Scientific Reports in Life Sciences 6 (3): 27-32

DOI: https://doi.org/10.5281/zenodo.16894998

Potential impact of climate change on body condition and jump capacity of tree frogs from the southeastern part of Madagascar

Rodin Raberanto[1,2,3], Rodlis Raphali Andrianstimanarilafy[3,4*], Herizo Randrianandrasana[2], Lily-Arison René De Roland[3]

[1]*Institut des Sciences et Techniques de l'Environnement, Université de Fianarantsoa, Madagascar*
[2]*Faculté des Sciences, Université de Fianarantsoa, Madagascar*
[3]*Ecole Doctorale de Biodiversité et Environnement Tropicale, Université de Toliara, Madagascar*
[4]*Madagasikara Voakajy, BP 5181, Antananarivo, Madagascar*
[*]*Email: arraphali@voakajy.mg*

Received: 04 February 2025 / Revised: 09 April 2025/ Accepted: 1 April 2025/ Published online: 20 August 2025.
How to cite: Raberanto, R., Andrianstimanarilafy, R. R., Randrianandrasana, H., & De Roland, L.-A. R. (2025). Potential impact of climate change on body condition and jump capacity of tree frogs from the southeastern part of Madagascar, Scientific Reports in Life Sciences 6(3), 27-32. **DOI:** https://doi.org/10.5281/zenodo.16894998

Abstract

We studied the impact of temperature changes on body fitness and jumping performance of tree frogs from forest fragments around Ambalavero, southeastern Madagascar. Animals were captured and measured before the experimentation. They were placed in a small temperature-controlled box where the temperature was increased by 5 to 10°C above their natural conditions. Our results showed a decline in body mass and jumping performance after the experiment. These findings informed the vulnerability of amphibians to climate change.

Keywords: Amphibians, Behavior, Climate change, Ecology, Madagascar

Introduction

Madagascar is home to at least 427 amphibian species (Frost et al., 2024), and this number is not exhaustive. Based on an integrative approach of molecular, morphological, and bioacoustic characters, another almost two-fold increase in species numbers up to 465 species is anticipated (Vieites et al., 2009). On the other hand, amphibians are the most endangered vertebrates in the world because more than 40% of assessed species are listed as threatened on the IUCN Red List

(IUCN, 2024). Habitat loss linked to landscape alteration and degradation is their main threat. Previous studies indicate that amphibians might be vulnerable to climate change given their biphasic life histories, low dispersal abilities, endangerment from other threats, sensitivity to weather, and association with freshwater ecosystems characterized by high climate risks (Corn, 2005; McMenamin et al., 2008). Climate change is altering species abundances, ranges, and interactions as well as ecosystems worldwide (Scheffers et al., 2016; IPBES Secretariat, 2019). Although evidence suggests that some species are tracking changing climates through dispersal (Chen, et al., 2011; Urban et al., 2013) or persisting through plasticity or adaptation (Hoffmann & Sgrò, 2011; Urban et al., 2023), other species face declining populations, range retractions, and possible extinctions (Urban, 2015; Maclean & Wilson, 2011). Based on that previous paper, the general impact of climate change on species, such as the change of their distribution range or ecological niche, including reduction, shift, or increase, is commonly known. However, direct impact on small-scale animal life is still underexplored. This study aims to identify the impact of the change of ambient temperature on the animal fitness and survival according to their locomotion capacity.

