

## Final Project Evaluation Report

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Your Details	
<b>Full Name</b>	Pierre A. Mvogo Ndongo, Ph.D.
<b>Project Title</b>	Conservation of the Re-Discovered Endangered Freshwater Crab <i>Louisea balssi</i> on Mount Manengouba in the Cameroon Highlands
<b>Application ID</b>	24245-B
<b>Grant Amount</b>	9960
<b>Email Address</b>	mpierrearmand@yahoo.fr
<b>Date of this Report</b>	March, 2018 - Feb. 2019

**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
<p>To establish a conservation action plan for the endangered freshwater crab <i>Louisea balssi</i> (Bott, 1959) which was recently rediscovered after a gap of 117 years.</p>				<p>The specimens of <i>L. balssi</i> reported in this project were all collected from a stream near Man's Crater Lake in Mount Manengouba Ecological Reserve near Bangem in the Southwest Region of Cameroon. Any other specimens were found from other streams visited in this Ecological Reserve. Mount Manengouba is located along the Cameroon Volcanic Line, a 1,600 km long chain of volcanoes that stretches from the Gulf of Guinea islands to the mountains of eastern Nigeria and western Cameroon, including Mount Cameroon.</p> <p>The distributional range of <i>L. balssi</i> also includes Lake Barombi Mbo near Kumba. Both of these volcanic crater lakes are part of the Western Equatorial Crater Lakes freshwater ecoregion. This ecoregion is dominated by a volcanic ridge (the Cameroon Line) that extends inland along the northwestern side of the interior plateau of Cameroon and Nigeria that has given rise to about 36 crater lakes, the largest of which is Lake Barombi Mbo (area 5 km<sup>2</sup> and 111 m deep) (Hughes &amp; Hughes 1992). Before this project, field surveys from Lake Barombi were not succeeded in collecting specimens of <i>Louisea balssi</i>.</p> <p>Mount Manengouba Ecological Reserve is dominated by Mount Manengouba, a dormant volcano with three crater lakes at the rim of the summit (Deruelle et al. 1991, Kagou 1998, Noumi 2013). These are Woman's Lake Manengouba, Man's Lake Manengouba, and Child's Lake Manengouba (from largest to smallest respectively). The waters and shorelines of the two largest lakes are different: the waters of Woman's Crater Lake are suitable for bathing and swimming and its</p>

