

# Biodiversity in a forest island: reptiles and amphibians of the West African Togo Hills

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**Abstract.**—Our recent surveys of the herpetological diversity of the West African Togo Hills documented a total of 65 reptile and amphibian species, making Kyabobo National Park one of the most diverse sites surveyed in Ghana. We provide accounts for all species recorded along with photographs to aid in identification. We recorded 26 amphibians, including six new records for Kyabobo N. P., one of which is a record for the Togo Hills. Our collection of reptile species (22 lizards, 16 snakes, and one crocodile) also provides new records and range extensions for Kyabobo N. P., such as the first observation of the dwarf crocodile, *Osteolaemus tetraspis*. Amphibian species still lacking from our surveys in the Togo Hills include several species that are adapted to fast running water or large closed forests, like the Togo toad, *Bufo togoensis* and the slippery frog, *Conraua derooi*. Appropriate habitat for such species still remains in Kyabobo, highlighting the need for additional survey work. We draw attention to the importance of conserving forest stream habitats, which will in turn help ensure the persistence of forest-restricted species. We also highlight those species that may prove most useful for evolutionary studies of West African rain forest biogeography.

**Key words.** Ghana, reptiles, amphibians, biogeography, conservation, biodiversity, Dahomey Gap, West Africa, Togo Hills, Kyabobo National Park

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## Introduction

The Guinean rain forest of Western Africa is a center of biological diversity with considerable endemism (Myers et al. 2000). The percentage of reptile and amphibian species endemic to this region far exceeds that of other tetrapod groups (reptiles = 33% and amphibians = 77% versus mammals = 8% and birds = 18%; Myers et al. 2000). Concomitant with this impressive diversity is an alarming rate of habitat loss. In Ghana alone, natural forests have diminished to about 11.8–14.5% of their former cover (IUCN 1996; Poorter et al. 2004). Worldwide, habitat loss and forest fragmentation are recognized as key factors driving the global extinction of genetically distinct populations and species (Bierregaard et al. 1992; Hughes et al. 1997; Brooks et al. 1999; Stuart et al. 2004).

While the host of factors driving wildlife declines in the Guinean rain forest ecosystem involve some of the usual suspects (i.e., logging and land use conversion for agriculture), several studies have demonstrated that hunting of wildlife for

human consumption through the bushmeat trade is among the most immediate threats (Milner-Gulland et al. 2003; Brashares et al. 2004; Cowlshaw et al. 2005). Although these studies focused primarily on mammals and birds, it is clear that reptiles are also harvested for human consumption (Fa et al. 2000; Luiselli 2003). Additional human pressures with possible adverse effects on reptile and amphibian diversity include the collection of animals for medical uses, the pet trade, and the killing of snakes, poisonous or not, out of fear.

It is interesting to compare the current trend of habitat loss with the historical oscillations of the rain forest distribution. The forest probably formed a large belt of continuous habitat extending from West to Central Africa during the early Holocene and the last interglacial (Maley 1991; Dupont et al. 2000). During the last glacial maximum, the expansion of dry forest and savannah resulted in a very restricted and patchy distribution of rain forest (Dupont et al. 2000). Currently, the large West African rain forest blocks are separated by the Dahomey Gap, a stretch of dry savannah extending from central Ghana, through Togo, Benin, and western Nigeria (Fig. 1).

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## Herpetofauna of the Togo Hills

**Table 1.** Frogs (Anura), Lizards (Squamata), Snakes (Squamata), and Crocodiles (Archosauria) recorded at Kyabobo National Park and the surrounding areas. Habitat classification types are as follows: S=savannah; F=forest; FB=farmbush.

Family	Scientific Name	Common Name	Habitat
<b>Frogs</b>			
<b>Arthroleptidae</b>	<i>Arthroleptis cf. poecilonotus</i>	West African Screeching Frog	FB, F
<b>Bufonidae</b>	<i>Bufo maculatus</i>	Flat-backed Toad	S, FB
	<i>Bufo regularis</i>	Square-marked Toad	S, FB
<b>Hemisotidae</b>	<i>Hemisis cf. marmoratus</i>	Marbled Shovel-nosed Frog	S, FB
<b>Hyperoliidae</b>	<i>Afrixalus dorsalis</i>	Cameroon Leaf-folding Frog	FB
	<i>Afrixalus vittiger</i>	Savannah Leaf-folding Frog	S, FB
	<i>Afrixalus weidholzi</i>	Weidholz's Leaf-folding Frog	S
	<i>Hyperolius baumanni</i>	Baumann's Reed Frog	F, FB
	<i>Hyperolius concolor</i>	Variable Reed Frog	S, FB
	<i>Hyperolius fusciventris burtoni</i>	Lime Reed Frog	FB
	<i>Hyperolius nasutus</i>	Long-nosed Reed Frog	S
	<i>Hyperolius nitidulus</i>	West African Reed Frog	S
	<i>Hyperolius torrentis</i>	Ukami Reed Frog	F
	<i>Kassina senegalensis</i>	Senegal Running Frog	S, FB
	<i>Leptopelis hylroides</i>	Gbanga Tree Frog	F, FB
	<i>Leptopelis viridis</i>	Rusty Tree Frog	S
<b>Petropedetidae</b>	<i>Phrynobatrachus accraensis</i>	Accra Puddle Frog	S, FB
	<i>Phrynobatrachus calcaratus</i>	Horned Puddle Frog	F, FB
	<i>Phrynobatrachus natalensis</i>	Natal Puddle Frog	S
	<i>Phrynobatrachus plicatus</i>	Coast Puddle Frog	F
<b>Ranidae</b>	<i>Amnirana albolabris</i>	White-lipped Frog	F
	<i>Amnirana galamensis</i>	Galam White-lipped Frog	S
	<i>Hoplobatrachus occipitalis</i>	Crowned Bullfrog	S, FB
	<i>Ptychadena bibroni</i>	Broad-banded Grass Frog	S, FB
	<i>Ptychadena oxyrhynchus</i>	Sharp-nosed Grass Frog	S
	<i>Ptychadena pumilio</i>	Medine Grass Frog	S, FB
<b>Lizards</b>			
<b>Agamidae</b>	<i>Agama agama</i>	Rainbow Lizard	S, FB
	<i>Agama sankaranica</i>	Senegal Agama	S
<b>Chamaeleonidae</b>	<i>Chamaeleo senegalensis</i>	Senegal Chameleon	S
<b>Eublepharidae</b>	<i>Hemitheconyx caudicinctus</i>	Fat-tail Gecko	S
<b>Gekkonidae</b>	<i>Hemidactylus brookii</i>	Brooke's House Gecko	S, FB
	<i>Hemidactylus fasciatus</i>	Banded Leaf-toed Gecko	F
	<i>Hemidactylus mabouia</i>	House Gecko	FB
	<i>Hemidactylus muriceus</i>	Guinea Leaf-toed Gecko	F
	<i>Lygodactylus gutturalis</i>	Uganda Dwarf Gecko	S, FB
<b>Gerrhosauridae</b>	<i>Gerrhosaurus major</i>	Rough-scaled Plated Lizard	S, FB
<b>Lacertidae</b>	<i>Holaspis guentheri</i>	Sawtail Lizard	F
<b>Scincidae</b>	<i>Cophoscincopus cf. simulans</i>	Keeled Water Skink	F
	<i>Lygosoma brevicaudis</i>	Short-tailed Writhing Skink	S
	<i>Lygosoma guineensis</i>	Guinea Writhing Skink	S, FB
	<i>Panaspis togoensis</i>	Togo Lidless Skink	F

Continued on page 26



**Figure 1.** Satellite image of Western Africa. The disjunct distribution of the major blocks of African rain forest (wet lowland and drier and mixed types) and the Togo Hills is highlighted in green (adapted from Schiøtz 1967 and Lawson 1968). Kyabobo National Park, located in the center of the Dahomey Gap in the Togo Hills, is highlighted by the red box and shown in figure 2. Base map downloaded from Google Earth (Google, Inc.).

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Although the Dahomey Gap became established during the late Holocene, it has also experienced fluctuations in range and only reached its current extent within the last 1,100 years (Salzmann and Hoelzmann 2005).

The Dahomey Gap is thought to be a major biogeographic border separating forest faunas restricted to blocks of rain forest in West and Central Africa (Booth 1958; Schiøtz 1967; Hamilton 1976). Situated in the center of the Dahomey Gap are the Togo Hills, a mountainous area with peaks reaching 800 m that receives a substantial amount of rain and includes vegetation composed of moist semi-deciduous forest and montane ravine forest. Thus, the Togo Hills are a virtual “island” of lush forest surrounded by savannah and contain many forest species that are isolated from the more expansive rain forest blocks to the west and east (Fig. 1). The presence of relatively few rainforest endemics in the Togo Hills (e.g., Togo slippery frog *Conraua derooi*, Baumann’s reed frog *Hyperolius baumanni*, Ukami reed frog *H. torrentis*) corroborates geological data suggesting that this region has not been isolated for a long period of time and is consistent with the hypothesis that the area served as a forest refugium during dryer periods associated with glacial maximum (Haffer 1982).

Ghana has an excellent national park system that encompasses the major habitat types located in the country. Located in Eastern Ghana, bordered by the Koue River and Togo to the east and the villages of Nkwanta and Shiare to the south, is Kyabobo National Park (Fig. 2). Although Kyabobo is relatively small (~380 km<sup>2</sup>) compared to other national parks in Ghana, it is important in terms of biodiversity conservation and biogeography. Situated in the Dahomey Gap, Kyabobo contains much of the residing large tracts of semi-deciduous

forest habitat remaining in the Togo Hills. It is crucial to catalog and study the forest species of Kyabobo and the immediate surrounding areas as an important first step toward understanding the evolutionary history and biogeography of the entire West African rain forest ecosystem.

Despite the clear understanding of the Togo Hills as an important area for biodiversity conservation and biogeography, it is surprising that so little is known about the reptiles and amphibians of the area. Ghana has a fascinating history of herpetological research beginning with the exportation of specimens to European countries during the 1800s (Hughes 1988). The most comprehensive synopsis of the reptiles and amphibians of Ghana is a checklist of species compiled by Barry Hughes (1988), but this list is by no means definitive. New country records and new species are still being discovered (Leaché 2005; Rödel et al. 2005).

A recent survey of amphibians of the Togo Hills concluded that, with 31 amphibian species, the area is more diverse than previously assumed and probably contains at least 41 amphibian species (Rödel and Agyei 2003). The periphery of Kyabobo National Park was also surveyed and found to contain a total of 20 frog species (Rödel and Agyei 2003). The reptiles of the area have never been targeted for biological survey.

Here, we summarize the results of our herpetological surveys of Kyabobo National Park. We provide accounts for all species recorded along with photographs to aid in identification. We draw attention to the importance of conserving forest stream habitats, which will in turn help ensure the persistence of forest-restricted species. We also highlight those species that may prove most useful for evolutionary studies of West African rain forest biogeography.

