

## The amphibian fauna of Pendjari National Park and surroundings, northern Benin

S. GILLES A. NAGO, OLAF GRELL, BRICE SINSIN & MARK-OLIVER RÖDEL

**Abstract.** We present the results of the first comprehensive survey of the amphibian fauna of a savannah region in Benin, West Africa. We herein add 17 species to the countries' amphibian list: *Bufo pentoni*, *Hildebrandtia ornata*, *Pyxicephalus* cf. *edulis*, *Ptychadena bibroni*, *P.* cf. *schillukorum*, *P. tellini*, *P. tournieri*, *P. trinodis*, *Phrynobatrachus accraensis*, *P. francisci*, *P. gutturosus*, *Arthroleptis* sp., *Kassina cassinoides*, *K. fusca*, *K. senegalensis*, *Leptopelis bufonides* and *Hyperolius nasutus*. We comment on the taxonomy and biology of some rare and/or unusual species. The amphibian species richness of the Pendjari area is among the most diverse of African savannahs. The species assemblage is mainly composed of 'typical' West African savannah frogs, especially those that are restricted to drier habitats. However, especially along the mountainous Atakora chain in the South of the area, we also recorded species that are dependent on higher humidity, e.g. *Arthroleptis* sp., *Hyperolius* sp. In the future, more emphasis should be given to survey this mountainous area that might prove to have close faunal affinities to the Togolese mountains.

**Key words.** Amphibia, Anura, Benin, diversity, savannah, taxonomy, West Africa.

**Résumé.** Nous présentons les résultats du premier aperçu complet des amphibiens d'une région de savane au Bénin, l'Afrique de l'Ouest. Nous ajoutons ainsi 17 espèces à la liste des amphibiens du pays: *Bufo pentoni*, *Hildebrandtia ornata*, *Pyxicephalus* cf. *edulis*, *Ptychadena bibroni*, *P.* cf. *schillukorum*, *P. tellini*, *P. tournieri*, *P. trinodis*, *Phrynobatrachus accraensis*, *P. francisci*, *P. gutturosus*, *Arthroleptis* sp., *Kassina cassinoides*, *K. fusca*, *K. senegalensis*, *Leptopelis bufonides* et *Hyperolius nasutus*. Nous avons discuté sur la taxonomie et la biologie de quelques espèces rares et/ou peu communes. La richesse spécifique des espèces d'amphibiens de la Réserve de Biosphère de la Pendjari, milieu d'étude, fait d'elle l'une des régions africaines savaniques les plus diversifiées. La communauté d'amphibien se compose principalement d'espèces «typiques» de savane d'Afrique Occidentale, particulièrement ceux qui sont limitées à des habitats secs. Cependant, particulièrement le long de la chaîne montagneuse de l'Atakora dans le Sud du milieu d'étude, nous avons également enregistré les espèces qui dépendent d'une humidité plus élevée, par exemple *Arthroleptis* sp. et *Hyperolius* sp. À l'avenir, les efforts devraient être concentrés sur cette chaîne qui pourrait avoir des affinités de faune que la partie togolaise.

**Mots clés.** Amphibia, Anura, Bénin, diversité, savane, taxonomie, Afrique occidentale.

### Introduction

Benin is a comparatively small West African country (112,622 km<sup>2</sup>), situated right in the Dahomey Gap, that is a natural gap in the coastal rainforest belt of West Africa. Dahomey also was the former country's name, originating from the equally named famous West African kingdom that rose in the 15th century. This territory became a French Colony in 1872 and achieved independence in 1960, as the Republic of Dahomey. A succes-

sion of military governments ended in 1972 with the rise to power of MATHIEU KEREKOU whose government had changed the former name Dahomey to the People's Republic of Benin in 1975. In 1991 the first successful transfer of power in Africa from a dictatorship to a democracy resulted in the election of NICEPHORE SOGLO as president.

Maybe it is for the combination of long lasting political unrest and the lack of rainforest, that Benin only rarely was the target of zoological surveys (ATACHI et al. 1994).

We are aware of only three herpetological studies, all unpublished. In 2002, O. GRELL started to investigate the Pendjari area in the North (GRELL 2003), whereas DAOUA et al. (1998) and ULLENBRUCH (2003) investigated one of the few forests in southern Benin. These contributors found 17 anuran species each. Although GRELL (2003) already postulated the occurrence of many more amphibian species in the Pendjari area, in general the available data pointed into the direction of a very poor amphibian fauna for Benin. This is summarized in the current Global Amphibian Assessment (GAA) that lists only 22 amphibian species for the country (IUCN et al. 2004). However, from other West African countries it is known that even savannah habitats may harbour a rich amphibian fauna (e.g. LAMOTTE 1967, RÖDEL & SPIELER 2000, JOGER & LAMBERT 2002, GREENBAUM & CARR 2005). We therefore started herpetological investigations in one of West Africa's largest protected areas and its surroundings – the Pendjari biosphere reserve. This paper presents the amphibian data of this intensive survey work.

### Study site

The Pendjari Biosphere Reserve (PBR) is situated in the Atakora department, north-western Benin (10°30' to 11°30' N; 0°50' to 2°00' E; Fig. 1). It was declared a Game Reserve in 1954 and upgraded to a National Park in 1961. It nowadays comprises a strictly protected core area (the Pendjari National Park, PNP: 2,660 km<sup>2</sup>) and a buffer and hunting zone in the West and South of it (1,870 km<sup>2</sup>). In the North and East, the River Pendjari forms a natural border of the PBR that in the North is also the country's border to Burkina Faso (DELVINGT et al. 1989, MAB-UNESCO 1990, BRUCKER 2001). The River Pendjari is the most important water course of PNP. In the South the reserve is bordered by the Atakora chain (400-513 m above sea level), which is directly connected to mountainous northern Togo. Apart from

these mountains and a few isolated hills, the topography of the reserve is generally very flat and mostly ranges between 150-200 m above sea level (DELVINGT et al. 1989). PBR has a Sudanian climate with a seven month dry period. The mean annual precipitation is 1,000 mm; most of the rain is falling during a period between late May and early October. The mean annual temperature is 27 °C (VERSCHUREN 1988). There are a few large and permanent ponds in PNP. Most savannah waters are temporary and form only after heavy rains in May/June and dry up in October/November (Fig. 2). The vegetation of the PNP is a mixture of different savannah types, mostly open shrub and tree savannah (Fig. 2). Small island forests are situated in the areas of former villages. Patches of dry forests and open gallery forests along water courses are present. Huge areas in the North of the reserve are flooded (and thus inaccessible) during the rainy season and only very sparsely vegetated during the dry season. In the periphery of the PNP the landscape is dominated by fields and fallows. Cultivated crops are amongst others: rice, yams, maize and cotton, the latter requiring intense use of pesticides (DJIBRIL 2002, CENAGREF 2003). The savannah in the buffer zone is also used for grazing cattle and intensively collecting firewood. So far only the larger mammals of the reserve have attracted considerable scientific interest (VERSCHUREN 1988, SINSIN et al. 2000, LAMARQUE 2004).

