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Amphibian & Reptile Conservation
9(2) [Special Section]: 56–84 (e111).

The tadpoles of eight West and Central African *Leptopelis* species (Amphibia: Anura: Arthroleptidae)

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***Abstract.*—The tadpoles of more than half of the African tree frog species, genus *Leptopelis*, are unknown. We provide morphological descriptions of tadpoles of eight species from Central and West Africa. We present the first descriptions for the tadpoles of *Leptopelis boulengeri* and *L. millsoni*. In addition the tadpoles of *L. aubryioides*, *L. calcaratus*, *L. modestus*, *L. rufus*, *L. spiritusnoctis*, and *L. viridis* are herein reinvestigated and their descriptions complemented, e.g., with additional tooth row formulae or new measurements based on larger series of available tadpoles.**

Key words. Anuran larvae, external morphology, diversity, mitochondrial DNA, DNA barcoding, lentic waters, lotic waters

Citation: Barej MF, Pfalzgraff T, Hirschfeld M, Liedtke HC, Penner J, Gonwouo NL, Dahmen M, Grözinger F, Schmitz A, Rödel M-0. 2015. The tadpoles of eight West and Central African *Leptopelis* species (Amphibia: Anura: Arthroleptidae). *Amphibian & Reptile Conservation* 9(2) [Special Section]: 56–84 (e111).

Received: 02 October 2015; **Accepted:** 14 November 2015; **Published:** 31 December 2015

Introduction

Given that sequences of correctly determined species are available, the application of DNA-barcoding has facilitated species-assignment of tadpoles. Thus, tadpole morphology is more and more frequently included in species descriptions (e.g., Blackburn 2008a; Das and Haas 2010; Rödel et al. 2012; Lima et al. 2014; Portillo and Greenbaum 2014b; Vassilieva et al. 2014) and numerous publications even focus exclusively on tadpole descriptions. Insights from larval morphology have been important for recognizing, or hinting at, cryptic species (e.g., Randrianiaina et al. 2012; Pfalzgraff et al. 2015), have contributed to systematics (Haas 2003; Müller et al. 2005) or indicated the presence of range-restricted taxa and the appropriateness of a habitat for elusive, i.e., semi-fossorial species (e.g., *Cardioglossa*: Hirschfeld et al. 2012; *Leptodactylodon*: Cruz et al. 2013; Mapouyat et al. 2014).

Moreover, detection of tadpoles can be informative for habitat preferences of species and even more importantly, provides direct evidence of successful reproduction of recorded species even in the absence of adult vouchers (e.g., Hirschfeld et al. 2012). Thus, determination of tadpoles is beneficial for conservation assessments and long-term management strategies. However, due to the bi-phasic life-cycle of anurans, tadpoles and adults are exposed to different threats in their habitat or during migration, and conservation efforts should be considered accordingly (e.g., Becker et al. 2007; Wells 2007).

While four herpetological journals provided insight on tadpoles of more than 80 species in the last two years (2014–2015 those dealing with or describing African tadpoles were relatively few; e.g., *Herpetologica*: 0/4; *Zootaxa*: 11/70; *Salamandra*: 4/9; *The Herpetological Journal*: 1/1; accessed 30 September 2015) our knowledge is still far from complete (Channing et al. 2012).

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This likewise applies to the genus *Leptopelis* Günther, 1859 which is endemic to sub-Saharan Africa and currently comprises 53 species (Frost 2015). New species are continuously being added to this list (e.g., Lötters et al. 2005; Köhler et al. 2006; Rödel 2007; Portillo and Greenbaum 2014a,b; Gvoždík et al. 2014) and further species complexes are already known (Portillo et al. 2015; Barej and Rödel, unpubl. data). These medium to large-sized frogs inhabit a wide variety of vegetation types, from tropical and subtropical forests to open grasslands (Rödel 2000; Channing 2001; Minter et al. 2004; Channing and Howell 2006; Amiet 2012). The common name "treefrogs" is not applicable to the entire genus, as some species are adapted to burrowing and a terrestrial lifestyle (e.g., Poynton and Broadley 1987; Rödel 2000 and references therein).

Generally, knowledge of the biology and natural history of *Leptopelis* is rather incomplete although advertisement calls of more than half of the species are known (e.g., Amiet and Schiøtz 1974; Schiøtz 1999; Grafe et al. 2000; Rödel 2000; Köhler et al. 2006; Greenbaum et al. 2012; Portillo and Greenbaum 2014b) and anecdotal observations on predation events by spiders (Barej et al. 2009), death-feigning reflexes (de Witte 1941; Perret 1966; Kofron and Schmitt 1992; Schmitz et al. 1999; Rödel et al. 2000), cocoon building (Grafe 2000), and malacophagy (Perret 1966; Amiet 2012) have been documented. Furthermore, *Leptopelis* are featured as magical creatures used in traditional wars and modern sports (Pauwels et al. 2003).

Details on the reproduction of *Leptopelis* species are generally scarce. As far as known egg deposition occurs outside water in or on top of moist soil, the development is slow, and hatching starts when the eggs in their nest are inundated during the beginning of the rainy season. Hatched tadpoles then move towards the water where they develop and metamorphosis takes place (Schiøtz 1963, 1975; Oldham 1977; Wager 1986; Rödel 2007). It is presumed that tadpoles are exotrophic (developmental energy derived from ingested food as a free-living tadpole) and live in the thin muddy layer in the benthos of lentic waters (Altig and McDiarmid 1999a; Channing et al. 2012). However, Amiet (2012) also reports on reproduction in lotic waters. Direct development has been speculated for *L. brevirostris* (Schiøtz 1999).

A simplified morphological description of the described *Leptopelis* tadpoles comprises: an elongated and eel-like shape, in particular a very long tail with low fins, and a predominantly dark coloration of body and tail (Perret 1966; Channing et al. 2012).

Recently, Channing et al. (2012) compiled available data on African tadpoles including 22 *Leptopelis* tadpoles, nine being described for the first time. Since then, two more *Leptopelis* tadpoles have been described (Portillo and Greenbaum 2014b; Penske et al. 2015). However, several tadpole descriptions in Channing et al. (2012) were often based on single specimens and require a through comparison with larger series of specimens as it is well known that tadpole morphology can be very variable due to genetic and environmental factors as well as during development (e.g., Duellman and Trueb 1994; Laurila and Kujasalo 1999; Relyea 2001; Kraft et al. 2006; Wells 2007).

We herein use larger voucher series to re-describe the tadpoles of four Central African (*L. aubryioides* $n = 20$, *L. calcaratus* $n = 16$, *L. modestus* $n = 3$, *L. rufus* $n = 18$), and two West African *Leptopelis* species (*L. spiritusnoctis* $n = 20$, *L. viridis* $n = 2$). In addition, we provide the first descriptions of two other Central African species: *L. boulengeri* ($n = 16$) and *L. millsoni* ($n = 1$).

Materials and Methods

Sampling. Field surveys were carried out in Liberia and Guinea by M.F. Barej and J. Penner (June 2011); in Cameroon on Mt. Manengouba, Littoral and South-West Province by M. Hirschfeld and F. Grözinger (November 2010 to October 2011), in the Abo Forest, North West Province by T.M. Doherty-Bone (August 2012), in the Ebo forest, Littoral Province by M.-O. Rödel, M. Dahmen, F. Grözinger, and M. Hirschfeld (September 2010 to October 2011), on Mt. Nlonako, Littoral Province by M.F. Barej, H.C. Liedtke, N.L. Gonwouo, and M. Hirschfeld (October 2011), and around Kribi, South Province and Etome, South-West Province by M.F. Barej, H.C. Liedtke, and N.L. Gonwouo (October to November 2011). Detailed locality data of investigated tadpoles are provided in Appendix Table A1. Tadpoles were caught either by hand or with dip nets. They were anaesthetized in a tricaine methane sulphonate (MS222, Thomson & Joseph Ltd), chlorobutanol, or benzocaine solution. For molecular analyses a piece of tail muscle was removed and preserved in ethanol (99%) from at least one individual for each set of morphologically distinct tadpoles for every locality. All tadpoles were then fixed in formalin (8%) and later transferred into ethanol (75%).

Determination. Species identity of the tadpoles was verified by DNA-barcoding, comparing 16S ribosomal RNA sequences from tadpoles to those of adult vouchers and/or available GenBank sequences. For comparison of the partial 16S rRNA a total of 37 sequences (474–554 bp) has been generated and deposited in GenBank (KT967076-KT967112; Appendix Table A1). For details of extraction, primers, and PCR protocols, and sequencing see Barej et al. (2014). Sequences were aligned using ClustalX (Thompson et al. 1997; default parameters) and manually checked using the original chromatograph data in the program BioEdit (Hall 1999). Uncorrected p-distances for the partial 16S rRNA gene between included *Leptopelis* species were calculated with PAUP* 4.0b10 (Swofford 2002).

All tadpoles could be unambiguously assigned to a valid *Leptopelis* species. Intraspecific genetic divergences ranged from 0.0–0.8% (Table 1), except in *L. rufus* where a 1.5% difference indicated two distinct lineages herein referred to as *L. rufus*_1 and *L. rufus*_2. Voucher IDs and GenBank numbers of adults and tadpoles are provided in Appendix Table A1. For further synonyms and chresonyms used in older publications on *Leptopelis* tadpoles see Frost (2015).

Character assessment. Measurements were taken with a dissecting microscope or digital calliper by one person (TP). Summaries for several individuals are given as mean values. The following measurements were taken (for details see Appendix Figure A1): EL (entire length), BL (body length), TL (tail length), BH (body height at the point of the spiracle insertion), BW (maximum body width, in dorsal view), AW (width of the tail muscle [axis], at the tail base), AH (maximum tail muscle (axis) height), VF (maximum height of ventral fin), DF (maximum height of dorsal fin), TTH (total tail height), ED (horizontal eye diameter), IOD (interocular distance), IND (internostril distance), SND (snout-nostril distance), SED (snout-eye distance), ODW (oral disc width), SL (spiracle length), and SSD (snout-spiracle distance). Distances including eyes and/or nostrils were taken from respective centers (e.g., SED: centre of the eye to snout tip). Measurements of all examined specimens are provided in Appendix Table A2. The following ratios were calculated: BL/TL, BH/BL, BW/BL, SND/SED, ED/BL, IOD/IND, TL/EL, DF/VF, AH/DF, TTH/BH, AW/BW, AH/BH, SL/BL, ODW/BW, and SSD/BL. Ratios of all examined specimens are provided in Appendix Table A3; mean ratios for each species are provided in Appendix Table A4. The relation of body length to total length was mostly not measurable in genotyped vouchers, as tail tips have been removed for tissue sampling. Specimens were staged according to Gosner (1960) and labial tooth row formulae are based on Rödel (2000).

Illustrations of genotyped representatives in the best condition of each taxon were prepared with the help of a camera lucida on a dissecting microscope. Missing parts resulting from tissue sampling are drawn as outlines based on non-genotyped vouchers. Schematic sketches were made of the oral discs of genotyped tadpoles.

Comparative morphometrics. Morphological features like fin height, body shape or tail length point to adaptations to particular habitat types (e.g., Altig and McDiarmid 1999b). To assess morphological adaptations in *Leptopelis* tadpoles to particular habitats all 18 measurements were $\log_{10}$ transformed and subjected to a rigid rotation via a Principal Component Analysis. Only individuals with full sets of measurements were included, and so *L. viridis* and *L. rufus*_1 were not represented in the final dataset and *L. millsoni* and *L. modestus* were only represented by one and two individuals, respectively. The prcomp function was used in R v3.2 (R core team 2013), data was scaled and centered and the ordispider function in the vegan package (Oksanen et al. 2013) was used to add a cluster dendrogram to species groupings.

Table 1. Intraspecific genetic distances (uncorrected p) in the mitochondrial 16S ribosomal RNA between *Leptopelis* species, compared to adult individuals (for GenBank# see Appendix Table A1); SD = standard deviation, *n* = number of pairwise comparisons, alignment: 558 bp. Note that the maximum value in *L. rufus* results from two lineages in this species; if independently analysed both lineages show p-distance values within the range of remaining taxa: *rufus*_1 (*n* = 1): 0.43%; *rufus*_2 (*n* = 10): 0%.

Species	min	max	mean	SD	*n*
aubryioides	0	0.75	0.37	0.24	36
boulengeri	0	0.19	0.08	0.1	10
calcaratus	0.18	0.6	0.39	0.21	3
millsoni	—	—	0	—	1
modestus	0	0.2	0.13	0.11	3
rufus	0	1.5	0.66	0.68	21
spiritusnoctis	0	0.83	0.21	0.27	28
viridis	0	0.21	0.11	0.12	6
interspecies	1.92	13.03	8.8	2.2	712

Results and Discussion

The tadpoles of eight *Leptopelis* species are described herein: *Leptopelis aubryioides* (Andersson, 1907), *L. boulengeri* (Werner, 1898), *L. calcaratus* (Boulenger, 1906), *L. millsoni* (Boulenger, 1895), *L. modestus* Werner, 1898, *L. rufus* Reichenow, 1874 from Central Africa, and *L. spiritusnoctis* Rödel, 2007, and *L. viridis* (Günther, 1869) from West Africa. The morphology of the analyzed tadpoles is generally consistent with the simplified tadpole diagnosis of the genus *Leptopelis* provided by Altig and McDiarmid (1999a): oval/depressed body shape; generally uniformly dark colored; dorsal eyes; small nares, nearer snout than eye; labial tooth row formula 3–5/3, usually 2-n rows on upper labium broken medially and one row on lower labium may be broken; typical, anteroventral oral apparatus; wide dorsal gap on marginal distribution; uniserial dorsally and biserial ventrally; submarginal papillae absent; wide upper jaw sheath with medial indentation; wide, V-shaped lower jaw sheath; dextral vent tube; sinistral spiracle; low dorsal fin which originates near dorsal tail body junction ends in a pointed tip.

Leptopelis aubryioides (Andersson, 1907)

The description of *L. aubryioides* tadpoles is based on twenty tadpoles: ZMB 79604 (two tadpoles, at Gosner stages 30 and 36, near Etome, Cameroon, 4.8317°N; 9.9253°E, 476 m a.s.l., 23 October 2011, the tadpoles were found in a small muddy puddle along a stream bank; stream characterised by lots of little rapids), ZMB 79605 (one tadpole at Gosner stage 25) and ZMB 79606

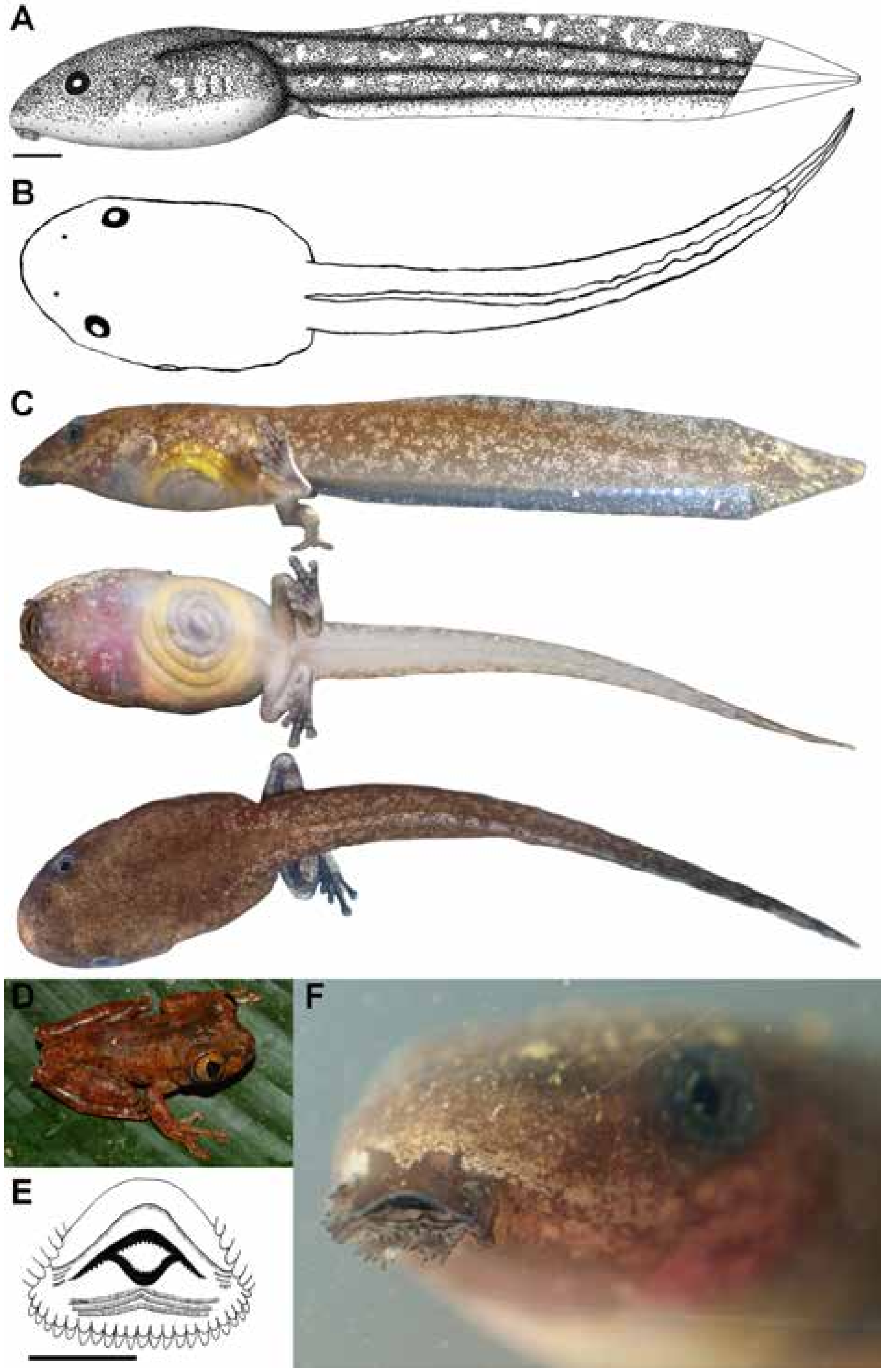

Fig. 1. Lateral (A) and dorsal (B) view of *Leptopelis aubryioides* (ZMB 79605) at Gosner stage 25; coloration of tadpole (ZMB 79604) in life (C); adult *L. aubryioides* (ZMB 83029) (D); oral disc opened in life (F); sketch of the oral disc (E); scale bars: 1 mm.

