

Darwin Fellowship - Final Report

Due within one month of the end date of the Fellowship (maximum 6 pages)

Darwin Fellowship reference	DARFW053
Name of Darwin Fellow	Rodlis Raphali Andriantsimanarilafy
Lead organisation	North of England Zoological Society, Chester Zoo
Fellow's organisation(s)	Madagasikara Voakajy
Fellow's role within their organisation	Manager, Species and Conservation Program
Start/end date of Fellowship	1 July 2021 - 31 March 2024 (includes agreed extension)
Location	Madagascar, Chester Zoo, DICE
Darwin Fellowship grant value (£)	£11,200
Type of work (e.g. research, training, if other please specify)	Research and training
Main contact in UK organisation	Gerardo [REDACTED]
Author(s) and date	Rodlis [REDACTED] Richard [REDACTED] Kieran [REDACTED] Gerardo [REDACTED] 08/07/24

1. Background

I was involved in two projects funded by Darwin led by DICE University of Kent in collaboration with Madagasikara Voakajy (MV), Madagascar, who I work for. The first was Chameleon trade and Conservation in Madagascar, 2009-2012, ref: 17-010; and the second was Implementing CITES in Madagascar, 2012-2015, ref: 19-014. Both of these projects had a focus on the threat posed by wildlife trade to amphibians and reptiles in Madagascar and building capacity to strengthen and implement CITES. The Darwin Fellowship project developed from this earlier work by carrying out further work on priorities highlighted by the IUCN Madagascar Amphibian Conservation Action Plan.

Capitalising on a two-phased process of training in the UK, the fellow will (1) build capacity in Madagascar for undertaking the assessment of critically endangered species and habitats; and (2) undertake research that has been prioritised within the Madagascar Amphibian Conservation Action Plan. One of the key elements of the latter is to understand the habitats, threats and conservation needs of one of Madagascar's most threatened amphibians, the harlequin mantella, *Mantella cowanii*. This species is confined to just four remaining populations and is under threat from habitat loss and degradation and illegal collection for the wildlife trade. My PhD research therefore focused on fieldwork at one of the last remaining populations with a view to determining habitat requirements, threat mitigation and conservation interventions for the species, including the establishment of an ex situ captive assurance population.

The North of England Zoological Society (NEZS) is a leading conservation and education charity, based at Chester Zoo in the UK, which it owns and runs. They deliver their mission of 'Preventing Extinction' at the Zoo and through partnerships across the globe, guided by their Conservation Plan, which promotes an integrated approach and provides a set of targets covering species and populations, conservation landscapes, empowerment of people and influencing policy for wildlife. In addition to a strong science, training and field programmes team, Chester Zoo has dedicated biosecure and off-show facilities for several threatened amphibian species that provide unique opportunities for both captive breeding and research on behaviour and reproductive biology.

Madagasikara Voakajy is a Malagasy biodiversity organisation dedicated to the conservation of endemic vertebrates and their habitats in Madagascar. Our mission is to promote the conservation and sustainable use of Malagasy ecosystems, habitats and species by mitigating key threats to this unique biodiversity through targeted action and applied research.

During the fellowship, I completed my PhD at the University of Toliara. I also undertook a drone pilot course to gain skills in safe and successful piloting of drones for survey work. During September 2023 I undertook a formal postgraduate module at DICE on 'Multidisciplinary Perspectives on Conservation'.

Link to drone pilot course: <https://www.dronepilotacademy.co.uk/product/caa-general-visual-line-of-sight-course/>

Link to 'multidisciplinary perspectives in conservation' module at DICE: <https://www.kent.ac.uk/courses/modules/module/DICE1001>

2. Achievements

During this fellowship, I led and coordinated fieldwork with various national and international collaborators on the study of distribution, population size, habitat preference, and behaviours to aid in the conservation of a highly endangered amphibian in Madagascar. I also received one-to-one training and mentoring on data analysis using the software R. Additionally, I attended a number of sessions on the course module on 'Multidisciplinary Perspectives in Conservation' from the Durrell Institute of Conservation and Ecology (DICE) at the University of Kent in September 2023.

During this fellowship, I also learned a lot about research principles, leadership, and the management of large-scale projects. After completing various training sessions at Chester Zoo and DICE, I organised sharing and training sessions on research principles, database management, and data analysis using the software R with the staff at MV. I also gave presentations to groups of doctoral students during my three years of Ph.D. studies.

I completed my Ph.D. on the topic: "BIOLOGY, SPATIAL DISTRIBUTION, AND IMPACTS OF CLIMATE CHANGE ON THE AMPHIBIAN *MANTELLA COWANII*" at the University of Toliara in March 2024. Three scientific papers were planned as part of this doctorate, one of which has been published, and the other two are currently being written and revised with the authors. This PhD will enable new insights into the conservation of this species going forwards, and also contains much work that is applicable to other threatened species in Madagascar.