### Material and methods

In February 2002 and in October 2003, O. GRELL started accomplishing first faunal surveys for fishes, amphibians, reptiles and birds in PBR (GRELL 2003). With respect to amphibians, he applied visual encounter surveys (VES) and dip-netting (DN). Since September 2004, S.G.A. NAGO has regularly investigated all possible kinds of waters within and outside the reserve for amphibians by employing VES and acoustic encounter surveys (AES) and the box method for tadpoles

(HEYER et al. 1994, RÖDEL 1998, RÖDEL & ERNST 2004). The latter investigations are designed to compare the amphibian community composition in pristine and altered savannahs (S.G.A. NAGO et al. unpubl. data). During two especially intensive searching periods, 1-8 September 2004 and 27 May to 8 June 2005, S.G.A. NAGO and M.-O. RÖDEL employed VES and AES in search for adult frogs, accompanied by DN for tadpoles. During these periods we tried to find as many species per day as possible to achieve a complete anuran species list for the region. We thereby tried to investigate all possible habitat types throughout the area. We tested the efficiency of our inventories with the Jack-knife 1 and Chao2 estimators (software package EstimateS, COLWELL 1994-2000; cf. VEITH et al. 2004). Calculation bases were the daily presence/absence lists gathered throughout the two intensive sampling periods (total 19 days). To prevent order effects we performed 500 random runs of our daily species lists and calculated mean and standard deviation of the respective estimations.

We collected voucher specimens of almost all recorded species (see Appendix 1). These amphibians were anesthetized and killed in a chlorobutanol solution and thereafter preserved in 70 % ethanol. Tissue samples of toe tips were stored in 95 % ethanol. Vouchers were deposited in the working collections of M.-O. RÖDEL (MOR) and S.G.A. NAGO (GAN). The latter collection will be housed at the University of Abomey-Calavi. All other specimens were released at the sites where they were encountered. All measurements were taken with dial-callipers and given in mm (accuracy:  $\pm 0.1$  mm); snout to vent length is abbreviated SVL. Taxonomy follows RÖDEL (2000) and FROST (2004).

## Results and discussion

### Sampling efficiency

During the field seasons in 2002 and 2003, 17 amphibian species were recorded by VES and DN. In the field periods of 2004 and

2005 we could recapture all those and add several species, resulting in a total of 32 species. Based on presence/absence data of the 19 days of intensive search we estimated for the Pendjari region a total of  $33.5 \pm 2.2$  (Chao2) and  $35.8 \pm 1.7$  species (Jack-knife 1), respectively (Fig. 3). This suggests that we recorded 89.4-95.5 % of the regional amphibian fauna.

### Species account

A complete list of recorded amphibian species is summarized in Appendix 1. Most species are well known West African savannah anurans, already dealt with in detail in RÖDEL (2000). Herein we only comment on selected species of particular interest.

*Bufo pentoni* ANDERSSON, 1893 lives in xeric habitats south of the Sahara. Known species records range from Mauritania eastward to the Red Sea coast of Egypt, Sudan, Eritrea and Djibouti. The toad has been even recorded from within the Sahara, namely in the Trarza region (Mauritania) and in the Air mountains (Niger; RÖDEL 2000, IUCN et al. 2004). This is the first country record from Benin. SCHIØTZ (1964c) found this toad reproducing in large pools with bare banks. This is in contrast to BÖHME et al. (1996) who found tadpoles in shallow puddles. In PBR *B. pentoni* choruses exclusively formed around small puddles and ponds, most of them without vegetation. This toad seems to avoid rivers and creeks as breeding sites, where *B. maculatus* and *B. regularis* were commonly observed breeding in the PBR region. This habitat separation was also reported by FORGE & BARBAULT (1978) from Senegal. Choruses formed even at smallest road puddles ( $< 2$  m<sup>2</sup> water surface). At a given site males could only be observed on the banks of one puddle, nearby puddles were ignored. The closest distance that we observed between two choruses was about half a kilometre. Usually choruses around a puddle met only for one night. Given further rainfall, during the next night a chorus could form at a neighbouring



Fig. 1. Map of the Pendjari region (black square in insert photo). The Atakora chain forms the southern border of the reserve. The Pendjari River constitutes its north-western border. Country boundaries are marked in grey.

puddle. At a given site only a few males were calling (Fig. 4), whereas others males were sitting aside remaining mute. Unfortunately we have no data which males eventually succeeded with reproduction. Chorus size was usually less than 20 males. We could confirm the extremely fast development of *B. pentoni* tadpoles, leaving their waters only 10-13 days after spawning took place (FORGE & BARBAULT 1977).

*Hildebrandtia ornata* (PETERS, 1878) is a widespread African savannah frog that ranges from Senegal and Sudan in the North to northern Namibia and South Africa in the South (RÖDEL 2000, IUCN et al. 2004, GREENBAUM & CARR 2005). This species is rarely reported, most probably due to the fact that it spends most of the year underground. We herein report it for the first time from Benin. Adult frogs from PBR measured 58.1-62.2 mm snout-vent-length (SVL, N = 3, males), and 64.5 mm (one female), and hence were close to the range of other known

specimens (65-70 mm; LAMBIRIS 1989, RÖDEL 2000, CHANNING 2001). In PBR we observed this species breeding at the very beginning of the rainy season in newly formed savannah ponds. These temporary waters included large ponds (> 500 m<sup>2</sup> surface) as well as small mud holes, with and without vegetation. Males called from the ponds' banks below vegetation or completely exposed, hence disproving RÖDEL (2000), who speculated that males in Comoé National Park might call from subterranean refuges. We observed always very few, in most cases even only one male at a given pond. Next calling males were always heard far away. The call seems to be audible at least more than 1 km in open tree savannah. This call was already well described as a sonorous "hôn", a rather nasal quack or a harsh bellow (AMIET 1974, LAMBIRIS 1989, CHANNING 2001; see AMIET 1989-1990 for a picture of a calling male, well illustrating the enormous vocal sacs). Frogs from PBR and Cameroon (AMIET

1974) seem to call less frequently than specimens from Zimbabwe (LAMBIRIS 1989). According to CHANNING (2001) *H. ornata* starts calling late at night, often not before 22:30 hours. Males from PBR were often but not exclusively starting their calling activity late. At every pond calling activity was restricted to only one night after a heavy rain. However, it is likely that *H. ornata* reproduces again after subsequent rains as we occasionally discovered tadpoles of two clearly distinct size classes. In most case *H. ornata* was associated with *Ptychadena trinodis*. We observed three amplexant couples, all sitting almost motionless on the ponds' banks (Fig. 5). Two couples sat completely exposed, the third was hidden under grass. From one of these couples, transferred to a water filled plastic box, we received a clutch, comprising 1,336 eggs with brown-white poles, and transparent jelly. We measured 10 eggs (egg:  $3.3 \pm 0.4$  mm, with jelly:  $5.4 \pm 0.4$  mm). The eggs were deposited singly on the ground. In Zimbabwe *H. ornata* also spawns its eggs singly on the ground, however the eggs are much smaller (egg: 1.4 mm, with jelly: 3.0 mm; WAGER 1986, LAMBIRIS 1989). The carnivorous tadpoles of *H. ornata* (RÖDEL 1998, 2000) were very common in the PBR ponds.

