Global warming and extinction risks for amphibians in Madagascar, an overview

Franco Andreone, Museo Regionale di Scienze Naturali and Amphibian Specialist Group / Madagascar, Via G. Giolitti, 36, I-10123 Torino, Italy; email franco.andreone@regione.piemonte.it and franco.andreone@gmail.com

The amphibians of Madagascar represent one of the most extraordinary biodiversity off-shots, with around 240 known species, and many other, already identified, taxa, that still wait to be formally described and are considered as "candidate species". Seen this species-wealth and the parallel ongoing habitat alteration, it is obvious that a special attention should be paid on amphibian conservation, especially taken into account that Madagascar is a good "candidate country" for being considered a "natural laboratory", where experimenting techniques and politics to prevent the introduction and diffusion of infective emerging diseases of amphibians, at present not yet signalled (and most likely absent) on its territory (Andreone et al., 2008).

In the last years a particular effort was paid to design a tailored conservation action plan for the amphibians of Madagascar. This project, named "Sahonagasy Action Plan" is a result of the so-called "A Conservation Strategy for the Amphibians of Madagascar", launched under the auspices of the Amphibian Specialist Group (ASG) of IUCN (Andreone & Randriamahazo, 2008). Among the threats affecting Madagascar amphibians an important place is held by the climatic change. Amphibians are particularly sensitive to habitat alterations, and evidences were reported all through the for cases of species extinction and reductions driven by the increased mean temperature (Raxworthy et al., 2008).

Although the number of publications and related researches on Malagasy amphibians almost exponentially in the last years, little has been done so far concerning the repeatability of community data-sets in natural habitats, that could be ideally interpreted within the framework of the global climate change. This gap was filled up in the last times, thanks to the efforts done by Raxworthy et al. (2008) and Raxworthy (2008). These authors worked on the Tsaratanana Massif, which is also the highest mountain peak of Madagascar. Since high altitudes endemics are likely the best candidates to study climatic change effects, the work team analysed the community composition after a delay of ten years (1993-2003). What they found is that many species found on the first visit were found at a higher altitude ten years later. This change was interpreted as a consequence of increased mean temperature, witnessed by other climatic studies as well. At the same time, they analysed amphibians from many other montane massifs, which are also featured by peculiar high altitude endemics. Their analysis also showed that among the 39 montane species (those having a known elevational distribution > 800 m) 18 (or 26 under a more severe scenario) are at risk of extinction with an upslope displacement of 700 m. .

What is especially worrying is that this temperature increase would be logically followed by an up-slope displacement of local amphibian populations, following the variation of their climate envelope. Since Madagascar experienced (and is still under) a worrying situation of deforestation and/or forest fragmentation, the total habitat loss will be dramatically followed by the species extinction, especially when the species are closely tied and endemic of certain isolated forests.

This is also true for high altitude amphibians, that, therefore, include among the most threatened species of Madagascar. An example is also given for *Mantella cowani*, most likely one of the most (if not "the" most") threatened frogs of Madagascar, and present only at high altitude in residual plateaux habitats, which are among the most altered and exploited environments of Madagascar. This frogs still survives with very small populations and in very tiny residual habitats, and was also affected by heavy commercial take-off for the international pet-trade. Luckily enough the trade was totally banned since 2003 and recent efforts through the ASG led the purchasing one of the last sites where the species occur. The species was also ideal for being analysed in the context

of future climatic change, and basing upon the known occurrence and museum samples a potential distribution was drawn by Rakondrazafy et al. (in preparation).

The projections of future distribution under different climatic models showed an alarming shrinkage, and the prevision of a rapid extinction if no conservation measures will be taken in due time. All these considerations highlight the crucial need of carrying out conservation-aimed actions. The "Sahonagasy Action Plan" provided indications in this sense for a 5-years framework. To assess more clearly the effect of climatic change on amphibians (that so far have been only preliminarily shown) more repeated and long-term high altitude transects should be carried out. Furthermore, the increase of the protected areas network is a clearly necessity.

Sadly enough, the recent political changes in Madagascar affected the programmed triplication process for the protected areas. Only with the security of most altitude forests it will be possible to assure a reliable long-term viability of montane and endemic species. Much importance is to be given to protecting broad elevational transects of primary and mature secondary forests.

Acknowledgements. I wish to thank all those that shared published and unpublished information on climatic effects in Madagascar: Sandra Nieto, Nirhy H. Rabibisoa, Chris J. Raxworty, Ny Aina Rakotondrazafy, David R. Vieites.

References

Andreone F., Carpenter A. I., Cox N., du Preez L., Freeman K., Furrer S., Garcia G., Glaw F., Glos J., Knox D., Koehler J., Mendelson III Joseph R. , Mercurio V., Mittermeier R. A., Moore R. D. Rabibisoa N. H. C., Randriamahazo, Herilala, H. Randrianasolo, Rasoamampionona Raminosoa N., Ravoahangimalala Ramilijaona O., Raxworthy C.J., Vallan D., Vences M., Vieites D.R., Weldon C., 2008. The Challenge of Conserving Amphibian Megadiversity in Madagascar. PLoS Biology 6 (5).

Andreone F., Randriamahazo H., 2008. Sahonagasy Action Plan. Conservation Programs for the Amphibians of Madagascar / Programmes de Conservation pour les Amphibiens de Madagascar. Museo Regionale di Scienze Naturali, Conservation International, IUCN / Amphibian Specialist Group.

Rabibisoa N.H.C, Raxworthy C.J., Andreone F. 2008. Climate change and amphibians / Changements climatiques et amphibiens. In: Andreone F., Randriamahazo H. (editors), Sahonagasy Action Plan. Conservation Programs for the Amphibians of Madagascar / Programmes de Conservation pour les Amphibiens de Madagascar, 43-48. Museo Regionale di Scienze Naturali, Conservation International, IUCN / Amphibian Specialist Group.

Rakotondrazafy A. M. A., Rabibisoa N. H., Andreone F., in prep. Prédiction de la distribution de *Mantella cowani,* Boulenger, 1882.

Raxworthy C.J., 2008. Global warming and extinction risks for amphibians in Madagascar: a preliminary assessment of upslope displacement. In: Andreone F. (ed.), A Conservation Strategy for the Amphibians of Madagascar, 67-84. Monografie 45. Museo Regionale di Scienze Naturali, Torino.

Raxworthy C.J., Pearson R.G., Rabibisoa N., Rakotondrazafy A.M., Ramanamanjato J., Raselimanana A.P., Wu S., Nussbaum R.A., Stone D., 2008. Extinction vulnerability of tropical montane endemism from warming and upslope displacement: a preliminary appraisal for the highest massif in Madagascar. Global Change Biology, 14: 1-18.

Vieites D.R., Wollenberg K.C., Andreone F., Koehler J., Glaw F., Vences M. 2009. Vast underestimation of Madagascar's biodiversity evidenced by an integrative amphibian inventory. PNAS, 106: 8267-8272.