African Journal of Ecology

Notes and records

Reptiles of Katavi National Park, western Tanzania, are from different biomes

Tim Caro[1,2]*, Owen 'Squack' Evans[3], Emily Fitzherbert[2], Toby A. Gardner[2,4], Kim Howell[5], Robert Drewes[6] and H. Bradley Shaffer[2,7]

[1]*Center for Population Biology and Department of Wildlife, Fish and Conservation Biology, University of California, Davis, CA 95616, U.S.A.,* [2]*Tanzania Wildlife Research Institute, PO Box 661, Arusha, Tanzania,* [3]*PO Box 345, Usa River, Tanzania,* [4]*Conservation Science Group, Department of Zoology, University of Cambridge, Downing Street, Cambridge CB2 3EJ, U.K.,* [5]*Department of Zoology and Wildlife Conservation, University of Dar es Salaam, Tanzania, PO Box 35064, Dar es Salaam, Tanzania,* [6]*California Academy of Sciences, 55 Music Concourse Drive, Golden Gate Park, San Francisco, CA 94118, U.S.A. and* [7]*Center for Population Biology and Department of Evolution and Ecology, University of California, Davis, CA 95616, U.S.A.*

Biotic communities are characterized by dominant forms of plant life and a corresponding set of climatic or environmental conditions. For instance, the Katavi area in western Tanzania is classified as part of the central Zambezian biome, a tropical and subtropical dry broadleaf forest (miombo) that stretches across the south-central portion of the African continent (Burgess *et al.*, 2004). Geographically, however, Katavi resides near the northern edge of the Zambezian biome, and some of its animal and plant groups reflect this. For example, surveys demonstrate that large and small mammals are Zambezian (Caro, 1999, 2003; Fitzherbert *et al.*, 2007), bird species derive from both Zambezian and Somali–Maasai biomes (Engilis, Lalbhai & Caro, 2009), while butterflies are from several biomes (Fitzherbert *et al.*, 2006). Tree genera are dominated by *Terminalia* and *Combretum* (Banda, Schwartz & Caro, 2006; Banda *et al.*, 2008), whereas *Brachystegia*, *Julbernardia* and *Isoberlinia* are more generally characteristic of miombo woodland (White, 1983; Rodgers, 1996; Burgess *et al.*, 2004). Given this current mixture of different biome assemblages, it is important to further describe and categorize additional taxonomic groups from Katavi according to their biome affinities. Characterization of areas that are a blend of biotic communities is important as they are often biologically diverse, ecologically unique areas that may be considered high priorities for global conservation efforts (Smith *et al.*, 1997; Moore *et al.*, 2003; Greyner *et al.*, 2006).

We report on three herpetological ecological surveys, one systematic and two more irregular, that were conducted in and around Katavi National Park (latitude 6°45′–7°05′S, longitude 30°45′–31°25′E, *ca.* 800 m a.s.l., Fig. 1) in Mpanda District, western Tanzania, between 2002 and 2009. Very few herpetological surveys have been conducted in this area (but see Vesey-Fitzgerald, 1958, 1975). Katavi National Park is the third largest in Tanzania, consisting of dry broadleaf woodland punctuated by large seasonally flooded plains. Annual rainfall totals approximately 900 mm falling between November and April. The first study, between August 2002 and April

Fig 1 Map showing the location of Katavi National Park in Tanzania to the east of Lake Tanganyika

*Correspondence: E-mail: tmcaro@ucdavis.edu

Table 1 Species of reptiles confirmed or expected to occur in the vicinity of Katavi National Park†

