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The anuran fauna of a Volunteer Nature Reserve: the Tanoé-Ehy Swamp Forests, south-eastern Ivory Coast, West Africa

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Abstract

We report the results of an amphibian survey in the Tanoé-Ehy Swamp Forests, south-eastern Ivory Coast. During 26 days we recorded at least 33 frog species. These include a new record for the recently described *Morerella cyanophthalma*, which seems to be endemic to the south-eastern Ivorian forests. Some individuals of the genus *Phrynobatrachus* may represent the so far unknown males of *P. intermedius*, described from neighboring Ghana and only known from the type locality, or a species new to science. Based on the IUCN Red List more than one quarter of the recorded species are threatened. The study sites comprise an amphibian fauna mainly consisting of forest specialists that are endemic to the Upper Guinea forest zone. Although some regional endemics were lacking from our records, the Tanoé-Ehy Swamp Forests have great value for amphibian conservation in Ivory Coast. However, the presence of some invasive species is a clear hint to past and present forest alteration. We urge for the protection of these forests as they represent an important refuge for the forest fauna in the south-eastern Ivory Coast, a region where only few forests persisted until today.

Introduction

Most West African countries have lost the majority of their natural forests. Ivory Coast has been experiencing a great loss of rainforest cover in the west (e.g. Chatelain et al. 1996), and this has been worsening during the political crisis in the first decade of the 21st century (Bible 2013, Hansen et al. 2013). This situation is also severe in other parts of this country, although forest loss in these other areas has received much less attention. The rainforests in south-eastern Ivory Coast are actually among the most highly threatened African forests (Norris et al. 2010, Mayaux et al. 2013). In particular they face logging, shifting agriculture and poaching (Lauginie 2007).

Although, since 1926, the Ivorian State created protected areas throughout the country (Lauginie 2007), the eastern forested areas were neglected (Bakarr et al. 2004). To reinforce its conservation policy, the Ivorian state is now encouraging compensatory measures, i.e. the creation of volunteer nature reserves (VNR), in addition to protected areas. One of these VNRs is the Tanoé-Ehy Swamp Forests, which has been designated as a "Very High" priority area for primates. To further enhance protection it has been recommended to collect

and update the scientific information for this forest area (Koné et al. 2008).

Recently it has been shown that the amphibian faunas of the western (western Ivory Coast and westwards) and eastern (eastern Ivory Coast to the Dahomey Gap in Benin and Togo) Upper Guinea forests are distinctly different (Penner et al. 2011). The discovery and descriptions of several new species from eastern Ivory Coast and western Ghana, further underline the faunistic uniqueness of this region (Assemian et al. 2006, Rödel et al. 2009a, 2009b, Rödel et al. 2012, Kouamé et al. 2014a).

So far the scientific knowledge of the Tanoé-Ehy Swamp Forests is fragmentary (Koné and Akpatou 2004, Ahon 2010, Zadou et al. 2011) and completely excludes amphibians. However, amphibians are important parts of tropical ecosystems and provide numerous ecosystem services (Mohneke and Rödel 2009, Hocking and Babbitt 2014). Furthermore representatives of this taxonomic group are known to react sensitively to habitat alteration. The composition of amphibian assemblages thus may reflect the degree of habitat degradation and destruction (for Ivorian examples compare e.g. Ernst and Rödel 2005, Ernst et al. 2006, Hillers et al. 2008). Hence, conservation recommendations could be based on the presence or absence of particular amphibian species and their continued monitoring.

The Tanoé-Ehy Swamp Forests have recently been the focus for exploitation by an agro-industrial company, making a comprehensive survey of its biological richness more pressing. We therefore participated in a survey of the Tanoé-Ehy Swamp Forests organized by the "Centre Suisse de Recherche Scientifique." The amphibian data are presented in this paper.

Material and methods

The Tanoé-Ehy Swamp Forests (TESF; 5°05′–5°15′ N; 2°45′–2°53′ W) constitute 12,000 ha of remaining rainforest in the department of Tiapoum, south-eastern Ivory Coast. The mean annual temperature is 26 °C, the mean annual precipitation is about 2000 mm. A longer dry season lasts from December to March, and is followed by the period with highest precipitation in March to July. A minor rainy season extends from October to November (Eldin 1971). The River Tanoé crosses the southern and eastern parts of the TESF while the western part of these forests is marked by the Ehy lagoon (Fig. 1). The TESF mainly consist of moist, partly primary forests on predominantly sandy soil with vegetation typical for south-eastern Ivory Coast (Béligné 1994).