*Pyxicephalus cf. edulis* PETERS, 1854 ranges from southern Mauritania to Somalia, and south to Botswana and north-eastern South Africa and Swaziland (RÖDEL 2000, CHANNING 2001, IUCN et al. 2004). The specific distinctiveness of *P. edulis* from *P. adspersus* was clarified by CHANNING et al. (1994). Isolated West and Central African *Pyxicephalus* populations are known from Mauritania (BÖHME et al. 2001), Gambia (EMMS et al. 2006), Nigeria (SCHIÖTZ 1963, WALKER 1966, 1968) and northern Cameroon (PERRET 1966, AMIET 1973). We herein report the genus for the first time from Benin.

LAMBIRIS (1989) characterizes *P. edulis* (as *P. adspersus edulis*) as being smaller than 120 mm SVL, having a tympanum with a distinct white spot, a strongly barred upper lip in adults and a frequently present light interocular bar. According to CHANNING et al.



Fig. 2. Overview of typical savannah habitats in the Pendjari buffer zone with a permanent waterhole in the background (top). Temporary savannah pond (bottom), breeding site of e.g. *Ptychadena cf. schillukorum*, *Phrynobatrachus francisci*, *P. natalensis*, *Leptopelis viridis* and *Kassina fusca*.

(1994) and CHANNING (2001), these characters are not very reliable and the best criteria to distinguish *P. edulis* from *P. adspersus*, is the distance between eye and tympanum that equals the eye widths in *P. edulis*, whereas in *P. adspersus* the distance between eye and tympanum is larger. CHANNING (2001) describes breeding *P. edulis* males as bright green, while females are duller and brownish. The frog's back bears dark spots, and often a pale vertebral stripe. *P. edulis* does not have distinct elongated dorsal ridges (*P. adspersus* has), but instead possesses short folds or bumps (cf. CHANNING 2001: plate 22.5). In contrast to *P. adspersus*, *P. edulis* males do not perform lek-breeding and also seem not to guard and defend their tadpoles.

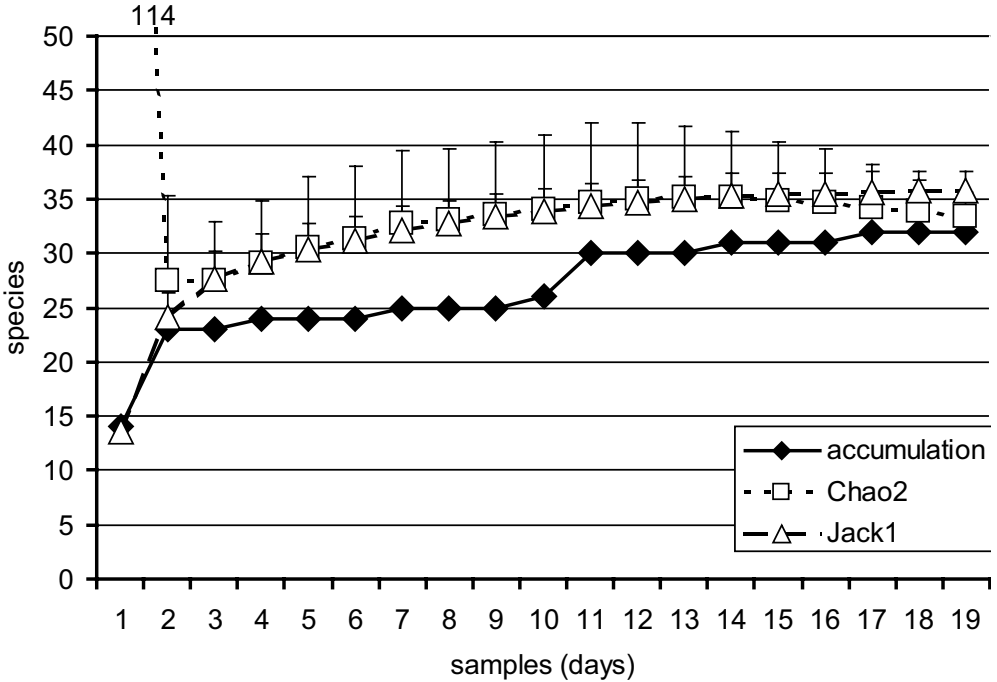


Fig. 3. Species accumulation curve and estimations of species richness based on amphibian presence/absence lists gathered throughout 19 days of intensive survey work (see text).

Both species only emerge after heavy rains for breeding.

On 21 October 2003, a subadult specimen was captured after sunset on the bare bank near the River Pendjari. On 5 June 2005, after the first heavy rain in the north of the park, we discovered a male *Pyxicephalus* in dry Sudan savannah at a puddle without vegetation, 40 cm deep, 6 m long and 50 cm wide. This part of PNP is flooded later in the year. We discovered two further specimens the same night, a male and a female, while they crossed a dirt road. It was not clear if the frogs were searching for a breeding site or if they were active because of swarming termites. The males measured 106 and 110 mm SVL, respectively. The female measured 90.3 mm. Later in the season we occasionally found active subadult specimens. The two adult males had yellow throats, the female's throat was white mottled with black; oth-

erwise the venter of both sexes was white. Both sexes had black spots on the brownish back. In the two breeding males this pattern was almost invisible and the back seemed to be uniform olive grey. The dorsal ridges of both sexes were fragmented, but still much longer than figured in CHANNING (2001). The eye diameter was larger than the distance between eye and tympanum. All specimens had a pale spot on the tympanum, a pale vertebral stripe, and yellowish femoral glands on the outer parts of the thighs (including a subadult frog, 52.7 mm SVL). Hence, the PBR frogs showed some differences to *P. edulis* from East and South Africa (cf. frogs in Fig. 6, see WALKER 1966, 1968 for description of Nigerian specimens). PASSMORE & CARRUTHERS (1995) figure a specimen from the Kruger National Park that looks similar to West African specimens, having at least short (however not continuous) dorsal ridges (cf. figure in

PIENAAR et al. 1976, as *P. adspersus*).

The taxonomic situation of West African *Pyxicephalus* populations needs further clarification and is currently investigated by E. PRENDINI and A. OHLER. Potentially available names for West African *Pyxicephalus* could be *Pyxicephalus bufonia* (BOETTGER, 1881) described from Senegal, or *Pyxicephalus reiensis* (MONARD, 1951) described from Cameroon (see FROST 2004). Due to the secretive lifestyle of these frogs we cannot yet decide if *P. edulis* is a rare species in the PNP region. However, as it seemed to be a very much appreciated part of the local menu (cf. WALKER 1968 for Nigeria), its populations outside the reserve should be monitored.

*Ptychadena* cf. *schillukorum* (WERNER, 1908 "1907") ranges from Senegal, east to southwestern Ethiopia and southern Somalia, south to Malawi, central Mozambique, southeastern Democratic Republic of Congo and western Angola (CHANNING 2001, IUCN et al. 2004). This taxon comprises many synonyms: *P. floweri* (BOULENGER, 1917), described from Sudan, *P. barbouri* (LOVERIDGE, 1925), described from Tanzania, *P. cotti* (PARKER, 1931), described from Mozambique, and *P. frontalis* (LAURENT, 1954), described from Congo (see FROST 2004 for summary). In West Africa, at least two distinct species have been dealt with under this name. One seems to live exclusively in mountainous savannahs of the Upper Guinea highlands (cf. text and fig. 5 in RÖDEL & ERNST 2003), the other one lives in dry Sudanese savannah (e.g. SCHIÖTZ 1964 a, c).