Scientific name	Common name	Surveys by		
		OSE	TG&EF	HBS&TC
Testudines	Turtles and Tortoises			
Testudinidae	Tortoises			
Kinixys spekii[z]	**Speke's hinged tortoise**	**X**	**X**	**X**
Pelomedusidae				
Pelomedusa subrufa[z]	Helmeted terrapin	X		
Pelusios sinuatus[z]	Serrated hinged terrapin			
Pelusios subniger[z]	Pan hinged terrapin	X	X	X
Squamata	Lizards and Snakes			
Gekkonidae	Geckos			
Hemidactylus mabouia[eac]	Tropical house gecko			
Lygodactylus angolensis[z]	Angolan dwarf gecko			
Lygodactylus angularis[sm]	Angulate dwarf gecko			
Lygodactylus capensis[z]	Cape dwarf gecko			X
Pachydactylus tuberculosus[z]	Tuberculate thick-toed gecko	X	X	X
Scincidae	Skinks			
Lygosoma afrum[eac]	Peter's writhing skink	X	X	
Mabuya maculilabris[gc+lv+eac]	Speckle-lipped skink		X	
Mabuya planifrons[sm]	**Tree skink**	**X**	**X**	**X**
Mabuya striata[sm+eac]	Striped skink	X	X	X
Mabuya varia[z+sm]	Variable skink	X	X	X
Melanoseps loveridgei[z+a]	**Loveridge's limbless skink**		**X**	
Panaspis wahlbergii[z+sm+eac]	Wahlberg's snake-eyed skink	X	X	X
Typhlacontias kataviensis	**N/A**	**X**	**X**	
Lacertidae	Lacertids			
Heliobolus neumanni[sm+eac]	Neumann's sand lizard			
Ichnotropis squamulosa[z]	Mozambique rough-scaled lizard			
Ichnotropis tanganicana[z]	Tanzanian rough-scaled lizard			
Latastia johnstoni[z]	**Johnston's long-tailed lizard**		**X**	**X**
Nucras boulengeri[z+lv]	**Boulenger's scrub lizard**	**X**	**X**	**X**
Cordylidae	Girdled Lizards			
Chamaesaura macrolepis[a]	Zambian snake lizard			
Gerrhosauridae	Plated Lizards			
Gerrhosaurus flavigularis[eac]	Yellow-throated plated lizard			X
Gerrhosaurus major[eac]	Great plated lizard			
Gerrhosaurus nigrolineatus[z]	Black-lined plated lizard		X	
Tetradactylus ellenbergeri[z]	Ellenberger's long-tailed lizard			
Agamidae	Agamas			
Acanthocercus atricollis[z]	**Blue-headed tree agama**	**X**	**X**	
Acanthocercus cyanogaster[z]	Black-necked tree agama			
Agama agama[z+sm]	Red-headed rock agama			
Agama armata[z]	**Tropical spiny agama**	**X**		
Chamaeleonidae	Chameleons			
Chamaeleo dilepis[z]	Flap-necked chameleon	X	X	X
Chamaeleo laevigatus[lv]	Smooth chameleon	X	X	X
Varanidae	Monitors			
Varanus albigularis[z]	White-throated savannah monitor			
Varanus niloticus[sv]	Nile monitor	X	X	X

Table 1 (Continued)

Scientific name	Common name	Surveys by		
		OSE	TG&EF	HBS&TC
Crocodylia	Crocodilians			
Crocodylidae	Crocodiles			
Crocodylus cataphractus[gc]	Slender-snouted crocodile			
Crocodylus niloticus[sv]	Nile crocodile	X	X	X
Serpentes	Snakes			
Typhlopidae	Blind Snakes			
Rhinotyphlops mucruso[z]	**Zambezi blind snake**	**X**	**X**	
Rhinotyphlops gracilis[z]	Slender blind snake			
Rhinotyphlops graueri[a]	Lake Tanganyika blind snake			
Typhlops lineolatus[z+s+lv]	Lineolate blind snake			
Leptotyphlopidae	Worm Snakes			
Leptotyphlops emini[z+sm+eac+lv]	Emin Pasha's worm snake	X	X	
Leptotyphlops scutifrons[z]	Peter's worm snake		X	
Boidae	Boas and Pythons			
Python natalensis[z]	Southern African rock python	X		X
Colubridae	Typical Snakes			
Boiga blandingii[gc]	Blanding's tree snake			
Crotaphopeltis hotamboeia[sv]	**White-lipped snake**	**X**	**X**	
Crotaphopeltis tornieri[a]	Tornier's cat snake			
Dasypeltis scabra[sv]	Common egg-eater	X		
Dipsadoboa unicolor[gc]	Gunther's green tree snake			
Dispholidus typus[sv]	Boomslang	X		X
Hemirhagerrhis nototaenia[z+sm]	Bark Snake			
Lamprophis fuliginosus[sv]	Brown house snake	X	X	
Lycodonomorphus bicolor[z]	Lake Tanganyika water snake			
Lycophidion capense[lv]	Cape wolf snake	X	X	X
Mehelya capensis[a]	Cape file snake			
Meizodon semiornatus[z+sm]	Semi-ornate snake	X	X	
Natriciteres olivacea[z+s+lv]	Olive marsh snake			
Natriciteres sylvatica[z+eac]	South-eastern forest marsh snake	X	X	
Philothamnus carinatus[gc]	Thirteen-scaled green-snake			
Philothamnus hoplogaster[z+eac]	South-eastern green-snake	X	X	X
Philothamnus nitidus[gc]	Loveridge's green-snake			
Philothamnus ornatus[z]	Stripe-backed green-snake			
Philothamnus semivariegatus[sv]	Spotted bush snake	X		X
Prosymna stuhlmanni[eac]	East African shovel-snout			
Psammophis angolensis[z]	Dwarf sand snake	X		
Psammophis mossambicus[s+sm]	Olive sand snake	X	X	
Psammophis rukwae[s+sm]	Lake Rukwa sand snake	X	X	
Psammophylax tritaeniatus[z]	Southern striped skaapsteker			X
Rhamnophis aethiopissa[lv]	Large-eyed green tree snake			
Rhamphiophis acutus[z]	Striped beaked snake			
Rhamphiophis rostratus[z+sm]	Rufous beaked snake	X		
Scaphiophis albopunctatus[sm+s]	Hook-nosed snake			
Telescopus semiannulatus[z+eac]	Tiger snake	X		
Thelotornis capensis[eac]	Savanna vine snake			
Thelotornis kirtlandii[gc]	Forest vine snake			
Atractaspididae	African Burrowing Snakes			
Amblyodipsas polylepis[eac]	Common purple-glossed snake			

