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A conservation assessment of the herpetofauna of a moist semi-deciduous forest in Ghana

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Abstract

A conservation assessment of amphibians and reptiles was undertaken in the Gyemera Forest Reserve (GFR) and Gyeni River Forest Reserve (GRFR) in the Moist Semi-deciduous forests of the Amansie West District of the Ashanti Region of Ghana. Refuge examination, acoustic searches, pitfall trapping and interviews were employed in data collection at the study sites. Forty herpetofaunal species were recorded comprising 16 amphibians (two toads and 14 frogs) and 24 reptiles (one chelonian, 14 lizards and nine snakes). Four species (one lizard and three snakes) were not directly encountered but were recorded from interviews of local residents. The GRFR recorded a higher number of species than GFR and there was a low similarity in species composition between the sites (Sorenson's Similarity Index CS = 0.52). Five species were widely distributed and frequently encountered and only 12 species were directly recorded within the forest reserves. The main threats to herpetofaunal species in the study area were habitat destruction and fragmentation due to illegal logging and small-scale/artisanal mining. Four species were of conservation concern; Phrynobatrachus alleni is listed as Near Threatened by the IUCN and the other three; Kinixys erosa, Varanus niloticus and Python sebae are listed in CITES Appendix II where limited trading is allowed and are nationally protected. Inclusion of the local people in conversation initiatives as well as conservation education and awareness programmes would help sensitise and concientise them about the need to conserve biodiversity. Also, enforcement of the laws on illegal logging and mining should be intensified.

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Introduction

Tropical forests are the most diverse terrestrial ecosystems but they also suffer most in terms of destruction (Hillers et al., 2008). With a mean annual forest loss of 0.48 – 0.56% between 1990 and 2005, deforestation rates are exceptionally high in West and Central Africa (Hillers et al., 2008). The Guinean rain forest of Western Africa is a center of biological diversity with considerable endemism (Leache et al., 2006), with the percentage amphibians (77%) and reptiles (33%) far exceeding that of other tetrapod notably birds (18%) and mammals (8%) (Leache et al., 2006).

The rate of deforestation however started escalating greatly about a century ago due to demands for timber and a rapidly expanding agriculture including establishment of cocoa plantations (Rodel et al., 2005). In Ghana alone, natural forests have diminished to about 11.8 –14.5% of their former cover (Leache et al., 2006) with the remaining forests often highly fragmented and/or degraded.

Generally, fragmentation causes ecological degradation and ecosystem changes (Hillers et al., 2008). Nevertheless, the degree of degradation following fragmentation may vary, depending on, for example, on the time since a fragment was isolated and the quality of the surrounding landscape. Even when forest fragments remain in their nearly pristine conditions fragmentation may directly affect the composition of plant and animal communities (Hillers et al., 2008). Thus, a higher value must be placed on the remaining forest fragments to ensure biodiversity preservation (Leache and Boateng, 2009).

Herpetofaunal species are a prominent and conspicuous component of the West African forest fauna. They can occur at high densities in the tropics and play important roles as consumers (Leache and Boateng, 2009). Amphibians are especially useful for evaluating the health and integrity of the environment because they respond early to environmental changes and are relatively easy to detect in even the most complex forest habitats. The herptofauna of Ghana is among the most diverse and well-studied in West Africa. This wealth of information on the distribution and ecology of herpetofauna in Ghana, coupled with the utility of amphibians as good environmental indicator species, makes this an appropriate taxonomic group for rapid assessment (Leache and Boateng, 2009).

Over a third of amphibian species are globally threatened, and over 120 have likely gone extinct since 1980 (Whitfield et al., 2007). Amphibian populations worldwide are negatively affected by invasive predators and anthropogenic factors like habitat modification and population declines, but extinctions have occurred even in habitats lacking obvious anthropogenic disturbances (Whitfield et al., 2007). Information on herpetofaunal species diversity in Ghana's protected areas is scanty and not regularly updated. Inventories of species in reserves are essential for conservation, monitoring and management and the acquisition of baseline data on the distribution and status of even common species is important (Trakimas, 1999).

