

Rapid survey of amphibians and reptiles of North Lorma, Gola and Grebo National Forests

Authors: Hillers, Annika, and Rödel, Mark-Oliver

Source: A Rapid Biological Assessment of North Lorma, Gola and Grebo National Forests, Liberia: 29

Published By: Conservation International

URL: <https://doi.org/10.1896/978-1-934151-01-3.29>

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Chapter 3

Rapid survey of amphibians and reptiles of North Lorma, Gola and Grebo National Forests

Annika Hillers and Mark-Oliver Rödel

SUMMARY

During a herpetological survey of three national forests in northwestern (North Lorma, Gola) and southeastern (Grebo) Liberia we recorded at least 40 amphibian and 17 reptile species. Fifteen amphibians are on the IUCN Red List: 11 are classified as Near Threatened, two as Vulnerable and two as Endangered. We observed five species that had not been recorded in Liberia before. For several species our findings represent large range extensions. Five of the reptile species recorded and one amphibian are listed under CITES. All three forests have a high conservation value as their herpetofauna mainly consists of forest specialists which are endemic to the Upper Guinea forest block.

INTRODUCTION

Liberia is assumed to harbour a high biodiversity and to be one of the richest countries in animal and plant species in West Africa (Bakarr et al. 2001). The diversity of amphibians and reptiles is also thought to be extremely high and to comprise a great number of Upper Guinea endemics. The eastern part of the country (Cape Palmas) in particular is assumed to be very rich in species since it was a rainforest refugium in northern glacial times, which were dry periods in Africa (e.g. Sosef 1994). However, while the herpetofauna of neighboring Guinea and Côte d'Ivoire is relatively well documented (e.g. Guibé and Lamotte 1958a, 1958b, 1963; Schiøtz 1967, 1968; Böhme 1994a, 1994b; Rödel and Bangoura 2004; Rödel et al. 2004; Greenbaum and Carr 2005) and surveys were conducted in Sierra Leone's forests in 2005 (Hillers et al. in prep.), there are almost no recent herpetological data available for Liberia.

Whereas most other West African countries have lost most of their forest cover (e.g. more than 80% of Côte d'Ivoire's forests have been logged during the last 30 years: Chatelain et al. 1996), Liberia's forests seem to still be quite extensive. They are, however, increasingly threatened by logging, shifting agriculture, hunting and mining activities. Therefore data on species' occurrence in Liberia and, more specifically, their distributions within the country, are urgently needed.

Amphibians and reptiles are not only important with regard to biodiversity. They are extremely sensitive to habitat changes, which qualifies them as excellent bio-indicators. The composition of amphibian assemblages may indeed be indicative of the quality of a habitat (compare Rödel and Branch 2002; Rödel and Ernst 2003; Ernst and Rödel 2005; Ernst et al. 2006). Based on this knowledge, conservation recommendations can be made.

METHODS

The RAP survey was carried out between 16 November and 14 December 2005, which is the end of the rainy season and the beginning of the dry season, and hence not the most appropriate period to search for amphibians and reptiles.

The first study area, North Lorima National Forest, situated in northwestern Liberia (surveyed from 19–24 November 2005) was characterized by primary forest crossed by a large river and many smaller streams on slightly hilly terrain. There was no obvious anthropogenic disturbance to the investigated locations and habitat variation was minimal.

The second study site, Gola National Forest (28 November–4 December 2005) was mainly characterized by primary forest with rocky streams on very hilly terrain with several indications of anthropogenic impact, including old mining areas and a miners' camp.

The third site, Grebo National Forest (7–11 December 2005) was characterized by a 20-year old, mature secondary forest, but sites investigated contained some remaining primary forest. The actual study site was situated in a previously logged area and next to an old logging road. Aquatic sites included sandy streams with a few stones and rocks, and large pools.

Coordinates were taken with a hand-held GPS receiver (Garmin 12XL; WGS 84) and are listed in Appendix 3.

During our survey we concentrated on amphibians, as there are standardized methods to investigate these, while reptile records were only collected opportunistically. Amphibians were mainly recorded during encounter surveys, conducted both during the day and at night, by up to three people. Searching techniques included visual scanning of the terrain, investigation of potential refuges and acoustical monitoring (see Heyer et al. 1994; Rödel and Bangoura 2004; Rödel and Ernst 2004). Despite the fact that we experienced some rain at the different study sites (with almost daily, heavy rain at the last site), the number of calling males (indicating reproductive activity) was limited. A higher calling activity was observed at pools within the forest, but these did not occur at all study sites.

In addition to visual and acoustic monitoring, **drift fences** and pitfall traps (15 m of drift fence with five buckets), as well as drift fences and funnel traps (10 m of drift fence with eight funnel traps) were installed at all study sites (four nights per site). Only in Grebo National Forest did the trapping add a single amphibian species to our list. These results are therefore not reported in detail.