The survey was carried out in the northern part of TESF from 17 June to 29 July 2010 (long rainy season) and from 19 September (minor dry season) to 5 October 2010 (minor rainy season). We searched for frogs along eight sites during day and night. Searching techniques included visual

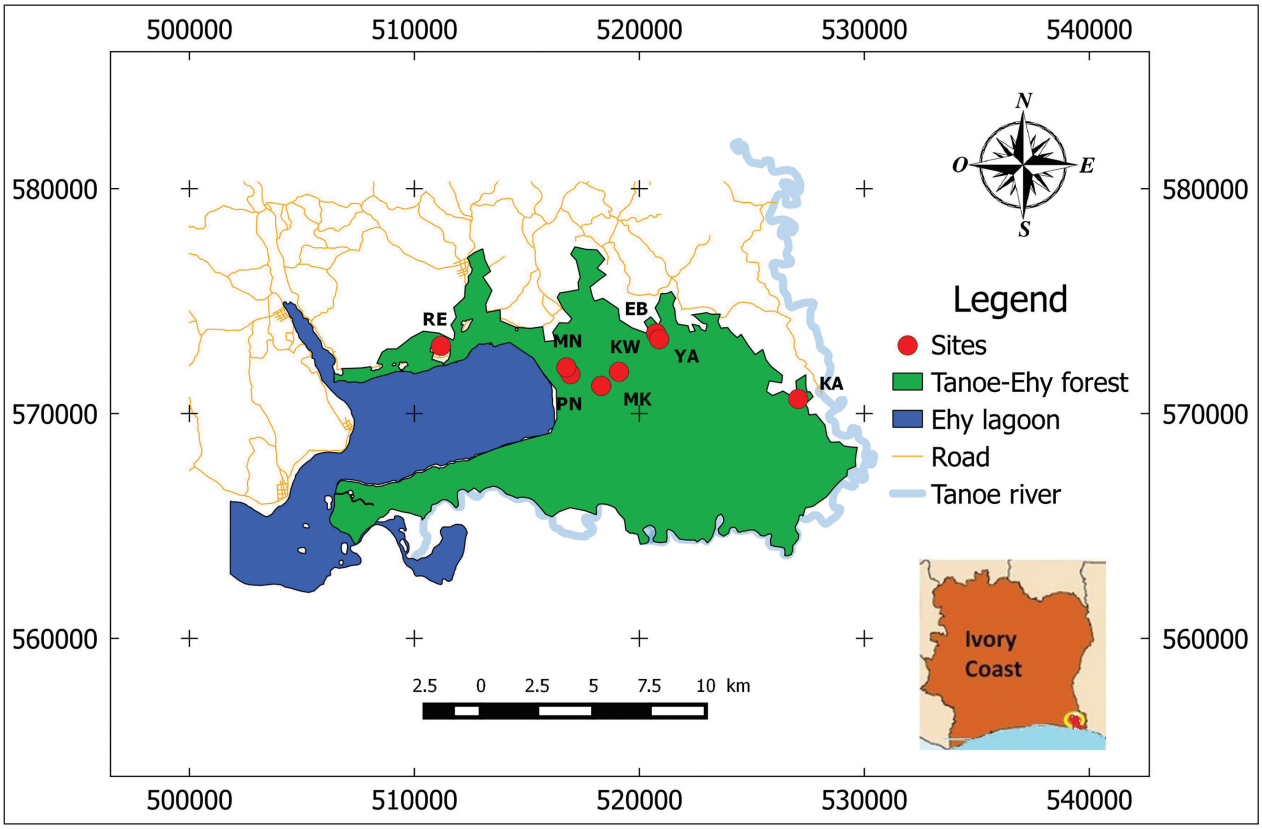

Figure 1. The geographic position of the sample sites (red dots) within the Tanoé-Ehy Swamp Forests (modified from the Research and Action Program for the Conservation of Primates – Côte d'Ivoire 2010, unpubl. data).

search for frogs, the investigation of potential hiding places or very specific habitats (e.g. exceptional breeding sites such as water-filled tree holes), and the acoustic monitoring of frog calls (see Heyer et al. 1994, Zimmerman 1994, Rödel and Ernst 2004). All available habitats were examined by two people. We searched for frogs on 26 days, each day for seven hours (07:00–11:00 h & 19:00–22:00 h GMT). The sampling effort therefore was always 14 person-hours per day and thus comparable throughout the survey. A GPS receiver (Etrex venture HC Garmin) was used to record geographic positions. Coordinates and short site descriptions are given in the Appendix 1. As our sampling design provides only qualitative and semi-quantitative data we calculated the estimated species richness, and thus the sampling efficiency, with the Chao 2 and Jack-knife 1 estimators (software: EstimateS, Colwell 2006). These estimators are incidence based, calculating using the presence/absence data of the daily species lists (26 days of survey work) for 33 species. To avoid order effects we accomplished 500 random runs of the daily species lists.

Encountered individuals were usually determined to species level and the nomenclature used herein follows Frost (2014). *Arthroleptis* species in the Upper Guinean forests are currently difficult to identify because of overlapping intraspecific and interspecific variation in morphology (Rödel and Bangoura 2004). Judging from their advertisement calls our *Arthroleptis* records comprise more than one species, but are treated herein as one taxon *Arthroleptis* spp. Snout-vent-lengths (SVL) of the living frogs were taken with a dial caliper (accuracy ± 0.5 mm). Voucher specimens of all frog species were euthanized in a chlorobutanol solution and preserved in 70% ethanol. Voucher specimens are deposited at the "Laboratoire de Zoologie et de Biologie Animale" at the Félix Houphouët Boigny University, Abidjan. Some specimens of particular interest (see below) have been deposited in the Museum für Naturkunde, Berlin (ZMB).

