Journal of Biology and Nature
4(4): 200-205, 2015
ISSN: 2395-5376 (P), ISSN: 2395-5384 (O)

International Knowledge Press
www.ikpress.org



RASTAPODIDAE FAM. NOV. OF "HARROWFOOT FROGS" (ANURA: NEOBATRACHIA) INFERRED FROM *Breviceps mossambicus* RE-DESCRIPTION (FORMERLY IN BREVICIPITIDAE) FROM TANZANIA

NICODEMUS D. MATOJO[1*]
[1]Department of Life Science, Mkwawa University College of Education, University of Dar es Salaam, P.O.Box 2513 Iringa, Tanzania.

AUTHOR'S CONTRIBUTION
The sole author designed, analyzed and interpreted and prepared the manuscript.

Received: 26th August 2015
Accepted: 31st October 2015
Published: 24th November 2015

Original Research Article

ABSTRACT

A new family comprising "Harrowfoot Frogs" (Anura: Neobatrachia) has been inferred from the Mozambique rain frog, *Breviceps mossambicus*, also known as flat-faced frog, re-described from Tanzania. Members have football-shaped eyes, horizontal pupils and smooth skin with no paratoid glands, typically like Hemisotidae – the shovelnose frogs also known as snout burrowers. Most importantly, the new family has a distinct heavy framework of keratinous harrow-like digging device on hind foot, correlating to one or two lesser foot tubercles known in the spadefoot toads (Pelobatidae and Scaphiopodidae) and true toads (Bufonidae), respectively. The identified harrow is made up of three forklets trifurcated on metatarsal 2 to 4 of each foot. All frogs with this homology fall under their own group, Rastapodidae **fam. nov.**, native to Africa. The analysis also elucidates the taxonomic status of *B. mossambicus*, formerly included in Brevicipitidae with no clear morphological delineation.

Keywords: Anura; *Breviceps;* Brevicipitidae*;* Hemisotidae; *Mossambicus;* Neobatrachia.

1. INTRODUCTION

The Mozambique rain frog, *Breviceps mossambicus* Peters, 1854, also known as the flat-faced frog, belongs to the family Brevicipitidae of suborder Neobatrachia and order Anura [1-2]. It is known from Botswana, Democratic Republic of the Congo (DRC), Malawi, Mozambique, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe and possibly Lesotho [2-3]. Its natural habitats are dry to moist savanna, subtropical to tropical shrubland and dry lowland grassland, temperate and high-altitude grasslands, arable and pasture lands, and rural gardens [4-5]. It is a complex short-headed frog with six synonyms, namely, *Engystoma granosum* Cuvier, 1829; *Bufo (Engystoma) granosus* Cuvier, 1829; *Breviceps mossambicus* Peters, 1854; *Systoma granosum* Parker, 1868; *Breviceps mossambicus* var. *mossambicus* Werner, 1903; and *Breviceps mitchelli* Hoffman, 1944 [1,5-6]. The enormous number of synonyms provides a testimony for ever-emerging information on this species.

The rain frogs, Brevicipitidae Bonaparte, 1850, formerly regarded as a subfamily of Microhylidae, are a small family with 34 species in 5 genera, which are,

**Corresponding author: Email: matojodn@yahoo.com;*

Balebreviceps Largen & Drewes, 1989 (1 species.), *Breviceps* Merrem, 1820 (17 spp.), *Callulina* Nieden, 1911 (9 spp.), *Probreviceps* Parker, 1931 (6 spp.), and *Spelaeophryne* Ahl, 1924 (1 species) (1-5). Most adults of the Brevicipitidae are not easily available for analysis as they spend extended periods of time in soil or leaf litter and some species are partly arboreal [1,3-6].

Due to poor understanding of their biology, the rain frogs have a total of sixteen synonyms; these are Brevicipitina Bonaparte, 1850; Systomata Stannius, 1856; Engystomatidae Günther, 1858; Brevicipitidae Cope, 1867; Engystomitidae Hoffmann, 1878; Engystomata Peters, 1882; Engystomatida Knauer, 1883; Engystomatinae Gadow, 1901; Brevicipitinae Stejneger, 1910; Engistomatidae Methuen & Hewitt, 1913; Engistomatinae Methuen & Hewitt, 1913; Brevicipetidae Romer, 1933; Brevicepitidae Miranda-Ribeiro, 1937; Brevicipinae Lynch, 1971; Brevicepinae Bogart & Tandy, 1981; Brevicipitidae Dubois, 2005 [6-8].

