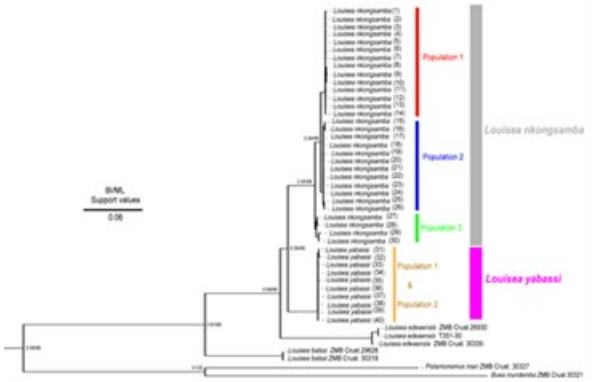
Final Evaluation Report

Your Details	
Full Name	Dr. Pierre A. Mvogo Ndongo
Project Title	Conservation and monitoring strategies of the rare endemic and threatened freshwater crab *Louisea yabassi* from the Ebo Forest near Yabassi in Cameroon
Application ID	35189-C
Date of this Report	10. Feb. 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 assess habitat, and distributional range and threats for Louisea yabassi				The updated distributional range of *L. yabassi* is presented in the following figure below.  The newly rediscovered two populations of *Louisea yabassi* in the Ebo Forest were collected from two small streams ('stream one' and 'stream two') that flow independently into the Dibamba River at the locality N'dogbanguengue. The first population was found c. 10 m from the middle of stream-1. The second population of *L. yabassi* was found c. 8 m from the middle of stream-2. Most of the natural vegetation at these localities had been destroyed because of human activities (by foresters, farmers, and others). The trees had been logged to build huts, camps, and toilets. The remaining vegetation in these locations had been removed for intensive agricultural practices and for firewood. In addition, the farmers encroaching on these habitats use agro-

				chemicals and pesticides on their crops, and these pollutants eventually drain into the aquatic systems and can poison the freshwater communities. This information was also published in: Mvogo Ndongo et al. (2021). Discovery of two new population of the rare endemic freshwater crab *Louisea yabassi* Mvogo Ndongo, von Rintelen & Cumberlidge, 2019 (Brachyura: Potamonautdae) from the Ebo Forest near Yabassi in Cameroon, Central Africa, with recommendations for conservation action. Journal of Threatened Taxa 13(6): 18551–18558. https://doi.org/10.11609/jot.6724.13.6.18551-18558
To Evaluate the phylogenetic relationships within Louisea and to estimate the genetic distance between the species using molecular data				The four *Louisea* species were recovered here each as a monophyletic clade (see Figure below) with strong topological statistical support, and high pairwise uncorrected p-distance values between *Louisea* species pairs (see Mvogo Ndongo et al. 2022). This study, therefore, supports the continued recognition of all four *Louisea* species that are endemic to the southwest Cameroon rainforests. The divergence time estimates for *Louisea* species showed that the earliest divergence happened at about 5.6 myr (late Miocene), which corresponds to the dates for cladogenesis within genera. The latest divergence within *Louisea* (between *L. nkongsamba* and *L. yabassi*) seems to have occurred during the late Pliocene (2.48 myr). Similar results were recovered for another West African freshwater crab species pair, *Sudanonautes aubryi* (H. Milne Edwards, 1853) and *S. floweri* (de Man, 1901). Even the two morphologically variable species, *L. nkongsamba* and *L. yabassi*, were found in the molecular analyses to have low uncorrected p-distance values between population pairs, but both were recognised as distinct (see Mvogo Ndongo et al. 2019). *Louisea* species are found in different habitats within the rainforest zone: *L. balssi* in montane forest streams; L. *nkongsamba*

