

## Revision of the genus *Werneria* Poche, 1903, including the descriptions of two new species from Cameroon and Gabon (Amphibia: Anura: Bufonidae)

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### Abstract

We review and summarize present knowledge of the western Central African toad genus *Werneria*, and describe two new species. Both new species seem to be more closely related to *W. mertensiana*, *W. tandyi* and *W. preussi* than to *W. bambutensis*. *Werneria submontana* nov. sp., from Mt. Kupe and the Bakossi Mts., Cameroon, is unique in having a wrinkled throat skin in adults and has a unique combination of other morphological and colour characters. *Werneria iboundji* nov. sp. is only known from its type locality, Mt. Iboundji, and represents the first record of this genus from Gabon. It is characterized by extensive webbing of the toes, slender, almost straight body shape, truncate snout, and colour.

**Key words:** Amphibia, Anura, Bufonidae, *Werneria bambutensis*, *Werneria iboundji* nov. sp., *Werneria mertensiana*, *Werneria preussi*, *Werneria submontana* nov. sp., *Werneria tandyi*, Cameroon, Gabon, Africa

### Introduction

The genus *Werneria* currently comprises four species of medium sized toads from Cameroon (Amiet 1972, 1976b) and Equatorial Guinea (de la Riva 1994; Lasso *et al.* 2002) in

western Central Africa. The first described species, *Werneria preussi* (Matschie, 1893) from Buëa, Cameroon, was originally assigned to the genus *Bufo*. In 1903, Andersson proposed the toad genus *Stenoglossa* and described *S. fulva*. Because the name was preoccupied by a beetle genus, Poche (1903) introduced the replacement name *Werneria*. *Werneria fulva* is the type species of this genus and also originated from Buëa. It was later placed in the synonymy of *W. preussi* (Mertens 1938b). The same species was described as *Atelopus africanus* from Bismarckburg in Togo by Werner (1898). However, according to Boulenger (1906), the latter type locality is based on an error. This opinion was adopted by all subsequent authors reporting on this species (e.g. Mertens 1938b; Perret 1966; Amiet 1972).

*W. preussi* was long treated as a member of the genus *Bufo*, and the only member of the *B. preussi*-group (Tandy and Keith 1972). Mertens (1938a, b, 1940) added much to our knowledge of *W. preussi*, but it was not until 1972 that Amiet (1972) described three new species of the *Bufo preussi*-group. Characters shared by all these species are: a more or less smooth skin; the absence of parotoid glands and tympani; first finger smaller than the second; toes without clearly discernible subarticular tubercles; snout protruding in comparison to mouth; and a body shape unique among African toads (Amiet 1972). Based on these and other common characters shared with *B. preussi*, Amiet (1976b) revived the name *Werneria* for these Central African toads. Grandison (1981) confirmed the distinctness of these species from *Bufo* and considered them members of a bufonid lineage (*Nectophryne* line) that, among others, also comprised the Central African toad genera *Didynamipus*, *Nectophryne* and *Wolterstorffina*.

Accepting that the type locality of *A. africanus* was based on an error, all *Werneria* records originated from south-western Cameroon and all species, except *W. mertensiana*, seemed to have very small ranges restricted to certain altitudes of particular mountains. It was thus logical when de la Riva (1994) and Lasso *et al.* (2002) assigned a specimen from Equatorial Guinea to *Werneria mertensiana* (as *W. preussi mertensiana*). This species affiliation was accepted by several authors (Frétey and Blanc 2000; Frost 2002) and the record was subsequently added to the range of *W. mertensiana* by Frétey and Blanc (2000).

The most recent summary of the genus was given by Gartshore (1984) in her report of the montane herpetofauna of the Cameroon highlands, in which several new records were added. We recently collected *Werneria* species in Cameroon and Gabon, including the first and second known specimens of this genus for Gabon. Some inconsistencies between the new vouchers with the reported characters of described species caused us to re-examine representatives of all known *Werneria* species. We herein give a review of known taxa and describe two new species from Cameroon and Gabon.

## Materials and methods

*Morphological data.*—Frogs were anesthetized with chlorobutanol, ether or ethylacetate,

fixed in 4% formaldehyde or 70% ethanol, and stored in 70% ethanol. Measurements were taken with an electronic dial caliper ( $\pm 0.1$  mm) or an ocular micrometer in a dissecting microscope ( $\pm 0.1$  mm, Zeiss Stemi SV 6). Some specimens were dissected to determine sex and reproductive status. All measurements are given in mm. Measurements taken from specimens investigated are summarized in Tables 1–4. Drawings were done with the aid of a camera lucida. Descriptions and natural history observations of the four previously known species were supplemented by published data, notably by those from Mertens (1938b) and Amiet (1972), and by unpublished data, kindly provided by J.-L. Amiet. Hence, ranges for snout-vent-length (SVL) are not accompanied by statement of sample size. Characters typical for the genus (see above and Amiet 1972, 1976b) are generally not repeated. Staging of tadpoles follows Gosner (1960). The labial tooththrow formula follows Dubois (1995). Collection details of specimens investigated are given in the species descriptions. Geographic position were taken from Perret (1966), Gartshore (1984), Lawson (1993), and from The Global Gazetteer (<http://www.calle.com/world/>) or collected with a handheld GPS receiver. Geographic coordinates are summarized in appendix 1.

**TABLE 1.** Summary of morphological measures (mm) of adult male *Werneria*. Given are minimum, maximum and mean values, including standard deviation. SVL = snout-vent-length, HW = head width, ED = eye diameter, IOD = interorbital distance, EN = distance eye nose, NS = distance nose snout-tip, FE = femur, TI = tibia, FO = foot including longest toe. For specimens investigated see respective species descriptions. Values from specimens kept in the research collection of J.-L. Amiet are given in parenthesis (data kindly provided by J.-L. Amiet).

species		SVL	HW	ED	IOD	EN	NS	FE	TI	FO	N
<i>bambutensis</i>	Min	31.1 (28.4)	9.1	2.7	3.3	2.1	1.6	12.3	13.1	22.5	2 (7)
	Max	32.1 (32.5)	9.5	3.3	3.4	2.2	2.0	13.2	15.2	23.3	
	x	(30.5)									
	sd	(1.6)									
<i>mertensiana</i>	Min	34.3	10.6	4.0	4.0	2.3	1.7	15.5	16.1	23.5	6
	Max	41.0	11.5	5.2	4.8	4.1	2.4	17.5	18.0	25.9	
	x	36.7	10.9	4.5	4.5	3.3	2.0	16.6	16.8	24.7	
	sd	2.6	0.4	0.5	0.3	0.7	0.3	0.7	0.7	1.0	
<i>preussi</i>	Min	30.2 (37.1)	9.3	3.1	3.1	2.7	1.7	14.2	14.2	21.5	6 (13)
	Max	42.9 (43.5)	16.2	4.9	5.0	3.5	2.7	21.0	20.3	30.3	
	x	36.0 (40.0)	12.0	4.1	4.1	3.1	2.1	17.2	16.6	25.0	
	sd	4.3 (1.7)	2.4	0.6	0.6	0.4	0.4	2.3	2.1	2.9	
<i>submontana</i> nov. sp.	Min	31.3	8.7	4.0	3.1	2.4	1.7	13.1	14.4	21.6	4
	Max	35.4	11.3	4.7	4.6	3.9	2.4	17.2	18.3	25.7	
	x	34.2	10.5	4.3	4.2	3.1	2.1	15.7	16.5	24.0	
	sd	2.0	1.2	0.3	0.7	0.6	0.3	1.8	1.7	1.9	
<i>tandyi</i>	Min	31.6 (28.4)	9.3	3.5	3.9	2.7	1.9	13.4	14.1	22.9	3 (14)
	Max	33.3 (35.0)	10.0	3.9	4.6	2.9	2.0	15.6	16.0	24.2	
	x	32.3 (31.7)	9.7	3.7	4.2	2.8	2.0	14.7	15.0	23.4	
	sd	0.9 (1.8)	0.4	0.2	0.4	0.1	0.1	1.2	1.0	0.7	

**TABLE 2.** Summary of morphological measures (mm) of adult female *Werneria*. Given are minimum, maximum and mean values, including standard deviation. For specimens investigated see respective species descriptions. Values from specimens kept in the research collection of J.-L. Amiet are given in parenthesis (data kindly provided by J.-L. Amiet). For abbreviations see Tab. 1.

species		SVL	HW	ED	IOD	EN	NS	FE	TI	FO	N
<i>bambutensis</i>	Min	(30.4)	9.8	3.2	3.4	2.3	1.9	13.6	14.4	24.1	1 (27)
	Max	34.4 (38.0)									
	x	(34.9)									
	sd	(2.1)									
<i>iboundji</i> nov. sp.		37.7	10.8	4.5	4.1	3.2	2.6	15.9	16.1	24.6	1
<i>mertensiana</i>	Min	39.6	11.3	4.3	4.4	3.1	1.3	16.3	16.6	25.7	9
	Max	47.7	13.5	5.2	5.6	4.0	2.5	21.2	21.0	30.8	
	x	44.9	12.2	4.6	5.0	3.5	2.1	19.5	19.4	27.7	
	sd	2.9	0.9	0.2	0.4	0.3	0.5	1.7	1.5	1.7	
<i>preussi</i>	Min	43.5 (43.6)	12.5	4.4	4.6	3.1	2.4	19.2	20.2	30.0	6 (2)
	Max	49.2 (48.3)	15.4	5.1	5.7	3.3	2.9	22.4	21.4	32.7	
	x	46.6	13.7	4.7	5.1	3.2	2.6	20.6	20.8	31.2	
	sd	2.2	1.0	0.3	0.4	0.1	0.2	1.2	0.5	1.1	
<i>submontana</i> nov. sp.		44.5	13.2	4.9	5.5	3.9	1.8	20.4	21.1	29.8	1
<i>tandyi</i>	Min	(37.4)									(6)
	Max	(40.0)									
	x	(38.7)									
	sd	(11.4)									