As our sampling design provides only qualitative and semi-quantitative data we estimated species richness and sampling efficiency with the Chao 2 and Jackknife 1 estimators (software EstimateS: Colwell 2005). These estimators are incidence based, using the presence/absence data of the daily species lists (15 days) for 40 species. The sampling effort was measured in man-hours spent searching at each study site and it was assumed that this effort was the same

for each habitat. To obtain quantitative data, mark-recapture experiments along standardized transects or on well-defined plots would have been necessary. These techniques could not be used due to the limited time available at each site.

The nomenclature of amphibians follows the taxonomy by Frost (2004); changes according to Frost et al. (2006) are listed in Appendix 4. For reptiles, the nomenclature follows Uetz et al. (1995). Some voucher specimens were anesthetized and euthanized in a chlorobutanol solution (amphibians) or ether (reptiles) and preserved in 70% ethanol. Voucher specimens have been deposited at Mark-Oliver Rödel's collection at the University of Würzburg (MOR); some of these will be transferred to natural history museums. Tissue samples (toe tips) were preserved in 95% ethanol. These samples have been stored at the Institute for Biodiversity and Ecosystem Dynamics at the University of Amsterdam, the Netherlands (Appendix 5).

RESULTS

We recorded at least 40 amphibian and 17 reptile species at the different study sites. A list of amphibian species with record sites, known habitat preference, distribution area and IUCN Red List category (IUCN et al. 2004) is given in Appendix 3. The list of reptile species with record sites is given in Appendix 6.

Twelve (30%) of the recorded amphibian species have a known distribution range that exceeds Western Africa. Eight species (20%) are restricted to West Africa, while the majority (19 species, 47.5%) are endemic to the Upper Guinea forest bloc. Further genetic analyses will clarify if one specimen can be referred to a known species (*Phrynobatrachus annulatus*) or if it is new to science and then probably a Liberian endemic (see below). The majority of the amphibians recorded are typical forest specialists, with some of them also being tolerant of farmbrush areas (Appendix 4). Only a few prefer savannah and/or farmbrush habitats. The occurrence of the latter in a forest is an indication of environmental disturbance (see Rödel and Branch 2002).

In North Lorima National Forest we recorded 18 amphibian and six reptile species, in Gola National Forest 30 amphibian and nine reptile species and in Grebo National Forest 30 amphibian and six reptile species.

North Lorima National Forest's amphibian community was dominated by true primary forest species, including four Near Threatened, one Vulnerable and one Endangered species. Most of these species were all very abundant within the study area. The presence of *Bufo maculatus* was a sign of some habitat disturbance.

Due to the presence of old mining areas, we observed a higher number of invasive species, i.e. species that normally do not occur within forest, in Gola National Forest (e.g. *Hoplobatrachus occipitalis*, *Afrixalus dorsalis*). The rocky streams represented a special habitat for species that were not or only rarely recorded in the other two forests.

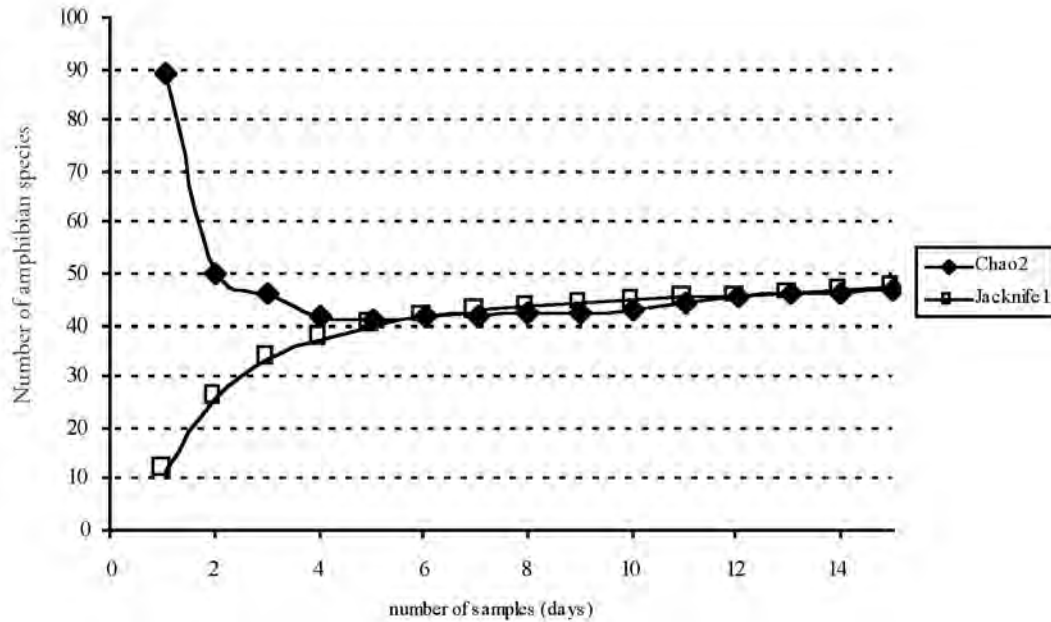


Figure 3.1: Estimated species richness of amphibians in North Lorma, Gola and Grebo National Forests.