(nine tadpoles at Gosner stages 25 to 40, near Ekomtolo, at the foot of Mt. Nlonako, Cameroon, 4.8329°N; 9.9259°E, 477 m a.s.l., 24 October 2011, the tadpoles were found in a slow flowing forest stream), ZMB 79607 (three tadpoles, at Gosner stages 36 and 39, Njuma, Ebo Forest, Cameroon, 4.3483°N; 10.2329°E, 238 m a.s.l., 08 August 2011), ZMB 79608 (one tadpole, at Gosner stage 40, Njuma, Ebo Forest, Cameroon, 4.3483°N; 10.2329°E, 238 m a.s.l., 19 August 2011), ZMB 79609 (one tadpole, at Gosner stage 31, Njuma, Ebo Forest, Cameroon, 4.3394°N; 10.2458°E, 320 m a.s.l., 20 August 2011), ZMB 79610 (one tadpole, at Gosner stage 36, Njuma, Ebo Forest, Cameroon, 4.3483°N; 10.2329°E, 238 m a.s.l., 07 October 2011), ZMB 79611 (one tadpole, at Gosner stage 41, Njuma, Ebo Forest, Cameroon, 4.3483°N; 10.2329°E, 238 m a.s.l., 08 October 2011) and ZMB 79612 (one tadpole, at Gosner stage 34, Camp Njuma, Ebo Forest, Cameroon, 4.3480°N; 10.2323°E,

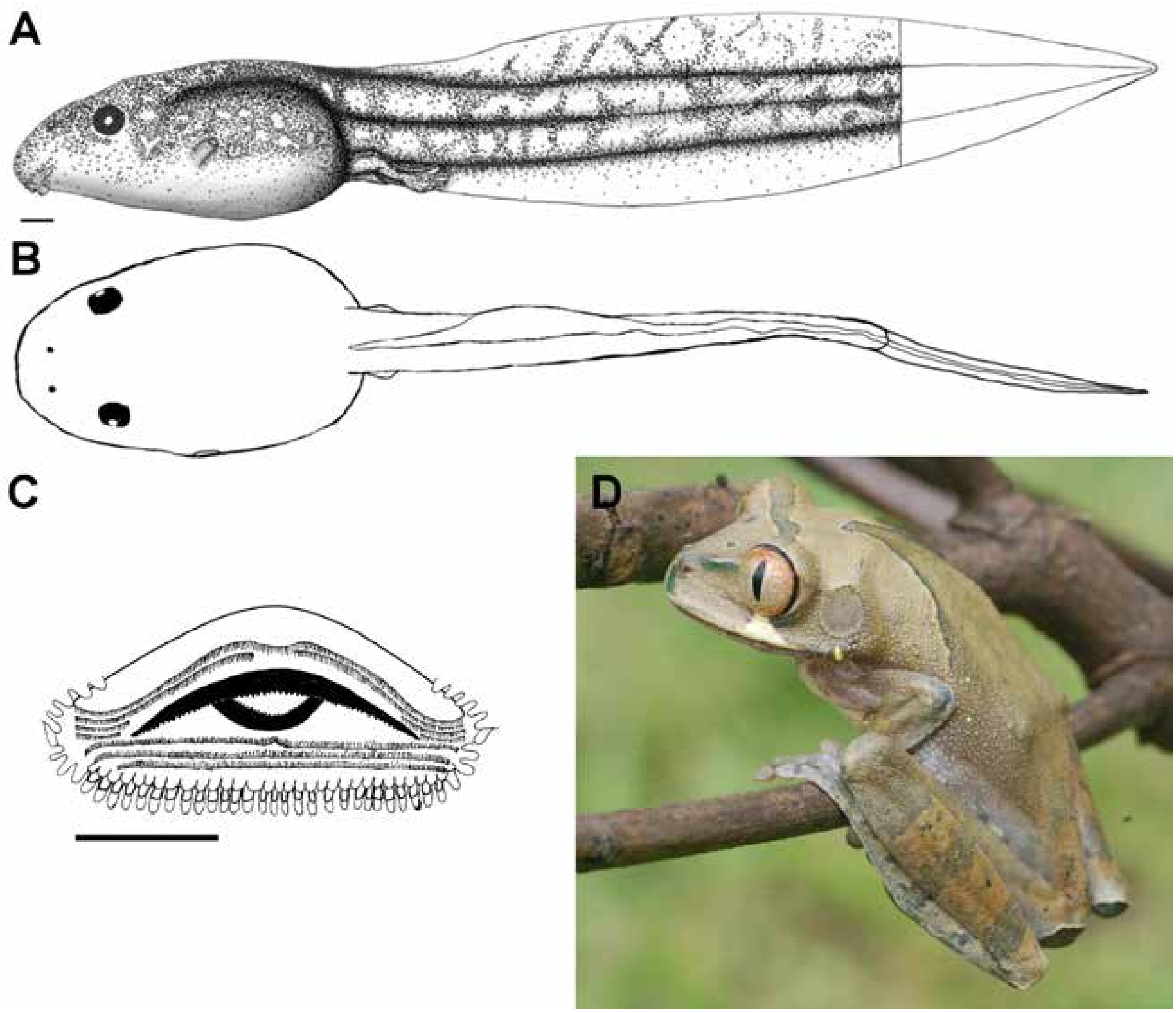

Fig. 2. Lateral (A) and dorsal (B) view of *Leptopelis boulengeri* (ZMB 79616) at Gosner stage 38; sketch of the oral disc (C); adult L. boulengeri (ZFMK 87857) (D); scale bars: 1 mm.

315 m a.s.l., 23 September 2011, the locality was situated in primary rainforest). Proportions including total or tail length were only available for non-genotyped individuals.

Description. Body oval with nearly rounded snout in dorsal view (Fig. 1B); ovoid to slightly compressed in lateral view (Fig. 1A); tail length-body length ratio 2.38 (TL/BL); body height 0.44 of body length (BH/BL); body width 0.58 of body length (BW/BL); maximum body width slightly behind the spiracle's posterior end; nostrils situated dorsally, slightly closer to snout tip than eyes (SND/SED = 0.42), distance snout-nostrils 0.20 of body length (SND/BL); eyes positioned laterally; eye diameter 0.11 of body length (ED/BL); interocular distance exceeds internostril distance by a factor of 1.93 (IOD/IND); tail length 0.70 of entire length (TL/EL), with moderately pronounced fins and narrow fin tip; dorsal fin originates at dorsal tail-body junction, barely rising at the first quarter of the tail; dorsal fin slightly curved with maximum height at three-quarters of the tail length; ventral fin originates on the ventral terminus of the body; ventral fin narrower than tail axis with maximum height at three-quarters of the tail length; maximum fin height in dorsal fin higher (DF/VF = 1.29); fin tip pointed; maximum tail height including fins lower than body height (TTH/BH = 0.90); tail axis width (in dorsal view) 0.42 of body width (AW/BW); maximum height of tail axis (at base) 0.56 of body height (AH/BH); tail axis height (at base) distinctly higher than maximum height of dorsal fin (AH/DF = 2.07); dextral vent tube, positioned basicaudally; spiracle sinistral, visible in dorsal view, originating anterior to mid-body (SSD/BL = 0.45); spiracle tube length 0.14 of body length (SL/BL); mouth opens anteroventrally; oral disc width less than quarter of body width (ODW/BW = 0.24); one row of papillae (with rounded tips) laterally at anterior lip with huge rostral gap, these connected to papillae in labial angles and posterior lip; second row of papillae caudal at posterior lip (Fig. 1F); labial tooth row formula 1/3+3//3 (Fig. 1E) or 1/2+2//3;

jaw sheaths black, of equal width and serrated; upper jaw widely V-shaped; lower jaw U-shaped.

Coloration in preservation. Dorsolateral part of the body, tail axis and dorsal fin mostly speckled dark brown on light brown ground at the body and yellowish ground at the tail; areas without brown spots shine through as yellow blots; ventral part of the body light brown with some dark brown spots at the anterior third of the body; vent tube translucent; spiracle translucent or pigmented; ventral fin predominantly translucent with few brown spots composed of dense melanophores towards tail tip.

Coloration in life (Fig. 1C). Pale brown with shiny golden speckles at dorsolateral part of the body, tail axis and dorsal fin; ventral fin translucent with few speckles; ventral part of the body translucent.

Remarks. *Leptopelis aubryioides* occurs from eastern Nigeria through Cameroon to Gabon and the Republic of the Congo (e.g., Schiøtz 1967, 1999, 2007; Frétey and Blanc 2001; Blanc and Frétey 2004; Amiet 2012). Amiet and Schiøtz (1974) and Amiet (2006, 2012) reported on habitat use and the call activity of the species. The tadpole of *L. aubryioides* has already been described by Channing et al. (2012) based on a single specimen, which belongs to a larger series of tadpoles examined herein (MH198 = ZMB 79612). Shape of body and tail, as well as tail shape and overall pigmentation are congruent with the available description. In addition to the labial

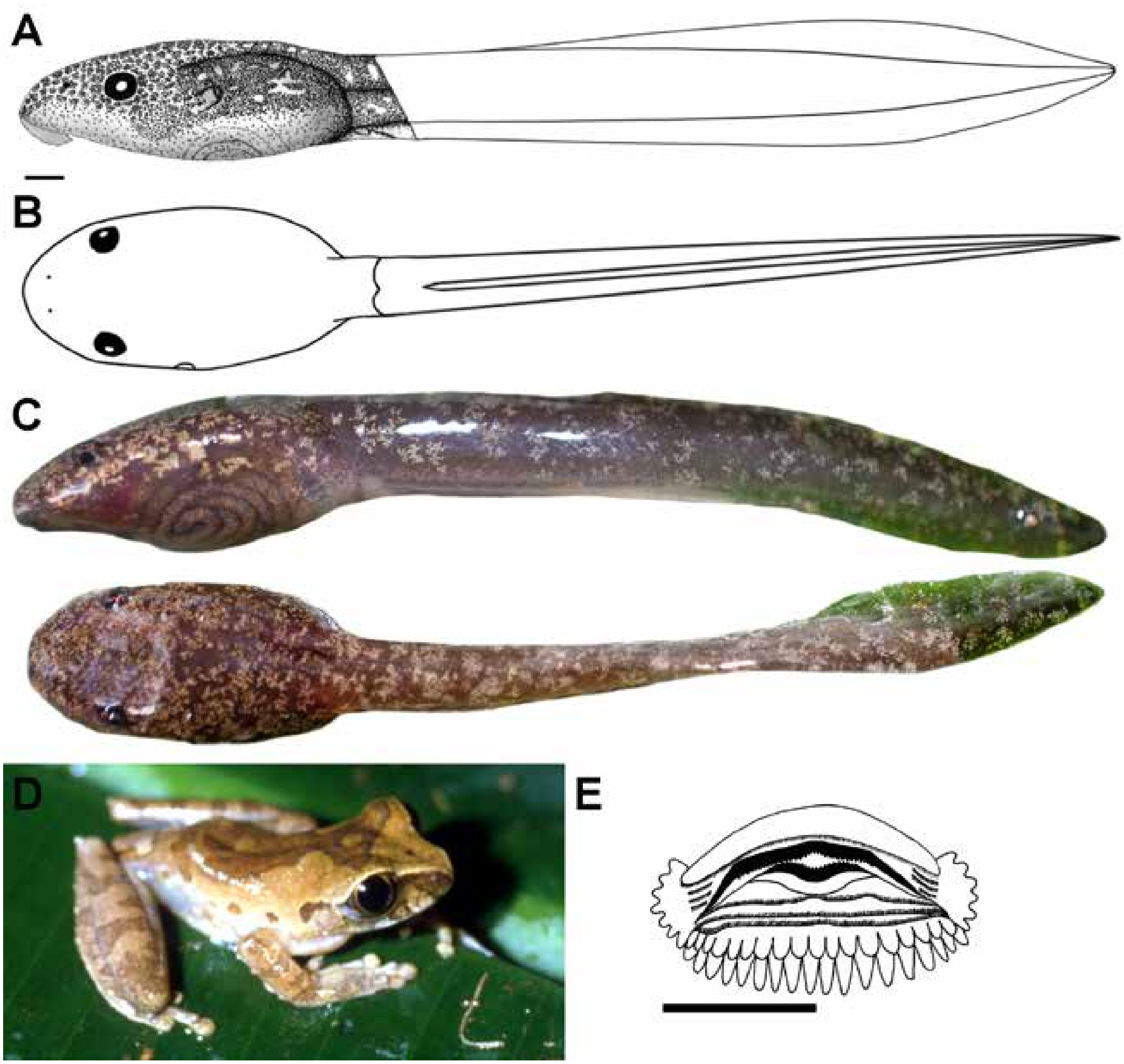

Fig. 3. Lateral (A) and dorsal (B) view of *Leptopelis calcaratus* (ZMB 79618) at Gosner stage 28; coloration in life of tadpole (ZMB 79618) in lateral (top) and dorsal (below) view (C); adult *L. calcaratus* (ZFMK 75590) (D); sketch of the oral disc (E); scale bars: 1 mm. Note that the greenish coloration at the tail tip results from a leaf used as the background.

tooth row formula presented by Channing et al. (2012: 1/2+2//3) a second labial tooth formula has been recognized 1/3+3//3 (Fig. 1E). While Channing et al. (2012) refer to a tail length-body length ratio of 2.2, the mean value of our measures was slightly higher (2.4) in the present series. Regarding the coloration, pale blotches are present in our material on the tail as well as the lateral part of the body (Fig. 1A, C). The spiracle was translucent, lacking any pigmentation.

Leptopelis boulengeri (Werner, 1898)

The description of *L. boulengeri* tadpoles is based on sixteen tadpoles: ZMB 79613 (one tadpole, at Gosner stage 37, Bekob, Ebo Forest, Cameroon, 4.3578°N; 10.4170°E, 921 m a.s.l., 27 August 2011), ZMB 79614 (four tadpoles, at Gosner stage 36 to 40, Bekob, Ebo Forest, Cameroon, 4.3578°N; 10.4170°E, 921 m a.s.l., 28 August 2011), ZMB 79615 (three tadpoles, at Gosner stage 36, Bekob, Ebo Forest, Cameroon, 4.3575°N; 10.4168°E, 903 m a.s.l., 29 August 2011), ZMB 79616 (one tadpole, at Gosner stage 38) and ZMB 79617 (seven tadpoles, at Gosner stages 36 to 40), Bekob, Ebo Forest, Cameroon, 4.3578°N; 10.4170°E, 921 m a.s.l., 08 September 2011. Proportions including total or tail length were only available for non-genotyped individuals.

Description. Body oval with subovoid snout in dorsal view (Fig. 2B); ovoid to slightly compressed in lateral view (Fig. 2A); tail length-body length ratio 2.44 (TL/BL); body height 0.43 of body length (BH/BL); body width 0.53 of body length (BW/BL); maximum body width on the level of the spiracle's posterior end; nostrils situated dorsally, closer to snout tip than eyes (SND/SED = 0.41), distance snout-nostrils 0.14 of body length (SND/BL); eyes positioned laterally; eye diameter 0.08 of body length (ED/BL); interocular distance exceeds internostril distance by a factor of 2.35 (IOD/IND); tail length 0.71 of entire length (TL/EL), with moderately pronounced fins with narrow fin tip; dorsal fin originates at dorsal tail-body junction with maximum height at half of the tail length; dorsal fin and ventral fin particularly curved; ventral fin originates on the ventral terminus of the body; ventral fin narrower than tail axis with maximum height at half of the tail length; maximum fin height in dorsal fin slightly higher (DF/VF = 1.12); fin tip pointed; maximum tail height including fins exceeds body height (TTH/BH = 1.20); the tail axis width (in dorsal view) 0.34 of body width (AW/BW); maximum height of tail axis (at base) 0.55 of body height (AH/BH); tail axis height (at base) higher than maximum height of dorsal fin (AH/DF = 1.63); dextral vent tube, positioned basicaudally; spiracle sinistral, visible in dorsal view, originating anterior to mid-body (SSD/BL = 0.43); spiracle tube length 0.18 of body length (SL/BL); mouth opens anteroventrally; oral disc width wider than a third of body width (ODW/BW = 0.36); one row of papillae (with rounded tips) laterally at anterior lip with huge rostral gap, these connected to papillae in labial angles and posterior lip; second and third row of papillae at posterior lip; labial tooth row formula 1/3+3//3 (Fig. 2C); jaw sheaths black, of equal width and serrated; upper jaw very widely U-shaped; lower jaw U-shaped.

Coloration in preservation. Dorsolateral part of the body mostly speckled dark brown on yellowish ground, tail axis and dorsal fin speckled with lighter brown spots on yellowish ground; areas without brown spots shine through as yellow blots; ventral part of the body yellow without any spots; spiracle and vent tube yellowish; ventral fin translucent without any brown spots.

Remarks. *Leptopelis boulengeri* is known from Nigeria to Gabon, the Republic of the Congo in the south and the Democratic Republic of the Congo to the east (e.g., de la Riva 1994; Schiøtz 1967, 1999; Amiet 2012). Similar to *L. aubryioides* the species inhabits dense forests with small rivulets and ponds (Schiøtz 1967; Amiet 2012). The call and call activity have been reported by Amiet and Schiøtz (1974) and Amiet (2006). The tadpole is herein described for the first time. The tadpole of *L. boulengeri* exhibits the generic diagnostic characters: elongated and slender body with a long thin tail (TL/BL = 2.4) and acute tip (Fig. 2A). The coloration is similar to other *Leptopelis* tadpoles with brown spots on yellowish ground, the spots however, being brighter than usual. The chromatophores on the dorsal part of the body and the tail are less dense in *L. boulengeri* than in the remaining examined species, the fin has dorsally only very few chromatophores and is translucent ventrally (Fig. 2A). Likewise, the labial tooth row formula 1/3+3//3 is common in the genus but the keratodonts are relatively long. Further typical characters of *L. boulengeri* tadpoles are small eyes (ED/BL= 0.08), a very high tail (including fins) in comparison to its congeners despite a narrow tail axis, and the presence of three rows of caudal papillae on the lower lip (Fig. 2C), the latter character being unique in the genus (compare Channing et al. 2012; Penske et al. 2015; Portillo and Greenbaum 2014b).

Leptopelis calcaratus (Boulenger, 1906)

The description of *L. calcaratus* tadpoles is based on eleven tadpoles: ZMB 79618 (one tadpole at Gosner stage 28) and ZMB 79619 (nine tadpoles at Gosner stages 25 to 40), all on Mt. Nlonako, Cameroon, 4.9250°N; 9.9817°E, 1,035 m a.s.l., 25 October 2011, the tadpoles were found in a stream near a village) and ZMB 79620 (one tadpole at Gosner stage 41, near Manengouba village, Mt. Manengouba, Cameroon, 4.9502°N; 9.8639°E, 1,116 m a.s.l., 23 November 2011, the tadpoles were found in a stream near the village). Proportions including total or tail length were only available for non-genotyped individuals and ZMB 79620.

