Amphibians of the Togo-Volta highlands, eastern Ghana

MARK-OLIVER RÖDEL & ALEX CUDJOE AGYEI

Abstract

During the present survey, we were able to record 31 amphibian species for the whole Volta region. Based on our sampling effort and statistical and comparative extrapolation, we estimate that at least 41 amphibian species live within the study area. Therefore, the Togo-Volta Highlands are more diverse than assumed. We failed to record amphibians that are highly adapted to fast running water, e. g. the endemic *Conraua derooi*, or larger closed forests, e. g. *Bufo togoensis*. Torrenticolous amphibians may be declining in the area investigated.

We could not find larger tracts of closed forests in the Volta region. This explains the lack of several primary forest specialists in our records. The high percentage of „farmbush" species in our list is a clear indication that the natural forest cover has been largely destroyed in many areas. Relict populations of true forest specialists could be found especially around Wli waterfall and Shiare village.

Future conservation efforts should encourage all local activities that are likely to preserve village forests in the Volta region. Additionally all larger remaining forest areas should be given highest conservation priority and efforts should be considered to either link or buffer smaller forest remnants through reforestation efforts.

Key words: Amphibia: Anura; conservation; diversity; forest remnants; West Africa: Ghana; habitat choice.

1 Introduction

West African rain forests rank among the 25 most important biodiversity hotspots of the world (MYERS et al. 2000). They are highly threatened by logging, agriculture and an increasing human population (BAKARR et al. 2001). About 80 % of primary forests in western Ivory Coast have been destroyed during the last 20 years (ROMPAY 1993, CHATELAIN et al. 1996). In Ghana even less of the original forest cover is still present (BAKARR et al. 2001). Remnants of original forest are only found in remote and inaccessible areas, where forest reserves were established a long time ago (OATES 1999). In the Volta region the condition of the forests is especially serious. Most of the original forest cover has been destroyed by extensive deforestation and subsequent transformation into agricultural areas. The demand for land in that region has even increased by movements of dispossessed people before the damming of Volta Lake in 1966 (HAWTHORNE 2001). It is likely that most West African forest dwelling species might become threatened in the near future. This is even more alarming when facing the fact that our knowledge of the forest fauna is still rather poor.

Despite the fact that West Africa has been the target of herpetological investigations for more than 100 years (e. g. WERNER 1898; AHL 1924 a,b; PARKER 1936), our present knowledge is still scanty (HUGHES 1988 provided an overview on the history of herpetological investigations in Ghana). For most of the described West African amphibians biological data are still more or less anecdotal or completely lacking. However, in the 1970s it was assumed that at least the species inventory was nearly complete. Based on this assumption West Africa was seen as an area with a comparatively low diversity. LAMOTTE (1983) said that there is no place in West Africa where more than 40 amphibian species live in sympatry. This seemed also to be true for the eastern part of the Upper Guinea Forest block. According to an unpublished checklist, compiled by A. SCHIØTZ for the Conservation Priority Setting Workshop (From the

Forest to the Sea: Biodiversity Connections from Guinea to Ghana, December 6-10th 1999 in Elmina, Ghana), only 36 amphibian species are known from this region.

However, recent investigations in Ivory Coast revealed anuran communities comprising more than 30 species, even in savanna habitats (RÖDEL 1998a, 2000, RÖDEL & SPIELER 2000, RÖDEL & ERNST 2003). Well studied forest communities comprise between 40 and 56 species (RÖDEL & BRANCH 2002, RÖDEL 2003, RÖDEL & ERNST 2003). Seven new species have been described from West Africa within the last eight years and further species still await description (PERRET 1994; LAMOTTE & OHLER 1997; RÖDEL 1998b; RÖDEL & ERNST 2000, 2002; RÖDEL et al. 2002a, 2003). Larger undisturbed forests in the Upper Guinea forest block may contain more than 60 sympatric amphibian species.

From the eastern part of the Upper Guinea forests nine endemic amphibian taxa have been described so far. The most recent extensive field work conducted in this region dates back to the early 1960s (SCHIØTZ 1964a, b, 1967). Subsequent investigations in Ghana were not focused on forest habitats nor were they undertaken with special emphasis on amphibians (e. g. HOOGMOED 1979, 1980a-g). Judging from our results in Ivory Coast, the herpetofauna of Ghana is probably just incompletely known. In particular, this concerns the almost neglected Togo highlands in the East of the country. For this reason, A. SCHIØTZ and M.-O. RÖDEL defined the eastern Ghanian forests as an area with an exceptionally high priority level for rapid assessment during the Conservation Priority Setting Workshop in Ghana (BAKARR et al. 2001). As an outcome of that workshop, we conducted an amphibian survey in the Ghanian Togo-Volta Highland area in August 2000, together with a group surveying small mammals, led by J. DECHER from the University of Vermont (DECHER & ABEDI-LARTEY 2002).

2 Study sites

For our survey we defined the Ghana-Togo highlands (Fig. 1) as extending from Akwamufie in the eastern region (east bank of lower Volta), near the Volta Dam northeastward, including Kalakpa Resource Reserve, Mount Adaklu and Mont Agou in Togo; from there northward to Atakpamé and along the line Sotouboua-Sokodé, including the Faille d'Alédjo region; westward to Bassar, then south to the Fazao Malfakassa Wildlife Reserve and Kyabobo National Park in Ghana; then along the line Pawa-Odomi-Jongo to Worawora, Kpandu back to Akwamufie. Most of the Ghanian part of that region is covered by dry semi-deciduous forest of the „fire zone subtype" (DECHER & ABEDI-LARTEY 2002). This area is part of the wet semi-equatorial climatic region, geologically belonging to the Voltaian Basin (Buem series and Togo series, FREMPONG 1995). A short characterization of our study sites is given below (habitat # in parentheses, compare Tab. 1).

2.1 Wli and Liati-Wote Waterfalls Region, southeast of Hohoe

The Agumatsa Wildlife Sanctuary (Wli Waterfalls, 6°27' N, 0°21' E) is under legal protection and situated about 0.75 km east of Afegame. Liate-Wote (Tagbo Falls, 7°00' N, 0°33' E) is traditionally protected. The geological subsurface is comprised of quartzite, shale and phyllite. Mean annual precipitation is 1650 mm (FREMPONG 1995). Sampling effort in this region was 94.25 man-hours (m-h; see 3, numbers in parentheses refer to habitat numbers in Tab. 1).

Wli Waterfall: Escarpment close to the Togo border, steep slopes with scattered forest remnants and plantations (11); fast flowing mountain creek in the valley (3);

bordered by rain forest remnants (10); open areas with scattered lower trees (3); densely vegetated swamps fully exposed to sun, forest fragments nearby, small shrubs (2, 12); shallow, densely vegetated pond, part of large flooded area, shrubs and larger herbs at pond border (5); plantations and secondary forest (9); degraded forest between a tree nursery and larger pond (6); dense understory, open canopy, rocky mountainous creek, waterfall (4); small pond in dry bed of small creek (7); path through forest remnants, dead tree with water hole (8).

Liati Wote Waterfall (=Tagbo Fall): valley with fast running rocky creek, waterfall, cacao plantations and forest remnants (35); village, artificial pond, rice fields, surrounding of village resembles humid savanna (36).

2.2 Kyabobo Range National Park, Shiare and Nkwanta

In Kyabobo Range National Park we stayed in the south of the park at Laboum Creek (8°19' N, 0°35' E). The traditionally protected forests of Shiare village are at 8°17' N, 0°37' E. There we could only investigate forest remnants outside of the sacred forest. Around Nkwanta (8°18' N, 0°29' E) we investigated ponds, puddles and rice fields along the roads north and east of the town. The subsurface is formed of quartzite, shale and phyllite. Mean annual precipitation is 1400 mm (FREMPONG 1995). Sampling effort in this region was 75.75 m-h.

Nkwanta: road ditches, garden (13); rice fields east of Nkwanta, puddles on dirt road (14), rice fields north of Nkwanta, small ponds (15).

Kyabobo National Park: way into park, hilly landscape, character of tree savanna, dense but low forest on the slopes, corn, cassava and banana plantations in the valley (16); in the national park fast flowing rocky creek, very hilly landscape, forest with single larger trees (up to 40 m) on steep slopes, primary forest on bottom of valley, forest merges into savanna on hilltops (17, 18).

Shiare: dirt road with shallow puddles (33); plantations, fast flowing creek (water polluted with sewage run-off from village), some deep water, rocks, rapids, forest remnants with dense understory (32); small rocky creek, bank with dense vegetation, gallery forest, partly high forest, bordered by plantations (cassava, bananas), savanna forest on hilltops (34).

2.3 Apesokubi area and northern Lake Volta

Most of our field work was done in forest remnants about 4 km north of the town of Apesokubi (7°36' N, 0°23' E). Other field sites were directly south of the town and on the north-eastern bank of Lake Volta (near village Katanka). The Upper Precambrian underground comprises shale sandstone, arhose and lava. Mean annual precipitation is 1524 mm (FREMPONG 1995). Sampling effort in this region was 37.5 m-h.

Apesokubi: West of town, dried up pond, bank with herbs and shrubs, degraded forest remnant (19, 20); puddles on dirt road, bordered by dense shrubs and degraded forest and cacao plantations (21, 25, 26); rice fields (22, 24); shallow, slow running muddy creek, secondary forest, single emergent trees, few puddles in a rice field (23); south of town, large pond, partly heavily vegetated, floating herbs, secondary forest, plantations (27); small pond, bank vegetated with herbs and shrubs (28); two shallow ponds between dirt road and secondary forest (29).

Katanka and bank of Lake Volta: small puddle without vegetation, surrounded by savanna (30); Volta bank without vegetation, *Borassus* palm savanna (31).