We found six Near Threatened, two Vulnerable and one Endangered species in Gola National Forest.

A similar situation occurred in Grebo National Forest, where streams and big pools harboured species characteristic of these habitats. These species were not found at North Lorma National Forest, where similar habitats did not occur. In Grebo National Forest we recorded ten Near Threatened and two Vulnerable species. Surprisingly, these were mainly true forest species, although the study area mostly consisted of mature secondary forest. Genetic analysis will show if the Grebo National Forest community additionally includes one Endangered species.

The two incidence-based species richness estimators calculated that additional amphibian species are likely to occur within the three study sites. Both the Jackknife 1 and the Chao 2 estimator computed a species richness of 47 amphibian species (Figure 3.1). The recorded number of species thus corresponds to 85% of the estimated species richness.

Several amphibian species were recorded for the first time in Liberia: *Bufo superciliaris*, *Astylosternus occidentalis*, *Phrynobatrachus villiersi* (Vulnerable), *Chiromantis rufescens* and *Afrivalus nigeriensis* (Near Threatened). Range extensions were noted for *Phrynobatrachus plicatus*, *Ptychadena aequiplicata* and the Endangered *Amnirana occidentalis*.

DISCUSSION

Although it rained heavily on a few days during the survey period, there were few calling males within the forest. Probably the reproductive period of most species had already

come to an end. It is likely that some species were therefore overlooked. This may have led to an underestimation of species richness. Another factor contributing to this underestimation is that we covered only a small area within the three forests and did not visit all the existing habitat types (e.g. inselbergs or Grebo National Forest's primary forest). These habitats are likely to harbour additional frog species. This is also illustrated by the fact that during 15 days of observation we continuously detected additional species.

We recorded all Upper Guinea forest amphibians dependant on lotic forest habitats (*Astylosternus occidentalis*, *Bufo togoensis*, *Cardioglossa leucomystax*, *Conraua alleni*, *Hyperolius chlorosteus*, *Petropedetes natator*) as well as some species typical of lentic forest habitats (e.g. *Chiromantis rufescens*, *Phlyctimantis boulengeri*, *Phrynobatrachus plicatus*). Five reptile species (African Dwarf Crocodile *Osteolaemus tetraspis*, Rock Python *Python sebae*, Monitor Lizard *Varanus ornatus*, and two tortoises *Kinixys erosa* and *K. homeana*) as well as the toad *Bufo superciliaris* are threatened and protected by international law.

CONSERVATION RECOMMENDATIONS

In all three national forests the observed amphibian community is of high conservation value, comprising typical forest assemblages with only a few invasive farmbrush species. Many of the recorded species are Near Threatened and some are Endangered or Vulnerable.

Some Near Threatened species (*Phrynobatrachus alleni*, *Phrynobatrachus liberiensis*, *Phrynobatrachus phyllophilus*)

were extremely abundant in North Lorima and this habitat thus seemed quite healthy. This amphibian community was dominated by true primary forest species, but the presence of e.g. *Bufo maculatus* was a signal of disturbance. The Vulnerable (*Phrynobatrachus villiersi*), Endangered (*Phrynobatrachus annulatus*) and Near Threatened species mentioned live in extremely different habitat types. The variety of habitats in North Lorima National Forest should therefore be conserved and prevented from any further alteration.

In Gola National Forest, former mining activities created disturbed habitats, which led to the presence of invasive savannah species. However, some of these new habitats were also favourable to forest species (e.g. *Afrivalus nigeriensis*, *Phrynobatrachus fraterculus*, *Chiromantis rufescens*), as, for example, old mining ponds were used as breeding sites by various frog species. Possible contamination from former mining that could affect amphibians, such as quicksilver residues, could not be examined during our survey. The many rocky streams in Gola National Forest represent a typical habitat for a number of frogs, including Near Threatened (*Hyperolius chlorosteus*, *Petropedetes natator*), Vulnerable (*Conraua alleni*) and Endangered (*Ammirana occidentalis*) species. Therefore, this forest, and especially its aquatic habitats, should be protected and preserved from further disturbance.

