Speculation versus data-driven conclusions: A response to Gereau et al.'s "Phylogenetic patterns of extinction risk: the need for critical application of appropriate datasets"

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ABSTRACT

Gereau et al. (2013) criticized our recent analysis on the phylogenetic patterns of extinction risk in the Eastern Arc biodiversity hotspot (Yessoufou et al. 2012). However, Gereau and colleagues based their critique on preconceptions and speculation rather than data. Here we identify several shortfalls in their lines of argument, and suggest that, given current rates of extinction, it is far more dangerous to wait for complete Red List assessments than to explore patterns of threat using available data. Nonetheless, we agree that all analyses should be based upon the best available data, and we encourage the rapid releases of new data on threat status for the flora of the Eastern Arc.

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Introduction

There is growing evidence indicating that we are entering a sixth mass extinction event (Millennium Ecosystem Assessment 2005), driven by various pressures including invasive species (Winter et al. 2009), habitat destruction (Vitousek et al. 1997; Haberl et al. 2007), climate change and climate variability (Willis et al. 2008, 2010). It is estimated that rates of species loss may be 1,000–10,000 times more rapid than background rates in the paleontological past (Pimm et al. 1995; Millennium Ecosystem Assessment 2005), and this loss is particularly pronounced in tropical biomes (Vamosi & Vamosi 2008). As a consequence, ~ 30% of assessed species are considered threatened with extinction, and a greater proportion is predicted to become threatened in the near future (Thomas et al. 2004; Mace et al. 2005). Biodiversity provides many ecosystem services that are particularly crucial for rural communities in the developing world (e.g. food production, medicinal plants, clean water, etc.), which is particularly vulnerable to the impacts of global change (Mendelsohn 2006). There is therefore an urgent need for increased efforts towards a better understanding of extinction risk to provide options for a better management of the Earth's natural resources (McKinney 1997).

In a recent study (Yessoufou et al. 2012), we assessed the phylogenetic pattern of extinction risk in an African biodiversity hotspot – the Eastern Arc Mountains. We used publicly available data from the IUCN Red List database (www.iucnredlist.org), and showed that the distribution of extinction risks is phylogenetically clustered, and suggested that this pattern might be driven by vulnerable species. Gereau et al. (2013) challenge our conclusion along a number of lines: (i) inadequate knowledge of the study area, its flora and relevant literature; (ii) lack of transparent or repeatable methods for the data selection, compounded by inadequate sample size; and (iii) compilation and analysis of an inconsistent dataset containing non-equivalent Red List assessments performed under different criteria and at different times. However, Gereau and colleagues provide no new evidence and present no additional analysis, but rather base their claims on speculation and their own preconceptions. Here, we respond to the specific criticisms raised by Gereau et al. and we request that if, as they claim, there is new data on extinction risk for the Eastern Arc flora, it should be made available to the public rapidly. The threats posed by the current extinction crisis are too urgent to be concerned about data exclusivity. In our responses, we follow the structure used by Gereau et al. (2013).

1. Characterization and delimitation of study area

Gereau et al. (2013) suggested that we had "inadequate knowledge of the study area, its flora and relevant literature". They justified this by claiming that we did not cite recent literature on the study area, its ecosystems, flora, level of endemism, ecology and history. Gereau et al. go on to list various references they considered important, including the Critical Ecosystem Partnership Fund (2003). However, we did in fact use this database, and it is cited on page six of our paper. Furthermore, we provided numerous references on the Eastern Arc’s ecosystems, its flora, endemism, ecology and history of the ecosystems (e.g. Burgess et al. 2007; Fjeldså & Lovett 1997; Lovett 1988, 1993, 1998; Trauth et al. 2005). Whilst there are of course many more references that could be cited,

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the objective of our paper was not to provide a comprehensive review of the history of the Eastern Arc biodiversity of hotspot, but to present a timely analysis of the extinction risk of its flora. To the best of our knowledge, additional citations would not have changed our interpretations of results.