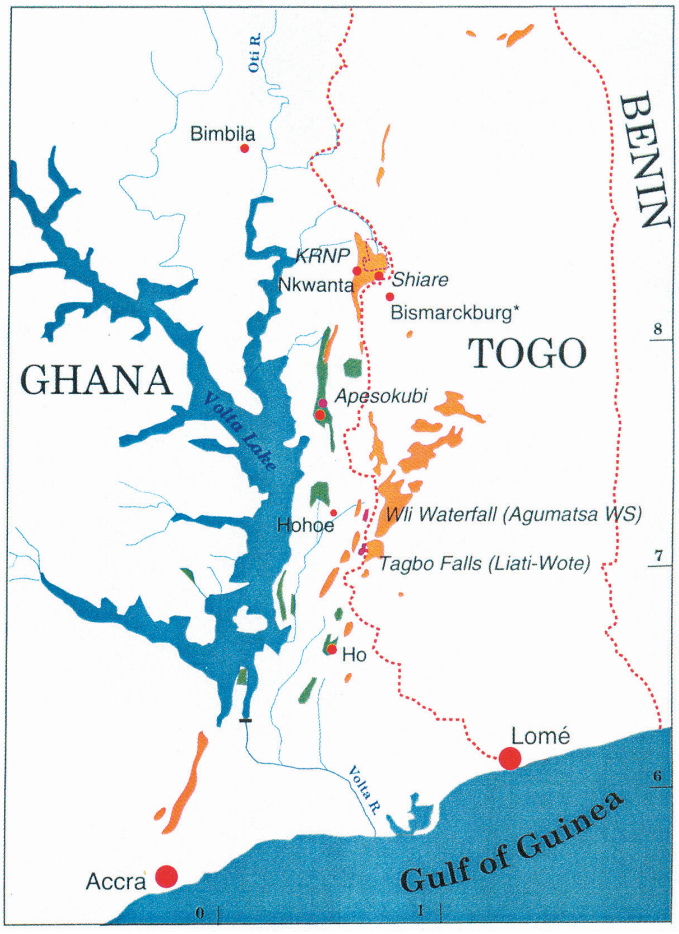

Fig. 1. Map of the Togo-Volta region; green = forest reserves; brown = elevations > 600 m a.s.l. (© by JAN DECHER).

Karte der Togo-Volta Region; grün = Waldschutzgebiete; braun = Erhebungen > 600 m üNN.

3 Sampling methods and sampling effort

The sampling method for amphibians was the same for all areas investigated and consisted of opportunistic visual and acoustical monitoring of all present habitat types (HEYER et al. 1993). Sampling was done during day and night time, preferably after rainfall. With this kind of sampling method, only qualitative and semi quantitative data can be obtained. For exact quantitative data mark-recapture experiments along either standardized transects or on definite plots would have been necessary. Since every region was investigated for only three to five days, time was not sufficient to employ these methods. To evaluate our sampling efficiency we measured the time in man hours (m-h), looking for amphibians at a certain place. More time for investigation

region / Region	habitat # / Lebensraum Nr.	date / Datum	man-hours / Mannstunden
Wli	1	10.-13.8.2001	14
Wli	2	10.-12.08.2001	11
Wli	3	10.08.2001	3
Wli	4	11.08.2001	16
Wli	5	12.08.2001	12
Wli	6	12.08.2001	3
Wli	7	12.08.2001	0.3
Wli	8	11.-14.08.2001	9
Wli	9	12.08.2001	8
Wli	10	13.08.2001	4
Wli	11	13.08.2001	5
Wli	12	13.-14.08.2001	5
Nkwanta	13	15.-20.08.2001	7.5
Nkwanta	14	20.08.2001	0.3
Nkwanta	15	20.08.2001	3
Kyabobo	16	16.08.2001	2
Kyabobo	17	16.-18.08.2001	5
Kyabobo	18	16.-18.08.2001	11
Apesokubi	19	25.08.2001	3
Apesokubi	20	25.-28.08.2001	10
Apesokubi	21	26.08.2001	2
Apesokubi	22	26.08.2001	2
Apesokubi	23	26.08.2001	3
Apesokubi	24	26.08.2001	0.5
Apesokubi	25	26.08.2001	0.5
Apesokubi	26	26.08.2001	1.5
Apesokubi	27	27.08.2001	7
Apesokubi	28	27.08.2001	3
Apesokubi	29	27.08.2001	3.5
Volta Lake	30	28.08.2001	0.5
Volta Lake	31	28.08.2001	2
Shiare	32	22.08.2001	13
Shiare	33	21.-24.08.2001	14
Shiare	34	21.-23.08.2001	20
Liati	35	29.08.2001	3.5
Liati	36	29.08.2001	0.5

Tab. 1. Region, habitat number, date and sampling effort (m-h), for habitat description see 2.1-2.3.

Region, Lebensraumnummern, Datum und Sammelaufwand für jedes Habitat, für Habitatbeschreibungen siehe 2.1-2.3.

was spent in complex and larger habitats than in small and uniform ones. Table 1 summarizes sampling time and date for all habitats investigated. We additionally checked drift fences established by the small mammal group for frogs, however with negligible success.

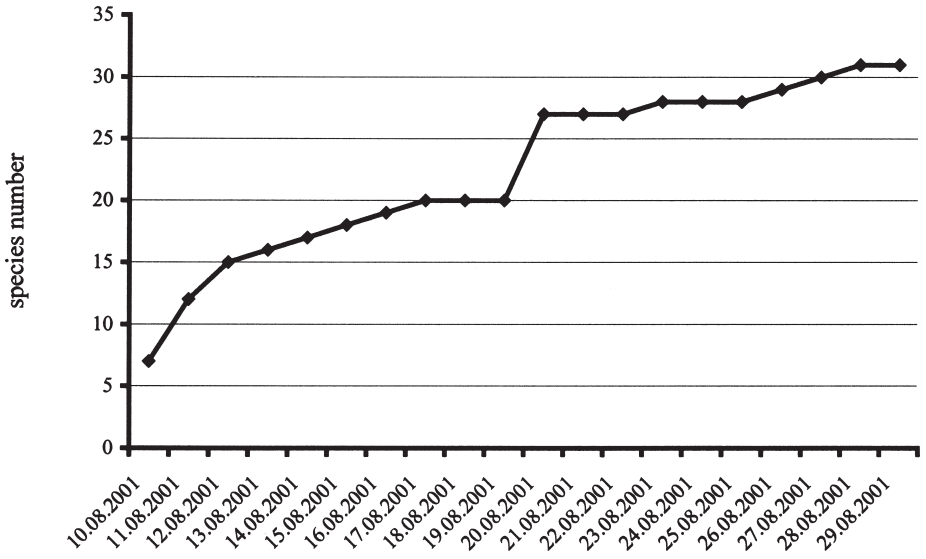

Fig. 2. Species accumulation of amphibians registered in the Volta region from 10-29th August 2001.

Artenakkumulation der in der Voltaregion vom 10.-29. August nachgewiesenen Amphibienarten.

4 Sampling efficiency

During the whole investigation 31 amphibian species were recorded. A species accumulation curve shows how many new species were added each day (Fig. 2). The curve's slope indicates that, during the survey period, we most likely did not record all amphibian species living within the Volta region.

Based on the assumption that relative sampling effort was the same for every habitat we calculated the approximate total number of amphibian species living in the Volta region. Because we had no quantitative data available, we used the Jack-knife 1 estimator, based on presence/absence data for all habitats (program: BiodivPro from the Natural History Museum London). These procedures indicated that approximately 41 amphibian species live within the Volta region (Fig. 3).

5 Species account

Below we give a short description of size, coloration, distribution, and habitat preferences for those amphibian species for which we could gather new or additional data through the survey. Well known and widespread species that have been dealt with in detail in other publications (e. g. SCHIØTZ 1967, 1999, RÖDEL 2000), are treated briefly. Nomenclature mainly follows SCHIØTZ (1967), RÖDEL (2000) and FROST (2002), otherwise we give respective citations. Species names are followed (in parentheses) by a quotation of habitat numbers (compare 2.1-2.3), and by collection numbers (in italics), referring to vouchers and tissue samples. We collected more tissue samples than vouchers. Therefore numbers refer always to a tissue sample but only in few cases to vouchers. Vouchers are deposited in the collection of the senior author (MOR) and will be transferred later on to different museum collections. Tissue samples are stored in

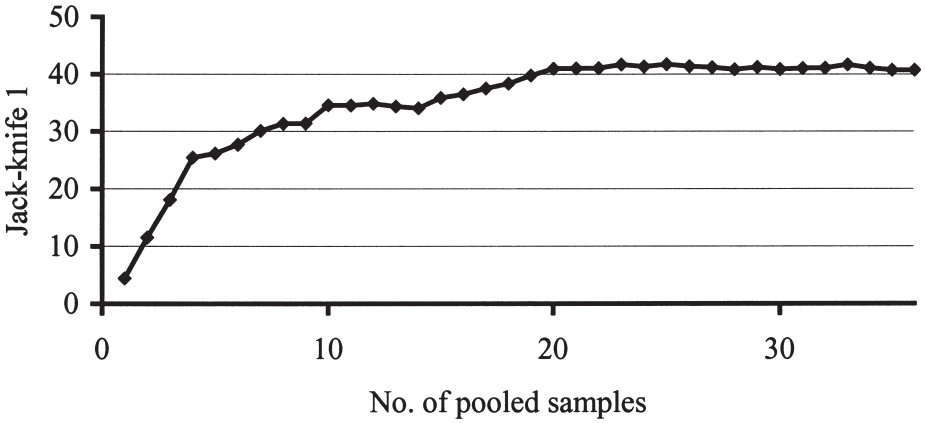

Fig. 3. Estimation of amphibian species number in the Volta region. Approximately 41 amphibian species may be living in that area.

Hochrechnung der in der Voltaregion lebenden Amphibienarten. Ungefähr 41 Arten dürften in dieser Region nachzuweisen sein.

the Institute of Zoology at Mainz University, Germany. Museum specimens for comparison were lent from the Zoologisk Museum at Universitets København (ZMUC) and the Musée Royal de l'Afrique Centrale, Tervuren (MRAC) (see appendix). If not otherwise stated, measures always refer to snout-vent-length (SVL in mm).

Pipidae

Silurana tropicalis GRAY, 1864 (5; *MOR G22-23*). A widespread aquatic, West African forest frog that takes advantage of gallery forests to colonize also the savanna zone as well (RÖDEL 2000).

Bufonidae

Bufo maculatus HALLOWELL, 1885 „1854" (5, 9, 10, 13, 20, 32, 33, 36; *MOR G36, 93*). A very common and widespread African toad, that inhabits habitats ranging from degraded forests to moist savannas. Only very dry savannas and primary rain forest are avoided (RÖDEL 2000).