			<p>flat shores make this lake accessible to fishermen, campers, and local herdsmen and their cattle. In contrast, the waters of Man's Crater Lake are hostile to most forms of life, and the shores of this lake are steep sided, precarious, and difficult to access. The result is that Man's Crater Lake is rarely disturbed except for cultural ceremonies.</p> <p><i>Louisea balssi</i> was not collected from Man's Crater Lake itself: it lives in a small spring-fed stream that drains into the lake through the piece of remaining forest on the south side. During this project and despite the perturbation from unrest issue in the region, we were able to observe 21 specimens. We thus realized that the survival of <i>L. balssi</i> depends on the canopy of the small forest around Man's Lake Manengouba that shades the streams from direct sunlight and keeps the habitat moist and humid. Unfortunately, forest from Mt. Manengouba Ecological Reserve is not actually protected, and has been degraded and destroyed over time by local people seeking firewood.</p> <p>Man's Crater Lake lies on top of volcanic conduits that act as condensers or traps for volatile chemicals released from magma and there is an excessive accumulation of CO<sub>2</sub> in the bottom layers of the lake (Kusakabe 2017). This gives the waters of Man's Crater Lake an unusual green colour, and may explain why very little life is found there. In fact, there are no reports of invertebrates (insects, molluscs, crabs and other crustaceans) or vertebrates (fish, amphibians, snakes, birds) from the lake itself, suggesting that the accumulation of lethal compounds may be excluding most organisms, except for certain microbes.</p> <p>Discussions with local fishermen and other people from nearby villages in the Manengouba area also confirm that the waters of Man's Crater Lake are a potential danger to humans as well. It is likely that these lake conditions are the reason that <i>L. balssi</i> is not found in Man's Crater Lake itself, although it was also not</p>
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			<p>collected from the other two nearby lakes that do support other life (including crabs). <i>Louisea balssi</i> appears to be a stream-living species that prefers temporary water bodies such as puddles near small permanent streams as well as the damp environment under small stones or fallen leaves on land adjacent to streams. It is noteworthy that no specimens were found in the deeper waters in the centre of the stream. Our water chemistry data indicate that these marginal stream habitats favoured by <i>L. balssi</i> have a very low average pH of 5.4, which is much lower than the preferred pH range (6.5–9.0) for most freshwater organisms (Robertson-Brayan 2004). This extreme water chemistry is of concern because acidic conditions may influence hatching and survival of <i>L. balssi</i> and other aquatic invertebrates whose larval and/or juvenile stages are often more sensitive to low pH than are the adults (although no such research has yet been carried out for these freshwater crabs). The immediate threats from habitat disturbance, deforestation, and possibly from altered water chemistry all clearly raise questions about the long-term existence of <i>L. balssi</i> at this locality.</p> <p><b>Educational component</b></p> <p>The on-going educational component in this project was aimed at encouraging local people to become aware of the negative impacts of agriculture on the freshwater ecosystems on Manengouba Ecological Reserve and the surrounding areas that could negatively impact populations of crabs. Before the field studies began we met with the Chiefs in this area. The targets of the educational messaging were the local people living around Manengouba Ecological Reserve where the only known extant populations of <i>L. balssi</i> are found. The stability we found in the Manengouba area was no doubt due to the migration of much of the population because of the crisis in Anglophone Cameroon. The main threats to <i>L. balssi</i> were identified as the intensive</p>
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			<p>agricultural practices that degrade and destroy the natural vegetation in many of the Manengouba Ecological Reserve. Our preliminary results showed that the water chemistry of Man's Lake Manengouba made it unsuitable for any life form – both invertebrates (insects, molluscs, crabs, shrimps etc.) and vertebrates (fish, amphibians, snakes, birds etc.) suggesting that there may be an accumulation of lethal gases in this volcanic crater lake.</p> <p>Due to our conservation effort the steep forested slopes that include the stream habitat of <i>Louisea balssi</i> is now regenerating.</p> <p><b>Conservation status (also see Mvogo Ndongo et al. 2018).</b> The extinction risk status of <i>L. balssi</i> was assessed in 2008 (Cumberlidge 2008b) as EN B1ab (i, ii, iii, iv, v) at a time when this species was known only from a single locality and had not been collected for over 100 years (IUCN 2003; Cumberlidge et al. 2009; Cumberlidge 2011). The extinction risk assessment for this species was based on the available knowledge of <i>L. balssi</i>: that it had a very small range (extent of occurrence (EOO) much less than 5000 km<sup>2</sup>), a small area of occupancy (AOO), and the quality of its habitat was in decline (Cumberlidge 2008b). The present study adds a second location for <i>L. balssi</i> making a total of two localities, some 63 km apart. However, these two locations are still not enough to allow the accurate calculation of a revised geographic range (EOO) and AOO using GeoCAT (<a href="http://geocat.kew.org">http://geocat.kew.org</a>; Bachman et al. 2011). Moreover, we estimate that the increase in the known range (EOO) of <i>L. balssi</i> alone would still not be enough to warrant a change in its extinction risk assessment. Nevertheless, it is clear that there are immediate threats to the habitat of <i>L. balssi</i>. For example, the wetland ecosystems of the Southwestern Region of Cameroon are being impacted by intensive agricultural practices that are severely altering the flow patterns of small streams and the biodiversity that depends</p>
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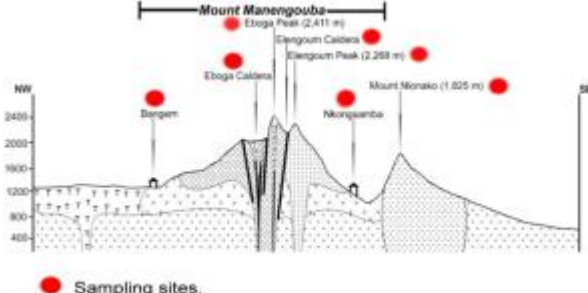