**TABLE 3.** Summary of morphological measures (mm) of juvenile and subadult *Werneria*. Given are minimum and maximum values. For specimens investigated see respective species descriptions. For abbreviations see Tab. 1.

species		SVL	HW	ED	IOD	EN	NS	FE	TI	FO	N
<i>iboundji</i> nov. sp.		16.3	5.7	2.9	2.7	1.2	1.1	7.7	6.6	11.4	1
<i>mertensiana</i>	Min	18.2	5.1	2.4	2.2	1.6	1.2	8.2	8.0	11.3	7
	Max	32.5	9.8	4.1	4.0	3.6	2.0	16.0	15.5	20.8	
<i>preussi</i>	Min	22.7	7.2	2.7	3.2	1.8	1.7	10.4	10.4	16.3	4
	Max	28.0	9.0	3.2	3.8	2.1	1.8	13.9	13.6	19.4	
<i>submontana</i> nov. sp.	Min	10.5	5.4	2.3	2.2	1.4	1.2	7.7	7.3	10.6	17
	Max	31.9	9.4	4.4	3.3	2.9	1.7	14.0	15.6	21.8	

**TABLE 4.** Morphological measures (mm) of *Werneria* cf. *tandyi* tadpoles (MHNG 1020.44 1-3); BL = body length, TL = tail length, BW = body width, FH = fin height, EN = distance eye-nose, NS = distance nose-snout.

	Gosner stage	BL	TL	BW	FH	EN	NS
MHNG 1020.44-1	25	6.0	10.8	4.4	1.8	0.5	2.0
MHNG 1020.44-2	25	7.3	11.1	5.2	2.5	0.6	2.2
MHNG 1020.44-3	36	10.1	14.4	7.0	3.5	1.2	3.0

*Museum acronyms.*— BM = British Museum (Natural History), London; IRSNB = Institut Royal des Sciences naturelles de Belgique, Brussels; JLA = private collection of J.-L. Amiet; MCZ = Museum of Comparative Zoology, Cambridge; MHNG = Muséum d'Histoire Naturelle Genève; SMF = Senckenbergmuseum Frankfurt/M.; SMNS = Staatliches Museum für Naturkunde, Stuttgart; ZFMK = Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn; ZMB = Humboldt Museum, Berlin.

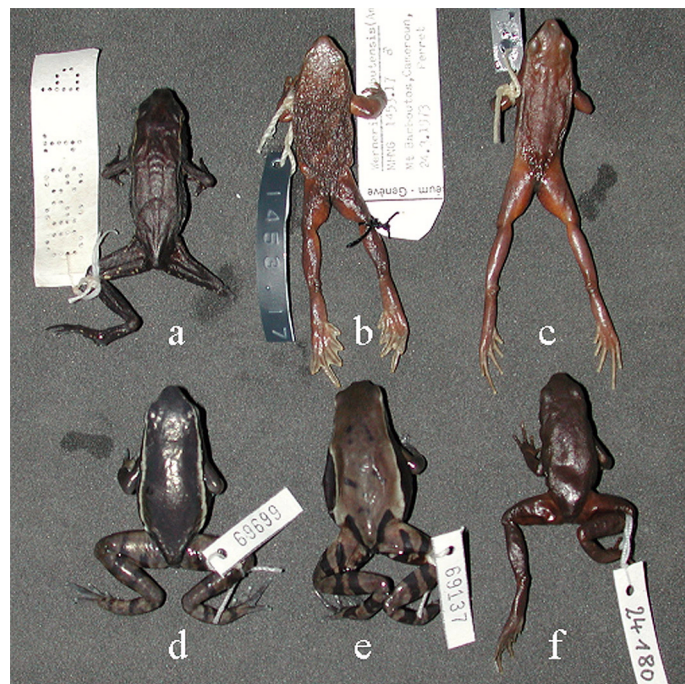
## Results

### *Werneria bambutensis* (Amiet, 1972)

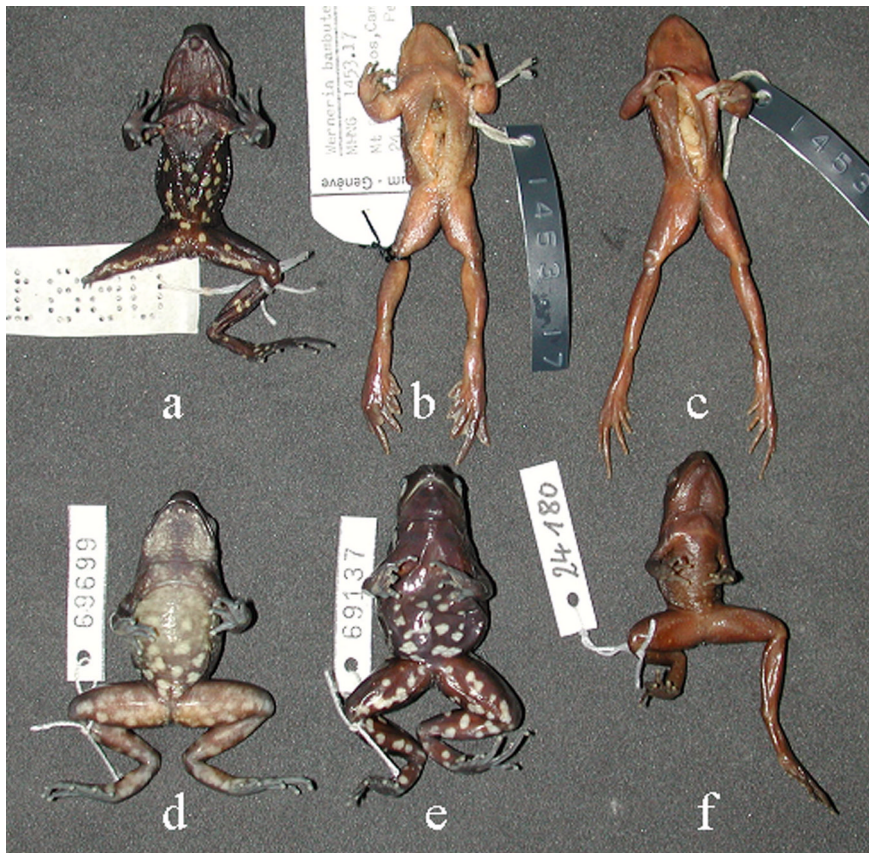
Figs. 1b, 2b, 3b, 4b

*Holotype.*— MHNG 1253.92 (formerly JLA 71.026), female, Mts. Bamboutos, app. 2,600 m, Cameroon, 21.II.1971, J.-L. Amiet.

*Additional material examined.*— MHNG 1453.17–19, two males, one female, Mts. Bamboutos, top of mountain, Cameroon, 24.III.1973, J.-L. Perret.



**FIGURE 1:** Dorsal view of *Werneria* species; a: *W. iboundji* nov. sp. female, holotype, IRSNB 1929; b: *W. bambutensis* male, MHNG 1453.17; c: *W. tandyi* male, MHNG 1453.21; d: *W. submontana* nov. sp. male, holotype, ZFMK 69699; e: *W. mertensiana* male, ZFMK 69137; f: *W. preussi* male, SMF 24180.