Herein we report the savannah species (Fig. 7). Breeding males measured 30.7-34.0 mm SVL (N = 3), an amplexant female measured 39.1 mm. Males have long gular pouch slits that run almost parallel to the mandible and end in front of the arm bases (in three males from one pond only one exhibited on one side a slightly oblique vocal sac slit as shown in PERRET 1997: fig. 2b – stated to be typical for *P. floweri*). The vocal sacs' skin is black. The outer part of the thumb in breeding males is covered by a huge, whitish nuptial pad. The nostrils are closer to

the snout-tip than to the eye. The internarial distance is larger than the distance nostril-snout. These frogs have a brownish back with black spots that are arranged in longitudinal rows. Dorsal ridges are broken into warts. A reddish-brown dorsolateral ridge extends almost continuously from behind the tympanum to the groins or at least to the last two thirds of the body. The skin of the back is smooth; the flanks' skin is granular. The venter is uniform whitish and smooth. The extremities bear black transversal bars; the outer parts of the thighs are mottled yellowish. The foot is shorter than the tibia. Tibia length is 41.9-45.0 % of the SVL. The inner metatarsal tubercle is always large. An outer metatarsal tubercle may be present, but then is very small and indistinct. The metatarsus of all toes lack additional tubercles. The feet are well webbed. Webbing formulae according to the scheme of RÖDEL (2000) is: 1(0.5), 2(1-0), 3(1-0.5), 4(1), 5(0).

We caught the first specimen in PNP after a short rain. The juvenile frog was captured on a yams field, far away from water. We heard this species calling only at a very few shallow savannah ponds. Calling males were mostly floating in shallow water close to the bank, a behaviour that was also described by AMIET (1974), STEVENS (1974 as *P. cotti*), and CHANNING (2001). We can confirm the description of the call as sounding like a dry rattle or a machine gun (see SCHIÖTZ 1964c, AMIET 1974, ELZEN & KREULEN 1979). The species was always associated with large choruses of *P. francisci* and single calling *P. natalensis* males. On 4 June we received a clutch from an amplexant pair, comprising 1,089 eggs with dark brown and white poles. The eggs were floating singly or in small groups on the water surface. The jelly was transparent. We measured 10 eggs (egg:  $2.0 \pm 0.3$  mm, jelly:  $3.0 \pm 0.4$  mm). The tadpoles, dealt with in a separate publication, started metamorphosing after one month.

CHANNING (2001) gives a SVL for *P. schillukorum* males of 48 mm and for females of 49 mm. He characterizes the species as having no continuous dorsal ridges, com-



Fig. 4. Calling *Bufo pentoni* male at a road puddle close to the village of Batia, illustrating the short snout and enormous size of the vocal sac.

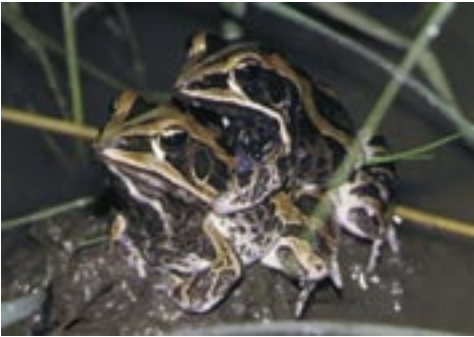


Fig. 5. Amplexant pair of *Hildebrandtia ornata* at a temporary savannah pond in Pendjari National Park.

paratively short legs, the internarial distance being greater than distance nose-snout-tip, the gular pouch slits end at the middle of the arm insertions, there are no rows of tubercles under the fourth metatarsal, the webbing is reduced (2-3 phalanges of fourth toe free of web), the posterior face of thigh is usually covered with fine vermiculations. CHANNING (2001) figures a frog (plate 21.6) that superficially resembles the West African populations, but seems to have much more pronounced fragments of the dorsal ridges. POYNTON (1964, 1970) gave similar descriptions for what he called *P. floweri*. SCHMIDT & INGER (1959) differentiate between *P. frontalis* (gular pouch openings oblique to mandible) and *P. floweri* (openings parallel



Fig. 6. Breeding *Pyxicephalus edulis* males from Malindi, Kenya (top) and northern Pendjari National Park, Benin (bottom) to illustrate differences between East and West African specimens.

to mandible). However, according to POYNTON (1970) this character varies and hence is useless. POYNTON (1970) mentions that the mid dorsal pair of skin folds in *P. floweri* is continuous from the occiput to the vent. POYNTON & BROADLEY (1985) recognize *P. floweri* and *P. cotti*. The later is said to have very interrupted skin folds. According to the original description of *P. floweri*, based on a single male (SVL 45 mm), this species has only feebly prominent and interrupted dorsal, glandular folds, but a strong and continuous dorsolateral fold (BOULENGER 1917). POYNTON & BROADLEY (1985) give the tibia length of *P. cotti* as ranging from 51-57 % of the body length (*P. floweri*: 44 %). PERRET (1966) distinguishes two species from Cameroon, *P. floweri* and *P. cotti*, amongst other characters



Fig. 7. Calling *Ptychadena* cf. *schillukorum* male at the bank of a savannah pond (see Fig. 2).



Fig. 8. *Ptychadena trinodis* male in calling position at the bank of a savannah pond.



Fig. 9. *Ptychadena tournieri* male from southern Pendjari National Park.



Fig. 10. Three male *Arthroleptis* sp. from the Tanougou waterfall population, illustrating variability of colour patterns.

because of differing tibia length. Later he discusses *P. schillukorum* (male SVL: 39-51 mm) with *P. floweri* (male SVL: 38-51 mm) and *P. cotti* (the later treating as a synonym

of the first, PERRET 1987). His *P. cotti* had tibia exceeding half of the SVL. Females ranged from 34-42 mm. As he supposes that females are smaller than males, it is however possible that his frogs were not fully grown. In an unpublished checklist of Cameroonian anurans, J.-L. AMIET (in litt.) only recognizes

*P. floweri* for this country. STEWART (1967) described frogs from Malawi as *P. floweri* that almost completely match the PBR frogs, however with the exception that the Malawi specimens were much larger (SVL males: 43–48 mm, females: 43–49 mm). A male with SVL 43 mm just started to develop vocal slits (STEWART 1967).

In summary, the PBR frogs were smaller than any other population and also were not completely in accordance with the above descriptions. Our specimens best fitted *P. floweri* from North Cameroon (PERRET 1987, Fig. 3), especially concerning the length of the extremities and the colour pattern. It is obvious that the PBR frogs belong to a difficult group of *Ptychadena* species, which are all characterized by the possession of dorsal ridges that are broken into warts. The Benin frogs most likely are conspecific with *Ptychadena* populations reported from other West and Central African savannah habitats (as *Abrana* or *Ptychadena floweri*, e.g. SCHIØTZ 1964a, b, c, LAMOTTE 1969, AMIET 1973, 1974, HUGHES 1988). Other authors reporting *P. floweri* from West Africa, most likely refer to a distinctly different, mountainous species from the Upper Guinea highlands that most probably is undescribed. Both West African species are easily distinguished from *P. retropunctata*, which also has rows of warts instead of ridges, by a different pattern on the outer parts of the thighs (cf. GUIBÉ & LAMOTTE 1957, RÖDEL et al. 2004). Right now it remains uncertain which names correctly apply to the PBR species.