The most closely related sister taxon of the brevicipitine frogs has been considered as Hemisotidae (3-8). Additionally, the true toads (Bufonidae: Neobatrachia) and spadefoot toads (Pelobatidae, Scaphiopodidae: Anomocoela) are key representatives of terrestrial life, with typical shape to most fossorial (burrowing) frogs [4,9-11]. The spadefoots are easily distinguished from true toads by the presence of a single metatarsal tubercle (spade) on each foot (true toads have two), vertical pupils (true toads have horizontal pupils), a relatively smooth skin (true toads have "warty skin"), and the absence of parotoid glands, which are present on the shoulders in true toads [12-16]. A recent re-description of *B. mossambicus* from Tanzania has elucidated new characters for a new family of rain frogs hereby described.

2. MATERIALS AND METHODS

One Mozambique rain frog was revealed on 3rd July 2015 and collected for analysis. It was in a small grassy biotope within the campus of Mkwawa University College of Education (MUCE), some 2 km east to the Iringa Municipal headquarters in Iringa region, Tanzania. This region lies within the southern highlands zone of this country at 7° 46' 0" South and 35° 42' 0" East (Fig. 1). It borders the northern dry belt of central Tanzania, and lies within the wet belt of the southern highlands zone all through Lake Nyasa in the south. Approximately 74% of this region is suitable for agriculture and the remaining 26% is occupied by water, hills, forests and conservation parks [17].

Analysis of the frog was done in the field and at the laboratory of the Department of Life Science, MUCE. Field analysis mainly involved characterization of the locomotion and burrowing activities of the frog for 6 hours in the natural environment where found. Necessary pieces of information on these activities were recorded using a JVC Video camera (Model GR-D770, Japan).

The frog was captured using a soft damp net, and it was generally handled with wet gloves following the acceptable guidelines [18], and then collected to the laboratory for further analysis. In the laboratory, the frog was first characterized of its skin colour and immediately sacrificed and fixed by submerging it in 10% formalin for 24 hours and then shifted into 70% ethanol for preservation, following [19]. Laboratory analysis mainly focused on the key morphological patterns of this animal, especially its tagmata, skin, eyes, pupil, snout, limbs and tubercles. These examinations were done both visually and with the aid of a hand lens. Systematic analysis was done based on the observed morphological and behavioural characters of the frog in relation to the known records from literature [6-8,15,20].

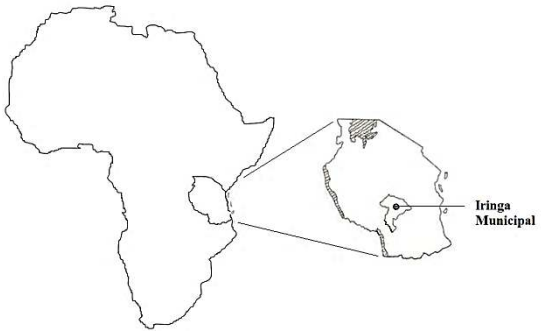


Fig. 1. Map showing the locality of Iringa Municipal (co-ordinates are given in the text)

3. RESULTS

3.1 Rastapodidae fam. nov.

Type genus: *Breviceps.*

Etymology: The name of the new family is derived from the Latin nouns *raster* (harrow) and *pous* (foot), alluding to "harrow foot". Rastapodidae **fam. nov.** Matojo, 2015.

Description: Body relatively smallish and roundish with short legs and a smooth skin that is dully coloured with various bands and speckles. Lack of parotoid glands. Football-shaped eyes with horizontal

pupils. Unwebbed feet with straight toe tips. Efficient runners with lost ability for hopping. Typically fossorial, preferring to burrow under loose soil by digging backwards down the ground using hind limbs. The hind limbs are aided with a distinct harrow-like device trifurcated on metatarsal 2 to 4 of each foot (Section 3.3).

Diagnosis: Members of_Rastapodidae **fam. nov.** can be recognized by their exclusive harrow-like device on each hind foot.