Table 1 (Continued)

Scientific name	Common name	Surveys by		
		OSE	TG&EF	HBS&TC
***Aparallactus jacksoni*[sm]**	**Jackson's centipede-eater**	**X**	**X**	
Atractaspis bibronii[z+eac]	Bibron's burrowing asp			
Chilorhinopus gerardi[z]	Gerard's black-and-yellow burrowing snake			
Polemon christyi[lv]	Christy's snake eater			
Elapidae	Cobras and their relatives			
Boulengerina annulata[z]	Banded water cobra			
Elapsoidea boulengeri[z]	Boulengeri's garter snake			
Naja melanoleuca[gc+a+lv+eac]	Forest cobra			
Naja nigricollis[z+sm+s]	Black-necked spitting cobra	X		
Dendroaspis polylepis[z+sm+s+eac]	Black mamba	X		
Viperidae	Vipers			
Atheris rungwensis[a]	Mount Rungwe bush viper			
Bitis arietans[sv]	Puff Adder	X	X	
Causus defilippi[eac]	Snouted night adder			
***Causus resimus*[s+lv]**	**Velvety-green night adder**	**X**	**X**	
Causus rhombeatus[z+s]	Rhombic night adder			

Letters refer to surveys by different individuals: OSE refers to field survey by Evans; TG&EF by Gardner and Fitzherbert; BS&TC by Shaffer and Caro. X indicates a positive identification during that survey. **Bold** indicates species found in field surveys that were not expected based on Spawls *et al.* (2002). Superscripts of reptile species refer to ecological life zones (biomes) as documented by Broadley & Howell (1991): Z, Zambezian region; S, Sudanian region; SM, Somalia–Maasai region; A, Afromontane region; EAC, East African coastal mosaic; GC, Guinea Congolian region; LV, Lake Victoria region; SV, ubiquitous. Taxonomy generally follows Spawls *et al.* (2002).

†Although it may be naïve to think that we can predict the distributions of species in a newly explored area of central Africa based on a field guide, Spawls *et al.* (2002) was correct for a minimum of 43.6% of species, and this table provides a reference list to which future reptile surveys can refer.

Note: it is possible that the field surveys may have also seen *Lygosoma sundevalli* but this cannot be definitely confirmed.

2003 by TAG and EF, was a survey of anurans with incidental captures of small surface-dwelling reptiles (Gardner *et al.*, 2007a). Forty-one sites in an area of approximately 250,000 ha in late dry, early wet and late wet seasons were sampled; fourteen sites were surveyed three times, 22 sites twice and five surveyed once, all using drift fence arrays. The second survey was by OSE, who recorded reptiles and anurans found on an *ad hoc* basis while living near the Chada floodplain in the Park between 2003 and 2006, principally during dry seasons. The third was by HBS and TC in February 2009. Their survey specifically targeted reptiles and consisted of 3–4 person, time-constrained diurnal surveys. They used visual encounters and cover-object searching for lizards and snakes, road cruising for snakes and seining and trapping for aquatic turtles (Caro & Shaffer, 2010).

Here, we provide the first list of field-verified reptiles for this little studied national park and compare our findings to those expected from the best available field guide (Spawls *et al.*, 2002). In addition, we ask whether the reptile fauna of Katavi National Park consists primarily of Zambezian biome species as expected, using Broadley & Howell's (1991) catalogue of Tanzanian reptile biome affinities. Although biomes are heterogeneous and made up of many habitats, their catalogue is based on standard classifications derived from geographic location and climatic associations.