Material and methods

Field data collection

This study was undertaken from forest fragments around Ambalavero village located in the buffer zone of Ranomafana National Park (Latitude S21°30'10.08"; Longitude E47°26'17.40"). Annual precipitation of this area varies between 800 mm to 1,000 mm, and the mean temperature is around 21°C to 23°C. For locating the frogs, diurnal and nocturnal searches along transects of 30m length were carried out by four experimenters. Weather parameters, including ambient temperature, relative humidity, and humidity index, were collected at the start and the end of each survey using Kestrel. To increase the chance of finding tree frogs, canopy surveys were carried out by climbing on the branches. For each encountered frog, we recorded the species name and time of observation. Some individuals were captured and placed within plastic bags for the artificial experiment in the camp the day after the survey. Morpho-metric measurements were done for each animal, such as the snout vent length, mass, and leg length were measured before running the experiment. For the artificial experiment, we used a manual incubator, the temperature inside was controlled using HOBO Pro and a thermocouple. Individuals were placed inside the incubator for 10 to 30 minutes, and the temperature was changed from 25 to 30°C. To

assess the impact of the temperature changes on the animal, we measured two main parameters such as: (1) the change in its mass before and after the experiment, and (2) its jumping capacity by measuring the distance of its first jump and the total distance until its first stop.

Data analysis

Statistical analysis was done using R4.3.3 (R core team). Comparison of measured parameters before and after the experiment was undertaken using the Mann-Whitney nonparametric test because our data showed a Poisson distribution. Relative correlation between parameters was analysed with the Spearman correlation rank.

Results

Species key characteristics

Four tree frog species from two families were used during this study, such as two Mantellidae (*Boophis albilabris* and *B. madagascariensis*) and two Hyperoliidae (*Heterixalus alboguttatus* and *H. betsileo*). The number of encountered individuals varied between species, with *B. madagascariensis* being the most abundant, with 132 records. In contrast, *B. albilabris* was the least abundant, which was encountered only 43 times. For the rest of the species studied, *H. alboguttatus* and *H. betsileo* were recorded for 97 and 102 times.

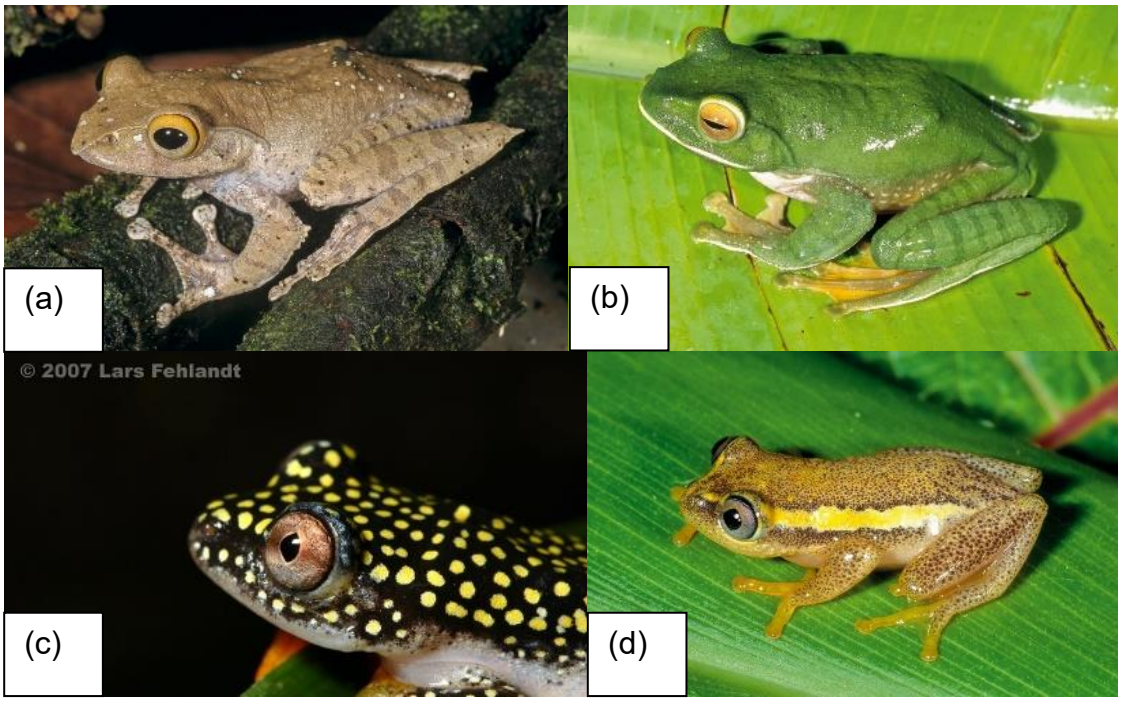

Figure 1. Photos of studied species (a): *Boophis madagascariensis*; (b): *B. albilabris*; (c): *Heterixalus alboguttatus*; (d): *H. betsileo*

