

Final Evaluation Report

Your Details	
Full Name	Cristina Sagnotti
Project Title	Don't shock the monkey! Habitat suitability modelling and non-invasive genetic monitoring of <i>Macaca maura</i> (South Sulawesi, Indonesia)
Application ID	36305-1
Date of this Report	29/09/2023

1. Indicate the level of achievement of the project's original objectives and include any relevant comments on factors affecting this.

Objective	Not achieved	Partially achieved	Fully achieved	Comments
To produce the first habitat suitability map of moor macaque population in the TNBABUL and to predict current and potential distribution on the entire geographic range.				Occurrence data (N=247) collected during the 24 stratified-random plots surveys made it possible to model the potential distribution of this species at the level of TNBABUL area and the entire geographical range.
To carry out the first non-invasive genetic study and implement a standard protocol to fill the lack of knowledge about genetic variability at intraspecific level.				During the survey we collected 194 faecal samples to estimate genetic variability parameters of different moor macaque social groups in the TNBABUL. A panel of 30 SNPs and the D-loop sequence of mitochondrial DNA allowed to identify two main genetically distinct populations, and to estimate divergence and inbreeding at intra- and inter-population levels.
To evaluate the effect of landscape characteristics on the population genetic structure.				Genotyped samples collected in the TNBABUL areas with different environmental characteristics (land cover, altitude, tree cover, anthropogenic impact, etc.) allowed to identify a possible barrier to gene flow between north and south populations, probably due to presence of unsuitable areas such as roads and crop fields.
To identify potential ecological corridors to promote functional landscape connectivity among isolated forest patches.				The habitat suitability map projected on the entire geographic range, even if with due caution as projected from occurrence data collected only in the TNBABUL area, allowed to identify suitable areas, outside the national park, which appear to be isolated from each other. Further surveys should be carried out to investigate the level of gene flow among the presumed isolated populations to eventually propose potential

			ecological corridors.
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2. Describe the three most important outcomes of your project.

a). The survey of 24 plots allowed the identification of new social groups of moor macaques in the TNBABUL area. During the survey, the national park staff had the opportunity to acquire skills in research and in approaching social groups not habituated to the human presence, as well as in proper data and faecal sample collection techniques. This is the most important outcome because it will allow the national park staff to independently continue to monitor the population trend of this species.

b). The faecal samples collection and the collaboration with Dr. Isra Wahid from Hasanuddin University allowed to improve lab protocols to carry out a non-invasive genetic monitoring of moor macaque social groups in the wild. The monitoring protocols identified can be applied to the study of further populations in other areas outside the national park and to monitor the genetic parameters of the park's populations in future years.

c). Presence data, land cover, tree cover and bioclimatic variables were analysed using a Maximum Entropy (MaxENT) Approach, to predict potential distribution of moor macaques over the entire geographic range. Even if based on occurrence data collected in the TNBABUL area, this habitat suitability map is a valuable support to identify new suitable areas and to cautiously predict the degree of fragmentation among them.

This first phase of the project contributes to fill the gap in the existing knowledge on important factors affecting the geographic distribution and genetic variation of the moor macaque populations in the TNBABUL, in addition to increasing the efficiency of non-invasive genetic techniques to facilitate the study of this endangered species in the next future.

From a genetic point of view, moor macaques' populations in the TNBABUL result to be subdivided in two main distinct clusters, with the north cluster showing less genetic variation at intra-population level compared to the south cluster, characterised by genetically diversified individuals from both populations. This north-south difference seems to be plausible for three main reasons:

- The habitat of the northern population is characterised predominantly by lower mountain forest and lowland alluvium forest subjected to higher degree of anthropogenic disturbance, while the southern population prevalently inhabits the limestone karst ecosystem, less suitable for the human exploitation.
- A partial barrier to gene flows probably persists between the two areas, characterised by the presence of the Mount Bulusaraung (with a height of 1,535 m asl), cultivated fields and roads interspersed with a lowland alluvium forest area.

- The southern population shows higher level of genetic variation probably also due to direct human intervention. In fact, the national park staff reported several interventions during which illegally captured individuals in the north area were confiscated and moved to the more suitable core-zone located in the southern part of the TNBABUL.