Results

Species richness and community composition. Overall, we recorded 33 anuran species in nine families and 13 genera. A total species list with sites records (compare Appendix 1), known habitat preferences, distribution and IUCN Red List Category (IUCN 2013) is given in Table 1. The comparison of the species accumulation curve to the two incidence-based species richness estimators revealed that more amphibian species could probably be encountered within the TESF (Fig. 2). The Jack-knife 1 estimator calculated 39 (sd: ± 2.3) species for the area, the Chao 2 estimator estimated 40 (sd: ± 8.6) species. We hence probably recorded about 77.5–79.5% of the local species pool.

We recorded the highest species numbers at KA (21 species), followed by RE (20), MN, EB, YA (each 10). Species richness was lowest at MK (8), KW (7) and PN (5). While the site RE consisted of a swampy forest with *Raphia* palms and partly open canopy, EB, KA and KW

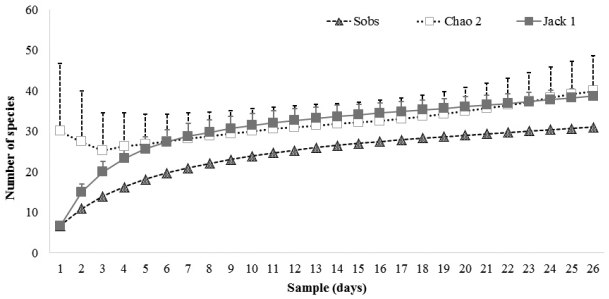

Figure 2. Species accumulation curve (Sobs) and estimated amphibian species richness (Chao 2 and Jack-knife 1; mean and positive values of standard deviation shown) of the Tanoé-Ehy Swamp Forests, south-eastern Ivory Coast.

comprised dense vegetation characterized by large canopy gaps and thick shrubby undergrowth along a river. At KA we recorded creeks, numerous puddles and ponds, and more leaf-litter compared to other sites. The site PN, which was relatively dry, mainly consisted of a more uniform forest with dense canopy. The four other sites (MK, MN and YA) were partly degraded and comprised also rice fields, small farms or oil palm plantations.

The majority of the encountered species are closely associated with forest habitats (13 species, 39.4%). Eight species (24.2%) predominantly occur in forest, but tolerate degraded habitats such as farmbush (secondary growth or degraded forest) or even savanna (Table 1). Twelve species (36.4%) usually prefer savanna and farmbush habitats and normally do not occur in pristine forests. At most survey sites, the amphibian assemblages were dominated by forest species (Table 1). Nevertheless, we observed species with preferences for farmbush and savanna habitats at all sites, suggesting that the area has already suffered from habitat degradation.

Most recorded species (54.5%) do not occur outside West Africa (defined as the area west of the Cross River in Nigeria), and are often restricted to smaller parts of West Africa. More than one quarter (27.3%) of all recorded species only occur in the Upper Guinea forest zone (forests west of the Dahomey Gap), while three records (*Morerella cyanophthalma*, *Phrynobatrachus ghanensis* and *P.* cf. *intermedius*) are potentially endemic to the forests in south-eastern Ivory Coast and adjacent Ghana.

According to the IUCN Red List, almost a quarter (24.2%) of all recorded species are threatened or near threatened: four species are Near Threatened (*Afrixalus nigeriensis*, *Leptopelis occidentalis*, *Phrynobatrachus alleni* and *P. liberiensis*), two are Vulnerable (*Kassina arboricola* and *Morerella cyanophthalma*), and two *Hylarana occidentalis* and *Phrynobatrachus ghanensis*, are Endangered (IUCN 2013; Table 1). If the *Phrynobatrachus* sp. males are *P. intermedius* (see below), the list would also comprise a Critically Endangered species.

Notes on selected species. We only comment on four species of particular interest.

Afrixalus fulvovittatus fulvovittatus (Cope, 1861) was described from Liberia and is mainly distributed in the

Table 1. Amphibian species recorded in the Tanoé-Ehy Swamp Forests with recorded sites (see Appendix), general habitat preferences, distribution and IUCN Red List category (IUCN 2013). S = savanna, FB = farmbush (degraded forest and farmland), F = rainforest, A = sub-Saharan Africa (occurs also outside West Africa), WA = West Africa (defined as the area West of the Cross River in Nigeria, see Penner et al. 2011), UG = Upper Guinea (forest zone west of the Dahomey Gap), E = Endemic to the forests in south-eastern Ivory Coast and western Ghana (west of Lake Volta), * = records comprise several species, [1] = likely being a complex of cryptic species (M.-O. Rödel et al. unpubl. data), (cf.) = taxonomic status of records needs to be clarified, LC = Least Concern, NT = Near threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered.