Thirty-five of the 78 reptile species that were expected to occur in the area (43.6%) based on the study by Spawls *et al.* (2002) were located in at least one of our field surveys (Table 1). An additional twelve species were discovered that were not predicted, including the newly discovered lizard *Typhlacontias kataviensis* (Broadley, 2006). This amounts to a 13.3% increase in the expected reptile fauna for a new possible total of 90 expected (based on the field guide) or confirmed (based on our field surveys)

species (Table 1). Overall, 36.4% of chelonians, 29.0% of lizards, 50.0% of crocodilians and 57.6% of snakes of mainland Tanzania were found or are expected to be found in and around Katavi National Park (using Spawls *et al.*, 2002). Our field data verify the occurrence of ubiquitous pan-African savannah reptiles such as the white-lipped snake *Crotaphopeltis hotamboeia* and boomslang *Dispholidus typus*, demonstrate continuity of species that appeared to have disjunct populations like the velvety-green night adder *Causus resimus* and the tree skink *Mabuya planifrons*, previously known from East Africa, the Democratic Republic of Congo and Angola, and may indicate range extensions of north-central East African taxa like Jackson's centipede-eater *Aparallactus jacksoni*.

Our analysis indicates that reptiles found in and around Katavi National Park are derived from all eight of Broadley & Howell's (1991) biomes (Table 1). As expected, the greatest representation is from the Zambezian biome, but reptile species also derive from the Somalia–Maasai and East African coastal mosaic biomes (Table 2). Indeed, a greater number of both lizard (including amphisbaenian) and possibly snake species characterized as non-Zambezian in origin were confirmed or are expected to be found in the Katavi vicinity compared with reptile biome affinities expected across the country (Table 2, $\chi^2 = 9.171$, df = 1, $P < 0.01$ for lizards; $\chi^2 = 3.173$, df = 1, $P < 0.1$ for snakes). Our sampling is still far from complete, particularly for snakes, which are notoriously difficult to sample, but our preliminary findings indicate that for reptiles, the Katavi area consists of a mixture of species from many different biomes. We are unsure as to how to interpret this but it is possible that some reptile species at Katavi exist at the edge of their ecological and geographic ranges. Our findings thus parallel those found for birds which show avian fauna with both Zambezian and Somali–Maasai affinities living in and around Katavi National Park (Engilis, Lalbhai & Caro, 2009) and suggest that this area of unusual miombo woodland may be an extremely rich assortment of diverse biome components for birds, lizards and, to a lesser extent, snakes. Therefore, Katavi National Park and its surrounding area provide an important, previously unrecognized conservation service beyond the Park's original goal of conserving large charismatic mammals; it also protects a particularly diverse community of vertebrates that were previously not predicted to live in this area (see also Gardner *et al.*, 2007b).

Table 2 Biomes for reptiles confirmed and expected to be found in and around Katavi National Park, and in Tanzania (one species can be found in more than one biome, see Table 1)

	GC	S	Z	SM	A	LV	EAC	SV
Chelonians								
Katavi								
Expected and confirmed	0	0	4	0	0	0	0	0
Confirmed	0	0	3	0	0	0	0	0
Tanzania	0	0	7	2	0	1	2	0
Sauria and Amphisbaenia								
Katavi								
Expected and confirmed	1	0	18	7	2	3	8	1
Confirmed	1	0	11	4	1	3	5	1
Tanzania	2	2	30	17	40	9	49	1
Crocodilians								
Katavi								
Expected and confirmed	1	0	0	0	0	0	0	1
Confirmed	0	0	0	0	0	0	0	1
Tanzania	1	0	0	0	0	0	0	1
Serpentes								
Katavi								
Expected and confirmed	6	9	25	10	5	8	11	6
Confirmed	1	5	13	8	0	3	5	6
Tanzania	13	15	37	31	25	20	36	6

Acknowledgements

We thank TAWIRI, COSTECH and TANAPA for permission to conduct research; Michael Sungula, Osca Ulaya and Louise Whitaker for help in the field; and Stephen Spawls for comments on the manuscript. We thank the National Geographic Society, Columbus Zoo and University of California, Davis (TC); NSF grant DEB 0817042 and the UC Davis Agricultural Experiment Station (HBS); University of East Anglia, Sigma Xi, Percy Sladen Foundation and University of California, Davis (EF and TAG) for financial support. Research was conducted within the guidelines of the animal care and use committee of the University of California, Davis. The specimens upon which this report is based are either deposited in collections of the Department of Zoology, University of Dar es Salaam, and Department of Herpetology, California Academy of Sciences, or in the form of digital images.

