

The amphibians of Mont Sangbé National Park, Ivory Coast

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Zusammenfassung

Die Amphibien des Mont Sangbé Nationalparks, Elfenbeinküste.

Die Amphibienfauna des Mont Sangbé Nationalparks, Elfenbeinküste, wurde während mehrerer Aufenthalte in den Jahren 2000 und 2001 erfasst. Der Park zeichnet sich durch eine für Westafrika einzigartige Kombination aus Wald-, Berg- und Savannenlebensräumen aus. Insgesamt wurden 45 Anurenarten nachgewiesen. Das Vorkommen von circa zehn weiteren Arten ist wahrscheinlich. Etwa die Hälfte der nachgewiesenen Arten sind westafrikanische Endemiten. Fünf Arten sind Lokalendemiten des westlichen, oberguineischen Waldblocks (*Conraua* sp., *Petropedetes natator*, *Astylosternus occidentalis*, *Hyperolius chlorosteus*, *H. zonatus*). Diese und einige andere Waldarten (*Amnirana albolabris*, *Leptopelis hyloides*, *L. occidentalis*) erreichen im Mont Sangbé Nationalpark ihre nördliche Verbreitungsgrenze in der Elfenbeinküste.

Schlagwörter: Amphibia: Anura: Biologie; Diversität; Elfenbeinküste; Habitatwahl; Regenwald; Savanne; Schutz; Westafrika.

Abstract

I investigated the amphibian fauna of Mont Sangbé National Park, Ivory Coast, during several field trips in 2000 and 2001. The park is unique for West Africa in combining a variety of different habitat types, e.g. rain forest, mountainous habitats and different savanna formations. In total I recorded 45 anuran species and calculated that the occurrence of 10 additional species in the park is likely. About half of the recorded species are endemic to West Africa. Five species are local endemics, restricted to an area stretching from western Ivory Coast into neighboring Guinea and Liberia (*Conraua* sp., *Petropedetes natator*, *Astylosternus occidentalis*, *Hyperolius chlorosteus*, *H. zonatus*). These and some other forest species (*Amnirana albolabris*, *Leptopelis hyloides*, *L. occidentalis*) reach their northernmost Ivorian distribution in Mont Sangbé National Park.

Key Words: Amphibia: Anura: biology; conservation; diversity; habitat selection; Ivory Coast; rain forest; savanna; West Africa.

1 Introduction

Although herpetological investigations in West Africa started in the late 19th century (e.g. PETERS 1875, 1876, 1877, WERNER 1898), very few areas are well known. It was not until the 1960s, that nearly complete amphibian inventories were presented for a number of West African localities, e.g. Mt. Nimba (GUIBÉ & LAMOTTE 1958, 1963), Lamto (LAMOTTE 1967) and Mts. Loma (LAMOTTE 1971). With an emphasis on tree frogs, SCHIØTZ (1963, 1964a, b, 1967) surveyed several other West African localities. In the 1990's I started to investigate most national parks of Ivory Coast. All together (including the present study) the amphibian faunas of no more than nine areas in Ivory Coast can be regarded as more or less well known.

Mont Sangbé National Park was never investigated herpetologically, although due to its forest habitats in the South, the savanna habitats in the North, and the close proximity to the Mont Nimba area, it promises especially high amphibian diversity. In 2000 and 2001 an inventory of the flora and fauna of the park was made possible by funds from the European Community. This paper documents the results of the amphibian survey in this peculiar park.

2 Methods

2.1 Study site

The Mont Sangbé National Park (MSNP) is situated in western-central Ivory Coast, close to the border to Guinea (Fig. 1). BELIGNÉ (2000) summarized the general geographical and climatological data available for MSNP. According to him: the southern part of MSNP forms the north-easternmost part of the Upper Guinea highlands, stretching west into Guinea and Sierra Leone. The longest west-east extension of MSNP is 36.8 km; the longest north-south extension is 39.2 km. The MSNP is delimited in the North by the river Baba, and in the South by the rivers Goué and Bafing. The river Sassandra forms its eastern border (Fig. 1). Generally the park can be divided into two main vegetation regions. The mountainous zone comprises the area southwest of the river Gan. Inselbergs, mountains of granite origins, which range from 500 to 1072 m a.s.l, characterize this whole area. The highest elevations are Mt. Boin (1072 m a.s.l.) and Mt. Sangbé (1070 m a.s.l.). Whilst the mountaintops are covered by savanna formations, valleys harbor rain forest (Fig. 2). The savanna zone stretches north of Mt. Sangbé down to the confluence of the rivers Gan and Bafing. The lowest point of MSNP is the confluence of the Bafing and Sassandra rivers (247 m a.s.l.). The savanna is of the Sudanese type and comprises predominantly tree savanna with a mosaic of island forests of various sizes (Fig. 3). Typical Guinea savanna, with e.g. *Borassus ethiopum* palms, that is normally present in-between the forest zone and the Sudanese savanna, is lacking in MSNP (compare LAMOTTE 1967). Up to now about 546 plant species have been recorded for MSNP (BELIGNÉ 2000).