## Herpetofauna of the Togo Hills

**Table 1.** Continued.

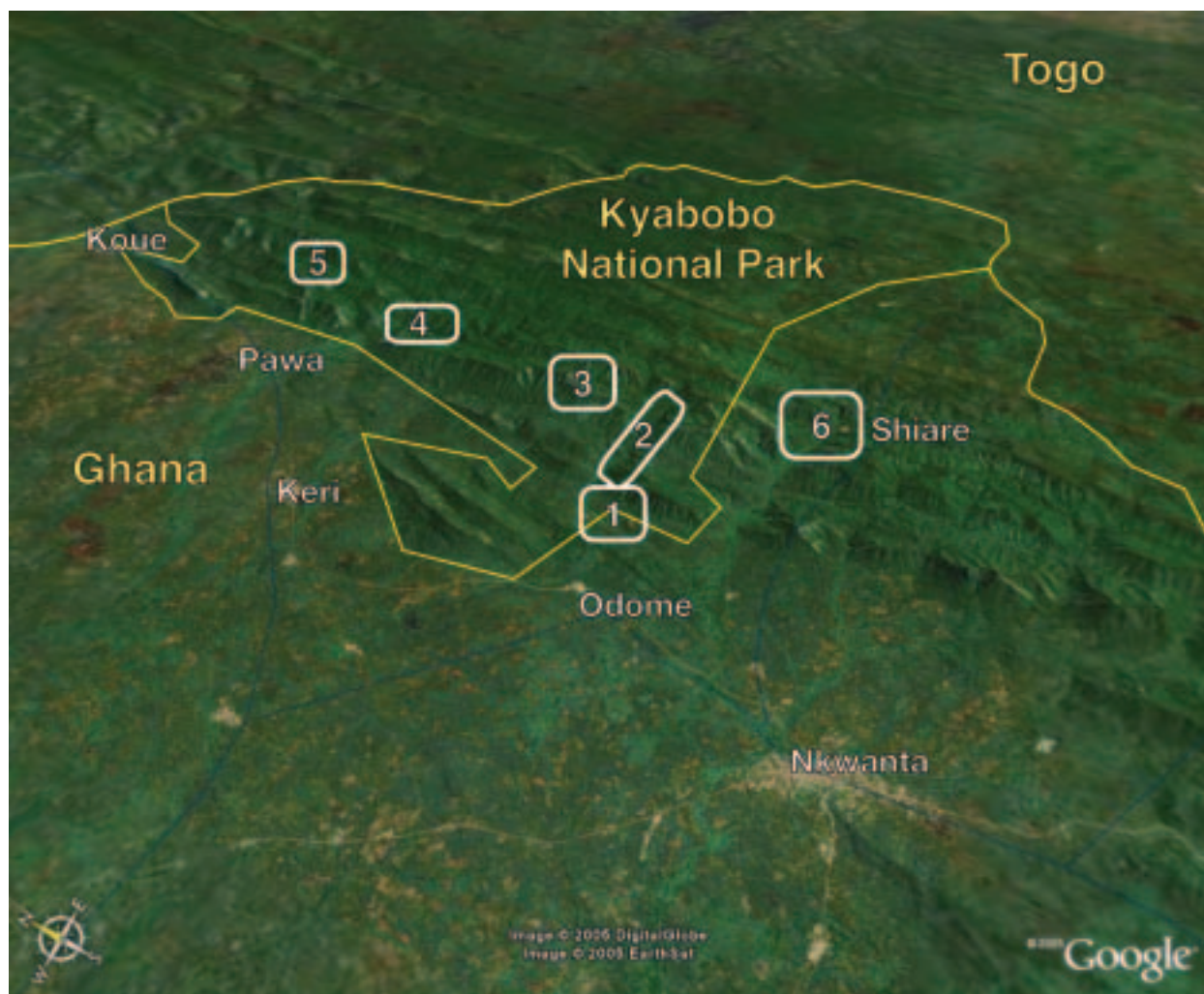
Family	Scientific Name	Common Name	Habitat
<b>Scincidae (cont.)</b>	<i>Trachylepis affinis</i>	Senegal Mabuya	S, FB, F
	<i>Trachylepis buettneri</i>	Buettneri's Long-tailed Mabuya	S, FB
	<i>Trachylepis maculilabris</i>	Speckle-lipped Mabuya	FB, F
	<i>Trachylepis perrotetii</i>	Teita Mabuya	S, FB
	<i>Trachylepis quinquetaeniata</i>	Rainbow Mabuya	S, FB
<b>Varanidae</b>	<i>Varanus exanthematicus</i>	Savannah Monitor	S
	<i>Varanus niloticus</i>	Nile Monitor	S, FB, F
<b>Snakes</b>			
<b>Atractaspididae</b>	<i>Polemon acanthias</i>	Reinhardt's Snake-eater	F
<b>Colubridae</b>	<i>Afronatrix anoscopus</i>	African Brown Water Snake	S, FB, F
	<i>Crotaphopeltis hotamboeia</i>	Herald Snake	S, FB
	<i>Gonionotophis klingi</i>	Matschie's African Ground Snake	F
	<i>Lamprophis lineatus</i>	Striped House Snake	S, FB
	<i>Lycophidion nigromaculatum</i>	Blotched Wolf Snake	F
	<i>Natriciteres variegata</i>	Forest Marsh Snake	FB, F
	<i>Philothamnus heterodermus</i>	Variable Green Snake	FB, F
	<i>Philothamnus semivariatus</i>	Spotted Bush Snake	S, FB
	<i>Psammophis phillipsi</i>	Olive Grass Racer	S, FB
	<i>Psammophis rukwae</i>	Rukwa Sand Racer	S
	<i>Rhamnophis aethiopissa</i>	Large-eyed Green Treesnake	F
<b>Elapidae</b>	<i>Naja melanoleuca</i>	Black Forest Cobra	S, FB, F
<b>Pythonidae</b>	<i>Python regius</i>	Royal Python	S, FB
<b>Typhlopidae</b>	<i>Typhlops punctatus</i>	Spotted Blind Snake	S, FB, F
<b>Viperidae</b>	<i>Causus maculatus</i>	Spotted Night Adder	S, FB, F
<b>Crocodyles</b>			
<b>Crocodylidae</b>	<i>Osteolaemus tetraspis</i>	Dwarf Crocodile	F

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### Methods

We surveyed six general areas located inside or on the periphery of Kyabobo National Park (Plates 1-6) on three occasions spanning a 5-year period, each during the rainy season. These surveys were conducted on an eight-day visit from 15–22 August, 2001, a nine-day visit from 10–18 June, 2004, and a 20-day visit from 23 June–12 July, 2005. Kyabobo is situated on the boundary between woodland and semi-deciduous forest zones and is extremely hilly (peaks reaching 800 m) with vegetational changes occurring over short distances. Apart from the ridge tops, which are almost bare of trees, the park is generally densely wooded or forested. A small amount of farming activity is still taking place in the park, but most farmers have relocated. We sampled from as many distinct microhabitats as possible at each general survey area including streams, rivers, ponds, savannah grassland, savannah woodland, transition woodland, semi-deciduous rain forest, riparian forest, farm bush, and urbanized areas.

Specimens were found by visual encounter surveys (Heyer et al. 1994; Rödel and Ernst 2004) supplemented with acoustic searching for frogs, turning rocks and logs, peeling bark, digging through leaf litter, and excavating burrows and termite mounds. Surveys were conducted during the day and night to detect both diurnal and nocturnal species. We collected voucher specimens for future systematic and genetic studies. We primarily collected specimens by hand, but many fast moving lizards were captured by blowgun using blunt, plastic plugs as ammunition. Snake tongs were used to capture poisonous snakes. Pitfall trap arrays were installed at four locations (Laboum outpost near Odome, South Repeater Station, Middle Control Camp, and the new Wildlife Headquarters outside of Nkwanta) and monitored over a five-day period. Each pitfall array consisted of five-gallon plastic buckets (seven total) dug into the ground flush with the surface, one-foot-tall plastic drift fence connecting the buckets, and six wire-mesh snake traps set adjacent to the drift fence.



**Figure 2.** Satellite image of Kyabobo National Park in the Togo Hills, Volta Region, Ghana. White boxes outline key survey sites, and are numbered according to habitat photograph Plates 1-6. Base map downloaded from Google Earth (Google, Inc.). DOI: 10.1514/journal.arc.0040017g002

Pitfall traps were left open continuously and monitored in the morning and evening.

Digital photographs were taken of representatives of each species and habitats at 5.0 or 6.1 megapixels (Nikon D-70). When possible, calling frogs were recorded using a digital video camcorder (Sony DCR DVD-203) coupled with a directional zoom microphone (Sony ECM-HGZ1). Geographic coordinates for each survey site were determined in the field with a Garmin GPS 72 or a Garmin eTrex receiver. Coordinates were recorded as latitude and longitude in decimal degrees, and referenced to the WGS84 (World Geodetic System of 1984) datum. Voucher specimens and tissue samples are deposited at the Museum of Vertebrate Zoology, University of California, Berkeley, or within the personal collection of Mark-Oliver Rödel. Complete voucher specimen information for most species, including specific locality data and GPS coordinates, is available online at the Museum of Vertebrate Zoology, University of California, Berkeley website (<http://mvz.berkeley.edu/>).

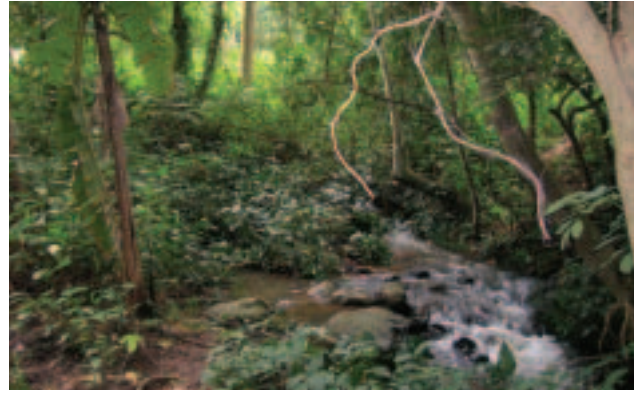
We identified specimens using the following literature: tree frogs (Schjötz 1967, 1999), savannah frogs (Rödel 2000), Ghanaian amphibians (Rödel and Agyei 2003; Rödel et al. 2005), snakes (Hughes and Barry 1969; Chippaux 1999), lizards (Spawls et al. 2002), skinks (Horton 1973; Hoogmoed 1974; Greer et al. 1985; Böhme et al. 2000), geckos (Henle and Böhme 2003), and crocodilians (Spawls et al. 2002).

### Species list

We recorded a total of 65 species in Kyabobo National Park, including 26 frogs, 22 lizards, 16 snakes, and one crocodile (Table 1). Voucher specimens representing 61 of these species were collected. The records for the savannah monitor (*Varanus exanthematicus*), sawtail lizard (*Holaspis guentheri*), Buettneri's long-tailed mabuya (*Trachylepis buettneri*), and dwarf crocodile (*Osteolaemus tetraspis*) are based on observations.



**Plate 1.** DOI: 10.1514/journal.arc.0040017g003



**Plate 2.** DOI: 10.1514/journal.arc.0040017g004



**Plate 3.** DOI: 10.1514/journal.arc.0040017g005



**Plate 4.** DOI: 10.1514/journal.arc.0040017g006



**Plate 5.** DOI: 10.1514/journal.arc.0040017g007



**Plate 6.** DOI: 10.1514/journal.arc.0040017g008



**Plate 7A.** DOI: 10.1514/journal.arc.0040017g009



**Plate 7B.** DOI: 10.1514/journal.arc.0040017g010

**Plate captions:** 1. Savannah and farmbrush habitat at the Labour Outpost entrance to Kyabobo. The western edge of the Togo Hills is shown in the background. 2. Stream (originating from a waterfall) flowing through semi-deciduous forest vegetation at the southern end of Kyabobo. 3. Savannah vegetation at South Repeater Station in Kyabobo, Togo Hills mountain-top at ~800 meters elevation. The Togo Hills are shown in the background extending to the south. 4. Semi-deciduous forest and stream adjacent to Middle Control Camp located on the Western edge of Kyabobo. 5. Overview of the canopy of semi-deciduous forest bordering a stream viewed from Bad-legged Man Camp in Kyabobo. 6. Shiare Village. Photograph by Martin Weinbrenner ([www.eyelustrate.com](http://www.eyelustrate.com)). 7A. West African Screeching Frog *Arthroleptis* cf. *poecilnotus*, amplexant pair, South Repeater Station. 7B. *Arthroleptis* cf. *poecilnotus*, male with elongated third toe, South Repeater Station.