Description. Body oval with nearly rounded snout in dorsal view (Fig. 3B); ovoid to slightly compressed in lateral view (Fig. 3A); tail length-body length ratio 2.27 (TL/BL); body height 0.43 of body length (BH/BL); body width 0.54 of body length (BW/BL); maximum body width on the level of the spiracle's posterior end; nostrils situated dorsally, closer to snout tip than eyes (SND/SED = 0.38), distance snout-nostrils 0.16 of body length (SND/BL); eyes positioned dorsolaterally; eye diameter 0.10 of body length (ED/BL); interocular distance exceeds internostril distance by a factor of 2.56 (IOD/IND); tail length 0.69 of entire length (TL/EL), with moderately pronounced fins with narrow fin tip; dorsal fin originates posterior to the dorsal tail-body junction with maximum height at three-quarters of the tail length; dorsal fin slightly curved; ventral fin originates on the ventral terminus of the body; ventral fin narrower than tail axis with maximum height at three-quarters of the tail length; maximum fin height in dorsal fin higher (DF/VF = 1.18); fin tip pointed; maximum tail height including fins equals body height (TTH/BH = 1.00); tail axis width (in dorsal view) 0.50 of body width (AW/BW); maximum height of tail axis (at base) 0.53 of body height (AH/BH); tail axis height (at base) higher than maximum height of dorsal fin (AH/DF = 2.15); dextral vent tube, positioned basicaudally; spiracle sinistral, visible in dorsal view, originating anterior to mid-body (SSD/BL = 0.43); spiracle tube length 0.17 of body length (SL/BL); mouth opens anteroventrally; oral disc width less than fifth of body width (ODW/BW = 0.19); one row of papillae (with rounded tips) laterally at anterior lip with huge rostral gap, these connected to papillae in labial angles and posterior lip; second row of papillae caudal at posterior lip with slightly pointed tips; labial tooth row

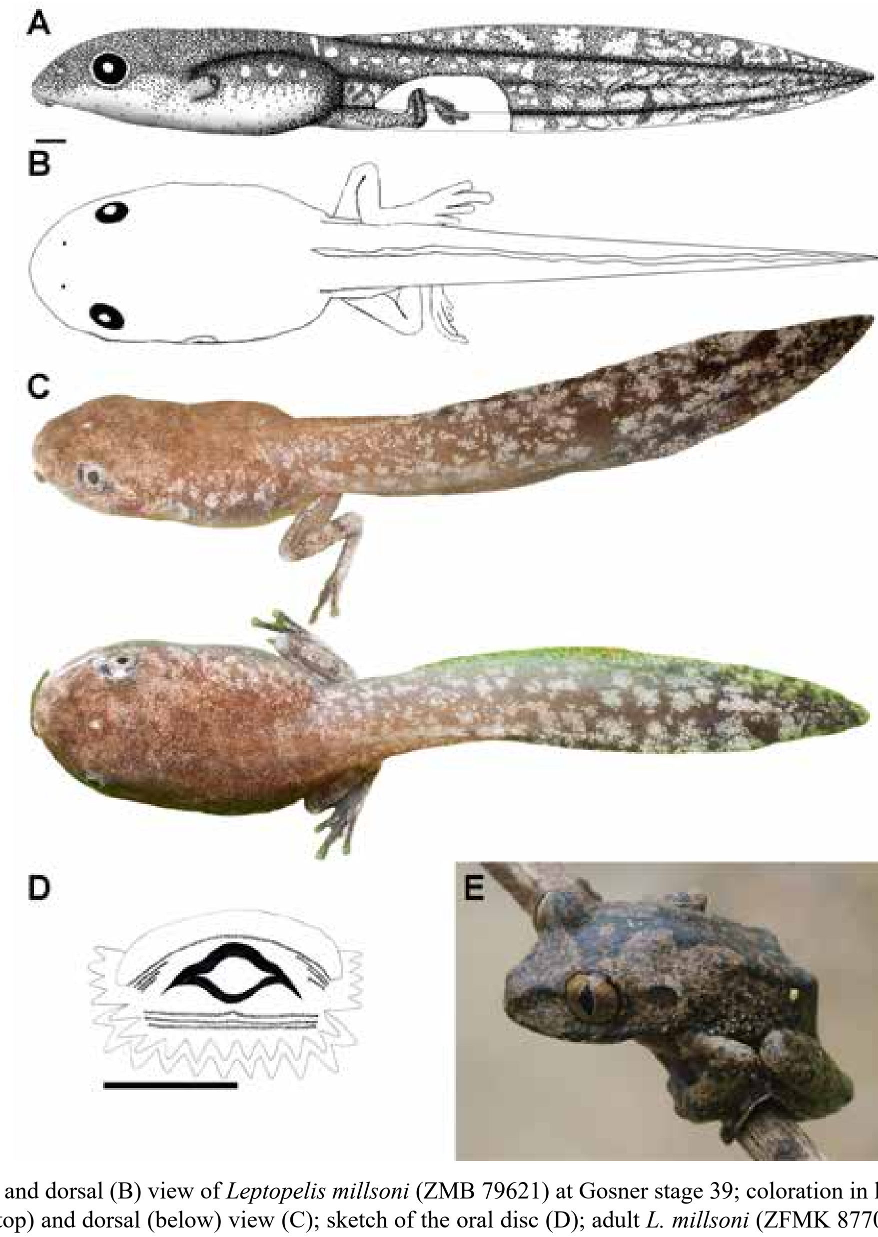

Fig. 4. Lateral (A) and dorsal (B) view of *Leptopelis millsoni* (ZMB 79621) at Gosner stage 39; coloration in life of tadpole (ZMB 79621) in lateral (top) and dorsal (below) view (C); sketch of the oral disc (D); adult *L. millsoni* (ZFMK 87708) (E); scale bars: 1 mm. Note that the greenish coloration on the lower fin results from a leaf used as the background.

formula 1/3+3//3 (Fig. 3E); jaw sheaths black, of equal width and serrated; upper jaw very widely U-shaped with median concavity; lower jaw widely V-shaped.

Coloration in preservation. Dorsolateral part of the body, tail axis and dorsal fin mostly mottled brown on yellowish ground; areas without brown spots shine through as yellow blots; ventral part of the body pale yellow with some homogeneously distributed brown spots; spiracle and vent tube translucent; ventral fin translucent without any brown spots.

Coloration in life (Fig. 3C). Dark brown with shiny golden speckles at dorsolateral part of the body, tail axis and dorsal fin; ventral fin predominantly translucent with few spots towards tail tip; ventral part of the body without golden speckles.

Remarks. *Leptopelis calcaratus* is known from Nigeria to Gabon and the Republic of the Congo in the south and the Central African Republic and the Democratic Republic of the Congo to the east (e.g., de la Riva 1994; Schiøtz 1963, 1999; Frétey and Blanc 2001; Frétey et al. 2006; Jackson and Blackburn 2007; Amiet 2012). Reproduction takes place in more or less swampy forests that are crossed by small rivers (Amiet 2012). Notes on habitat use and call activity of this species were documented by Schiøtz (1967, 1999), Amiet and Schiøtz (1974) and Amiet (2006, 2012). The tadpole of *L. calcaratus* has been described by Lamotte and Perret (1961) and Channing et al. (2012). Shape of body and tail, as well as overall pigmentation are congruent with the available tadpole descriptions. In addition to the above recorded labial tooth row formula Lamotte and Perret (1961) mention 1/2+2//3. The eyes are positioned dorsolaterally in our material, as described by Channing et al. (2012); in contrast, Lamotte and Perret (1961) refer to a dorsal position; however, it cannot be excluded that their series comprised material of different species (their descriptions were usually based on morphological series and not on tadpoles from known parents). The tail length-body length ratio of 2.3 was higher in comparison to both for-

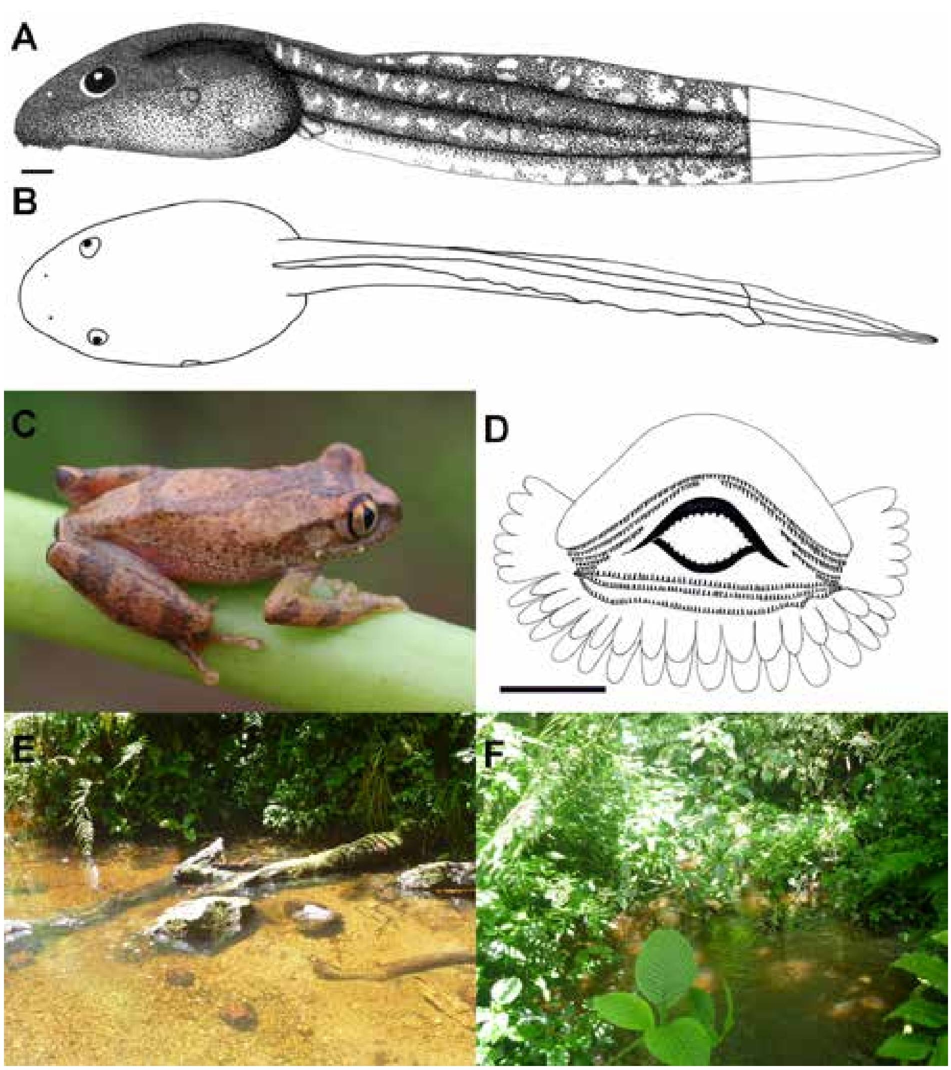

Fig. 5. Lateral (A) and dorsal (B) view of *Leptopelis modestus* (ZMB 79622) at Gosner stage 34; adult *L. modestus* (MCZ A138023, *photo courtesy David C. Blackburn*) (C); sketch of the oral disc (D); habitat of *L. modestus* on Mt. Manengouba (E and F); scale bars: 1 mm.

mer descriptions (1.9). Examined tadpoles also differed in coloration to the voucher examined by Channing et al. (2012). While these authors note black pigments on tail and fins, pigmentation in our material was mottled brown on a pale ground or forming large, almost uniform brown blotches, with a small translucent spiracle and vent tube as described by Lamotte and Perret (1961). Pigmentation tended to decrease from body to tail.

Leptopelis millsoni (Boulenger, 1895)

The description of *L. millsoni* tadpoles is based on one tadpole: ZMB 79621 (at Gosner stage 39, the tadpole was found in Kribi, near Miangasio Lendi, Cameroon, 2.8930°N; 9.9542°E, 31 m a.s.l., 04 November 2011, in a slow flowing, sandy bottom forest stream).

Description. Body oval with semi-circular snout in dorsal view (Fig. 4B); ovoid to slightly compressed in lateral view (Fig. 4A); tail length-body length ratio 1.82 (TL/BL); body height 0.38 of body length (BH/BL); body width 0.58 of body length (BW/BL); maximum body width on the level of the spiracle's anterior end; nostrils situated dorsally, slightly closer to snout tip than eyes (SND/SED = 0.43), distance snout-nostrils 0.16 of body length (SND/BL); eyes positioned laterally; eye diameter 0.12 of body length (ED/BL); interocular distance exceeds internostril distance by a factor of 2.33 (IOD/IND); tail length 0.65 of entire length (TL/EL), with moderately pronounced fins with narrow fin tip; dorsal fin originates at dorsal tail-body junction; dorsal fin moderately curved with maximum height at two-thirds of the tail length; ventral fin originates on the ventral terminus of the body; ventral fin narrower than tail axis with maximum height at half of the tail length; maximum fin height of dorsal fin higher (DF/VF = 1.25); fin tip pointed; maximum tail height including fins exceeds body height (TTH/BH = 1.06); tail axis width (in dorsal view) 0.52 of body width (AW/BW); maximum height of tail (axis at base) 0.69 of body height (AH/BH); tail axis height at its base higher than maximum height of dorsal fin (AH/DF = 2.50); dextral vent tube, positioned basicaudally; spiracle sinistral, visible in dorsal view, originating slightly anterior to mid-body (SSD/BL = 0.47); spiracle tube length 0.11 of body length (SL/BL); mouth opens anteroventrally; oral disc width more than a third of body width (ODW/BW = 0.36); one row of short papillae (with slightly pointed tips) laterally at anterior lip with huge rostral gap, these connected to papillae in labial angles and posterior lip; second row of papillae at posterior lip; labial tooth row formula 1/3+3//3 (Fig. 4D); jaw sheaths black, of equal width and serrated; upper jaw widely U-shaped with median concavity; lower jaw widely V-shaped.

Coloration in preservation. Body, tail axis, dorsal fin and ventral fin mostly speckled dark brown on yellowish ground, areas without brown spots shine through as yellow blots, ventral part of the body yellow with some light brown spots; spiracle and vent tube in the same color as body and tail.

Coloration in life (Fig. 4C). Dark brown with shiny golden speckles at dorsolateral part of the body, tail axis, dorsal fin and ventral fin; speckles very dense at dorsal part of the body; dorsoventral part of the body with few speckles.

Remarks. *Leptopelis millsoni* is known from Nigeria to Gabon and the eastern Democratic Republic of the Congo (e.g., Schiøtz 1967, 1999; Lötters et al. 2001; Blanc and Frétey 2004; Rödel et al. 2014). As in the other species male calling sites are found close to streams in the breeding season but reproduction most probably occurs in stagnant water (Amiet 2012). The call has been recorded by Amiet and Schiøtz (1974) and call activity is detailed in Amiet (2006). The tail with low fins is long (TL/BL = 1.8), but not as long as observed in other *Leptopelis* species. Because we had only one tadpole available we cannot check if this is a peculiarity of our specimen or a general trend in this Gosner stage. What distinguishes *L. millsoni* from the other studied tadpoles is the shape of the papillae. While all other *Leptopelis* species showed papillae with rounded tips, the papillae of *L. millsoni* had fairly pointed tips (Fig. 4D). The eyes of our voucher were relatively big compared to the other species (ED/BL = 0.12); only *L. viridis* had similar sized eyes in relation to body length. We cannot evaluate whether the TL/BL value reflects a species specific state, an individual character state or the advanced Gosner stage.

Leptopelis modestus (Werner, 1898)

The description of *L. modestus* tadpoles is based on three tadpoles: ZMB 79622 (one tadpole, at Gosner stage 34), ZMB 79623 (one tadpole, at Gosner stage 31), near summit of Mt. Manengouba, Cameroon, 5.0098°N; 9.8568°E, 2,135 m a.s.l., 27 September 2011, the tadpoles were found in a medium sized river in a gallery forest) and ZMB 79624 (one tadpole, at Gosner stage 36, North West Province Abo Forest, Cameroon, 24 August 2012). Proportions including total or tail length were only available for the non-genotyped individual and ZMB 79624.

Description. Body oval with nearly rounded snout in dorsal view (Fig. 5B); ovoid to slightly compressed in lateral view (Fig. 5A); tail length-body length ratio 2.27 (TL/BL); body height 0.49 of body length (BH/BL); body width 0.57 of body length (BW/BL); maximum body width slightly behind the level of the spiracle's posterior end; nostrils situated dorsally, closer to snout tip than eyes (SND/SED = 0.39), distance snout-nostrils 0.19 of body length (SND/BL); eyes positioned laterally; eye diameter 0.09 of body length (ED/BL); interocular distance exceeds internostril distance by a factor of

1.94 (IOD/IND); tail length 0.70 of entire length (TL/EL), with moderately pronounced fins with narrow fin tip; dorsal fin originates at dorsal tail-body junction rising barely at the first eighth of the tail length; dorsal fin slightly curved with maximum height at half of the tail length; ventral fin originates on the ventral terminus of the body; ventral fin narrower than tail axis with maximum height around half of the tail length; maximum fin height in dorsal fin higher (DF/VF = 1.25); fin tip pointed; maximum tail height including fins equals body height (TTH/BH = 1.00); tail axis width (in dorsal view) 0.36 of body width (AW/BW); maximum height of tail axis (at base) 0.46 of body height (AH/BH); tail axis height at its base higher than maximum height of dorsal fin (AH/DF = 1.55); dextral vent tube, positioned basicaudally; spiracle sinistral, visible in dorsal view, originating anterior to mid-body (SSD/BL = 0.53); spiracle tube length 0.07 of body length (SL/BL); mouth opens anteroventrally; oral disc width more than a third of body width (ODW/BW = 0.34); one row of papillae (with rounded tips) laterally at anterior lip with huge rostral gap, these connected to papillae in labial angles and posterior lip; second row of papillae at posterior lip, also with rounded tips; labial tooth row formula 1/3+3//3 or 1/4+4//3 (Fig. 5D); jaw sheaths black, of equal width and serrated; upper jaw and lower jaw widely U-shaped.

Coloration in preservation. Dorsolateral part of the body, tail axis and dorsal fin mostly speckled dark brown on brownish ground on the body and yellowish ground on the tail; areas without brown spots shine through as yellow blots; ventral part of the body yellowish with some homogeneously distributed dark brown spots at the anterior third of the body; spiracle and vent tube translucent; ventral fin at the anterior part translucent with some brown spots towards tail tip.