In Grebo National Forest, the anthropogenic alteration is very obvious. However, a high number of typical forest species occurred in the mature secondary forest, including ten Near Threatened (e.g. *Bufo togoensis*, *Afrivalus nigeriensis*, *Leptopelis occidentalis*, *Phrynobatrachus guineensis*) and two Vulnerable species (*Conraua alleni*, *Phrynobatrachus villiersi*). Further genetic analysis will show if one frog can be correctly assigned to the Endangered *Phrynobatrachus annulatus*. Additionally, we assume Grebo National Forest to be very important for conservation because of its proximity to Taï National Park in Côte d'Ivoire. The latter is one of the most species-rich West African sites for amphibians (Rödel 2000) and harbours highly specialized and endemic forest species (Perret 1988; Rödel and Ernst 2000, 2001; Rödel et al. 2003). Since both sites were connected in the past, several threatened species and species considered endemic to Taï National Park are likely to occur in Grebo National Forest as well. This might be the case for *Kassina lamottei* and *Bufo taiensis*. Grebo National Forest could likely play a major role by connecting Taï and Sapo National Parks as a kind of stepping stone.

Further surveys are highly recommended for all three forests. These should predominantly take place during the rainy season, when amphibians and reptiles are more active. In Grebo National Forest these studies should focus on the primary forest habitat. Intensive research will lead to a better knowledge of the existing herpetofauna and its assemblage composition, population size and distribution patterns. This is especially important for species of conservation concern. Further studies will also lead to a better understanding of the importance of certain habitats, which will help in developing reliable and detailed conservation recommendations.

REFERENCES

- Bakarr, M., B. Bailey, D. Byler, R. Ham, S. Olivieri and M. Omland. 2001. From the Forest to the Sea: Biodiversity Connections from Guinea to Togo. Conservation International. Washington DC.
- Böhme, W. 1994a. Frösche und Skinke aus dem Regenwaldgebiet Südost-Guineas, Westafrika. I. Einleitung; Pipidae, Arthroleptidae, Bufonidae. Herpetofauna 16 (92): 11–19.
- Böhme, W. 1994b. Frösche und Skinke aus dem Regenwaldgebiet Südost-Guineas, Westafrika. II. Ranidae, Hyperoliidae, Scincidae; faunistisch-ökologische Bewertung. Herpetofauna 16 (93): 6–16.
- Chatelain, C., L. Gautier and R. Spichiger. 1996. A recent history of forest fragmentation in southwestern Ivory Coast. Biodiv. Conserv. 5: 783–791.
- Collwell, R.K. 2005. EstimateS Version 6.0b. Statistical estimation of species richness and shared species from samples. Website: viceroy.eeb.uconn.edu/estimates.
- Ernst, R., K.E. Linsenmair and M.-O. Rödel. 2006. Diversity erosion beyond the species level: Dramatic loss of functional diversity after selective logging in two tropical amphibian communities. *Biol. Conserv.* 133: 143–155.
- Ernst, R. and M.-O. Rödel. 2005. Anthropogenically induced changes of predictability in tropical anuran assemblages. *Ecology* 86: 3111–3118.
- Frost, D.R. 2004. Amphibian species of the World: an online reference. Version 3.0. American Museum of Natural History, New York. Website: research.amnh.org/herpetology/amphibia/index.html. (January 6th, 2006).
- Frost, D.R., T. Grant, J. Faivovich, R.H. Bain, A. Haas, C.F.B. Haddad, R.O. De Sá, A. Channing, M. Wilkinson, S.C. Donnellan, C.J. Raxworthy, J.A. Campbell, B.L. Blotto, P. Moler, R.C. Drewes, R.A. Nussbaum, J.D. Lynch, D.M. Green and W.C. Wheeler. 2006. The Amphibian tree of life. *Bull. Am. Mus. Nat. Hist.* 297: 1–370.
- Greenbaum, E. and J.L. Carr. 2005. The Herpetofauna of Upper Niger National Park, Guinea, West Africa. *Sci. Papers, Nat. Hist. Mus. Univ. Kansas* 37: 1–21.
- Guibé, J. and M. Lamotte. 1958a. La réserve naturelle intégrale du Mont Nimba. XII. Batraciens (sauf *Arthroleptis*, *Phrynobatrachus* et *Hyperolius*). *Mém. Inst. fond. Afr. noire, sér. A*, 53: 241–273.
- Guibé, J. and M. Lamotte. 1958b. Morphologie et reproduction par développement direct d'un anoure du Mont Nimba, *Arthroleptis cruscolum* Angel. *Bull. Mus. natl. Hist. nat., 2e sér.* 30: 125–133.
- Guibé, J. and M. Lamotte. 1963. La réserve naturelle intégrale du Mont Nimba. XXVIII. Batraciens du genre *Phrynobatrachus*. *Mém. Inst. fond. Afr. noire, sér. A*, 66: 601–627.
- Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.-A.C. Hayek and M.S. Foster. 1994. *Measuring and Monitoring Biological Diversity. Standard Methods for Amphib-*

