

Notes on some *Hyperolius* (Anura: Hyperoliidae) from Tanzania, with supplementary information on two recently described species

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Steenstrupia



Schiøtz, A. & M. M. Westergaard. Notes on some *Hyperolius* (Anura: Hyperoliidae) from Tanzania, with supplementary information on two recently described species. – *Steenstrupia* 25 (1): 1-9. Copenhagen, Denmark, September 2000 (for 1999). ISSN 0375-2909.

Supplementary information is given for two treefrogs of the genus *Hyperolius*, *H. kihangensis* Schiøtz & Westergaard in Schiøtz 1999 and *H. pseudargus* Schiøtz & Westergaard in Schiøtz 1999, recently described from the Udzungwa Mountains in Tanzania, and notes are given on *H. minutissimus* and *H. spinigularis*. An annotated list of 10 other treefrogs collected by the authors from 5 localities is also provided.

Keywords: Africa, Tanzania, Eastern Arc, taxonomy, treefrogs, *Hyperolius*

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INTRODUCTION

The Centre for Tropical Biodiversity in Denmark has for some years carried out studies on the biodiversity of the Udzungwa Mountains, part of the Eastern Arc Mountains, in Tanzania. In February 1997 the authors had the opportunity to spend two weeks studying and collecting amphibians in the Udzungwa Mountains, both in a forest area and in open cleared farmland. The junior author also spent a week collecting in the vicinity of Iringa. In December 1997, the junior author returned to the same areas of Udzungwa for further two weeks of fieldwork.

Two new *Hyperolius* were found and supplementary material of a number of little-known species of treefrogs was collected. The new species were published in Schiøtz (1999); the present paper was unfortunately not, as planned, published prior to Schiøtz (1999). All references therein to Schiøtz & Westergaard (1999, *Steenstrupia*) refer to the present paper. The descriptions are completed and additional information is presented here. A list of the treefrogs collected during the two trips is given as part of the description of the collecting sites.

Tissue samples for DNA analysis were secured from all collected species and voices of the treefrogs were recorded.

MATERIALS AND METHODS

Collecting and fixation procedures follow Schiøtz (1967: 13-14). Types, other material, color slides, and sonagrams are deposited in the Zoological Museum, University of Copenhagen (ZMUC). Material of *Hyperolius argus* was kindly provided by Professor Alan Channing (AC; see Table 2).

LOCALITIES

Udzungwa Scarp Forest Reserve (Luhega Forest Reserve on some maps). The camp was situated in dense, undisturbed primary forest at Kihanga Stream, 11 km SE of Masisiwe, Iringa District (08°22'S, 35°58'E), 1740 m.a.s.l. Collecting was done along a small stream and in swamps with stagnant water in the forest.

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Fauna:

Leptopelis barbouri Ahl, 1929 – many individuals were calling along the stream. A pair *in copula* was found half-buried in the ground about 10 meters from the stream; 32 large (\varnothing 6 mm) eggs were deposited.

Leptopelis parkeri Barbour & Loveridge, 1928. – one female was collected, no males were heard calling.

Africalus uluguruensis (Barbour & Loveridge, 1928) – abundant along the stream and in the swamps. The voice is similar to that recorded at Amani (Schjøtz 1975).

Hyperolius spinigularis – see section on *H. spinigularis*.

Hyperolius puncticulatus (Pfeffer, 1893) – a few males were collected in the swamps, but no voice was heard.

Hyperolius kihangensis Schjøtz & Westergaard, 1999 – type locality; see section on *H. kihangensis*.

Masisiwe Village. Iringa District, Udzungwa Mts (08°17'S, 35°54'E), 1840 m.a.s.l. The village is situated in open farmland in a hilly country about 7 km from the forest edge. The area was probably forested once, but now the original forest is gone. The small patches of forest present consist of exotic conifers and eucalyptus.

Fauna:

Phlyctimantis keithae Schjøtz, 1975 – abundant and calling from the edges of small ponds in open fields. They would sit concealed at the base of grass tufts at the water's edge. When disturbed they quietly slipped into the water. Ten males and one juvenile were collected.