3.2 *Breviceps*

Type species: *Breviceps mossambicus.*

Re-description: Possessing all of the identified key characters of Rastapodidae **fam. nov.** (Section 3.1) and the formerly recognized key characters of the genus, including the distinct short head which accounts for its common name (Section 1). The three forklets of foot harrow are strikingly axe-shaped, chisel-shaped and horn-shaped on metatarsal 2 to 4, respectively. Front limbs as long as the rear limbs, with twofold longer front tibia than hind tibia (Table 1). *Breviceps* Merrem, 1820.

Diagnosis: Members of the *Breviceps* can be recognized by their short head with axe-shaped, chisel-shaped and horn-shaped forklets of foot harrow.

3.3 *Breviceps mossambicus*

Paratype: Adult ♂ (one); Tanzania, (7° 46' 0" South, 35° 42' 0" East), collected by Dr. Nicodemus D. Matojo on 3rd July 2015; the specimen is deposited in the Department of Life Science, Mkwawa University College of Education, Tanzania; Mozambique harrowfoots (formerly known as the Mozambique rain frog or flat-faced frog), *Breviceps mossambicus* Peters, 1854 (Figs. 2 - 5).

Allotype: No sympatric female presently described under the new family.

Re-description: Possessing all of the known characters of Rastapodidae **fam. nov.** (Section 3.1) and genus *Breviceps* (Section 3.2), with a strikingly blunt snout which accounts for its common name (the flat-faced frog). It also has a distinct dark collar with a yellowish harrow of foot and a white underside dispersed with grey mottling (Figs. 6 - 8). It is a highly efficient runner with lost ability for hopping.



Fig. 2. *Breviceps mossambicus*, side view (x3)



Fig. 3. *Breviceps mossambicus*, front view (x3)



Fig. 4. *Breviceps mossambicus*, ventral view (x3)



Fig. 5. Body plan of *Breviceps mossambicus* (x3)



Fig. 6. *Breviceps mossambicus* burrowing under loose soil with the use of hind limbs (x3)

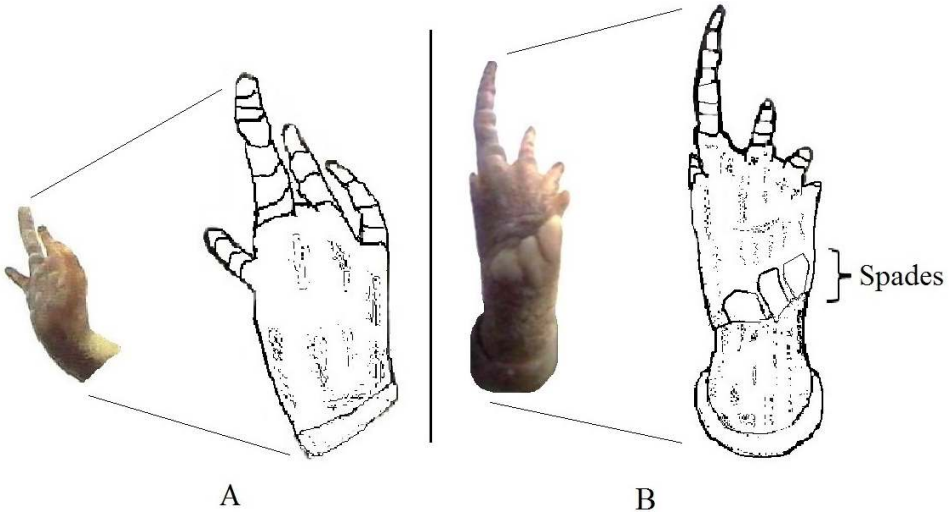


Fig. 7. Bottom view of right hand (A) and foot (B) of *Breviceps mossambicus*

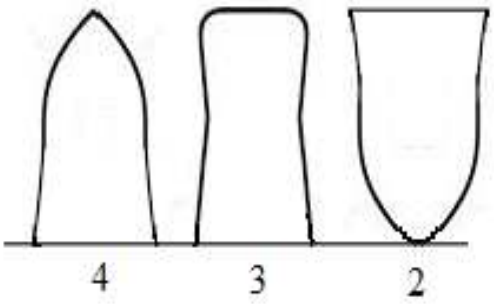


Fig. 8. Morphological patterns of harrow forklets on the right foot bottom of *Breviceps mossambicus* (numbers demarcate respective metatarsals)

Diagnosis: *B. mossambicus* can be distinguished from other members of its genus by the blunt snout with a strikingly dark collar and a yellow harrow of foot and the distinct axe-shaped, chisel-shaped and horn-shaped forklets on metatarsal 2 to 4, respectively.