- ians. Biological Diversity Handbook Series. Smithsonian Institution Press. Washington, DC.
- IUCN, Conservation International and Nature Serve. 2004. Global Amphibian Assessment. Website: globalamphibians.org. (January 6th, 2006).
- Perret, J.-L. 1988. Les espèces de *Phrynobatrachus* (Anura, Ranidae) à éperon palpépral. Arch. Sci. 41: 275–294.
- Rödel, M.-O. 2000. Les communautés d'amphibiens dans le Parc National de Taï, Côte d'Ivoire. Les anoures comme bio-indicateurs de l'état des habitats. In: Girardin, O., I. Koné and Y. Tano (eds.), Etat des recherches en cours dans le Parc National de Taï (PNT). Sempervira, Rapport du Centre Suisse de la Recherche Scientifique, Abidjan, 9: 108–113.
- Rödel, M.-O. and A.C. Agyei. 2003. Amphibians of the Togo-Volta highlands, eastern Ghana. Salamandra 39: 207–234.
- Rödel, M.-O. and M.A. Bangoura. 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 *Amnirana* species (Amphibia Anura Ranidae). Trop. Zool. 17: 201–232.
- Rödel, M.-O. and W.R. Branch. 2002. Herpetological survey of the Haute Dodo and Cavally forests, western Ivory Coast, Part I: Amphibians. Salamandra 38: 245–268.
- Rödel, M.-O. and R. Ernst. 2000. *Bufo taiensis* n. sp., eine neue Kröte aus dem Taï Nationalpark, Elfenbeinküste. Herpetofauna 22 (125): 9–16.
- Rödel, M.-O. and R. Ernst. 2001. Description of the tadpole of *Kassina lamottei* Schiøtz, 1967. J. Herpetol. 36: 561–571.
- Rödel, M.-O. and R. Ernst. 2003. The amphibians of Marahoué and Mont Péko National Parks, Ivory Coast. Herpetozoa 16: 23–39.
- Rödel, M.-O. and R. Ernst. 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., J. Kosuch, M. Veith and R. Ernst. 2003. First record of the genus *Acanthixalus* Laurent 1944 from the Upper Guinean rain forest, West Africa, including the description of a new species. J. Herpetol. 37: 43–52.
- Rödel, M.-O., M.A. Bangoura and W. Böhme. 2004. The amphibians of south-eastern Republic of Guinea (Amphibia: Gymniphiona, Anura). Herpetozoa 17: 99–118.
- Schiøtz, A. 1967. The treefrogs (Racophoridae) of West Africa. Spolia zool. Mus. haun. 25: 1–346.
- Schiøtz, A. 1968. On a collection of amphibia from Liberia and Guinea. Vidensk. Medd. dansk naturh. Foren. 131: 105–108.
- Schiøtz, A. 1999. Treefrogs of Africa. Edition Chimaira. Frankfurt/M.
- Sosef, M.S.M. 1994. Refuge begonias: taxonomy, phylogeny and historical biogeography of *Begonia* sect. *Loasibegonia* and sect. *Scutobegonia* in relation to glacial rain forest refuges in Africa. Studies in Begoniaceae 5. Wageningen Agricultural University Papers.
- Uetz, P., R. Chenna, T. Etzold and J. Hallermann. 1995. The EMBL reptile database. Website: www.reptile-database.org (January 6th, 2006).

Appendix 3

Locality list and short description of habitats investigated in North Lorima National Forest/ Wologizi (WOL), Gola National Forest (GO) and Grebo National Forest (GRE).