*Ptychadena trinodis* (BOETTGER, 1881) is a widespread frog that lives in dry savannahs from Senegal to Central African Republic and southern Sudan (RÖDEL 2000, IUCN et al. 2004). We herein report it for the first time from Benin. Two collected males measured 42 and 54.2 mm SVL and hence were in the range of known male sizes (cf. GUIBÉ & LAMOTTE 1957, RÖDEL 2000). This species is rarely recorded and usually most active during the beginning of the rains (RÖDEL 2000). In PBR we found it quite common after the first rains of the season. It called only the

first few days after a rain from the banks of newly formed, mostly very small and shallow, ponds. We always observed only one or a very few calling males per pond (Fig. 8). The call was first described by AMIET (1974). SPIELER (1997) reports that tadpoles of this species only need about 12 days to reach metamorphosis.

*Ptychadena tournieri* (GUIBÉ & LAMOTTE, 1955) is a West African savannah species, so far believed to range only from southern Senegal to central Ivory Coast (GUIBÉ & LAMOTTE 1957, PERRET 1991, LAMOTTE & ÖHLER 2000, RÖDEL 2000, IUCN et al. 2004). We herein extend the known range into northern Benin. Not much is known about this small *Ptychadena* (for summary of present knowledge see RÖDEL 2000), which can be easily differentiated from similarly small congeners [e.g. *P. pumilio* (BOULENGER, 1920)] by its extremely slender body shape and its colour pattern (Fig. 9). These frogs seem to be very patchily distributed. In PBR we so far recorded *P. tournieri* only from a few localities in the southern part of the area, close to the humid Atakora chain. There males called well separated from each other, a few centimetres to a few meters from the banks of very shallow savannah ponds, while being well concealed in dense vegetation. The soil was incrustated and extremely hard. These habitats were in accordance with descriptions of other known breeding sites (e.g. SCHIØTZ 1964b, LAMOTTE 1969, RÖDEL 2000).

*Arthroleptis* sp. was so far exclusively recorded from a comparatively very humid area on the foothills of the Atakora chain, close to the Tanougou waterfall. Although similar in morphology and colour pattern (Fig. 10) to frogs from eastern Ghana (RÖDEL & AGYEI 2003), the Benin frogs are genetically distinct (A. HILLERS et al. unpubl. data). The taxonomy of West Africa *Arthroleptis* species generally needs clarification (see RÖDEL & BANGOURA 2004).

*Leptopelis bufonides* SCHIØTZ, 1967 is a rarely recorded West African savannah frog that ranges into northern Cameroon (SCHIØTZ 1967, 1999, WALKER 1968, BÖHME 1978, RÖ-

DEL 2000, AMIET 2004, IUCN et al. 2004). We herein report it for the first time from Benin. From the syntopic *L. viridis* (GÜNTHER, 1868) it can be easily distinguished by a more compact body shape, a very characteristic dark pattern on the back, and a warty skin (Fig. 11). Males measured 30.0-35.8 mm SVL, one female measured 38.8 mm. Whereas *L. viridis* was very abundant and called from shrubs and trees almost everywhere in PBR, *L. bufonides* seemed to be very patchily distributed. Males called completely exposed from bare ground or slightly concealed between isolated tufts of grass. Their advertisement call were typical *Leptopelis* click sound (sounds like clicking with the tongue), but compared to *L. viridis*, with a more snarling acoustic impression (cf. AMIET & SCHIÖTZ 1974, SCHIÖTZ 1999). In addition to this single note advertisement call, we often heard a more complex trill, obviously consisting of numerous notes (cf. GRAFE et al. 2000 for similar observations on *L. viridis*). Males often called far away (> 10 m) from mostly vegetation-less savannah ponds of varying size. According to our impression *L. bufonides* starts calling later than *L. viridis*. The latter often already called in the late afternoon. At some ponds we heard *L. bufonides* not earlier than 23:00 h. We caught an amplexant couple, which spawned two days later in captivity. The clutch was burrowed 10 cm deep in loamy soil. The large brownish yellowish eggs measured  $3.4 \pm 0.4$  mm (N = 9). We did not count and remove the whole clutch because we were afraid to prevent eggs' development, unfortunately the eggs did not develop anyway.

#### Diversity and community similarities

According to the GAA, only 22 anuran species have been recorded for Benin (IUCN et al. 2004). We herein added another 17 species to the country's anuran list (*Bufo pentoni*, *Hildebrandtia ornata*, *Pyxicephalus* cf. *edulis*, *Ptychadena bibroni*, *P. cf. schillukorum*, *P. tellini*, *P. tournieri*, *P. trinodis*,

*Phrynobatrachus accraensis*, *P. francisci*, *P. gutturosus*, *Arthroleptis* sp., *Kassina cassinoides*, *K. fusca*, *K. senegalensis*, *Leptopelis bufonides*, *Hyperolius nasutus*). With 32 recorded species, Pendjari Biosphere Reserve, ranges even within the upper level of amphibian species richness in African savannah regions. With 33 amphibian species, RÖDEL & SPIELER (2000) and PIENAAR et al. (1976) recorded similar richness in Comoé National Park, Ivory Coast and Kruger National Park, South Africa, respectively. Comparable species numbers are known from Niassa Game Reserve, Mozambique (31 species, W.R. BRANCH et al. unpubl. data); Lamto reserve, Ivory Coast (40 species recorded but only 29 occurred in the savannah areas of the reserve; LAMOTTE 1967, P.J. ADEBA & M.-O. RÖDEL unpubl. data); Mont Sangbé, Ivory Coast (45 species recorded, but only 28 from the savannah, RÖDEL 2003); the Serengeti National Park, Tanzania (27 species, ELZEN & KREULEN 1979, CHANNING et al. 2004); Marahoué National Park, Ivory Coast (32 species recorded, including 25 savannah species, RÖDEL & ERNST 2003); and Nikola-Koba National Park, Senegal (25 species, LAMOTTE 1969, JOGER & LAMBERT 2002). Other potentially well investigated areas are home to fewer savannah anurans: Abuko Nature Reserve, Gambia (19 species, BARNETT et al. 2001); Kiang West National Park, Gambia (14 species, WANGER 2005); Arusha National Park, Tanzania (11 species, RAZZETTI & MSUYA 2002). Whereas the Gambian sites seemed to be well investigated and hence less diverse, this is unlikely for the Haute Niger National Park, central Guinea, where the anuran fauna according to GREENBAUM & CARR (2005) is likely to comprise more than the 17 recorded species.

We guess that our calculation of 90-95 % completeness of the recorded Pendjari amphibian fauna is realistic. The recorded amphibian fauna is typical for West African savannahs. In comparison to other well know West African savannahs, like the Lamto reserve and southern Comoé National Park (LAMOTTE 1967, RÖDEL & SPIELER 2000),



Fig. 11. *Leptopelis bufonides* male from Pendjari National Park.