Hyperolius pictus Ahl, 1931 – abundant.

Hyperolius spinigularis – see section on *H. spinigularis*.

Hyperolius puncticulatus (Pfeffer, 1893) – abundant.

Hyperolius pseudargus Schjøtz & Westergaard, 1999 – type locality; see section on *H. pseudargus*.

Africalus morerei Dubois, 1985 – 13 specimens were collected.

Idete Village. Iringa District (08°40'S,

36°20'E), 1520 m.a.s.l. The village is situated in open, cultivated land in hilly country in the Udzungwa Mts.

Fauna:

Hyperolius spinigularis – see section on *H. spinigularis*.

Hyperolius pictus Ahl, 1931 – abundant.

Hyperolius pseudargus Schjøtz & Westergaard, 1999.

Hyperolius puncticulatus (Pfeffer, 1893) – abundant.

Africalus morerei Dubois, 1985 – 22 specimens were collected.

Kibebe Farm. 16 km E of Iringa (07°48'S, 35°46'E), 1560 m.a.s.l., in savanna.

Fauna:

Kassina senegalensis Duméril & Bibron, 1841 – present in large numbers.

Africalus "pygmaeus", sensu Schjøtz, 1975 – scarce.

Hyperolius nasutus Günther, 1864 – abundant.

Hyperolius viridiflavus Ahl, 1931 – abundant.

Near Sao Hill. Iringa District (08°29'S, 35°09'E), 1820 m.a.s.l., in open grassland.

Fauna:

Hyperolius minutissimus – see section on *H. minutissimus*.

Hyperolius pictus Ahl, 1931 – many were heard calling.

Hyperolius nasutus Günther, 1864 – abundant.

FORMAL DESCRIPTIONS AND ADDITIONAL INFORMATION ON *HYPEROLIUS KIHANGENSIS* AND *H. PSEUDARGUS*

Hyperolius kihangensis Schjøtz & Westergaard, 1999

Fig. 1.

Hyperolius kihangensis Schjøtz & Westergaard in Schjøtz, 1999: 177, figs 368, 370.

Material:

Holotype. An adult male (ZMUC R 77861), in a small swamp



Fig. 1. *Hyperolius kihangensis*, male from Udzungwa Scarp Forest Reserve, Eastern Arc Mountains. Photo A. Schiøtz.)

in dense forest, Udzungwa Scarp Forest Reserve, Iringa Region, Iringa District, Tanzania, coll. 19 Feb 1997 by Arne Schiøtz & Mette M. Westergaard.

Paratypes. 28 ♂♂, 5 ♀♀ (ZMUC R 77862-894), same locality as holotype, coll. between 18 and 24 Feb 1997. 17 ♂♂ (ZMUC R 77900-77916), from two swamps in Udzungwa Scarp Forest Reserve, coll. between 12 and 16 Dec 1997.

Diagnosis

A small (♂♂ 16-19 mm, ♀♀ 23-26 mm) *Hyperolius* from dense forest in the Eastern Arc Mountains. An hourglass-pattern in brownish-grey is present on the back in both sexes. Dorsal skin rather coarsely granular in males (Fig. 1), smooth in females.

Description

See also Table 1. Body and head broad and flat. Eyes large and protruding, snout brief. Males' gular sac with a flat, smooth gular flap (or gular gland), slightly heart-shaped in some specimens, leaving very little loose skin exposed in preserved specimens. Webbing much reduced. Webbing formula (see Schiøtz 1967: 15): 1(1), 2i(½-1), 2e(¼-1), 3i(1-2), 3e(0-1), 4i(1-2), 4e(1-1½), 5(1).

Colour in life. All specimens have a rather similar dorsal hourglass-pattern outlined by dark brown spots on the light golden-brown back.

Fingers, toes, and discs yellowish to reddish. Gular flap white, ventrum yellowish. The much larger females had a reddish ventrum. A few of the males had small golden spots scattered on the

Table 1. Dimensions of *Hyperolius kihangensis* and *H. pseudargus* in mm. Material is in ZMUC. NA = not applicable.