Family / Species	Site	Habitat			Distribution				IUCN Red List
		S	FB	F	A	WA	UG	E	
Arthroleptidae									
Arthroleptis spp.*	RE		X	X			X		LC
Leptopelis occidentalis	KA			X			X		NT
L. spiritusnoctis	EB, KA, KW, YA		X	X		X			LC
Bufonidae									
Amietophrynus maculatus	KA, RE	X	X		X				LC
A. regularis	EB, MN, RE	X	X		X				LC
Dicroglossidae									
Hoplobatrachus occipitalis	KA, RE, YA	X	X		X				LC
Hyperoliidae									
Afrixalus dorsalis	EB, KA, MN, RE, YA	X	X		X				LC
A. fulvovittatus fulvovittatus	RE	X	X				X		LC
A. nigeriensis	RE			X		X			NT
Hyperolius concolor concolor	EB, KA, KW, MK, MN, RE, YA	X	X		X				LC
H. fusciventris burtoni	EB, KA, KW, MK, MN, PN, RE, YA		X	X		X			LC
H. guttulatus	KW, MK, MN, RE		X		X				LC
H. picturatus	KW, RE		X	X			X		LC
H. sylvaticus	KA			X		X			LC
Kassina arboricola	KA			X			X		VU
Morerella cyanophthalma	MK, RE			X				X	VU
Phrynobatrachidae									
Phrynobatrachus alleni	PN			X			X		NT
P. calcaratus[1]	KA, MK		X	X	X				LC
P. ghanensis	KA			X				X	EN
P. gutturosus[1]	EB, KA, KW	X	X	X			X		LC
P. sp. (cf. *intermedius*)	RE			X				X	CR
P. latifrons	EB, KA, KW, MK, MN, RE, YA	X	X		X				LC
P. liberiensis	RE			X			X		NT
P. plicatus	KA			X		X			LC
Pipidae									
Silurana tropicalis	RE		X	X	X				LC
Ptychadenidae									
Ptychadena bibroni	EB, MN, YA	X	X		X				LC
P. longirostris	EB, KA, RE			X		X			LC
P. mascareniensis[1]	KA, MK, PN	X	X		X				LC
P. oxyrhynchus[1]	KA	X	X		X				LC
P. pumilio[1]	KA, MK, MN, RE, YA	X	X		X				LC
Pyxicephalidae									
Aubria subsigillata	KA, RE, YA			X	X				LC
Ranidae									
Hylarana albolabris	EB, KA, MN, PN, YA		X	X	X				LC
H. occidentalis	KA, MN, PN, RE			X			X		EN

western Upper Guinea forest zone. Our present records (Fig. 3) confirm the species' presence in south-eastern Ivory Coast (Pickersgill 2007).

Morerella cyanophthalma Rödel, Assemian, Kouamé, Tohé & Perret, 2009 (Fig. 4) is a recently erected monotypic genus (Rödel et al. 2009a), known so far only from the type locality, Banco National Park in Abidjan, and Azagny National Park, west of Abidjan (the latter locality was recently confirmed by N.G. Kouamé et al., unpubl. data). In TESF, a few of these frogs could be found in the swampy parts of the forest, dominated by *Raphia* palms. While two males and two females were found in disturbed forest parts next to a road, another female was seen in a forested part at the edge of a rice field. One male was seen

Figure 3. *Afrixalus fulvovittatus fulvovittatus* from the Tanoé-Ehy Swamp forests.

during the day on the ground. The four other individuals were captured at night perched on *Raphia* palms.

In sun light the frogs have the horizontal oval pupil shape typical for the genus (Fig. 4a); males possess a medium-sized medioposterior gular gland without dilatable skin beneath and around the gland (Fig. 4b); males bear small spines on the back and extremities, being most pronounced on the external side of toe V; and the sexes exhibit a pronounced sexual color dimorphism (Fig. 4). In contrast to frogs from the type locality, the males from TESF reached 23.5–26.6 mm SVL (largest male: ZMB 80869), the females 31.0–32.0 SVL, thus showing a more pronounced sexual size dimorphism and smaller sizes (Rödel et al. 2009a). However, these differences could be also due to a much smaller sample size at TESF, compared to the series from Banco National Park. The dorsal spines in ZMB 80869 are less pronounced than in the type series, with spines on the back, femur, tibia and tarsus being difficult to see; only those spines on the external side of toe V are immediately visible. The sexual dichromatism was similar to the type series. However, in contrast to females from Banco forest (iris colored blue), some females from TESF had a reddish brown iris (Fig. 4c).

We believe that the frogs presented herein represent the easternmost known record of *Morerella cyanophthalma,* approximately 177 km from the type locality. However, the small morphological differences mentioned above urge for a molecular and acoustic examination of the newly discovered population.

Hylarana occidentalis (Perret, 1960) was so far known from primary or nearly primary rainforests in Ghana (Perret 1977, 1983, Rödel et al. 2005), western Ivory Coast (Rödel and Branch 2002), south-eastern Guinea (Böhme 1994, Rödel et al. 2004), Liberia (Hillers and Rödel 2007) and Sierra Leone (A. Hillers and M.-O. Rödel, unpubl. data). This is only the second record for south-eastern Ivory Coast (compare Kouamé et al. 2014b).