Even though the large and small mammals of the moist semi-deciduous forests of the Amansie West District of the Ashanti Region of Ghana have currently been published (Ofori et al., 2012; Ofori et al., in-press), there is lack of information on herpetofauna. Hence, this survey was conducted to (i) provide a preliminary species list for the Moist Semi Deciduous forest reserves of the Amansie West District (ii) provide data on herpetofaunal abundance and diversity for the two forest reserves (iii) identify current threats to the conservation of herpetofauna and (iv) provide recommendations that will facilitate the development of an effective and sustainable management plan for the reserves.

Materials and methods

Study area

The Amansie West District (6° 28'- 6° 38'N; 1° 53'- 2° 01'W) covers a land area of 1,364 km² and is located

in southwestern Ashanti Region, Ghana with Manso Nkwanta as District Capital.

The area is characterized by an average annual double-peak rainfall ranging between 1,500 mm and 1,700 mm. The major rainy and minor seasons are between April - July and September – October respectively, while the dry season (Harmattan) falls between December - February. The temperature ranges between 22°C - 36°C and relative humidity between 70% - 90 % (Dickson and Benneh, 1980).

The District falls within the Moist Semi-Deciduous Forest vegetation and Wet Semi-Equatorial climatic zones. The former is also described as the *Celtis-Triplochiton* rainforest association (Taylor, 1960), indicating that the area is undergoing various degrees of degradation. The multi-storey structural representation of the forest is lost, and the resultant vegetation now comprises of:

- Forest Reserves (Gyeni River and Gyemera).
- Off- reserve Areas consisting of fragmented secondary forest thicket at various stages of regeneration mostly on isolated hilltops and slopes, active farms with both annual and perennial crops and fallow farmland probably awaiting clearing for the next farming season

Some tree species that characterise the area include *Celtis adolphi-friderici*, *Celtis mildbraedii*, *Bombax buonopozense*, *Musanga cecropioides*, *Morinda lucida*, *Albizia zygia* and *Ceiba pentandra* (silk cotton), *Terminalia ivorensis* (emire), *Khaya ivoriensis* (mahogany), *Triplochiton scleroxylon* (wawa), *Milicia excelsa* (odum), *Chromolaena odorata*, *Elaeis guineensis*, *Leucaena leucocephala* and *Alchornea cordifolia*. Grasses such as *Imperata cylindrica* and *Panicum maximum* occur around ponds.

The topography of the area is generally undulating with an elevation of approximately 260 mASL in the lowlands. The area falls within the Bonte drainage basin (headwaters of the Bonte River and its tributaries that run westwards or southwards). The estimated population size in 2010 was 144,104 (MOFA, 2010) with the main ethnic group being Akan and the rest being mainly settlers from the Northern regions of Ghana. The main economic activities in the area are agriculture and small-scale/artisanal mining. Major food crops cultivated include plantain, corn, cassava, yam and tomatoes and cash crops such as cocoa and oil palm.

Selection of study sites

In addition to the two selected Forest Reserves; Gyeni River (GRFR) and Gyemera (GFR), other habitat types surveyed within the reserves were plantations (cocoa and plantain), grasses/shrubs, and water bodies.

- Gyemera Forest Reserve (GFR) (6° 36'N, 1° 55'W): A 63 km² area with other habitat types such as farms, grassland, shrubland, *Terminalia* spp., and teak

- Gyeni River Forest Reserve *(GRFR)* (6° 30'N, 1° 55'W): A 22 km² area with other habitat types such as *Triplochiton scleroxylon*, *Celts* spp., *Milicia excelsa*, and *Terminalia* spp.

Survey methods

Surveys were undertaken during the day and evenings to record both diurnal and nocturnal species. A wide range of sampling methods was used to collect as many species as possible.

The methods include pitfall trapping with drift fences, opportunistic searches, refuge examination, acoustic searches, dip-netting in water bodies and interviews of local people in the study area. During refuge examination, searches were undertaken by turning over rocks and logs, peeling tree bark, digging through leaf litter and visual scanning of trees and buildings.