This study informed a positive correlation between leg length and total jump distance across all studied species, although the strength of the correlation varied among them. The highest correlation was observed in *Boophis albilabris* ($r^2 = 0.42$), while the lowest was found in *Heterixalus alboguttatus*, where the correlation was nearly nonexistent ($r^2 = 0.01$). For the other species, the correlation is $r^2 = 0.06$ for *B. madagascariensis* and $r^2 = 0.07$ for *H. betsileo*.

Mass before and after the experience

Our results indicated that the mass of frogs decreased after the experiment, but the rate of change was different from each species. However, this change was not significant in general except for *Heterixalus betsileo* (*p-value=0.04*) which was the species with the highest declining rate equal of -12.85%. *Boophis albilabris* mass presented the smallest rate which was -4.89% (Table 1).

Table 1. Comparison of animal mass before end after the experience

Species	**Number**	**Mass before**	**Mass after**	**Percentage of change**	***p-value***
B. albilabris	43	15.04±1.97	14.49±1.93	-4.89±0.53	*0.67*
B. madagascariensis	132	10.31±0.59	9.79±0.58	-5.80±0.38	*0.31*
H. alboguttatus	97	1.93±0.05	1.80±0.04	-6.68±0.62	*0.07*
H. betsileo	102	1.29±0.56	1.13±0.05	-12.85±1.42	*0.04*

Jump performance before and after the experience

This study indicated that high temperature affects the animal jump performance with a significant decreasing of their total jump distance, but the rate varies between species. This change of jumping capacity is significant for all studied species. *Boophis albilabris* presents the highest decreasing rate of jump capacity and the lowest is for *Heterixalis alboguttatus* (Table 2).

Table 2. Comparison of total jump before end after the experience

Species	**Number**	**Total jump before**	**Total jump after**	**Percent of change**	***p-value***
B. albilabris	43	506.57±29.93	337.70±24.82	-42.21±6.09	*0.0003*
B. madagascariensis	132	521.17±14.67	353.06±15.13	-36.37±2.84	*<0.0001*
H. alboguttatus	97	396.41±13.12	304.96±12.04	-25.46±2.12	*<0.0001*
H. betsileo	102	363.54±11.44	256.36±9.90	-40.43±4.45	*<0.0001*

Discussion

Species key characteristics

We studied tree species and nocturnal frogs from southern central of Madagascar. The study area is known as a tropical highland dominated by a long period of low temperatures. Nocturnal and arboreal behavior are the result of the adaptation from mountain biogeography against terrestrial predators (Glaw & Vences, 2007).

Effect of temperature on animal body condition and behavior

This study informed that the mass and jumping capacity of the frogs decreased after the experience. This case can affect the animal foraging mode and capacity which can affect its survival. Previous study indicated that amphibians are potential targets of environmental stressors due to their skin permeability (Blausten et al., 2003). This increase of temperature might be the result of evaporation of its body liquid which impacted its body fitness. However, this reduction of body capability can affect in its turn its moving ability. With this situation, these species are threatened by climate change by reducing their dispersal capacity. Raxworthy et al. in 2006 reported that Madagascar's highland species are vulnerable into climate change and this study can confirm this vulnerability. Between each species, *Heterixalus albogutatus* presents a limited range and might be highly vulnerable such as reported by previous study that species with small distribution range are more vulnerable to climate change because of their limited disperse capacity and their low physiological adaptation (Botts et al., 2015).