Phrynobatrachus sp. We found adult *Phrynobatrachus* males (ZMB 80870-80871) which are not assignable unambiguously to a described species (Fig. 5). Superficially they resemble most either *P. liberiensis* Barbour & Loveridge, 1927 or *P. intermedius* Rödel, Boateng, Penner & Hillers, 2009. With both they share, amongst other characters, the general body shape, as well as the shape of a pair of feebly developed scapular ridges. From *P. liberiensis* males, they differ by a darker patterning on the breast, more numerous and more distinct spines on the back (in particular on the posterior-most part of the back), more distinct and denser spines on the black throat, more dark dots on the belly and a blackish facial mask. With *P. intermedius* they share the black facial mask. The latter species is only known from two females and a juvenile from the primary forest of the Ankasa Reserve in south-western Ghana (Rödel et al. 2009b). Males of this species have not yet reported. Our two males measure 22.4 and 22.1 mm SVL, respectively. They differ from both described species by more pronounced pedal webbing. One individual (ZMB 80870) exhibits very contrasting pattern on

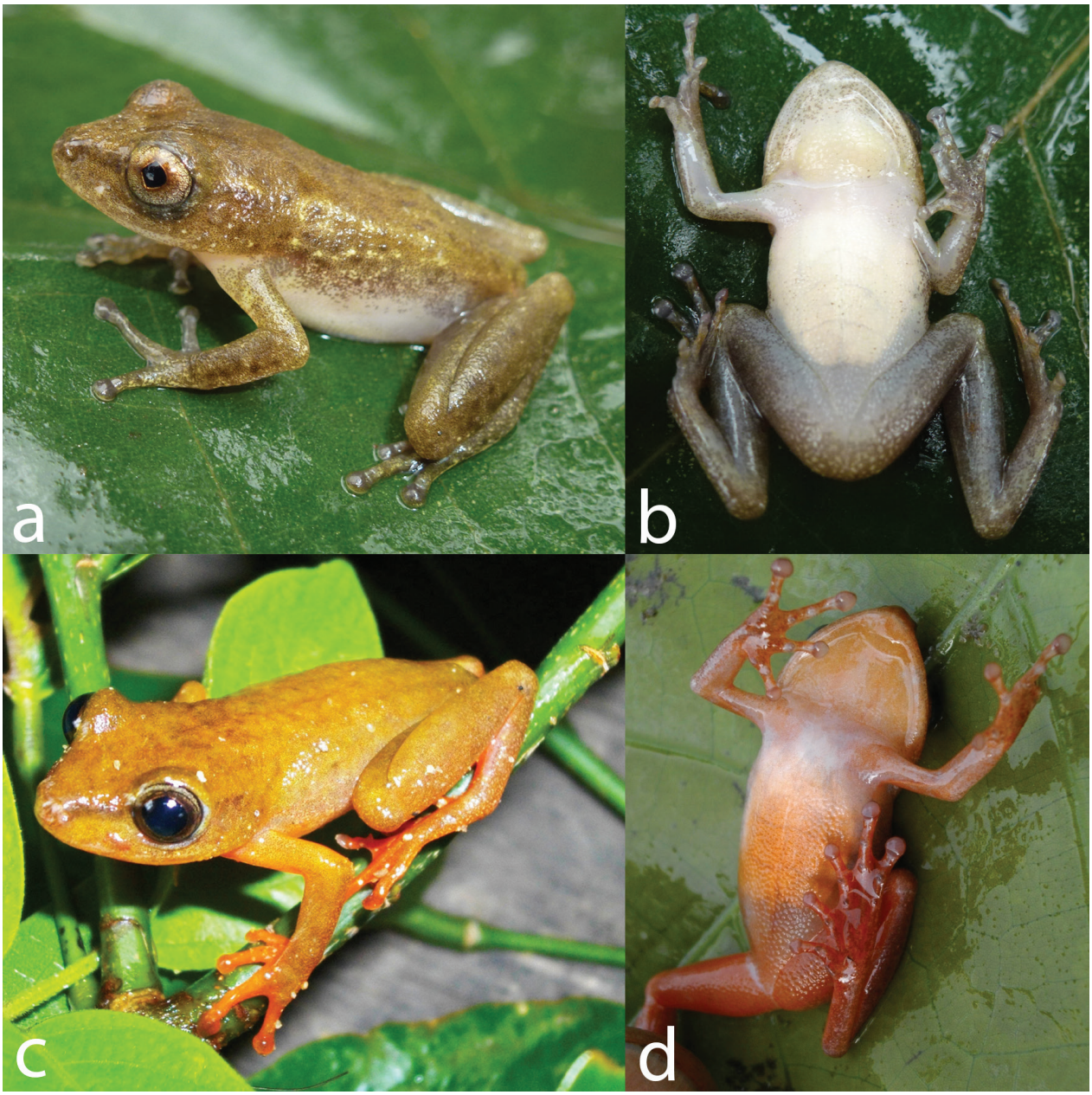

Figure 4. Dorsolateral and ventral views of male (a, b; ZMB 80869) and female (c, d; not collected) *Morerella cyanophthalma* from the Tanoé-Ehy Swamp forests.

flanks and back, not known to us to occur in *P. liberiensis* and not reported from *P. intermedius* either. The pair of white dorsal roundish dots occurs as well in *P. liberiensis*, however, there usually only in juveniles.

