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Tanzania's reptile biodiversity: Distribution, threats and climate change vulnerability

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ABSTRACT

Assessments of biodiversity patterns and threats among African reptiles have lagged behind those of other vertebrate groups and regions. We report the first systematic assessment of the distribution, threat status, and climate change vulnerability for the reptiles of Tanzania. A total of 321 reptile species (including 90 Tanzanian endemics) were assessed using the global standard IUCN Red List methodology and 274 species were also assessed using the IUCN guidelines for climate change vulnerability. Patterns of species richness and threat assessment confirm the conservation importance of the Eastern Arc Mountains, as previously demonstrated for birds, mammals and amphibians. Lowland forests and savannah-woodland habitats also support important reptile assemblages. Protected area gap analysis shows that 116 species have less than 20% of their distribution ranges protected, among which 12 are unprotected, eight species are threatened and 54 are vulnerable to climate change. Tanzania's northern margins and drier central corridor support high numbers of climate vulnerable reptile species, together with the eastern African coastal forests and the region between Lake Victoria and Rwanda. This paper fills a major gap in our understanding of the distribution and threats facing Tanzania's reptiles, and demonstrates more broadly that the explicit integration of climate change vulnerability in Red Listing criteria may revise spatial priorities for conservation.

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1. Introduction

Tanzania (Fig. 1) is characterised by a diverse range of landscapes and habitats, from mangroves through diverse savannah and forest habitats to alpine grasslands (Burgess et al., 2004). Some regions, for example the Eastern Arc Mountains, are thought to have acted as both refuges and areas of speciation during climatic cycles (Fjeldså and Lovett, 1997; Tolley et al., 2011). Tanzania's central arid region is regarded as an important element of Africa's 'Arid Corridor', facilitating faunal movements between the Namib in the south and Horn of African in the north (Bobe, 2006; Broadley, 2006). However, there is no documentation of vertebrate biodiversity patterns at the Tanzanian national

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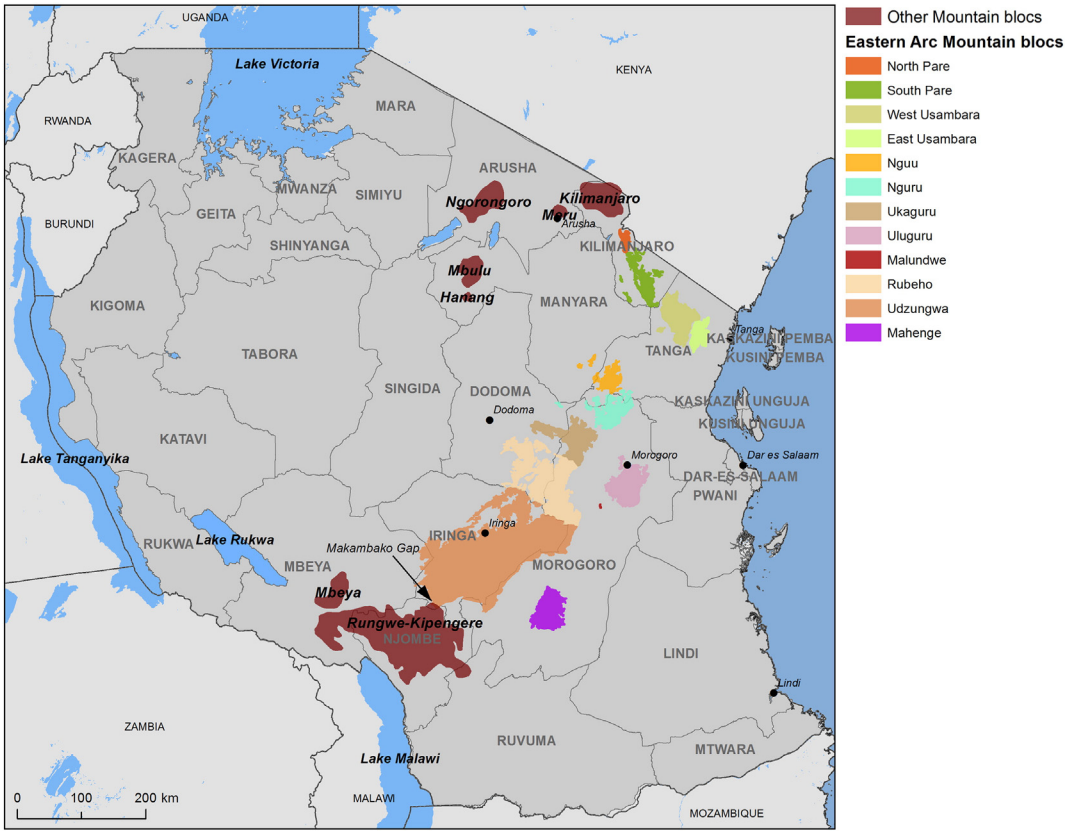