Pitfall traps consisted of 17 litre buckets of 175 mm depth, 290 mm top internal diameter and 220 mm bottom internal diameter were sunk in the ground with their rims flush with the ground and placed along a drift fence made of 1-metre high mosquito

netting stapled in a vertical position to thin wooden stakes. The drift fence ran across the middle of each pitfall bucket. Each bucket had 1.5cm diameter drainage holes in the bottom to prevent flooding during rains. The fence bottoms were buried into the ground with soil and leaf litter to prevent passage underneath. Each study site had two 100-metre long pitfall traps with drift fences and each pitfall trap line had 21 buckets at 5-metre intervals. The buckets were checked daily in the morning, afternoon and evening. Human activities that represented threats to species and their habitats were also noted.

Specimen handling and identification

The date, time, microhabitat and morphometric data of captured specimens were recorded, the specimen photographed and then released at the point of capture. Specimens kept as vouchers were killed with chloroform, fixed in 10% formalin and preserved in 70% alcohol. For general herpetofaunal identification, Hughes, 1988 and Leache *et al.* (2006) were used. Amphibian species identification followed Schiotz (1999), Rodel (2000), Rodel and Agyei (2003). Rodel *et al.* (2005) and Onadeka and Rodel (2009). Skink identification was based on Hoogmoed (1974), while Cansdale (1961) and Hughes and Barry, 1969 were used fo snake identification.

Analysis of data

Relative Abundance Estimation

Due to the sampling methods used, only qualitative and semi-quantitative data were obtained. Also, the possibilities of multiple counts of the same species did not permit rigorous statistical and ecological analyses to be performed. Species encountered during this survey were thus classified using a system similar to that of Wilson and McCranie (2004) summarized as follows:

- Abundant (large numbers encountered on a regular basis)
- Common (encountered on a regular basis)
- Infrequent (unpredictable, few individuals seen)
- Rare (rarely seen).

For the purposes of this study, number of individuals of a species higher than 20 are classified as Abundant, between 11 – 20 are Common, between 6 – 10 are Infrequent and less than 6 are Rare These classifications are based on data collected using all survey techniques (except interviews) and refer to the total number of individuals encountered for each species.

Sorensen's similarity

Sorenson's Similarity Index (C_S) was used to determine the extent of similarity among sites and was estimated as follows (Magurran, 2004):

$$C_S = \frac{2c}{a+b+2c} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

a = number of species in first site,

b = number of species in second site and

c = number of species common to both two sites.

Results

Herpetofaunal Species Abundance, Diversity and Distribution

Thirty-six herpetofaunal species were directly-encountered belonging to 14 families and comprising of 16 amphibians (two toads and 14 frogs) belonging to six families and 20 reptiles (one chelonian, 13 lizards and six snakes) belonging to eight families (Table 1). Twenty-nine species were recorded for GRFR, while GFR recorded 25 species. There were more amphibians in GRFR than in GFR but both areas had the same number of reptiles. However, in addition to the Four (three snakes and a lizard) species that were not directly encountered and were recorded through interviews of the local inhabitants, 40 herpetofaunal species (16 amphibians and 24 reptiles) were recorded in the study area (Table 2). A Sorenson's similarity index of 0.52 indicates that the two sites were not very similar. There were 14 species common to both sites, with 11 species exclusive to GFR and 15 species exclusive to GRFR (Table 2).

Overall, four species (11%) were Abundant (*H. occipitalis, T. maculilabris, P. calcaratus* and *A. agama*), three species (8%) were Common (*H. concolor, T. affinis* and *T. albilabris*) and the remaining 29 (81%) were Rare. In the GRFR, four species (16%) were Abundant (*H. occipitalis, T. maculilabris, P. calcaratus* and *A. agama*), three (12%) were Common (*H. concolor, T. affinis* and *T. albilabris*) and 18 (72%) were Rare. In the GFR, one species (5%) was Abundant (*H. occipitalis*), two (10%) were Common (*T. maculilabris* and *H. concolor*), three (14%) were Infrequent (*A. agama, T. affinis* and *T. albilabris*) and 15 (71%) were Rare. As many as 26 herpetofaunal species occurred at only one site while 17 species were encountered only once (Table 1). Sixteen species (44.4%) were recorded in the typical forests in the study area, nine each in the GRFR (five amphibians and four reptiles) and GFR (one amphibian and eight reptiles) with two species common to both (Table 1). The rest of the 20 species were recorded in forest clearings (farm bush, plantations, grassland and shrublands) within and around the reserves.