Annika Hillers and Mark-Oliver Rödel

Site	Latitude (N)	Longitude (W)	Date	Description
WOL1	8°01.741'	9°44.119'	20.11.2005	Primary forest with small stream
WOL2	8°01.929'	9°44.161'	20.11.2005	Dry primary forest on hill above big river
WOL3	8°01.434'	9°44.414'	21.11.2005	Primary forest, one part slightly swampy area, other part brook, next to big river
WOL4	8°01.523'	9°44.226'	21.11.2005	Dry forest over river, many lianas, thick undergrowth
WOL5	8°02.043'	9°43.970'	22.11.2005	Forest around stream with rocks and stones, further in forest sandy, and slightly swampy area with temporary puddles
WOL6	8°02.023'	9°44.143'	22.11.2005	Forest over river, on one side stream with small waterfall, many shrubs and bushes
WOL7	8°02.509'	9°43.682'	23.11.2005	Dry forest with big rocks and stones
WOL8	8°02.391'	9°43.750'	23.11.2005	Swampy area in forest, with <i>Raffia</i> and <i>Marantaceae</i> , partly open canopy
WOL9	8°01.722'	9°44.124'	24.11.2005	Forest with streams and partly swampy area
GO1	7°27.178'	10°41.522'	28.11.2005 & 1.12.2005	Hilly primary forest with stream, stream with rocks and sand
GO2	7°27.272'	10°41.548'	29.11.2005	Dry forest on hill, with some rocks
GO3	7°27.376'	10°41.736'	29.11.2005 & 1.12.2005	Old diamond mines and ponds within forest, partly open area, and forest around this area
GO4	7°27.293'	10°41.632'	29.11.2005	Dry forest on hill
GO5	7°27.352'	10°41.483'	30.11.2005	Valley within forest with small brook, partly swampy area and forest around, partly on hill
GO6	7°26.781'	10°39.063'	2.12.2005	Big pond near SLC village
GO7	7°26.404'	10°39.150'	2.12.2005	Small pond next to big river Mano, with stones and a few trees
GRE1	5°24.108'	7°44.011'	7.12.2005	Mature secondary forest, partly thick undergrowth, with sandy stream and temporary puddles
GRE2	5°24.358'	7°44.106'	8.12.2005 & 10.12.2005	Swampy area in forest with small stream, with many treefall gaps and lianas, forest around the swampy area
GRE3	5°24.535'	7°44.276'	8.12.2005	Dry forest
GRE4	5°24.285'	7°43.786'	9.12.2005	Swampy area within secondary forest near stream with many lianas and shrubs, thick leaf litter coverage
GRE5	5°24.334'	7°43.631'	9.12.2005	Dry forest on hill
GRE6	5°23.857'	7°42.536'	10.12.2005	Big pond next to old logging road in mature secondary forest
GRE7	5°24.083'	7°42.892'	10.12.2005	Pond next to old logging road in mature secondary forest
GRE8	5°24.286'	7°42.954'	10.12.2005	Small pond next to old logging road in mature secondary forest
GRE9	5°24.127' & 5°23.827'	7°43.965' & 7°44.160'	9.12.2005 & 11.12.2005	On or next to old logging road in mature secondary forest

Appendix 4

Amphibian species recorded in North Lorma, Gola and Grebo National Forests.

Annika Hillers and Mark-Oliver Rödel

Amphibian species recorded in North Lorma (WOL), Gola (GO) and Grebo (GRE) National Forests with record sites (see Appendix 3), habitat preference and their distribution in Africa.

S = savannah

FB = farmbush (degraded forest and farmland)

F = forest

A = Africa (occurs also outside West Africa)

WA = West Africa (Senegal to eastern Nigeria)

UG = Upper Guinea (forest zone West of the Dahomey Gap)

E = endemic to Liberia

* = records possibly comprise several species

** = CITES listed species

spp. & cf. = determination needs confirmation or new species are involved

LC = Least concern

NT = Near Threatened

VU = Vulnerable

EN = Endangered

¹ = first country record

Frost et al. (2006) introduced many new names and relationships. As these are not yet generally accepted and to allow for a better orientation with older literature, we herein list the old names. The new affiliations according to Frost et al. (2006) are: The West African *Bufo* species are now in the genus *Amietophrynus*. The African *Amnirana* species in the genus *Hydrophylax*. *Astylosternus* and *Leptopelis* moved into the family Arthroleptidae. *Conraua* now belongs into the family Petropedetidae, *Hoplobatrachus* into the family Dicroglossidae, *Ptychadena* into the family Ptychadenidae and *Phrynobatrachus* forms the family Phrynobatrachidae.

Species	Site	S	FB	F	A	WA	UG	E	IUCN Red List category
Arthroleptidae									
<i>Arthroleptis</i> spp. *	WOL 1,6,7 GO 1,5 GRE 1,2,4,5,9		x	x			x		LC
<i>Cardioglossa leucomystax</i>	WOL 1,5 GO 1,5 GRE 1			x	x				LC
Astylosternidae									
<i>Astylosternus occidentalis</i> ¹	GO 1,5			x			x		LC
Bufonidae									
<i>Bufo maculatus</i>	WOL 6 GO 3,6 GRE 7,9	x	x	x	x				LC