Bufo regularis REUSS, 1833 (1, 4, 6, 9, 10, 13, 20, 31, 33, 36; *MOR G10, 95*). Very common West and Central African toad that reaches highest abundances around human settlements (RÖDEL 2000).

Family Hemisotidae

Hemisus sp. (1, 5; *MOR G20, 55*). Burrowing frog and therefore rarely encountered. The collected specimens occurred close to forest remnants. Two preserved males measured 31.5 and 33 mm. Their dorsal color was brownish with a few irregularly shaped yellow patches (Fig. 4), thus more resembling more the probably forest dwelling *Hemisus guineensis* COPE, 1865 (compare LAURENT 1972). However, their size speaks in favor of the savanna dwelling *Hemisus marmoratus* (PETERS, 1854) (see RÖDEL et al. 1995, RÖDEL 2000). Many calling males were heard after heavy rain, close to a swampy area. The

Fig. 4. Male *Hemisus* sp. from Wli.
Männlicher *Hemisus* sp. aus Wli.

calls could not be recorded. However, they sounded similar to *H. marmoratus* (RÖDEL 2000). The taxonomic status of these frogs remains doubtful.

Ranidae

Hoplobatrachus occipitalis GÜNTHER, 1858 (4, 5, 10, 12, 15, 20, 26, 29, 30, 33, 35; *MOR G21*). Extremely common, aquatic savanna species that penetrates the forest zone in disturbed areas (RÖDEL 2000). We found specimens in rather fast flowing cold rivers as well as in small heavily vegetated puddles, where water sometimes heats up to more than 40 °C during daytime. The largest specimen measured was a female (124 mm). Not threatened in most areas, possibly threatened in others by human consumption.

Amnirana albolabris (HALLOWELL, 1856) (3, 7, 23, 25, 27, 32; *MOR G1, 84, 88-89*). Common West and Central African frog that inhabits both primary and degraded forests. We found specimens often close to flowing water. At night we found even large individuals often sitting on leaves at 0.5 to several meters height. Males measured 59-61.5 mm. The largest specimen was a female (76 mm). The unmistakably marked tadpoles (red and black pattern, LAMOTTE et al. 1957) are obviously toxic and most often the only tadpoles that can be observed moving in flowing water even during day time (compare MCINTYRE 1999, RÖDEL & ERNST 2001).

Amnirana galamensis (DUMÉRIL & BIBRON, 1844) (15; *MOR G78*). Common, but patchily distributed West African savanna species. The only female caught measured 78 mm and was the largest West African specimen recorded so far (RÖDEL 2000).

Fig. 5. Male *Phrynobatrachus* aff. *calcaratus* from Wli.
Männlicher *Phrynobatrachus* aff. *calcaratus* aus Wli.

Ptychadena aequiplicata (WERNER, 1898) (12; *MOR G56*). Widespread but nowhere abundant West and Central African forest frog (RÖDEL et al. 2002b). With few exceptions inhabits only primary forest. We caught only one male (46 mm) close to a remnant of heavily degraded forest. Two other males were heard calling at that site. Possibly vulnerable due to habitat destruction.

Ptychadena bibroni (HALLOWELL, 1845) (1, 5, 15, 33). Very common West African inhabitant of degraded forests and moist savannas, formerly known as *P. maccarthyensis* (see LAMOTTE & OHLER 1997, RÖDEL 2000).

Ptychadena mascareniensis (DUMÉRIL & BIBRON, 1841) (24, 28). A taxonomically difficult species complex that occurs in almost all habitats throughout Africa and Madagascar (LAMOTTE & OHLER 1997, PERRET 1997, RÖDEL 2000). Taxonomy is not sufficiently settled to estimate possible threats, but it seems that all species of that complex show a patchy distribution. Where they occur they are very abundant, however, there are also huge areas offering a variety of possibly suitable habitats without harboring any of these frogs. Typical *P. mascareniensis* always have a broad green vertebral band. So far we found them only in rice fields and larger swampy areas (RÖDEL unpubl.).

Ptychadena oxyrhynchus (SMITH, 1849) (33, 34). Widespread and common African savanna frog (RÖDEL 2000). We observed frogs breeding in small, nearly vegetationless puddles on a dirt road in very open surroundings.

Ptychadena pumilio (BOULENGER, 1920) (15, 20, 31; *MOR G79-80*). Widespread and very common African frog that inhabits degraded forests and moist savannas. With SVL of 33 and 33.5 mm two captured males were comparatively large (RÖDEL 2000). CHANNING (2001) recognizes *P. taenioscelis*, a former synonym of *P. pumilio*, as a distinct species based on call parameters (pers. comm.). At the current state of knowledge, it is not clear if *P. taenioscelis* also occurs in West Africa.

Ptychadena tellinii (PERACCA, 1904) (29, 30, 36, *MOR G114, 132-134*). Common West and Central African savanna species (RÖDEL 2000). According to LARGEN (2001) *P. schubotzi* (STERNFELD, 1917) is a junior synonym of *P. tellinii* (PERACCA, 1904).

Phrynobatrachus accraensis AHL, 1923 (3, 4, 5, 8, 12, 13, 15, 21, 23, 27, 29, 33; *MOR G8-9, 11-14, 16, 24-27, 109, 111, 115-116*). Extremely common and widespread West African savanna species that inhabits also degraded forest areas (RÖDEL 2000). DNA analyses have proved the species to be conspecific with frogs termed *P. latifrons* by RÖDEL (1996, 2000), and therewith possibly also with the Volta „endemic" *P. latifrons togoensis* AHL, 1924 (RÖDEL & KOSUCH, unpubl.). In the Volta region we found this species along flowing water, in stagnant puddles, and in densely vegetated ponds. Breeding males always have yellow throats. Finger and toe tips are sometimes enlarged without forming real discs. With males measuring 18.5-19 mm and females measuring 24-26 mm, the Volta specimens were a little bit larger than those from Comoé National Park, Ivory Coast (RÖDEL & SPIELER 2000).

Phrynobatrachus calcaratus (PETERS, 1863) (17, 10, 18, 33; *MOR G63-66, 85*). Widespread West and Central African forest *Phrynobatrachus* with eyelid cornicle (PERRET 1988). In the savanna zone it occurs in gallery forests (RÖDEL 2000). Males (20 mm) and females (22-28.5 mm) always had black points on the belly. If present the black lateral band was indistinct. The back was either colored uniform brown, or showed a reddish or yellow vertebral stripe that started behind the eyes (compare descriptions and figures in PERRET 1988, RÖDEL 2000). We often observed parasitic mites on the ventral side of their thighs (compare SPIELER & LINSENMAIR 1999).

Phrynobatrachus aff. *calcaratus* (8; *MOR G17, 37-38, 42-44, 54*). Very similar to typical *P. calcaratus*; however, it differs in coloration and the presence of one large and several small cornicle on each eyelid instead of one. We caught six males (18.5-20 mm) and one female (24 mm). The basic colour of all specimens was a reddish brown. They had very distinct black lateral bands, orange to red spots on the flanks, a white belly, the throat was clear grey, and two greyish spots were present on the chest. Two specimens had yellow vertebral stripes starting behind the eyes (Fig. 5). The head of these frogs seemed to be shorter than in *P. calcaratus* collected at other sites in the Volta region. Males had swollen thumbs. We have collected these frogs in a water filled tree hole where they reproduced. One clutch comprised 200 small brown eggs floating in a single layer on the water surface. So far tree holes were not known to be breeding habitats of *P. calcaratus* (compare RÖDEL 2000). Further analyses will clarify the taxonomic status of these frogs. If this proves to be an undescribed species, it may be threatened due to a very small range.

Phrynobatrachus francisci BOULENGER, 1912 (31; *MOR G130*). Widespread and common West African savanna frog (RÖDEL 2000). We only caught one male (20.5 mm) on bare ground close to the bank of Lake Volta.

Phrynobatrachus natalensis (SMITH, 1849) (15, 20, 33, 34; *MOR G68, 90-92*). These widespread African savanna frogs probably comprise several cryptic species (RÖDEL 2000). Males (29-31 mm) were caught while calling during night on the banks of vegetationless small puddles. Some specimens had orange vertebral bands.

Phrynobatrachus plicatus (GÜNTHER, 1859 „1858") (12). Widespread West African forest frog (LAMOTTE 1966).

Arthroleptidae

Arthroleptis sp. (1, 4, 6, 11, 16, 17, 18, 20, 23, 26, 33, 34, 35; *MOR G7, 15, 28, 45-51, 57-60, 107-108, 110, 112-113, 131*). Very common frog in degraded forests throughout the Togo-Volta highlands. Taxonomic status uncertain. Differs from species from the western part of the Upper Guinea Forest Block by its advertisement call. Coloration and morphology are identical to forest *Arthroleptis* from Ivory Coast (RÖDEL unpubl.). Frogs from the Volta region seem to be comparatively small (males: 18-24 mm, females: 21 mm). The third finger in males was hardly longer than in females. It may either be *A. brevipes* AHL, 1923, originally described from a locality nearby Togo (Bismarckburg) and never recorded since its description, or *Schoutedenella zimmeri* (AHL, 1925) described from Accra. However, as frogs of the genera *Arthroleptis* and *Schoutendenella* (it is unclear whether both of these genera are valid or *Schoutedenella* is simply a subgenus of *Arthroleptis*) comprise the taxonomically most difficult African frogs, and morphological comparison with museum vouchers is insufficient for determination, the taxonomic status of our vouchers remains unclear.

The advertisement call, a high single note whistle, resembled that of *Cardioglossa leucomystax* (compare RÖDEL et al. 2001). Calling sites were most often in very dense vegetation. They were also very common even in cacao plantations. Calling activity was highest at dusk or after rain. Frogs uttering identical advertisement calls most often showed the "typical" *Arthroleptis* pattern, brown back with a darker hourglass pattern. The flanks were most often greyish black. The area between flanks and belly was normally marbled in grey, the belly was white, and the throat grey. However, we also found calling males with a uniform reddish brown back (Fig. 6), with clear vertebral stripes, with clear dorsolateral bands and a clear vertebral stripe, or with copper red color on the dorsolateral stripe, the snout, and the extremities. Investigations in Taï National Park, Ivory Coast (two syntopic *Arthroleptis* species) showed that neither coloration nor a variety of morphological criteria (like finger length in males) were suitable to differentiate between species (RÖDEL & LEISTNER, unpubl.). The only reliable characters have been advertisement call and behaviour (and surely genetics). It seems likely that similar variation may exist in other *Arthroleptis* species as well. We therefore highly recommend our colleagues to refrain from describing more species out of this group on the basis of morphology and coloration only.