Fig. 1. General map: regions, major lakes, mountain blocs and cities of Tanzania.

scale, with studies focused on more local biodiversity centres (e.g. Eastern Arc: Rovero et al., 2014; Coastal Regions: Burgess and Clarke, 2000), or at regional (e.g. African: Brooks et al., 2001; Burgess et al., 2004; Platts et al., 2014) or global scales (Pimm et al., 2014). As Tanzania is party to many global conventions, in particular the Convention of Biological Diversity, the lack of appropriate data on biodiversity patterns and threats hinders the development of National Biodiversity Strategies and Actions Plans, and other national policy instruments.

The IUCN Red List of Threatened Species (hereafter 'the Red List') provides the most widely-accepted framework for assessing the types and severity of threats to the survival of individual species (IUCN Standards and Petitions Subcommittee, 2014). Species distribution maps compiled during the Red Listing process, using primary data and expert knowledge, represent a species' known global range. In addition, the Red List system also gathers data of threats to species, which is being augmented to explicitly consider the threats from climate change (Carr et al., 2013; Foden et al., 2013). This development addresses some of the limitations of the Red List (Akçakaya et al., 2006) and acknowledges that climate change poses an increasingly significant threat to species.

Reptiles occur throughout Tanzania, with the exception of areas above the snowline (Spawls et al., 2002). Some reptile species have very small, restricted ranges and rely upon highly-specific environmental conditions, such as rainfall and temperature regimes and/or specific habitats in order to undergo particular life-history events (e.g. Zani and Rollyson, 2011; Weatherhead et al., 2012). Others, such as viviparous reptiles need to balance thermal budgets between normal daily activities and reproductive demands. As such, reptiles are particularly sensitive to changes in insolation (Sinervo et al., 2008) and may be especially vulnerable to climate change (Whitfield Gibbons et al., 2000).

Protected areas are an important conservation approach to preventing biodiversity loss. However, the coverage of an existing protected area network, for example in Tanzania, does not always reflect the distribution of species that may require protection with urgency (e.g. Sritharan and Burgess, 2012). These gaps can be caused by various factors during the protected area planning stage, such as not prioritising threatened or endemic biodiversity patterns, not considering global climate change as a threat, and biases towards areas that can least prevent land conversion (Rodrigues et al., 2004; Joppa and Alexander, 2009).

In this paper we present new and existing reptile data for Tanzania to show: a) species richness; b) richness of threatened species; and c) richness of species considered vulnerable to climate change. Reptile distribution patterns are compared with those for birds, mammals and amphibians to determine if biodiversity patterns are congruent between vertebrate groups. Gaps within Tanzania's protected area network are identified by evaluating the extent of reptile range overlap with protected areas. We also present knowledge-gaps that need to be filled for more effective conservation practices in the future. Our analyses are targeted at policy-makers and planners, and aim to facilitate the consideration of biodiversity in planning and conservation decision-making and the better understanding of future protection requirements.

2. Data and methodology

2.1. Species data and the Red List assessment process

Species data came from two sources: i) an IUCN Red Listing Workshop in Bagamoyo, Tanzania (January 2014); and ii) published IUCN Red List assessments. Nine expert herpetologists (from the author list: CM; IS; JCh; JB; KH; PM; PW; SS; WB) attended the 2014 workshop where they completed the standard IUCN Red Listing process (IUCN Standards and Petitions Subcommittee, 2014; IUCN, 2015) and also provided climate change vulnerability-related trait information (see Section 2.2). Prior to this workshop a total of 37 Tanzanian reptile

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