continued

Species	Site	S	FB	F	A	WA	UG	E	IUCN Red List category
<i>Bufo regularis</i>	WOL 6 GO 6 GRE 9	x	x		x				LC
<i>Bufo superciliaris</i> ** [†]	WOL 1,3			x	x				LC
<i>Bufo togoensis</i>	WOL 1 GRE 1			x			x		NT
Hyperoliidae									
<i>Afrivalus dorsalis</i>	GO 3,6 GRE 8	x	x	x	x				LC
<i>Afrivalus nigeriensis</i> [†]	GO 3 GRE 1,7,8		x	x		x			NT
<i>Hyperolius chlorosteus</i>	GO 1 GRE 1,4		x	x			x		NT
<i>Hyperolius concolor</i>	GO 6	x	x	x		x			LC
<i>Hyperolius fusciventris</i>	GO 3,6 GRE 6,7		x	x		x			LC
<i>Hyperolius guttulatus</i>	GO 3,6 GRE 6,7		x	x	x				LC
<i>Hyperolius picturatus</i>	GO 6 GRE 1,2		x	x			x		LC
<i>Leptopelis hyloides</i>	WOL 1,5 GO 6 GRE 1		x	x		x			LC
<i>Leptopelis macrotis</i>	GRE 1			x			x		NT
<i>Leptopelis occidentalis</i>	GRE 1			x			x		NT
<i>Phlyctimantis boulengeri</i>	GRE 8		x	x		x			LC
Petropedetidae									
<i>Petropedetes natator</i>	GO 1			x			x		NT
<i>Phrynobatrachus accraensis</i>	GO 6	x	x			x			LC
<i>Phrynobatrachus alleni</i>	WOL 1,2,3,5,6,8,9 GO 4 GRE 4			x			x		NT
<i>Phrynobatrachus annulatus</i>	WOL 3,6			x			x		EN
<i>Phrynobatrachus</i> cf. <i>annulatus</i>	GRE 2			x			(x)		(EN)
<i>Phrynobatrachus fraterculus</i>	WOL 1,3,5,9 GO 3			x			x		LC
<i>Phrynobatrachus guineensis</i>	GRE 2,4			x			x		NT
<i>Phrynobatrachus liberiensis</i>	WOL 1,2,3,5 GO 1,5 GRE 1,2,4			x			x		NT
<i>Phrynobatrachus phyllophilus</i>	WOL 1,5 GO 1,3,5 GRE 2,4			x			x		NT
<i>Phrynobatrachus plicatus</i>	WOL 1,6,9 GO 1 GRE 2,4,9			x		x			LC

continued

Species	Site	S	FB	F	A	WA	UG	E	IUCN Red List category
<i>Phrynobatrachus tokba</i>	WOL 1,3 GO 1,4,5 GRE 2,9			x			x		LC
<i>Phrynobatrachus villiersi</i> ¹	WOL 2 GO 5 GRE 2			x			x		VU
Pipidae									
<i>Silurana tropicalis</i>	GRE 1		x	x	x				LC
Rhacophoridae									
<i>Chiromantis rufescens</i> ¹	WOL 6 GO 3, 7 GRE 8			x	x				LC
Ranidae									
<i>Ammirana albolabris</i>	WOL 1 GO 6 GRE 1,2,4		x	x	x				LC
<i>Ammirana occidentalis</i>	GO 1			x			x		EN
<i>Conraua alleni</i>	GO 1 GRE 2			x			x		VU
<i>Hoplobatrachus occipitalis</i>	GO 3,6	x	x	x	x				LC
<i>Ptychadena aequiplicata</i>	WOL 1,4,5 GO 3 GRE 2			x	x				LC
<i>Ptychadena bibroni</i>	GO 3,6	x	x		x				LC
<i>Ptychadena longirostris</i>	GO 3 GRE 9		x	x		x			LC
<i>Ptychadena superciliaris</i>	GRE 6			x			x		NT

Appendix 5

Amphibian tissue samples and voucher specimens collected during Liberia RAP survey.

Annika Hillers and Mark-Oliver Rödel

List of tissue samples (DNA) and voucher specimens.

MOR = collection Rödel; tissue samples preserved in 95% ethanol, voucher specimens preserved in 70% ethanol.

North Lorma (WOL) National Forest

Gola (GO) National Forest

Grebo (GRE) National Forest

Species	DNA	MOR
<i>Arthroleptis</i> spp.	WOL 15, 16, 22, 56, 68, 74, 83, 84, 86, 94 GO 6, 21, 22, 23, 45, 55, 72 GRE 1, 2, 3, 7, 8, 11, 15, 16, 18, 20, 21, 22, 23, 24, 25, 26, 27, 31, 55, 58, 76, 78, 79, 80, 81	WOL 15, 68, 74, 94 GO 6, 45 GRE 11, 58
<i>Cardioglossa leucomystax</i>	WOL 87, 88, 89, 98 GO 7, 43, 50 GRE 56	WOL 87 GO 43 GRE 56
<i>Astylosternus occidentalis</i>	GO 4, 29, 58	GO 4
<i>Bufo regularis</i>	GRE 73, 74	GRE73
<i>Bufo superciliaris</i>	WOL 19, 78, 79	
<i>Bufo togoensis</i>	WOL 80, 18, 23, 80, GRE 28, 29, 36	WOL 80 GRE36
<i>Afrixalus dorsalis</i>	GO 60	GO 60
<i>Afrixalus nigeriensis</i>	GO 61 GRE 43	GO 61 GRE 43
<i>Hyperolius chlorosteus</i>	GRE 5, 46, 64	GRE 46
<i>Hyperolius fusciventris</i>	GO 16, 17, 62, 64, 65, 67	GO 62, 64, 65, 67
<i>Hyperolius guttulatus</i>	GO 63, 66 GRE 72	GO 63 GRE 72
<i>Hyperolius picturatus</i>	GRE 41	GRE 41
<i>Leptopelis hylroides</i>	WOL 101, 102, 103 GRE45	WOL 101 GRE 45
<i>Leptopelis macrotis</i>	GRE 40	GRE 40
<i>Leptopelis occidentalis</i>	GRE 42	GRE 42
<i>Phlyctimantis boulengeri</i>	GRE 75	GRE 75
<i>Petropedetes natator</i>	GO 15, 19, 39	GO 39