Plate 8A. DOI: 10.1514/journal.arc.0040017g011

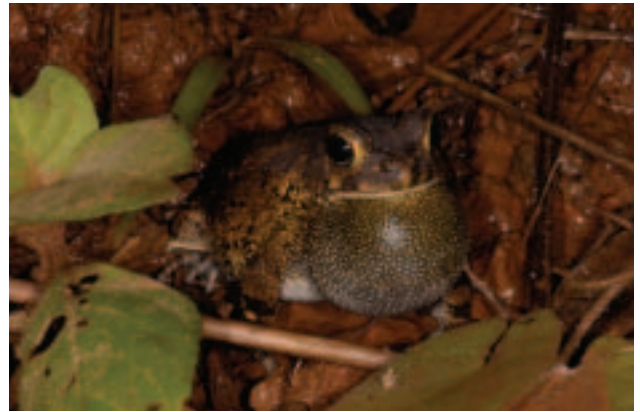


Plate 8B. DOI: 10.1514/journal.arc.0040017g0012



Plate 9. DOI: 10.1514/journal.arc.0040017g013



Plate 10. DOI: 10.1514/journal.arc.0040017g014



Plate 11. DOI: 10.1514/journal.arc.0040017g015

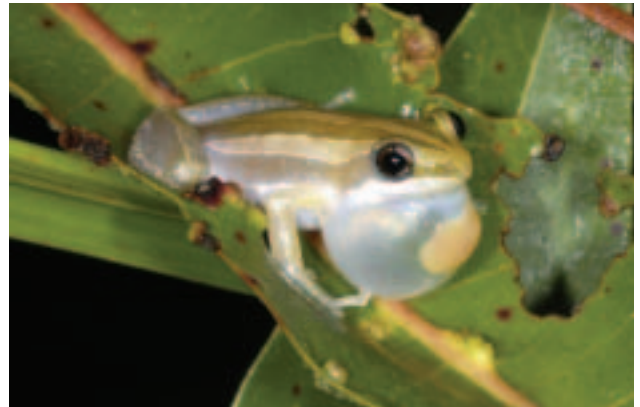


Plate 12. DOI: 10.1514/journal.arc.0040017g016



Plate 13. DOI: 10.1514/journal.arc.0040017g017



Plate 14. DOI: 10.1514/journal.arc.0040017g018

**Plate captions:** 8A. Flat-backed Toad *Bufo maculatus*, South Repeater Station. 8B. *Bufo maculatus*, calling male, Pawa. 9. Square-marked Toad *Bufo regularis*, Accra. 10. Marbled Shovel-nosed Frog *Hemisus* cf. *marmoratus*, Odome. 11. Cameroon Leaf-folding Frog *Afrixalus dorsalis*, Pawa. 12. Savannah Leaf-folding Frog *Afrixalus vittiger*, calling male, Pawa. 13. Weidholz's Leaf-folding Frog *Afrixalus weidholzi*, Pawa. 14. Baumann's Reed Frog *Hyperolius baumanni*, Middle Control Camp.

## Frogs (Anura)

### Arthroleptidae

**West African Screeching Frog *Arthroleptis cf. poecilonotus*** Peters 1863 (Plate 7A and 7B). *Arthroleptis* are the most common leaf litter frogs in the Togo Hills. They inhabit degraded forests and farmbrush habitats. Their taxonomic status is uncertain (Rödel and Agyei 2003). It is clear that they do not belong to *A. brevipes* Ahl, 1923 (compare Rödel et al. 2005). They might be conspecific with either *A. zimmeri* (Ahl 1925) or *A. poecilonotus*, both described from southern Ghana. However, most West African frogs of the genus *Arthroleptis* (and *Schoutedenella*) cannot be distinguished by morphological criteria, although they are clearly distinct taxa based on genetic and acoustic characters that cannot be assigned to available names (Rödel and Bangoura 2004; Rödel et al. 2005). The frogs from the Togo Hills exhibited the variability in dorsal coloration typical for most of their congeners including: brown or reddish brown dorsal coloration with or without a dark hourglass pattern, a vertebral stripe, or pale dorsolateral bands. The exact range of *A. poecilonotus* is uncertain given this taxonomic confusion, but is reported from southern Sudan westward to Guinea (Rödel 2000).

### Bufonidae

**Flat-backed Toad *Bufo maculatus*** Hallowell 1854 (Plate 8A and 8B). This medium-sized toad is brown or red in appearance, with dark blotches on its warty back. Males in breeding condition are uniform yellowish (Rödel 2000). The parotoid glands are large, yet can be indistinct because they are covered with warts, causing their appearance to blend with the skin. *Bufo maculatus* inhabits savannah and degraded forests, but never primary forest. *Bufo maculatus* has a wide distribution, encompassing most of sub-Saharan Africa.

**Square-marked Toad *Bufo regularis*** Reuss 1833 (Plate 9). This is a large, robust toad with prominent, long, and smooth parotoid glands. Its dorsal coloration is typically brown with irregular dark blotches. This toad inhabits savannah and frequently occurs in water-filled ditches around human habitations. Its distribution includes sub-Saharan West and East Africa.

### Hemisotidae

**Marbled Shovel-nosed Frog *Hemisus cf. marmoratus*** (Peters 1854) [Plate 10]. The subterranean *Hemisus* species with their squat bodies and pig-shaped snouts are unmistakable, but are rarely encountered. Two species are known to occur in West Africa including the forest dwelling *H. guineensis* Cope 1865 and the savannah-dwelling *H. marmoratus*. However, the morphological criteria, as defined by Laurent (1972), are not sufficient for species delimitation (M.-O. Rödel et al., unpublished data). Our species assignment should be taken as tentative. *Hemisus marmoratus* is distributed throughout savannah regions south of the Sahara (Rödel 2000).

### Hyperoliidae

**Cameroon Leaf-folding Frog *Afrixalus dorsalis*** (Peters 1875) [Plate 11]. This is a small frog that inhabits degraded forests and farmbrush habitats in the forest zone, and gallery

forests in the savannah zone (Schiøtz 1967; Rödel 2000). Most frogs have two broad yellowish dorsolateral bands and a brownish back. Occasionally, specimens with a pale vertebral band occur. The latter might be confused with the next species that, however, has a much more slender body shape. *Afrixalus dorsalis* is distributed from Sierra Leone to Angola (Schiøtz 1999).

**Savannah Leaf-folding Frog *Afrixalus vittiger*** (Peters 1876) [Plate 12]. Two distinct forms of striped *Afrixalus* occur in West Africa. They seem to occur in different habitats, namely savannah and degraded forests or forest edges. The forest form exhibits a fine black line within the paler longitudinal stripes on the back and is considered *A. fulvovittatus* Cope 1860 by Perret (1976) and Rödel (2000). The savannah species lacks the fine black lines and is considered *A. vittiger* by Perret (1976) and Rödel (2000). Schiøtz (1999) considered these forms *A. fulvovittatus* “type A” and “type B”. *Afrixalus vittiger* (or *A. fulvovittatus* type A) occurs in Kyabobo, and is widely distributed throughout savannah regions of West Africa.

**Weidholz’s Leaf-folding Frog *Afrixalus weidholzi*** (Mertens 1937) [Plate 13]. A tiny savannah frog with a yellow-gold back and often with a black vertebral line and brownish flanks with minute white spots. Males call from higher grasses several meters from open water. Their buzzing advertisement call can easily be mistaken for an insect (Rödel 2000). It ranges from Senegal into Central Africa.

**Baumann’s Reed Frog *Hyperolius baumanni*** Ahl 1931 (Plate 14). This frog is one of the few endemic species of the Togo Hills. It prefers degraded forests and forest edges, where it often occurs in high densities. Males have brownish backs and whitish dorsolateral bands that begin on the snout and terminate at the groin.

**Variable Reed Frog *Hyperolius concolor*** Rapp 1842 (Plate 15A and 15B). This is a very common medium-sized reed frog that inhabits farmbrush and other open forest habitats. Males often have an indistinct hourglass pattern on their brownish backs, whereas females are most often grass-green. The venter of both sexes is white. At night their dorsal color is more or less uniform yellow. *Hyperolius concolor* is distributed from Guinea to Cameroon.

**Lime Reed Frog *Hyperolius fusciventris burtoni*** Schiøtz 1967 (Plate 16). *Hyperolius fusciventris burtoni* was reported to occur from western Ghana to eastern Nigeria (Schiøtz 1967). Recently, this subspecies and *H. f. lamtoensis* have been reported to occur in sympatry in southwestern Ghana (Rödel et al. 2005). In western Ivory Coast the latter occurs in sympatry with the nominate form (Rödel and Ernst 2004). We thus think that all three subspecies would be more appropriately treated as full species. Males from the Togo Hills frequently have pale dorsolateral bands. We recorded green and brown males. Brown specimens always had yellow gular flaps, whereas green males have green ones. Most calling sites are right at the border to open water.

**Long-nosed Reed Frog *Hyperolius nasutus*** Günther 1864 (Plate 17). These small, green reed frogs are common around ephemeral savannah ponds. They might be confused with *H. fusciventris*, but the latter inhabits very different habitats. In comparison, *H. nasutus* has a more slender body shape and a longer, more pointed snout. The taxonomic situation of



Plate 15A. DOI: 10.1514/journal.arc.0040017g019



Plate 15B. DOI: 10.1514/journal.arc.0040017g020



Plate 16. DOI: 10.1514/journal.arc.0040017g021

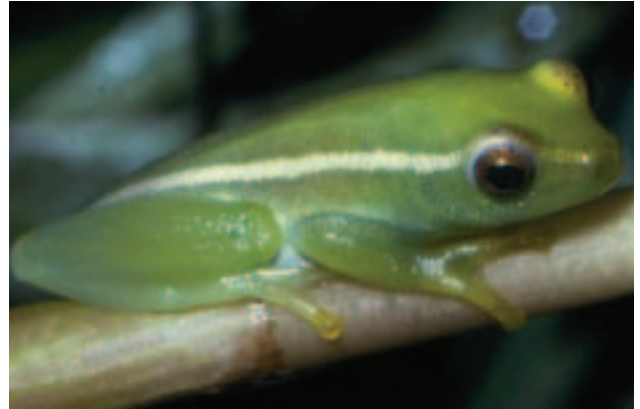


Plate 17. DOI: 10.1514/journal.arc.0040017g022

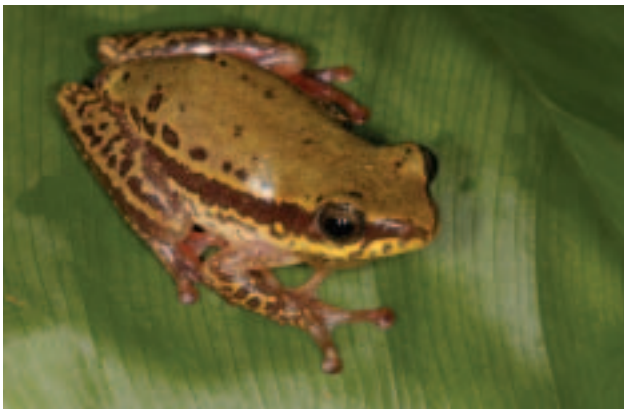


Plate 18. DOI: 10.1514/journal.arc.0040017g023



Plate 19. DOI: 10.1514/journal.arc.0040017g024



Plate 20. DOI: 10.1514/journal.arc.0040017g025



Plate 21A. DOI: 10.1514/journal.arc.0040017g026

**Plate captions:** 15A. Variable Reed Frog *Hyperolius concolor*, male, Pawa. 15B. *Hyperolius concolor*, female, Pawa. 16. Lime Reed Frog *Hyperolius fusciventris burtoni*, calling male, Wli, Volta Region, Ghana. 17. Long-nosed Reed Frog *Hyperolius nasutus*, Comoé, Ivory Coast. 18. West African Reed Frog *Hyperolius nitidulus*, male, Pawa. 19. Ukami Reed Frog *Hyperolius torrentis*, female, forest stream southwest of South Repeater Station. 20. Senegal Running Frog *Kassina senegalensis*, Laboum outpost. 21A. Gbanga Tree Frog *Leptopelis hyloides*, male, Wli, Volta Region, Ghana.

this species group is not resolved (compare Channing et al. 2002; Rödel and Ernst 2003; Amiet 2005; Rödel et al., *in press*). We therefore continue to apply the name *H. nasutus*. *Hyperolius nasutus* is widely distributed south of the Sahara (Rödel 2000).