Gereau et al. suggest that a lack of adequate context is reflected in our references to the Eastern Arc Mountains as "woefully-understudied", and that this crucially undermines their ability to interpret their findings accurately and objectively". We might debate whether the Eastern Arc can be considered well studied or understudied in comparison to other floras. We suggest that in comparison to the floras of much of the world, including North America, Europe and most temperate biomes, our characterization of the Eastern Arc Flora is wholly accurate. We additionally struggle to understand how this could in any case change our interpretation of results; Gereau et al. remain somewhat vague about this. We also found surprising that Gereau et al. suggest we did not focus on the elevational distribution of extinction risk, as this is one of the key results of our paper, and is clearly referred to in the abstract of the paper. We show that elevation range was the best single predictor of threatened species richness, and could explain up to 42% of threatened plant species richness.

Gereau et al. also state that the criteria for selection of the 230 Eastern Arc plant species that we analyzed were unclear, such that “the list cannot be tested nor a comparable list compiled from other data or by other researchers". We cannot comprehend this statement as we clearly state that “(w)e retrieved from the IUCN Red List database

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(www.iucnredlist.org, accessed May 2012), assessment details for all angiosperm species (about 5% of the total flora) that have been evaluated in the region". As for the Eastern Arc, we state that we "also compiled a checklist of the Red-Listed flora within the Eastern Arc forest blocks based upon a thorough literature survey [62,78] and information extracted from the CEPF database (Critical Ecosystem Partnership Fund: http://www.cepf.net, accessed 21st September 2011)". Finally, we include a complete list of the threatened species included in our analyses in Table S2, making their criticism particularly bizarre. We suggest that Gereau and coauthors might benefit from a closer reading of our original paper.

Gereau et al.'s final criticism in this section is that we did not include the flora of the Taita Hills of Kenya. It was not possible to simply generate a phylogenetic tree for the floras of both Tanzania and Kenya because synonyms make combining published floras exceedingly complex. However, as 12 of the 13 forest plots were in Tanzania, it was not clear how this limitation would bias our results on phylogenetic clustering. Further, when exploring predictors of threatened species richness, we included all plots in our analyses, so the criticism of Gereau and colleagues is unjustified here, and we could have easily clarified this point if asked.

2. **Limitations and bias of the dataset**

Gereau et al. suggest that our sample of 581 species that we analyzed for Tanzania (representing all the Red Listed species for the region in the IUCN Red List database, but only ~5% of the total flora of Tasmania, as we acknowledge in our paper) "is not

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adequate or representative, either phylogenetically or phytogeographically, to address patterns of extinction risk across any regional flora". This is a somewhat surprising criticism of our paper as we state clearly that "(m)ost critically, there is an urgent need for increased effort to evaluate threat status of unassessed species. Currently, only 5% of the Tanzanian flora has been evaluated by the IUCN, and such lack of information could itself pose a significant risk to the flora through under-informed management decisions [57–59]" (cf. last two sentences of the discussion of our paper). We can only conclude that Gereau and colleagues must agree with us, or that perhaps they did not read to the end of our paper.

Despite this admitted paucity of data, we argue strongly that we cannot afford to wait for comprehensive data on extinction risks to become available before attempting to make management decision. It is imperative that we draw attention now to the extinction crisis that is impacting global hotspots of biodiversity. As we note above, it is increasingly likely that we are on the verge of a sixth mass extinction event, and that impacts might be particularly severe in the tropics (Vamosi & Vamosi 2008). In the Eastern Arc there is already a growing body of work suggesting that the fauna and flora of the region are severely threatened (Balmford et al. 2001a,b; Brooks et al. 2002; Burgess et al. 2004, 2007; Hall et al. 2009), and there has been at least one documented extinction (*Platypterocarpus tanganyikensis*) (Lovett & Stuart 2001). Eastern Africa is one of the most vulnerable regions to climate change in Africa (Trauth et al. 2005; Olwoch et al. 2007), which is considered a major driver of species to extinction (Willis et al. 2008). More research in the region is urgently needed. We conducted the first study of the phylogenetic structure of extinction risk in the region (Yessoufou et al. 2012), and encourage further research to be focused here.