Hyperoliidae

Leptopelis viridis (GÜNTHER, 1868) (13, 15): Widespread West and Central African savanna frog (SCHIØTZ 1967, 1999, RÖDEL 2000).

Leptopelis hyloides (BOULENGER, 1906) (1, 5, 10, 12, 20, 23, 32, 33, 35; *MOR G2, 18-19, 52-53, 106*). A widespread West African species that inhabits primary and degraded forests. At most forest sites in the Volta region very common. Males called most often well concealed from shrubs and trees. Calling activity was highest during dusk, and

Fig. 6. Male *Arthroleptis* sp. with uniform red back from Wli.
Männlicher *Arthroleptis* sp. mit einheitlich rotem Rücken aus Wli.

decreased after 10 pm. Males measured 30-35 mm, one female measured 47 mm. SCHIØTZ (1999) discusses the availability of this name for frogs from the Upper Guinea forests.

Hyperolius baumanni AHL, 1931 (2, 5, 12, 20, 22, 23, 25, 27, 28, 29; *MOR G3, 35, 41, 102-105, 127, 129*). A frog endemic to eastern Ghana and the Togo highlands. Where present it was always very abundant. It inhabited degraded forests and forest edges. Males (26-30 mm) called, well concealed in dense vegetation, from 0.5-4 m height, always in some distance to potential breeding sites (up to 30 m from next open water). They preferred very shallow, heavily vegetated swampy ponds as breeding sites. In a swampy area adjacent to a rice field, and at a small heavily vegetated pond, we recorded more than 100 calling males. *H. baumanni* started calling later (after 8 pm) than the syntopic *Hyperolius* species (*H. concolor, H. fusciventris burtoni*). The advertisement call consisted of a long series of metallic click sounds, initiated by a longer croaking sound. SCHIØTZ (1967, 1999) mentions the possibility that *H. baumanni* may be simply a subspecies of the very similar *H. picturatus*. Genetic investigations proved *H. baumanni* to be genetically sufficiently distinct from *H. picturatus* to justify its species status (RÖDEL & KOSUCH, unpubl.).

Males had a yellowish brown or a black chocolate brown dorsum. Extremities were speckled dark. Dorsolateral bands, from snout tip to hips, were either white or beige yellow. These bands were either bordered ventrally by black lines or a row of black spots, or this dark border was lacking. Most had dark canthal stripes. The flanks were fleshy with or without clear spots. The transversal area between flank and belly was marbled yellowish brown. The belly was always yellow or whitish yellow. Finger and toe tips were reddish or yellow. The gular flap was often indistinct but much dilatable,

Fig. 7. Two *Hyperolius baumanni* males with different coloration, both from Wli.

Zwei *Hyperolius baumanni* Männchen mit unterschiedlicher Zeichnung aus Wli.

yellow skin covered the throat. Iris always golden. Upper lip with clear spots (Fig. 7a, b).

Hyperolius cf. *torrentis* SCHIØTZ, 1967 (18, 32, 34; *MOR G61-62, 67, 81-83, 86-87*). The taxonomic status of our vouchers is uncertain. Most probably it is *H. torrentis* that is a forest species endemic to eastern Ghana and adjacent Togo, and known up to now only from three localities (SCHIØTZ 1967, 1999). Males from Kyabobo (Fig. 8b) and females from Shiare (Fig. 8a) proved to be genetically identical (RÖDEL & KOSUCH, unpubl.). One male from Shiare (Fig. 8c, see below) had a different body shape and more granular skin and therefore might represent another species (it was not possible to get good DNA sequences from that specimen).

In Kyabobo National Park two males (32 and 32.5 mm) were caught on large-leaved herbs at the border of a fast flowing river. The river was bordered by higher forest that turned into savanna woodland on the top of the hills. They had green backs that turned into brown during daylight (Fig. 8b), a yellow or yellowish white venter, fine black canthal stripes, black points on snout and around tympanum, red or yellow finger and

toe tips. One had a short dorsolateral stripe bordered black ventrally, and a dark canthal stripe. Throat and ventral part of extremities were green.

Female frogs from Shiare (38-42 mm, n = 4) used water filled axils of *Colocesia xanthipholium* (water jams) as day time retreats. During night we observed them foraging in trees close to a very fast flowing river. According to villagers frogs with that pattern utter bird-like chirping calls. Their dorsum was uniformly green, their belly yellowish green. The flanks and cheeks were yellow with black, red and blue points. The canthal region and upper lip were marked black with blue points. Iris was greyish blue. The throat was green, the finger and toe tips and the webs red. The upper parts of their thighs were deep red, disrupted by a longitudinal green band bordered with black or blue spots. The ventral part of thighs was orange. The lower leg and foot were green dorsally, and yellowish green ventrally. The upper and lower arms were green with rows of black spots dorsally, yellowish green ventrally.

A male from Shiare (36 mm) had a beige green dorsum, a clearer coloured snout, a clear spot on the neck, several clear spots on the back, clear heel, and upper lip, an orange yellow throat, a clear yellow belly, green upper parts of extremities and webs, finger and toe tips red. Its daytime coloration was uniform golden-yellow dorsally. Skin was granular (Fig. 8c). Its iris was golden, its gular flap yellow, the centre of the belly yellow, the lateral parts of belly nearly white, rest of throat and lower parts of extremities were beige yellow, toe tips were red. This male and similar coloured ones that could not be caught, called from a height of 2-5 m above the flowing water of a very small creek in degraded forest. They sat exposed on little branches. The vocalization consisted of 2-3 loud creak sounds (similar to *H. chlorosteus*) followed by 3-6 metallic click sounds.

The male from Shiare best fitted published descriptions of *H. torrentis*, however, it had a much larger gular flap than frogs collected by A. SCHIØTZ (compare appendix: specimens examined). SCHIØTZ (1967, 1999) also described forests as habitats of that species, but mentioned dripping water and small waterfalls instead of fast flowing rivers. Possibly vulnerable due to forest destruction.

Hyperolius concolor RAPP, 1842 (2, 3, 5, 6, 12, 15, 19, 20, 22, 23, 26, 27, 28, 29; *MOR G4-5, 69-70, 76, 95, 98-99, 125-126, 128*). Widespread West African species that occurs also in Cameroon. It lives in degraded forest habitats as well as in very moist savanna areas (SCHIØTZ 1967, 1999, RÖDEL 2000). Males in the Volta region measured 28-31.5 mm, females about 35 mm. Males often showed juvenile coloration with a dark hourglass pattern on the back. Females were always yellowish green. One female deposited 90 yellow eggs embedded in slightly milky jelly.

Hyperolius fusciventris burtoni SCHIØTZ, 1967 (5, 12, 27, 28; *MOR G29, 33, 39-40, 117-121*). A typical farmbush frog extending from Sierra Leone to Nigeria (SCHIØTZ 1967). The subspecies *H. f. burtoni* was recorded from western Ghana to eastern Nigeria (SCHIØTZ 1967). Morphologically it is very similar to *H. f. fusciventris* and *H. f. lamtoensis*. SCHIØTZ (1967) and more recently RÖDEL (1998b) summarize characters for differentiation. However, the taxonomic situation of frogs from the *H. fusciventris* complex may be more difficult than previously thought. Respective investigations will form the topic of a separate publication. Males (21-22 mm) from the Volta region more frequently seemed to have clear dorsolateral bands than their more western relatives (Fig. 9). We recorded green and brown males. Brown specimens always had yellow dorsolateral stripes that fade out towards the hips. Their gular flap was yellow,

the upper parts of their extremities greyish. Green males had dorsolateral stripes or not. Their gular flap was green, and the upper parts of their extremities were bluish or yellowish green. All specimens had dark canthal stripes, golden irises and yellow toe and finger tips. They called either from small shrubs and trees or from floating plants, most often right at the border of open water, where they are hard to catch.

Hyperolius nasutus GÜNTHER, 1864 (15; *MOR G73, 75*). A widespread frog that lives mostly in drier savanna areas all over Africa south of the Sahara (SCHIØTZ 1999). Very recently CHANNING at al. (2002) published a paper renaming some African populations as *H. acuticeps* AHL, 1931, originally described from Tanzania (e. g. frogs from Comoé National Park, RÖDEL 2000, RÖDEL & SPIELER 2000). According to CHANNING et al. (2002) *H. acuticeps* includes *H. lamottei*. The frogs recognized by them as *H. nasutus* reportedly live in forests in West Africa. However, there are no forest-dwelling *H. nasutus* at least in those parts of West Africa that we and all other people working in West Africa have investigated so far. Furthermore, *H. lamottei* (e. g. from Mont Péko National Park, Ivory Coast RÖDEL & ERNST 2003) are clearly not conspecific with frogs from Comoé. We therefore continue naming all West African green sharp nosed reed frogs as *H. nasutus*. Based on acoustical and genetic data, we plan to reinvestigate the taxonomic situation of West African sharp nosed reed frogs.

Hyperolius nitidulus PETERS, 1875 (14, 15; *MOR G71-72, 74*). Very common and widespread West African savanna frog (RÖDEL 2000). We follow DREWES (1984) and WIECZOREK et al. (1998, 2001) in recognizing *H. nitidulus* as full species (but compare SCHIØTZ 1971, 1999).

Afrixalus dorsalis (PETERS, 1875) (2, 4, 5, 12, 19, 27, 28; *MOR G6, 30-32, 34, 96, 97, 100-101, 122-124*). Widespread and common West and Central African forest frog that inhabits degraded forests in the forest zone and gallery forests in the savanna zone (SCHIØTZ 1967, 1999, RÖDEL 2000). Very common in degraded vegetation. Males in the Volta region reached 26-34 mm, females 25.5-28.5 mm. Two females deposited 86 eggs and 95 eggs (diameter 2 mm), respectively. We found one male that had a vertebral stripe in addition to its dorsolateral bands (Fig. 10).