<i>Hyperolius kihangensis</i>	Sex	Snout-vent	Tibia	Eye horizontally	Eye-nare	Gular flap width
R 77861	♂	17.8	10.5	3.2	1.9	6.0
R 77862	♂	16.1	9.0	3.0	1.5	5.0
R 77863	♂	18.7	10.3	3.0	1.5	6.2
R 77864	♂	18.0	10.9	3.3	1.9	5.5
R 77865	♀	24.7	14.3	3.6	2.1	NA
R 77866	♀	25.8	14.5	3.7	2.5	NA
R 77867	♀	23.4	13.5	3.4	2.4	NA

<i>Hyperolius pseudargus</i>	Sex	Snout-vent	Tibia	Eye horizontally	Eye-nare	Gular flap width
R 77858	♂	34.6	18.2	4.5	3.1	10.4
R 77859	♂	32.7	17.6	4.0	3.0	10.5
R 77860	♂	34.6	18.0	3.9	3.4	10.0
R 77917	♂	32.9	16.2	3.9	2.8	9.3
R 77918	♂	33.8	17.9	3.6	2.8	10.8

dorsum. All specimens had a little white spot on the heel. In addition white dorsal spots are found on 25% of the specimens. A light- and electron microscopy study of the spots has been carried out by Westergaard et al. (2000).

Colour after preservation. Very much as in life, with the hourglass-pattern clearly visible.

Systematic remarks

This form is quite different from other *Hyperolius* in the region. Elsewhere, similar coloration is found in a number of other small, forest-living *Hyperolius* with hourglass patterns and greyish-brownish colours, such as *H. platyceps langi* sensu Schiøtz, 1975 from Uganda and northeastern Zaire, and more western forms, like *H. kuligae* Mertens, 1940, subspecies of *H. sylvaticus* Schiøtz, 1967, *H. zonatus* Laurent, 1958 and *H. bobirensis* Schiøtz, 1967. The geographically closest form, *H. p. langi*, is much slimmer, with a narrower head and smaller, more rounded gular flap. With the coarse skin, which gives the frog a dry appearance, *H. kihangensis* resembles the much larger species *H. bobirensis*, found in similar habitats in West Africa.

Voice

No breeding calls were heard during several nights of observation and males kept in plastic bags did not call either, although they were in full breeding condition, as shown by the fact that eggs were laid during the night when males and females were kept together. Some creaking distress noises were heard when males were harassing each other in the bag. By being apparently mute, *H. kihangensis* seems similar to *H. tanneri* Schiøtz, 1982 and *H. spinigularis* Stevens, 1971, where no breeding call has been heard either (Schiøtz 1982), although the gular sac is well developed in all three species. It may be relevant in this respect to compare these forms with *H. zonatus* Laurent, 1958 from West Africa, a form also from swamps in dense forest. No breeding calls of *H. zonatus* had ever been heard in the field so the senior author kept some specimens in a terrarium in Denmark. A year later, at the time of the onset of the rains in West Africa, the very quiet breeding call was heard for the first time (Schiøtz 1967).

Habitat

All specimens were taken in swamps with stagnant, shallow water in the dense forest. The ground was almost completely covered by grass tufts in all swamps. A few specimens were collected close to a small stream, but also in an area with stagnant water, none were collected from the stream itself.

Breeding

Eggs were deposited in plastic bags when the sexes were kept together. The eggs have a black and a white pole; the egg slime is clear.

Hyperolius pseudargus Schiøtz & Westergaard, 1999

Figs 2-4.

Hyperolius pseudargus Schiøtz & Westergaard in Schiøtz 1999: 174-176, figs 357 (map), 364, 366.

Material:

Holotype. An adult male (ZMUCR 77858), collected in open farmland at Masiwi Village, Udzungwa Mts, Tanzania by Arne Schiøtz and Mette M. Westergaard on 25 Feb 1997.