Remarks. Since a record of *Leptopelis modestus* from eastern Congo (Laurent 1972) and subsequent recognition as a distinct sub-species (Laurent 1973), *L. modestus* has been regarded as a species with a disjunct distribution with known occurrences in Nigeria, Cameroon, and Bioko – Equatorial Guinea (Schiøtz 1967, 1999; Amiet 2012; Frétey et al. 2012) and the eastern Democratic Republic of the Congo and Kenya (Köhler et al. 2006; Portillo and Greenbaum 2014b). However, the latter populations have been recently recognized as several distinct species (Schiøtz 1975: *L. fiziensis* from South Kivu Province, DRC; Köhler et al. 2006: *L. mackayi* from the Western Province, Kenya; Portillo and Greenbaum 2014b: *L. mtoewaate* from South Kivu Province, DRC). Although males congregate close to streams and torrents during the

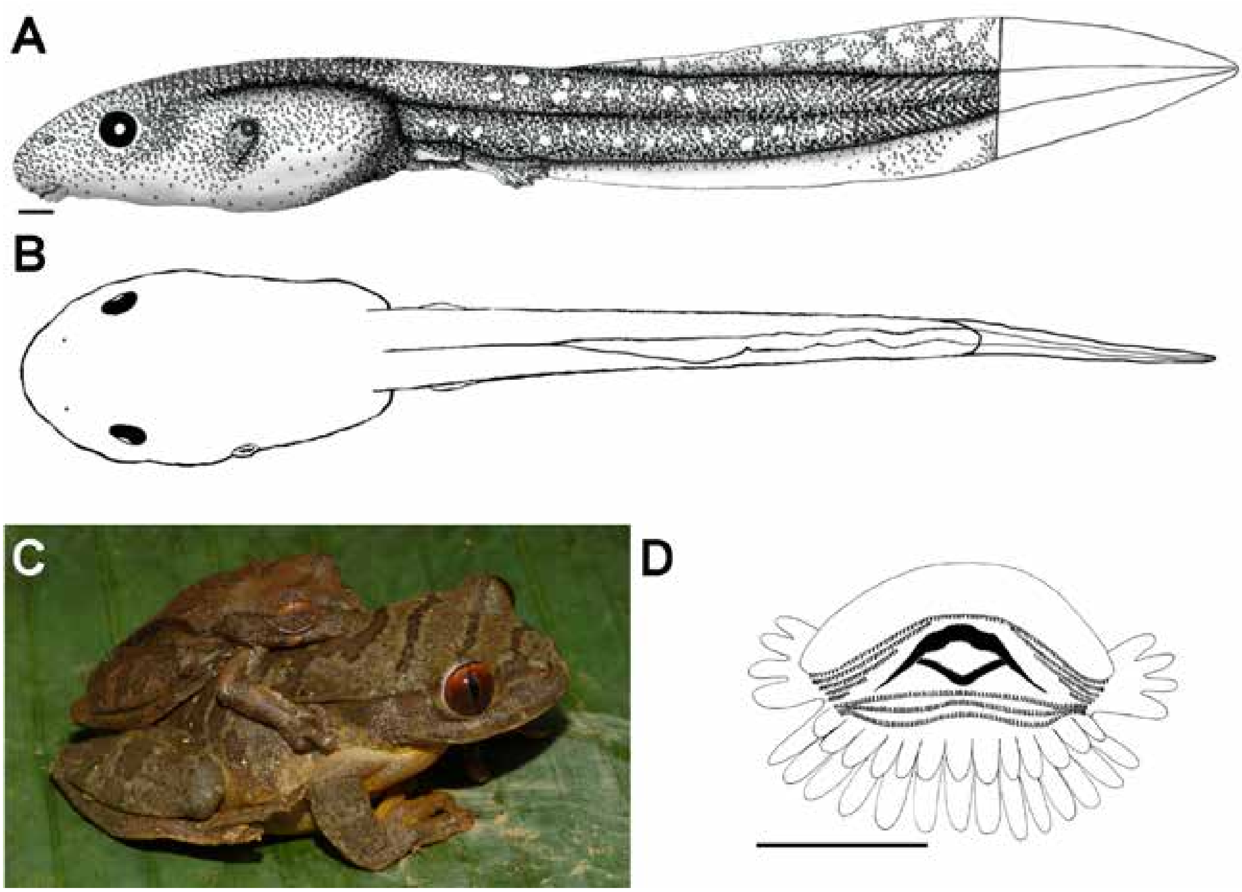

Fig. 6. Lateral (A) and dorsal (B) view of *Leptopelis rufus* (ZMB 79627) at Gosner stage 36; adult *L. rufus* (female: ZMB 78398 and male: ZMB 78399) (E); sketch of the oral disc (D), scale bars: 1 mm.

breeding season, reproduction takes place in slow running and stagnant water bodies (Amiet 2012). Further notes on call activity and the advertisement call are provided by Schiøtz (1999) and Amiet (2006). Based on two vouchers the tadpole has been described by Channing et al. (2012). Our observations are in agreement with their description. Minor differences refer to coloration and the interocular distance-internostril distance ratio and an additional labial tooth row formula (1/4+4//3; Fig. 5D). The IOD/IND was marginally lower (1.94) in comparison to the value of 2 recorded by Channing et al. (2012). Noteworthy, the tail length-body length ratio differed between different Gosner stages (stage 31: TL/BL= 2.1; stage 36: TL/BL= 2.5). Concerning the coloration, the anterior half of the ventral fin lacked speckles in Gosner stages 31 and 34 (Fig. 5A) while it was pigmented in the more developed tadpole (Gosner stage 36).

Taxonomic remark. Amiet (2012) discussed the possibility of cryptic speciation based on a *modestus*-like female from Mwandong, West Cameroon, which differed in coloration of skin and iris, size of tympanum, and snout-vent length from remaining populations and cooccurred with congeneric species (*L. brevirostris*, *L. calcaratus*, and *L. modestus*). The herein investigated tadpoles have been collected on Mt. Manengouba, in close proximity to Mwandong, and in the Abo Forest. The barcoded sequences included a specimen (MCZ A138023; Fig. 5C) collected near Nsoung on Mt. Manengouba. MCZ A138023 exhibits characters that assign the specimen to the "true" *L. modestus*. Although the two genotyped tadpoles originate from high elevation localities on Mt. Manengouba and Mt. Oku (both app. 2,150 m a.s.l.), with a distance of more than 150 km between them, they show no difference in the analysed 16S fragment and point to the occurrence of the same taxon on both mountain ranges.

Leptopelis rufus Reichenow, 1874

The description of *L. rufus* tadpoles is based on eighteen tadpoles (remark: two different molecular lineages have been recognized in *L. rufus* in the course of the present analyses, thus we herein refer to *L. rufus*_1 and *L. rufus*_2 in order to assure differentiation of the examined material): ZMB 79625 (*L. rufus*_1, three tadpoles, at Gosner stages 26 and 29, Camp Bekop, Ebo Forest, Cameroon, 4.3519°N; 10.4244°E, 845 m a.s.l., 07 January 2011, the tadpoles were found in secondary forest), ZMB 79626 (*L. rufus*_2; two tadpoles, at Gosner stages 28 and 29, Mt. Nlonako, Cameroon, 4.8309°N; 9.9255°E, 459 m a.s.l., 23 October 2011, the tadpoles were found in a small rock pool of approximately 50 cm diameter), ZMB 79627 (*L. rufus*_2; one tadpole, at Gosner stage 36, Njuma, Ebo Forest, Cameroon, 4.3394°N; 10.2458°E, 320 m a.s.l., 20 August 2011, the tadpole was found in primary rainforest), ZMB 79628 (*L. rufus*_2; one tadpole, at Gosner stage 29, Ndogbanguengue, Ebo Forest, Cameroon, 4.4069°N; 10.1653°E, 96 m a.s.l., 19 September 2010, the tadpole was found in farmbush) and ZMB 79629 (*L. rufus*_2; seven tadpoles, at Gosner stages 28 to 36, Ekom Khan, Mt. Manengouba, Cameroon, 5.0633°N; 10.0163°E, 587 m a.s.l., 29 December 2010, the tadpoles were found in a medium sized river in a forest fragment). Proportions including total or tail length were only available for non-genotyped individuals.

Description. Body oval with nearly rounded snout in dorsal view (Fig. 6B); ovoid to slightly compressed in lateral view (Fig. 6A); tail length-body length ratio 2.04 (TL/BL); body height 0.37 of body length (BH/BL); body width 0.53 of body length (BW/BL); maximum body width between the level of the eyes and the spiracle's anterior end; nostrils situated dorsally, closer to snout tip than eyes (SND/SED = 0.40), distance snout-nostrils 0.20 of body length (SND/BL); eyes positioned laterally; eye diameter 0.10 of body length (ED/BL); interocular distance exceeds internostril distance by a factor of 1.78 (IOD/IND); tail length 0.67 of entire length (TL/EL), with moderately pronounced fins with narrow fin tip; dorsal fin originates at dorsal tail-body junction, but very low, not visible in lateral view; rising behind anterior sixth of tail length; dorsal fin moderately curved with maximum height at three-quarters of the tail length; ventral fin originates on the ventral terminus of the body; ventral fin narrower than tail axis with maximum height at three-quarters of the tail length; maximum fin height higher in dorsal fin (DF/VF = 1.18); fin tip pointed; maximum tail height including fins nearly equals body height (TTH/BH= 0.98); tail axis width (in dorsal view) 0.36 of body width (AW/BW); maximum height of tail axis (at base) 0.65 of body height (AH/BH); tail axis height at its base higher than maximum height of dorsal fin (AH/DF = 1.75); dextral vent tube, positioned basicaudally; spiracle sinistral, visible in dorsal view, originating at mid-body (SSD/BL = 0.50); spiracle tube length 0.13 of body length (SL/BL); mouth opens anteroventrally; oral disc width more than a third of body width (ODW/BW = 0.36); one row of papillae (with rounded tips) laterally at anterior lip with huge rostral gap, these connected to papillae in labial angles and posterior lip; second row of longer papillae caudal at posterior lip, also with rounded tips; labial tooth row formula 1/3+3//3 or 1/4+4//3 (Fig. 6D); jaw sheaths black and serrated, upper jaw sheath thicker; upper jaw widely U-shaped with median concavity; lower jaw widely V-shaped.

Coloration in preservation. Dorsolateral part of the body, tail axis and dorsal fin mostly speckled dark brown on brownish ground at the body and yellowish ground at the tail; areas without brown spots shine through as small yellow blots; ventral part of the body yellowish with many homogeneously distributed dark brown spots at the anterior third of the body and fewer spots at the

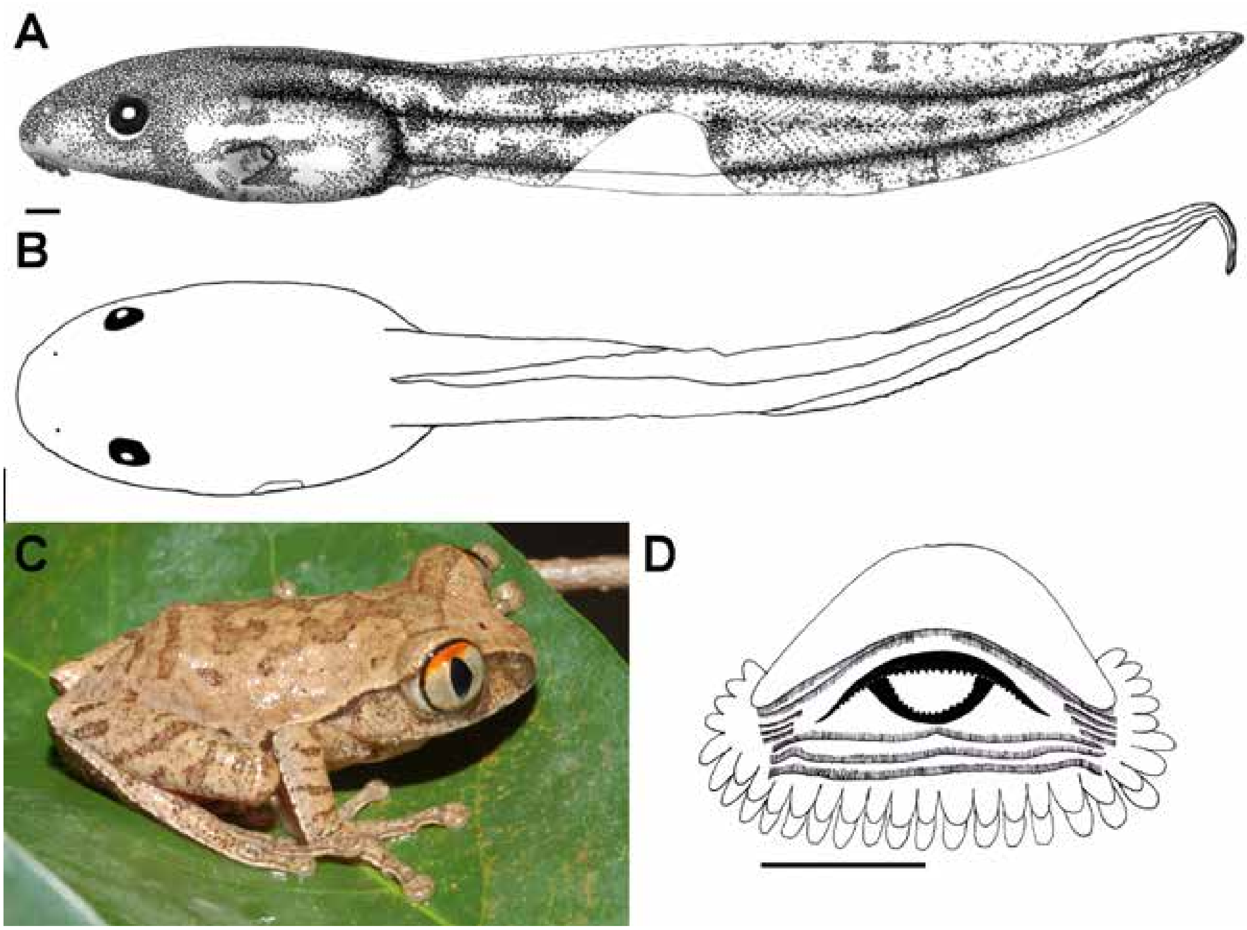

Fig. 7. Lateral (A) and dorsal (B) view of *Leptopelis spiritusnoctis* (ZMB 79634) at Gosner stage 34; adult *L. spiritusnoctis* (ZMB 79578) (C); sketch of the oral disc (D), scale bars: 1 mm.

posterior two-thirds of the body; spiracle and vent tube translucent; ventral fin at the anterior part translucent with some brown spots towards tail tip.

Remarks. *Leptopelis rufus* is known from Nigeria to northern Angola (de la Riva 1994; Schiøtz 1963, 1999; Amiet 2012). Adults are common on branches and lianas in proximity to streams during the breeding season (Amiet 1975). The call has been reported by Amiet and Schiøtz (1974). The tadpole of has been described by Channing et al. (2012) based on a single tadpole belonging to a larger series examined herein (MH399 = ZMB 79629; herein assigned to *L. rufus*_2). Generally our observations of the larger series coincide with the former description. However, while early tadpole stages of *L. rufus* exhibit the labial tooth row formula 1/3+3//3, also reported in Channing et al. (2012), we observed an increase of tooth rows on the upper lip in more developed tadpoles (Gosner stage 29: 1/4+4//3; Fig. 6D). Further differences refer to a lower tail length-body length ratio (TL/BL= 2.0) than in Channing et al. (2012; TL/BL = 2.6).

Taxonomic remark. A comparison of 16S sequences of adults and tadpoles revealed two molecular lineages in *L. rufus*, diverging by app. 1.5% in the mitochondrial 16S gene (Tab. 2). Each lineage could be assigned to adult specimens that have morphologically been assigned to *L. rufus*. While no obvious differences have been assessed, neither in tadpoles nor adults, we herein refer to *L. rufus*_1 and *L. rufus*_2 in order to highlight this molecular divergence beyond intraspecific variance in remaining species analysed herein. A similar genetic divergence (0.9–1.1% in 16S) has recently been uncovered between two species in the eastern Democratic Republic of the Congo (Portillo and Greenbaum 2014a) warranting further morphological and bio-acoustical analyses to examine the status of lineages of *L. rufus* in western Central Africa.

Leptopelis spiritusnoctis Rödel, 2007

The description of *L. spiritusnoctis* tadpoles is based on twenty tadpoles: ZMB 79630 (five tadpoles, at Gosner stages 25 to 40, 7.2347°N; 9.3096°E, 398 m a.s.l.), ZMB 79631 (one tadpole, at Gosner stage 40, 7.2347°N; 9.3096°E, 398 m a.s.l.), ZMB 79632 (one tadpole, at Gosner stage 31, 7.2316°N; 9.3118°E, 382 m a.s.l.), ZMB 79633 (eight tadpoles, at Gosner stages 25 to 36, 7.2308°N; 9.3023°E, 387 m a.s.l.), ZMB 79634 (one tadpole, at Gosner stage 36, 7.2308°N; 9.3023°E, 387 m a.s.l.), ZMB 79635 (three tadpoles, at Gosner stages 25 and 27, 7.2376°N; 9.3117°E, 417 m a.s.l.), and ZMB 79636 (one tadpole, at Gosner stage 25, 7.2376°N; 9.3117°E, 417 m a.s.l.). All *L. spiritusnoctis* tadpoles were caught near Gbanju, Liberia, 08 June 2011. Proportions including total or tail length were only available for non-genotyped individuals, ZMB 79630, 79632, 79634, and 79636.

Description. Body oval with subovoid snout in dorsal view (Fig. 7B); ovoid to slightly compressed in lateral view (Fig. 7A); tail length-body length ratio 2.33 (TL/BL); body height 0.49 of body length (BH/BL); body width 0.60 of body length (BW/BL); maximum body width on the level of the spiracle's anterior end; nostrils situated dorsally, closer to snout tip than eyes (SND/SED = 0.37), distance snout-nostrils 0.21 of body length (SND/BL); eyes positioned laterally; eye diameter 0.09 of body length (ED/BL); interocular distance exceeds internostril distance by a factor of 1.76 (IOD/IND); tail length 0.70 of entire length (TL/EL), with moderately pronounced fins with narrow fin tip; dorsal fin originates at dorsal tail-body junction; dorsal fin moderately curved with maximum height at three-quarters of the tail length; ventral fin originates on the ventral terminus of the body; ventral fin narrower than tail axis with maximum height at three-quarters of the tail length; maximum fin height in dorsal fin higher (DF/VF = 1.28); fin tip pointed; maximum tail height including fins slightly exceeds body height (TTH/BH = 1.08); tail axis width (in dorsal view) 0.41 of body width (AW/BW); maximum height of tail axis (at base) 0.56 of body height (AH/BH); tail axis height at its base higher than maximum height of dorsal fin (AH/DF = 1.93); dextral vent tube, positioned basicaudally; spiracle sinistral, visible in dorsal view, originating at mid-body (SSD/BL = 0.50); spiracle tube length 0.12 of body length (SL/BL); mouth opens anteroventrally; oral disc width more than a quarter of body width (ODW/BW = 0.30); one row of papillae (with rounded tips) laterally at anterior lip with huge rostral gap, these connected to papillae in labial angles and posterior lip; second row of papillae (also with rounded tips) at posterior lip; labial tooth row formula 1/4+4//3 (Fig. 7D); jaw sheaths black, of equal width and serrated; upper jaw widely U-shaped; lower jaw U-shaped.