Afrixalus vittiger (PETERS, 1876) (14, 15; *MOR G77*). Widespread West African savanna species (RÖDEL 2000). M. PICKERSGILL (pers. comm.), who checked the type specimen, confirmed RÖDEL's (2000) view that the West African savanna species' name is *A. vittiger* (but compare discussion in SCHIØTZ 1999 and RÖDEL 2000).

Kassina senegalensis (DUMÉRIL & BIBRON, 1841) (14). Widespread African savanna frog (SCHIØTZ 1999, RÖDEL 2000).

6 Anuran community composition in different study sites in the Volta region

Table 2 gives an overview of all amphibian species recorded by us and SCHIØTZ (1964a, 1967) in the Volta region. We recorded 31 species in total. Additionally known from that area are *Conraua derooi* HULSELMANS, 1972*, Bufo togoensis* AHL, 1924*, B. latifrons* BOULENGER, 1900 (possibly only *B. maculatus*), and *Werneria preussi* (MATSCHIE, 1893) (doubtful, see below). Judging from published records from species that are known to occur east and west of the Volta region, the following species may additionally occur: *Geotrypetes seraphini* (DUMÉRIL, 1859), *Bufo superciliaris* BOULENGER, 1888 „1887",

Fig. 8. *Hyperolius* cf. *torrentis* from a: Shiare (female), b: Kyabobo (male) and c: Shiare (male). Females from Shiare and males from Kyabobo proved to be genetically identical (compare text).

Hyperolius cf. *torrentis* aus a: Shiare (Weibchen), b: Kyabobo (Männchen) und c: Shiare (Männchen). Weibchen aus Shiare und Männchen aus Kyabobo waren genetisch identisch (vergleiche Text).

Fig. 9. Calling *Hyperolius fusciventris burtoni* male from Wli.

Rufendes *Hyperolius fusciventris burtoni* Männchen aus Wli.

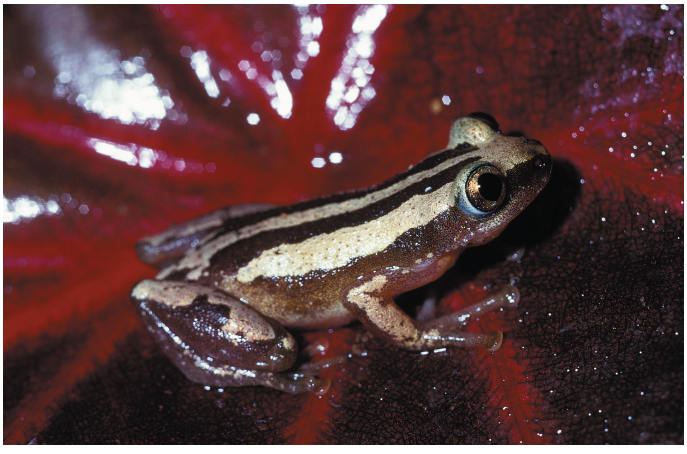

Fig. 10. *Afrixalus dorsalis* male with unusual vertebral stripe from Apesokubi.

Afrixalus dorsalis Männchen mit ungewöhnlichem Vertebralband aus Apesokubi.

Aubria occidentalis PERRET, 1995, *Phrynobatrachus alleni* PARKER, 1936, *P. gutturosus* (CHABANAUD, 1921), *P. batesii* (BOULENGER, 1906), *Cardioglossa leucomystax* (BOULENGER, 1903), *Hyperolius guttulatus* GÜNTHER, 1858, *Hyperolius sylvaticus* SCHIØTZ, 1967, *Phlyctimantis boulengeri* PERRET, 1986 and *Chiromantis rufescens* (GÜNTHER, 1869). That would raise the species number for the region to 44-46. That is close to the above (4) given estimate of 41 species for the region.

Table 2 also provides information, which principal habitat types were mainly selected by a certain species. Forest species are those requiring more or less closed forest, both degraded and primary forest. The definition of farmbush species is based on SCHIØTZ (1967). It comprises all amphibian species that live within the former forest zone, but are not dependent on closed forest canopy and are not able to reproduce successfully within true savanna habitats. Normally these species can be found at forest edges, in highly degraded forests, in agricultural areas within the forest zone that still provide small forest remnants, and in forests within the savanna zone (gallery forests and island forests). As savanna species we define those amphibians that mainly

reproduce in moist and/or dry savanna types. Sometimes these species can penetrate the forest zone in areas where forest cover is greatly destroyed.

Species	W	K	A	AM*	B*	N*	F	FB	S
Silurana tropicalis	1	0	0	0	0	0	X		
Bufo maculatus	1	1	1	0	0	0		X	
*B. latifrons***	0	0	0	0	1	0	X		
B. regularis	1	1	1	0	1	0			X
Hemisus sp.	1	0	0	0	0	0		X	
Hoplobatrachus occipitalis	1	1	1	0	0	0			X
Conraua derooi	0	0	0	1	1	0	X		
Amnirana albolabris	1	1	1	1	1	0	X		
A. galamensis	0	1	0	0	1	0			X
Ptychadena aequiplicata	1	0	0	0	0	0	X		
P. bibroni	1	1	0	0	0	0		X	
P. mascareniensis	0	0	1	0	0	0		X	
P. oxyrhynchus	0	1	0	0	0	0			X
P. pumilio	0	1	1	0	0	0		X	
P. tellinii	1	0	1	0	0	0			X
Phrynobatrachus accraensis	1	1	1	0	1	0		X	
P. aff. *calcaratus*	1	0	0	0	0	0	X		
P. calcaratus	1	1	0	0	0	0	X		
P. francisci	0	0	1	0	0	0			X
P. natalensis	0	1	1	0	0	1			X
P. plicatus	1	0	0	0	0	0	X		
Arthroleptis sp.	1	1	1	0	0	0		X	
Leptopelis viridis	0	1	0	0	0	0			X
L. hyloides	1	1	1	0	1	0	X		
Hyperolius baumanni	1	0	1	1	1	0		X	
H. cf. *torrentis*	0	1	0	1	1	0	X		
H. concolor	1	1	1	0	1	1		X	
H. fusciventris burtoni	1	0	1	0	1	0		X	
H. nasutus	0	1	0	0	0	0			X
H. nitidulus	0	1	0	0	0	0			X
Afrixalus dorsalis	1	0	1	0	1	1		X	
A. vittiger	0	1	0	0	0	1			X
Kassina senegalensis	0	1	0	0	0	0			X
species	W	K	A	AM	B	N	F	FB	S
species #	19	20	16	4	12	4	10	11	12

Tab. 2. Amphibian species recorded in the Volta region and their preferred macrohabitat type. W = Wli, K = Kyabobo, A = Apesokubi, AM = Amedofe (6°45' N, 0°28' E), B = Biakpa (6°44' N, 0°28' E), N = Nkwanta, F = forest, FB = farmbush, S = savanna, * records from SCHIØTZ (1964a, 1967), ** possibly *Bufo maculatus*; 1 = recorded, 0 = not recorded.

In der Voltaregion nachgewiesene Amphibienarten und ihr bevorzugter Großlebensraum, F = Wald, FB = degradierter Wald, S = Savanne, * Nachweise von SCHIØTZ (1964a, 1967), ** möglicherweise Verwechslung mit *Bufo maculatus*; 1 = nachgewiesen, 0 = nicht nachgewiesen.

The Wli/Liati Wote area had the highest percentage of forest specialists (36.8 %), compared to the two other areas. In Apesokubi farmbush species were predominant (56.3 %). In the northernmost area (Kyabobo/Nkwanta) we found the highest percentage of savanna species within the regional amphibian community (50 %, Tab. 3). Composition of different habitat specialists was not statistically different between the three regions (Kruskal Wallis test, $p = 0.3$).

7 Comparison of the amphibian diversity from the Volta region with other West and Central African regions

Despite the fact that biological inventories in West Africa started already in the 19th century, very few areas are really well known. It was not until the 1960s that the first nearly complete West African amphibian inventories were presented by GUIBÉ & LAMOTTE (1958, 1963), LAMOTTE (1967, 1971) and SCHIØTZ (1967, with the main emphasis on tree frogs). In the 1990s one of us (MOR) started to investigate most National Parks of Ivory Coast.

In Table 4 we have summarized all West African amphibian inventories in which at least ten species have been recorded. Generally areas that naturally comprise different habitat types (e. g. mountain savannas, different forest types, different savanna types) showed highest species richness. This became also obvious for relatively dry areas, e. g. Comoé National Park, where different vegetation zones meet (Guinea and Sudan savanna, as well as gallery and island forests). However, normally diversity was higher in the more humid forest zone than in the savanna area. The western part of the Upper Guinea forest block harbours more species than its eastern part. This is also shown by comparing species numbers of Ivory Coast (>100 species; RÖDEL unpubl.) and Ghana (70 species, including several that have not yet been recorded, but are believed to exist in the country; HUGHES 1988).

These differences may have historical explanations. During very dry periods some 10,000-40,000 years ago, the West African forest was split up into relatively small forest remnants (MOREAU 1963, 1969, JAHN et al. 1998). These areas may have been larger in western Ivory Coast and Liberia, possibly allowing more species to survive and/or to evolve into new species than in the Ghana-Togo area. Within the Volta region there were no Pleistocene forest refugia at all (ROMPAY 1993, PARREN & DEGRAAF 1995). Additionally, the Ghana-Togo area probably has been continuously inhabited by more humans and natural habitats have been scarcer than in the western forests throughout the past millenium.

	forest / Wald	farmbush / degradierter Wald	savanna / Savanne	total #
Wli & Liati-Wote Waterfalls	7 (36.8)	9 (47.4)	3 (15.8)	19
Kyabobo & Nkwanta	4 (20)	6 (30)	10 (50)	20
Apesokubi & Lake Volta	2 (12.5)	9 (56.3)	5 (31.3)	16

Tab. 3. Number of amphibian ecotypes per region (percentage in parenthesis).
Anzahl der Amphibien-Ökotypen pro Region (Prozentzahl in Klammern).

Fig. 11. Typical small river, bordered with forest, in the Togo-Volta highlands.