During the survey, the national park staff had the opportunity to explore new areas and to discover new moor macaque social groups as well as identifying critical areas subjected to heavy anthropic disturbances (as already reported in the Project Update document) that need to be monitored over time.

The successful collaboration with the TNBABUL staff, Dr. Isra Wahid, and the local community involved during the project has made it possible to set up future monitoring plans which will be carried out both independently by the park staff, and at the level of the entire geographic range with further surveys.

3. Explain any unforeseen difficulties that arose during the project and how these were tackled.

The biggest unforeseen challenge during the project was the delay due to Covid-19 travel restrictions. The delay led to the postponement of data collection, the last part of which took place during the first months of the rainy season. To be able to carry out the surveys anyway, it was necessary to reorganise the expeditions day by day based on the weather conditions and the accessibility of the different areas of the national park. This was possible thanks to the availability and flexibility of the national park staff and the local guides who promptly adapted to the sudden changes during the fieldwork.

4. Describe the involvement of local communities and how they have benefited from the project.

As reported in the Project Update document, a total of 35 people (both TNBabul rangers and locals) were involved in the project and paid. During the expeditions, information to locals was provided about the project and the importance of preserving the species and its ecological role. The rangers involved were trained in research and approach to new social groups of moor macaques, and in non-invasive data collection and sampling techniques. In addition to these people directly involved during the surveys, each expedition included a period of stay of at least 2 nights near each plot, during which we were hosted by the local community who received compensation for accommodation and food. Once a week, upon returning from sample collection, DNA extractions were carried out at the entomology laboratory of Dr. Isra Wahid at Hasanuddin University during which it was possible to interact with the students, explain the project and discuss of non-invasive genetic monitoring protocols.

5. Are there any plans to continue this work?

Yes. Once the doctoral thesis will be defended in June 2024, I plan to start again with the search for funds. The objective will be to expand the surveys in areas

outside the national park, found to be suitable and not suitable for the presence of moor macaques, thus allowing to better understand the degree of adaptability of the species, and to identify important areas to be protected or restored. The second phase of the project will involve local students who will be offered the opportunity to collect and process faecal samples directly in the field, without the need to export DNA samples outside the country. For this purpose, we are now testing new equipment using the faecal samples collected during the first phase of the project.

6. How do you plan to share the results of your work with others?

I plan to disseminate these results through the doctoral thesis first, and then publish the most important outcomes on at least two peer-reviewed journals. As reported in the Project Update document, I already presented the preliminary results at the TNBABUL meeting and at the Department of Life Sciences and Biotechnology (University of Ferrara). I also plan to attend several international conferences and disseminate my results through oral presentations during the next year.

7. Looking ahead, what do you feel are the important next steps?

The next important steps are to disseminate the results obtained until now and to start planning the second phase of the project with the members of the team. First, it is necessary to expand the survey to other areas to better understand the actual distribution of the species and the degree of gene flow among the presumed isolated populations. This second phase will allow to better understand the current conservation status of moor macaques by comparing genetic and geographic distribution data with a broader range of environmental characteristics and anthropogenic impacts.

8. Did you use The Rufford Foundation logo in any materials produced in relation to this project? Did the Foundation receive any publicity during the course of your work?

During each presentation I used the Rufford Foundation logo to acknowledge the support (see Project Updates document).

9. Provide a full list of all the members of your team and their role in the project.

Prof. Giorgio Bertorelle – Project supervisor

Prof. Silvia Fuselli – Laboratory supervisor

Dr. Isra Wahid – Local counterpart and collaborator during the DNA extraction phase in the Indonesian lab

Pak Pado – Principal collaborator during the survey

TNBABUL staff – Fieldwork collaborators and logistics

Dr. Ettore Fedele – Laboratory collaborator

Dr. Maëva Gabrielli – Data analysis collaborator

10. Any other comments?

The entire project team is extremely grateful to The Rufford Foundation for contributing to the success of this study, and we look forward to publishing our findings and fully recognising your contribution.