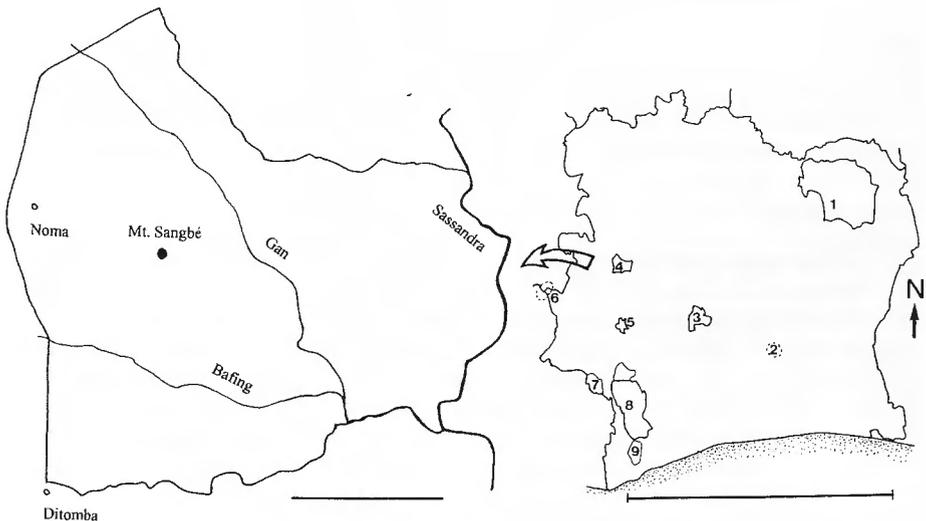


Fig. 1. Mont Sangbé National Park (left) and its geographic position in Ivory Coast. 1 = Comoé National Park; 2 = Lamto; 3 = Marahoué National Park; 4 = Mont Sangbé National Park; 5 = Mont Péko National Park; 6 = Mont Nimba integrated reserve; 7 = Cavally classified forest; 8 = Taï National Park; 9 = Haute Dodo classified forest; scale bars: 10 km (left) and 500 km (right).

Mt. Sangbé Nationalpark (links) und seine Lage in der Elfenbeinküste. Maßstriche: 10 km (links) und 500 km (rechts).

The park is situated in the transition zone between a subequatorial and a tropical climate. Consequently there is annual change in receiving either two dry and rainy seasons or only one. Simplified, the rainy season stretches from April to October. The period with highest precipitation is September in the South and August to October in the North. In the core dry season the climate is influenced by the Harmattan, a dry sandy wind from the Sahara desert. This high dry season stretches from January to February in the South and from January to May in the North. There is a marked precipitation gradient from South to North in MSNP. In Biankouma, southwest of the park, the mean annual precipitation from 1961-1990, was 1570 mm; that of Touba, northwest of the park, was 1280 mm. Like in other parts of West Africa it seems that annual precipitation is diminishing throughout the last decades. So in 1965 Biankouma was situated on the 1700 mm isohyets, and Touba at 1400 mm. Mean annual temperature is 24.5 °C. Lowest temperature in the dry season drop down to 10 °C. The mean annual humidity is about 75 %.

During this survey I investigated two main areas within MSNP: the savanna zone in the North and the mountainous forest zone in the Southwest of the reserve.

Fig. 2. Mountainous landscape with forest in the valleys and savanna on the hilltops.

Berglandschaft mit Wald in den Tälern und Savanne auf den Gipfeln.



Fig. 3. View from top of Mont Sangbé (1070 m a.s.l.) towards North-West. Various savanna types, dominated by tree savanna.

Blick vom Gipfel des Mt. Sangbé (1070 m NN) nach Nordwesten. Unterschiedliche Savannenformationen, dominiert von Baum-savanne.



Fieldwork was conducted on 3 October 2000, 23-25 June 2002, and 11-12 October 2001 in the forest zone. The savanna zone was investigated from 29 September to 2 October 2000, 20-22 June 2001, 24-29 September 2001 and 10 October 2001. In addition my field assistants from the "Taï Amphibian Project" conducted some sampling during two weeks in the dry season of February 2002 around Maar Soumarou (msmaa1). Geographic positions were taken with a handheld GPS-receiver (Garmin 12XL). Positions and short habitat characterizations for the localities investigated are summarized in appendix 1.

2.2 Sampling methods and sampling effort

Specimens were mainly located opportunistically. Surveys were undertaken during the day and during night. Search techniques included visual scanning of terrain and refuge examination. I also applied acoustic monitoring of all available habitat types (HEYER et al. 1993). Additionally I checked all available watercourses for tadpoles by dip netting. To supplement opportunistic collecting, we installed pitfall traps along drift fences during February 2001 at msmaa1.

With the applied sampling design, only qualitative and semi quantitative data can be obtained. For exact quantitative data, mark-recapture experiments along standardized transects or on definite plots would have been necessary. Survey time was not sufficient to employ these methods. Assuming that sampling effort was comparable throughout habitats, I calculated the approximate total number of amphibian species living in both forest and savanna zone. Because I had no quantitative data available, I used the Jackknife1 and Chao2 estimators, based on presence/absence data for all habitats (COLWELL 1994-2000). For a brief introduction to these methods and the respective mathematic formulae see <http://viceroy.eeb.uconn.edu/Estimates6/EstimateS%20Pages/UsersGuideHTML/EstiMateS6Guide.html> and literature cited herein. To prevent order effects, all calculations have been based on 500 randomized runs of the daily species lists.

Some voucher specimens were collected, anesthetized and killed in a chlorbutanol solution and thereafter preserved in 70 % ethanol. Vouchers are in my possession. The field numbers are listed in appendix 2. All specimens will be transferred later on to collections of different natural history museums. Tissue samples of most recorded species were preserved in 95 % ethanol. These samples are stored in the Institute of Zoology at Mainz University, Germany.

3 Results and Discussion

3.1 Sampling efficiency

During the whole survey 45 amphibian species were recorded. Species accumulation curves show how many new species were added each day (Fig. 4). A continued increase of the curves slopes indicates that additional amphibian species remain to be discovered, at least in the forest zone.

Based on the number of species found per day, I estimated the number of species occurring in the savanna and in the forest zone, as well as in the entire park. The Chao2 and Jackknife1 procedures calculated about 55-56 amphibian species for the entire MSNP (Tab. 1). The recorded species thus would represent about 81 % of the species calculated to occur in the whole reserve. Concerning only the savanna area I recorded 28 of 29-32 calculated ones (88-97 %). In the forest zone I recorded 32 amphibian species. That makes 65-71 % of the 45-49 species estimated.