Acknowledgements

The author would like to thank everyone who participated until the fruition of this study. This research was made possible by the worldwide information network of Centre Valbio, the University of Fianarantsoa. Special thanks to the precious help and guidance of the Doctoral school of university of Toliara.

References

Blaustein, A. R., & Belden, L. K. (2003). Amphibian defenses against ultraviolet-B radiation. Evolution & Development, 5, 89–97. https://doi.org/10.1046/j.1525-142X.2003.03014.x

Botts, E. A., Erasmus, B. F. N., & Alexander, G. J. (2015). Observed range dynamics of South African amphibians under conditions of global change. Austral Ecology, 40(3), 309–317. https://doi.org/10.1111/aec.12206

Chen, I. C., Hill, J. K., Ohlemüller, R., Roy, D. B., & Thomas, C. D. (2011). Rapid range shifts of species associated with high levels of climate warming. Science, 333, 1024–1026. https://doi.org/10.1126/science.1206432

Corn, P. S. (2005). Climate change and amphibians. Animal Biodiversity and Conservation, 28, 59–67.

Glaw, F., & Vences, M. (2007). A field guide to the amphibians and reptiles of Madagascar (3rd ed.). Vences and Glaw Verlag.

Hoffmann, A. A., & Sgrò, C. M. (2011). Climate change and evolutionary adaptation. Nature, 470, 479–485. https://doi.org/10.1038/nature09670

Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). (2019). Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Settele, J., Diaz, S., & Ngo, H. T., Eds.). IPBES Secretariat.

Maclean, I. M., & Wilson, R. J. (2011). Analyzing the impacts of climate change on water level fluctuations of Tashk and Bakhtegan Lakes and its role in environmental sustainability. Proceedings of the National Academy of Sciences of the United States of America, 108, 12337–12342. https://doi.org/10.1073/pnas.1017677108

McMenamin, S. K., Hadly, E. A., & Wright, C. K. (2008). Climatic change and wetland desiccation cause amphibian decline in Yellowstone National Park. Proceedings of the National Academy of Sciences of the United States of America, 105, 16988–16993. https://doi.org/10.1073/pnas.0809090105

Scheffers, B. R., De Meester, L., Bridge, T. C. L., Hoffmann, A. A., Pandolfi, J. M., Corlett, R. T., Bichart, S. H. M., Pearce-Kelly, P., Kovacs, K. M., Dudgeon, D., Pacifici, M., Rondinini, C., Foden, W. B., Martin, T. G., Mora, C., Bickford, D., & Watson, J. E. M. (2016). The broad footprint of climate change from genes to biomes to people. Science, 354, eaaf7671. https://doi.org/10.1126/science.aaf7671

Urban, M. C. (2015). Accelerating extinction risk from climate change. Science, 348, 571–573. https://doi.org/10.1126/science.aaa4984

Urban, M. C., Swaegers, J., Stoks, R., Snook, R. R., Otto, S. P., Noble, D. W. A., Moiron, M., Hällfors, M., Gómez-Llano, M., Fior, S., Cote, J., Charmantier, A., Bestion, E., Berger, D., Baur, J., Alexander, J. M., Saastamoinen, M., Edelsparre, A., & Teplitsky, C. (2023). When and how can we predict adaptive responses to climate change? Evolution Letters, 8(1), 172–187. https://doi.org/10.1093/evlett/qrac021

Urban, M. C., Zarnetske, P. L., & Skelly, D. K. (2013). Moving forward: Dispersal and species interactions determine biotic responses to climate change. Annals of the New York Academy of Sciences, 1297, 44–60. https://doi.org/10.1111/nyas.12184

Vieites, D. R., Wollenberg, K. C., Andreone, F., Köhler, J., Glaw, F., & Vences, M. (2009). Vast underestimation of Madagascar's biodiversity evidenced by an integrative amphibian inventory. Proceedings of the National Academy of Sciences of the United States of America, 106, 8267–8272. https://doi.org/10.1073/pnas.0810821106