Table 1. Herpetofauna distribution and relative abundance at the study area

Scientific Name	Common Name	GFR		GRFR	
AMPHIBIA: ANURA	**Frogs and Toads**	**EN**	**RA**	**EN**	**RA**
BUFONIDAE					
Amietophrynus maculatus	Flat-backed toad	2	R	4*	R
Amietophrynus regularis	Square-marked toad	5*	R	1	R
RANIDAE					
Hoplobatrachus occipitalis	Crowned bullfrog	40	A	21	A
Amnirana albolabris	white-lipped frog			2	R
Ptychadena mascareniensis	Mascarene-ridged frog	2	R		
Ptychadena longirostris	Snouted grassland frog	1	R		
HEMISOTIDAE					
Hemisus guineensis	Guinea snout-burrower	1	R		
Hemisus marmoratus	Marbled shovel-nosed frog			1	R
ARTHROLEPTIDAE					
Arthroleptis poecilonotus	West African Screeching frog			4	R
Leptopelis viridis	Rusty tree frog			1*	R
Leptopelis spiritusnoctis	Gbanga Tree frog			1*	R
HYPEROLIIDAE					
Hyperolius concolor	Variable reed frog	15	C	11	C
Hyperolius sp	Reed frog	1	R		
PETROPEDETIDAE					
Phrynobatrachus alleni	Allen's river frog			1*	R
Phrynobatrachus plicatus	Coast river frog			1	R
Phrynobatrachus calcaratus	Boutry river frog			29*	A
REPTILIA: CHELONIA	**Chelonians**				
TESTUDINIDAE					
Kinixys erosa	Forest hinged-backed tortoise	1*	R		

REPTILIA: SQUAMATA: LARCETILIA	**Lizards**				
AGAMIDAE					
Agama agama	Rainbow lizard	9	I	24	A
SCINCIDAE					
Cophoscincopus simulans	Keeled water skink			2*	R
Trachylepis maculilabris	Speckled-lipped Mabuya	15*	C	29*	A
Trachylepis affinis	Senegal Mabuya	8*	I	14*	C
Trachylepis albilabris	White-lipped Mabuya	6	I	15*	C
Trachylepis buettneri	Buettneri's long-tailed Mabuya			1	R
Panaspis togoensis	Togo lidless skink	1	R		
Lygosoma guineensis	Guinea writhing skink	1*	R		
Lygosoma sp.	Writhing skink	1*	R		
GEKKONIDAE					
Hemidactylus mabouia	House gecko			2	R
Hemidactylus fasciatus	Banded leaf-toed gecko			1	R
Hemidactylus muriceus	Guinea leaf-toed gecko	2*	R	3	R
Hemidactylus sp.	Gecko	4*	R		
REPTILIA: SQUAMATA: SERPENTES	**Snakes**				
BOIDAE					
Python sebae	African python	1	R		
COLUBRIDAE					
Lamprophis lineatus	Striped house snake	1	R		
Philothamnus semivariegatus	Spotted bush snake			1	R
Grayia smythii	Smith's water snake			4	R
ELAPIDAE					
Dendroaspis viridis	Green mamba			1	R
VIPERIDAE					
Causus maculatus	Night adder	2*	R	2	R
Total Encounters		**119**		**176**	
Number of Species		**21**		**25**	

*= recorded in a forest reserve

Study Sites: GFR – Gyemera Forest Reserve, GRFR – Gyeni River Forest Reserve,

A – Abundant, C – Common, I – Infrequent, R – Rare, EN = number of encounters

Table 2. Species List and conservation status of herpetofauna of Moist Semi – Deciduous Forest of the Amansie West District of Ghana.