Paratypes. 2 ♂♂ (ZMUC R 77859-60), same date and locality as for holotype. - 9 ♂♂ (ZMUC R 77917-925), Idete, Udzungwa Mts on 18 and 19 Dec 1997.

Diagnosis

A large (♂♂ 31-35 mm) *Hyperolius* from open farmland in Tanzania. The males (Fig. 2) are very similar to those of *H. argus* Peters, 1854, but differ in having toes less webbed and having an entirely different voice. The female of this species is not yet known.

Description

Morphometric data are given in Table 1. Head and body broad and flat, eyes not very protruding, vocal sac large, gular flap large and smooth. Dorsal skin smooth. Webbing formula: 1(½), 2i(1), 2e(¼), 3i(1), 3e(¼-½), 4i(1¼), 4e(1-1¼), 5(¼-½).

Colour in life. Dorsum light green with minute bronze specks. Upper eyelids dark bronze. Yellowish-green dorsolateral and canthal stripes. Gular flap bluish when calling, yellow-green when at rest. Ventrums yellowish-green. Feet and discs yellowish-green.

Colour after preservation. The green colour disappears completely so that the frogs are yellowish with dark, diffuse pigmentation on the



Fig. 2. *Hyperolius pseudargus*, male from Idete. (Photo M. M. Westergaard.)

dorsum. The dark canthal line remains and sometimes a faint indication of the light dorsolateral lines is seen.

Systematic remarks

This species is very similar to *H. argus* but was distinguished in the field by a very different voice. Morphologically, the reduced webbing seems distinctive when compared with that of *H. argus*. *H. pseudargus* is also very similar to *H. kachalolae* Schiøtz, 1975 but has a different voice

and the thin red canthal and dorsolateral stripes also seem to be diagnostic for *H. kachalolae* (as seen on type material and additional material collected by Drewes and Channing). Therefore, although the description of this *Hyperolius* is based on few specimens, its recognition seems justifiable.

Voice

The voice is very different from that of *H. argus*, in fact different from all other *Hyperolius* voices

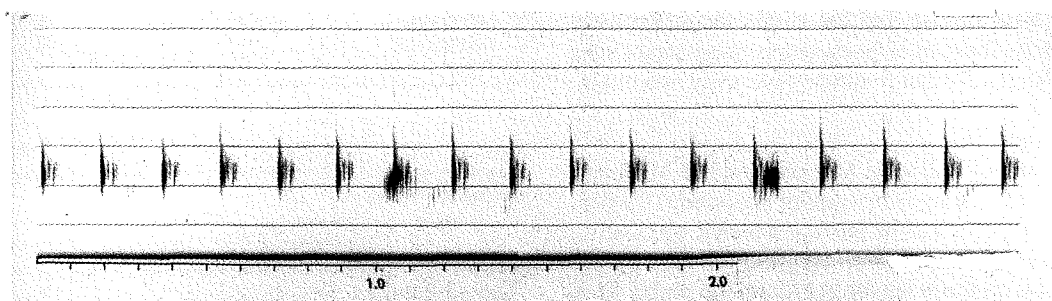


Fig. 3. *Hyperolius pseudargus*, part of call. Wide filter. Two calls of *Hyperolius pictus* in the background. Horizontal lines 1 KHz apart.

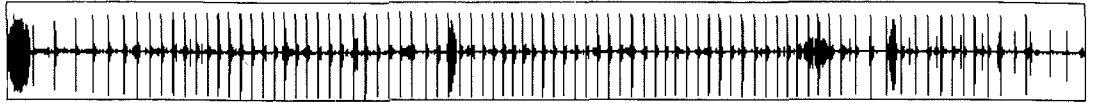


Fig. 4. *Hyperolius pseudargus*, structure of entire call recorded in the field at Masisiwe. Total duration: 16 seconds. The larger blobs are *Hyperolius pictus*.

which the senior author has heard. Acoustically, it resembles that of a very large *Africalus* rather than a *Hyperolius*. The call is a fast series of very harsh, loud clicks; a succession of figures in a measured rhythm, 10-12 per second with a considerably slower rhythm in the first part of the call, and a somewhat slower last part. The single elements are loud clicks without a well-defined frequency-intensity maximum. The call sometimes starts with a few slow croaks (Fig. 3).