			<p>on these habitats (Mvogo Ndongo et al. 2017a, b). On the other hand, the new knowledge of the specific habitat requirements of <i>L. balssi</i> and the existence of immediate threats to its habitat mean that this species is more likely to be upgraded from EN to critically endangered (CR) once a formal IUCN Red List extinction risk assessment has been carried out. The newly reported threats to an already endangered species are a cause for concern and they underline the need for further studies of this species. There is clearly a need for further field research aimed at gathering data needed to develop a conservation action plan in order to save this rare and endangered species from extinction.</p>
<p>Biodiversity inventory of freshwater crabs in Manengouba Ecological Reserve.</p>			<p>Nine species of freshwater crabs belonging to four genera (Buea gen. nov. <i>Louisea</i>, <i>Potamonemus</i>, and <i>Sudanonautes</i>) were collected from different parts of the study area: Bangem (Bakossi), Eboga Caldera, Eboga Peak, Elengoum Caldera, Elengoum Peak, Nkongamba, and Mount Nlonako.</p>  <p>Sampling site. Map modified from Tefogoum et al. 2014.</p>  <p>Fig. 1. <i>Potamonemus mambilorum</i> was collected from Eboga Caldera, Eboga Peak, Elengoum Caldera, and Elengoum Peak</p>



Fig. 2. *Louisea balssi* was collected from Eboga Peak (Manengouba).



Fig. 3. *Potamonemus* sp. n. was collected from Bangem (Bakossi), Eboga Caldera, Eboga Peak, Elengoum Caldera, and Elengoum Peak.



Fig. 4. *Sudanonautes* sp. n. from Bangem (Bakossi).



Fig. 5. *Potamonemus asylos* lineage (Buea sp 1).



Fig. 6. *Potamonemus* n. sp. 2 from Bangem (Bakossi), Eboga Caldera, Eboga Peak, Elengoum Caldera, & Elengoum Peak



Fig.7. *Louisea* sp. (cf. *edeensis*) from Mount Nlonako.





Fig. 8. *Potamonemus asylos*, sp. n. was collected from Bangem (Bakossi), Nkongsamba, Mount Nlonako and Korup National Park.



Fig. 9. *Sudanonautes* sp.n. from Nlonako Ecological reserve in a mating embrace.



				 <p>Fig. 10. Sudanonautes sp.n. from Nlonako Ecological reserve in a mating embrace. The most important outcome here is the discovered of new species of Louisea from Mt. Nlonako wildlife reserve that needs to be conserved as Louisea balsi and L. edeaensis. The new species of Potamonemus and Buea were also been rediscovered in the framework of this project.</p>
<p>This project will help to understand the ecological condition of the Man's Crater lake of Manengouba.</p>				 <p>Fig. 11. Man's Lake Manengouba The water in Man crater lake was found to be quite acidic (between pH 3.0–5.5) and at a lower pH than would normally be expected for a tropical freshwater ecosystem (where the majority of aquatic organisms prefer water with a pH between 6.5–9.0 (Robertson-Brayan 2004)). Water dissolved Oxygen (O<sub>2</sub>) was low (concentration of O<sub>2</sub> &lt; 21 %); Water</p>

				<p>dissolved Carbon dioxide was higher (concentration of CO<sub>2</sub> &gt; 0.04).</p> <p>At time being, atmosphere is not yet attacked. However, works by Kusakabe et al.1989 and Kusakabe, 2017 reported that mammals, including human beings, live on a normal atmosphere that contains 21 vol % of O<sub>2</sub>. If air is breathed containing less than half of this normal air concentration of O<sub>2</sub>, a coma, fainting, cyanosis, syncope, respiratory arrest, and ultimately, cardiac arrest can result. If we breathe air containing high concentrations of CO<sub>2</sub> (e.g., &gt;10 vol %), a coma, and eventually, death can result.</p>
To establish a long-term monitoring system in collaboration with local government agencies in charge of nature conservation				<p>I have established a strong collaboration with Cameroon Wildlife Conservation Society. This organisation is working in this issue in the way to establish a long-term monitoring system and transform Mt. Manengouba as a protected area recognized by the Cameroon government.</p> <p>As for international information, I am currently planning an international congress in Cameroon in the near future on "The Role of decapod crustaceans in the sustainable management and conservation of forest and wetland ecosystems in Sub-Saharan Africa".</p> <p>The recommendations are in process to be given to the authorities in charge of nature conservation in Cameroon.</p>