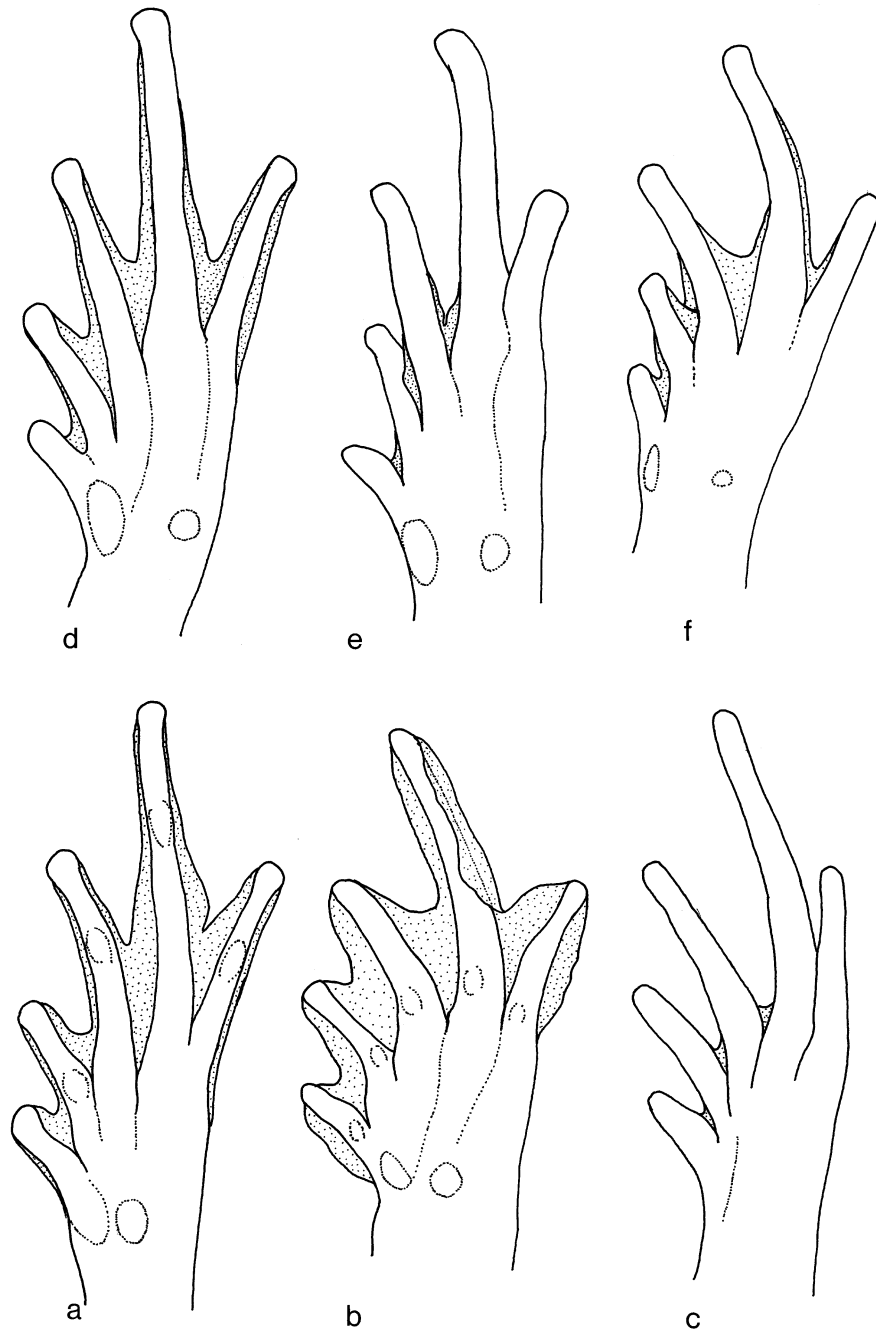


**FIGURE 2:** Ventral view of *Werneria* species; a: *W. iboundji* nov. sp. female, holotype, IRSNB 1929; b: *W. bambutensis* male, MHNG 1453.17; c: *W. tandyi* male, MHNG 1453.21; d: *W. submontana* nov. sp. male, holotype, ZFMK 69699; e: *W. mertensiana* male, ZFMK 69137; f: *W. preussi* male, SMF 24180.

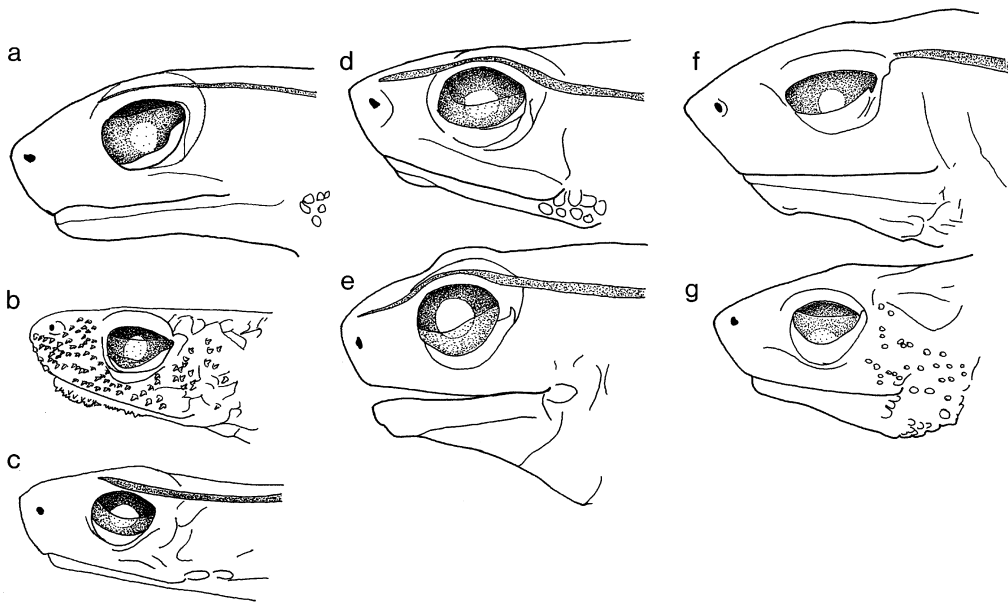
*Diagnosis.*— Smallest *Werneria* species; compact body; rounded snout; skin with micro-reticulation; neither sex with distinct, clear dorsolateral lines; belly without white spots; hind legs short and thick, without black bars, toes completely webbed; enlarged terminal phalange; head of males beset with minute spines; first finger of reproductive males with smooth, subdigital excrescence.

*Description.*— Males reach 28.4–32.5 mm SVL, females 30.4–38.0 mm; compact body shape; snout short and broad but rounded, not truncate; skin dull with micro-reticulation (Fig. 1b); dorsum in life dark greenish olive, in alcohol uniform brown to black, sometimes clear bronze with a gold shimmer or with blackish speckles; no obvious division between back and flank colour, however flank slightly darker in colour; no clear dorsolateral lines, only rarely traces of these lines on sides of head; no black bars on hind legs; ventral surface varies from uniform grey, to a dirty white, or whitish venter with greyish spots (Fig. 2b); hind legs comparatively short and thick; toes fully webbed (Fig. 3b); webbing more extensive during the reproductive season and more pronounced in males than in

females; sides of head and lower jaw in males densely beset with minute spines (Fig. 4b); first finger of reproductive males with smooth, subdigital excrescence; finger and especially toes of both sexes swollen during reproductive season.



**FIGURE 3:** Left hind feet of *Werneria* species, webs are stippled; a: *W. iboundji* nov. sp. female, holotype, IRSNB 1929; b: *W. bambutensis* male, MHNG 1453.17; c: *W. tandyi* male, MHNG 1453.21; d: *W. submontana* nov. sp. male, holotype, ZFMK 69699; e: *W. mertensiana* male, ZFMK 69137; f: *W. preussi* male, SMF 24180.



**FIGURE 4:** Heads of *Werneria* species, illustrating shape of snout, dorsolateral lines (stippled), warts and spines; a: *W. iboundji* nov. sp. female, holotype, IRSNB 1929; b: *W. bambutensis* male, MHNG 1453.17; c: *W. tandyi* male, MHNG 1453.21; d: *W. submontana* nov. sp. male, holotype, ZFMK 69699; e: *W. mertensiana* male, ZFMK 69137; f: *W. preussi* female SMF 24159; g: *W. preussi* male, SMF 24180.

*Natural history.*— *W. bambutensis* is a montane species of the Cameroon highlands, rarely occurring below 2,100–2,200 m a.s.l. It inhabits grassland as well as forest strips along fast-flowing streams. In the dry season it was found below stones in torrent water (Amiet 1972, 1975, 1976b; Gartshore 1984). The extensive webbing suggests a more aquatic life than that of other species of the genus. Adults and gravid females have been seen by J.-L. Amiet on Mt. Manengouba in February. Two dissected females contained 380 and 483 unpigmented eggs (2 mm dia., Amiet 1976b). On Mt. Manengouba tadpoles were abundant in fast flowing streams (Amiet 1976b). These tadpoles are similar to those of *W. preussi* but have a more robust body that is dark brown. The tail is speckled with golden chromatophores (Amiet 1972). In the rainy season after reproduction is completed, adults appear to disperse into open bamboo glades and relict forests (Amiet 1975, 1976b). *W. bambutensis* tolerates dry seasons longer than two months, and lower temperatures at greater temperature ranges and higher altitudes than any other species of the genus (Amiet 1972). The other two *Werneria* species occurring on Mt. Manengouba (*W. tandyi* and *W. mertensiana*) are separated from *W. bambutensis* along an altitudinal gradient (Amiet 1975, 1976b). According to Amiet (1976a, 1989), *W. bambutensis* is mute.

*Distribution.*— *W. bambutensis* was described from Mts. Bamboutos, Cameroon, at 2,600 m a.s.l. (Amiet 1972). It is known to occur at high altitudes between the Mts.



Manengouba and Okou in Cameroon (Fig. 5; Amiet 1972, 1975, 1976b). One male was caught at 1,750 m in the valley of Jungwé River, near Mouandong, southwest flank of Mt. Manengouba. Gartshore (1984) speculated that it might occur at Santa. This was confirmed by J.-L. Amiet (pers. comm.) who collected an adult female (JLA 75.331) on Mt. Neshele at about 2,200 m a.s.l.