Recorded calls had a duration of 10-16 seconds (Fig. 4).

Very few *Hyperolius* have voices consisting of a fast series of figures in measured rhythm. One is *H. (tuberculatus) nimbae* Laurent, 1958, another *H. guttulatus* Günther, 1858, both from West Africa (Schjötz 1967). The former is unrelated to *H. pseudargus* but the latter may belong to a group of allied species, since it has been suggested (Schjötz 1975) that the East African *H. argus* and the West African *H. guttulatus* are vicariating relatives. The single elements in the calls of *H. argus* and *H. guttulatus* are similar, with a rather pure tonal quality and low frequency-intensity maximum, but *H. guttulatus* has a call with a large number of elements in a fast, measured rhythm, while that of *H. argus* consist of single elements in an unmeasured rhythm. In structure, *H. guttulatus* and *H. pseudargus* are thus similar, but the single elements differ widely; those of *H. pseudargus* being loud clicks without a distinct frequency-intensity maximum.

Habitat

The males collected and observed at Masisiwe were all calling from a small fishpond. This particular pond had its surface covered by floating leaves of *Potamogeton* sp., and the males were sitting on these leaves. At Idete, the males were collected from sedges next to a small natural pond.

A MOLECULAR STUDY OF *HYPEROLIUS KIHANGENSIS* AND *H. PSEUDARGUS*

Mitochondrial DNA sequences for the 12S mitochondrial DNA gene have been made for *H. pseudargus* and *H. kihangensis* and compared with each other and that of *H. argus*. The aim was to investigate how similar when, measured as percentage difference, the three sequences are and to use these data as additional argumentation for the new species.

The molecular methods used are slightly modified from those described by Wiczorek & Channing (1997).

The comparison of the molecular data was done by aligning the sequences by eye with the editing programme ESEE - The Eyball Sequence Editor Version 1.09 d (see Fig. 5A-C). Subsequently, transition/transversion ratios and percentage difference were calculated. Table 2

Table 2. Transitions (above diagonal) and transversions (below diagonal). Catalogue numbers are given under the species names.

	<i>H. pseudargus</i> ZMUC R 77925	<i>H. kihangensis</i> ZMUC R 77894	<i>H. argus</i> AC 1268
<i>H. pseudargus</i>	—	24	18
<i>H. kihangensis</i>	13	—	23
<i>H. argus</i>	2	20	—

Table 3. Ratio of transitions to transversions (above diagonal), percentage divergence (below diagonal) in three species of *Hyperolius*.

	<i>H. pseudargus</i>	<i>H. kihangensis</i>	<i>H. argus</i>
<i>H. pseudargus</i>	—	1.8	9
<i>H. kihangensis</i>	15	—	1.2
<i>H. argus</i>	10	16	—

shows the number of transitions and transversions, and Table 3 presents the ratio of transitions to transversion and the percentage difference. All comparisons had higher rates of transitions compared with transversions indicating that no significant multiple substitutions have occurred, and that the data are appropriate for analysis (Simon et al. 1994). Although reservations must be made on account of the minimal sample size and the possibility that *H. argus* is a sister species, the percentage difference is so high in all comparisons that they should at least be looked into with interest. By comparison, Wieczorek & Channing (1997) found that a percentage difference of 5.3, for the same gene for species of the same genus, was high enough to present a good species.

NOTES ON SOME POORLY KNOWN SPECIES

Hyperolius minutissimus Schiøtz, 1975

Fig. 6.

Hyperolius minutissimus Schiøtz, 1975: 167-169, figs 164-165; 1999: 20, 180-181, figs 376-378, 380.

Remarks

The junior author and Mr. David Moyer found a population of this little-known species near Sao Hill; 19 males and 1 female were collected.