**West African Reed Frog *Hyperolius nitidulus*** Peters 1875 (Plate 18). *Hyperolius nitidulus* is the most abundant savannah tree frog in West Africa. The brownish frogs are most conspicuous due to their xylophone like sounds of their choruses around all kinds of vegetated, stagnant savannah waters. *Hyperolius nitidulus* is widely distributed in savannah regions from Senegal to Cameroon (Rödel 2000).

**Ukumi Reed Frog *Hyperolius torrentis*** Schiøtz 1967 (Plate 19). *Hyperolius torrentis* is so far believed to be endemic to eastern Ghana and adjacent Togo (Schiøtz 1967; Rödel and Agyei 2003). We have unpublished evidence that this species may range along the Togolese mountains into northern Benin (photo record by T. Moritz). This large reed frog exhibits a variety of color patterns (compare Schiøtz 1967, 1999; Rödel and Agyei 2003). From the similar sized *H. concolor*, it can be best distinguished by its yellowish to greenish venter; from *H. baumanni*, it most conspicuously differs by larger size and the lack of pale dorsolateral bands. *Hyperolius torrentis* seems to occur exclusively on the forested borders of rapidly flowing streams.

**Senegal Running Frog *Kassina senegalensis*** (Duméril and Bibron 1841) [Plate 20]. This is a small to medium-sized frog that typically inhabits savannah in most of sub-Saharan Africa. Its dorsal coloration is a very pale brown, with five longitudinal stripes. The three central stripes are usually uninterrupted, while the two lateral stripes have a fragmented pattern starting from the snout and extending to the vent. The only specimen we found was inside a hole three meters high in a tree trunk during the day. *Kassina senegalensis* is widely distributed throughout sub-Saharan Africa (Schiøtz 1999).

**Gbanga Tree Frog *Leptopelis hyloides*** (Boulenger 1906) [Plate 21A and 21B]. A small (male) to medium-sized (female) forest tree frog that is generally brownish in color with a darker hour-glass pattern on the dorsum. The eyes are prominent and contain red pigmentation, a distinguishing character from the savannah species *Leptopelis viridis*. *Leptopelis hyloides* also has more extensive webbing compared to *L. viridis*. A proper name for this species is lacking, since the type specimen actually represents *L. viridis* (Schiøtz 1999). *Leptopelis hyloides* is distributed throughout the forest belt of West Africa west of the Cross River in Nigeria (Schiøtz 1999).

**Rusty Tree Frog *Leptopelis viridis*** (Günther 1869) [Plate 22]. This fairly large hyperoliid has a compact appearance, with large eyes and a general coloration of light to reddish brown. Darker patches of color form a triangle on the head and continue to form an irregular, and often broken, circle pattern on the back. On each side of its face is a dark mask that starts at the tip of snout and continues to the forelimb. We found individuals at night moving on the ground in savannah habitat, and often heard their “chuck” call from low-lying bushes. This species is abundant throughout West Africa (Schiøtz 1999).

### ***Petropedetidae***

**Accra Puddle Frog *Phrynobatrachus accraensis*** Ahl 1923 (Plate 23). This is a small and extremely common species that occurs in almost all stagnant waters from dry savannah to disturbed rainforest. It is best differentiated from similar puddle frogs by its call and the combination of yellow throats in breeding males, a well-developed webbing, and the lack of an eyelid cornicle. *Phrynobatrachus accraensis* is distributed throughout West Africa.

**Horned Puddle Frog *Phrynobatrachus calcaratus*** (Peters 1863) [Plate 24]. This widespread West and Central African forest frog differs from other puddle frogs in the Togo Hills by the presence of an eyelid cornicle. Furthermore, the vocal sac of males is dark violet to black. The frogs almost completely lack webbing. The dorsum can be uniform brown or bear a reddish longitudinal or transverse band. *Phrynobatrachus calcaratus* is distributed from Senegal to Cameroon.

**Natal Puddle Frog *Phrynobatrachus natalensis*** (Smith 1849) [Plate 25]. This widespread savannah frog probably comprises several cryptic species (Rödel 2000; Crutsinger et al. 2004). They most often inhabit and breed in small puddles almost devoid of vegetation. They differ from the similar *P. accraensis* in having a larger size, more compact body, and black throats on breeding males. *Phrynobatrachus natalensis* is widely distributed throughout Africa south of the Sahara.

**Coast Puddle Frog *Phrynobatrachus plicatus*** (Günther 1859) [Plate 26]. This is a widespread West African forest frog (Lamotte 1966). It differs from all other West African puddle frogs by its large size, exceeding 30 mm snout-vent length, and two very long dorsal ridges that form an “X” pattern. Males have a dark black throat. They most often breed in small ponds in swampy forest or in small puddles on forest roads. This species is distributed from Guinea to Nigeria.

### ***Ranidae***

**White-lipped Frog *Ammirana albolabris*** (Hallowell 1856) [Plate 27]. This is a large, slender frog with enlarged toe discs, noticeably webbed hind feet, and a brown dorsal coloration, often with distinct black spots. The skin appears smooth but is covered with minute spines (Rödel and Bangoura 2004). A white stripe along the upper lip does not extend much past the tympanum, though speckles of white can occur along the sides of the body. We found these frogs near streams and creeks well within forested areas, often clinging to overhanging vegetation and rocks. *Ammirana albolabris* is common in West and Central Africa forests.

**Galam White-lipped Frog *Ammirana galamensis*** (Duméril and Bibron 1841) [Plate 28]. This is a relatively large ranid frog, typically brown to light brown above with striking golden dorsolateral ridges. Both the upper and lower lips are cream-colored; the stripe on the upper lip continues along the side of the body. We found *A. galamensis* in savannah habitat; at night, they were active and moving on land, and during the day we heard vocalization in pools of water. We also found adults underneath piles of bricks and concrete rubbish near ponds. This wide-ranging frog occurs in West, East, and Central Africa.



Plate 21B. DOI: 10.1514/journal.arc.0040017g027



Plate 22. DOI: 10.1514/journal.arc.0040017g028



Plate 23. DOI: 10.1514/journal.arc.0040017g029



Plate 24. DOI: 10.1514/journal.arc.0040017g030



Plate 25. DOI: 10.1514/journal.arc.0040017g031



Plate 26. DOI: 10.1514/journal.arc.0040017g032



Plate 27. DOI: 10.1514/journal.arc.0040017g033



Plate 28. DOI: 10.1514/journal.arc.0040017g034

**Plate captions:** 21B. *Leptopelis hyloides*, female, Middle Control Camp. 22. Rusty Tree Frog *Leptopelis viridis*, male, Pawa. 23. Accra Puddle Frog *Phrynobatrachus accraensis*, gravid female, Middle Control Camp. 24. Horned Puddle Frog *Phrynobatrachus calcaratus*, female, note the eyelid cornicle, South Repeater Station. 25. Natal Puddle Frog *Phrynobatrachus natalensis*, Middle Control Camp. 26. Coast Puddle Frog *Phrynobatrachus plicatus*, Bad-legged Man Camp. 27. White-lipped Frog *Amnirana albolabris*, forest stream south-west of South Repeater Station. 28. Galam White-lipped Frog *Amnirana galamensis*, Accra.

**Togo Slippery Frog *Conraua derooi*** Hulselmans 1972 (Plate 29A and 29B). This large aquatic frog is one of the few amphibian species that is endemic to the Togo Hills. It is only known from the type locality in Bismarckburg (Misahöhe), Togo (Hulselmans 1971), and a few localities in southeastern Ghana (Schiøtz 1967; Rödel and Agyei 2003). This species was not recorded in the Volta region by Rödel and Agyei (2003), and we did not record it in Kyabobo. However, we were informed by people in Shiare village that the frog might live in nearby Togo (large blackish frogs in flowing water with very slimy skin). Very recently, *C. derooi* was rediscovered in the Volta Region, including voice recordings from Amedzofe and Biakpa (A. Hillers et al., *unpublished data*). Hence its potential occurrence in Kyabobo should be further investigated.

**Crowned Bullfrog *Hoplobatrachus occipitalis*** (Günther 1859) [Plate 30]. This large frog is highly aquatic and extremely common. It mainly lives in savannah habitats, but penetrates the forest zone in disturbed areas (Rödel 2000). This species inhabits almost all kinds of waters, ranging from small, sun-heated puddles to cold, fast-flowing streams. We found several individuals in small puddles in residential areas, large ponds, and slow-moving streams. The largest specimen measured was a female (124 mm). They are very shy but easily recognized by their furious flights during which they partly run over water. They are olive-green above with dark mottling, and generally pale below. Their dorsally positioned eyes, warty back (but particularly slimy skin), light interorbital stripe, and full webbing of their hind feet are suitable criteria for determination. At night they can be traced by their reflective red eye-shine. This species is not threatened. However, in some areas it is harvested for human consumption. Its range includes much of Africa south of the Sahara (except southern Africa).

**Broad-banded Grass Frog *Ptychadena bibroni*** (Hallowell 1845) [Plate 31]. A common, medium-sized, West African grass frog that inhabits degraded forests and moist savannahs. A reddish vertebral band is most often present. Pale dorsolateral ridges are absent or fragmented into a few warts.

**Sharp-nosed Grass Frog *Ptychadena oxyrhynchus*** (Smith 1849) [Plate 32]. A large (snout-vent length 40-68 mm) frog with an extremely pointed snout and enormous hind legs. A pale dorsolateral ridge is present and not interrupted. Breeding frogs most often call from small puddles in open surrounding. This frog is widely distributed throughout Africa.

**Medine Grass Frog *Ptychadena pumilio*** (Boulenger 1920) [Plate 33]. A widespread frog that inhabits degraded forests and moist savannahs. It is characterized by its small size, uninterrupted pale dorsal ridges, well-developed webbing and a comparatively compact body shape. *Ptychadena pumilio* is distributed from Senegal to Ethiopia, and south to Zambia (Rödel 2000).

## Lizards (Squamata)

### Agamidae

**Rainbow Lizard *Agama agama*** (Linnaeus 1758) [Plate 34A and 34B]. An extremely common diurnal lizard found in most

types of habitats except for dense primary rain forest and can be found in particularly high abundance around human settlements. Sexual dimorphism in this species is striking. At Kyabobo, adult males are dark blue in coloration with bright orange-red heads and tails, although the color on the tail gradually grades to white and appears as a “rainbow.” Adult females are drab grey or brown with distinctive paired orange markings on the back. *Agama agama* are widely distributed in Africa from Senegal to Egypt and south to Tanzania (Spawls et al. 2002).

**Senegal Agama *Agama sankaranica*** Mocquard 1905 (Plate 35). A common diurnal lizard found in savannah habitats. It is strictly terrestrial and often spotted darting between clumps of vegetation. Both sexes are brown with a thin yellow vertebral line extending from the neck to the base of the tail. Some specimens have iridescent blue scales on the sides of their face and around their ear openings. The local name for *A. sankaranica* is the “bush agama.” *Agama sankaranica* is distributed across West Africa from Senegal to Cameroon.

### Chamaeleonidae

**Senegal Chameleon *Chamaeleo senegalensis*** Daudin 1802 (Plate 36). A large green arboreal chameleon with a slightly raised casque at the back of the head and a prehensile tail. Found in moist savannah habitats. They are active during the day and can be found on the ground crossing roads, although they are more easily found at night in bushes and small trees where the reflection of their bodies contrasts with the surrounding vegetation. Possibly threatened by bush fires and collecting for local medicinal use. *Chamaeleo senegalensis* is distributed from Senegal to Cameroon.