**2. Please explain any unforeseen difficulties that arose during the project and how these were tackled.**

Three difficulties:

1. Social unrest in South West Region of Cameroon (the so-called 'Anglophone crisis'). So most people were confused and often considered that we are there for the questions related to the 'Anglophone crisis'. For this reason, it was difficult to gather vast majority of people (reluctant to us) for workshops. To overcome this, we intensify the on-going educational component, meeting all people individually and over-use the Chiefs of village to help us in this strategy. In addition local people were rare in the area.
2. Another difficulty was based to carry out the accurate population estimates based on the mark recapture method *L. balssi* (as did for *L. edeensis*). To

improve the accuracy of this method, we maximised the number of transects to reduce the chances of capturing the same individuals more than once.

3. The last difficulty was to collect specimens of *L. balssi* (as did for *L. edeaensis*) inside tree holes where we suspected that ovigerous females may be found, due to reluctance to damage the habitat of this crab. But, our main objective was to keep it habitat healthy.

### **3. Briefly describe the three most important outcomes of your project.**

1. The habitat preferences and the population levels and trends of *L. balssi* (as did for *L. edeaensis*), the endangered freshwater crab from Cameroon have been described but we still need more information on its breeding cycle. The water in Man Crater Lake of Manengouba is recorded to be an endangered close to raise a potential disaster in the future.
2. Despite Social unrest in South West Region of Cameroon, the ongoing educational component was effective. Consequencely, the steep forested slopes that include the stream habitat of *Louisea balssi* is safe from pressures from human activities. In addition, my local field assistants were trained on how to recognize the habitat of *L. balssi* and how to collect routine data on behalf of conservation action plan.
3. The discovered of the third new species of *Louisea* (*L. nkongsamba* **sp.n.**) from which molecular phylogeny reveals that, the endangered species of *Louisea edeaensis* was erected. This new species was recorded from submontane zone of Mt. Nlonako wildlife reserve and (similarly to *L. balssi* and *L. edeaensis*) also recorded from under small stones or fallen leaves in the shallow waters of a small permanent streams. Preliminary data show that this species also faces similarly threats to *L. balssi* and *L. edeaensis* and also deserves development conservation action plan and red List assessments.

### **4. Briefly 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 village and others organizations) and field assistants who were people originating from Bangem, a close town to Mt. Manengouba.

All of the local communities that have helped us to accomplish this project in different points described below.

In the ongoing education component, the Chiefs of village 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.