We used the best available data in our analysis. Of course we agree that more and better quality data would be beneficial. However, the concerns raised by Gereau and colleagues on the validity of our results perhaps reflect a poor understanding of our analysis and phylogenetic methods in general. Gereau et al. suggest that "species are selected for (Red List) assessment primarily due to other factors including rarity, restricted distribution, extreme habitat specialization, and human exploitation (Gereau et al. 2009)", and that "this creates an *a priori* bias toward inclusion on the Red List in the threatened categories". This bias is a strong possibility, but our analyses indicated that vulnerable species were more clustered than expected by chance. An operational bias towards including species in the 'Vulnerable' category would not influence phylogenetic clustering (there would simply be more vulnerable species included in the analysis). What might drive phylogenetic clustering for vulnerable species, however, is shared traits that confer sensitivity to particular extinction drivers, and/or taxonomic bias in the assessment of Red Listed species, which we discuss in depth, but Gereau and colleagues oddly dismiss.

Gereau and colleagues also highlighted that "in a series of seven Red List workshops conducted between 2006 and 2013, the Eastern African Plant Red List Authority (EAPRLA) has reassessed many of these species under version 3.1 and has moved many of them into higher threat categories or downgraded them to Near Threatened or Least

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Concern". We do not find this result at all surprising, and we firmly support the extremely valuable and ongoing efforts of these assessments. Over time, we would (unfortunately) predict many susceptible species would move up the Red List categories, and that assessments based on different criteria might place species in different categories. We suggest that new analyses of extinction risks should be undertaken as new data becomes available, but that this should not detract from the importance of conducting research now, just as future Red List assessments do not devalue existing Red List efforts.

3. Improvement of the dataset

Finally, Gereau and colleagues call upon us to use updated Red List assessments, but these were still not available as of January 2014, and thus we do not find such suggestions particularly helpful. Gereau et al. indicated that they had a checklist of 1142 species, subspecies and varieties for Eastern Arc flora using www.tropicos.org, and that all these species have threat status on www.iucnredlistorg as for April 2013 (we published our work in 2012). The first two authors of this paper met with Gereau in January 2014, where it was confirmed that the data are still in process and not yet available for public use. That the authors' claim that they downloaded data on the new threat status for 1142 taxa in April 2013 is thus questionable. It might however suggest that they have access to unpublished IUCN data. We would urge them to make these data available. Although we are not able to verify these data, the authors state that of species that are threatened, 14% = CR, 45% = EN and 41% = VU, a distribution they describe somewhat disingenuously as relatively balanced, and thus suggest that "any statistical groupings of families based on the admixture of assessments performed under versions 2.3 and 3.1 are unlikely to have phylogenetic relevance". We are not entirely clear as to their meaning, but if their intention was to imply that it is unlikely that there will be similar phylogenetic structure in the new threat status (i.e. that revealed under version 3.1), we do not see any logical link. There is growing evidence that extinction risk is phylogenetically non-random (e.g. Purvis 2008; Davies et al. 2011), and we might expect this pattern to become more pronounced as better data becomes available.

4. Conclusion

In summary, we reaffirm that our methods were robust, transparent and reproducible. We do not see any justification for the criticism levelled at our analysis by Gereau and colleagues, and perhaps they reveal a lack of understanding of phylogenetic methods. Gereau et al. call upon us to use more recent Red List assessment data, but they were not able to provide us with access; we therefore find this suggestion particularly unhelpful. Nonetheless, I am sure we agree with Gereau and colleagues that new analyses will be valuable as and when new data become available, a point we made clearly in our original manuscript.

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