### Eublepharidae

**Fat-tail Gecko *Hemitheconyx caudicinctus*** (Duméril 1851) [Plate 37]. A medium-sized terrestrial gecko that can be distinguished from other geckos by the presence of eyelids and the lack of toe-pads. Laterally banded with yellow and black with white bands on the tail. A savannah species distributed throughout West Africa.

### Gekkonidae

**Brooke’s House Gecko *Hemidactylus brookii*** Gray 1845 (Plate 38). A common nocturnal gecko that is abundant around anthropogenic habitats. Usually found on building surfaces near cracks or in rafters. Resembles *H. mabouia*, but is distinguishable by a shorter snout and the inability to make a defensive “squeak” sound (Gramentz 2000). It has dorsal tubercles that continue down the tail, but regenerated tails lack tubercles. *Hemidactylus brookii* has a broad distribution throughout West and Central Africa.

**Banded Leaf-toed Gecko *Hemidactylus fasciatus*** Gray 1842 (Plate 39A and 39B). A medium-bodied nocturnal forest gecko. Juveniles have distinct lateral black bands with yellow borders and a banded white tail. As adults, the black and white bands fade and the yellow bands remain resulting in a uniform dark purple body with thin yellow bands. Commonly found near streams on large rocks and fallen logs, but can also be found on mountaintops away from water. In other areas they



Plate 29A. DOI: 10.1514/journal.arc.0040017g035



Plate 29B. DOI: 10.1514/journal.arc.0040017g036



Plate 30. DOI: 10.1514/journal.arc.0040017g037



Plate 31. DOI: 10.1514/journal.arc.0040017g038



Plate 32. DOI: 10.1514/journal.arc.0040017g039



Plate 33. DOI: 10.1514/journal.arc.0040017g040



Plate 34A. DOI: 10.1514/journal.arc.0040017g041



Plate 34B. DOI: 10.1514/journal.arc.0040017g042

**Plate captions:** 29A. Togo Slippery Frog *Conraua derooi*, Biakpa, Volta Region, Ghana. 29B. *Conraua derooi*, Biakpa, Volta Region, Ghana. 30. Crowned Bullfrog *Hoplobatrachus occipitalis*, Koue River. 31. Broad-banded Grass Frog *Ptychadena bibroni*, Mole N.P., Ghana. 32. Sharp-nosed Grass Frog *Ptychadena oxyrhynchus*, Comoé, Ivory Coast. 33. Medine Grass Frog *Ptychadena pumilio*, Comoé, Ivory Coast. 34A. Rainbow Lizard *Agama agama*, male, Nkwanta. 34B. *Agama agama*, female, South Repeater Station.

are common on large forest trees and even in houses within forests (M.-O. Rödel, *unpublished data*). A forest species distributed throughout West Africa.

**House Gecko *Hemidactylus mabouia*** (Moreau De Jonnés 1818) [Plate 40]. Often referred to as the tropical house gecko. *Hemidactylus mabouia* is commonly seen feeding near light sources and is capable of producing a “squeak” sound used for defense (Gramentz 2000). Similar in appearance and behavior to *H. brookii*, but has a longer snout-to-eye distance. This species is distributed throughout Africa, Madagascar, and the Seychelles, and is also found in South and North America (Spawls et al. 2002).

**Guinea Leaf-toed Gecko *Hemidactylus muriceus*** Peters 1870 (Plate 41). A small forest gecko that prefers terrestrial habitat. Commonly found in leaf debris and under logs. Partially diurnal and forages in fine vegetation (Branch and Rödel 2003). The dorsal surface is highly tuberculate. Its small body size distinguishes it from *H. mabouia* and *H. brookii*. Henle and Böhme (2003) provide characters for identifying *H. muriceus* from species with which it is often confused. *Hemidactylus muriceus* is distributed throughout West and Central Africa.

**Uganda Dwarf Gecko *Lygodactylus gutturalis*** (Bocage 1873) [Plate 42]. A very small gecko (maximum size up to 9 cm) lacking a claw on the thumb. Mostly diurnal and prefers arboreal habitats. Their cryptic coloration and small size make them difficult to detect on trees. This species is distributed throughout West and Central Africa.

**Gerrhosauridae**

**Rough-scaled Plated Lizard *Gerrhosaurus major*** Duméril 1851 (Plate 43). A large lizard with prominently keeled and armor-like scales. The dorsal surface is laterally striped yellow and black, whereas the flanks are red and the ventral surface is cream-colored. The limbs and tail are very powerful. Can be seen basking on termite mounds in which they commonly live. This species has been split into an eastern and western subspecies, *G. m. major*, Duméril, 1851, and *G. m. bottegoi*, Del Prato, 1895, respectively. *Gerrhosaurus major* is widely distributed throughout Africa south of the Sahara.

**Scincidae**

**Keeled Water Skink *Cophoscincopus cf. simulans*** (Vaillant 1884) [Plate 44]. A small, secretive skink that is the only semi-aquatic skink in the region. Dark brown and black in color with a keeled back and tail. Occurs in muddy seeps of water near streams. Based on their intermediate morphology, it is unclear whether the specimens at Kyabobo represent *C. simulans* or the recently described *C. greeri* (Böhme et al. 2000). *Cophoscincopus simulans* is distributed from Sierra Leone to the Togo Hills.

**Short-tailed Writhing Skink *Lygosoma brevicaudis*** Greer et al. 1985 (Plate 45). A medium-sized skink with reduced limbs and a thick, chunky appearance, and an especially truncated tail with a tapering end. A savannah species that inhabits seasonally variable and xeric habitat (Greer et al. 1985). Our record of *Lygosoma brevicaudis* in Kyabobo represents a northeastern range extension of ~330 kilometers

based on specimen distributions presented in Greer et al. (1985). Formerly known from central Ivory Coast to western and southern Ghana.

**Guinea Writhing Skink *Lygosoma guineensis*** (Peters 1879) [Plate 46]. A medium-sized leaf litter skink with reduced limbs and a cylindrical body. Easily distinguished from *L. brevicaudis* by the presence of a longer, narrower tail. Greer et al. (1985) note that *L. guineensis* is primarily a forest species that is capable of penetrating more open savannah under certain mesic conditions. Distributed throughout West and Central Africa.

**Togo Lidless Skink *Panaspis togoensis*** (Werner 1902) [Plate 47]. A small, slim, leaf-litter skink with well developed limbs. This species has a moveable lower eyelid with a transparent disk. The color is a dull grey-brown above that changes to a rusty red color at the hind limbs and tail. Taxonomic changes based on morphological and ecological similarities initiated by Broadley (1989) and followed by Haft (1993) placed many West African species of lidless skinks into the genus *Leptosiphos*, including *P. togoensis*. A recent molecular phylogenetic analysis by Schmitz et al. (2005) based on specimens from Cameroon clarifies the evolutionary relationships of these groups and recommends the use of *P. togoensis*. *Panaspis togoensis* is distributed across West and Central Africa.

**Senegal Mabuya *Trachylepis affinis*** (Gray 1838) [Plate 48]. A medium-sized skink with a moderately long tail and fully developed limbs. Adults have a brown back with dark-brown spots arranged in two pairs of longitudinal rows, and males have an immaculate white throat. The sides of the head and neck can have a dull red color. This species may have a white stripe extending from the upper lip to the groin, but we did not see this condition in any specimens at Kyabobo. They are found in a variety of forested and open savannah habitats. The taxonomic status of *T. blandingii*, *T. raddonii*, and *T. affinis* is unclear (Hoogmoed 1974), and a rigorous phylogenetic study including all West African *Trachylepis* is needed. *Trachylepis affinis* is distributed across West and Central Africa.

**Buettneri’s Long-tailed Mabuya *Trachylepis buettneri*** (Matschie 1893) [Plate 49]. A medium-sized lizard with a long, slender body and limbs. The tail can reach up to four times the length of the body. Found in small bushes, rocks and vegetation in savannah habitat. Distributed from Ivory Coast to Cameroon.

**Speckle-lipped Mabuya *Trachylepis maculilabris*** (Gray 1845) [Plate 50]. A medium-sized, heavy built skink with well-developed limbs and a long tail. Dorsal scales of adults have five to seven keels. Adults are brown with dark brown to black flanks with a white stripe extending from under the eye to the forelimbs. The throat is yellow. Diurnal and found in forested areas or around human settlements. *Trachylepis maculilabris* occurs throughout Africa south of the Sahara.

**Teita Mabuya *Trachylepis perrotetii*** (Duméril and Bibron 1839) [Plate 51]. A large, heavy skink with short, thick limbs and a long tail. The color is olive-brown above, and adults generally have red flanks. Commonly found in savannah areas in grass or basking on low branches and tree trunks. They usually run up trees when chased, but have also been



Plate 35. DOI: 10.1514/journal.arc.0040017g043



Plate 36. DOI: 10.1514/journal.arc.0040017g044



Plate 37. DOI: 10.1514/journal.arc.0040017g045



Plate 38. DOI: 10.1514/journal.arc.0040017g046



Plate 39A. DOI: 10.1514/journal.arc.0040017g047



Plate 39B. DOI: 10.1514/journal.arc.0040017g048



Plate 40. DOI: 10.1514/journal.arc.0040017g049



Plate 41. DOI: 10.1514/journal.arc.0040017g050

**Plate captions:** 35. Senegal Agama *Agama sankaranica*, Odome. 36. Senegal Chameleon *Chamaeleo senegalensis*, female, Hoehoe. 37. Fat-tail Gecko *Hemitheconyx caudicinctus*, Laboum Outpost. 38. Brooke's House Gecko *Hemidactylus brookii*, South Repeater Station. 39A. Banded Leaf-toed Gecko *Hemidactylus fasciatus*, gravid female, South Repeater Station. 39B. *Hemidactylus fasciatus*, juvenile, Middle Control Camp. 40. House Gecko *Hemidactylus mabouia*, Laboum Outpost. 41. Guinea Leaf-toed Gecko *Hemidactylus muriceus*, South Repeater Station.

observed to escape into water (Rödel et al. 1997). Distributed throughout West and Central Africa.

**Rainbow Mabuya** *Trachylepis quinquetaeniata* (Lichtenstein 1823) [Plate 52]. A medium-sized skink with well-developed limbs and long tail. Juveniles and females have a black dorsum with five white lines extending from behind the head to base of the tail. The tail is bright blue. Adult males lose this color pattern and become brown and acquire a black-blue throat. They are common in savannah habitats and abundant around human settlements, but not found in forested areas (Hoogmoed 1974). *Trachylepis quinquetaeniata* is distributed throughout Africa.

### Lacertidae

**Sawtail Lizard** *Holaspis guentheri* Gray 1863. A small arboreal lacertid with a long head and pointed snout. The body and tail are extremely flattened to aid in gliding between trees in the forest (Spawls et al. 2002). The dorsum is black with cream stripes down the sides that fade into a blue tail with black crossbars. We encountered one specimen in Kyabobo that was first spotted on the trunk of a large tree near a stream before it retreated into the forest canopy. *Holaspis guentheri* is widely distributed throughout West and Central Africa (Spawls et al. 2002).

### Varanidae

**Savannah Monitor** *Varanus exanthematicus* (Bosc 1792) [Plate 53]. This large monitor lizard has a broad head with prominent ocular ridges. *Varanus exanthematicus* prefers savannah habitat and can be spotted in agricultural areas around Kyabobo. Active diurnally, mostly terrestrial but can be found under rocks, in termite mounds, and in trees where it rests. We observed one specimen basking on a termite mound near Laboum Outpost. This species is CITES appendix II protected due to its popularity in the pet and skin trade (de Buffrénil 1993). Distributed from Senegal to western Ethiopia (Bayless 2002).