Typischer kleiner, von Wald gesäumter Bach im Togo-Volta Hochland.

right page: Tab. 4. West and Central African amphibian inventories. Only those West African areas are included, where at least ten species have been recorded; *including five *Arthroleptis* (compare text) and eight undescribed species, possibly not all representing valid taxa.

Amphibieninventare West- und Zentralafrikas. Für Westafrika wurden nur Regionen berücksichtigt, aus denen mindestens zehn Arten nachgewiesen wurden; *inklusive fünf *Arthroleptis*- und acht unbeschriebene Arten, die möglicherweise nicht alle valide Taxa repräsentieren, savanna = Savanne, forest = Wald, farmbush = Buschwald und Anbaugebiete in der Regenwaldzone, degraded forest = degradierter Wald (geloggt); mountain = Berglebensraum.

country / Land	locality / Region	main habitat / Großlebensraum	species # / Artenzahl	source / Literaturquelle
The Gambia	Abuko	savanna	19	Barnett et al. 2001
Senegal	Nikola-Koba	savanna	24	Lamotte 1969, Joger & Lambert 2002
Sierra Leone	Mts. Loma	mountain, forest	38	Schiøtz 1967, Lamotte 1971
Sierra Leone	Freetown	farmbush, forest	11	Schiøtz 1967
Sierra Leone	Kamakwie	savanna	10	Schiøtz 1967
Sierra Leone	Gola	forest	15	Schiøtz 1967
Sierra Leone	Kassewe	forest, farmbush	18	Schiøtz 1967
Sierra Leone	Kenema	forest, farmbush	15	Schiøtz 1967
Guinea	Ziama	forest, farmbush	27	Böhme 1994 a/b
Liberia, Guinea, Ivory Coast	Mt. Nimba	mountain, forest	57	Guibé & Lamotte 1958, 1963; Schiøtz 1967
Ivory Coast	Mt. Sangbé	forest, mountain, savanna	45	Rödel 2003
Ivory Coast	Mt. Péko	forest, farmbush	33	Rödel & Ernst 2003
Ivory Coast	Taï	forest	56	Rödel & Ernst unpubl.
Ivory Coast	Marahoué	forest, savanna	33	Rödel & Ernst 2003
Ivory Coast	Lamto	forest, savanna	39	Lamotte 1967
Ivory Coast	Comoé	savanna	34	Rödel 2000, Rödel & Spieler 2000
Ivory Coast	Haute Dodo	degraded forest	37	Rödel & Branch 2002
Ivory Coast	Cavally	degraded forest	36	Rödel & Branch 2002
Ghana	Kakum	forest	11	Schiøtz 1967
Ghana	Kumasi	forest	10	Schiøtz 1967
Ghana	Muni	lagoon	13	Raxworthy & Attuquayefia 2000
Ghana	Bobiri	forest	20	Schiøtz 1967
Ghana	Achimota	savanna	11	Schiøtz 1967
Ghana	Biakpa	farmbush	12	Schiøtz 1967
Ghana	Wli	forest, farmbush	19	this paper
Ghana	Apesokubi	farmbush, savanna	16	this paper
Ghana	Kyabobo	forest, savanna	20	this paper
Ghana	Bolgatanga	savanna	10	Schiøtz 1967
Ghana	Walewale	savanna	12	Schiøtz 1967
Nigeria	Ibadan	forest, savanna	23	Schiøtz 1967
Nigeria	Oyo	savanna	13	Schiøtz 1967
Nigeria	Iperin	forest, farmbush	18	Schiøtz 1967
Nigeria	Osomba	forest, farmbush	30	Schiøtz 1967
Nigeria	Obudu	mountain, forest	12	Schiøtz 1967
Cameroon	Korup	mountain, forest, farmbush	88*	Lawson 1993
Cameroon	Mt. Kupe	mountain, forest, farmbush	31	Euskirchen et al. 1999; Hofer et al. 1999, 2000; Schmitz et al. 1999
Congo	Kouilou	forest, farmbush	37	Largen & Dowsett-Lemaire 1991
Equatorial Guinea	Mt. Alen	forest, farmbush	48	De la Riva 1994

8 Status of amphibians endemic to the Togo-Volta highlands and conservation status of the amphibian fauna of that region

While farmbush frogs like *Arthroleptis* sp. (taxonomic status uncertain, compare species account) and *Hyperolius baumanni* seemed to be very common frogs in the Volta region, true forest frogs were rarely encountered. Some of the most interesting records of forest frogs have been obtained in the Kyabobo/Shiare area (e. g. *Hyperolius* cf. *torrentis*). However, at these localities none of the recorded species was common. Two forest toads that are known from the Togo/Volta region couldn't be found during our survey. While *Bufo togoensis*, described by AHL (1924b) from Bismarckburg in Togo, may be widespread in the western part of the Upper Guinea forests (RÖDEL & BRANCH 2002, RÖDEL & ERNST unpubl.), *Werneria preussi* (MATSCHIE, 1893) is a Central African species, not recorded from West Africa during recent investigations (*Atelopus africanus* described by WERNER in 1898 from Bismarkburg is a synonym of *Werneria preussi*). The Togo record therefore may be based on an error. Because larger virgin forest areas seemed to be almost gone along the Togo/Ghana border, the remaining forest remnants should be urgently protected to avoid extinction of these species.

In 1972 an aquatic frog, *Conraua derooi,* was described by HULSELMANS from Misahöhe, Togo. Like other species from that genus it was said to live in fast running rivers. Other West African species that share this habitat niche are *Astylosternus occidentalis, Petropedetes natator* and *Conraua alleni*. The latter species was recorded by SCHIØTZ (1964a) from Biakpa and Amedzofe, which are close to the Wli/Liati-Wote area. We re-examined these specimens (see appendix) and could confirm HULSELMANS' (1972) assumption that they belong to *C. derooi*. In Shiare local people confirmed the presence of blackish frogs from neighbouring Togo. According to them these frogs reach 6-8 cm in size, have smooth skin, and live around waterfalls, especially where water is jammed. That was our best evidence for the presence of *C. derooi*. Despite extensive searches along fast running creeks and rivers in Wli, Liati-Wote, Shiare, and Kyabobo National Park (Fig. 11), we failed to find any torrenticolous frog species (species that are specialized on fast flowing waters). At all these sites, however, we recorded large *Hoplobatrachus occipitalis* and catfish (*Clarias* sp., *Heterobranchus* sp.). *H. occipitalis* usually does not live in this habitat type and may have replaced the other species. Both *H. occipitalis* and catfish are known to prey on frogs. Additionally, *H. occipitalis* has carnivorous tadpoles that feed on other tadpoles (RÖDEL 2000). In our opinion it is very likely that the typical torrenticolous frog species were definitely not present, at least at those sites that we have investigated. It should be urgently examined, whether species are generally declining in eastern Ghana. Known populations in Ivory Coast were still numerous and active (RÖDEL 2003, recorded only two weeks after the Ghana survey).

9 Conclusions and conservation implications

During the present survey we were able to record about 31 amphibian species for the whole Volta region. One or two species might be new to science, but details still need to be clarified. Based on our sampling effort and statistical and comparative extrapolation, we estimate that at least 41 amphibian species live within the study area. Therefore the Togo-Volta highlands were more diverse than previously assumed. We failed to record those species that are highly adapted to fast flowing water (*Conraua derooi, Petropedetes natator, Astylosternus occidentalis*) or larger closed forests (e. g. *Bufo togoensis*).

The fact that most creeks and rivers appear to be in good condition, notwithstanding intensive investigations which revealed no verification of torrenticolous species, leads us to the assumption that these species may be declining due to causes others than habitat destruction.

We could not find larger tracts of closed forests in the Volta region. This explains the lack of several primary forest specialists in our records. In fact most of the „forest" species we found preferred forest edges, natural disturbances within forests (e. g. tree fall gaps), or so called „farmbush" habitats. The high percentage of farmbush species in our list is a clear hint that the natural forest cover has been largely destroyed in many areas, probably for quite some time. However, since we could still find some true forest specialists (especially around Wli and Shiare), there seem to be some relict populations in those areas, where at least smaller, well protected forest remnants are present. These forests are not necessarily part of officially protected areas such as the new Kyabobo Range National Park. It seems that communally protected forests, including so called sacred groves (DECHER 1997, DECHER & BAHIAN 1999), may play at least an equal role in the maintenance of natural diversity within the Togo-Volta highlands.

Future conservation efforts should encourage all local activities that are likely to preserve these forests. Additionally, all larger remaining forest areas in the Volta region should be given highest conservation priority. We recommend conservation efforts that link or buffer smaller forest remnants through reforestation. Since our study reveals that amphibian diversity in the eastern part of Ghana may have suffered considerably by recent forest destruction, it seems pressing to investigate other forests and water catchment areas in western and central Ghana for their remaining amphibian diversity.

Acknowledgements

We thank the Critical Ecosystem Partnership Fund (CEPF) for financial support of this survey and especially N. MARSHALL for support and help prior to our tour. We are especially thankful to N. K. ANKUDEH of the Ghana Wildlife Division for permission to work in the Volta Region wildlife reserves, for collecting permits and CITES certifications. We are very grateful to L. ASHRIFIE and J. MASON of the Nature Conservation Research Center in Accra for logistic support and various other helps. Without that support the whole trip would not have been possible. Thanks to the Wildlife Division staff and local guides at Kalakpa Game Production Reserve, Agumatsa Wildlife Sanctuary, and Kyabobo Range National Park. The Ghana Wildlife Society provided permission to work in the Afadjato area.

Many thanks for the hospitality of Senior Game Warden L.K. BAHIAN and his family at Nkwanta and M.P.K. AHWIRENG and his family and local guides D. ABOAGYE and E. TAWIA at Apesokubi. We thank Nkwanta paramount chief N.O. AGYEI II, E.B. OGAH and the elders of Shiare, and local guide A.K. OKRAH for permissions and assistance while working at Shiare. Thanks to chief T. KORDJADZA and Peace Corps volunteer L. MARBURY for their hospitality at Liati Wote (Tagbo Fall).

