

Final Evaluation Report

Your Details	
Full Name	Armand Richard Nzoko Fiemapong, PhD
Project Title	Conservation of the giant African millipede community in the Cameroon's rain-forest zones: distribution, threats and research needs.
Application ID	36690-B
Date of this Report	26 April 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
<p>Assess the community structure, occurrence, distribution range, diversity, habitat preference and formulate propositions regarding the conservation status of giants' millipede species occurring in the Dja Biosphere Reserve and Ebo Forest using both collected and existing data following the IUCN criteria</p>				<p>We recorded 10 giant millipede species belonging to seven genera and two families. The Family Spirostreptidae was the most speciose, with nine species out of the 10 recorded. The Dja Biosphere Reserve was the richest site (eight species) of the two prospected areas. The species of giant millipedes identified during this study mainly occurred in mature forests. Among the 10 giant millipede species recorded and status assessed for extinction under IUCN Criterion B with a cell width of 2 km, seven ("<i>Spirostreptus</i>" <i>servatius</i> Attems, 1914, "<i>Spirostreptus</i>" <i>pancratius</i> Attems, 1914, <i>Telodeinopus bibundinu</i> (Attems, 1914), <i>Telodeinopus</i> sp., <i>Brevitibuis polyptychus</i> (Kraus, 1958), <i>Treptogonostreptus intricatus</i> Voges (1878) and <i>Ophiostreptus</i> sp.) were evaluated as Endangered (EN) and the remaining (<i>Telodeinopus canaliculatus</i> (Porat, 1894), <i>Spiropoeus fischeri</i> Brandt, 1833 and <i>Pelmatojulus excisus</i> (Cook, 1897)) as Least Concern (LC).</p>
<p>Assess anthropogenic threats to the target giant's millipede species in the study area</p>				<p>Most of the target millipede species are highly threatened in their distribution range. The most observed threats included slash and burn agricultural practice, cutting of trees for traditional medicine, deforestation for charcoal as well as firewood, and the clear-cut practices for installing cocoa, palm oil, rubber, cassava, and plantain plantations.</p>
<p>Assess the perception and knowledge of the target species by the local population</p>				<p>Concerning the perception and knowledge of the importance of the target species by the local population, it appeared that all respondents knew the target species, but none of them</p>

			<p>was aware on their conservation importance. These species are perceived negatively by the local population, who believe that the encounter with some giant millipede species, such as <i>Spirostreptus servatius</i> is unlucky.</p>
<p>Raise awareness among the local population through a sensitization and education campaign on the role and importance of the target species in the functioning of the natural ecosystem and influence the local belief and superstitions around the target taxa</p>			<p>During awareness campaigns, we showed to local populations the importance of the target millipede species in ecosystem functioning and the need to conserve and preserve them and their natural habitats. The populations were sensitised about the threats to the target species and the necessity of reducing these threats for long-term survival of these species in their natural ecosystems.</p> <p>The second awareness campaign showed that the perception and level of knowledge of local populations had significantly evolved regarding the target species. This sufficiently proves that the education and awareness of local populations are imperative for the efficient conservation of this taxonomic group, which is often neglected in conservation projects at the local level and for which no specific conservation measure exists in Cameroonian legislation.</p>
<p>Design plans to protect the target species and its habitats in the Dja Biosphere Reserve</p>			<p>This project enables us to understand factors influencing giant millipede occurrence and distribution, which are crucial for appropriate and valuable conservation action plans. In light of all these results and findings, concrete and urgent actions must be taken by nature and wildlife conservation organisations and authorities to strengthen conservation strategies in Cameroon to preserve the target species.</p> <p>Regarding the management plan for these target species, some proposals for better conservation of giant millipede are:</p> <ul style="list-style-type: none"> -Intensify the monitoring of target species in all sectors of the Dja

			<p>Biosphere Reserve and in the proposed Ebo protected area as well as in adjacent areas to identify all existing populations.</p> <ul style="list-style-type: none"> -Encourage the consideration of these species in large projects which generally focus on birds, mammals, amphibians, and reptiles. - Conduct regular missions in collaboration with wildlife conservation officers (MINFOF) to assess the size of populations of target species of giant millipedes with specific conservation needs. - Initiate urgent measures with a view to reducing the threats to the target species. To this end, it should be noted that the localities prospected during our work, although being key areas for the conservation of biodiversity, are subject to enormous anthropogenic pressures. -Continue to carry out awareness campaigns both at the level of local populations and of authorities and partners (NGOs) in charge of wildlife conservation with aiming at drawing their attention to the role of these invertebrate species in natural ecosystems functioning and the need to pay attention to their population assessment during inventory programs.
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2. Describe the three most important outcomes of your project.

a). A list of giant millipede species was established for the first time in each of the surveyed areas. We have determined their diversity, the structure of their communities, their abundance distribution, and their frequency of occurrence.