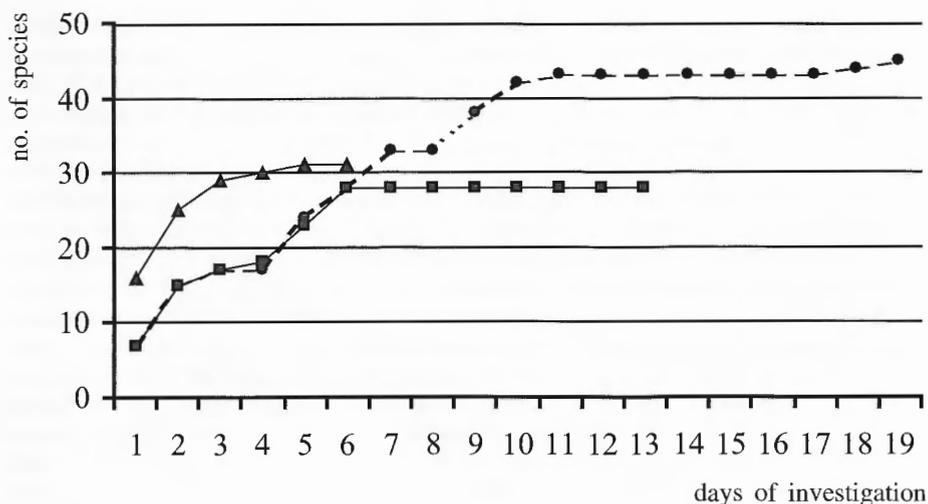


Fig. 4. Amphibian species accumulation curve per survey day; triangles: species of the forest, squares: species of the savanna; points: all species.

Akkumulationskurven der pro Erfassungstag nachgewiesenen Arten; Dreiecke: Arten der Waldzone; Quadrate: Arten der Savannenzzone; Punkte: alle Arten.

3.2 Species account

Below I give a short description of distribution and habitat preferences for some amphibian species I gathered data on during this survey. For some species taxonomical remarks and biological and morphological data were added as well. Species that have

	total / gesamt	savanna zone / Savannenzzone	forest zone / Waldzone
recorded species / nachgewiesene Arten	45	28	32
Chao2-estimator / Chao2 Schätzstatistik	56 ± 9.7	29.2 ± 1.9	49.3 ± 14.5
Jackknife1 estimator / Jackknife1 Schätzstatistik	55.4 ± 4.6	31.7 ± 2.9	45.3 ± 5.3
# of days / Anzahl der Tage	19	13	6

Tab. 1. Number of recorded and estimated species (with standard deviation) for the entire park and the savanna and forest zones, respectively. Number of days = number of days that amphibians have been searched for in a given part of the park. Compare text.

Anzahl der nachgewiesenen und hochgerechneten Amphibienarten (mit Standardabweichung) für den gesamten Park, sowie für die Savannen- und die Waldzone. Die Anzahl der Tage entspricht der Tage an denen in einer bestimmten Zone des Parks nach Amphibien gesucht wurde. Vergleiche Text.

been dealt with in detail in other recent publications (e.g. SCHIØTZ 1999, RÖDEL 2000, RÖDEL & BRANCH 2002, RÖDEL & AGYEI in press) are only listed in appendix 2. Nomenclature mainly follows SCHIØTZ (1967), RÖDEL (2000) and FROST (2002). For exceptions see citations in appendix 2. I summarize all localities where a particular species has been found in appendix 2.

Hemisus cf. *marmoratus* (PETERS, 1854). This widespread but secretive subterranean frog (RÖDEL et al. 1995, KAMISNSKY et al. 1999, RÖDEL 2000) was only recorded once in MSNP. I found tadpoles in a puddle without vegetation in a small gallery forest within the savanna zone. These tadpoles showed all characters of typical *H. marmoratus*, however differed genetically from other savanna populations and were most similar to *Hemisus* from Taï National Park (KOSUCH & RÖDEL unpubl.). It remains uncertain, whether they are *H. guineensis* or *H. marmoratus* (compare LAURENT 1972, RÖDEL 2000). Because I could not find any differences in morphology between the MSNP specimens and *H. marmoratus* from Comoé National Park (RÖDEL 2000), and the MSNP tadpoles were collected in a savanna environment I decided to assign them tentatively to *H. marmoratus*.

Amnirana albolabris (HALLOWELL, 1856). A common West and Central African forest frog (PERRET 1977). According to AMIET (1975) and PERRET (1977) *A. albolabris* is mainly a farmbush species (sensu SCHIØTZ 1967) in Cameroon. There it reproduces only in stagnant waters. LAWSON (1993) reports that in Korup National Park, Cameroon, he only found one specimen in primary forest, all others in farmbush and secondary growth along running water. In MSNP breeding aggregations occurred along slow flowing creeks and larger ponds. The largest population (> 50 calling males) was recorded in a very small forest, surrounding a large, deep pond with only a few shallow areas with vegetation (msmaa1). Here we found one clutch on 1 October 2001. This seems to be the northernmost locality of the species in West Africa. Other habitats were slow running creeks in the forest zone, often bordered with dense vegetation. Males often called completely exposed from roots close to crocodile (*Osteolaemus tetraspis*)



Fig. 5. Male *Conraua* sp. from Mont Sangbé National Park.

Männlicher *Conraua* sp. aus dem Mt. Sangbé Nationalpark.

holes. The unpalatable tadpoles (LAMOTTE et al. 1957, PERRET 1977) could regularly be observed at all sites, even in the presence of fish (MCINTYRE 1999, RÖDEL & ERNST 2001).

Conraua sp. The genus *Conraua* comprises highly aquatic frogs. The MSNP specimens were found in pools of a fast flowing forest stream with sandy and rocky ground. Calling frogs sat in shallow water or floated on the water surface and were separated widely from each other. They called with open mouth as reported from *C. crassipes* by AMIET (1989-1990). Two specimens that were kept in captivity for more than a year continuously called. After preservation and dissection they proved to be a male and a female. *Conraua* sp. therefore is one of the few anuran species, in which both sexes emit advertisement calls. The call of both sexes was a bird like whistle. Additionally we occasionally heard a second, growling sound that was uttered under water. In MSNP I first heard the species at night on 24 June 2001 after a heavy rain that turned a few stagnant puddles into a raging stream. Single frogs started calling at dusk. However, calling activity was much higher during early morning hours (4-6 hours). During night males were colored reddish brown (Fig. 5). During daytime they were brown to black. Tadpoles were regularly observed in deeper parts of the stream, seeking refuge under rocks.