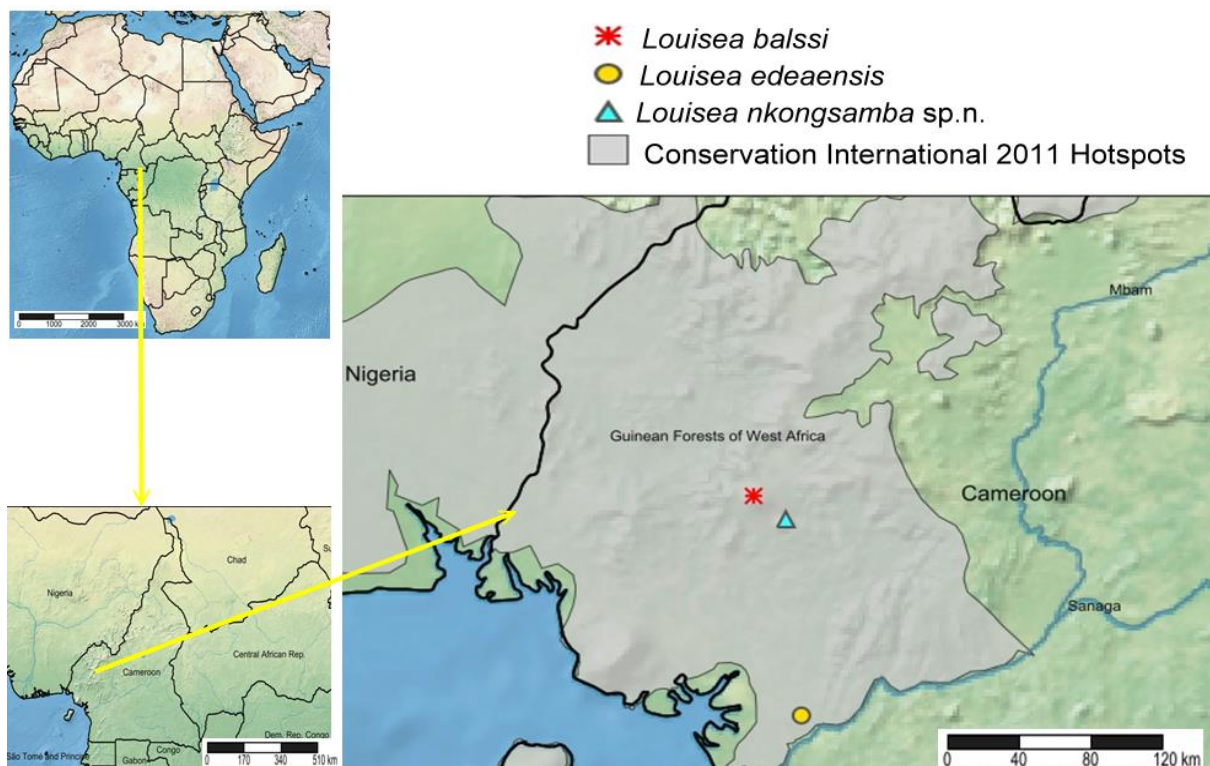
Local farmers provided us with constructive advice. To try to compare threats to other localies, we visited other localities viz, Mt. Nlonako, Dja ecological reserve,

National Park of Korup and we reported important data that are necessary to be developed in the future.

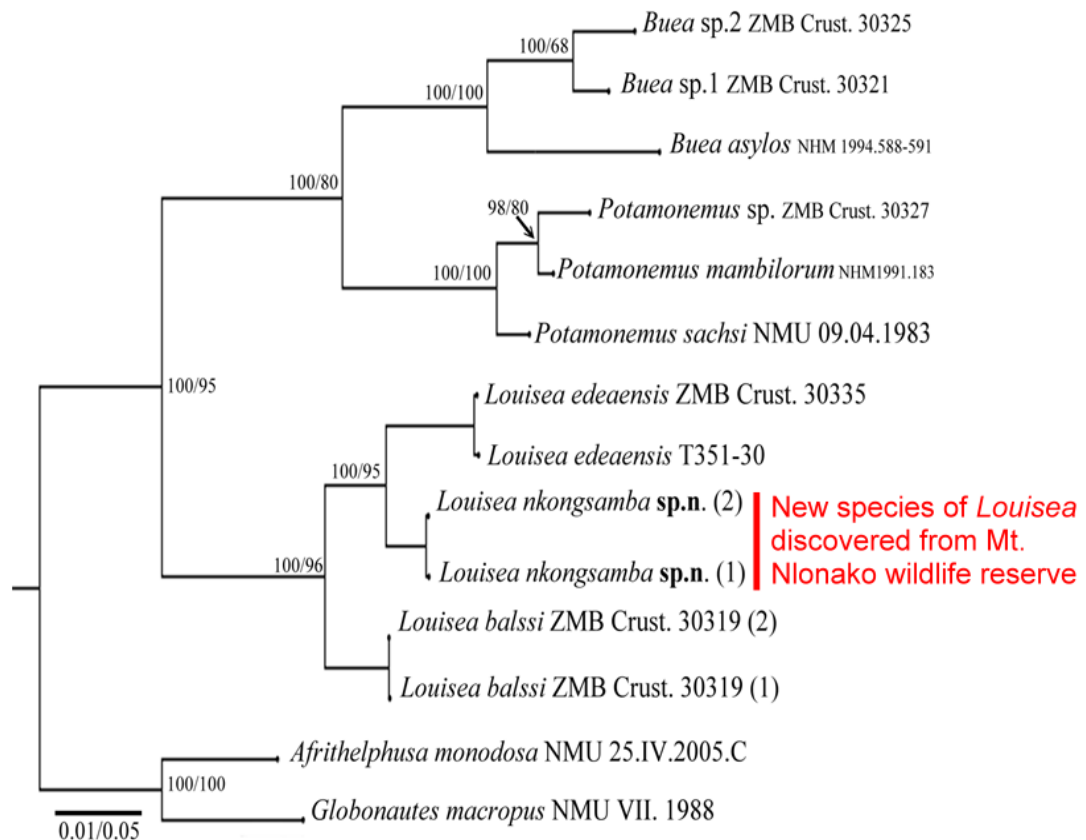
### 5. Are there any plans to continue this work?