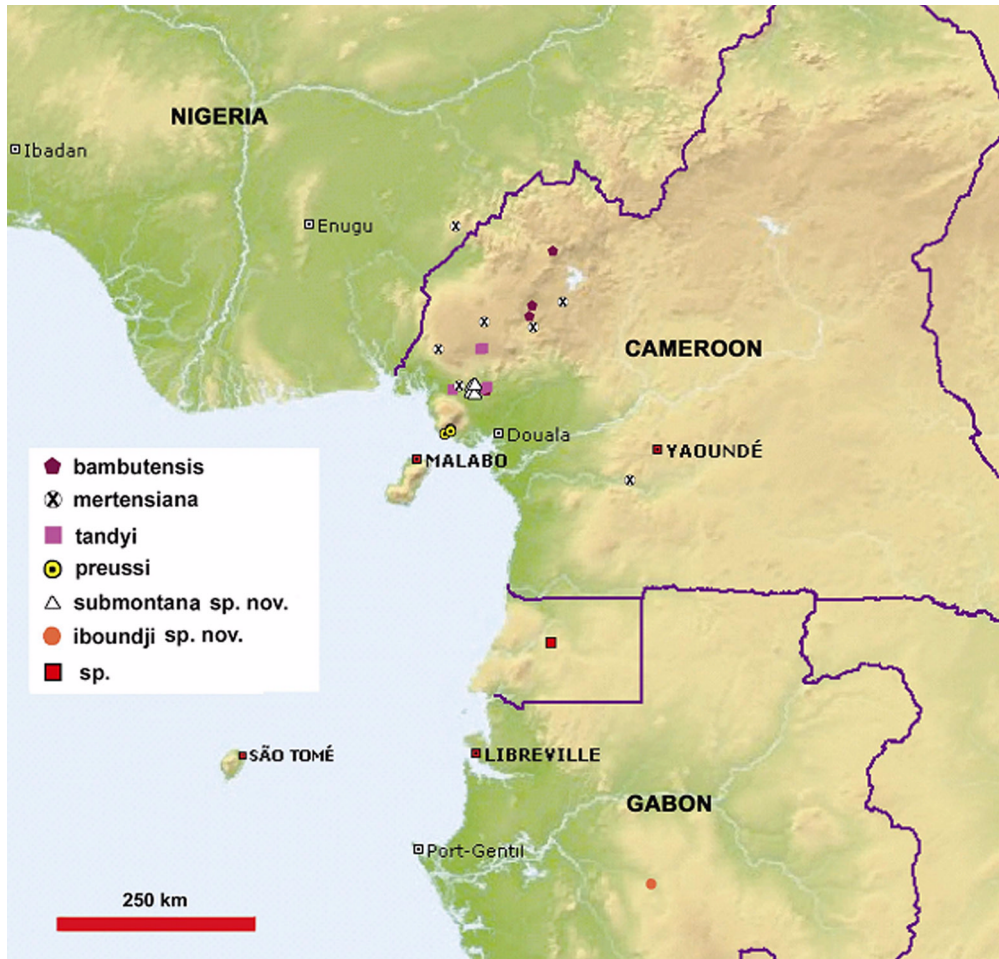


FIGURE 5: Distribution of known *Werneria* species; compare with text.

***Werneria tandyi* (Amiet, 1972)**

Figs. 1c, 2c, 3c, 4c

*Holotype*.— MHNG 1253.93 (formerly JLA 71.912), male, Nsong, Mt. Manengouba, app. 1,400 m, Cameroon, 29.III.1971, J.-L. Amiet.

*Additional material examined*.— MHNG 1453.20–22, three males, Nsong, Mt. Manengouba, Cameroon, 29.III.1973, J.-L. Perret; MHNG 1020.44, three tadpoles, 3.I.1959, otherwise same data as MHNG 1453.20–22.

*Diagnosis.*— Medium sized, very slender *Werneria*; dorsum dark with white very well-delimited dorsolateral lines; back skin smooth but dull; venter with minute clear spots; hind legs thin and long, covered with flattened tubercles; hind legs without black bars; toes are straight and only show traces of webbing.

*Description.*— This species has a longer, more slender and more parallel body shape than the other *Werneria* species (Fig. 1c). Males reach 28.4–35.0 mm SVL, females 37.4–41.2 mm. It has a straight and pointed head (Fig. 4c); dorsum uniform chocolate brown; or slightly silverish white, with white very well-delimited dorsolateral lines (1 mm wide); hind legs without black bars, coloured like back; flanks very dark to black; venter clear brown (Fig. 2c), sometimes nearly yellowish grey, with scattered minute (0.3–0.5 mm) white or yellow spots, that may be absent on the throat and ventral surfaces of the hind legs; hind legs are thin and long and covered with flattened tubercles (hence skin appearing granular); rest of dorsal skin smooth but dull; whitish tubercles might be present on the dorsal surface of thighs, especially in subadults; toes are very straight and almost smooth, with only traces of webbing (Fig. 3c). With the exception of nuptial pads on the first finger no obvious sexual characters are visible. However, Perret (1966) described a male (as *B. preussi*) completely covered with spinulae, especially on the head and on the breast.

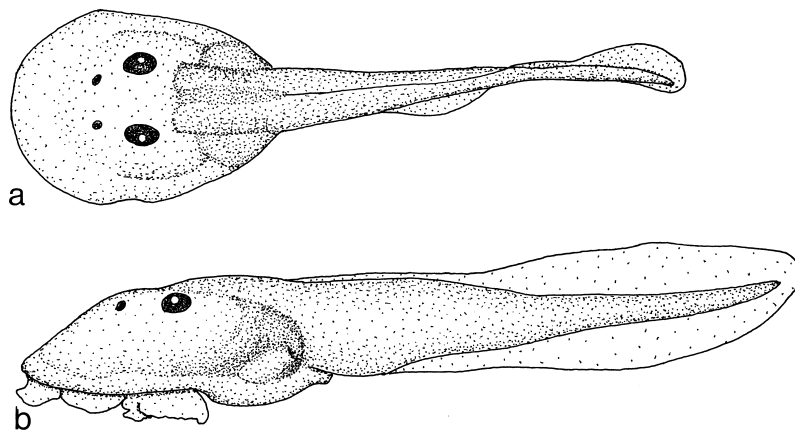
*Tadpole description.*— The MHNG collection includes three tadpoles collected by J.-L. Perret at Nsong, Mt. Manengouba, and assigned by him to *W. tandyi*. We herein figure and describe briefly these typical *Werneria* tadpoles. Body very broad and dorsoventrally flattened (Fig. 6a, b); eyes and nostrils positioned dorsally; nostrils much closer to eyes than to snout; short and very muscular tail; tail fin inserting approximately at body end; only posterior half of tail with broader fin, rounded at tail tip; spiraculum sinistral, invisible from dorsal view; large sucker-like mouth; labial tooth row formula is 2 / 3; upper jaw small, in form of a compressed 'm'; only narrow part of upper and lower jaws distinctively keratinized (black colour) (Fig. 7); median vent tube; dorsal colour brown, anterior part of body and venter nearly hyaline; fin hyaline without pattern. Measurements of the three tadpoles are summarized in Tab. 4. As these tadpoles were not raised from eggs obtained from known parents and two other *Werneria* species are known from Mt. Manengouba, species affiliation should be taken as tentative.

*Natural history.*— *W. tandyi* is a frog with a typical submontane distribution, occurring at altitudes of 1,000–1,700 m. The habitat is characterized by cool temperature, low insolation, high precipitation and frequent mist. At Mt. Manengouba *W. tandyi* lives at 1,350–1,750 m a.s.l. A specimen from Dikome Balue was found at 1,000 m. This toad occurs on the verges of fast-flowing streams, often under stones and always in forest habitats. Several individuals may cluster together on rocks in the splash zone. Males with nuptial callosities have been collected from the end of November to the end of March. *W. tandyi* was most often encountered in the dry season. Gravid females have been collected at the end of March, whilst migrating during daytime. It is thus likely that the species reproduces at the beginning of the rainy season (Amiet 1972). A dissected female con-

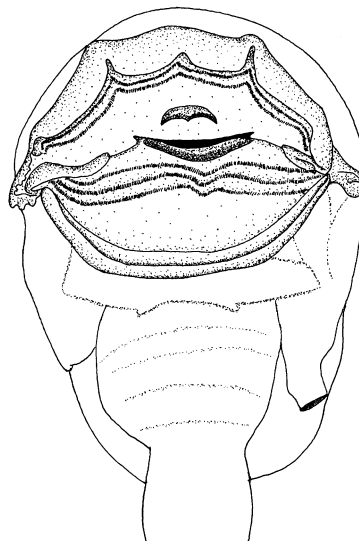
tained 629 unpigmented eggs (1.5 mm dia., Amiet 1976b). Amiet (1976a) described and figured a call (described as "tiuc" or "hui") for the species, but did not consider it to be an advertisement call. Instead he believed it to have some territorial function.

*Distribution.*— *W. tandyi* was described from Nsoug on Mt. Manengouba, Cameroon, at 1,400 m a.s.l. It was formerly thought to be endemic to Mt. Manengouba, and reported from Nsoug (1,400–1,600 m), Mwandong (1,350 m) and near Nkongsamba (1,650 m), but is now also known from the Rumpi Hills (Dikome Balue, Gartshore 1984; Amiet pers. comm.; Fig. 5). It is known from the source of the Nsoug waterfall at 1,700 m at, but was not recorded above 1,750 m in the Jungwé valley (Amiet 1975).