**Nile Monitor** *Varanus niloticus* (Linnaeus 1758) [Plate 54]. A large black monitor with 6–11 yellow crossbars or ocelli on the body (Dunger 1967; Spawls et al. 2002). The tail is laterally compressed with a prominent vertebral ridge. Commonly found at night sleeping on vegetation overhanging streams or pools. Active diurnally, they are very quick and wary. This species is CITES appendix II protected due to its popularity in the pet and skin trade (de Buffrénil 1993). A study by Bayless and Luiselli (2000) shows microhabitat differences between *V. niloticus* and *V. ornatus* in Nigeria, with the latter being primarily a forest species. *Varanus niloticus* is broadly distributed throughout Africa from Egypt to South Africa, and West to Senegal (Bayless 2002).

### Snakes (Squamata)

#### Atractaspididae

**Reinhardt's Snake-eater** *Polemon acanthias* (Reinhardt 1860) [Plate 55]. A rare nocturnal burrowing snake with smooth scales and a short, sharp tail. *Polemon acanthias* has

grooved rear fangs and is ophiophagous, but probably not dangerous to humans. Many aspects of their natural history remain unknown due to their secretive habits. Lives in forest habitats close to water. Conservation status is uncertain, but is possibly vulnerable due to forest destruction. This snake is distributed from Guinea to Nigeria (Chippaux 1999).

#### Colubridae

**African Brown Water Snake** *Afonatrix anoscopus* (Cope 1861) [Plate 56]. A medium-sized snake with an overall olive coloration with yellow ventral coloration. Round and robust in appearance, *A. anoscopus* is an aquatic snake found along streams where it hunts for small vertebrate prey, mainly frogs. Individuals can be found resting under rocks in the stream or basking along the bank in forest and savannah habitat wherever water is available. When captured, individuals do not hesitate to strike and release musk from their cloaca. This snake is distributed from Senegal to Cameroon (Chippaux 1999).

**Herald Snake** *Crotaphopeltis hotamboeia* (Laurenti 1768) [Plate 57]. A small dark-colored snake, usually black, grey or olive-green with rear fangs. Transverse rows of small white spots are present dorsally. Scales on this species transition from smooth to keeled posteriorly. Commonly active at night, we observed this species feeding on small frogs of the genus *Phrynobatrachus* (in the lab, frogs became incapacitated after being bitten by this snake). Individuals were found in savannah habitat near bodies of water. Defensive displays for this snake include an intricate combination of flattening the head into a triangular form (viper-shaped) followed by hissing and striking (Spawls et al. 2002). This snake is distributed broadly throughout Africa south of the Sahara (Spawls et al. 2002).

**Matschie's African Ground Snake** *Gonionotophis klingi* Matschie 1893 (Plate 58). *Gonionotophis klingi* is small, dark, and subtriangular in cross section with a prominent longitudinal row of dorsal vertebral scales. Body scales are keeled with ventral scales lighter in coloration than dorsal scales. Members of the genus *Gonionotophis* differ from the very similar and closely related genus *Mehelya* through the presence of a continuous row of maxillary teeth (Loveridge 1939). These snakes are slow-moving and nocturnal. Their diet consists mostly of terrestrial amphibians. Possibly threatened due to destruction of forest habitat. This snake is distributed from Guinea to Nigeria (Chippaux 1999).

**Striped House Snake** *Lamprophis lineatus* (Duméril et al. 1854) [Plate 59]. A medium-sized snake with smooth scales, a triangular-shaped head and relatively large eyes with vertical pupils. They are nocturnal and feed primarily on lizards and frogs, but occasionally eat small mammals (Chippaux 1999). *Lamprophis lineatus* is distributed throughout West and Central Africa.

**Blotched Wolf Snake** *Lycophidion nigromaculatum* (Peters 1863) [Plate 60]. A small terrestrial forest snake with a distinct broad head and vertical pupils. The body is sub-triangular in cross section. Individuals are orange dorsally with black diamond-shaped markings staggered down their back. The venter is dark grey. The head and "neck" region are

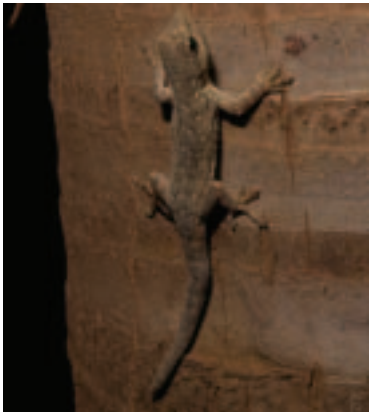


Plate 42. DOI: 10.1514/journal.arc.0040017g051



Plate 43. DOI: 10.1514/journal.arc.0040017g052



Plate 44. DOI: 10.1514/journal.arc.0040017g053



Plate 45. DOI: 10.1514/journal.arc.0040017g054



Plate 46. DOI: 10.1514/journal.arc.0040017g055



Plate 47. DOI: 10.1514/journal.arc.0040017g056



Plate 48. DOI: 10.1514/journal.arc.0040017g057



Plate 49. DOI: 10.1514/journal.arc.0040017g058

**Plate captions:** 42. Uganda Dwarf Gecko *Lygodactylus gutturalis*, Nkwanta. 43. Rough-scaled Plated Lizard *Gerrhosaurus major*, Mole N. P., Ghana. 44. Keeled Water Skink *Cophoscincopus* cf. *simulans*, Waterfall east of Laboum Outpost. 45. Short-tailed Writhing Skink *Lygosoma brevicaudis*, South Repeater Station. 46. Guinea Writhing Skink *Lygosoma guineensis*, Middle Control Camp. 47. Togo Lidless Skink *Panaspis togoensis*, Comoé, Ivory Coast. 48. Senegal Mabuya *Trachylepis affinis*, Tai, Ivory Coast. 49. Buettneri's Long-tailed Mabuya *Trachylepis buettneri*, Comoé N. P., Ivory Coast.

retracted backward onto the body to form an S-shape, which they maintain when striking at a predator. Leston and Hughes (1968) revived this species from synonymy with *L. irroratum*. *Lycophidion nigromaculatum* is distributed from Guinea to Ghana (Chippaux 1999).

**Forest Marsh Snake *Natriciteres variegata*** (Peters 1861) [Plate 61]. A harmless snake with a small head, round pupils, and relatively short tail. Semi-aquatic and eats frogs. We found one juvenile specimen (116 mm snout-vent length; 1.1 g) under leaf litter in the forest. The range spans from Guinea to Cameroon (Hughes and Barry 1969).

**Variable Green Snake *Philothamnus heterodermus*** (Hallowell 1857) [Plate 62]. A green arboreal snake with large, round pupils and a slightly upturned lip. Scales are smooth with 15 midbody scale rows and a relatively long tail (approximately 25% total length). Body scales have a concealed white spot. According to Hughes and Barry (1969), *P. heterodermus* can be distinguished from congeners by the presence of an entire anal plate along with 2+ temporal scales. This is a slender and fast species with both green and brown phases. Spawls et al. (2002) mention a Ghanaian survey of this species where brown individuals spent more time on the ground while green individuals spent more time on trees during the dry season. This is a diurnal snake whose main food consists of frogs. Distribution ranges from Guinea to Uganda and Angola.

**Spotted Bush Snake *Philothamnus semivariatus*** (Smith 1847) [Plate 63]. A large, slender snake with black dorsal crossbars. The appearance of an eyebrow is given by the presence of its raised supraocular scale. Body is cylindrical with a long tail, ranging from 25–35% of total body length. Scales are smooth with 15 midbody scale rows. Hughes and Barry (1969) diagnose this species from its congeners by the presence of 183–199 ventral scales with 1+ temporal scales. Ventral scales are yellowish or bright green. Ventral scales are also strongly keeled. This is a diurnal snake that is very agile in trees, bushes and shrubs. According to Spawls et al. (2002), the diet of this snake consists mainly of lizards. This snake is widely distributed throughout Africa south of the Sahara.

**Olive Grass Racer *Psammophis phillipsi*** (Hallowell 1844) [Plate 64]. A large, fast diurnal snake that feeds primarily on lizards. Found in savannah habitats and around villages and agricultural areas. This species, as well as others belonging to the genus, have the ability to “break off” their tail when in danger as an escape mechanism (without regeneration). *Psammophis phillipsi* has been considered by many to be a complex of species due to its wide range throughout Africa and seemingly diagnosable characters for groups within.

**Rukwa Sand Racer *Psammophis rukwae*** Broadley 1966 (Plate 65). A fast-moving, rear-fanged diurnal snake that is both terrestrial and arboreal. It is slender with a long tail. Scales are smooth with 17 midbody scale rows and 148 to 183 ventrals. Anal plate is divided. This species is diagnosed from its congeners by its very fine black ventral lines and by having the first five lower labials usually in contact with the anterior sublinguals (Spawls et al. 2002). This species is mainly a savannah inhabitant and distributed from Senegal to Tanzania.

**Large-eyed Green Treesnake *Rhamnophis aethiopissa*** Günther 1862 (Plate 66). A slender arboreal snake with a relatively short snout and large prominent eyes with round pupils and a golden iris. The lip curves upward posteriorly, giving the snake the impression of smirking. Each scale has a black border, which gives the snake a striped or checkered appearance. This snake reaches a length of over one meter, and the tail is approximately 33% of the total length. This species inhabits primary forest. When in defensive posture, this snake laterally compresses its neck, hisses, and strikes. It is suspected to be primarily a frog eater. Distributed throughout West and Central Africa (Chippaux 1999).

### **Elapidae**

**Black Forest Cobra *Naja melanoleuca*** Hallowell 1857 (Plate 67). A large, thick-bodied cobra reaching 2.5 m with a large head and yellow throat with black crossbars. The chin and ventral parts of the belly are cream and/or white. In Ghana it is found in well-forested habitat. This snake is agile and active day and night. It can be found hiding among piles of brush, rocks, hollow logs, and holes. A very deadly snake, which can be aggressive when approached. It eats a wide variety of vertebrates, from frogs to monitor lizards and mammals. Possibly threatened due to intense pressure from humans who view the cobra as a threat and go out of their way to kill them. This snake is widely distributed across the afrotropics (Spawls et al. 2002).

### **Pythonidae**

**Royal Python *Python regius*** (Shaw 1802) [Plate 68]. A very muscular snake that is relatively small (reaching just over one meter) with an elongate snout that is broader at the jaws. The iris is yellow with vertical pupils and has black with golden-yellow marbling dorsally. The tail is short, and males possess spurs lateral to the cloacal opening. It is a slow-moving snake that is active at night when it comes out to hunt for small warm-blooded prey, which it sees with its heat-sensing infrared pits that line its upper lip. This species is mainly found in dry grassland habitat or moist savannahs. It is distributed throughout West and Central Africa and is commonly exported for the pet trade (Spawls et al. 2002).

### **Typhlopidae**

**Spotted Blind Snake *Typhlops punctatus*** (Leach 1819) [Plate 69]. A small and secretive fossorial snake. Its natural history still remains elusive, except for the fact that they are one of the largest typhlopids, reaching up to 66 cm total length. It has an obvious eye under the ocular scale and has 30 to 32 midbody scale rows with 374–465 scales in a mid-dorsal longitudinal series (Spawls et al. 2002). The coloration is dark brown to grey dorsally with a yellow spot on the posterior margin of each scale. Mainly fossorial, but can be found at night when they are active on the surface. Although primarily considered a lowland savannah inhabitant, we found specimens on mountain tops (~800 m) predominated by savannah vegetation. Presumed to feed on termites like other members



Plate 50. DOI: 10.1514/journal.arc.0040017g059



Plate 51. DOI: 10.1514/journal.arc.0040017g060



Plate 52. DOI: 10.1514/journal.arc.0040017g061



Plate 53. DOI: 10.1514/journal.arc.0040017g062



Plate 54. DOI: 10.1514/journal.arc.0040017g063



Plate 55. DOI: 10.1514/journal.arc.0040017g064



Plate 56. DOI: 10.1514/journal.arc.0040017g065



Plate 57. DOI: 10.1514/journal.arc.0040017g066

**Plate captions:** 50. Speckle-lipped Mabuya *Trachylepis maculilabris*, South Repeater Station. 51. Teita Mabuya *Trachylepis perrotetii*, Mole N. P., Ghana. 52. Rainbow Mabuya *Trachylepis quinquetaeniata*, South Repeater Station. 53. Savannah Monitor *Varanus exanthematicus*, Mole N.P., Ghana. 54. Nile Monitor *Varanus niloticus*, Laboum Outpost. 55. Reinhardt's Snake-eater *Polemon acanthias*, forest stream near Laboum Outpost. 56. African Brown Water Snake *Afronatrix anoscopus*, Laboum Outpost. 57. Herald Snake *Crotaphopeltis hotamboeia*, Comoé, Ivory Coast.

of its family. For a summary of the taxonomic discussion of the *T. punctatus* complex see Branch and Rödel (2003). This snake is distributed throughout West and Central Africa.