Coloration in preservation. Dorsolateral part of the body mostly speckled dark brown on yellowish ground, tail axis, dorsal fin and spiracle speckled with less brown spots on yellowish ground; ventral part of the body yellow with some homogeneously distributed brown spots

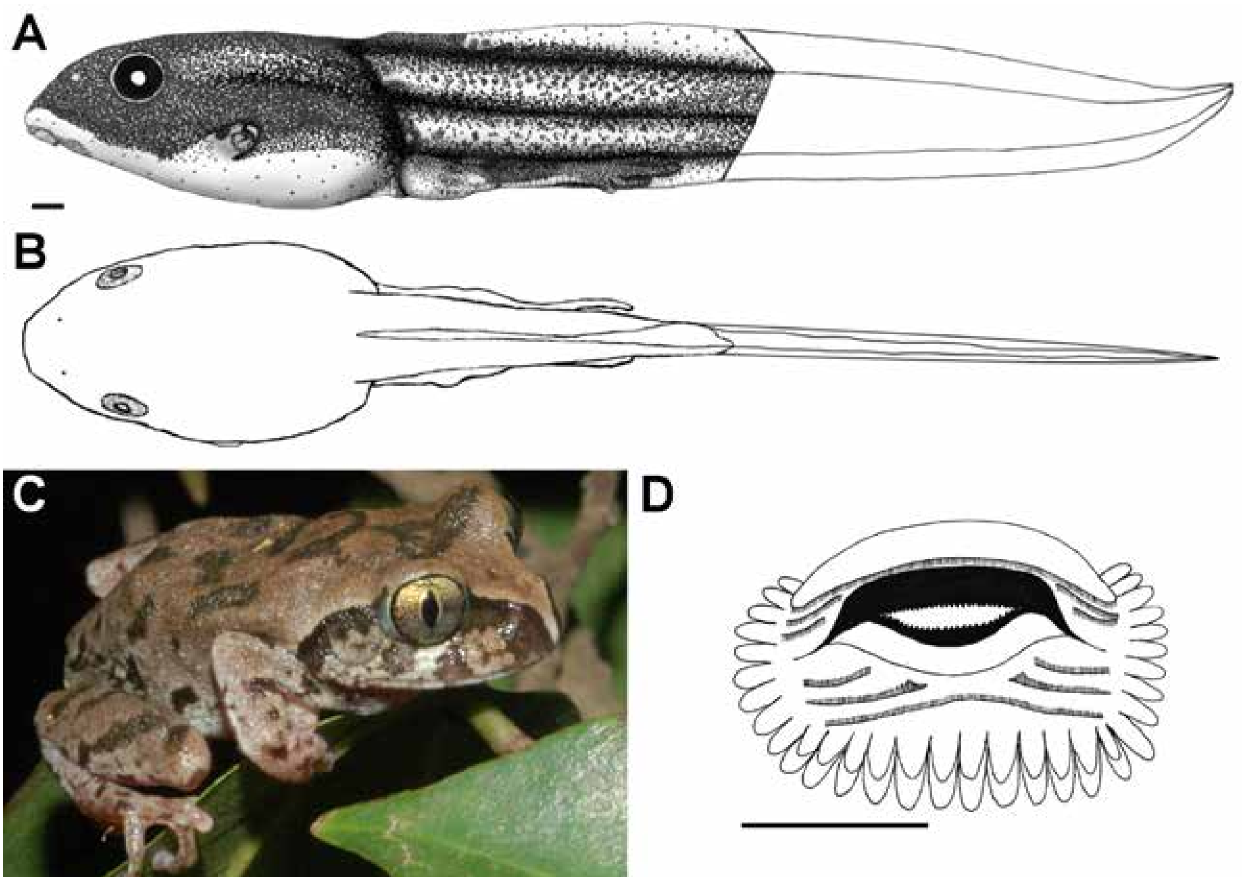

Fig. 8. Lateral (A) and dorsal (B) view of *Leptopelis viridis* (ZMB 79638) at Gosner stage 40; adult *L. viridis* (ZMB 83028) (C); sketch of the oral disc (ZMB 79637) at Gosner stage 30 (D), scale bars: 1 mm.

at the anterior third of the body; vent tube translucent; ventral fin translucent at anterior part with some brown spots towards tail tip.

Remarks. *Leptopelis spiritusnoctis* is known from the entire West African forest belt ranging from Guinea, through Sierra Leone, Liberia, Côte d'Ivoire, Ghana, Togo, Benin to western Nigeria (e.g., Schiøtz 1963, 1967; Rödel et al. 2000, 2004; Hillers and Rödel 2007; Rödel 2007; Segniagbeto et al. 2007). Male calling sites have been reported from close to various water bodies, from fast flowing creeks with rocky bed to tiniest puddles on the forest floor (Rödel 2007). Females deposit up to 140 eggs below the soil surface (Schiøtz 1963; Rödel 2007). After three weeks tadpoles hatch and wriggle up to 50 cm towards the water (Schiøtz 1963; Oldham 1971). The tadpole was described by Lamotte and Perret (1961), Schiøtz (1963, 1967), Rödel (2007), and Channing et al. (2012). Prior to the description of *L. spiritusnoctis* by Rödel (2007) records of the species, including tadpole descriptions, have been named *L. hyloides*. Generally the observations of our larger series agree with former descriptions. However, an additional labial tooth row formula has been encountered 1/4+4//3 (Fig. 7D). Lamotte and Perret (1961) reported a change of the number of tooth rows during tadpole growth. The observed tail length-body length ratio was marginally higher (TL/BL= 2.3) than in the previous descriptions of Channing et al. (2012: TL/BL= 2.2) and Lamotte and Perret (1961: TL/BL= 2). The position of nostrils was closer to the snout tip than to the eyes while they are closer to the eye according to Channing et al. (2012).

Taxonomic remark. Amiet (2012) assumed the West African *L. spiritusnoctis* and the Central African *L. aubryi* to be conspecific. However, based on genetics and bioacoustics Rödel et al. (2014) recently confirmed their specific distinctness. This is herein further supported by tadpole morphology, as tadpoles of the two species differed in their size (tadpoles of *L. aubryi* growing larger 53 mm; Schiøtz 1963), tail length-body length ratio (higher in in *L. aubryi*; TL/BL = 3.4x) and labial tooth row formulae 1/3+3//3 in *L. aubryi*; diverse in *L. spiritusnoctis*; see above).

Leptopelis viridis (Günther, 1869)

The description of *L. viridis* tadpoles is based on two tadpoles: ZMB 79637 (one tadpole, at Gosner stage 30) and ZMB 79638 at (one tadpole, at Gosner stage 40). Both tadpoles were caught near Banambala, Guinea, 7.9899°N; 9.1312°E, 449 m a.s.l., 01 June 2011. Proportions including total or tail length for this species were not available, because there were only two individuals to examine, both with incomplete tail as tail tips were used for DNA analysis.

Description. Body oval with subelliptical snout in dorsal view (Fig. 8B); ovoid to slightly compressed in lateral view (Fig. 8A); body height 0.50 of body length (BH/BL); body width 0.58 of body length (BW/BL); maximum body width on the level of the spiracle's posterior end; nostrils situated dorsally, closer to snout tip than eyes (SND/SED = 0.35), distance snout-nostrils 0.20 of body length (SND/BL); eyes positioned laterally; eye diameter 0.12 of body length (ED/BL); interocular distance exceeds internostril distance by a factor of 1.92 (IOD/IND); tail with moderately pronounced fins; dorsal fin originates at dorsal tail-body junction; dorsal fin nearly parallel; ventral fin originates on the ventral terminus of the body; ventral fin narrower than tail axis and parallel to it; maximum fin height in dorsal fin higher (DF/VF = 1.60); maximum tail height including fins equals body height (TTH/BH= 1.00) at the level, where the tail was cut; tail axis width (in dorsal view) 0.49 of body width (AW/BW); maximum height of tail axis (at base) 0.61 of body height (AH/BH); tail axis height at its base higher than maximum height of dorsal fin (AH/DF = 2.19); dextral vent tube, positioned basicaudally; spiracle sinistral, visible in dorsal view, originating at mid-body (SSD/BL = 0.53); spiracle tube length 0.10 of body length (SL/BL); mouth opens anteroventrally; oral disc width about a quarter of body width (ODW/BW = 0.24); one row of papillae (with rounded tips) laterally at anterior lip with huge rostral gap, these connected to papillae in labial angles and posterior lip; second row of papillae (also with rounded tips) at posterior lip; labial tooth row formula 1/2+2//1+1/2 or 1/2+2//2+2/1 (Fig. 8D); jaw sheaths black and serrated, upper jaw sheath broader than lower jaw sheath; upper jaw widely U-shaped; lower jaw widely U-shaped as well.

Coloration in preservation. Dorsolateral part of the body mostly speckled dark brown on brownish ground; tail axis with less brown spots on yellow ground; ventral part of the body yellowish with some brown spots at the anterior third of the body; spiracle and vent tube translucent; ventral fin predominantly translucent with few brown spots composed of dense melanophores, dorsal fin brownish with some dark brown spots particularly at the anterior part of the tail.

Remarks. *Leptopelis viridis* covers a wide geographic range from Senegal to Nigeria and the north-eastern Democratic Republic of the Congo (e.g., Perret 1966; Schiøtz 1963, 1967, 1999; Rödel 2000; Amiet 2012). Females produce up to 220 eggs of 3.1–4.7 mm that are rich in yolk and of yellowish-white color (Barbault 1984; Rödel 2000). Rödel (2000) assumed egg deposition in rock-pools or transport of tadpoles by adults as the elevated surrounding was rocky and did not make digging of burrows possible. The tadpole of *Leptopelis viridis* has already been described in the past (Lamotte and Perret

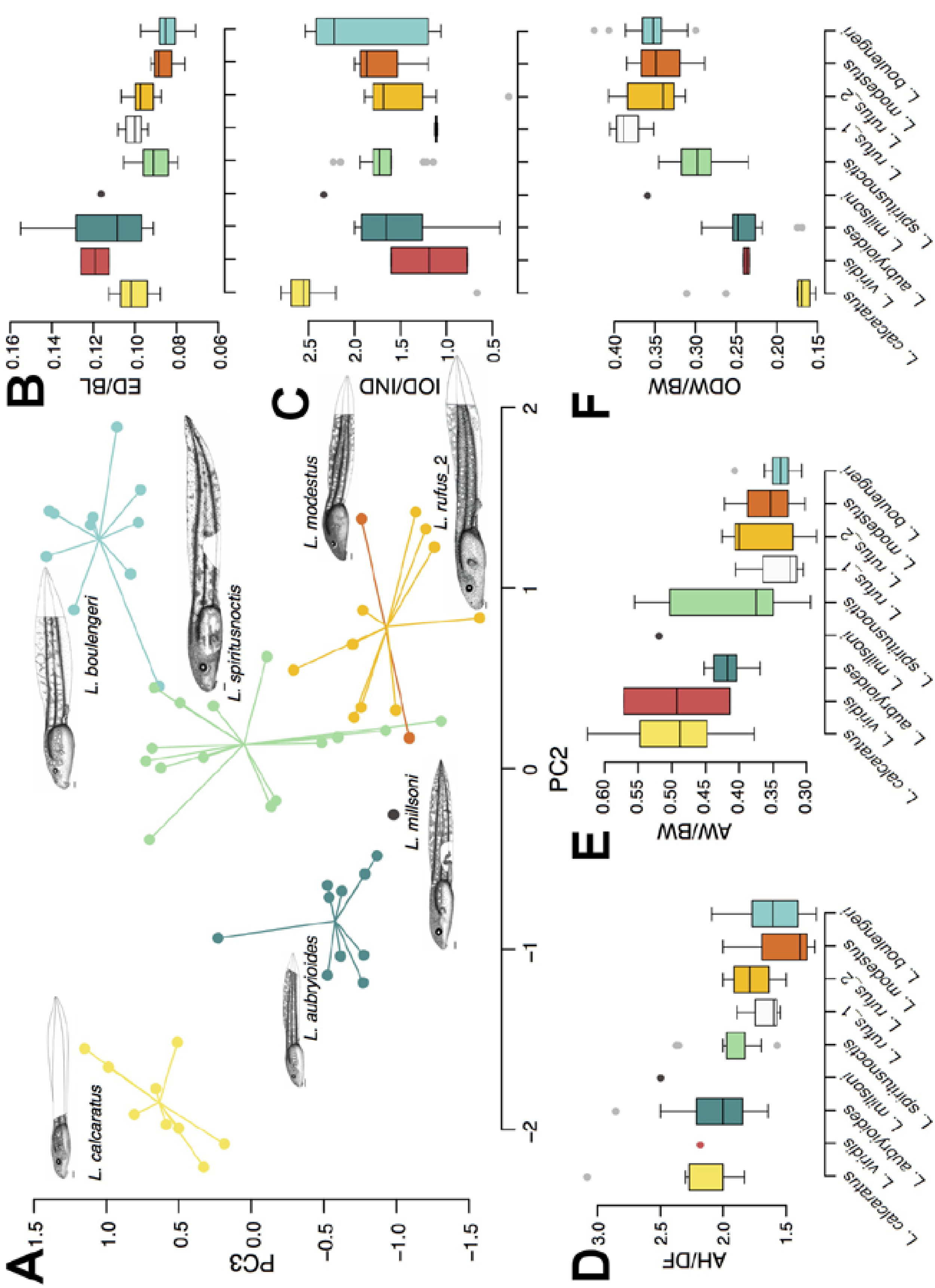

Fig. 9. Biplot of the second and third components of a Principal Component Analyses of morphological measures of *Leptopelis* tadpoles (A). Illustrations are of genotyped representatives (not necessarily included in the PCA) roughly to scale. Boxplots show morphometric ratios of variables contributing most to these components (B–F).

1961; Schiøtz 1963, 1967; Rödel 2000; Channing et al. 2012). Both of our tadpole vouchers had a cut tail, thus we can only refer to formerly reported tail length-body length ratios (Lamotte and Perret 1961: TL/BL = 2.1; Rödel 2000: TL/BL = 2.5; Channing et al. (2012): TL/BL = 2). In comparison to other *Leptopelis* species, the tooth rows are very variable. Rödel (2000) mentioned the labial tooth row formula of 1//2 for a tadpole two days after hatching and various formulae are known in more developed tadpoles: 1/2+2//3 (Lamotte and Perret 1961; Rödel 2000; Channing et al. 2012), 1/2+2//1+1/2 (Lamotte and Perret 1961; Channing et al. 2012; this study, in Gosner stage 40 in ZMB 79638), 1/3+3//3 and 1/3+3//1+1/2 (both Lamotte and Perret 1961) and 1/2+2//2+2/1 (this study, in Gosner stage 30 in ZMB 79637; Fig. 8D). A dark pigmentation of dorsal parts of the body has already been reported in the past and is more conspicuous than in other known *Leptopelis* tadpoles. While the spiracle was translucent in ZMB 79637, a condition also reported by Lamotte and Perret (1961) and Channing et al. (2012), it contained some chromatophores in ZMB 79638 (Fig. 8A). Lamotte and Perret (1961) reported the presence of pigmentation on the fins, ventral body parts and absence of chromatophores at the intestinal region, which could be confirmed herein. Likewise the presence of low and nearly parallel fins of similar height (Channing et al. 2012) and large eyes (Lamotte and Perret 1961) is in agreement with our observations (ED/BL = 0.12).

Comparative Morphometrics and Habitat

Morphometric patterns in *Leptopelis* tadpoles were compared to investigate whether species occupy different areas of morpho-space. This was achieved by subjecting $\log_{10}$-transformed body measurements to a rigid rotation (Principal Component Anlaysis; PCA) and by comparing morphometric ratios based on measurements that are contributing most to PC1 and PC2. The first component of the PCA was largely dominated by overall size differences (likely also influenced by differences in Gosner stages), but the second and third components could clearly separate species into distinct morphological clusters (Fig. 9A). PC2 is loaded negatively by AW, ED, and IOD, and positively by ODW, VF, and DF. This means that species clusters with negative PC2 values (*L. calcaratus*, *L. aubryioides*) have wider, more muscular tails, bigger eyes and wider interocular distances, compared to clusters with positive PC2 values (*L. boulengeri*, *L. rufus*, and *L. modestus*), which have wider oral discs and deeper tail fins. *Leptopelis millsoni* and *L. spiritusnoctis* are intermediate for these traits (PC2 values close to 0). *Leptopelis rufus*, *L. modestus*, and *L. boulengeri* show strongly overlapping values for these traits, but *L. boulengeri* is distinct from the other two, by having a narrower internarial distance (similar to *L. calcaratus*), the main loading of PC3. The relevant ratios (AH/DF, AW/BW, OWD/BW, IOD/IND, ED/BL; Fig. 9B–F) reiterate these patterns and in addition, show that *L. rufus*_1 tadpoles have similar body proportions to *L. rufus*_2 and that *L. viridis* is most similar to *L. aubryioides* in morphology, with possibly a wider tail muscle, more similar to *L. calcaratus*.

It should be noted however, that tadpole morphology, especially tail shape, can be plastic in response to extrinsic conditions (Duellman and Trueb 1994; Laurila and Kujasalo 1999; Relyea 2001; Kraft et al. 2006; Wells 2007) and due to limited sampling, morphological variation due to differences in Gosner stage could not be investigated. Nonetheless, the eight tadpoles included in the analyses occur in differing microhabitats that can roughly be grouped into temporary ponds, marshes or slow running to stationary parts of streams (*L. viridis*, *L. spiritusnoctis*, *L. modestus*, and *L. aubryioides*), versus faster flowing running streams (*L. calcaratus*, *L. millsoni*, *L. rufus*, and *L. boulengeri*). Differences in features, such as the hydrodynamics of the tail shape, may thus be experiencing diverging selective pressures across these differing habitats (Altig and McDiarmid 1999b). Greater sampling and more empirical data on microhabitat of these tadpoles is needed however, to thoroughly test whether such morphological differences are indeed correlated to environmental parameters or a result of phenotypic plasticity or development.

Concluding Summary of Morphological Characters

On a continental scale, and taking into account the latest taxonomic decisions (Gvoždík et al. 2014; Portillo and Greenbaum 2014a), tadpoles of only 25 of the 53 recognized *Leptopelis* species have been described. This is astonishing as most species are abundant during the breeding season.

Generally, tadpoles in the genus *Leptopelis* are morphologically conservative and can be unambiguously assigned to that genus directly in the field. They possess either the labial tooth row formula 1/3+3//3 or 1/2+2//3. Only *L. gramineus* has strongly divergent formulae (LTRF: 1/4+4//4, 1/4+4//1+1/2), and the first anterior tooth row may sometimes be interrupted (Channing et al. 2012). Future studies on these tadpoles should consider a potential ontogenetic change as increase of tooth rows has been reported in *L. aubryioides* (this study), *L. calcaratus* (Lamotte and Perret 1961), and *L. viridis* (Rödel 2000).

West and western Central African regions experienced an increase in herpetological surveys and subsequent taxonomic works in the last decades. But despite this positive development and the present descriptions of eight *Leptopelis* tadpoles, detailed accounts of the larval morphology for ten western African congeners are still missing: West Africa: *Leptopelis bufonides*, *L. macrotis*, *L. occidentalis*; western Central Africa: *Leptopelis bocagii*, *L. brevirostris*, *L. bufonides*, *L. christyi*, *L. crystallinoron*, *L. palmatus*, and *L. zebra*.

Among the eight herein described tadpoles, a superficial similarity is conspicuous. However, preliminary analyses not only reveal their morphological distinctness but tentatively indicate morphological adaptations to the respective habitat (lentic or lotic). Two species were underrepresented (*L. millsoni*, *L. modestus*) or even missing completely (*L. viridis*) in the analysis.