This study on the giant African millipede community in the Dja Biosphere Reserve and the proposed reserve of Ebo forest permitted us to record 10 giant millipede species belonging to seven genera and two families (Spirostreptidae and Pachybolidae). The Family Spirostreptidae was the most speciose with nine species. The Family Pachybolidae was representing by one species (Table 1). The Dja Biosphere Reserve was the richest site (eight species) of the two prospected areas. Among the species collected during this study, *Brebitibuis polyptychus* is reported for the first time in the Cameroonian fauna. Two species (*Ophiostreptus* sp. and *Telodeinopus* sp.) have been formally identified as new to science and are being described for publication in a specialised journal.

Overall, 498 specimens of giant African millipedes were identified during the study period. The highest abundance of target millipedes was observed in the Dja Biosphere Reserve (278 specimens, representing 55.82 % of all giant millipedes collected). There were no significant differences in giant millipede abundance between the two prospected areas ($P > 0.05$). *Pelmatojulus excisus* (43.78%), *Telodeinopus canaliculatus* (21.69 %) and *Telodeinopus* sp. (21.49 %) were the most abundant species during the study period (Table 1).

Table 1. Absolute and relative abundance (given in the brackets) of each giant millipede species recorded in the Dja Biosphere Reserve and Ebo Forest.

Family	Species	Sites		Total
		Dja Biosphere Reserve	Ebo Forest	
Pachybolidae	<i>Pelmatojulus excisus</i> (Cook, 1897)	83 (16.67)	135(27.11)	218(43.78)
Spirostreptidae	<i>Brevitibuis polyptychus</i> (Kraus, 1958)	2(0.40)	0(0.00)	2(0.40)
	<i>Ophiostreptus</i> sp.	4(0.40)	3(0.60)	7(1.41)
	<i>Spiropoeus fischeri</i> Brandt, 1833	12(2.41)	3(0.60)	15(3.01)
	" <i>Spirostreptus</i> " <i>pancratius</i> Attems, 1914	2(0.40)	7(1.41)	9(1.81)
	" <i>Spirostreptus</i> " <i>servatius</i> Attems, 1914	7(1.41)	0(0.00)	7(1.41)
	<i>Telodeinopus bibundinus</i> (Attems, 1914)	0(0.00)	9(0.181)	9(1.81)
	<i>Telodeinopus canaliculatus</i> (Porat, 1894)	61(12.25)	47(9.44)	108(21.69)
	<i>Telodeinopus</i> sp.	107(21.49)	0(0.00)	107(21.49)
	<i>Treptogonostreptus intricatus</i> (Voges, 1878)	0(0.00)	16(3.21)	16(3.21)
Total		278(55.82)	220(44.18)	498(100.00)

" ": represent species with uncertain generic position (Orphan species).

Based on the classification of the frequency and constancy of the different species, three giant millipedes were considered intermediate in the Dja Biosphere Reserve and the other five species found in this area as rare (Table 2). When considering the Ebo Forest, the trend was different. Indeed, in the Ebo Forest site, we mentioned four species with intermediate status and three rare species. *Pelmatojulus excisus* was classified as intermediate because it was not considered to be dominant. When considering the two study giant millipede communities, the rare group (nondominant and accidental) included most of the species.

The most species-rich habitat was the primary forest (nine species), followed by the secondary forest (seven species) and the cocoa-based agroforest (three species).

b). This study recorded several threats (principally due to anthropogenic practices) to giant African millipede species.

They include harvesting of tree products, wood exploitation, slash-and-burn agriculture practices, and implantation of agro-industrial exploitation (e.g., palm oil, rubber, and cocoa) were the major activities leading to the degradation of the forest cover in our two prospected areas that have a significant negative effect on the target millipede populations. The slash-and-burn agriculture is a common practice in the southern forest region of Cameroon and principally in the Dja Biosphere Reserve and Ebo Forest, where most of the local population depends solely on this practice. They cut down trees and set them on fire to establish plots of cassava, groundnuts, and plantains. The use of fire results in the destruction of soil organic matter. Consequently, there is a decrease in the productivity of the vegetation and the crops planted on the burnt plot. In addition, most of giant millipede species which generally have low dispersal ability and a high level of endemism would likely perish during these activities. The harvesting of tree products mainly for medicinal purposes is also a cause of canopy degradation due to unsustainable harvesting techniques.