### Viperidae

**Spotted Night Adder *Causus maculatus*** (Hallowell 1842) [Plate 70]. A stout, thick-bodied viper with a short tail, round pupils, and a rounded snout. Predominantly found in savannah habitat, but it can also be found in forests. Its dorsal coloration is light brown, dark tan or light olive with dark, diamond-shaped vertebral markings. A V-shape is present on the top of the head with the apex oriented anteriorly. The head is slightly differentiated from the girth of the body, not a distinctive triangular head like most vipers. Nine large scales are present on the top of the head, unlike most vipers (Spawls et al. 2002). Scales are lightly keeled. Belly is white or cream in coloration. Locomotion is very slow, and it is active at various times of the day and night. It inhabits many human disturbed areas and is responsible for many snake bites of humans. Distributed throughout West Africa to Angola (Chippaux 1999).

### Crocodyles (Archosauria)

**Dwarf Crocodile *Osteolaemus tetraspis*** Cope 1861 (Plate 71). Combined with its small size, robust appearance, and broad snout, *Osteolaemus tetraspis* is easily distinguishable from other crocodylians. It inhabits small rivers, and we observed one individual in a remote forest stream in Kyabobo. This is the first report of this CITES appendix I species for Kyabobo National Park. This species is widespread in the forests of West and Central Africa (Spawls et al. 2002).

### Results and discussion

With a total of 65 reptile and amphibian species, Kyabobo National Park is one of the most diverse sites surveyed in Ghana. Raxworthy and Attuquayefio (2000) surveyed the herpetofaunal community at Muni Lagoon in the Volta Region of Ghana during the peak of the rainy season and found up to 26 species at a site. Leaché (2005) surveyed three sites located in the Northern, Brong-Ahafo, and Greater Accra Regions of Ghana during the dry season and found up to 30 species at a site. While surveys that focused specifically on amphibian diversity in southwestern Ghana documented up to 47 species, they were not restricted to a single site, but rather encompassed a broad geographic area (Rödel and Agyei 2003; Rödel et al. 2005). All of these studies predicted higher species abundance at their sites based on non-asymptotic species accumulation curves and/or comparisons to historical data. Additional species, especially snakes, certainly inhabit Kyabobo National Park. Their absence from our survey does not necessarily indicate that they are not present, but rather that they are secretive and/or difficult to find. Long-term herpetological surveys in the neotropics indicate that a great deal of effort is necessary to detect every species at a site (Duellman 2005; Myers and Rand 1969). In addition, we only surveyed during the rainy season, and seasonality has some effect on the abundance of

different species of reptiles and amphibians in Ghana (Hughes 1988). Thus, continued survey work in Kyabobo National Park is warranted.

A recent biodiversity survey of amphibians of the entire Volta Region recorded 31 amphibian species, including 20 species from the area including Kyabobo National Park (Rödel and Agyei 2003). We found 26 frogs at Kyabobo. Of the six new records, five are a subset of the 31 recorded throughout the entire Volta Region (*Hemisus* sp., *Phrynobatrachus plicatus*, *Hyperolius baumanni*, *H. fusciventris*, and *Afrixalus dorsalis*), and one (*Afrixalus weidholzi*) is a new record for the Togo Hills. The amphibians absent from our surveys in the Togo Hills include some that are adapted to fast-running water or large closed forests, like *Conraua derooi* and *Bufo togoensis*. Recently, *C. derooi* was discovered in the Togo Hills (A. Hillers et al., unpublished data). In addition, we have unconfirmed reports from people in Shiare village that a frog fitting the description of *C. derooi* might live in nearby Togo. Hence, the presence of suitable habitat in Kyabobo makes the detection of these highly threatened species possible.

We recorded 39 species of reptiles in our survey (22 lizards, 16 snakes, and one crocodile). Unfortunately, a lack of historical data on the diversity of reptiles in the Togo Hills, and no records from Kyabobo National Park, make area comparisons difficult. Some of the reptile species we found at Kyabobo were not surprising, given their occurrence in a broad variety of habitats and wide distribution throughout West Africa. However, we did detect nine forest-restricted reptiles in Kyabobo known primarily from other West African forest blocks (Table 1). In general, we can assume that many of our records are new for the area and therefore represent range extensions. For instance, our observation of the dwarf crocodile (*Osteolaemus tetraspis*) is the first report of this CITES appendix I species for Kyabobo National Park, and our record of *Lygosoma brevicaudis* in Kyabobo represents a range extension of ~330 kilometers based on specimen distributions presented in Greer et al. (1985).

Most reptiles and amphibians in Kyabobo National Park that are connected to forest habitats should be considered threatened. While many reptiles and amphibians thrive in human-disturbed areas, others are restricted to specific micro-habitat types and do not persist in the face of habitat destruction. Given this setting, preserving sensitive habitats is the most effective method of conserving reptiles and amphibians. In particular, the forest habitats in Kyabobo, and specifically the forests bordering the streams and rivers, should be considered sensitive areas. Some frogs appear to inhabit and breed exclusively in these areas (e.g., *Hyperolius torrentis*, *Phrynobatrachus plicatus*, *Amnirana albolabris*, and *Leptopelis hylodes*). We can assume that these species once had widespread distributions throughout the Togo-Volta highlands, but habitat modification has all but eliminated them from most areas. Successful conservation of these species equates to protecting their forest stream habitats. Any destruction to this habitat type, such as clearing of forest or increasing sedimentation in the water, could have damaging effects on the herpetofauna, especially to the breeding amphibian populations. Thus, focusing attention on this specific habitat type could benefit multiple species simultaneously.



Plate 58. DOI: 10.1514/journal.arc.0040017g067



Plate 59. DOI: 10.1514/journal.arc.0040017g068



Plate 60. DOI: 10.1514/journal.arc.0040017g069



Plate 61. DOI: 10.1514/journal.arc.0040017g070



Plate 62. DOI: 10.1514/journal.arc.0040017g071



Plate 63. DOI: 10.1514/journal.arc.0040017g072



Plate 64. DOI: 10.1514/journal.arc.0040017g073



Plate 65. DOI: 10.1514/journal.arc.0040017g074

**Plate captions:** 58. Matschie's African Ground Snake *Gonionotophis klingi*, forest habitat northeast of South Repeater Station. 59. Striped House Snake *Lamprophis lineatus*, Comoé, Ivory Coast. 60. Blotched Wolf Snake *Lycophidion nigromaculatum*, Middle Control Camp. 61. Forest Marsh Snake *Natriciteres variegata*, forest stream near Laboum Outpost. 62. Variable Green Snake *Philothamnus heterodermus*, Tai, Ivory Coast. 63. Spotted Bush Snake *Philothamnus semivariiegatus*, near Laboum Outpost. 64. Olive Grass Racer *Psammophis phillipsi*, male, Nkwanta. 65. Rukwa Sand Racer *Psammophis rukwae*, Nkwanta.



Plate 66. DOI: 10.1514/journal.arc.0040017g075



Plate 67. DOI: 10.1514/journal.arc.0040017g076



Plate 68. DOI: 10.1514/journal.arc.0040017g077



Plate 69. DOI: 10.1514/journal.arc.0040017g078

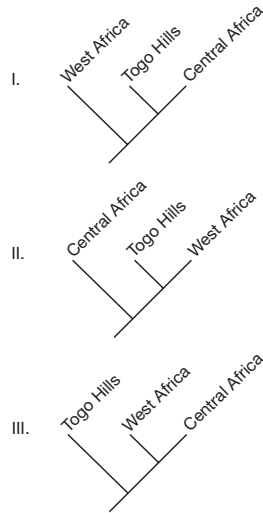


Plate 70. DOI: 10.1514/journal.arc.0040017g079



Plate 71. DOI: 10.1514/journal.arc.0040017g080

**Plate captions:** 66. Large-eyed Green Treesnake *Rhamnophis* cf. *aethiopissa*, Ankasa National Park, Ghana. 67. Black Forest Cobra *Naja melanoleuca*, Comoé, Ivory Coast. 68. Royal Python *Python regius*, Keri. 69. Spotted Blind Snake *Typhlops punctatus*, South Repeater Station. 70. Spotted Night Adder *Causus maculatus*, Nkwanta. 71. Dwarf Crocodile *Osteolaemus tetraspis*, Comoé, Ivory Coast.



**Figure 3.** The three resolved phylogenetic hypotheses for the evolutionary history of forest-restricted species in Western Africa, assuming exclusivity of each forest block.  
DOI: 10.1514/journal.arc.0040017g081

Compared to the 47 amphibian species documented in the southwestern forests of Ghana (Rödel et al. 2005), the Togo Hills harbor less diversity with 26 species. The climatological and geological history of the forests themselves may explain present day patterns of organismal diversity. During the last glacial maximum the expansion of dry forest and savannah fragmented rain forests reduced the size and extent of rain forest habitat within the Togo Hills to a minimum (Dupont et al. 2000). Larger blocks of forest persisted along the coast to the west of Ghana and in Central Africa. These areas may have experienced less retraction and therefore maintained higher species diversity. Thus, a positive correlation may exist between forest patch size during the Pleistocene and present-day biodiversity. This hypothesis should be scrutinized more closely using genetic data from multiple, co-distributed forest species restricted to forest habitat, but with distributions spanning West Africa. Feasible target species fitting these criteria include *Leptopelis hyloides*, *Phrynobatrachus plicatus*, *Amnirana albolabris*, *Hemidactylus fasciatus*, *Panaspis togoensis*, *Gonionotophis klingi*, *Rhannophis aethiopiassa*, and *Osteolaemus tetraspis*. Genetic data will provide a more sensitive measure of diversity for these forest-restricted species and facilitate the estimation of divergence dates between lineages. In addition, a comparative phylogeographic approach will enable us to determine whether co-distributed forest species have shared evolutionary histories (Fig. 3). Our surveys have contributed to the sampling essential for comparative biogeographic research of the herpetofauna in this complex biodiversity hotspot.