Acknowledgments.—We thank all respective authorities from Cameroon, Guinea, and Liberia for research, access, collection, and export permits as well as our many guides and field assistants for their courageous help. Thomas M. Doherty-Bone (Leeds) kindly provided comparative material from Abo Forest, Mt. Oku. Fieldwork of MH was supported by scholarships from the Federal State of Berlin (Elsa-Neumann-Stipendium) and the German Academic Exchange Service (DAAD). MD's field work was supported by the German Herpetological Society (DGHT, Wilhelm-Peters-Fonds). Simon Loader supported, and secured funding for, the field- and lab-work of HCL (Swiss National Science Foundation: 31003A-133067). Barcoding of tadpoles was financially supported by the Förderverein des Museums für Naturkunde, Berlin and the Swiss National Science Foundation.

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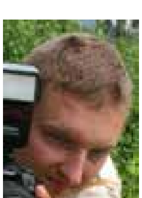
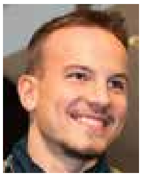
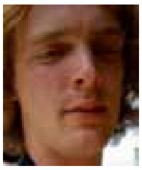


Michael F. Barej is interested in the diversity of African amphibians and reptiles, their biology, biogeographic patterns, as well as resulting puzzles in taxonomy and systematics. He received his Ph.D. from the Humboldt University Berlin (Germany) for unravelling patterns and systematics of African torrent frogs.

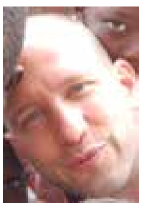


Tilo Pfalzgraff graduated with a B.S. in Biology from the Freie Universität Berlin, Germany. He worked for the Museum für Naturkunde Berlin studying Central African tadpoles, and is currently a M.S. student of aquaculture and sea ranching in the Faculty of Agricultural and Environmental Sciences at the University of Rostock, Germany. He conducts surveys for alternative fish nutrition and is interested in ichthyology, herpetology, biodiversity, and sustainable development.

Mareike Hirschfeld studied Biological Sciences at the Universities of Marburg and Würzburg, Germany and received her Diplom (M.Sc. equivalent) in 2009. Currently she is a scientist and Ph.D. candidate at the Museum für Naturkunde in Berlin. She is interested in amphibian ecology and the taxonomy of West and Central African anurans.



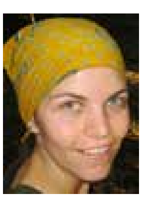
H. Christoph Liedtke is a zoologist currently based at the Estación Biológica de Doñana (Seville, Spain). His main interests are comparative phylogenetics and life history evolution and his Ph.D. thesis, undertaken at the University of Basel (Switzerland), was centered on understanding the life history and species diversity of African amphibians, particularly the evolution of terrestrial modes of reproduction in anurans.



Johannes Penner received his Diploma from the University of Würzburg and Ph.D. from the Humboldt University Berlin (both in Germany). Engaged in various herpetological projects for the last 14 years, he is currently located at the Museum für Naturkunde Berlin (Germany) and focuses on African amphibians and reptiles with a geographic emphasis on West Africa. In addition he works for a large European Biodiversity project (EU BON) and as a freelance consultant in West Africa. He is also engaged in various IUCN specialist groups, mainly the IUCN Viper Specialist Group.

Nono L. Gonwouo, as a conservation biologist, is interested in the responses of biodiversity to environmental change. His research to date has focused on the effects of anthropogenic activities on the herpetofauna of Cameroon, with particular interest in the distributions and dynamics of endemic species near their geographic range margins. His interest as well involves systematics and taxonomy of reptiles and amphibians, community ecology, ethology, biology of vertebrates, and environmental impact assessment studies.

Matthias Dahmen studied Applied Biogeography at Trier University. He undertook research on degradation tolerances of Central African rainforest anurans and their life-cycle strategies. Thereby he focused on species of lower altitude range and conducted his fieldwork in the Ebo Forest in Cameroon. Meanwhile, he is working as a landscape planner and thereby, specialized on the detection, legal consideration, and conservation of amphibians and reptiles.



Franziska Grözinger studied biology at the Universities of Heidelberg and Würzburg, Germany. She completed her Ph.D. thesis at the Museum für Naturkunde in 2014, where she focused on the phenotypic plasticity of the European Common Frog (*Rana temporaria*). She is an experienced field biologist, interested in the interaction between organisms and their environment.

Andreas Schmitz received both his Diploma and his Ph.D. at the University of Bonn in Germany. He has worked in herpetology for over 20 years, first at the Zoological Research Museum in Bonn (ZFMK), Germany and since 2003 he is the leading Research Officer of Herpetology at the Natural History Museum of Geneva (MHNG), Geneva, Switzerland. He works on the systematics, taxonomy, phylogenetics, and conservation of a multitude of amphibian and reptile groups mostly in Africa and Southeast Asia.

Mark-Oliver Rödel is the Curator of Herpetology and head of the department of "Diversity Dynamics" at the Museum für Naturkunde, Berlin. Since his teens he has studied amphibians and reptiles, mostly those from Europe and Africa. With his team he investigates the taxonomy, systematics, ecology, and biogeography of amphibians and reptiles, but in particular uses amphibians as model organisms in order to understand the effect of environmental change on species and ecosystems.

Figure Appendix 1.

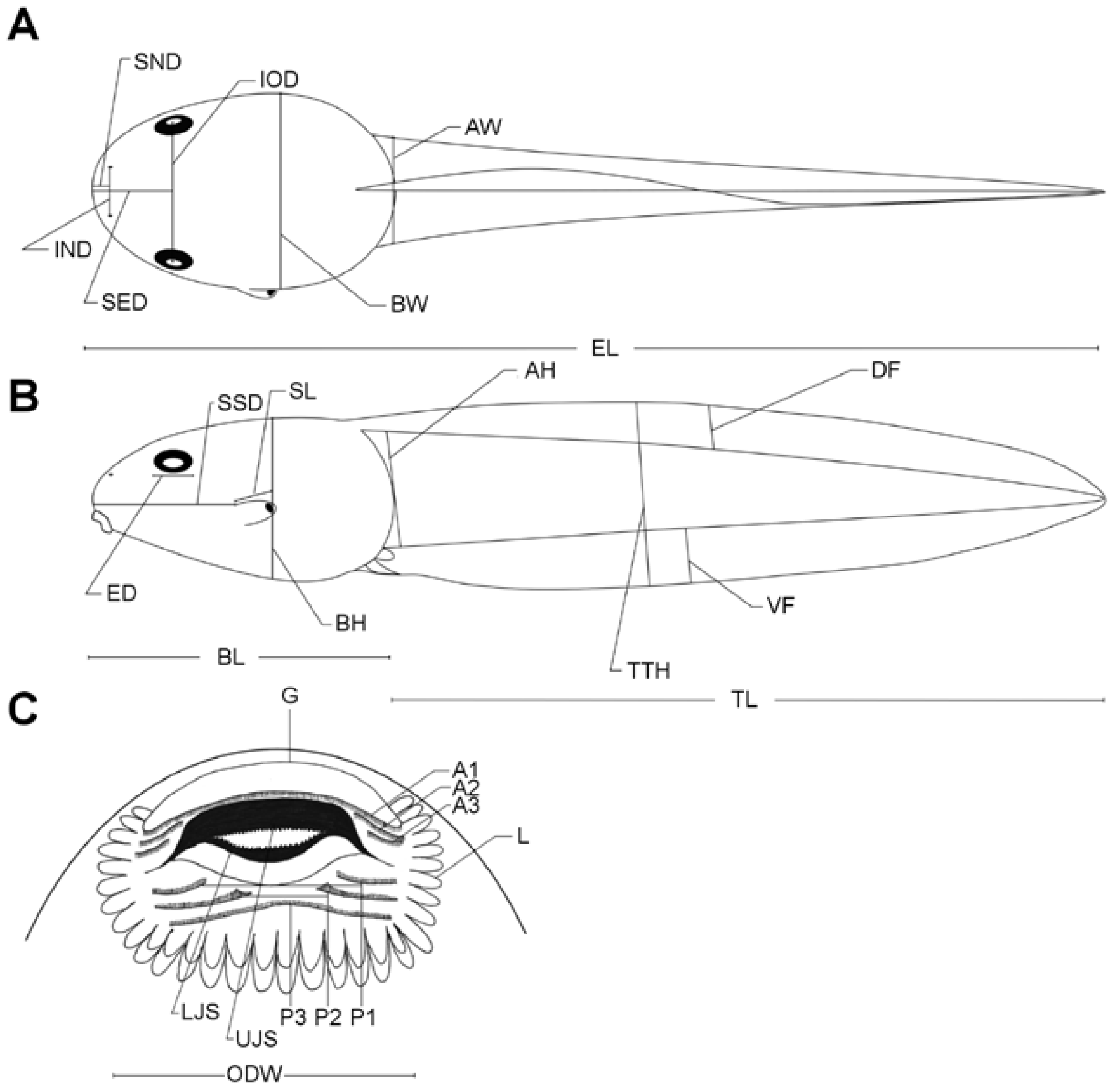


Fig. A1. Schematic tadpole in dorsal (A), lateral (B) view and sketch of the mouth part in ventral view (C) showing assessed distances and mouth parts. Abbreviations: G – dorsal gap; A1–A3 – anterior papillae; L – lateral papillae; P1–P3 – posterior papillae; LJS – lower jaw sheath; UJS – upper jaw sheath; for abbreviations of measurements see material and methods.

Table Appendix 1.

Table A1. Collection numbers (Museum für Naturkunde, Berlin, ZMB; Zoologisches Forschungsmuseum Alexander Koenig, Bonn, ZFMK), localities of *Leptopelis* tadpoles studied herein, and GenBank data analysed in our 16S DNA-barcoding analysis; *n* = number of tadpoles (a single one genotyped, see Appendix Tables A2 and A3).

Species	Collection number	Stage	*n*	Country	Region	Site	Latitude	Longi-tude	Elevation [m a.s.l.]	GenBank number	Reference
aubryioides	ZFMK 81604	adult	—	Cameroon	foot of Mt. Nlonako	near Ekomtolo	4.8397°N	9.9303°E	470	KT967076	this study
aubryioides	ZMB 79604	tadpole	2	Cameroon	Etome	near Etome	4.8317°N	9.9253°E	476	KT967077	this study
aubryioides	ZMB 79605	tadpole	1	Cameroon	foot of Mt. Nlonako	near Ekomtolo	4.8329°N	9.9259°E	477	KT967078	this study
aubryioides	ZMB 79606	tadpole	9	Cameroon	foot of Mt Nlonako	near Ekomtolo	4.8329°N	9.9259°E	477	—	—
aubryioides	ZMB 79607	tadpole	3	Cameroon	Ebo Forest	Njuma	4.3483°N	10.2329°E	238	KT967079	this study
aubryioides	ZMB 79608	tadpole	1	Cameroon	Ebo Forest	Njuma	4.3483°N	10.2329°E	238	KT967080	this study
aubryioides	ZMB 79609	tadpole	1	Cameroon	Ebo Forest	Njuma	4.3394°N	10.2458°E	320	KT967081	this study
aubryioides	ZMB 79610	tadpole	1	Cameroon	Ebo Forest	Njuma	4.3483°N	10.2329°E	238	KT967082	this study
aubryioides	ZMB 79611	tadpole	1	Cameroon	Ebo Forest	Njuma	4.3483°N	10.2329°E	238	KT967083	this study
aubryioides	ZMB 79612	tadpole	1	Cameroon	Ebo Forest	Camp Njuma	4.3480°N	10.2323°E	315	KT967084	this study
boulengeri	ZFMK 87860	adult	—	Cameroon	—	Amebishu	6.1239°N	9.6875°E	165	KT967085	this study
boulengeri	ZMB 79613	tadpole	1	Cameroon	Ebo Forest	Bekob	4.3578°N	10.4170°E	921	KT967086	this study
boulengeri	ZMB 79614	tadpole	4	Cameroon	Ebo Forest	Bekob	4.3578°N	10.4170°E	921	KT967087	this study
boulengeri	ZMB 79615	tadpole	3	Cameroon	Ebo Forest	Bekob	4.3575°N	10.4168°E	903	KT967088	this study
boulengeri	ZMB 79616	tadpole	1	Cameroon	Ebo Forest	Bekob	4.3578°N	10.4170°E	921	KT967089	this study
boulengeri	ZMB 79617	tadpole	7	Cameroon	Ebo Forest	Bekob	4.3578°N	10.4170°E	921	—	—
calcaratus	ZFMK 75509	adult	—	Cameroon	Mt Nlonako	Nguéngué	4.9172°N	9.9892°E	1140	KT967090	this study
calcaratus	ZMB 79618	tadpole	1	Cameroon	Mt Nlonako	—	4.9250°N	9.9817°E	1035	KT967091	this study
calcaratus	ZMB 79619	tadpole	9	Cameroon	Mt Nlonako	—	4.9250°N	9.9817°E	1035	—	—
calcaratus	ZMB 79620	tadpole	1	Cameroon	Mt Manen-gouba	Manen-gouba village	4.9502°N	9.8639°E	1116	KT967092	this study
millsoni	ZFMK 87708	adult	—	Cameroon	—	near Nkoelon	2.3972°N	10.0352°E	75	KF888342	Rödel et al. (2014)
millsoni	ZMB 79621	tadpole	1	Cameroon	Kribi	near Miangasio Lendi	2.8930°N	9.9542°E	31	KT967093	this study
modestus	MCZ A138023	adult	—	Cameroon	Mt. Manen-gouba	Nsoung	4.9814°N	9.8133°E	1346	JQ715683	Blackburn (2008b)
modestus	ZMB 79622	tadpole	1	Cameroon	Mt Manen-gouba	near summit	5.0098°N	9.8568°E	2135	KT967094	this study
modestus	ZMB 79623	tadpole	1	Cameroon	Mt Manen-gouba	near summit	5.0098°N	9.8568°E	2135	—	—
modestus	ZMB 79624	tadpole	1	Cameroon	North West Province	Abo Forest	6.2857°N	10.3580°E	2162	KT967095	this study

Table A1 (continued). Collection numbers (Museum für Naturkunde, Berlin, ZMB; Zoologisches Forschungsmuseum Alexander Koenig, Bonn, ZFMK), localities of *Leptopelis* tadpoles studied herein, and GenBank data analysed in our 16S DNA-barcoding analysis; *n* = number of tadpoles (a single one genotyped, see Appendix Tables A2 and A3).

Species	Collection number	Stage	*n*	Country	Region	Site	Latitude	Longi-tude	Elevation [m a.s.l.]	GenBank number	Reference
*rufus*_1	ZFMK 87897	adult	—	Cameroon	—	near Nkoelon	2.3972°N	10.0352°E	75	KT967096	this study
*rufus*_1	ZMB 79625	tadpole	3	Cameroon	Camp Bekop	Ebo Forest	4.3519°N	10.4244°E	845	KT967097	this study
*rufus*_2	ZFMK 67382	adult	—	Cameroon	Bakossi Mts.	Kodmin	4.9833°N	9.7000°E	1065	KT967098	this study
*rufus*_2	ZMB 79626	tadpole	2	Cameroon	Mt Nlonako	—	4.8309°N	9.9255°E	459	KT967099	this study
*rufus*_2	ZMB 79627	tadpole	1	Cameroon	Ebo Forest	Njuma	4.3394°N	10.2458°E	320	KT967100	this study
*rufus*_2	ZMB 79628	tadpole	5	Cameroon	Ebo Forest	Ndog-banguen-gue	4.4069°N	10.1653°E	96	KT967101	this study
*rufus*_2	ZMB 79629	tadpole	7	Cameroon	Mt Manen-gouba	Ekom Khan	5.0633°N	10.0163°E	587	KT967102	this study
spiritusnoctis	ZMB 79582	adult	—	Liberia	—	near Jarwodee	5.4938°N	8.3636°W	220	KF888336	Rödel et al. (2014)
spiritusnoctis	ZMB 79630	tadpole	5	Liberia	—	near Gbanju	7.2347°N	9.3096°W	398	KT967103	this study
spiritusnoctis	ZMB 79631	tadpole	1	Liberia	—	near Gbanju	7.2347°N	9.3096°W	398	KT967104	this study
spiritusnoctis	ZMB 79632	tadpole	1	Liberia	—	near Gbanju	7.2316°N	9.3118°W	382	KT967105	this study
spiritusnoctis	ZMB 79633	tadpole	8	Liberia	—	near Gbanju	7.2308°N	9.3023°W	387	KT967106	this study
spiritusnoctis	ZMB 79634	tadpole	1	Liberia	—	near Gbanju	7.2308°N	9.3023°W	387	KT967107	this study
spiritusnoctis	ZMB 79635	tadpole	3	Liberia	—	near Gbanju	7.2376°N	9.3117°W	417	KT967108	this study
spiritusnoctis	ZMB 79636	tadpole	1	Liberia	—	near Gbanju	7.2376°N	9.3117°W	417	KT967109	this study
viridis	ZMB 83027	adult	—	Liberia	—	near Gbanju	7.3242°N	9.3035°W	380	KT967110	this study
viridis	ZMB 79637	tadpole	1	Guinea	—	near Banam-bala	7.9899°N	9.1312°W	449	KT967111	this study
viridis	ZMB 79638	tadpole	1	Guinea	—	near Banam-bala	7.9899°N	9.1312°W	449	KT967112	this study

Table A2. Morphometrics of *Leptopelis* tadpoles; G = Gosner stage; measurements in mm; genotyped specimens are marked with an asterisk "*," genotyped and drawn specimens are marked with two asterisks "**;" for abbreviations see Materials and Methods.