Phrynobatrachus sp. was associated with small creeks in swampy forest areas, dominated by *Raphia* palms. The males could be the unknown males of *P. intermedius*, although sex dependent differences in webbing would be unusual for the genus. In order to clarify the taxonomic situation molecular data are needed. Future work in south-western Ghana and south-eastern Ivory Coast should carefully examine *P. liberiensis* and *P. plicatus* to assess if *P. intermedius* (or other cryptic species) occur in the few remaining rainforests in these regions, and in particular to collect tissue samples and call recordings.

Discussion

During our survey we recorded 33 anuran species. The overall species richness of TESF was lower compared to species richness recorded in western Ivorian forest areas, for instance the Taï National Park (Ernst et al. 2006), Mont Sangbé National Park (Rödel 2003), or the Haute Dodo and Cavally Classified Forests (Rödel and Branch 2002), but similar to Mont Péko National Park (Rödel and Ernst 2003). Compared to these and other West African forest areas with known amphibian assemblages such as south-western Ghana (Rödel et al. 2005), south-eastern Guinea (Rödel et al. 2004) or north-western Liberia (Hillers and Rödel 2007), the TESF ranks among the areas of median to low amphibian species richness. Amphibian

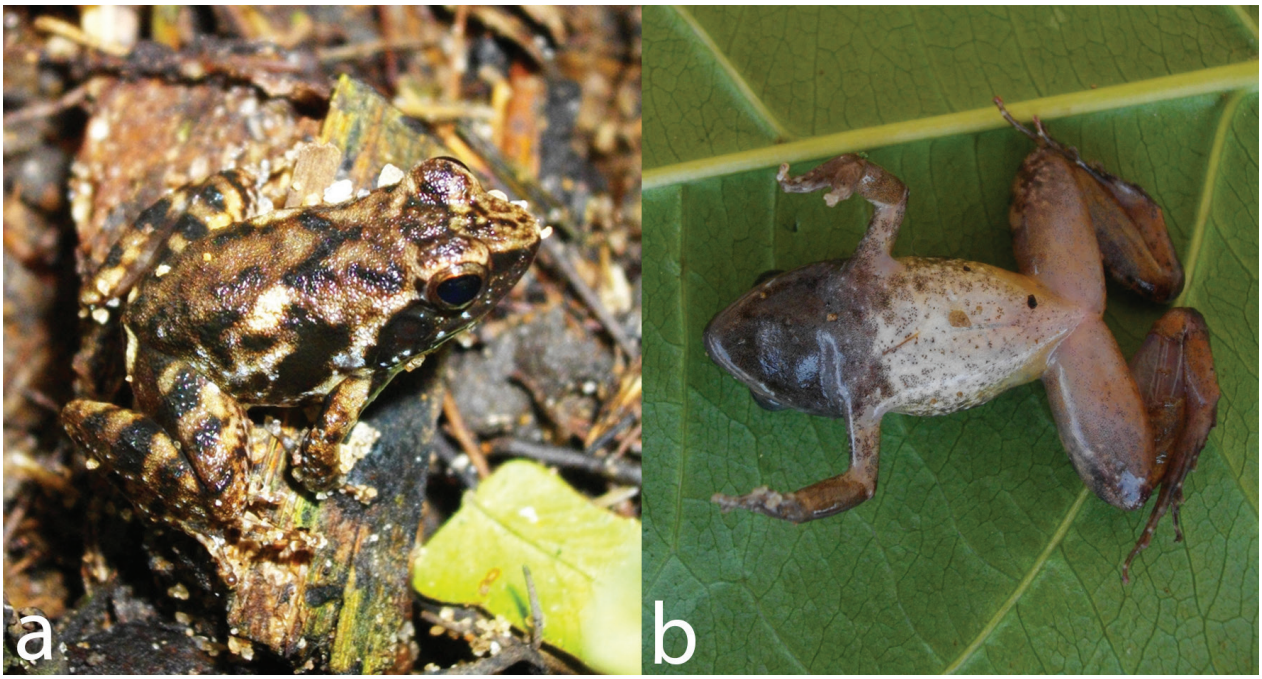

Figure 5. Dorsolateral and ventral view of a male (a, b; ZMB 80870) *Phrynobatrachus* sp. from the Tanoé-Ehy Swamp forests; compare text.

surveys in two other eastern Ivorian forests, Yakassé-Mé village forest and Banco National Park, documented 24 and 28 species, respectively (Assemian et al. 2006, Kouamé et al. 2014b). It thus could be speculated that this region is comparatively species poor concerning amphibians. However, our estimations revealed that we probably do not yet know the entire amphibian fauna of the TESF.