				in submontane forest streams; *L. edeaensis* on the islands of a freshwater lake; and *L. yabassi* in lowland forest streams. *Louisea nkongsamba* specimens from the cool mountainous streams, that drain the higher altitudes of the submontane zone of Mount Nlonako (938 to 1462 m asl), are small-bodied, with the adult males measuring CWs 16–20 mm. Males of *L. balssi* from the cool high-altitude streams (1,958 m asl), draining into the caldera of Mount Manengouba, are also noticeably small-bodied (CWs 13.0–16.2 mm). Genetic differentiation tends to be somewhat limited in small-bodied montane species of freshwater crabs (Daniels et al. 2016). Only a limited genetic variation, however, was found in the lowland forest species *L. edeaensis*. In comparison, the moist tropical rainforests surrounding Mt. Manengouba receive high annual rainfall and provide a stable climate supporting all forms even during the times of fluctuating drier periods. Consequently, in such high rainfall areas, *L. balssi* would be sheltered from the harsher effects of rainforest disruption arising from prolonged dry periods in the past, making the Cameroon highlands a Pleistocene forest refuge for freshwater crab species. Over time, *Louisea* dispersed from its original location of around Mt. Manengouba and into the surrounding forests of southwest Cameroon, including Mount Nlonako. Here species divergence gave rise to *L. nkongsamba*, then into the forested lowlands around Yabassi and Lake Ossa, where *L. yabassi* and *L. edeaensis* evolved. 

				This information was also published in: Mvogo Ndongo PA, von Rintelen T, Clark PF, Shahdadi A, Tchietchui CR, Cumberlidge N (2022) Phylogenetic relationships among the species of the Cameroonian endemic freshwater crab genus *Louisea* Cumberlidge, 1994 (Crustacea, Brachyura, Potamonautidae), with notes on intraspecific morphological variation within two threatened species. ZooKeys 1122: 125–143. https://doi.org/10.3897/zookeys.1122.85791
To investigate Intraspecific morphological variation				The two *L. yabassi* populations from localities c. 2–3 km apart in the Ebo Forest genetically form a single clade with little lineage differentiation, and these individuals show relatively low levels of morphological variation. Despite this, two *L. yabassi* morphotypes could be identified. Similarly, the six sampled localities around Mt. Nlonako, where *L. nkongsamba* is found, are 4–10 km apart. These individuals of *L. nkongsamba* fall into three genetically recognisable populations, which in turn have two distinct morphotypes. Populations 1 and 3 consisted of individuals that all belong to morphotype 1, while population 2 included individuals of both morphotypes. The high carapace (CH/FW = 1.3) and narrow front width (CW/FW = 2.9) of both *L. yabassi* and *L. nkongsamba* are associated with a semi-terrestrial lifestyle. Populations of both species prefer temporary water bodies such as puddles near small permanent streams, as well as damp environments under small stones or leaf litter on floor adjacent to streams. Freshwater crabs are known to have limited dispersal abilities due to the absence of a free-swimming larval phase and their direct development which results in crab hatchlings. This together with the restricted movements of the adults in combination with the isolated and fragmentary nature of their wetland habitats might be at least partly responsible for their rich diversity and high endemism. The intraspecific morphological and genetic variations observed within *L. yabassi* and *L.*

				nkongsamba are crucial for adaptation by natural selection, not least because low levels of variation are associated with the extirpation of populations and an increased risk of species extinction.

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

a). Data from this project was very crucial to resolve the phylogenetic and phylogeographic relationships with the threatened species in the genus *Louisea* Cumberlidge, 1994. And to investigate intraspecific morphological variation in some taxonomically important characters found within both *L. nkongsamba* and *L. yabassi*. All these outcomes are very important to better identify species boundaries within *Louisea*. Species delimitation is necessary for understanding levels of biodiversity, and for adopting effective conservation and sustainable management strategies.

b). This project has also help to explore other areas in southern and northern Cameroon on behalf of conservation action plan. This research has led to the discovery of six potential new species of freshwater crab (three in the genus *Sudanonautes*, two in the genus *Potamonemus* and one in the genus *Louisea*) and underscribed species of freshwater shrimps. We rediscovered other important species (*Sudanonautes chavanensis*) that will help to reconstruct the phylogeny of crab in the genus *Sudanonautes*. These discovered are very important for future conservation pilot projects by local young people.