species	ZMB#	G	BL	TL	EL	BW	BH	AH	VF	DF	TTH	AW	IOD	IND	SND	SED	ED	SSD	ODW	SL
aubryioides	79604*	30	9	-	-	5.3	3.8	2	0.5	-	-	2.2	3.5	1.8	1	2.4	0.9	5	1.3	0.7
aubryioides	79604	36	10.4	-	-	6.5	5.1	2.5	1	1.3	4.3	2.5	3.8	2	1	2.5	1	4.5	1.1	0.9
aubryioides	79605**	25	5.5	-	-	3.2	2.4	1.5	0.4	0.6	1.9	1.3	2.1	1.3	0.7	1.5	0.5	2.2	0.8	0.9
aubryioides	79606	40	10.3	23.8	34.1	6.3	5	2.3	1	1.4	4.2	2.6	3.8	2	1.1	2.6	1	4.6	1.1	0.9
aubryioides	79606	27	7.4	18.7	26.1	4.1	3.4	2	0.6	0.7	2.9	1.8	3.1	1.6	0.8	2.2	1	3.3	1.2	1
aubryioides	79606	25	7.1	16.9	24	4.2	3.3	1.9	0.7	0.8	3	1.9	3	1.5	0.8	2.3	1.1	3.6	1.1	1.2
aubryioides	79606	27	7.9	18.9	26.8	4.6	3.5	2	0.6	0.9	3.1	1.7	2.9	1.6	0.8	2.1	1	3.4	1.1	1
aubryioides	79606	27	7.7	-	-	4.8	3.8	2.1	0.7	1	3.4	1.8	2.8	1.5	0.8	2.2	1.1	3.5	1.2	1.3
aubryioides	79606	28	8.2	19.5	27.7	5	4.1	2	0.8	1.1	3.5	1.9	3	1.5	0.8	2.2	1.1	3.8	1.1	1.5
aubryioides	79606	37	10.4	23.6	34	5.5	4.5	2.4	1	1.3	4.2	2.4	3.9	2	1.1	2.6	1.2	4.7	1.4	1.7
aubryioides	79606	37	10.3	23.8	34.1	5.8	4.6	2.5	1.1	1.4	4.5	2.6	4.1	2.2	1.1	2.5	1.1	4.6	1.5	1.5
aubryioides	79606	37	10.5	24.4	34.9	6.2	4.5	2.7	1	1.4	4.5	2.5	3.9	2	1.1	2.6	1.2	4.7	1.4	1.8
aubryioides	79607*	36	10.7	-	-	6.1	5	2.7	1.1	1.3	3.8	2.6	3.8	2.1	1.4	2.9	1	4.5	1.6	1.7
aubryioides	79607	39	11.6	26.3	37.9	6.6	4.8	2.9	1.2	1.6	5.1	2.9	4.3	2.3	1.2	2.7	1.2	4.9	1.5	1.8
aubryioides	79607	36	10	24.8	34.8	6	4.4	2.6	1.1	1.3	4.5	2.5	4	2.1	1.1	2.5	1.1	4.3	1.4	1.7
aubryioides	79608*	40	10.6	-	-	5.5	4.5	2.4	1	1.3	2.9	2.4	3.9	2	1.1	2.6	1.2	4.7	1.4	1.7
aubryioides	79609*	31	8.8	-	-	5.2	3.2	2.2	0.9	1	2.9	2.3	3.3	1.7	1	2.3	0.8	4.2	1.3	1.1
aubryioides	79610*	36	9.8	-	-	5.5	4.4	2.5	1	1.3	3	2.3	3.8	1.8	1	2.4	1	4.7	1.2	1.2
aubryioides	79611*	41	10	-	-	5.4	3.9	2.3	0.9	1	3	2.3	4.1	1.9	1.2	2.6	1.3	4.4	1.3	0.7
aubryioides	79612*	34	9.4	-	-	5.2	3.9	2.3	0.9	1.1	2.8	2.1	3.3	1.6	0.9	2	0.9	4.1	1.3	1.3
boulengeri	79613*	37	10.9	-	-	5.5	3.5	2.2	1	1.2	4.4	1.8	3.5	1.5	1.1	2.9	0.9	5	1.9	1.5
boulengeri	79614*	37	11.5	-	-	7	5.6	2.9	1.5	1.7	6.1	2.3	4	1.6	1.1	2.8	1	5.5	2.1	1.7
boulengeri	79614	40	12.3	-	-	6.3	5	2.9	2	2.3	7.2	2.2	4.3	1.9	1.5	3.3	1	4.9	2.3	2.2
boulengeri	79614	40	12.2	34.7	46.9	5.9	4.9	2.8	1.8	2	6.6	2.4	4.1	1.9	1.4	3.2	1	5	2.4	2.4
boulengeri	79614	36	11.7	28.9	40.6	5.8	4.7	2.6	1.7	1.9	6.2	2.1	4	1.8	1.3	3.1	1	4.5	2.1	2.1
boulengeri	79615*	36	10.3	-	-	5.7	4.5	2.4	1	1.2	4.6	2	3.5	1.5	1.2	3	1	4.6	2	2
boulengeri	79615	36	9.3	20.9	30.2	5.1	4.3	2.3	1	1.1	4.4	1.7	3	1.3	1	2.4	0.7	4.2	1.8	1.7
boulengeri	79615	36	9.9	23.8	33.7	5.2	4.4	2.2	1.2	1.4	4.8	1.6	3.1	1.4	1	2.3	0.7	4.3	1.9	1.8
boulengeri	79616**	38	11.6	-	-	7.1	5.7	2.8	1.6	1.7	6.1	2.4	4	1.6	1.1	2.8	1	5.1	2.2	2
boulengeri	79617	40	10.8	24.7	35.5	5.7	4.6	2.5	1.3	1.5	5.3	1.9	3.7	1.5	1.2	2.7	0.8	4.4	2.2	2
boulengeri	79617	40	11.5	30.1	41.6	5.9	4.8	2.6	1.5	1.6	5.7	2	3.8	1.7	1.3	3.1	1	4.8	2	2.1
boulengeri	79617	36	10	24.2	34.2	5.3	4.5	2.4	1.5	1.7	5.6	1.8	3.5	1.6	1.2	2.8	0.8	4.7	2.3	2
boulengeri	79617	40	11.7	28.8	40.5	6	4.9	2.7	1.6	1.7	6	1.9	3.8	1.5	1	2.9	1.1	4.3	2.1	2.2
boulengeri	79617	38	10.8	25.8	36.6	5.7	4.5	2.4	1	1.2	4.6	2	3.7	1.5	1.2	3	1	4.6	2	2
boulengeri	79617	40	11.2	27.1	38.3	5.8	4.7	2.8	1.7	1.8	6.3	2.1	3.8	1.6	1.3	3.1	1	4.8	2.1	2.3
boulengeri	79617	40	11.8	30.6	42.4	6.2	4.8	2.5	1.8	1.9	6.2	2	4	1.6	1.2	3	1	4.5	2.1	2.3
calcaratus	79618**	28	8.8	-	-	4.5	3.3	1.8	0.3	-	2.2	1.7	3.2	1.3	0.7	2.3	0.8	4.9	1.4	0.7
calcaratus	79619	27	9.7	18.7	28.4	5.3	4	2.2	0.9	1.2	4.3	2.4	4	1.5	1	2.7	1	4.5	0.9	1.9
calcaratus	79619	29	9.2	22.4	31.6	5.2	4.1	2.3	0.9	1	4.2	2.3	3.8	1.4	0.9	2.6	1	4.3	0.9	2
calcaratus	79619	25	6.5	15.5	22	4	3.2	1.5	0.7	0.8	3	1.6	3	1.2	0.6	2	0.7	2.9	0.7	1.2
calcaratus	79619	40	11.8	26.8	38.6	5.8	4.5	2.5	1	1.1	4.6	3.2	4.6	1.8	1.1	2.7	1.1	4.6	0.9	2.1
calcaratus	79619	40	12	28.2	40.2	6	4.8	2.6	1	1.2	4.8	3.3	4.7	1.9	1.2	2.8	1.2	4.8	1	2.3
calcaratus	79619	40	11.6	26.4	38	5.9	4.7	2.4	1.1	1.2	4.7	3.2	4.6	1.7	1.2	2.9	1.1	4.3	0.9	1.7
calcaratus	79619	25	8	18.7	26.7	4.6	4.2	2	0.8	1	3.8	2.2	3.6	1.4	0.8	2.2	0.9	4.4	0.8	1.5
calcaratus	79619	36	11.4	24.9	36.3	5.6	5	2.6	1.1	1.3	5	3.5	4.5	1.8	1.3	3	1	4.2	0.9	2
calcaratus	79619	38	10.8	24	34.8	5.7	4.5	2.4	1	1.2	4.6	3.1	4.2	1.5	1.2	2.8	1.1	4.1	0.9	1.8
calcaratus	79620*	41	13.2	30.2	43.4	8	6	3.7	1	1.2	5.9	3.9	5.5	2.5	1.3	3.3	1.4	5	2.1	NA
millsoni	79621**	39	9.5	17.3	26.8	5	3.6	2.5	0.8	1	3.8	2.6	3.5	1.5	1	2.3	1.1	4.5	1.8	1
modestus	79622**	34	11.3	-	-	6.5	6	2.5	1.5	1.8	5.8	2.3	4.3	2.2	1.2	2.8	1	6.2	2.5	0.7

Table A2 (continued). Morphometrics of *Leptopelis* tadpoles; G = Gosner stage; measurements in mm; genotyped specimens are marked with an asterisk "*," genotyped and drawn specimens are marked with two asterisks "**;" for abbreviations see Materials and Methods.

species	ZMB#	G	BL	TL	EL	BW	BH	AH	VF	DF	TTH	AW	IOD	IND	SND	SED	ED	SSD	ODW	SL
modestus	79623	31	7.9	16.8	24.7	4.3	3.3	1.4	0.9	1.1	3.4	1.3	2.8	1.5	0.9	2.5	0.6	4.7	1.5	0.5
modestus	79624*	36	14.1	35.2	49.3	8.3	7.5	4	1.5	2	7.5	3.5	5	2.5	1.1	2.8	1.3	6.5	2.4	1
*rufus*_1	79625*	26	6.4	-	-	3.7	2.9	1.7	0.8	0.9	2.9	1.5	2.5	1.4	0.7	2.1	0.6	3.3	1.3	0.8
*rufus*_1	79625	29	7	-	-	3.7	2.3	1.6	0.9	1	2.2	1.2	2.7	1.6	0.8	2	0.7	3.7	1.5	0.9
*rufus*_1	79625	29	7.4	-	-	3.6	2.2	1.7	1	1.1	2.1	1.1	2.6	1.5	0.9	2.1	0.8	3.5	1.4	0.9
*rufus*_2	79626*	29	7.2	-	-	3.7	2.3	1.5	0.3	-	-	1.2	2.8	1.7	0.7	2	0.7	3.7	1.5	0.9
*rufus*_2	79626	28	5.7	-	-	2.7	2	1.2	0.6	0.8	2	1.1	2.1	1.3	0.8	1.8	0.5	3.1	1.1	0.7
*rufus*_2	79627**	36	10.2	-	-	5.6	4	2.4	1.1	1.3	3.9	2.3	3.5	1.5	1	2.6	1	5.3	1.8	1.6
*rufus*_2	79628*	29	8.8	-	-	4.7	3.5	2	0.9	1	3.4	1.9	3	1.8	0.9	2.4	0.8	4.3	1.6	1.2
*rufus*_2	79628	36	8.6	16.4	25	4.9	3.1	1.9	0.9	1.1	3	1.4	2.9	1.6	0.9	2	0.8	3.9	1.6	1
*rufus*_2	79628	32	7.6	15.5	23.1	3.7	2.4	1.9	0.9	1.2	2.4	1.2	2.7	1.6	1	2.1	0.8	3.6	1.4	0.9
*rufus*_2	79628	31	7.1	14.4	21.5	3.7	2.3	1.5	0.7	0.9	2.2	1.2	2.8	1.7	0.7	2	0.7	3.7	1.5	0.9
*rufus*_2	79628	40	8.8	14.7	23.5	4.7	3.5	2	0.9	1	3.5	1.9	3	1.8	0.9	2.4	0.8	4.3	1.6	1.2
*rufus*_2	79629*	36	12.6	-	-	8	5.8	3.3	1.7	2	5.6	3.4	4.5	2.4	1.2	3.3	1.1	6.4	2.5	1.5
*rufus*_2	79629	28	6.7	14.2	20.9	3.7	2.9	1.7	0.8	0.9	2.8	1.5	2.5	1.4	0.7	2.1	0.6	3.3	1.3	0.8
*rufus*_2	79629	29	7.7	15.1	22.8	3.8	2.4	1.8	1	1.2	2.4	1.2	2.7	1.6	1	2.1	0.8	3.6	1.4	0.9
*rufus*_2	79629	29	7.5	15.6	23.1	3.6	2.2	1.8	1	1.1	2.1	1.1	2.6	1.5	0.9	2.1	0.8	3.5	1.4	0.9
*rufus*_2	79629	35	10.2	22.7	32.9	5.6	4	2.4	1.1	1.3	4	2.3	3.5	1.9	1	2.6	1	5.3	1.8	1.6
*rufus*_2	79629	31	8.5	20.5	29	4.8	3	2	0.9	1	2.9	1.5	3	1.6	0.9	2	0.8	3.9	1.6	1
*rufus*_2	79629	34	9.9	22	31.9	5.5	3.9	2.3	1	1.2	3.9	2.2	3.4	1.8	1	2.5	1	5.1	1.8	1.5
spiritusnoctis	79630*	-	9.5	18.8	28.3	4.8	4	-	1	1.3	-	2.5	3.1	1.9	1	2.6	0.8	4.3	1.6	1.2
spiritusnoctis	79630	25	4.4	11.1	15.5	3.4	2.7	1.2	0.4	0.6	2.2	1	1.8	1	0.5	1.3	0.4	2.4	0.8	0.5
spiritusnoctis	79630	29	7.8	19.8	27.6	4.5	3.4	1.9	1	1	3.9	1.6	2.9	1.3	0.8	2.1	0.7	3.9	1.3	1
spiritusnoctis	79630	36	10.7	25.8	36.5	5.5	4.3	3	1	1.6	5.6	3	3.6	2	1	3	1	4.8	1.9	1.5
spiritusnoctis	79630	40	10.5	26.1	36.6	5.4	4.1	2.9	1	1.5	5.4	2.9	3.4	1.9	1	2.9	1	4.6	1.8	1.4
spiritusnoctis	79631*	40	13.3	-	-	7.4	6.3	4	1.4	1.7	7.1	3.8	5	2.7	1.2	2.7	1.4	6.4	2.1	1.5
spiritusnoctis	79632*	31	12.5	26.8	39.3	7.2	5.2	3.7	1.4	1.9	7	4	4	2.4	1.5	3.9	1.2	6.5	2.1	1.5
spiritusnoctis	79633*	25	6.6	-	-	4	3.3	1.7	0.8	1	3.5	1.4	2.3	1.5	0.7	2	0.6	3.6	1.2	0.7
spiritusnoctis	79633	25	5	12.1	17.1	2.8	2.7	1.3	0.5	0.7	2.5	1.1	1.9	1.1	0.5	1.4	0.4	2.6	0.9	0.6
spiritusnoctis	79633	25	4.8	11.6	16.4	3	2.9	1.1	0.5	0.7	2.3	1.1	1.9	1.1	0.5	1.4	0.4	2.6	0.9	0.6
spiritusnoctis	79633	36	8.7	22.8	31.5	4.7	3.6	2.1	1.2	1.2	4.5	1.8	3.1	1.6	1	2.3	0.9	4.2	1.3	1.3
spiritusnoctis	79633	27	7.2	17.7	24.9	4.1	3.5	1.9	0.7	0.8	3.4	1.8	2.4	1.5	0.7	2	0.6	3.2	1.2	0.7
spiritusnoctis	79633	26	5.9	-	-	4	3.3	1.7	0.8	1	3.5	1.4	2.3	1.5	0.7	2	0.6	3.6	1.2	0.7
spiritusnoctis	79633	26	6.2	14.2	20.4	4.1	3.2	1.8	0.8	1	3.6	1.5	2.5	1.4	0.7	2	0.6	3.8	1.3	0.8
spiritusnoctis	79633	30	7.6	17.9	25.5	4.4	3.3	1.9	0.9	1	3.8	1.6	2.8	1.3	0.7	2.1	0.7	3.9	1.3	1
spiritusnoctis	79634**	34	11.5	26.1	37.6	6.3	4.5	3.2	1.1	1.7	6	3.1	3.8	2.2	1.1	3.1	1.1	5.3	2	1.6
spiritusnoctis	79635*	27	6.3	-	-	3.8	3.2	1.5	0.7	0.8	3	1.3	2.2	1.3	0.6	1.7	0.5	2.9	1	0.7
spiritusnoctis	79635	25	5.5	12.2	17.7	3.6	3	1.4	0.6	0.7	2.7	1.2	2	1.2	0.6	1.5	0.5	2.7	1	0.6
spiritusnoctis	79635	25	4.9	10.7	15.6	3.5	2.8	1.3	0.5	0.7	2.5	1.1	1.9	1.1	0.5	1.4	0.4	2.6	0.9	0.6
spiritusnoctis	79636*	25	6.8	17.1	23.9	3.8	3.5	1.9	0.7	0.8	3.4	1.8	2.4	1.5	0.7	2	0.6	3.2	1.2	0.7
viridis	79637*	30	9.8	-	-	5.8	5.3	3.4	-	-	4.1	2.4	3.5	2.1	1	2.7	1.1	5.4	1.4	0.9
viridis	79638**	40	13.5	-	-	7.7	6.1	3.5	1	1.6	6	4.4	5.2	2.4	1.1	3.3	1.7	7	1.8	1.4

Table A3. Ratios of *Leptopelis* tadpoles; G = Gosner stage; measurements in mm; genotyped specimens are marked with an asterisk "*;" genotyped and drawn specimens are marked with two asterisks "**;" for abbreviations see Materials and Methods.