*Taxonomic remarks.*— This toad was reported as *B. preussi* by Perret (1966).



**FIGURE 6:** Dorsal (a) and lateral view (b) of a *Werneria* cf. *tandyi* tadpole, Gosner stage 25 (MHNG 1020.44-1).



**FIGURE 7:** Mouth part and ventral view of a *Werneria* cf. *tandyi* tadpole, Gosner stage 25 (MHNG 1020.44-2).

***Werneria preussi* (Matschie, 1893)**

Figs. 1f, 2f, 3f, 4f, 4g, 8a

*Type series.*— ZMB (originally 60 specimens), BM 1935.2.8.3, MCZ 10296, Buëa, Mt. Cameroon, Cameroon, 950 m (type series not seen).

*Topotypic material examined.*— SMF 24157–24161, 24180–24184, two males, five females, three juveniles, Buëa, below waterfall, Cameroon, 30.X.–11.XI.1937, R. Mertens; ZFMK 14904, female, Buëa waterfall, Cameroon, 20.–22.III. 1974, W. Böhme & W. Hartig; MHNG 918.49, male, MHNG 1019.85–88, one male, two females, one juvenile, Buëa, waterfall, Cameroon, R. Mertens; MHNG 1453.26–33, seven juveniles and tadpoles, Buëa, waterfall, Cameroon, J.-L. Perret.

*Additional material examined.*— SMNS 1814.1–2, one male, one female, Mueli, 500 m a.s.l., Mt. Cameroon, Cameroon, 1958, M. Eisentraut; ZFMK 15704, male, Fako, Nyasoso, 900–1,100 m a.s.l., Mt. Kupe, Cameroon, 8.IV.1954, M. Eisentraut; ZFMK 75580 (cf. *preussi*), male, Nyasoso, 1,100 m a.s.l., Mt. Kupe, Cameroon, 18.–21.I.2000, A. Schmitz.

*Diagnosis.*— A large *Werneria* with an obliquely truncate snout; juveniles and males with clear and broad dorsolateral lines of variable colour, large females with uniform back; venter uniform dark or with only small clear spots; juveniles with blackish bars on hind legs; toes moderately webbed; reproducing males with nuptial pads on thumb and second finger, spinulae on the body.

*Description.*— A medium sized toad with an obliquely truncate snout (Fig. 4f–g); males reach 30.2–43.5 mm SVL, females 43.5–49.2 mm; males and females with or without small warts at the angle of the mouth; back in males and younger females with brick-red, yellowish or smoky-grey dorsolateral bands, that stretch from the eyelid to the groin area; dorsolateral bands broad (up to 2 mm) but not well delimited against the back or flanks (Fig. 1f); adult females seem to have a uniform dark brown dorsum (Fig. 8a); flanks brown or black; lower flanks in some females with clear spots, venter in both sexes dark brown to almost black (Fig. 2f); males with numerous small whitish or yellowish spots; adult males may also show a few large clear spots on the posterior venter; blackish transversal bars on thighs, lower leg and foot are visible in juveniles, but vanish in adults; webbing of hind legs moderate, more extensive in males than in females (Fig. 3f); males in breeding condition have nuptial pads on thumb and second finger and spinulae on the body (Fig. 4g); colour of nuptial pads almost indistinct from rest of hand; females with more or less smooth venter.

*Natural history.*— *W. preussi* exclusively lives in creeks at altitudes of 700–1,200 m a.s.l. It prefers fast flowing creeks with many stones and few plants. At the type locality it appears to be the most abundant anuran. The toads live exclusively in and around water, and try to escape into water when disturbed. Preferred daytime retreats are cavities below stones in or beside water. They are active at night, and then can be found climbing on rocks. Reported prey mostly consisted of beetles (Mertens 1938b, 1940). The toads hide

during the dry season (Mertens 1938b, 1940). Amiet (1972) suppose that the lack of streams at high elevations on Mt. Cameroon may impose an altitudinal limit on the species. Mertens (1938b) also describes and figures (plate 2 fig. 5) the tadpole of this species, collected during February. The tadpole is dorsoventrally flattened, has a broad head, narrow rounded tail, eyes and nostrils positioned dorsally, median vent tube, and sinistral spiraculum. The mouth is sucker like and has a typical bufonid tooth row formula of 2 / 3 (Amiet 1989; Lamotte and Lescure 1989). Dorsal colour is described as a clear greyish brown with two broad black transverse bars, one on head, the other on back. The ventrum is uniform clear grey, the tail bears no pattern. One tadpole with 26.5 mm total length had fully developed hind legs. Freshly transformed toads measure 9.2–9.8 mm (Mertens 1938b). According to Boulenger (1906) and Perret and Amiet (1971) this species lacks a vocal sac and is mute.



**FIGURE 8:** a: *W. preussi* female from Buëa, Mt. Cameroon; b: *W. submontana* nov. sp. male, Bakossi Mts., Lake Edib; c: *W. mertensiana* male, Mt. Kupe (photo: K.-H. Jungfer); d: ventral view of *Werneria* sp., Monte Alén National Park, Equatorial Guinea (photo: I. de la Riva).

*Distribution.* *W. preussi* was described and most often reported from Buëa, southeast flank of Mt. Cameroon, about 1,170 m a.s.l. (e.g. Boulenger 1906; Nieden 1908; Perret 1966, Fig. 9). Some *W. preussi* records from other localities were based on other *Werneria* species (Perret 1966, *W. tandyi* in part; Perret and Amiet 1971, *W. mertensiana* in part). A record from Bismarckburg in Togo (Werner 1898) is thought to be an error (Boulenger 1906; Mertens 1938b; Perret 1966; Amiet 1972). However, Frost (2002) still lists "highlands of west-central Togo and southwestern Cameroon" as the range of this species (see below). According to Amiet (1972; pers. comm.) and Gartshore (1984), *W. preussi* is known from Buëa, Mt. Etinde and the Tolé Tea Estate on the lower slopes of Mt. Cameroon. We herein add a specimen from Mt. Kupe, collected by M. Eisentraut at 900 m (ZFMK 15704, see also Böhme & Schneider 1987). Another record from this locality was originally identified as *Arthroleptis bivittatus* by Mertens (1968) and later assigned to *W. mertensiana* (Böhme 1975). A more recently collected specimen, ZFMK 75580, from Mt. Kupe was not clearly assignable but also appeared to be most likely *W. preussi*. A wider range of *W. preussi* within the Cameroonian highlands thus seems possible (Fig. 5).

*Taxonomic remarks.*— This toad was described by Matschie (1893) as *Bufo preussi*. Synonyms of this species include *Stenoglossa fulva* Andersson, 1903 (Mertens 1938b, 1940; Amiet 1972), and *Atelopus africanus* Werner, 1898 (Nieden 1923; Lötters 1996). Lötters (1996) re-examined one of the *Atelopus africanus* syntypes from Bismarckburg, Togo and confirmed that it is conspecific with *W. preussi*. Although it is possible that the Togolese locality is erroneous, it would be worthwhile checking the type locality of *A. africanus* again.



**FIGURE 9:** Buëa waterfall on Mount Cameroon (1974), the type locality of *Werneria preussi*. Compare W. Böhme for scale.

***Werneria mertensiana* Amiet, 1976**

Figs. 1e, 2e, 3e, 4e, 8c, 10b

*Holotype*.— MHNG 1253.91 (formerly JLA 70.380), male, Mt. Nlonako, surroundings of Nkongsamba, 1,000 m, Cameroon, 21.III.1970, J.-L. Amiet.

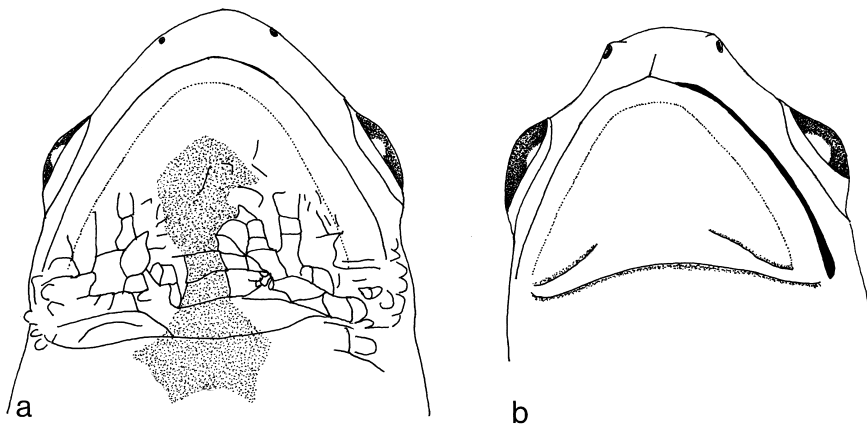
*Additional material studied*.— MHNG 1453.23, female, Kala river, under stone, ca. 800 m a.s.l., Yaoundé, Cameroon, 13.V.1969; MHNG 1453.24–25, two males, Nkolodou, Lékié valley, Yaoundé, Cameroon, III.1969, J.-L. Perret & J.-L. Amiet; ZFMK 69127-144, 72040-041, four males, seven females, nine juveniles, Mt. Nlonako, above Nguengué, 1,100–1,200 m a.s.l., Cameroon, 23.VI.–6.VII.1998, H.-W. Herrmann & A. Schmitz; ZFMK 75396-397, 75414, two males, one juvenile, Mt. Nlonako, Nguengué, ca. 1,100 m a.s.l., Cameroon, 18.–21.I.2000, H.-W. Herrmann & A. Schmitz; ZFMK 78242-243, 78251-252, female and juveniles, Mt. Nlonako, Nguengué, 1,000–1,100 m a.s.l., Cameroon, 25.III.2001, H.-W. Herrmann *et al.*; IRSNB 13072.1–2, male and female, 75 km W of Yaoundé, Cameroon, 10.X.1975, M. Lamotte.