Fig. 12. *Hyperolius* cf. *torrentis* from Kota, south-east of Natitingou (southern foothills of the Atakora chain). Photo: T. MORITZ

some elements of the more humid Guinea savannah are lacking (e.g. *Afraxalus dorsalis*, *Kassina schioetzi*). In contrast typical species of the Sudan savannah occur, i.e. *Bufo pentoni*, *Pyxicephalus* cf. *edulis*, *Ptychadena* cf. *schillukorum* and *Leptopelis bufonides*. Judging from the current faunistic knowledge, not many more species can be expected. Potential additional species are *Tomopterna cryptotis* and *Bufo xeros*, both already recorded from xeric West African savannahs (RÖDEL 2000). Further species might be also expected in the moist incisions of the Atakora chain. This is indicated by the occurrence of *Arthroleptis* sp. (this paper), and of a *Hyperolius* species from Kota, south-east of Natitingou, photographed by T. MORITZ. Judging from the pictures (Fig. 12) it might be *Hyperolius torrentis*, a species so far exclusively known from the Ghanaian site of the Togo Hills (SCHIÖTZ 1967, RÖDEL & AGYEI 2003, LEACHÉ

et al. 2006, in press). Hence, further survey activities now should focus on this mountain chain, including its Togoese parts.

### Acknowledgements

Our special thanks are to the Centre National de Gestion des Réserves de Faune (CENAGREF), especially to the director of the PNP DJAFAROU A. TIOMOKO, as well as to UDO LANGE and ARISTIDE TEHOU for their interest, and all kinds of logistic support, in particular the permission to use a house in Batia village as our research bases. In May-July 2005 CHRISTIAN BREDE and PHILIPP SCHIEFENHÖVEL assisted in surveying amphibians in PNP. TIMO MORITZ hinted towards an unknown *Hyperolius* and gave permission to use his respective picture. OLAF GRELL thanks the German Technical Cooperation (GTZ) for financing the first two surveys. Since 2004 this study is part of the BIOLOG-program of the German Ministry of Education and Science (BMB+F; Project W08 BIOTA-West, FZ 01 LC 00410). This support is gratefully acknowledged.

### References

- AMIET, J.-L. (1973): Compte rendu d'une mission batrachologique dans le Nord-Cameroun. – *Annales de la Faculté des Sciences du Cameroun*, **12**: 63-78.
- AMIET, J.-L. (1974): Voix d'amphibiens camerounais IV.– Raninae: genres *Ptychadena*, *Hildebrandtia* et *Dicroglossus*. – *Annales de la Faculté des Sciences du Cameroun*, **18**: 109-128.
- AMIET, J.-L. (1989–1990): Images d'amphibiens camerounais. I. Sacs vocaux et postures de chant. – *Alytes*, **8**: 3-10.
- AMIET, J.-L. (2004): A propos de deux *Leptopelis* nouveaux pour la faune du Cameroun (Anura, Hyperoliidae). – *Alytes*, **21**: 111-170.
- AMIET, J.-L. & A. SCHIÖTZ (1974): Voix d'amphibiens camerounais III. Hyperoliidae: genre *Leptopelis*. – *Annales de la Faculté des Sciences du Cameroun*, **17**: 131-163.
- ATACHI, P., A.M. BAGLO, W. BERGMANS, D.B. GUÈDÈGBÉ, J. KAMSTRA, M. NONFON, B. SINSIN & B. DOSSOU (1994): Inventaire bibliographique des connaissances sur la diversité biologique au Bénin. – *Ecoopération-CN/UICN-UNB, Cotonou, Bénin*. 101 pp.

- BARNETT, L.K., C. EMMS & C. SANTONI (2001): The herpetofauna of Abuko Nature Reserve, The Gambia. – *Herpetological Bulletin*, **77**: 5-14.
- BÖHME, W. (1978): Zur Herpetofaunistik des Senegal. – *Bonner zoologische Beiträge*, **29**: 360-417.
- BÖHME, W., H. MEINIG & M.-O. RÖDEL (1996): New records of amphibians and reptiles from Burkina Faso and Mali. – *British Herpetological Society Bulletin*, **55**: 7-26.
- BÖHME, W., T. WILMS, H. NICKEL & M. MERZ (2001): Bericht über eine herpetologische Forschungsreise in die westliche Sahara und ihre Randgebiete. – *Zeitschrift des Kölner Zoo*, **44**: 117-131.
- BOULENGER, G.A. (1917): Descriptions of new frogs of the genus *Rana*. – *Annals and Magazine of Natural History*, **20**: 413-418.
- BRUCKER, J. (2001): Mission pour l'élaboration du plan d'aménagement de la gestion de la Réserve de Biosphère de la Pendjari. – *Projet PENDJARI/CENAGREF*, Cotonou, pp: 2-7.
- CENAGREF (2003): Impacts de l'utilisation des engrais chimiques et des pesticides par les populations riveraines sur les écosystèmes (eaux de surface, substrats des réserves de faune) dans les complexes des aires protégées de la Pendjari et du W. – *CENAGREF/MAEP*, 93 pp.
- CHANNING, A. (2001): *Amphibians of Central and Southern Africa*. – Cornell University Press, New York, 470 pp.
- CHANNING, A., L. DU PREEZ & N. PASSMORE (1994): Status, vocalization and breeding biology of two species of African bullfrogs (Ranidae: *Ptyxicephalus*). – *Journal of Zoology*, **234**: 141-148.
- CHANNING, A., A.R.E. SINCLAIR, S.A.R. MDUMA, D. MOYER & D.A. KREULEN (2004): Serengeti amphibians: Distribution and monitoring baseline. – *African Journal of Herpetology*, **53**: 163-181.
- COLWELL, R.K. (1994-2000): EstimateS, statistical estimation of species richness and shared species from samples. – Version 6.0b1. [<http://viceroy.eeb.uconn.edu/estimates/>].
- DAOUDA, I.-H., B. SINSIN & E. AHOKPÈ (1998): Étude écologique du noyau central de la Lama, Volet faune, inventaire des reptiles et amphibiens. – *MDR/DFRN/ONAB*, Cotonou, Bénin, 14 pp.
- DELVINGT W., J.C. HEYMANS & B. SINSIN (1989): *Guide du Parc National de la Pendjari*. – *CECA-CEE-CEA*, Bruxelles, 125 pp.
- DJIBRIL, B.R. (2002): Impacts de l'utilisation des engrais chimiques et des pesticides sur la qualité des eaux de surface dans la Réserve de Biosphère de la Pendjari. – *Mémoire de fin de formation d'Ingénieurs de travaux en Techniques d'Aménagement et de Protection de l'Environnement, APE/CPU/UAC*.
- ELZEN, P. v.d. & D.A. KREULEN (1979): Notes on the vocalizations of some amphibians from the Serengeti National Park, Tanzania. – *Bonner zoologische Beiträge*, **30**: 385-403.
- EMMS, C., M.D.K. JAMBANG, O. BAH, B. MANKALI, M.-O. RÖDEL & L. BARNETT (2006): The amphibian fauna of The Gambia, West Africa. – *Herpetological Bulletin*, **94**: 6-16.
- FORGE, P. & R. BARBAULT (1977): Écologie de la reproduction et du développement larvaire d'un amphibien déserticole *Bufo pentoni* ANDERSON, 1893, au Sénégal. – *Terre Vie*, **31**: 117-125.
- FORGE, P. & R. BARBAULT (1978): Observations sur le régime alimentaire de deux amphibiens sympatriques du Sahel sénégalais: *Bufo pentoni* et *Tomoptera delalandi*. – *Bulletin de l'Institut fondamental d'Afrique noire, Sér. A*, **40**: 674-684.
- FROST, D.R. (2004): Amphibian species of the World: an online reference (version 3.0, 22 August, 2004). – New York. [<http://research.amnh.org/herpetology/amphibia/index.html>]; latest inquiry: 17 December 2005]
- GRAFE, T.U., J.O. STEFFEN & C. STOLL (2000): Vocal repertoire and effect of advertisement call intensity on calling behaviour in the West African tree frog, *Leptopelis viridis*. – *Amphibia-Reptilia*, **21**: 13-23.
- GREENBAUM, E. & J.L. CARR (2005): The herpetofauna of Upper Niger National Park, Guinea, West Africa. – *Scientific Papers of the Natural History Museum University of Kansas*, **37**: 1-21.
- GRELL, O. (2003): Untersuchung zum Vorkommen und zur Biotopbindung der Avi-, Herpeto- und Ichthyofauna im Pendjari-Nationalpark in Benin – West-Afrika und Konsequenzen für den Managementplan, *Projet Pendjari*. – Unpublished report for GTZ/CENAGREF, Cotonou, Bénin, 49 pp. + appendices.
- GUIBÉ, J. & M. LAMOTTE (1955): Un nouveau raniide d'Afrique Occidentale: *Rana (Ptychadena) tournieri* n. sp. – *Bulletin du Muséum national d'Histoire naturelle*, 2e Sér., **27**: 442-446.
- GUIBÉ, J. & M. LAMOTTE (1957): Révision systématique des *Ptychadena* (Batraciens Anoures