An *ex-situ* study on the impact of changes on ecological parameters on the behaviours and habitat use of *Mantella cowanii* was planned as part of this Fellowship. This study was supposed to be conducted at Chester Zoo as a research centre, for which the export of live individuals to the centre was necessary. This study has not yet been carried out because the export of *Mantella cowanii* individuals has not yet been authorised by the Malagasy authorities. Several steps towards this goal have been taken, including signing an agreement for managing the exported individuals until their return to Madagascar.

During this fellowship period, whilst at Chester Zoo on 16th and 17th October 2023, I took a drone pilot course, the CAA General Visual Line of Sight (GVC) Course, including Practical Flight Training. This course, offered by the Drone Pilot Academy, provided me with new skills in flying, operating, and landing a drone safely and effectively. These skills will be incredibly useful in the field where they will be used to locate potential and viable areas for *Mantella cowanii*. The application of the drone technology for this project has become a crucial tool for the next steps of studying the spatial distribution of *Mantella cowanii* and assessing the impact of climate change on these populations. The remote and difficult terrain are one of the major key reasons to use this technology. It is planned after this course to develop a comprehensive habitat mapping and with the integration of geospatial data in order to provide a comprehensive analysis of the potential sites where future reintroduction sites could be developed for this species.

I completed my Ph.D. on the topic: "BIOLOGY, SPATIAL DISTRIBUTION, AND IMPACTS OF CLIMATE CHANGE ON THE AMPHIBIAN MANTELLA COWANII" at the University of Toliara. I conducted research to aid in the conservation of the species in its natural habitat and initiated the concept of *ex-situ* research and conservation. Work from my PhD has already led to the publication of one journal article, in the journal Scientific Reports in Life Sciences, on the seasonal population structure and size variation in *M. cowanii*, with two more in progress, enabling the information gained during my PhD research being available to a wider audience of conservationists and scientists. Key highlights from the published paper (Andriantsimanarilafy et al., 2024, "Seasonal population structure and size variation of the endangered Harlequin mantella from East Betsileo, Madagascar") are that in visual encounters, roughly two thirds of encountered frogs were female, although multiple males heard calling but not seen suggest a more equal sex ratio in the population, and that the best time to search for the species is the start of the rainy season, when most of the frogs were found, with numbers falling later in the rainy season and none at all being found over winter. This work also indicated that the abundance of *Mantella cowanii* between both sites is not significantly different. The species abundance is low which means that it is vulnerable to extinction for both sites. On the other hand, the abundance index is significantly different according to the season. Fire and illegal gold mining were the main threats to the species and its habitat that we found during our surveys. Both sites are dominated by an open area; tree planting for restoration might be needed to help the animals survive. During my Ph.D. period, I was able to enhance my skills in project management and design, grant writing, data analysis, and scientific paper writing.

3. Outcome, lessons and impact

As the lead researcher within our organisation, this scholarship has helped me enhance my research capabilities for the conservation of endangered species in Madagascar. It has improved my knowledge in data analysis using the software R and in modelling the ecological niche of a rare species like *Mantella cowanii*. The knowledge and skills acquired during this scholarship will be used for data analysis of the various research projects we have conducted at our intervention site and may be applicable to a wide range of other threatened Malagasy wildlife going forwards.

My PhD research provided new insights into the habitat preferences, and daily and seasonal activity patterns of *Mantella cowanii*. These data are being used to identify potential new areas for the species, how climate change may affect its distribution in the future, and how ongoing threats to the remaining populations might be mitigated. My PhD research revealed a lot of new information on the ecology, behaviours, and the impact of climate change on the species.

The abundance of *Mantella cowanii* varies according to the season, with the beginning as well as the peak of the rainy season being the most favourable times for observing the species. This variation must be considered in future research in order to collect as much information as possible on the species. The period of seasonal activity of *M. cowanii* is very limited. The near-even sex ratio of *M. cowanii* detected during fieldwork shows that the species can still reproduce. The breeding period of the species is between November and February. Females lay eggs during these periods. However, despite efforts made during this fieldwork, neither eggs nor tadpoles were observed. This means that the exact breeding sites of the species are still difficult to determine. The low observation of juveniles shows that its larval development takes place in hard-to-access locations, possibly underground, and continues during the winter. *M. cowanii* exhibits sexual dimorphism in terms of size, with females being larger than males.

Mantella cowanii presents a variation in habitat preferences which is mainly linked to the presence of rocks. In addition, land use varies depending on the season. The species is active on rocky outcrops throughout the wet season, but the species also uses riparian and grassy areas during part of the year. During this daily activity the species is often observed near boulders, but they use different kinds of substrates such as herbaceous vegetation and lichens. Few individuals from riparian areas were found on submerged rocks. The daytime and nighttime resting sites of the species are different. It was only found in grassy patches during its nocturnal rest unlike diurnal activity where three types of microhabitats such as rock crevices,

meadows, and ground holes were used. Caves and rock crevices were used during the breeding period at the start of the rainy season.