*Diagnosis*.— Large *Werneria* with short, nearly truncate snout; back dark with clear dorsolateral lines; urostyle bordered by a pair of longitudinal black lines; flanks uniform black; belly with large clear spots; throat black or with only minute clear points; skin of throat smooth; hind legs and feet with distinct black bars; moderate webbing more or less reduced to bases of toes.

*Description*.— Median sized, compact toad with very short, nearly truncate snout (Figs. 4e, 10b); males reach 31.8–41.0 SVL, females 39.6–47.7 mm; greyish brown to reddish brown back; flanks are uniform black; white dorsolateral lines (about 1 mm broad) on the snout or just anterior to eye extend above the eye to the groins (Fig. 4e, 8c); dorsolateral line well delimited against flanks, less conspicuously against back; urostyle bordered by a pair of longitudinal black lines; thighs, lower legs and feet usually with two (rarely three) distinct black bars (Fig. 1e), otherwise same colour as back; basic colour of venter dark black, between the forearm bases the venter is covered with irregular large white spots that range from 4–20 mm and cover the ventral sides of body and extremities (Fig. 2e), throat and anterior part of breast are more or less black, but may show some small white points; hind legs with granulated skin, especially in females; moderate webbing more or less reduced to bases of toes (Fig. 3e); males with nuptial pads on first finger. Even very small juveniles (e.g. ZFMK 75483, SVL 10.4 mm) exhibit the same coloration as adults. White spots on the belly are always larger than in similar-sized specimens of the new *Werneria* species from the Bakossi Mts. and Mt. Kupe (see below).

*Natural history*.— *W. mertensiana* is a widespread, rock-loving, submontane species that is restricted to mountain bases and foothills (Gartshore 1984). Most, but not all, specimens have been found above 800 m a.s.l. (Amiet 1975). At Mt. Manengouba *W. mertensiana* is replaced at higher altitudes by *W. tandyi* and *W. bambutensis* (Amiet 1975). It lives in small streams with waterfalls (Amiet 1972, 1976b; Gartshore 1984). Amiet and Perret (1969) and Amiet (1986) report *W. mertensiana* (as *Bufo preussi* or as *Werneria p. mertensiana*).

*siana*) from the Yaoundé region at about 800 m. There it lives in primary rainforest in small rivers with clear, turbulent water and a sandy or stony bed. Specimens have been found hiding under stones during the day, sometimes within the splash zone of waterfalls. Lawson (1993) reported *W. mertensiana* from the lower limit of the submontane zone (850–1,050 m). In early September he collected three active toads in leaf litter, far from streams, around midday. He also collected an unidentified *Werneria* tadpole, probably belonging to this species, in the Rumpi Hills near Dikome Balue. *W. mertensiana* is said to utter a call similar to that of *W. tandyi* (Amiet 1976a).



**FIGURE 10:** Throats of male *Werneria*; a: *W. submontana* nov. sp. male, holotype, ZFMK 69699, the wrinkled throat is coloured greyish yellow with clear spots and a central blackish figure; b: *W. mertensiana* male, ZFMK 69137, the smooth throat is coloured uniform black.

*Distribution.*— *W. mertensiana* was described from the Mt. Nlonako in the vicinity of Nkongsamba at 1,000 m a.s.l. (Amiet 1972). It also occurs at Abang on Mt. Manengouba at 950 m, 40 km north of Kumba on the Kumba-Mamfe road at Fotabong at 900–1,000 m, and around Yaoundé including Mt. Kala and Mbam-Minkoum at 800 m (Amiet 1972; Joger 1982; Gartshore 1984; Fig. 5). It may occur on the southern and western slopes of the Bamiléké Plateau, and perhaps on the Obudu Plateau (Amiet 1972, 1975). Records from Mt. Kupe (e.g. Hofer *et al.* 2000) and the Bakossi Mts. most likely belong to a new species (described below). However, as vouchers were not accessible to us, this could not be confirmed. Mt. Kupe records might be also based on *W. preussi* (see above) or toads that are intermediate between *W. preussi* and *W. mertensiana* (as suggested by J.-L. Amiet pers. comm.). However, we never recorded any intermediate looking *Werneria* on Mt. Kupe. Other *W. mertensiana* records are known from Mt. Nta Ali massif, Cameroon (Lawson 1993) and Monte Alén in Equatorial Guinea (de la Riva 1994). However, the latter record probably does not refer to *W. mertensiana* (see discussion).



*Taxonomic remarks.*— The species was described in 1972 by Amiet as *Bufo mertensi*. Because this name was a junior homonym of *Bufo ictericus mertensi* Cochran, 1950, Amiet proposed the replacement name *W. mertensiana* (Amiet 1976b). Later Amiet (1986, 1987) treated this taxon as a subspecies of *W. preussi*, a decision that was followed by de la Riva (1994), but not in the most recent list of "Amphibian species of the World" (Frost 2002). The disjunct records of *W. preussi* from Buëa and Mt. Kupé, and the clear morphological distinctiveness of *W. preussi* and *W. mertensiana* are strong arguments against a subspecific relationship of these two taxa. Hence, we agree with Frost (2002) in treating *W. mertensiana* as a full species.

***Werneria submontana* nov. sp.**

Figs. 1d, 2d, 3d, 4d, 8b, 10a

*Holotype.*— ZFMK 69699, adult male, Bakossi Mts., Edib Hills, Lake Edib, N 4°57', E 9°39', 1,100 m a.s.l., Cameroon, 5.–7.V.1998, C. Wild.

*Paratypes.*— ZFMK 67271, juvenile, 1,250 m a.s.l., 14.I.1998, O. Euskirchen, other data as holotype; ZFMK 69747, adult male, same data as holotype; ZFMK 69698, 69700, adult female and male, Bakossi Mts., Edib Hills, Elabah Camp, 1,100 m a.s.l., Cameroon, 5.–7.V.1998, C. Wild; ZFMK 67272, 67781–785, six juveniles, Bakossi Mts., Mwendelengo Mts., Kodmin, 1,070 m a.s.l., Cameroon, 18.–25.XII.1997 & 24.I.1998, O. Euskirchen & A. Schmitz; ZFMK 67786, adult male, Maked, Cameroon, 8.–10.I.1998, A. Schmitz; ZFMK 67787–796, ten juveniles, Mt. Kupe, south-west side (north-west flank in catalogue of ZFMK), Nyasoso, 910 m a.s.l., Cameroon, 18.–25.XII.1997, A. Schmitz.

*Diagnosis.*— A medium-sized, slender but compact *Werneria* with short and rounded snout; skin of flanks and throat wrinkled, at least in adult males, otherwise skin smooth; a distinct, broad white, yellowish or reddish dorsolateral line occurs on the dark brown dorsum; urostyle bordered by a pair of longitudinal black lines; lower flanks with large clear spots; greyish venter with large clear spots, toes nearly fully webbed. Superficially this species is most similar to *W. mertensiana*, *W. preussi* and the new Gabonese species (see below). From the Gabonese species and *W. bambutensis*, *W. submontana* nov. sp. differs by its less-developed webbing and from *W. tandyi*, *W. mertensiana* and *W. preussi* by its more extensive webbing. It differs from the Gabonese species by a different body shape and much broader dorsolateral lines. With *W. mertensiana* it shares the black bars on hind legs and the black borders of the urostyle, but differs by its wrinkled flanks that bear clear spots on the ventral part, the more distinctly dorsal border of the dorsolateral lines and head shape. From *W. preussi* it differs by its dorsal and ventral coloration. It differs from all *Werneria* species by the wrinkled skin on throat (at least in adult males).

*Description of the holotype.*— The holotype is an adult male with slender but compact body shape (Fig. 1d); 35.4 mm SVL; short, broad but rounded snout; head width 11.3 mm, eye diameter 4.0 mm; interorbital distance 4.6 mm; naris closer to snout tip (2.4 mm) than

to eye (3.1 mm); small warts at angle of mouth (Fig. 4d), skin of back and venter smooth; broad (2 mm at mid-body) white dorsolateral lines that extend from snout to groins; dorso-lateral line distinctly separated from back and flank coloration and broadened posteriorly; back dark grey; blackish flanks with granular skin, lower flanks with white spots; back uniform dark brown to black; urostyle bordered by black lines; dorsal surfaces of extremities dark brown with two black bars on thighs, lower leg and feet (Fig. 1d); basic colour of venter brownish grey; posterior venter with large (> 4 mm) yellowish spots; breast and throat grey with a dark ventral figure on throat and few smaller yellowish spots; skin of throat wrinkled (Figs. 2d, 10a); ventral surfaces of thighs and lower leg reddish brown with large yellowish spots on the whole surface; long, but broad, hind legs, femur length 16.7 mm, tibia 17.2 mm, foot (incl. longest toe) 25.2 mm; toes 2, 3 and 5 completely webbed, tip of toe 1 and external side of toe 4 without web (Fig. 3d).