More intensive surveys, especially in areas and microhabitats not yet investigated, may result in an increasing number of species. Further species likely to be recorded in TESF are *Acanthixalus sonjae*, *Hyperolius laurenti* and *H. viridigulosus*. The occurrence of *Cardioglossa occidentalis*, *Astylosternus laticephalus*, *Leptopelis macrotis*, *Phlyctimantis boulengeri*, *Ptychadena aequiplicata* and *P. superciliaris*, seems possible because these species have been found in the Ankasa Conservation Area (Rödel et al. 2005), a rainforest in south-western Ghana and thus almost adjacent to TESF. Although we spent always the same number of hours per visit searching for frogs at the eight sites, the number of visits per site varied largely from 2–8 between sites (compare in Appendix 1). Therefore, the probability to record all species at a given site, and thus across different habitats, likely varied. Moreover, as the survey did not cover the entirety of the swamp forests, it is possible that further species occur in forest parts which were not studied. In contrast it is also possible that the documented forest alteration is responsible that some species, including the above mentioned ones, all being forest specialists, declined or even went extinct in our study site.

We recorded different subsets of the 33 anuran species in TESF. The highest species richness at site KA (21 spp.) was most probably due to the fact that this area was less altered and included more breeding sites, puddles, ponds, creeks, as well as thicker layer of leaf-litter than the remaining sites. More than half of the recorded species are restricted to West Africa, or to smaller parts of this region; the majority of these including all threatened species, are forest specialists. However, the records of many TESF species with wide distributional ranges, and broad habitat tolerance, clearly reflects altered forest conditions, due to deforestation and conversion of forests into palm plantations or rubber monocultures. The latter are steadily increasing in the eastern forest zone (Kouamé et al. 2014a). From western Ivorian forests it has been shown that logging has a serious effect on the composition of frog assemblages. Many forest specialists seem to be unable to prevail in degraded forests, most probably due to an altered microclimate with which they cannot cope (Ernst and Rödel 2005, Ernst and Rödel 2006, Hillers et al. 2008). Hence, exploring more of the potentially pristine areas in the southern parts of TESF is needed to get a complete impression concerning the presumed original anuran composition in TESF.

South-eastern Ivory Coast suffered from intensive deforestation and only a few forest remnants still prevail (Parren and de Graaf 1995, Bakarr et al. 2004, Zadou et al. 2011, Mayaux et al. 2013). This is worrying because the rainforests of this region and neighbouring western Ghana are supposed to have acted as a Pleistocene forest refugium (e.g. Parren and de Graaf 1995, Maley 1996), and thus may comprise a unique fauna and flora. This is especially true for amphibians (Penner et al. 2011), which however, are still far from being completely

known. Therefore, further surveys are highly recommended for all remaining forests, with a particular focus on primary forest. Such intensified research would lead to a better knowledge of the regional amphibian fauna, population sizes and distribution pattern of particular species. This would be especially important for species with high conservation concern, such as *Phrynobatrachus intermedius*, *Morerella cyanophthalma* and other rare or threatened endemics. Finally, further investigations could lead to a better understanding of the diversity in VNRs which would help to provide further conservation recommendations.

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Appendix 1

Geographic coordinates of the survey sites, search effort (measured in person-hours: p-h) and short habitat characterization.

Sites	Latitude	Longitude	# of visits	p-h	Habitat description
EB	05°20'742"N	05°73'568"W	2	28	dense vegetation with large canopy gaps and thick shrubby undergrowth; river present
KA	05°11'177"N	05°73'010"W	5	70	dense vegetation with large canopy gaps and thick shrubby undergrowth; river, creeks, numerous puddles and ponds present; thick leaf-litter layer
KW	05°18'292"N	05°70'840"W	3	42	dense vegetation with large canopy gaps and thick shrubby undergrowth; swamp; flooded site
MK	05°18'482"N	05°71'016"W	3	42	rice field; small scale subsistence farming; disturbed area; very large pond present
MN	05°16'755"N	05°72'052"W	8	112	palm tree plantation; very large pond present
PN	05°16'938"N	05°71'753"W	6	84	very uniform and relatively dry forest with dense canopy (no river, ponds or puddles present)
RE	05°11'181"N	05°73'011"W	5	70	swamp forest dominated by *Raphia* palms, partly open, on the periphery of a village
YA	05°20'739"N	05°73'565"W	3	42	grassland at the edge of the forest; creek present

Appendix 2

List of amphibian voucher specimens from the Tanoé-Ehy Swamp Forests. Given are field (TFK) and collection (ZMB) numbers, collection site (compare Appendix 1) and collection date.