Yes, the next step will be to develop a conservation action plan and to assess red List of a new species erected from a relic population (by a radiation speciation) of an endangered freshwater crab *Louisea balssi* (Bott, 1959), discovered from Mt. Nlonako Wildlife Reserve, a threatened habitat of Littoral Region of Cameroon (Fig. 12, 13). The goal would be to conserve the Nlonako's new species (and its habitat) through surveying and monitoring that collects data on distribution, population, habitat, and threats necessary to assess its IUCN Red List. In order to maintain and/or restore the population levels of this new species and other endangered species found in this zone, 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.

- In the perspective next step, it would also be interesting to follow up with a similar conservation action plan to the other wetland habitats (and small streams) in the localities (Yabassi, Yaounde, Barombi Mbo etc.) where other population of species of *Louisea* are known to occur in Cameroon. Maybe the intensification of fieldsurveys would help to rediscovered *Louisea* species or population from these areas.



**Fig 12.** Localisation of *Louisea balssi* (Bott, 1959), *Louisea edeaensis* and *L. nkongsamba* sp.n.



**Fig.13.** BI/ML tree topology for the freshwater crab included in this project derived from mtDNA sequences corresponding to three loci (partial 16S rRNA and COI genes, 12S rRNA) and nuclear gene H3. BI and ML statistical values on the nodes indicate posterior probabilities and bootstrap support, respectively (%).

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

The results of this project will be presented at the national level in Cameroon (Bioscience, seminars, etc.) and at the international journal.

Results of part of this project have been made available to the world scientific community via a publication in *Zootaxa*:

**Mvogo Ndongo P.A.**, von Rintelen T., Albrecht, C., Tamesse J.L. & Cumberlidge N., 2018. Lost species in Cameroon: rediscovery of the endangered freshwater crab, *Louisea balssi* (Bott, 1959) (Brachyura: Potamonautidae), with notes on its ecology and conservation. *Zootaxa*, 4231 (2), 273–280. <https://doi.org/10.11646/zootaxa.4231.2.9>.

## Other manuscripts related to this project are in preparation

- I. A taxonomic revision, ecology and conservation of the freshwater crab genus *Potamonemus* Cumberlidge & Clark, 1992 (Crustacea: Potamoidea: Potamonautidae) with description of a new species

- II. Phylogeographical analysis of Cameroonian populations of three species of freshwater crab of the genus *Sudanonautes* Bott, 1955 (Brachyura: Potamoidea: Potamonautidae) with description of a new species
- III. A taxonomic revision, colonization history and phylogeographic structure of the Cameroonian endangered freshwater crab species genus *Louisea* Cumberlidge, 1994 with description of a new species: implication for conservation
- IV. Evolutionary origins and biogeographical analysis of the endemic freshwater species genus *Buea* Cumberlidge et al., 2018 with description of three new species, from Southwestern tropical rainforest of Cameroon

**7. Timescale: Over what period was the grant used? How does this compare to the anticipated or actual length of the project?**

The Rufford Foundation Grant ran from March 2018 to February 2019. With a series of monthly surveys at Manengouba ecological reserve and additional 2-3 days surveys at, Dja faunal reserve, and Korup National Park, Mt. Nlonako wildlife reserve where we rediscovered *Louisea nkongsamba* **sp.n.**, a third species of *Louisea* erected from a relic population of *Louisea balsi* endemic from Cameroon.