*Variation and colour in life.*— Adult males SVL ranged from 31.3–35.4 mm, the only adult female measured 44.5 mm. The smallest juvenile was 10.5 mm long. Other measurements of paratypes are summarized in Tables 1–3. Body dimensions and colouration generally were as in the holotype. Other adult males also had a wrinkled skin on throat. The female's throat was only faintly wrinkled. Warts at angle of mouth may be difficult to see or absent. Juveniles generally differ from adults by having smooth skin on flanks and throat.

In life these toads have a golden iris; dorsal colour dark brown to black; pale, whitish, pink or orange-red dorsolateral stripes (Fig. 8b), very faint in the one adult female; upper part of flanks dark brown to black, lower part of flanks with yellowish spots that may be hard to see in juveniles; belly dark grey with numerous cream speckles; belly generally with larger spots than breast and throat, however, in some specimens not exceeding 1–2 mm in size; femur, tibia, foot brownish with two black bars on each; forefeet and fingers with yellowish spots.

*Natural history.*— *W. submontana* occurs in an altitudinal range of about 800–1,200 m a.s.l., occasionally it may be found at lower altitudes (see below). This species was found in broad daylight either under rocks in a partly dried up river basin (Kodmin; Fig. 11b), or on stony ground between wet, very low vegetation which was lying in the spray area of a small, artificial waterfall (Mt. Kupe; Fig. 11c). The habitat at the base of Mt. Kupe, where this species seem to live in sympatry with *W. preussi* (see above), was within a transition zone between good quality secondary forest, and more-or-less undisturbed primary forest at 910 m a.s.l. M. Gartshore (pers. comm.) found these toads near the same locality a little lower at 850 m a.s.l., under rocks during the day along a stream on the grounds of the Nyasoso Girls Secondary School, above the school reservoir, just outside town. The very wrinkled throat of adult males may indicate that this species utters an advertisement call.



**FIGURE 11:** Habitats of *Werneria submontana* nov. sp. on the Bakossi Mts.; a: Edib Hills, surroundings of Lake Edib (type locality); b: small forest creek on Mwendelengo Mts., Kodmin, several of the paratypes have been collected beneath the stones on the creek's bank; c: water-catchments at Mt. Kupe; the toads were living in the spray zone of the small, artificial waterfall.

*Distribution.*— Known from the Bakossi Mts., Mwendelengo Mts. and Nyasoso at the base of Mt. Kupe (Fig. 5). Judging from pictures kindly provided by M. Gartshore, the 38 *W. mertensiana* specimens recorded by her in February and April in the streams around

Nyasoso at 850 m on the western slope of Mt. Kupe (Gartshore 1984) are *W. submontana*. Likewise a specimen collected by Amiet (1975, 1976b) in the vicinity of Nkongsamba (Maholé, 10 km north-west of Tombel, forest reserve of Bakossi, primary rainforest, 300–350 m a.s.l.), may belong to this new species. *W. submontana* might also occur on the Rumpi Hills, as characters of three preserved specimens from Mofako showed characters that best fit this new species (photos provided by J.-L. Amiet).

*Etymology*.— The name *submontana* indicates the altitudinal range of this new species.

***Werneria iboundji* nov. sp.**

Figs. 1a, 2a, 3a, 4a

*Holotype*.— IRSNB 1929, adult female, Ogooué-Lolo province, department of Offoué-Onoy, Massif du Chaillu, east flank of Mt. Iboundji, S 1°8'42", E 11°46'48", 560 m a.s.l., in the large waterfall, Gabon, 21.IX.2001, O.S.G. Pauwels.

*Paratypes*.— ZFMK 81550, juvenile, other data as holotype.

*Diagnosis*.— A medium sized, slender *Werneria* with truncate snout and smooth skin; distinct but very narrow dorsolateral line, otherwise uniform dark brown dorsum; flanks uniform black; venter with large clear spots, restricted to median line on lower parts of hind legs; toes fully webbed. *W. iboundji* nov. sp. is similar to *W. mertensiana*, *W. preussi* and *W. submontana* nov. sp. It differs from all these species by the complete webbing of the feet, the more slender body and longer and thinner hind legs. From *W. mertensiana* and *W. submontana* it further differs by lacking black bars on the thighs and lower legs, and the much thinner dorsolateral line. In contrast to *W. submontana* the flanks are uniform black. From *W. preussi*, *W. tandyi* and *W. bambutensis* it differs by its ventral coloration. With *W. bambutensis* it shares fully webbed toes, but may also be easily distinguished by its general appearance and coloration. At present it is also geographically well-separated from all other *Werneria* species.

*Description of the holotype*.— The holotype is an adult female with a slender body; body lines almost parallel (Fig. 1a); short, truncate snout; 37.7 mm SVL; head width 10.8 mm, eye diameter 4.5 mm; interorbital distance 4.1 mm; naris closer to snout tip (2.6 mm) than to eye (3.2 mm); small warts at angle of mouth (Fig. 4a), otherwise skin smooth; narrow (0.7 mm at mid-body) yellowish white dorsolateral lines that extend from anterior part of eyelid to groin; back uniform dark brown to black; flanks uniform black; basic colour of venter dark brown to black; posterior venter with large (> 4 mm) yellowish spots; breast and throat uniform dark reddish brown (Fig. 2a); dorsal surfaces of extremities with same coloration as back, no black bars on thighs and lower leg; ventral surfaces of thighs and lower leg with large yellowish spots along median line, no such spots at sides of extremities; long and slender hind legs, femur length 15.9 mm, tibia 16.1 mm, foot (incl. longest toe) 24.6 mm; toes completely webbed (Fig. 3a).

In life the background colour of the eye was dark golden. The black, horizontally elliptic pupil, was encircled by an orange ring. The dorsum was dark brown, separated from the black flanks by a white dorsolateral line. The throat, belly and underside of arms and legs were black with white spots.

*Variation.*— The only other known specimen is a juvenile from the type locality, 16.3 mm SVL; head width 5.7 mm, eye diameter 2.9 mm; interorbital distance 2.7 mm; nostril to snout tip (1.1 mm), nostril to eye (1.2 mm); femur length 7.7 mm, tibia 6.6 mm, foot incl. longest toe 11.4 mm; toes also completely webbed; clear spots also on breast and throat, other coloration as holotype.

*Natural history.*— Preliminary botanical investigations proved Mt. Iboundji to harbour a submontane forest type (Stévant *et al.* 2004). The holotype and the paratype were caught by day, between rocks in water at the large waterfall of Mt. Iboundji (Fig. 12). The stomach of the holotype contained remains of small ants and ground beetles (Carabidae). Numerous, small, yellow ovarian eggs were present (as the eggs were shrunken and adherent due to preservation, counts and measures are not given). During two visits at the type locality, a total of 20 man-hours were searched for *Werneria*, without detecting more than the two type specimens. Surveys at a second waterfall on Mt. Iboundji, and at many other waterfalls in Gabon, likewise revealed no further *Werneria* specimens (O.S.G. Pauwels unpubl. data).



**FIGURE 12:** Type locality of *Werneria iboundji* nov. sp. at the base of the large waterfall at Mount Iboundji, Gabon. The specimens have been collected among the rocks at the water edge, compare person below arrow for scale (photo: T. Stévant).

*Ethnozoology.*— The vernacular name, recorded by Boussimbi inhabitants, in Mas-sango language was *mboungui*. This frog is said to be very dangerous ("dogs die when

they lick it”; “If a man approaches a large specimen, and if this specimen blows, the man can die”).

*Distribution.*— Only known from type locality (Fig. 5).

*Etymology.*— The species is named after the type locality, Mt. Iboundji, to further highlight the importance of this mountain as an outstanding Central African biodiversity hotspot. The specific epithet is treated as a noun in apposition.