The study of the distribution area of *Mantella cowanii* confirmed that the species is limited to the central high plateau. On the other hand, there are still potential sites other than the currently known sites and these need to be explored to determine if the species' full distribution is known. The species is very vulnerable to climate change, the majority of current distribution sites confirmed for the species will no longer be viable for the species within 30 years. Only a few localities in the highest places will be viable for the species. With its low capacity for movement, the species will therefore be very threatened and risks disappearing if no adequate conservation measures are taken. Average temperature and winter precipitation are the two bioclimatic parameters most influential on the distribution of the species. Effective conservation measures must be considered even in the most optimistic scenario where the increase in temperature will be the lowest.

This research from my PhD confirms that *Mantella cowanii* is only active during a short period of the day. This situation makes the species more vulnerable because it may limit the animal's diet which can lead to poor physical condition and therefore influence reproductive success or output. It can also limit the possibility of meeting between male and female individuals for sexual amplexus in small remnant populations. Given the alarming decrease in its population over the last ten years as well as the strong threat from repetitive fires; setting up an ex-situ reproduction conservation centre following the IUCN guidelines is strongly recommended for this species, in order to ensure having a rescue population but also to carry out reintroduction to strengthen existing populations in each of its distribution sites. In addition, should it be possible to collect and export some frogs from one of the last remaining wild populations to provide a captive assurance population at Chester Zoo, the environmental data collected during my PhD will inform the design and climatic conditions of the facility that will be needed to manage them.

Unfortunately, because of delays in decision-making within the Madagascar authorities, it was not possible to collect and export *Mantella cowanii* to Chester Zoo where I would have carried out detailed behavioural observations on the species that were not possible in the field. However, negotiations to undertake this element of the work are still ongoing.

After this fellowship, I need to develop detailed research plans with specific actions and methodologies for our target species in various regions of Madagascar. I will utilise skills gained in project management, research methodologies, and data analysis using R during this fellowship, and continue to disseminate these to my colleagues, students and partners to ensure these research plans are effective.

The skills acquired during this scholarship have helped me in the sustainable management of commercially traded species, leading to my integration into the CITES Scientific Authority of Madagascar for amphibians and reptiles. My PhD research, focused on the threats faced by a highly endangered amphibian, *Mantella cowanii*, can be used to drive further research and conservation efforts for this species, as well as other species in Madagascar facing similar threats.

During my visit to the UK I attended a meeting of the British Herpetological Society (BHS) on 8 October 2023 where I networked with various individuals involved with related projects, many of which involved techniques and methodologies which may be useful in future work on *Mantella cowanii* or other threatened Malagasy species. Ongoing links with that society and its members will be maintained through Dr Garcia, who is the BHS President.

Whilst various difficulties arose over the course of this fellowship, such as delays with authorities granting visas and permits, none of those were directly linked to the Darwin Initiative Fellowship scheme.

4. Impact of COVID-19 on Fellowship

In the original proposal; there were two periods of training proposed for 2021 and 2022 (phase 1) and 2022 and 2023 (phase 2). Because of the COVID pandemic and travel restrictions from Madagascar; no travel was possible in 2021-2022 and so the project was delayed by one year. Under the revised plan; the schedule anticipated two months of training at Chester Zoo in July-August 2022 followed by one month at DICE in September 2022. However as my VISA for travel to the UK was not granted until September 2022; this training period was not possible. Moreover, it was not possible to shift the three month period because of my PhD fieldwork commitment in Madagascar that ran from November to March, and the modules I was scheduled to attend started before I arrived. In discussion with the project team; we decided not to request a delay to the fellowship by a further year as this would have resulted in the proposed training occurring after I completed my fieldwork. To compensate for the delays; we further agreed that there would be a shorter period of training at Chester Zoo running from 24/02/23 to 09/03/23. As there was no time to attend DICE during this period, RG came to Chester Zoo for three days of face to face discussion and training. Additional training in the UK was carried out in September-October 2023, with training taking place both at DICE (2 weeks) and Chester Zoo (2 weeks). By that time my fieldwork had been completed and I was working on my PhD thesis to be submitted at the University of Toliara. The training therefore focused on advanced data analysis (e.g. GLMs/GLMMs in R), scientific writing and paper preparation. However, I also undertook a module on multidisciplinary approaches in conservation and some practical training in the field on amphibian and reptile survey methods. In addition a formal training course in the use of drones for ecological survey was undertaken.

Overall, the inability to travel to the UK as a result of the COVID pandemic resulted in the training element of the fellowship being de-synchronised from the fieldwork element. Nevertheless, in collaboration with Chester Zoo and DICE we managed to reschedule the training elements which still proved highly beneficial in successfully completing my PhD thesis.