- Ranidés) d'Afrique Occidentale. – Bulletin de l'Institut fondamental d'Afrique noire, Sér. A, **19**: 937-1003.
- HEYER, W.R., M.A. DONNELLY, R.W. McDIARMID, L.-A.C. HAYEK & M.S. FOSTER (1994): Measuring and monitoring biological diversity standard methods for amphibians. – Biological Diversity Handbook Series, Smithsonian Institution Press, Washington D.C.
- HUGHES, B. (1988): Herpetology in Ghana (West Africa). – British Herpetological Society Bulletin, **25**: 29-38.
- IUCN, Conservation International, & NatureServe (2004): Global Amphibian Assessment. [<http://www.globalamphibians.org>; latest inquiry: 17 December 2005]
- 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.
- LAMARQUE, F. (2004): Les grands mammifères du complexe WAP. – ECOPSA, Ouagadougou, Burkina Faso.
- LAMBIRIS, A.J.L. (1989): The frogs of Zimbabwe. – Museo Regionale di Scienze Naturali Torino, Monografia X, 247 pp.
- LAMOTTE, M. (1967): Les batraciens de la région de Gpakobo (Côte d'Ivoire). – Bulletin de l'Institut fondamental d'Afrique noire, Sér. A, **29**: 218-294.
- LAMOTTE, M. (1969): Le parc national du Niokolo-Koba, Fasciule III; XXX. Amphibiens (deuxième note). – Mémoires de l'Institut fondamental d'Afrique noire, **84**: 420-426.
- LAMOTTE, M & A. OHLER (2000): Révision des espèces du groupe de *Ptychadena stenocephala* (Amphibia, Anura). – Zoosystema, **22**: 569-583.
- LEACHÉ, A.D., M.-O. RÖDEL, C.W. LINKEM, R.E. DIAZ, A. HILLERS & M.K. FUJITA (2006, in press): Reptile and amphibian diversity in the forest islands of the Togo Hills, Kyabobo National Park, Ghana. – Amphibian and Reptile Conservation.
- MAB-UNESCO (1990): Pendjari (Bénin): Contribution aux études d'aménagement du Parc National et de sa zone périphérique. – Rapport d'étude, ENGREF-FSA, Cotonou, Bénin.
- PASSMORE, N.I. & V.C. CARRUTHERS (1995): South African frogs, a complete guide. – Witwatersrand University Press, Johannesburg, 322 pp.
- PERRET, J.-L. (1966): Les amphibiens du Cameroun. – Zoologische Jahrbücher (Systematik), **8**: 289-464.
- PERRET, J.-L. (1987): À propos de *Ptychadena schillukorum* (WERNER, 1907) (Anura, Ranidae). – Bulletin de la Société neuchâteloise, Sciences Naturelles, **110**: 63-70.
- PERRET, J.-L. (1991): Description de *Ptychadena ingeri* n. sp. (Anura, Ranidae) du Zaïre. – Archives de Science Genève, **44**: 265-281.
- PIENAAR, U. DE V., N.I. PASSMORE & V.C. CARRUTHERS (1976): The frogs of the Kruger National Park. – National Parks Board of South Africa, Pretoria, 91 pp.
- POYNTON, J.C. (1964): The Amphibia of Southern Africa: a faunal study. – Annals of the Natal Museum, **17**: 1-334.
- POYNTON, J.C. (1970): Guide to the *Ptychadena* (Amphibia: Ranidae) of the southern third of Africa. – Annals of the Natal Museum, **20**: 365-375.
- POYNTON, J.C. & D.G. BROADLEY (1985): Amphibia Zambesiaca 2. Ranidae. – Annals of the Natal Museum, **27**: 115-181.
- RAZZETTI, E. & C.A. MSUYA (2002): Field guide to the amphibians and reptiles of Arusha National Park (Tanzania). – Pubblinova Edizioni Negri, Varese, 84 pp.
- RÖDEL, M.-O. (1998): Kaulquappengesellschaften ephemerer Savannengewässer in Westafrika. – Edition Chimaira, Frankfurt/M., 195 pp.
- RÖDEL, M.-O. (2000): Herpetofauna of West Africa, Vol. I: Amphibians of the West African savanna. – Edition Chimaira, Frankfurt/M., 335 pp.
- RÖDEL, M.-O. (2003): The amphibians of Mont Sangbé National Park, Ivory Coast. – Salamandra, **39**: 91-110.
- RÖDEL, M.-O. & A.C. AGYEI (2003): Amphibians of the Togo-Volta highlands, eastern Ghana. – Salamandra, **39**: 207-234.
- RÖDEL, M.-O. & M.A. BANGOURA (2004): A conservation assessment of amphibians in the Forêt Classée du Pic de Fon, Simandou Range, southern Republic of Guinea, with the description of a new *Ammirana* species (Amphibia Anura Ranidae). – Tropical Zoology **17**: 201-232.
- RÖDEL, M.-O. & R. ERNST (2003): The amphibians of Marahoué and Mont Péko National Parks, Ivory Coast. – Herpetozoa, **16**: 23-39.
- RÖDEL, M.-O. & R. ERNST (2004): Measuring and monitoring amphibian diversity in tropical forests. I. An evaluation of methods with recommendations for standardization. – Ecotropica, **10**: 1-14.