### Key to *Werneria* species

- 1 Belly with larger (> 1–2 mm) white or yellow spots ..... 2
- 1' Belly with only very small (< 1 mm) white points ..... 4
- 2 Hind feet moderately webbed, at least web not extending middle of fourth toe; back clear brown or reddish brown; two dark bars on thighs; urostyle bordered by black stripes ..... *Werneria mertensiana*
- 2' Hind feet with webbing that extends at least to the middle of the medial side of the fourth toe ..... 3
- 3 Hind feet completely webbed; very thin dorsolateral line of equal width along body; flanks uniform black ..... *Werneria iboundji* nov. sp.
- 3' At least fourth toe of hind foot incompletely webbed; dorsolateral line extending posteriorly; lower flanks with clear spots ..... *Werneria submontana* nov. sp.
- 4 Hind feet with only traces of webbing ..... *Werneria tandyi*
- 4' Hind feet webbed ..... 5
- 5 Hind feet not completely webbed; young males and some females with distinct, clear dorsolateral lines ..... *Werneria preussi*
- 5' Hind feet completely webbed; neither sex with distinct, clear dorsolateral lines ..... *Werneria bambutensis*

### Discussion

The generic distinctiveness of *Werneria* from other African toads seems well established (Amiet 1976b; Grandison 1981). Ecologically they are unique in their torrenticolous life style (Amiet 1976b). This ecological niche may have led to the great morphological similarities in adults as well as in tadpoles of *Werneria* with South American *Atelopus* species (Lötters 1996), a group of toads with which *Werneria* formerly was even thought to be congeneric (Werner 1898). Amiet (1976b) suggested that life within a very noisy environment may have favoured the loss of an auditory system (no tympanum, columella, or vocal sac present) as well as the advertisement call, which may be useless in such situations. However, at present J.-L. Amiet (pers. comm.) is less confident about this ecological explanation and tends to take the loss of an auditory system as a general character in

smaller bufonids. How *Werneria* males advertise for females remains unknown. However, most species seem to be very abundant in their patchy habitats and long distance attraction might be unnecessary. Amiet (1976b) also noted that *Werneria* secreted a viscous liquid with a bitter taste when handled, a behaviour that may contribute to the Boussimbi people's belief that *W. iboundji* is very dangerous (see above). *Werneria* may communicate via chemical cues, similar to that hypothesised for *Acanthixalus* species, that also have characteristic odour when handled and are also mute (Perret 1961; Schmitz *et al.* 1999; Rödel *et al.* 2003).

Geographically *Werneria* appears most diverse in the Cameroonian highlands where five of the six known species occur on mountains (Fig. 5). Wherever several species occur on the same mountain they are separated along altitudinal gradients. Species occurring in submontane altitudes (*W. mertensiana*, *W. submontana*, *W. preussi*) may be more widespread than true mountainous species (*W. bambutensis*, *W. tandyi*). This is additionally supported by the present record from Mt. Kupe of *W. preussi*, a species previously thought to be endemic to two localities on Mount Cameroon. The most widespread species of the genus is *W. mertensiana*, whose range extends from the western Cameroonian mountains into the south Cameroonian plateau around Yaoundé.

De la Riva (1994) and Lasso *et al.* (2002) assigned a record of a *Werneria* reported from the Monte Alén National Park in Equatorial Guinea to *W. mertensiana*. They found only one specimen at a creek with stony ground in primary forest. Although they considered the specimen to show the typical pattern for the species, it lacks the two very distinct black bars on thighs and lower leg, typical for *W. mertensiana* (compare Fig. 3d in de la Riva 1994). A colour picture of the venter of the specimen (kindly provided by I. de la Riva; Fig. 8d) shows a pattern closer to *W. iboundji*, i.e. the clear spots on the ventral surface of the hind legs are comparatively small and restricted to the median part of thighs and lower leg, and do not cover the whole ventral surface of lower extremities as in topotypical *W. mertensiana* (Fig. 2e). The extent of webbing is hard to judge from the pictures, but it seems to resemble more the state in *W. mertensiana* (Fig. 4e) than that of *W. iboundji* (Fig. 4a). The specimen was not accessible to us, and probably also will not be accessible in the future as the Equatorial Guinea organization where it was deposited no longer exists (I. de la Riva, pers. comm.). The taxonomic status of the specimen therefore remains problematic. The toad was originally identified by J.-L. Amiet (Amiet pers. comm.) and as this authority hasn't had doubts about its identity, it could have been *W. mertensiana*. However, given the differences to *W. mertensiana*, outlined above, and the huge geographic distance of that record from *W. mertensiana* and *W. iboundji* (Fig. 5), we believe that it is unlikely to belong to either of the species dealt with herein. Thus we suggest that *W. mertensiana* be deleted from the Equatorial Guinea amphibian list (Frétey and Blanc 2000), and that the record be cited as *Werneria* sp. until future investigators can clarify its taxonomic status, in order to avoid the probably mistaken view that *W. mertensiana* is widely distributed in western Central Africa, and thus of less conservation concern. *Werneria* species are highly

adapted to mountainous streams and waterfalls, and thus very patchily distributed. They are therefore potentially vulnerable, particularly to habitat change and thus of probable conservation concern.

Other undescribed *Werneria* species may still exist, e.g. we were unable to identify several juvenile voucher specimens (which were either too small, or had lost characters in alcohol) from other parts of Cameroon. The high diversity of the West Cameroonian mountains might be due to these mountains acting as forest refugia during drier Pleistocene (Amiet 1987; Weber *et al.* 2001) or pre-Pleistocene times (Plana *et al.* 2004). Judging from the recent species' distributions, the genus *Werneria* possibly evolved within the area of the Kupe, Bakossi, Manengouba and Nlonako mountains. All five Cameroonian species are known from this region.

*W. bambutensis* is distinct from all other congeners by an enlarged terminal phalange, near absence of clear coloured dorsolateral bands, oedematous swollen extremities during reproduction, an extension of webbing during reproduction, and a smooth subdigital excrescence on the first finger of reproductive males. Additionally spinosities in reproductive male *W. bambutensis* are better developed than in all other species (Amiet 1972, 1976b). Within the remaining species, *W. tandyi* can be distinguished by its very reduced webbing, and the almost absence of a light spotted venter and clear coloured dorsolateral bands. *W. preussi* also has relatively small ventral spots and at least adult females lack dorsolateral bands. A character common to these three species seem to be the very spiny skin in reproducing males. The remaining species, *W. mertensiana*, *W. submontana* and *W. iboundji*, form a group of species that are apparently more closely related to each other than to any other known *Werneria*.

The very disjunct ranges of *W. bambutensis* and *W. tandyi*, that are restricted to higher altitudes, hint that they evolved before their habitat shrunk during diverse ice ages. The same might be true for *W. preussi*, where the most abundant populations on Mt. Cameroon are quite isolated from the other species. It may be worthwhile to genetically compare specimens from Mt. Kupe assigned to this species with those from Mt. Cameroon. *W. mertensiana*, *W. submontana*, and *W. iboundji* possibly evolved from one, once-wide-spread species confined to lower mountainous altitudes whose range was split through one of the many events of forest decline.

The occurrence of *Werneria* species in other western Central African mountainous regions, like Mont Iboundji and Monte Alén, may hint at the existence of other pre-Pleistocene or Pleistocene forest refugia (incl. e.g. gallery forests in savannah areas), that may have given rise to other undescribed endemic animal and plant species (compare Moritz *et al.* 2000; Plana *et al.* 2004). Most notably is the recent discovery of the genus *Stenoglottis* on Mont Iboundji, plants that were previously known only from submontane and montane areas in eastern and southern Africa (Stévant *et al.* 2004). This suggests unexpected zoogeographical relationships between this mountain and other mountainous places in Africa.

That only two specimens of *W. iboundji* were found could be alarming, as at most



other sites for *Werneria*, these toads are locally extremely abundant, albeit restricted to small habitat patches (compare e.g. Mertens 1938b, 1940; own personal experience with *W. preussi* — *W. Böhme*, *W. mertensiana* and *W. submontana* — A. Schmitz). We therefore highly recommend more field studies on this species on Mont Iboundji.

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**Appendix 1**

## Gazetteer

Be aware that we generally list point localities. Areas like e.g. the Bamiléké-Plateau of course comprise much larger surface. The coordinates listed thus are simply given to facilitate orientation for those readers less familiar with Central African geography.

Locality	Longitude	Latitude
Abang, Mt. Manenguba	9°46'	4°56'
Bamiléké-Plateau	10°10'	5°25'
Buëa	9°14'	4°09'
Dikome Balue, Rumpi Hills	9°16'	4°54'
Edib Hills, Bakossi Mts.	9°39'	4°57'
Fotabong	9°53'	5°31'
Jungwé, Muambong	9°44'	4°57'
Jungwé valley	9°51'	5°01'
Kodmin, Mwendelengo Mts.	9°42'	4°59'
Maholé, Tombel	9°38'	4°50'
Meked	9°41'	4°53'
Mt. Alén NP	10°30'	1°67'
Mt. Etinde	9°07'	4°04'
Mt. Iboundji	11°46'	-1°08'
Mt. Kala	11°22'	3°51'
Mt. Kupe	9°42'	4°48'
Mt. Manenguba	9°51'	5°01'
Mt. Neshele	10°14'	5°56'
Mt. Nlonako	9°55'	4°53'
Mt. Nta Ali	9°30'	5°36'
Mt. Okou	10°32'	6°12'
Mts. Bamboutos	10°05'	5°38'
Mwandong	9°48'	5°00'
Nkolodou, Mt. Mban-Minkoum	10°44'	5°54'
Nkongsamba, Mt. Nlonako	9°56'	4°57'
Nsoung	9°49'	4°55'
Nyasoso	9°40'	4°50'
Obudu-Plateau	9°20'	6°40'
Pastorale, Nkonsamba	9°56'	4°57'
Santa	10°08'	5°50'
Tolé Tea Estate, Mt. Cameroon	9°14'	4°07'
Yaoundé	11°52'	3°87'