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## References

- Amiet, J.-L. 2005. Les *Hyperolius camerounais* du groupe d'*H. nasutus* (Amphibia, Anura, Hyperoliidae). *Revue Suisse de Zoologie* **112**(1):271-310.
- Bayless, M. K. 2002. Monitor lizards: a pan-African check-list of their zoogeography (Sauria: Varanidae: Polydaedalus). *Journal of Biogeography* **29**(12):1643-1701.
- Bayless, M. K. and Luiselli, L. 2000. The ecological distribution of monitor lizards (Reptilia, Varanidae) in Nigeria. *Miscellanea Zoologica* **23**(1):1-8.
- Bierregaard, R. O., Lovejoy, T. E., Kapos, V., Dossantos, A. A., and Hutchings, R. W. 1992. The biological dynamics of tropical rain-forest fragments. *BioScience* **42**(11):859-866.
- Böhme, W., Schmitz, A., and Ziegler, T. 2000. A review of the West African skink genus *Cophoscincopus* Mertens (Reptilia: Scincidae: Lygosominae): resurrection of *C. simulans* (Vallant, 1884) and description of a new species. *Revue Suisse de Zoologie* **107**(4):777-791.
- Booth, A. H. 1958. The Niger, the Volta and the Dahomey Gaps as geographic barriers. *Evolution* **12**(1):48-62.
- Branch, W. R. and Rödel, M.-O. 2003. Herpetological survey of the Haute Dodo and Cavally forests, western Ivory Coast, Part II: trapping results and reptiles. *Salamandra* **39**(1):21-38.
- Brashares, J. S., Arcese, P., Sam, M. K., Coppolillo, P. B., Sinclair, A. R. E., and Balmford, A. 2004. Bushmeat hunting, wildlife declines, and fish supply in West Africa. *Science* **306**(5699):1180-1183.
- Broadley, D. G. 1989. Reappraisal of the genus *Panaspis* Cope, with the description of a new species of *Leptosiaophos* (Reptilia: Scincidae) from Tanzania. *Arnoldia Zimbabwe* **9**(32):439-449.
- Brooks, T., Pimm, S., and Oyugi, J. 1999. Time lag between deforestation and bird extinction in tropical forest fragments. *Conservation Biology* **13**(5):1140-1150.
- Channing, A., Moyer, D., and Burger, M. 2002. Cryptic species of sharp-nosed reed frogs in the *Hyperolius nasutus* complex: advertisement call differences. *African Zoology* **37**(1):91-99.
- Chippaux, J.-P. 1999. *Les serpents d'Afrique occidentale et centrale*. IRD Éditions, Paris. 278 p.
- Cowlishaw, G., Mendelson, S., and Rowcliffe, J. M. 2005. Structure and operation of a bushmeat commodity chain in southwestern Ghana. *Conservation Biology* **19**(1):139-149.
- Crutsinger, G., Pickersgill, M., Channing, A., and Moyer, D. 2004. A new species of *Phrynobatrachus* (Anura: Ranidae) from Tanzania. *African Zoology* **39**(1):19-23.
- de Buffrénil, V. de. 1993. Les varans africains (*Varanus niloticus* et *Varanus exanthematicus*): données de synthèse sur leur biologie et leur exploitation. Secrétariat de CITES, Genève, Suisse.
- Duellman, W. E. 2005. *Cusco Amazonico: the lives of amphibians and reptiles in an amazonian rainforest*. Cornell University Press, Ithaca. 472 p.
- Dunger, G. T. 1967. The lizards and snakes of Nigeria. Part 3: the monitor and a plated lizard. *Nigerian Field* **32**:170-178.
- Dupont, L. M., Jahns, S., Marret, F., and Ning, S. 2000. Vegetation change in equatorial West Africa: time-slices for the last 150 ka. *Palaeogeography Palaeoclimatology Palaeoecology* **155**(1-2):95-122.
- Fa, J. E., Yuste, J. E. G., and Castelo, R. 2000. Bushmeat markets on Bioko Island as a measure of hunting pressure. *Conservation Biology* **14**(6):1602-1613.
- Frost, D. R. 1985. *Amphibian Species of the World: a taxonomic and geographical reference*. The Association of Systematics Collections, Lawrence, Kansas. 732 p.

- Gramentz, D. 2000. Zur Biologie von *Hemidactylus brooki angulatus* in Ghana sowie *H. mabouia* und *H. muriceus* in Gabun. *Salamandra* **36**(3):185-198.
- Greer, A. E., Grandison, A. G. C., and Barbault, R. 1985. A new species of *Lygosoma* (Lacertilia: Scincidae) from West Africa, with comments on its biology. *Journal of Herpetology* **19**(3):365-372.
- Haffer, J. 1982. General aspects of the refuge theory, p. 6-24 in Prance, G. T. *Biological Diversification in the Tropics*. Columbia University Press, New York. 714 p.
- Haft, J. 1993. Ein Beitrag zur Biologie der Echsen der Insel Sao Tome (Golf von Guinea), mit naherer Betrachtung zur Systematik von *Leptosiphos africana* (Gray) (Reptilia: Sauria: Geckonidae et Scincidae). *Faunistische Abhandlungen des Staatlichen Museums für Tierkunde Dresden* **19**(6):59-70.
- Hamilton, A. 1976. The significance of patterns of distribution shown by forest plants and animals in tropical Africa for the reconstruction of Upper Pleistocene palaeoenvironments: a review. *Palaeoecology of Africa and of the Surrounding Islands and Antarctica* **9**:63-97.
- Henle, K., and Böhme, W. 2003. A new species of *Hemidactylus* (Squamata: Gekkonidae) from West Africa, and comments on species hitherto confused with *H. muriceus*. *African Journal of Herpetology* **52**(1):23-38.
- Heyer, W. R., Donnelly, M. A., McDiarmid, R. W., Hayek, L.-A. C., and Kent, M. S. 1994. *Measuring and Monitoring Biological Diversity: standard methods for amphibians*. Smithsonian Institution Press, Washington, DC. 364 p.
- Hoogmoed, M. S. 1974. Ghanaese lizards of the genus *Mabuya* (Scincidae, Sauria, Reptilia). *Zoologische Verhandlungen* **138**:1-68.
- Horton, D. R. 1973. Evolution of the genus *Mabuya* (Lacertilia, Scincidae). Unpublished Ph.D. thesis, University of New England, Armidale. 311 p.
- Hughes, B. 1988. Herpetology of Ghana (West Africa). *British Herpetological Society Bulletin* **25**:29-38.
- Hughes, B., and Barry, D. H. 1969. The snakes of Ghana: a checklist and key. *Bulletin de l'Institut fondamental d'Afrique noire Sér. A* **31**(3):1004-1041.
- Hughes, J. B., Daily, G. C., and Ehrlich, P. R. 1997. Population diversity: its extent and extinction. *Science* **278**(5338):689-692.
- Hulselmans, J. L. J. 1971. Contribution à l'herpétologie de la République du Togo, 4. Description de *Conraua derooi*, n. sp. (Amphibia). *Revue Zoologique Botanique Africaine* **84**:153-159.
- Lamotte, M. 1966. Types de répartition géographique de quelques batraciens dans l'Ouest Africain. *Bulletin de l'Institut fondamental d'Afrique noire Sér. A* **28**:1140-1148.
- Laurent, R. F. 1972. Tentative revision of the genus *Hemius* Günther. *Musée Royal d'Afrique Centrale Science Zoologique* **194**:1-67.
- Lawson, G. W. 1968. Ghana. *Acta phytogeographica suecica* **54**:81-86.
- Leaché, A. D. 2005. Results of a herpetological survey in Ghana and a new country record. *Herpetological Review* **36**(1):16-19.
- Leston, D., and Hughes, B. 1968. The snakes of Tafo, a forest cocoa-farm locality in Ghana. *Bulletin de l'Institut fondamental d'Afrique noire Sér. A* **30**:737-770.
- Loveridge, A. 1939. Revision of the African snakes of the genera *Mehyla* and *Gonionotophis*. *Bulletin of the Museum of Comparative Zoology* **86**(3):131-162.
- Luiselli, L. 2003. Comparative abundance and population structure of sympatric Afrotropical tortoises in six rainforest areas: the differential effects of "traditional veneration" and of "subsistence hunting" by local people. *Acta Oecologica* **24**(3):157-163.
- Maley, J. 1991. The African rain forest vegetation and paleoenvironments during late quaternary. *Climatic Change* **19**(1-2):79-98.
- Milner-Gulland, E. J., Bennett, E. L., and the SCB 2002 Annual Meeting Wild Meat Group. 2003. Wild meat: the bigger picture. *Trends in Ecology & Evolution* **18**(7):351-357.
- Myers, C. W. and Rand, A. S. 1969. Checklist of amphibians and reptiles of Barro Colorado Island, with comments on faunal change and sampling. *Smithsonian Contributions to Zoology* **10**:1-11.
- Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B., and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* **403**(6772):853-858.
- Perret, J.-L. 1976. Identité de quelques *Afraxalus* (Amphibia, Salientia, Hyperoliidae). *Bulletin de la Société neuchâteloise des Sciences Naturelles Sér. 3* **99**:9-28.
- Poorter, L., Bongers, F., and Lemmens, R. H. M. J. 2004. West African Forests: introduction, in Poorter, L., Bongers, F., Kouame, F. N., and Hawthorne, W. D. *Biodiversity of West African Forests: an ecological atlas of woody plant species*. CABI Publishing, Cambridge, Massachusetts. 521 p.
- Raxworthy, C. J. and Attuquayefio, D. K. 2000. Herpetofaunal communities at Muni Lagoon in Ghana. *Biodiversity and Conservation* **9**(4):501-510.
- Rödel, M.-O. 2000. *Herpetofauna of West Africa, Volume I: Amphibians of the West African Savanna*. Edition Chimaira, Frankfurt/M., Germany. 335 p.
- Rödel, M.-O. and Agyei, A. C. 2003. Amphibians of the Togo-Volta highlands, eastern Ghana. *Salamandra* **39**(3):207-234.
- Rödel, M.-O. and Bangoura, M. A. 2004. A conservation assessment of amphibians in the Forêt Classée du Pic de Fon, Simandou Range, southeastern Republic of Guinea, with the description of a new *Amirana* species (Amphibia Anura Ranidae). *Tropical Zoology* **17**:201-232.
- Rödel, M.-O. and Ernst, R. 2003. The amphibians of Marahoué and Mont Péko National Parks, Ivory Coast. *Herpetozoa* **16**(1/2):23-39.
- Rödel, M.-O. and Ernst, R. 2004. Measuring and monitoring amphibian diversity in tropical forests. I. An evaluation of methods with recommendations for standardization. *Ecotropica* **10**:1-14.
- Rödel, M.-O., Gil, M., Agyei, A. C., Leaché, A. D., Diaz, R. E., and Fujita, M. K. 2005. The amphibians of the forested parts of south-western Ghana. *Salamandra* **41**(3):107-127.
- Rödel, M.-O., Grabow, K., Hallermann, J., and Böckheler, C. 1997. Die Echsen des Comoé-Nationalparks, Elfenbeinküste. *Salamandra* **33**(4):225-240.
- Rödel, M.-O., Lampert, K. P., and Linsenmair, K. E. *In press*. 2006. Reproductive biology of the West African savannah frog, *Hyperolius nasutus* Günther, 1864 (Amphibia: Anura: Hyperoliidae). *Herpetozoa* **19**(1/2).
- Salzmann, U., and Hoelzmann, P. 2005. The Dahomey Gap: an abrupt climatically induced rain forest fragmentation in West Africa during the late Holocene. *Holocene* **15**(2):190-199.
- Schiøtz, A. 1967. The treefrogs (Rhacophoridae) of West Africa. *Spolia zoologica Musei haunienses* **25**:1-346.
- Schiøtz, A. 1999. *Treefrogs of Africa*. Edition Chimaira, Frankfurt/M. 350 p.
- Schmitz, A., Ineich, I., and Chirio, L. 2005. Molecular review of the genus *Panaspis* sensu lato (Reptilia: Scincidae) in Cameroon, with special reference to the status of the proposed subgenera. *Zootaxa* **863**:1-28.
- Spawls, S., Howell, K., Drewes, R., and Ashe, J. 2002. *A Field Guide to the Reptiles of East Africa: all the reptiles of Kenya, Tanzania, Uganda, Rwanda and Burundi*. Academic Press, San Diego, California. 543 p.
- Stuart, S. N., Chanson, J. S., Cox, N. A., Young, B. E., Rodrigues, A. S. L., Fischman, D. L., and Waller, R. W. 2004. Status and trends of amphibian declines and extinctions worldwide. *Science* **306**(5702):1783-1786.
- UICN. 1996. L'atlas pour la conservation des forêts tropicales d'Afrique. Jean-Pierre de Monza, Paris. 310 p.

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