Species Name	Common Name	GFR	GRFR	Capture Method	Conservation Status		
					IUCN	CITES	NPS
AMPHIBIA: ANURA							
BUFONIDAE							
Amietophrynus maculatus	Flat-backed toad	*	*	DC, PT	LC	NL	NL
Amietophrynus regularis	Square-marked toad	*	*	DC, PT	LC	NL	NL
RANIDAE							
Hoplobatrachus occipitalis	Crowned bullfrog	*	*	DC,C	LC	NL	NL
Amnirana albolabris	white-lipped frog		*	DC	LC	NL	NL
Ptychadena mascareniensis	Mascarene-ridged frog	*		DN	LC	NL	NL
Ptychadena longirostris	Snouted grassland frog	*		DC	LC	NL	NL
HEMISOTIDAE							
Hemisus guineensis	Guinea snout-burrower	*		DN	LC	NL	NL
Hemisus marmoratus	Marbled shovel-nosed frog		*	DN	LC	NL	NL
ARTHROLEPTIDAE							
Arthroleptis poecilonotus	West African Screeching frog		*	DC	LC	NL	NL
Leptopelis viridis	Rusty tree frog		*	DC	LC	NL	NL
Leptopelis spiritusnoctis	Gbanga Tree frog		*	DC	LC	NL	NL
HYPEROLIIDAE							
Hyperolius concolor	Variable reed frog	*	*	DC, DN	LC	NL	NL
Hyperolius sp	Reed frog	*		DC	LC	NL	NL
PETROPEDETIDAE							
Phrynobatrachus alleni	Allen's river frog		*	DC	NT	NL	NL
Phrynobatrachus plicatus	Coast river frog		*	DC	LC	NL	NL
Phrynobatrachus calcaratus	Boutry river frog		*	DC	LC	NL	NL
REPTILIA: CHELONIA							
TESTUDINIDAE							
Kinixys erosa	Forest hinged-backed tortoise	*		DC	DD	II	II
REPTILIA: SQUAMATA: LARCETILIA							
AGAMIDAE							

Agama agama	Rainbow lizard	*	*	S	LC	NL	NL
SCINCIDAE							
Cophoscincopus simulans	Keeled water skink		*	DC	LC	NL	NL
Trachylepis maculilabris	Speckled-lipped Mabuya	*	*	DC	LC	NL	NL
Trachylepis affinis	Senegal Mabuya	*	*	DC	LC	NL	NL
Trachylepis albilabris	White-lipped Mabuya	*	*	DC	LC	NL	NL
Trachylepis buettneri	Buettneri's long-tailed Mabuya		*	DC	LC	NL	NL
Panaspis togoensis	Togo lidless skink	*		DC	LC	NL	NL
Lygosoma guineensis	Guinea writhing skink	*		DC	LC	NL	NL
Lygosoma sp.	Writhing skink	*		DC	LC	NL	NL
GEKKONIDAE							
Hemidactylus mabouia	House gecko		*	DC	LC	NL	NL
Hemidactylus fasciatus	Banded leaf-toed gecko		*	DC	LC	NL	NL
Hemidactylus muriceus	Guinea leaf-toed gecko	*	*	DC	LC	NL	NL
Hemidactylus sp.	Gecko	*		DC	LC	NL	NL
VARANIDAE							
Varanus niloticus	Nile Monitor	*	*	I	NE	II	I
REPTILIA: SQUAMATA: SERPENTES							
BOIDAE							
Python sebae	African python	*		I	LC	II	II
COLUBRIDAE							
Lamprophis lineatus	Striped house snake	*		DC	LC	NL	NL
Philothamnus semivariegatus	Spotted bush snake		*	DC	LC	NL	NL
Grayia smythii	Smith's water snake		*	DC	LC	NL	NL
ELAPIDAE							
Dendroaspis viridis	Green mamba		*	S, I	LC	NL	V
Naja melanoleuca	Forest cobra	*	*	I	LC	NL	V
Naja nigricollis	spitting cobra	*	*	I	LC	NL	V
VIPERIDAE							
Causus maculatus	Night adder	*	*	DC, PT	LC	NL	V
Bitis gabonica	Gaboon viper	*	*	I	LC	NL	V
Number of species		**25**	**29**				