Fig. 6a/b.
Phrynobatrachus alleni males in breeding condition, note yellow back and vocal sac.
P. alleni Männchen in Laichfärbung, beachte die gelbe Rückenfärbung und die gelbe Schallblase.

Taxonomic remark: *Conraua alleni* (BARBOUR & LOVERIDGE, 1927) is endemic to the Upper Guinea rain forest and has been previously described from Ivory Coast only from Banco National Park and the region between Man and Mont Nimba (LAMOTTE & PERRET 1968). The specimens from MSNP differ considerably in morphology and vocalization from frogs collected in Haute Dodo classified forest (RÖDEL & BRANCH 2002). Two *Conraua* taxa, therefore occur in Ivory Coast and both clearly differ from *C. derooi* HULSELMANS, 1972 described from Togo, and other Central African species of the genus (RÖDEL unpubl.). The relationship of the MSNP records to *C. alleni*, and the description of a new species require further analysis and will be dealt with in a separate publication.

Ptychadena aequiplicata (WERNER, 1898). *P. aequiplicata* is a widespread West and Central African forest frog. With few exceptions it inhabits only primary forests (RÖDEL et al. 2002b). In MSNP I found the species only in the forest along a creek northeast of Ditomba. There I couldn't find suitable spawning habitats, small to larger forest ponds (RÖDEL et al. 2002b).

Phrynobatrachus alleni PARKER, 1936. A common West African inhabitant of leaf litter in closed canopy forest. In MSNP I recorded *P. alleni* only along one forest stream (msbac6-8). On 24 June 2001 I observed a large aggregation of breeding frogs at a stagnant remnant of that stream during daytime. This pond had an approximate surface of more than 30 m² and was up to 80 cm deep. The water was very clear, the ground consisted of large stones and rocks, and it completely lacked vegetation. More than a hundred males could be observed calling exposed on bare rock. Many couples were depositing their floating egg films in shallow parts of the pond. All calling males were colored uniform yellow (Fig. 6), but within minutes turned into various other patterns when disturbed. The same day much smaller aggregations, comprising about 10-15 calling males, could be observed further upstream at two shallow rock-pools with leaf litter on the ground (surface 30 x 20 x 10 cm, and 20 x 15 x 8 cm, respectively). While in Taï National Park breeding activity in *P. alleni* was highest after heavy rains at puddles on the forest floor (RÖDEL & ERNST unpubl.), the MSNP site was completely floated by a fast flowing stream after a heavy rain. Thereafter no *P. alleni* could be observed in the closer vicinity of that river.

Phrynobatrachus alticola GUBÉ & LAMOTTE, 1961. A small leaf litter species restricted to the Upper Guinea forest (LAMOTTE 1966). Due to its direct development, it is able to survive in forest parts without open water (RÖDEL & ERNST 2002). It is most common in secondary growth and degraded forest. Close to Noma I recorded *P. alticola* in dense tree savanna with very high grass (3 October 2000). This habitat was close to a gallery forest bordering a fast flowing stream. Males were calling during daytime after a heavy rain. Possibly the frogs hide in the gallery forest during drier periods. Further south I recorded *P. alticola* in forest remnants close to the village of Ditomba and along the forested slopes of the valley of msbac6-8. There they occurred from the bottom of the valley, close to the forest stream, up to the top of the valley where the forest abruptly changed into tree savanna. *P. alticola* was more abundant in forest areas with dense undergrowth. Males called during daytime. They were sitting, completely exposed, on vertical stems of larger trees. This behavior was different compared to frogs from Taï National Park. There, males call well concealed in leaf litter (RÖDEL & ERNST 2002). While *P. alticola* seems to be active year round

in forests further south in Ivory Coast, I could not record the species at known localities in MSNP in October 2001. Males from MSNP further differed from males from Taï by a venter marbled in gray and white (uniform white in Taï animals), and yellow coloration on ventral parts of thighs (white in Taï frogs). Genetically frogs from both populations proved to be identical (KOSUCH & RÖDEL unpubl.).

Phrynobatrachus liberiensis BARBOUR & LOVERIDGE, 1927. This species, endemic to the Upper Guinea forest bloc (GUIBÉ & LAMOTTE 1963, LAMOTTE 1966, SCHIØTZ 1964a, b), is associated with small creeks in swampy forest areas. In MSNP I recorded it from two sites in the forest zone. At both sites 2-3 males called from the border of ponds that originated from jammed creeks.

Petropedetes natator BOULENGER, 1905. This species is endemic to the forested hilly parts of western West Africa. Records are known from Sierra Leone, Liberia, Guinea, and Ivory Coast (GUIBÉ & LAMOTTE 1958, LAMOTTE 1966, BÖHME 1994). In MSNP I recorded this species only along one forest stream (msbac6-9). This river flew through open tree savanna on a plateau, and through forest further downstream. Its ground consisted mainly of pure rock (Fig. 7). A lot of smaller rapids to larger waterfalls were present. *P. natator* occurred in all parts along the river, even in the savanna part, but was more abundant around rapids and waterfalls in the forest. There most adults were hidden in crevices of large rocks during daytime. Only few individuals were active during daytime. Most specimens started to leave their hiding places during dusk. *P. natator* was very shy and tried to escape when disturbed by jumping into fast flowing water. At one part of the river (app. 100 m), I checked the sexes of all frogs that I managed to catch. All frogs sitting on rocky surfaces far from waterfalls were males ($n = 6$), all individuals around waterfalls were females ($n = 6$). Rarely some specimens could be observed sitting on smaller (20-30 cm) herbs. Advertisement calls were heard during day and night, but exclusively close to rapids and waterfalls. The call consisted of a series of click sounds with ever-shorter intervals, thus resembling a dropping ping-pong ball. Tadpoles could be found on pure rock in waterfalls. Using their sucker like mouthparts (LAMOTTE & ZUBER-VOGELI 1954), captive tadpoles managed to climb glass surfaces. Females were larger (46-56 mm, $n = 4$) than males (41-47 mm, $n = 3$, Fig. 8). The latter had huge yellow femoral glands.