Species	ZMB#	BL/ TL	BH/ BL	BW/ BL	SND/ SED	ED/ BL	IOD/ IND	TL/ EL	DF/ VF	AH/ DF	TTH/ BH	AW/ BW	AH/ BH	SL/ BL	ODW/ BW	SSD/ BL
aubryioides	79604*	-	0.42	0.59	0.42	0.10	1.94	-	-	-	-	0.42	0.53	0.08	0.25	0.56
aubryioides	79604	-	0.49	0.63	0.40	0.10	1.90	-	1.30	1.92	0.84	0.38	0.49	0.09	0.17	0.43
aubryioides	79605**	-	0.44	0.58	0.47	0.09	1.62	-	1.50	2.50	0.79	0.41	0.63	0.16	0.25	0.40
aubryioides	79606	0.43	0.49	0.61	0.42	0.10	1.90	0.70	1.40	1.64	0.84	0.41	0.46	0.09	0.17	0.45
aubryioides	79606	0.40	0.46	0.55	0.36	0.14	1.94	0.72	1.17	2.86	0.85	0.44	0.59	0.14	0.29	0.45
aubryioides	79606	0.42	0.46	0.59	0.35	0.15	2.00	0.70	1.14	2.38	0.91	0.45	0.58	0.17	0.26	0.51
aubryioides	79606	0.42	0.44	0.58	0.38	0.13	1.81	0.71	1.50	2.22	0.89	0.37	0.57	0.13	0.24	0.43
aubryioides	79606	-	0.49	0.62	0.36	0.14	1.87	-	1.43	2.10	0.89	0.38	0.55	0.17	0.25	0.45
aubryioides	79606	0.42	0.50	0.61	0.36	0.13	2.00	0.70	1.38	1.82	0.85	0.38	0.49	0.18	0.22	0.46
aubryioides	79606	0.44	0.43	0.53	0.42	0.12	1.95	0.69	1.30	1.85	0.93	0.44	0.53	0.16	0.25	0.45
aubryioides	79606	0.43	0.45	0.56	0.44	0.11	1.86	0.70	1.27	1.79	0.98	0.45	0.54	0.15	0.26	0.45
aubryioides	79606	0.43	0.43	0.59	0.42	0.11	1.95	0.70	1.40	1.93	1.00	0.40	0.60	0.17	0.23	0.45
aubryioides	79607*	-	0.47	0.57	0.48	0.09	1.81	-	1.18	2.08	0.76	0.43	0.54	0.16	0.26	0.42
aubryioides	79607	0.44	0.41	0.57	0.44	0.10	1.87	0.69	1.33	1.81	1.06	0.44	0.60	0.16	0.23	0.42
aubryioides	79607	0.40	0.44	0.60	0.44	0.11	1.90	0.71	1.18	2.00	1.02	0.42	0.59	0.17	0.23	0.43
aubryioides	79608*	-	0.42	0.52	0.42	0.11	1.95	-	1.30	1.85	0.64	0.44	0.53	0.16	0.25	0.44
aubryioides	79609*	-	0.36	0.59	0.43	0.09	1.94	-	1.11	2.20	0.91	0.44	0.69	0.13	0.25	0.48
aubryioides	79610*	-	0.45	0.56	0.42	0.10	2.11	-	1.30	1.92	0.68	0.42	0.57	0.12	0.22	0.48
aubryioides	79611*	-	0.39	0.54	0.46	0.13	2.16	-	1.11	2.30	0.77	0.43	0.59	0.07	0.24	0.44
aubryioides	79612*	-	0.41	0.55	0.45	0.10	2.06	-	1.22	2.09	0.72	0.40	0.59	0.14	0.25	0.44
boulengeri	79613*	-	0.32	0.50	0.38	0.08	2.33	-	1.20	1.83	1.26	0.33	0.63	0.14	0.35	0.46
boulengeri	79614*	-	0.49	0.61	0.39	0.09	2.50	-	1.13	1.71	1.09	0.33	0.52	0.15	0.30	0.48
boulengeri	79614	-	0.41	0.51	0.45	0.08	2.26	-	1.15	1.26	1.44	0.35	0.58	0.18	0.37	0.40
boulengeri	79614	0.35	0.40	0.48	0.44	0.08	2.16	0.74	1.11	1.40	1.35	0.41	0.57	0.20	0.41	0.41
boulengeri	79614	0.40	0.40	0.50	0.42	0.09	2.22	0.71	1.12	1.37	1.32	0.36	0.55	0.18	0.36	0.38
boulengeri	79615*	-	0.44	0.55	0.40	0.10	2.33	-	1.20	2.00	1.02	0.35	0.53	0.19	0.35	0.45
boulengeri	79615	0.44	0.46	0.55	0.42	0.08	2.31	0.69	1.10	2.09	1.02	0.33	0.53	0.18	0.35	0.45
boulengeri	79615	0.42	0.44	0.53	0.43	0.07	2.21	0.71	1.17	1.57	1.09	0.31	0.50	0.18	0.37	0.43
boulengeri	79616**	-	0.49	0.61	0.39	0.09	2.50	-	1.06	1.65	1.07	0.34	0.49	0.17	0.31	0.44
boulengeri	79617	0.44	0.43	0.53	0.44	0.07	2.47	0.70	1.15	1.67	1.15	0.33	0.54	0.19	0.39	0.41
boulengeri	79617	0.38	0.42	0.51	0.42	0.09	2.24	0.72	1.07	1.63	1.19	0.34	0.54	0.18	0.34	0.42
boulengeri	79617	0.41	0.45	0.53	0.43	0.08	2.19	0.71	1.13	1.41	1.24	0.34	0.53	0.20	0.43	0.47
boulengeri	79617	0.41	0.42	0.51	0.34	0.09	2.53	0.71	1.06	1.59	1.22	0.32	0.55	0.19	0.35	0.37
boulengeri	79617	0.42	0.42	0.53	0.40	0.09	2.47	0.70	1.20	2.00	1.02	0.35	0.53	0.19	0.35	0.43
boulengeri	79617	0.41	0.42	0.52	0.42	0.09	2.38	0.71	1.06	1.56	1.34	0.36	0.60	0.21	0.36	0.43
boulengeri	79617	0.39	0.41	0.53	0.40	0.08	2.50	0.72	1.06	1.32	1.29	0.32	0.52	0.19	0.34	0.38
calcaratus	79618**	-	0.38	0.51	0.30	0.09	2.46	-	-	-	0.67	0.38	0.55	0.08	0.31	0.56
calcaratus	79619	0.52	0.41	0.55	0.37	0.10	2.67	0.66	1.33	1.83	1.08	0.45	0.55	0.20	0.17	0.46
calcaratus	79619	0.41	0.45	0.57	0.35	0.11	2.71	0.71	1.11	2.30	1.02	0.44	0.56	0.22	0.17	0.47
calcaratus	79619	0.42	0.49	0.62	0.30	0.11	2.50	1.29	1.14	1.88	0.94	0.40	0.47	0.18	0.18	0.45
calcaratus	79619	0.44	0.38	0.49	0.41	0.09	2.56	0.69	1.10	2.27	1.02	0.55	0.56	0.18	0.16	0.39
calcaratus	79619	0.43	0.40	0.50	0.43	0.10	2.47	0.70	1.20	2.17	1.00	0.55	0.54	0.19	0.17	0.40
calcaratus	79619	0.44	0.41	0.51	0.41	0.09	2.71	0.69	1.09	2.00	1.00	0.54	0.51	0.15	0.15	0.37
calcaratus	79619	0.43	0.53	0.58	0.36	0.11	2.57	0.70	1.25	2.00	0.90	0.48	0.48	0.19	0.17	0.55
calcaratus	79619	0.46	0.44	0.49	0.43	0.09	2.50	0.69	1.18	2.00	1.00	0.63	0.52	0.18	0.16	0.37
calcaratus	79619	0.45	0.42	0.53	0.43	0.10	2.80	0.69	1.20	2.00	1.02	0.54	0.53	0.17	0.16	0.38
calcaratus	79620*	0.44	0.45	0.61	0.39	0.11	2.20	0.70	1.20	3.08	0.98	0.49	0.62	-	0.26	0.38
millsoni	79621**	0.55	0.38	0.53	0.43	0.12	2.33	0.65	1.25	2.50	1.06	0.52	0.69	0.11	0.36	0.47
modestus	79622**	-	0.53	0.58	0.43	0.09	1.95	-	1.20	1.39	0.97	0.35	0.42	0.06	0.38	0.55

Table A3 (continued). Ratios of *Leptopelis* tadpoles; G = Gosner stage; measurements in mm; genotyped specimens are marked with an asterisk "*;" genotyped and drawn specimens are marked with two asterisks "**;" for abbreviations see Materials and Methods.

Species	ZMB#	BL/ TL	BH/ BL	BW/ BL	SND/ SED	ED/ BL	IOD/ IND	TL/ EL	DF/ VF	AH/ DF	TTH/ BH	AW/ BW	AH/ BH	SL/ BL	ODW/ BW	SSD/ BL
modestus	79623	0.47	0.42	0.54	0.36	0.08	1.87	0.68	1.22	1.27	1.03	0.30	0.42	0.06	0.35	0.59
modestus	79624*	0.40	0.53	0.59	0.39	0.09	2.00	0.71	1.33	2.00	1.00	0.42	0.53	0.07	0.29	0.46
*rufus*_1	79625*	-	0.45	0.58	0.33	0.09	1.79	-	1.13	1.89	1.00	0.41	0.59	0.13	0.35	0.52
*rufus*_1	79625	-	0.33	0.53	0.40	0.10	1.69	-	1.11	1.60	0.96	0.32	0.70	0.13	0.41	0.53
*rufus*_1	79625	-	0.30	0.49	0.43	0.11	1.73	-	1.10	1.55	0.95	0.31	0.77	0.12	0.39	0.47
*rufus*_2	79626*	-	0.32	0.51	0.35	0.10	1.65	-	-	-	-	0.32	0.65	0.13	0.41	0.51
*rufus*_2	79626	-	0.35	0.47	0.44	0.09	1.62	-	1.33	1.50	1.00	0.41	0.60	0.12	0.41	0.54
*rufus*_2	79627**	-	0.39	0.55	0.38	0.10	2.33	-	1.18	1.85	0.98	0.41	0.60	0.16	0.32	0.52
*rufus*_2	79628*	-	0.40	0.53	0.38	0.09	1.67	-	1.11	2.00	0.97	0.40	0.57	0.14	0.34	0.49
*rufus*_2	79628	0.52	0.36	0.57	0.45	0.09	1.81	0.66	1.22	1.73	0.97	0.29	0.61	0.12	0.33	0.45
*rufus*_2	79628	0.49	0.32	0.49	0.48	0.11	1.69	0.67	1.33	1.58	1.00	0.32	0.79	0.12	0.38	0.47
*rufus*_2	79628	0.49	0.32	0.52	0.35	0.10	1.65	0.67	1.29	1.67	0.96	0.32	0.65	0.13	0.41	0.52
*rufus*_2	79628	0.60	0.40	0.53	0.38	0.09	1.67	0.63	1.11	2.00	1.00	0.40	0.57	0.14	0.34	0.49
*rufus*_2	79629*	-	0.46	0.63	0.36	0.09	1.88	-	1.18	1.65	0.97	0.43	0.57	0.12	0.31	0.51
*rufus*_2	79629	0.47	0.43	0.55	0.33	0.09	1.79	0.68	1.13	1.89	0.97	0.41	0.59	0.12	0.35	0.49
*rufus*_2	79629	0.51	0.31	0.49	0.48	0.10	1.69	0.66	1.20	1.50	1.00	0.32	0.75	0.12	0.37	0.47
*rufus*_2	79629	0.48	0.29	0.48	0.43	0.11	1.73	0.68	1.10	1.64	0.95	0.31	0.82	0.12	0.39	0.47
*rufus*_2	79629	0.45	0.39	0.55	0.38	0.10	1.84	0.69	1.18	1.85	1.00	0.41	0.60	0.16	0.32	0.52
*rufus*_2	79629	0.41	0.35	0.56	0.45	0.09	1.88	0.71	1.11	2.00	0.97	0.31	0.67	0.12	0.33	0.46
*rufus*_2	79629	0.45	0.39	0.56	0.40	0.10	1.89	0.69	1.20	1.92	1.00	0.40	0.59	0.15	0.33	0.52
spiritusnoctis	79630*	0.51	0.42	0.51	0.38	0.08	1.63	0.66	1.30	-	-	0.52	-	0.13	0.33	0.45
spiritusnoctis	79630	0.40	0.61	0.77	0.38	0.09	1.80	0.72	1.50	2.00	0.81	0.29	0.44	0.11	0.24	0.55
spiritusnoctis	79630	0.39	0.44	0.58	0.38	0.09	2.23	0.72	1.00	1.90	1.15	0.36	0.56	0.13	0.29	0.50
spiritusnoctis	79630	0.41	0.40	0.51	0.33	0.09	1.80	0.71	1.60	1.88	1.30	0.55	0.70	0.14	0.35	0.45
spiritusnoctis	79630	0.40	0.39	0.51	0.34	0.10	1.79	0.71	1.50	1.93	1.32	0.54	0.71	0.13	0.33	0.44
spiritusnoctis	79631*	-	0.47	0.56	0.44	0.11	1.85	-	1.21	2.35	1.13	0.51	0.63	0.11	0.28	0.48
spiritusnoctis	79632*	0.47	0.42	0.58	0.38	0.10	1.67	0.68	1.36	1.95	1.35	0.56	0.71	0.12	0.29	0.52
spiritusnoctis	79633*	-	0.50	0.61	0.35	0.09	1.53	-	1.25	1.70	1.06	0.35	0.52	0.11	0.30	0.55
spiritusnoctis	79633	0.41	0.54	0.56	0.36	0.08	1.73	0.71	1.40	1.86	0.93	0.39	0.48	0.12	0.32	0.52
spiritusnoctis	79633	0.41	0.60	0.63	0.36	0.08	1.73	0.71	1.40	1.57	0.79	0.37	0.38	0.13	0.30	0.54
spiritusnoctis	79633	0.38	0.41	0.54	0.43	0.10	1.94	0.72	1.00	1.75	1.25	0.38	0.58	0.15	0.28	0.48
spiritusnoctis	79633	0.41	0.49	0.57	0.35	0.08	1.60	0.71	1.14	2.38	0.97	0.44	0.54	0.10	0.29	0.44
spiritusnoctis	79633	-	0.56	0.68	0.35	0.10	1.53	-	1.25	1.70	1.06	0.35	0.52	0.12	0.30	0.61
spiritusnoctis	79633	0.44	0.52	0.66	0.35	0.10	1.79	0.70	1.25	1.80	1.13	0.37	0.56	0.13	0.32	0.61
spiritusnoctis	79633	0.42	0.43	0.58	0.33	0.09	2.15	0.70	1.11	1.90	1.15	0.36	0.58	0.13	0.30	0.51
spiritusnoctis	79634**	0.44	0.39	0.55	0.35	0.10	1.73	0.69	1.55	1.88	1.33	0.49	0.71	0.14	0.32	0.46
spiritusnoctis	79635*	-	0.51	0.60	0.35	0.08	1.69	-	1.14	1.88	0.94	0.34	0.47	0.11	0.26	0.46
spiritusnoctis	79635	0.45	0.55	0.65	0.40	0.09	1.67	0.69	1.17	2.00	0.90	0.33	0.47	0.11	0.28	0.49
spiritusnoctis	79635	0.46	0.57	0.71	0.36	0.08	1.73	0.69	1.40	1.86	0.89	0.31	0.46	0.12	0.26	0.53
spiritusnoctis	79636*	0.40	0.51	0.56	0.35	0.09	1.60	0.72	1.14	2.38	0.97	0.47	0.54	0.10	0.32	0.47
viridis	79637*	-	0.54	0.59	0.37	0.11	1.67	-	-	-	0.77	0.41	0.64	0.09	0.24	0.55
viridis	79638**	-	0.45	0.57	0.33	0.13	2.17	-	1.60	2.19	0.98	0.57	0.57	0.10	0.23	0.52

Table A4. Ratios of morphometrics in *Leptopelis* tadpoles. Given are mean values and range [minimum – maximum] of ratio values; *n*(max) = number of vouchers; genotyped specimens were inapplicable in some ratios, e.g., BL/TL, for details see Appendices A2 and A4. Ratios for *L. rufus* are provided for both lineages independently and combined vouchers (*rufus*_1 & *rufus*_2); for abbreviations see Materials and Methods.

species	*n*(max)	BL/TL	BH/BL	BW/BL	SND/SED	ED/BL	IOD/IND	TL/EL	DF/VF	AH/DF	TTH/BH	AW/BW	AH/BH	SL/BL	ODW/BW	SSD/BL
aubryioides	20	0.42 [0.40-0.44]	0.44 [0.36-0.50]	0.58 [0.52-0.63]	0.42 [0.35-0.48]	0.11 [0.09-0.15]	1.93 [1.62-2.16]	0.70 [0.69-0.72]	1.29 [1.11-1.50]	2.07 [1.64-2.86]	0.86 [0.64-1.06]	0.42 [0.37-0.45]	0.56 [0.46-0.69]	0.14 [0.07-0.18]	0.24 [0.17-0.29]	0.45 [0.40-0.56]
boulengeri	16	0.41 [0.35-0.44]	0.43 [0.32-0.49]	0.53 [0.48-0.61]	0.41 [0.34-0.45]	0.08 [0.07-0.10]	2.35 [2.16-2.53]	0.71 [0.69-0.74]	1.12 [1.06-1.20]	1.63 [1.26-2.09]	1.20 [1.02-1.44]	0.34 [0.31-0.41]	0.55 [0.49-0.63]	0.18 [0.14-0.21]	0.36 [0.30-0.43]	0.43 [0.37-0.48]
calcaratus	11	0.44 [0.41-0.52]	0.43 [0.38-0.53]	0.54 [0.49-0.62]	0.38 [0.30-0.43]	0.10 [0.09-0.11]	2.56 [2.20-2.80]	0.75 [0.66-1.29]	1.18 [1.09-1.33]	2.15 [1.83-3.08]	0.97 [0.67-1.08]	0.50 [0.38-0.63]	0.53 [0.47-0.62]	0.17 [0.08-0.22]	0.19 [0.15-0.31]	0.43 [0.37-0.56]
millsoni	1	0.55	0.38	0.53	0.43	0.12	2.33	0.65	1.25	2.50	1.06	0.52	0.69	0.11	0.36	0.47
modestus	3	0.44 [0.40-0.47]	0.49 [0.42-0.53]	0.57 [0.54-0.59]	0.39 [0.36-0.43]	0.09 [0.08-0.09]	1.94 [1.87-2.00]	0.70 [0.68-0.71]	1.25 [1.20-1.33]	1.55 [1.27-2.00]	1.00 [0.97-1.03]	0.36 [0.30-0.42]	0.46 [0.42-0.53]	0.07 [0.06-0.07]	0.34 [0.29-0.38]	0.53 [0.46-0.59]
*rufus*_1	3	—	0.36 [0.30-0.45]	0.53 [0.49-0.48]	0.39 [0.33-0.43]	0.10 [0.09-0.11]	1.74 [1.69-1.79]	—	1.11 [1.10-1.13]	1.68 [1.55-1.89]	0.97 [0.95-1.00]	0.35 [0.31-0.41]	0.68 [0.59-0.77]	0.13 [0.12-0.13]	0.38 [0.35-0.41]	0.51 [0.47-0.53]
*rufus*_2	15	0.49 [0.41-0.60]	0.37 [0.29-0.46]	0.53 [0.47-0.63]	0.40 [0.33-0.48]	0.10 [0.09-0.11]	1.78 [1.62-2.33]	0.67 [0.63-0.71]	1.19 [1.10-1.33]	1.77 [1.50-2.00]	0.98 [0.95-1.00]	0.36 [0.29-0.43]	0.64 [0.57-0.82]	0.13 [0.12-0.16]	0.36 [0.31-0.41]	0.50 [0.45-0.54]
*rufus*_1&2	18	0.49 [0.41-0.60]	0.37 [0.29-0.46]	0.53 [0.47-0.63]	0.40 [0.33-0.48]	0.10 [0.09-0.11]	1.78 [1.62-2.33]	0.67 [0.63-0.71]	1.18 [1.10-1.33]	1.75 [1.50-2.00]	0.98 [0.95-1.00]	0.36 [0.29-0.43]	0.65 [0.57-0.82]	0.13 [0.12-0.16]	0.36 [0.31-0.41]	0.50 [0.45-0.54]
spiritusnoctis	20	0.43 [0.38-0.51]	0.49 [0.39-0.61]	0.60 [0.51-0.77]	0.37 [0.33-0.44]	0.09 [0.08-0.11]	1.76 [1.53-2.23]	0.70 [0.66-0.72]	1.28 [1.00-1.60]	1.93 [1.57-2.38]	1.08 [0.79-1.35]	0.41 [0.29-0.56]	0.56 [0.38-0.71]	0.12 [0.10-0.15]	0.30 [0.24-0.35]	0.50 [0.44-0.61]
viridis	2	—	0.50 [0.45-0.54]	0.58 [0.57-0.59]	0.35 [0.33-0.37]	0.12 [0.11-0.13]	1.92 [1.67-2.17]	—	1.60	2.19	0.88 [0.77-0.98]	0.49 [0.41-0.57]	0.61 [0.57-0.64]	0.10 [0.09-0.10]	0.24 [0.23-0.24]	0.53 [0.52-0.55]