## The amphibian fauna of Pendjari National Park

- RÖDEL, M.-O. & M. SPIELER (2000): Trilingual keys to the savannah-anurans of the Comoé National Park, Ivory Coast. – Stuttgarter Beiträge zur Naturkunde, Serie A, Nr. **620**: 1-31.
- RÖDEL, M.-O., M.A. BANGOURA & W. BÖHME (2004): The amphibians of south-eastern Republic of Guinea (Amphibia: Gymnophiona, Anura). – Herpetozoa, **17**: 99-118.
- SCHIÖTZ, A. (1963): The amphibians of Nigeria. – Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening, **125**: 1-92 + 4 plates.
- SCHIÖTZ, A. (1964a): A preliminary list of amphibians collected in Ghana. – Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening, **127**: 1-17.
- SCHIÖTZ, A. (1964b): A preliminary list of amphibians collected in Sierra Leone. – Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening, **127**: 19-33 + 1 plate.
- SCHIÖTZ, A. (1964c): The voices of some West African amphibians. – Videnskabelige Meddelelser fra Dansk Naturhistorisk Forening, **127**: 35-83.
- SCHIÖTZ, A. (1967): The treefrogs (Rhacophoridae) of West Africa. – Spolia zoologica Musei Haunienses, **25**: 1-346.
- SCHIÖTZ, A. (1999): Treefrogs of Africa. – Edition Chimaira, Frankfurt/M., 350 pp.
- SCHMIDT, K.P. & R.F. INGER (1959): Amphibians exclusive of the genera *Afrivalus* and *Hyperolius*. – Exploration du Parc National de l'Upemba, Mission G.F. DE WITTE, Institut des Parcs Nationaux du Congo Belge, Fascicule **56**: 1-264 + 9 plates.
- SINSIN, B., A.C. TÈHO, I. DAOUA & A. SAÏDOU (2000): Abundance and species richness of larger mammals in Pendjari National Park in Bénin. – Mammalia, **66**: 369-380.
- SPIELER, M. (1997): Anpassungen westafrikanischer Froschlurche an Trockenstreß und Ränderdruck in einer westafrikanischen Savanne. – Salamandra, **33**: 133-152.
- STEVENS, R.A. (1974): An annotated check list of the amphibians and reptiles known to occur in south-eastern Malawi. – Arnoldia, **6**: 1-22.
- STEWART, M.M. (1967): The amphibians of Malawi. – State University Press, New York, 164 pp.
- ULLENBRUCH, K. (2003): Untersuchungen zur Biodiversität der Amphibien und Reptilien eines isolierten Regenwaldes in der Dahomey Gap, Bénin. – unpublished diploma thesis, Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn.
- VERSCHUREN, J. (1988): Notes d'écologie, principalement des mammifères du Parc National de la Pendjari, Bénin. – Biologie, **58**: 185-206.
- VEITH, M., S. LÖTTERS, F. ANDREONE & M.-O. RÖDEL (2004): Measuring and monitoring amphibian diversity in tropical forests. II. Estimating species richness from standardized transect censusing. – Ecotropica, **10**: 85-99.
- WAGER, V.A. (1986): Frogs of South Africa, their fascinating life stories. – Delta, Craighall, 183 pp.
- WALKER, B. (1966): An uncommon frog, *Pyxicephalus adspersus*. – Nigerian Field, **31**: 177-180.
- WALKER, R.B. (1968): The amphibians of Zaria, in the northern Guinea Savannah, Nigeria. – Copeia, **1968**: 164-167.
- WANGER, T.C. (2005): The amphibians of Kiang West National Park, The Gambia. – Salamandra, **41**: 27-33.

## Appendix 1

Complete list of amphibians from Pendjari National Park and surroundings, and collection numbers of voucher specimens; <sup>fr</sup> = first species records for Benin; Be = collected by S.G.A. NAGO & M.-O. RÖDEL, OG = collected by O. GRELL, \* acoustic record only. MOR and GAN refer to the collections by two of the authors (see text).

	MOR	GAN
<b>Pipidae</b>		
<i>Xenopus muelleri</i>	Be 29, 93, OG 26	Be 28
<b>Bufo</b>		
<i>Bufo maculatus</i>	Be 39	Be 01-02, 51
<i>B. regularis</i>	OG 31	Be 03, 54, 58
<i>B. pentoni</i> <sup>fr</sup>	Be 20, 86	Be 19, 85
<b>Hemisotidae</b>		
<i>Hemisis marmoratus</i>	Be 22, OG 5	Be 64, 106
<b>Ranidae</b>		
<i>Hoplobatrachus occipitalis</i>	Be 11, OG 4a, b	Be 25, 56-57, 63
<i>Hildebrandtia ornata</i> <sup>fr</sup>	Be 87, 102-103	Be 100
<i>Pyxicephalus cf. edulis</i> <sup>fr</sup>	Be 117-118, OG 1	Be 62, 65, 119
<i>Amnirana galamensis</i>	OG 3	Be 26, 55, 83
<i>Ptychadena bibroni</i> <sup>fr</sup>	Be 10, 99, 101	Be 59
<i>P. pumilio</i>	Be 24, OG 27-30	Be 33, 35, 38, 60-61
<i>P. oxyrhynchus</i>		Be 123
<i>P. cf. schillukorum</i> <sup>fr</sup>	Be 88, 105, 109-111	Be 104
<i>P. tellini</i> <sup>fr</sup>	Be 91, OG 2	Be 92
<i>P. tournieri</i> <sup>fr</sup>	Be 23	Be 50
<i>P. trinodis</i> <sup>fr</sup>	Be 89	Be 90
<b>Petropedetidae</b>		
<i>Phrynobatrachus accraensis</i> <sup>fr</sup>	OG 10-23	Be 04, 13
<i>P. francisci</i> <sup>fr</sup>	Be 18, 34, 108, OG 24-25	Be 53
<i>P. guttuosus</i> <sup>fr</sup>	Be 124	
<i>P. natalensis</i>	Be 05, 107	Be 08-09, 52
<b>Arthroleptidae</b>		
<i>Arthroleptis sp.</i> <sup>fr</sup>	Be 40, 42	Be 41
<b>Hyperoliidae</b>		
<i>Kassina cassinoides</i> <sup>fr</sup>	Be 84	
<i>K. fusca</i> <sup>fr</sup>	Be 31	Be 43
<i>K. senegalensis</i> <sup>fr</sup>	Be 27	Be 06
<i>Leptopelis bufonides</i> <sup>fr</sup>	Be 21, 96-97, 121-122	Be 32, 94
<i>L. viridis</i>	Be 17, 95, 98	Be 37, 49
<i>Hyperolius concolor</i>	*	*
<i>H. nitidulus</i>	Be 14, OG 6-8	Be 15-16, 44-45
<i>H. nasutus</i> <sup>fr</sup>	OG 1.2002	
<i>Afrixalus vittiger</i>	Be 30, 36, OG 9	Be 07, 46-48
<i>A. weidholzi</i>		Be 12
<b>Microhylidae</b>		
<i>Phrynomantis microps</i>	1 without #	

Manuscript received: 30 January 2006

Authors' addresses: GILLES A.S. NAGO, BRICE SINSIN, Faculté des Sciences Agronomiques, Université Abomey-Calavi, 01 B.P. 526 Cotonou, Bénin; OLAF GRELL, Freie Biologen GGV, Stralsunder Weg 16, D-24161 Altenholz-Stift, Germany; 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.