continued

Species	DNA	MOR
<i>Phrynobatrachus alleni</i>	WOL 1, 2, 3, 4, 6, 8, 10, 13, 20, 24, 25, 28, 34, 35, 38, 41, 43, 54, 59, 60, 61, 62, 67, 72, 73 GO 33, 35, 36 GRE 37, 59, 61, 67	WOL 13, 72, 73 GRE 37, 59
<i>Phrynobatrachus annulatus</i>	WOL 69, 82, 92	WOL 92
<i>Phrynobatrachus cf. annulatus</i>	GRE 47	GRE 47
<i>Phrynobatrachus fraterculus</i>	WOL 44, 46, 51, 52, 63, 97, 99, 100 GO 31, 37, 38, 44, 47	WOL 51, 52 GO 44
<i>Phrynobatrachus guineensis</i>	GRE 48, 62	GRE 48, 62
<i>Phrynobatrachus liberiensis</i>	WOL 5, 11, 21, 26, 27, 31, 32, 33, 34, 36, 37, 39, 40, 42, 50, 58, 81, 85 GO 27, 28, 41 GRE 6, 12, 13, 14, 17, 33, 53	WOL 50 GO 41 GRE 13, 53
<i>Phrynobatrachus phyllophilus</i>	WOL 7, 9, 12, 14, 17, 55, 64, 65, 93, 96 GO 5, 8, 25, 26, 30, 46, 48, 52 GRE 34, 60, 68	WOL 14, 93 GO 5, 46, 52 GRE 34
<i>Phrynobatrachus plicatus</i>	WOL 71, 76, 77, 90, 95 GO 42, 71 GRE 19, 30, 35, 49, 50, 51, 54	WOL 71 GO 42 GRE 30
<i>Phrynobatrachus tokba</i>	WOL 29, 30, 45, 53, 57 GO 2, 3, 9, 24, 32, 49, 51, 54 GRE 63, 65, 66, 69, 77, 82, 83, 84	WOL 53 GO 9 GRE 63
<i>Phrynobatrachus villiersi</i>	GRE 32	GRE 32
<i>Chiromantis rufescens</i>	GO 18, 53, 59 GRE 70	GO 53, 59 GRE 70
<i>Amnirana albolabris</i>	WOL 70 GO 73 GRE 4, 10	WOL 70 GO 73 GRE 10
<i>Amnirana occidentalis</i>	GO 10, 11, 12, 13, 14, 56, 57	GO 12, 14
<i>Conraua alleni</i>	GO 20, 40 GRE 38, 39, 44	GO 40 GRE 38, 39
<i>Ptychadena aequiplicata</i>	WOL 48, 49, 66, 75, 91 GRE 9	WOL 75 GRE 9
<i>Ptychadena longirostris</i>	GRE 52, 57	GRE 57
<i>Ptychadena superciliaris</i>	GRE 71	GRE 71

Appendix 6

Reptile species recorded in North Lorma,
Gola and Grebo National Forests.

Annika Hillers and Mark-Oliver Rödel

Taxa	Site	CITES Appendix #
REPTILIA - SAURIA		
Agamidae		
<i>Agama agama</i>	Gola, Grebo	
Gekkonidae		
<i>Hemidactylus aff. muriceus</i>	Gola	
Scincidae		
<i>Trachylepis affinis</i>	Grebo	
<i>Cophoscincopus</i> sp.1	North Lorma, Gola	
<i>Cophoscincopus</i> sp. 2	Gola	
Varanidae		
<i>Varanus ornatus</i>	Gola	2
REPTILIA - SERPENTES		
Boidae		
<i>Python sebae</i>	North Lorma	2
Colubridae		
<i>Dipsadoboa</i> sp.	Grebo	
<i>Grayia smythii</i>	Gola	
<i>Natriciteres variegata</i>	Grebo	
<i>Philothamnus heterodermus</i>	North Lorma	
<i>Rhamnophis aethiopissa</i>	North Lorma	
Viperidae		
<i>Bitis gabonica</i>	Gola	
<i>Atheris chlorechis</i>	North Lorma, Gola	
REPTILIA - CHELONIA		
Testudinidae		
<i>Kinixys homeana</i>	North Lorma	2
<i>Kinixys erosa</i>	Grebo	2
REPTILIA - CROCODYLIA		
Crocodylidae		
<i>Osteolaemus tetraspis</i>	Gola, Grebo	1