Major measurements (mm): Snout-urostyle length (SUL) 32.2, head width at angle with jaw 10.0, horizontal eye 3.0, tympanum 1.5, tympanum to eye 2.0, eye to nostril 2.0, internostril 5.0, distance between anterior corner of eyes 5.0, fore limb length 15.2, hind limb length 15.2, fore tibia 10.0, hind tibia 5.2, fourth toe including outer metatarsal harrow 14.1, third finger including carpal tubercle 8.0, and mean length of metatarsal harrow 2.1 (Table 1).

Table 1. Measurements of *Breviceps mossambicus* paratype

Parameter	mm
Snout-urostyle length (SUL)	32.2
Head width at angle with jaw	10.0
Horizontal eye	3.0
Tympanum	1.5
Tympanum to eye	2.0
Eye to nostril	2.0
Internostril	5.0
Distance between anterior corner of eyes	5.0
Fore limb length	15.2
Hind limb length	15.2
Fore tibia	10.0
Hind tibia	5.2
4^{th} toe including outer metatarsal tubercle	14.1
3^{rd} finger including carpal tubercle	8.0
Mean length of metatarsal harrow	2.1

4. DISCUSSION

The key distinguishing feature of Rastapodidae **fam. nov.** is a keratinous harrow on each hind foot, from which the family name is derived. This harrow is well built for digging in loose soil with ease, and it accounts for the high excavation efficiency observed in *B. mossambicus*. It corresponds with the single tubercle (spade) on metatarsal 1 of hind foot in the spadefoots, and the two tubercles on metatarsal 1 and 4 of hind foot in the true toads [5-8,17].

Although the foot harrow and foot spade play a similar role (digging), they differ from each other significantly in their basic plans and locations, indicating to have evolved differently hence belonging to different taxonomic groups. The observed distant ancestry is likewise demonstrated by the distinct warty skin with parotoid glands in the true toads, as well as the bulging eyes with vertical pupils in the spadefoot toads [4-8,16-17].

No sister species can presently be associated with *B. mossambicus*, being the only member described under the new family. However, this species facilitates a key to quick identification of its close relatives. This can be achieved by comparing the patterns of their foot harrow other than the head shape sorely inferred in the previous taxonomy. Specifically, *B. mossambicus* can be quickly identified by its distinct black collar and yellow foot harrow with distinct axe-shaped, chisel-shaped and horn-shaped forklets on metatarsal 2 to 4, respectively, other than the rather indistinct blunt head only considered in the previous taxonomy. Other terrestrial burrowing adaptions illustrated by *B. mossambicus* include the dry skin, unwebbed digits with straight toes, and an articulate running behaviour that is accompanied by the lost ability for hopping.

The close relatives of the new family include the shovelnose frogs, Hemisotidae, also known as snout burrowers. These frogs have smooth skin with no parotoid glands and their eyes are football-shaped with horizontal pupils, typically like the harrowfoots. However, the Hemisotidae indicate a distinct homology with stubby front legs and a small head with a pointed snout, and they burrow head-first into the earth, whilst the Rastapodidae **fam. nov.** and most other burrowing frogs do burrow rear-first.

5. CONCLUSIONS

The Mozambique rain frog (or flat-faced frog), *Breviceps mossambicus* (formerly in Brevicipitidae), represents a new family, Rastapodidae **fam. nov.**, of "Harrowfoot Frogs" distinguished by their distinct harrow-like device trifurcated on metatarsal 1 and 4 of each hind foot. *B. mossambicus* can be easily distinguished from other members by its strikingly dark collar and a yellow harrow of foot with distinct axe-shaped, chisel-shaped and horn-shaped forklets on metatarsal 2 to 4, respectively, other than the only and unreliable blunt snout inferred by the previous taxonomy.

ACKNOWLEDGEMENTS

The author extends sincere gratitude to MUCE management and staff at the Department of Life Science for their continued support in this research, as well as Mr. Pauline Mhango for his valuable assistance in the process of collecting the study animal.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Frost Darrel R. Names described as *'Breviceps mossambicus'*. *Amphibian* species of the World: an online reference. Version 5.6; 2013. Retrieved 25 July 2015.
2. Leslie Minter, Thierry Fretey, Alan Channing, John Poynton, James Harrison. *Breviceps mossambicus*. IUCN red list of threatened species. Version 2012.2. International Union for Conservation of Nature; 2004. Retrieved 25 July 2015.