We are especially thankful to the Ghana Wildlife Division for logistic support. We thank M. ABEDI-LARTEY, J. DECHER, A. NDINKE, J. OPPONG and M. WEINBRENNER for their company and help, and all other Ghanaians and expatriates who helped us so much during the survey either by going with us to the field or providing us with housing opportunities or various other things. J. DECHER's field experience in Ghana and his preparation of this survey was invaluable helpful. He also provided figure 1. J. RASMUSSEN and D. MEIRTE provided specimens from the Copenhagen and Tervuren museums, respectively. A. CHANNING and S. LÖTTERS provided valuable comments on the manuscript. ARND WEYERS and JIM BUSKIRK helped improving spelling and grammar.

This study is made possible through grants and additional support from Conservation International and the Critical Ecosystem Partnership Fund (CEPF), Washington, D.C. Analyzing

and publication of the data was part of the BIOLOG-program of the German Ministry of Education and Science (BMBF; Project W08 BIOTA-West, 01 LC0017).

Amphibien des Togo-Volta Hochlands, östliches Ghana

Auf der hier vorgestellten Mission in die Volta Region konnten wir 31 Amphibienarten nachweisen. Auf der Basis relativ vergleichbaren Sammelaufwandes in allen Lebensräumen kalkulierten wir, dass etwa 41 Amphibienarten in dem von uns untersuchten Gebiet vorkommen. Das Togo-Volta Hochland ist damit artenreicher als angenommen. Es konnte kein Fließgewässerspezialist, wie der endemische *Conraua derooi*, oder auf große geschlossene Waldgebiete angewiesene Arten, wie zum Beispiel *Bufo togoensis*, nachgewiesen werden. Wir glauben, dass unsere Ergebnisse ein Hinweis auf ein potenzielles Amphibiensterben von Fließgewässerspezialisten sein könnten.

Wir fanden keine größeren ungestörten Waldgebiete in der Voltaregion. Dies erklärt das Fehlen einiger Primärwaldspezialisten unter den Amphibien in unseren Nachweisen. Der hohe Anteil von Arten, die auf gestörten Waldflächen oder Agrarland überleben können („farmbush" Arten), ist ebenfalls ein klarer Hinweis darauf, dass die natürliche Waldstruktur in vielen Gegenden weitgehend zerstört ist. Reliktpopulationen von Waldspezialisten fanden wir hauptsächlich in der Umgebung des Wli-Wasserfalls und dem Dorf Shiare.

Zukünftige Naturschutzaktionen sollten alle Aktivitäten, die Dorfwälder erhalten, unterstützen. Zusätzlich muss dringend allen größeren in der Volta Region verbliebenen Wäldern oberster Schutzstatus eingeräumt werden und der Versuch unternommen werden, verbliebene Waldreste durch Wiederaufforstungsaktionen zu verbinden.

Schlagwörter: Amphibia: Anura; Diversität; Westafrika: Ghana; Habitatwahl; Schutz; Waldreste.

References

AHL, E. (1924a): Über einige afrikanische Frösche. – Zool. Anz., **59/60**: 269-273.

— (1924b): Neue Reptilien und Batrachier aus dem zoologischen Museum Berlin. – Archiv für Naturgeschichte, **1924**, A: 246-254.

BAKARR, M., B. BAILEY, D. BYLER, R. HAM, S. OLIVIERI & M. OMLAND (2001, eds.): From the forest to the sea: Biodiversity connections from Guinea to Togo, Conservation Priority-Setting Workshop, December 1999. – Washington D.C. (Conservation International), 78 pp.

BARNETT, L.K., C. EMMS & C. SANTONI (2001): The herpetofauna of Abuko Nature Reserve, The Gambia. – Herpetological Bulletin, **77**: 5-14.

BÖHME, W. (1994a): Frösche und Skinke aus dem Regenwaldgebiet Südost-Guineas, Westafrika. I. Einleitung; Pipidae, Arthroleptidae, Bufonidae. – herpetofauna, **16**(92): 11-19.

— (1994b): Frösche und Skinke aus dem Regenwaldgebiet Südost-Guineas, Westafrika. II. Ranidae, Hyperoliidae, Scincidae; faunistisch-ökologische Bewertung. – herpetofauna, **16**(93): 6-16.

CHANNING, A. (2001): Amphibians of Central and Southern Africa. – New York (Cornell University Press), 470 pp.

—, D. MOYER & M. BURGER (2002): Cryptic species of sharp-nosed reed frogs in the *Hyperolius nasutus* complex: advertisement call differences. – African Zoology, **37**: 91-99.

CHATELAIN, C., L. GAUTIER & R. SPICHIGER (1996): A recent history of forest fragmentation in southwestern Ivory Coast. – Biodiversity and Conservation., **5**: 37-53.

DECHER, J. (1997): Conservation, small mammals, and the future of sacred groves in West Africa. – Biodiversity and Conservation, **6**: 1007-1026.

— & M. ABEDI-LARTEY (2002): Small mammal zoogeography and diversity in West African forest remnants, final report. – unpublished report for Ghana Wildlife Division, National Geographic Committee for Research and Exploration and Conservation International, Vermont, 32 pp. + 32 pp. appendix.

— & L.K. BAHIAN (1999): Diversity and structure of terrestrial small mammal communities in different vegetation types on the Accra plains of Ghana. – Journal of Zoology (London), **247**: 395-408.

DE LA RIVA, I. (1994): Anfibios anuros del Parque Nacional de Monte Alén, Río Muni, Guinea Ecuatorial. – Revista Española de Herpetología, **8**: 123-139.

DREWES, R.C. (1984): A phylogenetic analysis of the Hyperoliidae (Anura): Treefrogs of Africa, Madagascar, and the Seychelles Islands. – Occasional Papers of the Californian Academy of Science, **139**: 1-70.

EUSKIRCHEN, O., A. SCHMITZ & W. BÖHME (1999): Zur Herpetofauna einer montanen Regenwaldregion in SW-Kamerun (Mt. Kupe und Bakossi-Bergland), II. Arthroleptidae, Ranidae und Phrynobatrachidea. – herpetofauna, **21**(122): 25-34.

FREMPONG, E. (1995): Limnological research and training in Ghana: The past, present and perspectives for future development. – pp. 1-39 in GOPAL, B. & R.G. WETZEL (eds.): Limnology in developing countries.

FROST, D.R. (2002): Amphibian species of the World: an online reference. V2.21 (15 July 2002). – http://research.amnh.org/herpetology/amphibia/index.html.

GUIBÉ, J. & M. LAMOTTE (1958): La réserve naturelle intégrale du Mont Nimba. XII. Batraciens (sauf *Arthroleptis, Phrynobatrachus* et *Hyperolius*). – Memoirs de l'Institute fondamental d'Afrique noire, Sér. A, **53**: 241-273.

— (1963): La réserve naturelle intégrale du Mont Nimba. XXVIII. Batraciens du genre *Phrynobatrachus*. – Memoirs de l'Institute fondamental d'Afrique noire, Sér A, **66**: 601-627.

HAWTHORNE, W.D. (2001): Forest conservation in Ghana: forestry, dragons, genetic heat. – pp. 491-512 in WEBBER, W., L.J.T. WHITE, A. VEDDER & L. NAUGHTON-TREVES (eds.): African rain forest ecology and conservation: an interdisciplinary perspective. – New Haven and London (Yale University Press).

HEYER, W.R., M.A. DONNELLY, R.W. MCDIARMID, L.-A.C. HAYEK & M.S. FOSTER (1993): Measuring and monitoring biological diversity, standard methods for amphibians. – Washington D.C. (Smithsonían Institution Press), 364 pp.

HOFER, U., L.-F. BERSIER & D. BORCARD (1999): Spatial organization of a herpetofauna on an elevational gradient revealed by null model tests. – Ecology, **80**: 976-988.

— (2000): Ecotones and gradients as determinants of herpetofaunal community structure in the primary forest of Mount Kupe, Cameroon. – Journal of Tropical Ecology, **16**: 517-533.

HOOGMOED, M.S. (1979): Herpetologische waarnemingen in Ghana. – Lacerta, **37**: 164-168.

— (1980a-g): Herpetologische waarnemingen in Ghana II-VIII. – Lacerta, **38**: 10-20, 42-48, 50-53, 62-65, 76-80, 88-95, 112-116.

HUGHES, B. (1988): Herpetology in Ghana (West Africa). – British Herpetological Society Bulletin, **25**: 29-38.

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.

JAHN, S., M. HÜLS & M. SARNTHEIN (1998): Vegetation and climate history of west equatorial Africa based on a marine pollen record off Liberia (site GIK 16776) covering the last 400,000 years. – Revue Palaeobotany Palynology, **102**: 277-288.

JOGER, U. & M.R.K. LAMBERT (2002): Inventory of amphibians and reptiles in SE Senegal, including the Niokola-Koba National Park, with observations on factors influencing diversity. – Tropical Zoology, **15**: 165-185.

LAMOTTE, M. (1966): Types de répartition géographique de quelques batraciens dans l'Ouest Africain. – Memoirs de l'Institute fondamental d'Afrique noire, Sér. A, **28**: 1140-1148.

— (1967): Les batraciens de la région de Gpakobo (Côte d'Ivoire). – Memoirs de l'Institute fondamental d'Afrique noire, Sér. A, **29**: 218-294.

— (1969): Le parc national du Niokolo-Koba, Fasciule III; XXX. Amphibiens (deuxième note). – Memoirs de l'Institute fondamental d'Afrique noire, Sér. A, **84**: 420-426.

— (1971): Le Massif des Monts Loma (Sierra Leone), Fasciule I; XIX. Amphibiens. – Memoirs de l'Institute fondamental d'Afrique noire, **86**: 397-407.

— (1983): Amphibians in savanna ecosystems. – pp. 313-323 in BOURLIÈRE, F. (ed.): Ecosystems of the World 13, Tropical savannas. – Amsterdam (Elsevier Scientific Publishing Company).

— & A. OHLER (1997): Redécouverte de syntypes de *Rana bibroni* HALLOWELL, 1845, désignation d'un lectotype et description d'une espèce nouvelle de *Ptychadena* (Amphibia, Anura). – Zoosystema, **19**: 531-543.

—, G. LAUWARIER & J.-L. PERRET (1957): Contribution à l'étude des batraciens de l'Ouest Africain V. – Le développement larvaires de *Rana (Hylarana) albolabris*. – Bulletin de l'Institute fondamental d'Afrique noire, Sér. A, **19**: 1312-1327.