Arthroleptidae: *Arthroleptis* spp.: TFK001–TFK043 (RE, 25 June 2010); *Leptopelis occidentalis*: TFK044–TFK046 (KA, 2 July 2010); *L. spiritusnoctis*: TFK047–TFK053 (EB, 3 July 2010), TFK054–TFK061 (KA, 27 June 2010), TFK062–TFK068 (KW, 4 July 2010), TFK069–TFK072 (YA, 5 October 2010); **Bufonidae:** *Amietophrynus maculatus*: TFK073 (KA, 17 June 2010), TFK074 (RE, 25 June 2010); *A. regularis*: TFK075 (EB, 26 June 2010), TFK076 (MN, 1 July 2010), TFK077 (RE, 4 July 2010); **Dicroglossidae:** *Hoplobatrachus occipitalis*: TFK078–TFK084 (KA, 17 June 2010), TFK085–TFK089 (RE, 20 June 2010), TFK090 (YA, 23 September 2010); **Hyperoliidae:** *Afrixalus dorsalis*: TFK091–TFK098 (EB, 26 June 2010), TFK099 (KA, 17 June 2010), TFK100 (MN, 23 June 2010), TFK101 (RE, 25 June 2010), TF102–TF105 (YA, 23 September 2010); *A. fulvovittatus fulvovittatus*: TFK106–TFK108 (RE, 3 October 2010); *A. nigeriensis*: TFK109–TFK112 (RE, 24 September 2010); *Hyperolius concolor concolor*: TFK113–TFK115 (EB, 03 July 2010), TFK116 (KA, 17 June 2010), TFK117 (KW, 22 June 2010), TFK118 (MK, 22 June 2010), TFK119 (MN, 25 June 2010), TFK120 (RE, 25 June 2010), TFK121 (YA, 3 July 2010); *H. fusciventris burtoni*: TFK122–TFK124 (EB, 26 June 2010), TFK125 (KA, 17 June 2010), TFK126 (KW, 22 June 2010), TFK127 (MK, 22 June 2010), TFK128 (MN, 23 June 2010), TFK129 (PN, 26 June 2010), TFK130 (RE, 25 June 2010), TFK131 (YA, 3 July 2010); *H. guttulatus*: TFK132–TFK143 (KW, 22 June 2010), TFK144–TFK145 (MK, 26 June 2010), TFK146–TFK148 (MN, 28 June 2010), TFK149 (RE, 4 July 2010); *H. picturatus*: TFK150 (KW, 4 July 2010), TFK151–TFK154 (RE, 29 June 2010); *H. sylvaticus*: TFK155 (KA, 2 July 2010); *Kassina arboricola*: TFK156–TF159 (KA, 17 June 2010); *Morerella cyanophthalma*: TFK160 (MK, 22 June 2010), TFK161–TFK164 (RE, 4 July 2010), ZMB 80869 (RE, 17 June-29 July 2010); **Phrynobatrachidae:** *Phrynobatrachus alleni*: TFK165–TFK171 (PN, 26–27 June 2010); *P. calcaratus*: TFK172–TFK175 (KA, 5 October 2010), TFK176–TFK178 (MK, 22 June 2010); *P. ghanensis*: TFK179–TFK191 (KA, 5 October 2010); *P. gutturosus*: TFK192–TFK197 (EB, 26 June 2010), TFK198 (KA, 5 October 2010), TFK199 (KW, 5 October 2010); *P.* sp. (cf. *intermedius*): TFK200 (RE, 3 October 2010), ZMB 80870-80871 (RE, 17 June-29 July 2010); *P. latifrons*: TFK201–TFK207 (EB, 26 June 2010), TFK208–TFK212 (KA, 17 June 2010), TFK213 (KW, 4 June 2010), TFK214 (MK, 22 June 2010), TFK215–TFK219 (MN, 25–26 June 2010), TFK220 (RE, 25 June 2010), TFK221–TFK224 (YA, 5 October 2010); *P. liberiensis*: TFK226 (RE, 24 September 2010); *P. plicatus*: TFK227–TFK229 (KA, 17 June 2010); **Pipidae:** *Silurana tropicalis*: TFK230 (RE, 3 October 2010); **Ptychadenidae:** *Ptychadena bibroni*: TFK231–TFK235 (EB, 26 June 2010), TFK236 (MN, 23 June 2010), TFK237 (YA, 3 July 2010); *P. longirostris*: TFK238 (EB, 26 June 2010), TFK239 (KA, 27 June 2010), TFK240 (RE, 4 July 2010); *P. mascareniensis*: TFK241–TFK249 (KA, 17 June 2010), TFK250 (MK, 19 June 2010), TFK251 (PN, 4 October 2010); *P. oxyrhynchus*: TFK252–TFK254 (KA, 17 June 2010); *P. pumilio*: TFK255 (KA, 17 June 2010), TFK256 (MK, 19 June 2010), TFK257 (MN, 21 June 2010), TFK258 (RE, 3 October 2010), TFK259 (YA, 5 October 2010); **Pyxicephalidae:** *Aubria subsigillata*: TFK260–TFK261 (KA, 22 September 2010), TFK262 (RE, 24 September 2010), TFK263 (YA, 23 September 2010); **Ranidae:** *Hylarana albolabris*: TFK264–TFK265 (EB, 3 July 2010), TFK266 (KA, 2 July 2010), TFK267 (MN, 2 October 2010), TFK268 (PN, 4 October 2010), TFK269 (YA, 5 October 2010); *H. occidentalis*: TFK270–TF271 (KA, 17 June 2010), TFK272 (MN, 18 June 2010), TFK273 (PN, 24 June 2010), TFK274 (RE, 3 October 2010).