3. Elizabeth Harper; James R. Vonesh. *Breviceps mossambicus* (Peters, 1854) (PDF). Field Guide to the Amphibians of the East Usambara Mountains; 2012.
4. Nussbaum, Ronald A. Brodie, Edmund D, Jr. Storm, Robert M. Amphibians and reptiles of the pacific northwest. Northwest Naturalist Books, Moscow; 1983.
5. Zimkus Breda, Minter LR. *Breviceps mossambicus* peters, 1854. African Amphibians Lifedesk; (2012.
6. Frost DR, Grant T, Faivovich J, Bain RH, Haas A, Haddad CFB, De Sá RO, Channing A, Wilkinson M, Donnellan SC, Raxworthy CJ, Campbell JA, Blotto BL, Molar P, Drewes RC, Nussbaum RA, Lynch JD, Green DM, Wheeler WC. The amphibian tree of life. Bulletin of the American Museum of Natural History. 2006; 297:1–370.
7. Evans SE, Milner AR. Frogs and salamanders from the Upper Jurassic Morrison Formation (Quarry Nine, Como Bluff) of North America. Journal of Vertebrate Paleontology. 1993;13: 24–30.
8. Arnold Nicholas, Ovenden Denys. Field Guide Reptiles & Amphibians of Britain & Europe 2, London: Harper Collins. 2002;68–69.
9. Hovingh Peter, Benton Bob, Bornholdt Dave. Aquatic parameters and life history observations of the Great Basin Spadefoot Toad in Utah. Great Basin Naturalist. 1985; 45(1):22–30.
10. Adams MJ, Bury RB. The endemic headwater stream amphibians of the American Northwest: Associations with environmental gradients in a large forested preserve. Global Ecology and Biogeography. 2002;11:169–178.
11. Müller H, Loader SP, Ngalason W, Howell KM, Gower DJ. Reproduction in brevicipitid frogs (Amphibia: Anura: Brevicipitidae)—Evidence from *Probreviceps m. macrodactylus*. Copeia. 2007;3:726–733. DOI: 10.1643/0045-8511(2007)2007[726:RIBFAA]2.0.CO;2.
12. Tarkhnishvili D, Serbinova I, Gavashelishvili, A. Modelling the range of Syrian Spadefoot Toad (*Pelobates syriacus*) with combination of GIS-based approaches. Amphibia-Reptilia, 2009;30:401-412.
13. Pyron AR, Wiens JJ. A large-scale phylogeny of Amphibia including over 2800 species, and a revised classification of extant frogs, salamanders, and caecilians. Molecular Phylogenetics and Evolution. 2011;61(2): 543–583. DOI: 10.1016/j.ympev.2011.06.012. PMID 21723399.
14. Henrici AC, Haynes SR. *Elkobatrachus brocki*, a new pelobatid (Amphibia: Anura) from the Eocene Elko Formation of Nevada. Annals of Carnegie Museum. 2006;76(1):11–35.
15. Dayton, Gage H, Skile R, Dayton L. Frogs and Toads of Big Bend National Park. Texas A&M University Press; 2007.
16. Henrici AC. Reassessment of *Scaphiopus neuter* Kluge, 1966 (Anura: Pelobatoidea: Pelobatidae), based on new material from Anceney, Montana (early Barstovian). Annals of Carnegie Museum. 2009;78(3):273–287.
17. Regional Commissioner's Office, Iringa (RCOI). Socio-Economic Profile of Iringa Region (second ed.). The Planning Commission, Dar es Salaam; 2007.
18. Florida International University. Amphibian Care and Handling, Institutional Animal Care & Use Committee, Office of Research Compliance, MARC. 2015;430. research.fiu.edu/iacuc/animalCareDocuments/ (Retrieved 13th October 2015)
19. Matojo ND. Bionomics and morphometrics of the Tanzanian Muller's Clawed Frog *Xenopus muelleri* Peters (Anura: Pipidae) corroborates holotype with monophyletic oversized lungs. Journal of Applies Sciences International. 2015;2(3):113-118.
20. Virginia Herpetological Society. Frog Identification Keys; 2015. Available:http://www.virginiaherpetologicalsociety.com/ (Retrieved 14th August 2015)

© Copyright International Knowledge Press. All rights reserved.