456	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
REPTILIA: SQUAMATA							
Agamidae							
Agama armata	BMNH 2018.2751	SL 2253	MK464483	Ngonye Falls Camp	-16.66139	23.57280	929

Appendix 1 (continued). List of amphibians and reptiles found in western Zambia, including species vouchers, GenBank accession numbers, and locality information. Museum acronym: BMNH – Natural History Museum, London, United Kingdom. GPS datum WGS-84.

Species	Voucher ID	Field ID	GenBank	Locality	Latitude	Longitude	Altitude
Chamaeleonidae							
Chamaeleo dilepis	BMNH 2018.2755	SL 2099	MK464458	Chavuma FR	-13.07006	22.92880	1073
Chamaeleo dilepis	BMNH 2018.2756	SL 2100	MK464457	Chavuma FR	-13.07006	22.92880	1073
Colubridae							
Crotaphopeltis hotamboeia	BMNH 2018.2773	SL 2247	MK464455	Hillwood Farm	-11.26690	24.31666	1308
Crotaphopeltis hotamboeia	BMNH 2018.2776	SL 2272		Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Crotaphopeltis hotamboeia	BMNH 2018.2777	SL 2258	MK464454	Sioma Ngwezi NP	-16.89873	23.59847	1009
Rhamnophis aethiopissa ituriensis	BMNH 2018.2772	SL 2249	MK464304	Hillwood Farm	-11.26690	24.31666	1308
Philothamnus hoplogaster	BMNH 2018.2775	SL 2277	MK464398	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Thelotornis kirtlandii	BMNH 2018.2760	SL 2182		Hillwood Farm	-11.26690	24.31666	1308
Gekkonidae							
Hemidactylus mabouia	BMNH 2018.2740	SL 2264		Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Hemidactylus mabouia	BMNH 2018.2742	SL 2263	MK464452	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Hemidactylus mabouia	BMNH 2018.2741	SL 2276	MK464453	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Lygodactylus angolensis	BMNH 2018.2766	SL 2213	MK464405	Nkwaji	-11.52743	24.53532	1343
Lygodactylus angolensis	BMNH 2018.2767	SL 2187	MK464404	Nkwaji	-11.60592	24.55448	1244
Lygodactylus chobiensis	BMNH 2018.2743	SL 2267	MK464403	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Lygodactylus chobiensis	BMNH 2018.2744	SL 2268		Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Pachydactylus punctatus	BMNH 2018.2757	SL 2265	MK464400	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Pachydactylus punctatus	BMNH 2018.2758	SL 2266		Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Pachydactylus punctatus	BMNH 2018.2759	SL 2269		Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Gerrhosauridae							
Gerrhosaurus bulsi	BMNH 2018.2754	SL 2181		Hillwood Farm	-11.26690	24.31666	1308
Lacertidae							
Ichnotropis capensis	BMNH 2018.2746	SL 2103	MK464417	Chavuma FR	-13.07006	22.92880	1073
Ichnotropis capensis	BMNH 2018.2747	SL 2260	MK464416	Lukwakwa	-12.66084	24.43697	1063
Ichnotropis capensis	BMNH 2018.2749	SL 2259		Lukwakwa	-12.66084	24.43697	1063
Ichnotropis capensis	BMNH 2018.2748	SL 2274		Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Ichnotropis capensis	BMNH 2018.2750	SL 2273	MK464415	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Ichnotropis capensis	BMNH 2018.2745	SL 2256	MK464418	Sioma Ngwezi NP	-16.89873	23.59847	1009
Meroles squamulosus	BMNH 2018.2753	SL 2275	MK464401	Nanzila Plains, Kafue NP	-16.28138	25.91676	1032
Meroles squamulosus	BMNH 2018.2752	SL 2257	MK464402	Sioma Ngwezi NP	-16.89873	23.59847	1009
Lamprophiidae							
Atractaspis congica	BMNH 2018.2274	SL 2160	MK464459	Hillwood Farm	-11.27444	24.32444	1416
Scincidae							
Typhlacontias rohani	BMNH 2018.2761	SL 2254	MK464275	New HQ complex of Sioma Ngwezi NP	-16.66953	23.56743	999
Panaspis cf. *wahlbergi*	BMNH 2018.2738	SL 2101	MK464399	Chavuma FR	-13.07006	22.92880	1073
Panaspis cf. *wahlbergi*	BMNH 2018.2739	SL 2104		Chavuma FR	-13.07006	22.92880	1073
Trachylepis cf. *albopunctata*	BMNH 2018.2762	SL 2270	MK464281	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Trachylepis cf. *albopunctata*	BMNH 2018.2763	SL 2032		Mayukuyuku, Kafue NP	-14.91533	26.06311	1012

Appendix 1 (continued). List of amphibians and reptiles found in western Zambia, including species vouchers, GenBank accession numbers, and locality information. Museum acronym: BMNH – Natural History Museum, London, United Kingdom. GPS datum WGS-84.

Species	Voucher ID	Field ID	GenBank	Locality	Latitude	Longitude	Altitude
Trachylepis cf. *albopunctata*	BMNH 2018.2765	SL 2013	MK464280	Mayukuyuku, Kafue NP	-14.91533	26.06311	1012
Trachylepis damarana	BMNH 2018.2764	SL 2255	MK464279	New HQ complex of Sioma Ngwezi NP	-16.66953	23.56743	999
Trachylepis wahlbergii	BMNH 2018.2769	SL 2271	MK464278	Itezhi-Tezhi, Kafue NP	-15.77340	26.01151	1036
Trachylepis wahlbergii	BMNH 2018.2768	SL 2262		Lukwakwa	-12.66084	24.43697	1063
Trachylepis wahlbergii	BMNH 2018.2770	SL 2261	MK464277	Lukwakwa	-12.66084	24.43697	1063
Trachylepis wahlbergii	BMNH 2018.2771	SL 2188	MK464276	Nkwaji	-11.60592	24.55448	1244
REPTILIA: Testudines							
Testudinidae							
Kinixys spekii	No voucher	No voucher		Nkwaji	-11.53906	24.55262	1336