Arthroleptis sp. 1. *Arthroleptis* spp. were very common in forests throughout the region, but their taxonomic status remains uncertain. For discussion compare RÖDEL & BRANCH (2002). In MSNP *Arthroleptis* sp. 1 was recorded in some island forest in the savanna zone, and regularly throughout the whole forest zone of the park. Specific identity with frogs from Taï National Park, Hauto Dodo and Cavally forests (RÖDEL & BRANCH 2002) was assured by comparing their advertisement calls.

Arthroleptis cf. *poecilonotus* PETERS, 1863. It is not sure if specimens dealt herein are *A. poecilonotus*, which was originally described from Ghana. However, it seems that only one very common *Arthroleptis* species lives in West African savannas. Others that may be found in that area (e.g. see above) have their main distribution in the forest zone (RÖDEL & BRANCH 2002, RÖDEL & AGYEI in press, RÖDEL & ERNST unpubl. data). I therefore continue using this name for frogs whose calls are identical to those of frogs from Comoé National Park (RÖDEL 2000). *A. poecilonotus* was very common in all parts of densely vegetated tree savanna that are close to island or gallery forests. It also

inhabited all types of forest in the savanna zone. The only record of *A. poecilonotus* from the forest zone was a large rocky inselberg with high grasses close to the village of Noma.

Astylosternus occidentalis PARKER, 1931. *A. occidentalis* is a species endemic to the western part of the Upper Guinea rain forest. In MSNP I found the species only along one forest stream (msbac7-8). Tadpoles, described by LAMOTTE & ZUBER-VOGELI (1954) under the name *A. diadematus*, were abundant in all parts of the river and could also be found in very small tributaries. Adults could be found at the stream bank as well as in the adjacent forest. One male was caught in the transition zone between forest and tree savanna.



Fig. 7. Forest stream (msbac7) in southern Mont Sangbé National Park.

Breeding habitat of: *Bufo maculatus*, *Conraua* sp., *Phrynobatrachus alleni*, *Petropedetes natator*, *Astylosternus occidentalis*, *Leptopelis hylroides*, *Hyperolius chlorosteus*, and *H. picturatus*.

Bergbach im südlichen Mt. Sangbé Nationalpark.

Laichhabitat von *Bufo maculatus*, *Conraua* sp., *Phrynobatrachus alleni*, *Petropedetes natator*, *Astylosternus occidentalis*, *Leptopelis hylroides*, *Hyperolius chlorosteus*, und *H. picturatus*.

Leptopelis "hyloides" (BOULENGER, 1906). *L. "hyloides"* is a widespread West African forest species, that inhabits primary and degraded forests (RÖDEL & BRANCH 2002, RÖDEL & AGYEI in press). In MSNP I recorded the species in the forest zone along streams and in forest remnants close to villages, as well as in the savanna zone. In the



Fig. 8. *Petropedetes natator* male from southern Mont Sangbé National Park.

P. natator Männchen aus dem südlichen Mt. Sangbé Nationalpark.



Fig. 9. *Hyperolius chlorosteus* male from southern Mont Sangbé National Park.

H. chlorosteus Männchen aus dem südlichen Mt. Sangbé Nationalpark.

latter it inhabited gallery and small and open island forests with stagnant ponds of various sizes. The savanna records represent the northernmost known localities in Ivory Coast.

Leptopelis occidentalis SCHIÖTZ, 1967. *L. occidentalis* is a West African forest endemic that is only known from a few localities in Ivory Coast and Ghana (SCHIÖTZ 1967, 1999). It inhabits primary and rarely degraded forests (RÖDEL & BRANCH 2002). The only MSNP record is based on one calling male in a gallery forest in the savanna zone. The call is unmistakable. However, as the habitat is unusual for the species and no voucher could be collected the record should be treated with the necessary precaution.

Hyperolius chlorosteus (BOULENGER, 1915). A large *Hyperolius* endemic to the western part of the Upper Guinea forests (SCHIÖTZ 1967, 1999) and closely associated with flowing water in forested habitats (RÖDEL & BRANCH 2002). I found the species only along msbac7. There, several males called on 11 October 2001 between 19-21 hours, from large trees in 3-10 m height. During preceding visits of that site no males were heard calling. One male could be caught. It had a green dorsum with scattered yellow spots and a yellow triangle on its forehead (Fig. 9). This is the northernmost record of the species in Ivory Coast.

Hyperolius picturatus PETERS, 1875. This frog endemic to the Upper Guinea forest zone might comprise two species (SCHIÖTZ 1967, 1999). In MSNP *H. picturatus* was recorded in the forest zone only. There the species lived along slow to fast running streams in open, as well as closed forests. The largest breeding aggregation was found close to Ditomba along a slow flowing creek with very dense understorey at the banks. Males always called very well concealed from larger leaves in 0.5-4 m height. A female caught at msbac4 had a yellow-blackish coloration on the sides of the head, an uniform brownish dorsum, black canthal- and supratympanal stripes, yellow throat and belly separated from dorsum by a partly broken black stripe, a distinct gular fold, red webbing on feet, yellow webbing on hands. It deposited 94 eggs with black and white poles. At msbac7-9 I caught several males that uttered long series of metallic click sounds or single clicks. Some of them uttered an initial note, which sounded similar to that of *H. baumanni* (SCHIÖTZ 1967, 1999, RÖDEL & AGYEI in press). During night all males were colored uniform yellow. All had a yellow venter with granular skin on belly and whitish spots in the angle of the mouth. Daytime coloration of backs differed between specimens. One had a brown back with a dark hourglass pattern and two rows of dark spots on flanks, others had beige to yellow dorsolateral bands that either had or lacked dark borderlines.