* = species present

Study Sites: GFR – Gyemera Forest Reserve, GRFR – Gyeni River Forest Reserve, Capture Method: DC – Direct capture (Handled), PT – Pitfall Trap, DN – Dip netting, I – Interview, S – Sighted but not captured, C - Calls

Conservation Status: IUCN: LC – Least Concern, NT – Near Threatened, NE – Not Evaluated, DD – Data Deficient, CITES: Appendix II – Limited levels of trading allowed, NPS – National Protection Status: I – First Schedule (Fully Protected), II – Second Schedule (partially protected), V – Fifth Schedule (measures may be taken to reduce numbers), NL – Not listed

Although typical forest frogs like *Phrynobatrachus alleni, P. plicatus, Amnirana albolabris* and *Leptopelis spiritusnoctis* were recorded, only *P. alleni* was encountered in the forest reserve (GRFR) in a stream bordered by rocks. The rest were encountered in forest clearings of the GRFR. Typical forest lizards like *Hemidactylus muriceus, H. fasciatus, Panaspis togoensis,* and *Cophoscincopus simulans* were also recorded. Only *C. simulans* was recorded in a reserve (GRFR) at the same location as *P. alleni*. This shows a direct case of forest species being recorded in forest clearings.

The night adder (*Causus maculatus*) was the only snake recorded in a pitfall trap, at a forest edge in the GFR. A green mamba (*Dendroaspis viridis*) was seen in grassland bordering the GRFR, and a spotted bush snake (*Philothamnus semivarigatus*) was also captured at the edge of a cocoa farm bordering grassland some metres away from the GRFR. Nile monitors (*Varanus niloticus*), gaboon vipers (*Bitis gabonica*), and forest/black and spitting cobras (*Naja melanoleuca* and *N. nigricollis* respectively) were not directly encountered but were recorded from interviews.

Issues of Conservation Concern

There was evidence of anthropogenic habitat disturbances in both GFR and GRFR. The former was drier with evidence of logging including recently cleared patches of forest. The forest hinged-backed tortoise (*Kinixys erosa*) was recorded in a recently cleared patch of the GFR. Throughout the study area, there was evidence of agricultural encroachment by local farmers, with food crop farms (plantain, cassava and maize) scattered in the GFR. There were cocoa farms bordering the GFR with few ones scattered in it. There was also evidence of logging though not as severe as that of the GFR and artisanal mining ('galamsay') activities in the GRFR. There were also farms (mainly cocoa) around the GRFR but none was sighted within the forest. The GRFR was wetter, with more 'galamsay' activities closer to it than the GFR.

Four herpetofaunal species of conservation concern were recorded in the study area. Allen's river frog (*Phrynobatrachus alleni*) is IUCN-listed as Near Threatened, while the African python (*Python sebae*), forest hinged-backed tortoise (*Kinixys erosa*) and Nile monitor (*Varanus niloticus*) are listed in Appendix II of CITES. The first two species are also nationally-protected under Schedule II (partial protection) of the Ghana Wildlife Conservation Regulation while the latter is listed in Schedule I (complete protection).

Discussion

Compared to Hughes's (1988) list of 130 herpetofaunal species in Ghana's rainforest, the 40 herpetofaunal species recorded in this study represents about 31% of known rainforest herpetofaunal species for Ghana. Some herpetofaunal groups not recorded in the current survey include crocodiles (Crocodylidae), amphibians (Pipidae, Microhylidae, Caecilidae), lizards squamates (Gerrhosauridae, Chamaeleonidae), amphisbaenids (Amphisbaenidae), and snakes (Leptotyphlopidae, Typhlopidae).

Members of the families Amphisbaenidae, Leptotyphlopidae and Typhlopidae are fossorial species which are usually encountered above ground only during the rainy season. They may completely avoid humans until forced out of their burrows by hunger and flooding (Hughes, 1988) or being dug out by humans. Species of the other families may be present at the survey sites but were not encountered in the course of the study.