**8. Budget: Provide a breakdown of budgeted versus actual expenditure and the reasons for any differences. All figures should be in £ sterling, indicating the local exchange rate used. It is important that you retain the management accounts and all paid invoices relating to the project for at least 2 years as these may be required for inspection at our discretion.**

Item	Budgeted Amount	Actual Amount	Difference	Comments
Photo-turbidimeter HI 93414-HANNA	800	800		As initially budgeted...
HI-8033 Handheld EC/TDS Meter.	400	400		As initially budgeted...
Portable oxymeter PCE-PHD1.	300	300		As initially budgeted...
PSense Portable CO2 Meter.	200	200		As initially budgeted...
Ethanol (70-90%) for preserving specimens	60	60		As initially budgeted...
Jars, boxes, field sampling equipment	100	100		The cost is as initially budgeted.
£3x3 (9) per a day for subsistence for three persons (myself & my two field guides) for 180 days. Since, we will be working a full day and need energy for our work.	1,620	1,620		This amount was sufficient for a series of monthly surveys at Manengouba ecological reserve and additional 2-3 days surveys at, Dja faunal reserve, and Korup National Park, Mt. Nlonako wildlife reserve. But, security was important in our

				team and we got help from some organisation like Museum Fur Naturkunde in Germany.
180 roundtrip trips Bangem to Manengouba for 3 persons (me and my two field assistants).	1,600	1,600		We manage that this amount became sufficient for a series of monthly surveys at Manengouba ecological reserve and additional 2-3 days surveys at, Dja faunal reserve, and Korup National Park, Mt. Nlonako wildlife reserve
12 roundtrip bus trips Yaoundé to Bangem for me.	300	300		
Hotel in Bangem for myself for 180 days.	1,620	1,620		We manage that this amount became sufficient for hotel for a series of monthly surveys at Manengouba ecological reserve and additional 2-3 days surveys at, Dja faunal reserve, and Korup National Park, Mt. Nlonako wildlife reserve
Series of monthly public educational sessions and follow-up.	800	800		This amount was mainly used to reinforce the ongoing educational component.
£6 a daily motivation for two field guides for 180 days field research. For each month, I will work for a total of 14 days (fieldwork+ ongoing education to people encountered in the field) + 1 full day for a public educational session).	2,160	2,160		This amount was sufficient for a series of monthly surveys at Manengouba ecological reserve and additional 2-3 days surveys at, Dja faunal reserve, and Korup National Park, Mt. Nlonako wildlife reserve. But, security was important in our team and we got help from some organisation like Museum Fur Naturkunde in Germany.
<b>TOTAL</b>	<b>9960</b>	<b>9960</b>		

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

As mentioned above, the next step will be the development of a conservation action plan and Red List assessment of a new species (*Louisea nkongsamba* sp.n., figure 12, 13) erected from a relic population (by a radiation speciation) of an

endangered freshwater crab *Louisea balssi* (Bott, 1959), discovered from Mt. Nlonako Wildlife Reserve, a threatened habitat of Littoral Region of Cameroon.

**10. 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, I have used the Rufford Foundation logo in my several official documents, PhD thesis document and in the materials produced for this project, and I have acknowledge the support of the RSGF in the publications to ZOOTAXA journal. The Rufford will also be thanked to all other upcoming manuscripts.

**11. Please provide a full list of all the members of your team and briefly what was 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.

At the end, I got great support from the Chair of the IUCN's Freshwater Crustacean Specialist Group, **Prof. Neil Cumberlidge** (Northern Michigan University, USA). He provided with constructive advice during this project in order to respect ethical considerations and all the policy require to work with an endangered species. He also provided me with the important strategies to educate local people. **Prof. Neil Cumberlidge** is also linked my research to IUCN society.

**Other sources** of input for the project were the Chiefs of villages, and other freshwater ecosystem field researchers in Cameroon. Their role was to facility the project with advices.

**12. Any other comments?**

The project helped to establish important links with traditional and administrative authorities around all the surveys localities and to get further experience for educational activities. Furthermore, this project helped me to achieve my PhD dissertation here at University of Yaounde 1 with is awarded. And my new title is [Dr. Pierre A. Mvogo Ndongo, Ph.D.](#)

We got help from the Museum Fur Naturkunde in getting material and other unforeseen things necessary in this project.





Man's Crater Lake Manengouba (endangered).



Habitat of *Louisea balssi* (endangered freshwater crabs).