

Final Evaluation Report

Your Details	
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Project Title	Cryptic Diversity in the agamid lizards of India
Application ID	20097-1
Date of this Report	11-05-2022

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
Sampling surveys				We achieved satisfactory success in terms of sampling and taxonomic representation. Species of seven genera were sampled to generate molecular and morphological data (see accompanying map).
Molecular analysis				Sequences of the mitochondrial 16S rRNA gene for all the collected tissues, and COI and ND2 for a subset of those tissues, were generated. Molecular phylogeography-phylogenetics analyses were run to test species boundaries within the Indian agamid species.
Distribution models and maps				Preliminarily done. This is an ongoing process and the results of this will be included in one of the upcoming publications.
Manuscript and report preparation				A paper dealing with the generic re-allocation of a species previously included under <i>Pseudocalotes</i> was published in <i>Evolutionary Systematics</i> (Gowande et al. 2021b). The biggest contribution of this work, the systematic revision of south Asian agamid lizard <i>Calotes versicolor sensu lato</i> was published in <i>Vertebrate Zoology</i> (Gowande et al. 2021b), which led to the restriction of the geographic distribution of <i>C. versicolor sensu stricto</i> to Peninsular India, and also led to unearthing the cryptic diversity in the species complex, with the resurrection of a synonym and elevation of a subspecies to species rank. This is an important contribution addressing the Linnean and Wallacean shortfalls in the South Asian agamid systematics. Three more manuscripts - two dealing with the systematics of two Peninsular Indian lizards, and another with the generic re-allocation of an endemic

			agamid species - are under preparation and will be communicated to suitable journals shortly.
Education			During the grant and later, numerous educational programmes were organised at schools, colleges and universities for students and for forest department staff and other enthusiasts. The programmes were aimed at spreading awareness about the poorly known Indian agamid diversity. Educational material in the form of Microsoft® PowerPoint presentations and printed photographs was used. RF logo was used in each of the presentations and printed educational material.

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

a). Molecular phylogeography and phylogeny of the Indian agamid species – We collected more than 150 samples of Indian agamids from numerous localities across India; multiple samples of the species belonging to the genera *Calotes*, *Draco*, *Japalura*, *Pseudocalotes*, *Psammophilus*, *Ptyctolaemus* and *Trapelus* from throughout the Indian Peninsula and from areas adjoining the peninsula were collected and subjected to molecular analyses. Mitochondrial 16S, COI and ND2 sequence data revealed the existence of population structure and cryptic diversity in most of the species sampled. This was the first important step involved in this study - uncovering the level of cryptic diversity in Indian agamid species.

b). Taxonomy, systematics, generic re-allocations – The widely distributed species complex - *Calotes versicolor* - has been resolved (Gowande et al. 2021b). The South Asian populations were shown to belong to four distinct species - *Calotes versicolor*, *C. irawadi*, *C. farooqi* and *C. vultuosus*. Of these, *C. farooqi* and *C. vultuosus* were previously included as subspecies/synonyms of *C. versicolor*, which were elevated to species level/resurrected from synonymy in this study (Gowande et al. 2021b). Further, *C. versicolor*, which was considered widely distributed throughout South Asia was shown to be restricted to Peninsular India. Similar intraspecific diversity was observed in other widely distributed genera, which are currently under revision (MS in prep.). The generic allocation of another species was also revised from *Pseudocalotes* to *Japalura* (Gowande et al. 2021a).

c). Numerous talks and presentations on Indian agamid diversity, its taxonomy, the current state of research and conservation were delivered at schools, colleges and university across India. The audience for such events was largely composed of young enthusiasts, school and university students, educators and forest department officials. I was also a faculty member at herpetology workshops where I delivered talks on the agamid taxonomy, diversity, distribution and conservation measures. A photographic field guide on the Indian agamids has been designed and is being reviewed by the experts in the field. The field guide will soon be published and made

available to the enthusiasts, forest department officials and policymakers, which will help conserve agamid species and their habitats more efficiently. It is expected that the field guide will be published shortly.

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

Travel and accommodation was costlier than previously accounted for. The expenses in those sections as well as the field assistants' salary exceeded our initial forecasts. However, these were addressed by re-allocating the funds from other sections of the budget such as books, contingency and equipment. The forest department permits took longer time to come in, which caused a delay in the completion of the project. Additionally, the budget heads on the proposal and those permitted at the grant handling institution did not match, which led to the re-allocation of some lines. Finally, we could not achieve adequate sampling within the stipulated time frame, which resulted in the extension of grant period by a couple of years. Nonetheless, we were successful in sampling adequately in the later stages of the project.

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

Although we could not involve local communities directly in the project, we did conduct naturalist training for members of Village Development Committees and Joint Forest Management Committees in Maharashtra, as well as naturalists of protected areas of Arunachal Pradesh. The participants were trained to identify the reptile (particularly agamid) species specific to their region, and to maintain an inventory of the reptile species found in their surroundings. They were also trained by us in handling, rescue and release of reptiles, to ensure that human-wildlife conflict was reduced. Similarly, naturalists from the regional communities were engaged in the project, which further catalysed the sampling process, due to the familiarity of the landscape.

5. Are there any plans to continue this work?

This study laid the foundation for agamid research in India. Molecular phylogenetics and phylogeography revealed the existence of cryptic diversity within numerous widely distributed agamid species. The unprecedented levels of cryptic diversity and the taxonomic uncertainties only show that much more dedicated effort is necessary. Of the roughly 68 agamid species found on the Indian mainland, we studied the variation in around 10% of these species and observed that up to 80% of the studied taxa demonstrated taxonomic uncertainty. Clearly, although we made a start, much more effort is necessary to address the Linnean and the Wallacean shortfalls in Indian agamid diversity. We plan to expand this project to include the remaining species of agamids. Besides, we have also began experimenting on the thermal ecology of the studied agamid species, with an objective of studying the effects of rising temperatures on Indian agamid species.

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

Manuscripts resolving the Indian agamid species complexes, elucidating distribution ranges and highlighting the conservation concerns are in preparation, and will be published shortly. Every scientific publication will be followed up by popular articles in magazines and newspapers. Similarly, the discoveries have been and will be shared on social networking sites such as Twitter, Facebook and Instagram. Such popularisation will ensure that our findings are not limited to the scientific community, and the results of our work reach a larger audience in general. We are also developing a book on Indian agamids, which will help introduce the school-going children and wildlife enthusiasts to agamid diversity.

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

The outcomes of this project were largely scientific in nature, dealing with morphological, molecular and geographic delimitation of species and with understanding the evolutionary relationships between species. While the scientific aspect has been addressed, we now need to popularise our findings further to raise awareness levels in society. Not many people are still aware of the kind of agamid diversity South Asia hosts. Clearly, much work is needed in those aspects, and it must be the focus of upcoming studies.

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?

RF logo was used on all the presentations and the other material (except research papers) produced as a result of this project. Also, since RF was the sole funding agency it will be acknowledged in all scientific publications (which are currently under preparation) resulting from this project. RF has also been acknowledged in some of the ancillary outcomes of this project (example Bhosale et al. 2019).

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

Dr. Kartik Shanker – Guidance, lab support, helped design experiments, molecular expenses.

Dr. S.P. Vijayakumar – Guidance, conceptualised and designed sampling strategy,

Pushkar Phansalkar – On field support.

10. Any other comments?

This important work would have been impossible without the financial support provided by this grant. We thank The Rufford Foundation for assistance in making this important study a success.