The locality was an open swamp with rather short grass, sparsely scattered bushes, and shallow water (depth approximately 20 cm). Most of the frogs were collected on bushes and grass at a height of about one meter above ground. Many males were calling, although this was only apparent at close range, as the voice of *H. minutissimus* is very quiet.

The sample agrees with the type material. All specimens have a conspicuous canthal and dorso-lateral stripe of varying width. The female has a slight indication of spots on the posterior part of dorsum, as has the female illustrated by Schiøtz (1975, 1999).

The size of the males is 12-17 mm, the female is 18 mm.

Voice

The voice is a fast series of unmelodic quiet clicks

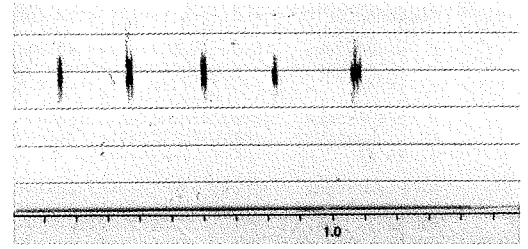


Fig. 6. Voice of *Hyperolius minutissimus*, recorded in a tent at Sao Hill. Wide filter. Horizontal lines 1 KHz apart.

in unmeasured rhythm. The ill-defined frequency-intensity maximum at 4200-4300 cycles per second (cps) is very high, as to be expected from such small animals (Fig. 6; Schiøtz 1999: fig. 377).

Hyperolius spinigularis Stevens, 1971

Hyperolius spinigularis Stevens, 1971: 313-320, plates 1-5. — Schiøtz 1999: 20, 21, 178-180, figs 372-375.

Remarks

Two specimens of *H. spinigularis* were collected along the small Kihanga Stream in dense forest but two males obtained at Masisiwe Village were found in open farmland and a large sample (48 specimens) was collected at Idete at the edge of the small natural pond in open farmland. This seems to confirm that *H. spinigularis* belongs both to the high forest fauna and to the farmbush (bushland) fauna.

Hyperolius spinigularis was very abundant at Idete even though none were heard calling. A chirping voice, acoustically similar to that of *H. minutissimus*, was noted from specimens kept in plastic bags.

Schiøtz (1975) noted some differences between the specimens from the only two known and widely separated localities, Mulanje Mt. in Malawi and Usambara Mts in Tanzania. The new material seems in these characters closest to the southern population; the gular flap is slightly heart-shaped with width greater than length in most specimens.

This secretive species is likely to have a widespread distribution if searched for on suitable habitats. The small differences between our scattered samples do not warrant any taxonomic

separation, at least not until more samples from intermediate areas are at hand.

In general morphology and pattern *H. spinigularis* and *H. minutissimus* are very similar, but the difference in size between males is dramatic. Since the two species in many respects appear similar and seem to inhabit similar habitats, it would be interesting to study the populations of the two species between the Udzungwa and Sao Hill as this might give a better understanding of the species relationship.

ACKNOWLEDGEMENTS

We are indebted to the Danish Centre for Tropical Biodiversity for enabling us to undertake the trip, to Mr. David Moyer and Professor Kim Howell, University of Dar Es Salaam, Tanzania, for much

support, and to Mr. Elia Mulungu for highly qualified assistance in the camp.

Dr. Poul Hansen, Naturhistorisk Museum in Aarhus, most kindly lent us a SONY Cassette Recorder and he and Torben Dabelsteen assisted in making the sonagrams.

The junior author is indebted to Mr. and Mrs. Philips for their outstanding hospitality at Kibebe Farm and to Mr. Benjamin Stevenson for assistance in the field.

Professor Alan Channing, from Western Cape University, South Africa, generously provided the facilities and encouragement to sequence the two new species. Ania Wiczorek, Western Cape University, South Africa, contributed substantially with her molecular expertise.

Finally, the junior author is grateful for having received a Biodiversity Grant from WWF/Novo Nordisk, which made the second field trip possible.

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Manuscript accepted 15.vii.1999