Hyperolius zonatus LAURENT, 1958. A species endemic to the western part of the Upper Guinea rain forest (SCHIÖTZ 1967, 1999). The record from MSNP was based on calls heard at a small forest stream with dense vegetation.

Kassina arboricola PERRET, 1985. In a recent review of West African spotted *Kassina* species (RÖDEL et al. 2002a) we showed that *K. arboricola*, described from eastern Ivory Coast and Ghana, also occurs in western Ivory Coast, west of the Sassandra river. The MSNP record is a further confirmation of this distribution. In Ditomba *K. arboricola* called well concealed in dense vegetation in secondary forests.

Kassina cf. *schioetzi* RÖDEL, GRAFE, RUDOLF & ERNST, 2002. In MSNP I also recorded a second arboreal *Kassina*, which in the South occurred in syntopy with *K. arboricola*. In the North I heard this call at two heavily vegetated ponds in close proximity of gallery forests. The males were calling from several meters height in dense bushes. Unfortunately I couldn't catch a *Kassina* at neither of these sites. My call recordings were not sufficiently good to assign them with certainty (compare RÖDEL et al. 2002a). Theoretically both, *K. cochranae* (LOVERIDGE, 1941) and *K. schioetzi*, might occur in MSNP.

3.3 The amphibian fauna from Mont Sangbé National Park

The MSNP is situated in the transition zone between the forest and savanna zone of Ivory Coast. Its unique anuran assemblage reflects this. A mixture of savanna and forest species characterized the amphibian fauna of MSNP. From the 45 species recorded, 15 (33.3 %) occurred in the forest and the savanna zone, 13 (28.9 %) were recorded in the savanna zone exclusively, whereas 17 (37.8 %) occurred only in the forest zone. Within the forest zone more than half of the recorded species (53.1 %) were true forest species. The amphibian community of the savanna zone comprised 46.4 % true savanna species.

In the savanna zone I recorded 28 species. Extrapolation from my records makes it likely that 29-32 species occur in that zone. Species diversity therewith nearly equals that of Comoé National Park (35 species recorded, RÖDEL 2000, RÖDEL & SPIELER 2000). Within the forest zone 32 species have been recorded. However, the forest fauna was probably much less completely recorded than the savanna fauna. This is supported

	all MSNP records / alle Nachweise	savanna zone / Savannenzone	forest zone / Waldzone
outside West Africa / außerhalb Westafrikas	22 (48.9)	17 (60.7)	15 (46.9)
West Africa / Westafrika	10 (22.2)	7 (25.0)	5 (15.6)
Upper Guinea / Oberguinea	8 (17.8)	4 (14.3)	7 (21.9)
western Upper Guinea / westliches Oberguinea	5 (11.1)	0	5 (15.6)
	45 (100)	28 (100)	32 (100)

Tab. 2. General distribution of the amphibians of Mont Sangbé National Park. Given are species numbers and percentages (in parentheses). Outside West Africa is defined as the distribution of a species that occurs in and outside West Africa; West Africa comprises species that occur within the range of Senegal to eastern Nigeria; Upper Guinea comprises all species that are restricted to the area West of the Dahomey gap to Sierra Leone; western Upper Guinea comprises species that occur only west of central Ivory Coast.

Verbreitung der im Mt. Sangbé Nationalpark nachgewiesenen Amphibienarten. Dargestellt sind Artenzahlen und Prozentzahlen (in Klammern). Außerhalb Westafrika bezieht sich auf alle Arten deren Verbreitungsgebiet sich zumindest noch bis nach Zentralafrika erstreckt; Westafrika umfasst alle zwischen Senegal und dem östlichen Nigeria verbreiteten Arten; Oberguinea umfasst alle Arten westlich der Dahomey-Lücke bis Sierra Leone; westliches Oberguinea bezieht alle Arten ein, die ausschließlich westlich der zentralen Elfenbeinküste vorkommen.

by the estimation of about 45-49 amphibian species that might be expected to occur in the forest zone. Amphibian species richness in the forests of MSNP therewith would be lower than in Taï National Park, a rain forest area further south in Ivory Coast. There, 56 amphibian species have been recorded so far (RÖDEL & ERNST unpubl. data). However, species richness of MSNP outranges that of two classified forests close to Taï National Park. In Haute Dodo and Cavally classified forests RÖDEL & BRANCH (2002) calculated 41-43 amphibian species. Typical farmbrush and forest species that were absent during the survey but are likely to occur (e.g. *Hyperolius fusciventris*, *Chiromantis rufescens*) in MSNP were species that reproduce in stagnant waters. I failed to find this habitat type within the forest zone. However, it will probably exist in forest areas not investigated in the course of this study.

The amphibians recorded in the forest or the savanna zone, respectively, showed remarkable differences concerning their general distribution patterns (Tab. 2). Whereas more than 60 % of the savanna species also occurred outside West Africa (defined as ranging from Senegal to eastern Nigeria), only 47 % of the forest species have been recorded east and south of Nigeria. More than half of the forest species have an exclusively West African distribution. More than one third is endemic to the Upper Guinea rain forest and five species are endemic to the western part of that region (*Conraua* sp., *Petropedetes natator*, *Astylosternus occidentalis*, *Hyperolius chlorosteus*, *H. zonatus*).

In MSNP some typical forest species range into the savanna area by making use of island forests (e.g. *Amnirana albolabris*, *Leptopelis hyloides*) and/or have their northernmost Ivorian records in the forests of MSNP (e.g. *Leptopelis occidentalis*, *Hyperolius chlorosteus*, *H. zonatus*). Additionally several rare or restricted species, that need special habitats, like *Astylosternus occidentalis* and *Petropedetes natator*, have been recorded. One species, *Conraua* sp. might be new to science. As only about two thirds of the forest amphibians have been recorded so far, the presence of further peculiar amphibians is likely. A more intensive survey of the forest zone therefore seems to be worthwhile.