References

Banda, T., Schwartz, M.W. & Caro, T. (2006) Woody vegetation structure and composition along a protection gradient in a

miombo ecosystem of western Tanzania. *For. Ecol. Manage.* **230,** 179–185.

Banda, T., Mwangulango', M., Meyer, B., Schwartz, M.W., Mbago, F., Sungula, M. & Caro, T. (2008) The woodland vegetation of the Katavi–Rukwa ecosystem in western Tanzania. *For. Ecol. Manage.* **255,** 3382–3395.

Broadley, D.G. (2006) A new species of Typhlacontias (Reptilia : Scincidae : Feylininae) from Western Tanzania. *Proc. Cal. Acad. Sci.* **57,** 557–560.

Broadley, D.G. & Howell, K.M. (1991) A checklist of reptiles of Tanzania with synoptic keys. *Syntarsus* **9,** 369–430.

Burgess, N., Hales, J., Underwood, E., Dinersteon, E., Olson, D., Itoua, I., Schipper, J., Ricketts, T. & Newmann, K. (2004) Terrestrial Ecoregions of Africa and Madagascar: A Conservation Assessment. Island Press, World Wildlife Fund, Washington.

Caro, T.M. (1999) Abundance and distribution of mammals in Katavi National Park, Tanzania.*Afr. J. Ecol.* **37,** 305–313.

Caro, T.M. (2003) Umbrella species: critique and lessons from East Africa. *Anim. Conserv.* **6,** 171–181.

Caro, T & Shaffer, H.B. (2010) Chelonian antipredator strategies: preliminary and comparative data from Tanzanian *Pelusios*. *Chelonian Conserv. Biol.* **9,** 302–305.

Engilis, A. Jr, Lalbhai, P. & Caro, T. (2009) Avifauna of the Katavi–Rukwa ecosystem. *J. East Afr. Nat. Hist.* **98,** 95–117.

Fitzherbert, E., Gardner, T., Davenport, T.R.B. & Caro, T. (2006) Butterfly species richness and abundance in the Katavi ecosystem of western Tanzania. *Afr. J. Ecol.* **44,** 353–362.

Fitzherbert, E., Gardner, T., Caro, T. & Jenkins, P. (2007) Habitat preferences of small mammals in the Katavi ecosystem of western Tanzania. *Afr. J. Ecol.* **45,** 249–257.

Gardner, T.A., Fitzherbert, E.B., Drewes, R.C., Howell, K.M. & Caro, T. (2007a) Spatial and temporal patterns of abundance and diversity of an East African leaf litter amphibian fauna. *Biotropica* **39,** 105–113.

Gardner, T., Caro, T, Fitzherbert, E., Banda, T. & Lalbhai, P. (2007b) Conservation value of multiple use areas in East Africa. *Conserv. Biol.* **21,** 1516–1525.

Greyner, R., Orme, C.D.L., Jackson, S.F., Thomas, G.H., Davies, R.G., Davies, T.J., Jones, K.E., Olson, V.A., Ridgely, R.S., Rasmussen, P.S., Ding, T.-S., Bennett, P.M., Blackburn, T.M., Gaston, K.J., Gittleman, J.L. & Owens, I.P.F. (2006) Global distribution and conservation of rare and threatened vertebrates. *Nature* **444,** 93–96.

Moore, J.L., Balmford, A., Brooks, T., Burgess, N.D., Hansen, L.A., Rahbek, C. & Williams, P.H. (2003) Performance of sub-Saharan vertebrates and indicators groups for identifying priority areas for conservation. *Conserv. Biol.* **17,** 207–218.

Rodgers, W.A. (1996) The miombo woodlands. In: East African Ecosystems and their Conservation (Eds T. P. Young and T. R. McClanahan). Oxford University Press, New York, pp. 299–325.

Smith, T.B., Wayne, R.K., Girman, D.J. & Bruford, M.W. (1997) A role for ecotones in generating rainforest biodiversity. *Science* **276,** 1855–1857.

Spawls, S., Howell, K., Drewes, R. & Ashe, J. (2002) A Field Guide to the Reptiles of East Africa. Academic Press, San Diego.

Vesey-Fitzgerald, D.F. (1958) The snakes of Northern Rhodesia and the Tanganyika borderlands. *Proc. Trans. Rhodesian Sci. Ass.* **46,** 17–102.

Vesey-Fitzgerald, D.F. (1975) A guide to the snakes of the Tanzania and Kenya borderlands. *J. East Afr. Nat. Hist. Soc. Mus.* **1490,** 1–26.

White, F. (1983) The Vegetation of Africa. UNESCO, Paris.

(*Manuscript accepted 15 February 2011*)

doi: 10.1111/j.1365-2028.2011.01261.x