LARGEN, M.J. (2001): Catalogue of the amphibians of Ethiopia, including a key for their identification. – Tropical Zoology, **14**: 307-402.

— & F. DOWSETT-LEMAIRE (1991): Amphibians (Anura) from the Kouilou River basin, République du Congo. – Tauraco Research Report, **4**: 145-168.

LAURENT, R.F. (1972): Tentative revision of the genus *Hemisus* GÜNTHER. – Musée Royal d'Afrique Centrale, Science Zoologique, no. **194**: 1-67.

LAWSON, D.P. (1993): The reptiles and amphibians of the Korup National Park project, Cameroon. – Herpetological Natural History, **1**: 27-90.

MCINTYRE, P. (1999): *Hylarana albolabris*, predation. – Herpetologiacl Review, **30**: 223.

MOREAU, R.E. (1963): Vicissitudes of the African biomes in the late Pleistocene. – Proceedings of the Zoological Society of London, **141**: 395-421.

— (1969): Climatic changes and the distribution of forest vertebrates in West Africa. – Journal of Zoology (London), **158**: 39-61.

MYERS, N., R.A. MITTERMEIER, C.G. MITTERMEIER, G.A.B. DA FONSECA & J. KENT (2000): Biodiversity hotspots for conservation priorities. – Nature, **403**: 853-845.

OATES, J.F. (1999): Myth and reality in the rainforest: how conservation strategies are failing in West Africa. – Berkeley (University of California Press), xxviii + 310 pp.

PARKER, H.W. (1936): Amphibians from Liberia and the Gold Coast. – Zoologische Mededeelingen, **19**: 87-102

PARREN, M.P.E. & N.R. DE GRAAF (1995): The quest for natural forest management in Ghana, Côte d'Ivoire and Liberia. – Wageningen, Tropenbos Series 13, 199 pp.

PERRET, J.-L. (1988): Les espèces de *Phrynobatrachus* (Anura, Ranidae) à éperon palpépral. – Archives des Sciences, Genève, **41**: 275-294.

— (1994): Revision of the genus *Aubria* BOULENGER 1917 (Amphibia Ranidae) with the description of a new species. – Tropical Zoology, **7**: 255-269.

— (1997): Description de *Ptychadena arnei* n. sp. (Amphibia, Ranidae) une espèce méconnue d'Afrique Occidentale. – Bulletin de la Societé neuchateloise, Science Naturelle, **120**: 77-86.

RAXWORTHY, C.J. & D.K. ATTUQUAYEFIO (2000): Herpetofaunal communities at Muni Lagoon in Ghana. – Biodiversity and Conservation, **9**: 501-510.

RÖDEL, M.-O. (1996): Amphibien der westafrikanischen Savanne. – Frankfurt/M. (Edition Chimaira), 295 pp + 8 plates.

— (1998a): Kaulquappengesellschaften ephemerer Savannengewässer in Westafrika. – Frankfurt/M. (Edition Chimaira), 195 pp.

— (1998b): A new *Hyperolius* species from Tai National Park, Ivory Coast (Anura: Hyperoliidae: Hyperoliinae). – Revue française d'aquariologie herpétologie, **25**: 123-130.

— (2000): Herpetofauna of West Africa, Vol. I: Amphibians of the West African savanna. – Frankfurt/M. (Edition Chimaira), 335 pp.

— (2003): The amphibians of Mont Sangbé National Park, Ivory Coast. – Salamandra, **39**(2): 91-110.

— & W.R. BRANCH (2002): Herpetological survey of the Haute Dodo and Cavally Forests, western Ivory Coast, I. Amphibians. – Salamandra, **38**(4): 245-268.

— & R. ERNST (2000): *Bufo taiensis* n. sp., eine neue Kröte aus dem Taï-Nationalpark, Elfenbeinküste. – herpetofauna, **22**(125): 9-16.

— & — (2001): Description of the tadpole of *Kassina lamottei* SCHIØTZ, 1967. – Journal of Herpetology, **35**: 678-681.

— & — (2002): A new *Phrynobatrachus* species from the Upper Guinea rain forest, West Africa, including a description of a new reproductive mode for the genus. – Journal of Herpetology, **36**: 561-571.

— & — (2003): The amphibians of Marahoué and Mont Péko National Parks, Ivory Coast. – Herpetozoa, **16**(1/2): 23-39.

—, U.T. GRAFE, V.H.W. RUDOLF & R. ERNST (2002a): Review of West African spotted *Kassina*, including a description of *Kassina schioetzi* sp. nov. (Amphibia: Anura: Hyperoliidae). – Copeia, **2002**: 800-814.

—, J. KOSUCH, M. VEITH & R. ERNST (2003): First record of the genus *Acanthixalus* LAURENT, 1944 from the Upper Guinea rain forest, West Africa, including the description of a new species. – Journal of Herpetology, **37**: 43-52.

—, D. KRÄTZ & R. ERNST (2002b): The tadpole of *Ptychadena aequiplicata* (WERNER, 1898) with the description of a new reproductive mode for the genus (Amphibia, Anura, Ranidae). – Alytes, **20**(1-2): 1-12.

—, G. SCHORR & R. ERNST (2001): Zur Biologie von *Cardioglossa leucomystax* (BOULENGER, 1903), im Taï-Nationalpark, Elfenbeinküste. – Salamandra, **37**(4): 239-260.

— & M. SPIELER (2000): Trilingual keys to the savannah-anurans of the Comoé National Park, Côte d'Ivoire. – Stuttgarter Beiträge zur Naturkunde, Ser. A, Nr. **620**: 1-31.

—, —, K. GRABOW & C. BÖCKHELER (1995): *Hemisus marmoratus* (PETERS, 1854) (Anura: Hemisotidae), Fortpflanzungsstrategien eines Savannenfrosches. – Bonner zoologische Beiträge, **45**: 191-207.

ROMPAEY, VAN R.S.A.R. (1993): Forest gradients in West Africa. A spatial gradient analysis. – PhD Thesis, Wageningen, 142 pp.

SCHIØTZ, A. (1964a): A preliminary list of amphibians collected in Ghana. – Vidensk. Meddr. fra dansk naturh. Foren., **127**: 1-17.

— (1964b): The voices of some West African amphibians. – Vidensk. Meddr. fra dansk naturh. Foren., **127**: 35-83.

— (1967): The treefrogs (Rhacophoridae) of West Africa. – Spolia zoologica Musei Haunienses, **25**: 1-346.

— (1971): The superspecies *Hyperolius viridiflavus* (Anura). – Vidensk. Meddr. fra dansk naturh. Foren., **134**: 21-76.

— (1999): Treefrogs of Africa. – Frankfurt/M. (Edition Chimaira), 350 pp.

SCHMITZ, A., O. EUSKIRCHEN & W. BÖHME (1999): Zur Herpetofauna einer montanen Regenwaldregion in SW-Kamerun (Mt. Kupe und Bakossi-Bergland), I. Einleitung, Bufonidae und Hyperoliidae. – herpetofauna, **21**(121): 5-17.

SPIELER, M. & K.E. LINSENMAIR (1999): The larval mite *Endotrombicula pillersi* (Acarina: Trombiculidae) as a species-specific parasite of a West African savannah frog (*Phrynobatrachus francisci*). – American Midland Naturalist, **142**: 152-161.

WERNER, F. (1898): Ueber Reptilien und Batrachier aus Togoland, Kamerun und Tunis aus dem kgl. Museum für Naturkunde in Berlin. – Verhandlungen der kaiserlich-königlichen zoologisch-botanischen Gesellschaft in Wien, **XLVIII**: 191-230 + 1 plate.

WIECZOREK, A.M., A. CHANNING & R.C. DREWES (1998): A review of the taxonomy of the *Hyperolius viridiflavus* complex. – Herpetological Journal, **8**: 29-34.

—, R.C. DREWES & A. CHANNING (2001): Phylogenetic relationships within the *Hyperolius viridiflavus* complex (Anura: Hyperoliidae), and comments on taxonomic status. – Amphibia-Reptilia, **22**: 155-166.

Appendix:

Specimens examined

Hyperolius picturatus: ZMUC R076053, R076055, Loma, Sierra Leone; R075361, R075363, Danané, Ivory Coast; R074158, R074170, Prince's Town, Ghana; R074387, R074472-73, Mamfe, Ghana; coll. A. SCHIØTZ.

Hyperolius baumanni: R074623-24, R073347, Biakpa, Ghana, coll. A. SCHIØTZ.

Hyperolius torrentis: R073356, R073358, R073441-42, R074375, R074510, Biakpa, Ghana, 13.VI.1961, coll. A. SCHIØTZ; R073351, Amedzofe, Ghana, 11.VI.1961, coll. A. SCHIØTZ; R071937, Misahöhe, Togo, 3.X.1958, coll. VOLSØE.

Hyperolius viridigulosus: R073440, R076604, Bobiri, Ghana, 21.V.1965, coll. A. SCHIØTZ, R076649, 35 km North of Abidjan, Ivory Coast, 7.VI.1965, coll. A. SCHIØTZ.

Hyperolius bobirensis: R074154, R074194, R074198-204, R074206, Bobiri, Ghana, 30.VII.1961, coll. A. SCHIØTZ.

Conraua derooi: MRAC B.112077-78, Misahöhe, Togo, 29.XII.1969; Miss. F. DEVREE & E. VANDERSTRAETEN; 112079-80, Misahöhe, Togo, 6.VIII.1969, Miss. J. HULSELMANS, W. VERHEYEN, F. REYFAERT (all paratypes); Ghana: ZMUC R073998, Pusu-pusu Gorge, 21.VI.1961, coll. A. SCHIØTZ; R073957-58, Biakpa, 12.VI.1961, coll. A. SCHIØTZ; R073750, 073948, 073950-51, 073955, Amedzofe, 11.VI.1961, coll. A. SCHIØTZ.

Received: 3 September 2002

Authors: MARK-OLIVER RÖDEL , Department of Animal Ecology and Tropical Biology (Zoology III); Biocenter of the University; Am Hubland; D-97074 Würzburg, Germany; E-Mail: roedel@biozentrum.uni-wuerzburg.de; ALEX CUDJOE AGYEI, Wildlife Division, P.B. M239, Accra, Ghana.