While the savanna fauna is probably not or less effected by potential climatic changes, it seems pressing to monitor several amphibian species of the forest zone in this regard, in particular the torrenticol *Petropedetes natator* and *Conraua* sp. Populations in ecotones will be the first to suffer from climatological changes and this part of the amphibian fauna might be already diminishing in other parts of West Africa (RÖDEL & AGYEI in press).

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The amphibians of Mont Sangbé National Park, Ivory Coast

Code	Latitude / Longitude	Habitat description
forest zone		
msbac6	07°50.666' N 007°23.490' W	deep valley, surrounded by high forest, tree savanna on hill top, depending on season: puddles of various sizes or fast flowing creek with cascades and small waterfalls, stony and rocky ground
msbac7	07°51.008' N 007°23.165' W	same valley as msbac6, 500 m further upstream, same habitat types
msbac8	07°51.395' N 007°22.247' W	same valley as msbac6 and 7, further upstream
msbac9	no GPS data	same creek as msbac6-8, app. 1000 m further upstream, high waterfalls, plateau in savanna zone, narrow gallery forest, large rocky areas with small rock-pools
Ditomb	07°49.220' N 007°24.171' W	puddles on dirt road; small creek with dense vegetation on bank; swampy area; forest remnants
msbac4	08°00.957' N 007°24.368' W	slow flowing creek, jammed to pond, small forest, densely vegetated, mostly palms, small trees and shrubs, water without submerse vegetation; creek continues running through small plantations, dense vegetation on bank
Noma	08°01.299' N 007°23.954' W	village
near Noma	08°01.305' N 007°23.949' W	dirt road in dense tree savanna; fast flowing creeks with dense gallery forests; inselberg with open rock and high grass, small rock-pools
savanna zone		
Bitis2	08°01.864' N 007°07.207' W	tree savanna
msbac1	08°00.891' N 007°14.670' W	small creek in the savanna, few smaller shrubs and high grass, deep pond transversed by a creek, scattered vegetation on bank, <i>Barbus</i> sp. in pond and creek, puddles on dirt road, larger road ditch; swampy area, shallow and densely vegetated with grasses
msbac2	07°59.308' N 007°13.442' W	creek; small puddle without vegetation, ground covered with leaves; narrow gallery forest, surrounded by tree savanna
msbac3	08°01.394' N 007°15.051' W	small creek, partly enlarged to small ponds, surrounded by small groups of shrubs and trees, larger water zones shallow and without vegetation; small ponds in savanna, few submerse plants; swampy areas; small gallery forest dominated by palms
msbac5	07°59.143' N 007°13.436' W	same creek as msbac2, depending on season: flowing creek, or several shallow ponds in gallery forest, some ponds larger (20 m width, 75 cm deep); small, shallow (5-10 cm) savanna pond, stony ground, water zone 80 % with scattered vegetation, bank with high grass
msbar1	08°00.846' N 007°06.501' W	large pond; similar to msbar2; ground covered with dead leaves
msbar2	07°55.345' N 007°05.532' W	near Sassandra river in savanna zone; large dammed up pond; shallow, few hiding places for tadpoles, many chichlid fish; water zone only with few floating plants

msbase	no GPS data	creek at base of Mont Sangbé; open savanna forest
msber1	08°00.865'N 007°11.217'W	inselberg, rocky surfaces
mscam2	08°01.136'N 007°14.876'W	large dry forest, scattered leaf litter
mscamp	08°02.743'N 007°16.125'W	open shrub-tree savanna, many small ponds, banks heavily vegetated, few submerge plants; many small ponds in high grass savanna, mostly shallow, sedges and <i>Utricularia</i>
msdor2	07°59.492'N 007°28.845'W	road puddles in heavily altered savanna area, large areas without vegetation
msdorf	08°09.028'N 007°23.886'W	village
msmaa1	08°00.105'N 007°11.541'W	road ditches in savanna; large swampy area in savanna, many small, shallow ponds, all densely vegetated with high grasses, scattered trees and bushes; large deep pond surrounded by small forest (Maar Soumarou), traversed by several periodical creeks, vegetation only in shallow parts, large leafed plants; fish (<i>Barbus</i> , catfish) and crocodiles (<i>Osteolaemus tetraspis</i>)
msmaa2	08°02.199'N 007°15.738'W	small savanna pond (2.5 m diameter), shallow, sedges; tree savanna, small island forest 30 m apart
msmaa3	07°58.034'N 007°12.995'W	shallow pond at the edge of a low forest; most parts of open water in shadow, water lenses
msmaa4	07°58.096'N 007°13.031'W	large swampy plain, heavily vegetated with sedges, open water with water lilies; many fish
msmaa5	08°00.650'N 007°11.640'W	swampy area in dense tree savanna, two larger areas with open water, otherwise densely vegetated, dominated by Poaceae and Cyperaceae; small puddles
msmaa6	08°01.229'N 007°14.639'W	small puddle, in gallery forest, surrounded by tree savanna
msmira	07°58.542'N 007°13.387'W	edge of gallery forest; large deep pond, partly in shadow, water covered with water lenses, little submerge vegetation, shallow parts with Poaceae and Cyperaceae; shallow puddle and bank without vegetation
mstop	no GPS data	top of Mont Sangbé; rocky areas with moor inbetween; carnivorous plants
park entrance	no GPS data	water pump in village, small shallow pond
Tabou to Kodhialo	no GPS data	savanna area, acoustic records along dirt road

Appendix 1. Localities and descriptions of amphibian habitats in Mont Sangbé National Park.