Hughes (1988) list included 71 amphibian species, and initial forest surveys revealed between 10 and 20 amphibian species per site in Ghana (Rodel et al., 2005). Recent surveys have however indicated greater species richness than previously thought (Hillers et al., 2009). A survey in the Ajenjua Bepo and Mamang River Forest Reserves in the Eastern Region of Ghana (Leache and Boateng, 2009), recorded 45 herpetofaunal species comprising of 22 amphibians and 23 reptiles. A more extensive survey in the Kyabobo National Park in Ghana, recorded 65 herpetofaunal species comprising of 26 amphibians and 39 reptiles (Leache et al., 2006).

The moist semi-decidious forest of the Amansie West District is continually being degraded by illegal logging, encroaching farmland and artisanal mining activities. Even though it is not surprising that only 16 amphibian species were recorded out of a country record of 71 because of the above reasons, lower numbers of amphibian species recorded in this survey could also be due to the fact that the survey was undertaken during the dry season. Omogbai et al. (2002) stated that there is a population explosion of amphibians during the rainy season, and this may also influence the population of reptiles. The higher number of amphibians in the GRFR than the GFR could also be attributed to the wetter conditions and the presence of more water bodies (pools, puddles, ponds and streams) in the former. This may also explain why petropedetid anurans, which show preference for temporary water bodies, were recorded only in the GRFR (Adeba et al., 2010).

Hoplobatrachus occipitalis is a common and widespread West African frog occurring in both savanna and disturbed forest habitats. It also inhabits diverse water habitats including small, large, fast flowing, stagnant, temporary and or permanent water bodies (Rodel, 2000). *Agama agama* is a common and widespread lizard in West Africa but does not occur in typical forest habitats. *Phrynobatrachus calcaratus* is widespread in West African forests (Leache et al., 2006) but also occurs in farm bush. The lizard family Scincidae has the largest number of species in Ghana (about 33% of the approximately 40 species of lizards) (Hoogmoed, 1974).

The presence of non-forest herpetofaunal species like *A. maculatus*, *A. regularis*, *H. concolor*, *H. occipitalis*, *A. agama* and *C. maculatus* indicate altered forest habitats. *Causus maculatus* (night adder) is a savanna species that is able to colonise forest clearings (Freedman et al., 2008). The presence of some of these species in Ghana's less destroyed forests such as Ankasa, Draw River and Boi-Tano of already established populations that might compete and eventually displace true forest species is worrying (Hillers et al., 2009). This may also apply to the forest reserves in this study. Also, the recording of several typical forest species in forest clearings but not in the forest reserves could indicate they are gradually adapting to life outside typical forests. This could have dire effects on the dynamics of the forest reserves if they regrow into their original cover. On the other hand, the presence of several forest species indicates the forest reserves are not completely destroyed and with effort can be allowed to regrow back to its original cover or close to it.

Mining and slash-and-burn agriculture have destroyed trees and created gullies and ponds, generally destroying the landscape and creating death traps for people and other animals. Even though no amphibian is listed for protection under the Ghana Wildlife Conservation Regulations, *Phrynobatrachus alleni* is listed as Near Threatened by the IUCN (IUCN, 2013). *Varanus niloticus* is listed under Schedule I (Complete Protection) whiles both *Pelomedusa subrufa* and *Python sebae* are listed under Schedule II (Partial Protection) of the Ghana Wildlife Conservation Regulations. All three species are listed in CITES Appendix II which allows limited levels of trading. Frogs, lizards and snakes are potentially suitable species for long-term monitoring due to factors like (i) permeable skins of frogs that render them sensitive to environmental degradation in both the terrestrial and aquatic habitats, and (ii) sensitivity to a broad range of environmental stressors. Savanna frog species such as *Amietophrynus* spp., which can colonise degraded forests are also suitable bio-indicators, since their presence, abundance, distribution and extent of colonisation of a forest reserve often provides an indication of level of degradation of the reserve.

In conclusion, it is important to note that this survey was not exhaustive enough to enable solid conclusions to be made about species presence or abundance. It is recommended that, measures must be put in place to stop the illegal logging of the forest, as well as the artisanal mining activities. The forest must be left undisturbed to regenerate over time.

Regular monitoring of herpetofaunal species as bio-indicators of forest health is also recommended. Any conservation initiative should involve the local people, and regular conservation education and awareness campaigns should be organised to sensitise the locals about the need to conserve and protect biodiversity.

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