c). Local young people were trained in the protocols relevant to collect specimens of a threatened species taking an example of the freshwater crab, *Louisea* species (and *L. yabassi*). Specifically, how to identify the collected specimens and how to recognise the gender and life stage (juvenile, sub-adult, adult); how to record the precise GIS location points and the details of the habitat. They were also informed of the importance of conserving an endangered species and the steps that need to be taken to protect it from extinction. In addition, they were trained on how to structure educational messages and to deliver the messages to local communities to bring local people to adopt practices that are less damaging to the ecosystem, and how to monitor the success of educational efforts. They were trained on how to take care with the specimens in the aquariums. Finally, they were trained on how to write a scientific project on behalf of conservation action plans, provide a report for a project and how to write scientific manuscripts for publications.

The most significant achievement of this work was the conservation of *Louisea yabassi*, the discovered of other threatened species and the building of the capacity of local youth in ecological / biological monitoring.

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

Large numbers of local youth did not attend in the capacity building in ecological/ biological monitoring was not taking into account on large number of students. We

maximised training for few people attended on how to collect routine monitoring data and how to preserve threatened species.

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

The local communities involved in this project include farmers, local authorities (chiefs of villages and other organisations) and field assistants who were people originating from Ebo Forest. Furthermore, local young students were part of this project for capacity building. All the local communities that have helped us to accomplish this project in different points described below. In the ongoing education component, the chiefs of villages and their assistants have helped us to reach people include those who were confused and primary reluctant to cooperate with us. Our field research assistants and guides were very active in helping us to collect scientific data and to educate local people using local and national languages.

5. Are there any plans to continue this work?

Yes, the next step will be to develop a conservation action plan and to assess red list of all threatened species and the newly discovered species from southern and northern Cameroon. This will be done via of supporting local students in pilot project of behalf of conservation action plan. The goal would be to conserve the discovered or rediscovered species through surveying and monitoring that collects data on distribution, population, habitat, and threats necessary to assess its IUCN Red List. To maintain and/or restore the population levels of these species and other endangered species found in each area of species, community training to build awareness and involve locals in the management of their aquatic and forest resources would be also planned for a favourable conservation status and to ensure the long-term conservation.

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

The results of this project were presented at the national and international conferences, meetings or seminars once restrictions from the global pandemic have been lifted. The results were also be published in international scientific journals. However, we still have data to publish in international journals and to share in national and international scientific meetings.

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

The next steps will be to support and follow up local young person involve in Conservation action plans for freshwater crabs and other species in southern and northern Cameroon and other countries counties in Africa.

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?

Yes, in publication, scientific meetings and during the fieldwork.

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

Same members as in the previous projects.

Field assistants and guides: their role was to guide me and help collect data in the field and to talk with local people on behalf of educational activities.

Dr Thomas von Rintelen (Museum für Naturkunde, Germany), and Dr Christian Albrecht (University of Giessen, Germany): both provided with constructive advice during fieldwork and helped analysed data reported. They also are helping me to share results with other stakeholders and other international researchers.

Prof. Neil Cumberlidge (Northern Michigan University, USA): I received substantial support from Prof. Cumberlidge who is the Chair of the IUCN's Freshwater Crustacean Specialist Group. He provided constructive advice during this project not only with the taxonomic and ecological aspects of this research but also with respect to ethical considerations and policies required to work with endangered species. He also provided me with important strategies for messaging and the education of local people.

Other sources of input for the project were the chiefs of villages, and other freshwater ecosystem field researchers in Cameroon.

10. Any other comments?

This pilot project provided results that are beyond of our expectation. Then, we have made significant progress for scientific research in northern and southern Cameroon. Several species were discovered that potentially new for science.

Left: Sudanonautes sp. 1 from Ngaoundere. Right: Sudanonautes sp. 2 from Garoua.

Left: Sudanonautes sp. 3 from Lake Tison (Ngaoundere). Right: Sudanonautes sp. 4 from Nlonako.

Left: Potamonemus sp. 1 from Ngaoundere. Right: Potamonemus sp. 2 from Manengouba.

Left: Pierre A. Mvogo Ndongo. Right: Pierre A. Mvogo Ndongo and colleagues during the field.