The amphibians of Mont Sangbé National Park, Ivory Coast

Taxa	sites	voucher
Pipidae		
<i>Silurana tropicalis</i>	msmaa1, msmaa3, msmira	MS1, S01.23G, S01.25G
Bufonidae		
<i>Bufo maculatus</i>	msbac7, msbac9, msbar1, msbase, msberg, mscamp, msdor2, msmaa1, msmaa2, mstop	
<i>Bufo regularis</i>	Ditomb, Noma	S01.35-36G
Hemisotidae		
<i>Hemisis</i> cf. <i>marmoratus</i>	msbac2	S01.17-19G
Ranidae		
<i>Conraua</i> sp.	msbac7, msbac8	S01.53-54
<i>Hoplobatrachus occipitalis</i>	Ditomb, msbac3, msbac4, msbac5, mscamp, msmaa1, msmaa3	MS16, S01.31G
<i>Ammirana albolabris</i>	Ditomb, msbac4, msmaa1	S01.37G
<i>A. galamensis</i>	msmaa1, msmaa3	
<i>Ptychadena aequiplicata</i>	msbac8	S0.49G
<i>P. bibroni</i>	Ditomb, msbar1, mscamp, msdor2, msmaa1, msmaa4, msmaa5, msmira	S01.26G
<i>P. longirostris</i>	Ditomb	S01.32-34G
<i>P. mascareniensis</i>	Ditomb	S01.40
<i>P. pumilio</i>	msbac5, msdor2, msbac5, msmira	
<i>P. tellinii</i> ¹	msmaa1, msmira, park entrance	S01.21-22G
<i>P. sp.Q</i>	msbac1, msbac3, mstop,	
Petropedetidae		
<i>Phrynobatrachus accraensis</i> ²	msbac1, msbac2, msbac3, msbac5, msbar1, msbar2, mscamp, msmaa1, msmaa4, msmaa5, msmaa6, msmira	S01.1G, S01.24G
<i>P. alleni</i>	msbac7, msbac8	S01.42-47G
<i>P. alticola</i>	Ditomb, msbac6, msbac7, msbac8, Noma	S01.48, MS17
<i>P. calcaratus</i>	msbac9	
<i>P. francisci</i>	msmira	S0127-28G
<i>P. gutturosus</i>	Ditomb, msmaa1	MS15, S01.38G
<i>P. liberiensis</i>	Ditomb, msbac4	MS17
<i>P. natalensis</i>	msbac3, msbac1, msbac2, msdor2, msmira	MS18
<i>P. plicatus</i>	Ditomb, msbac7	S01.41G
<i>P. sp.Q</i>	msbac3	
<i>Petropedetes natator</i>	msbac7, msbac8, msbac9	S01.51-52, S01.58-59, S01.60-61G, S01.62, S01.63G
Arthroleptidae		
<i>Arthroleptis</i> sp. 1 ³	bitis1, Ditomb, msbac6, Noma	MS4-14
<i>A. cf. poecilonotus</i>	bitis1, msbac2, mscam2, mscamp, msdor2, msmaa1, msmaa3, msmira, Noma, between Tabou and Kodhialo	
Astylosternidae		
<i>Astylosternus occidentalis</i>	msbac7, msbac8	S01.50, S01.57
Hyperoliidae		
<i>Afrixalus dorsalis</i>	Ditomb, msmaa1, msmaa3, msmira, between Tabou and Kodhialo	S01.16G
<i>A. sp.Q</i>	msmira	

<i>A. vittiger</i>	msmira, msbar1, msmaa1, msmaa3, msmaa4, msmaa5	S01.4-5G, S01.7G
<i>A. weidholzi</i>	msbar1, msmaa1, msmaa5, msmira	S01.9G, S01.29G
<i>Hyperolius chlorosteus</i>	msbac7	S01.55
<i>H. concolor</i>	Ditomb, msbac1, msbac4, msbar1, mscamp, msmaa1, msmaa3, msmaa4, msmaa5, msmira, between Tabou and Kodhialo	MS2, S01.13G, S01.15G
<i>H. guttulatus</i>	between Tabou and Kodhialo	
<i>H. nasutus</i> ^A	msbar1, msmaa1, msmaa3, msmaa4	S01.6G, S01.8G, S01.10G
<i>H. nitidulus</i>	msbac1, msbac3, msbar1, mscamp, msmaa1, msmaa3, msmaa4, between Tabou and Kodhialo	MS3, S01.11-12G, S01.14G
<i>H. picturatus</i>	Ditomb, msbac4, msbac6, msbac7, msbac9	MS19, <i>S01.39</i> , <i>S01.56</i> , <i>S01.64-65</i>
<i>H. sp.Q</i>	msbac9	
<i>H. zonatus</i>	Ditomb	
<i>Kassina arboricola</i>	Ditomb	
<i>K. fusca</i>	msbac1, msbac3	
<i>K. cf. schioetzi</i>	Ditomb, msmira, msbac1, msmaa2	
<i>K. senegalensis</i>	msbac3, mscamp, msmaa2, msmaa5, msmira	S01.20G
<i>K. sp.Q</i>	msmira	
<i>Leptopelis hyloides</i>	Ditomb, msbac2, msbac7, msbac8, msmaa1, msmaa3	<i>S01.30</i>
<i>L. occidentalis</i>	msbac2	
<i>L. sp.Q</i>	msbac6, msbac7	
<i>L. viridis</i>	Ditomb, msbac1, msbac2, msbar1, mscamp, msmaa1, msmaa4, msmaa5, msmira	S01.2-3G
Microhylidae		
<i>Phrynomantis microps</i>	mscamp, msmira	

Appendix 2. Amphibians recorded in Mont Sangbé National Park, respective site codes (see appendix 1) and voucher numbers; numbers with a G refer to tissue samples only, numbers given in italics refer to vouchers with respective tissue sample; sp.Q refers to records based on tadpoles that could not be determined to species level. ¹compare LARGEN (2001), ²compare RÖDEL & AGYEI (in press), ³ compare RÖDEL & BRANCH (2002), ⁴compare CHANNING et al. (2002) and for a contradicting view RÖDEL & AGYEI (in press).

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