Table 2. Composition and total abundance of Giant millipedes found in the study areas.

Sites	Species	AA	FI%	1/S%	C	O	CI%	C	Category
Dja Biosphere Reserve	<i>Brebitibuis polyptychus</i>	2	0,71	12.5	ND	2	0,58	AC	Rare
	<i>Ophiostreptus</i> sp.	4	1,42	12.5	ND	4	1,17	AC	Rare
	<i>Pelmatojulus excisus</i>	83	29,54	12.5	D	48	13,99	AC	Intermediate
	<i>Spiropoeus fischeri</i>	12	4,27	12.5	ND	12	3,50	AC	Rare
	« <i>Spirostreptus</i> » <i>pancratius</i> »	2	0,71	12.5	ND	2	0,58	AC	Rare
	« <i>Spirostreptus</i> » <i>servatus</i> »	7	2,49	12.5	ND	7	2,04	AC	Rare
	<i>Telodeinopus canaliculatus</i>	61	21,71	12.5	D	57	16,62	AC	Intermediate
	<i>Telodeinopus</i> sp.	107	38,08	12.5	D	45	13,12	AC	Intermediate
Ebo_Forest	<i>Ophiostreptus</i> sp.	3	62,21	14.3	D	3	0,87	AC	Intermediate
	<i>Pelmatojulus excisus</i>	135	1,38	14.3	ND	96	27,99	AS	Intermediate
	<i>Spiropoeus fischeri</i>	3	3,23	14.3	ND	2	0,58	AC	Rare
	<i>Spirostreptus pancratius</i>	7	4,15	14.3	ND	7	2,04	AC	Rare
	<i>Telodeinopus bibundinus</i>	9	21,66	14.3	D	7	2,04	AC	Intermediate
	<i>Telodeinopus canaliculatus</i>	47	7,37	14.3	ND	37	10,79	AC	Rare
	<i>Treptogonostreptus intricatus</i>	16	62,21	14.3	D	13	3,79	AC	Intermediate

AA: absolute abundance; **FI:** Frequency Index; **S:** observed species richness; **C:** class; **O:** occurrence; **D:** dominant; **ND:** not dominant; **AS:** accessory; **AC:** accidental.

Although deforestation inside the Dja Biosphere Reserve is remarkably low, logging occurs at the entire periphery of this area, causing fragmentation of the forest habitat and therefore impacting biodiversity in general and especially on the populations of giant millipedes highly fragmented, with a low dispersal ability. Logging and the advance of agricultural exploitation in the study area have an immediate consequence on the accentuation of deforestation. This trend towards progressive deforestation is probably linked to an increase in the human population living on the periphery of the Dja Biosphere Reserve. The activities of the company "Sud Cameroun Hévéc" on the outskirts of the Dja Biosphere Reserve on nearly 44,000 ha of concession (for rubber, oil palm, and cocoa plantations) have several negative impacts on the environment. The most significant of these activities are large-scale deforestation, the disappearance of certain animal and plant species, and the degradation of surface water resources and soil through the overuse of chemicals.

c). Seven of the ten giant millipedes recorded during this study have special conservation concern and have been classified as endanger (EN) using the B criteria of the IUCN red list (Table 3).

Table 3. Conservation status of the ten giant African millipede species recorded in the Dja Biosphere Reserve and Ebo Forest in Cameroon.

Species	EOO	AOO	Conservation status
" <i>Spirostreptus</i> " <i>servatius</i> Attems, 1914	288902 km ²	52.00 km ²	(EN) B2ab (ii, iii, iv).
" <i>Spirostreptus</i> " <i>pancratius</i> Attems, 1914	6156.00 km ²	16.00 km ²	(EN) B2ab (ii, iii).
<i>Telodeinopus canaliculatus</i> (Porat, 1894)	85497 km ²	116 km ²	Least Concern (LC).
<i>Telodeinopus bibundinu</i> (Attems, 1914)	114 km ²	12 km ²	(EN) B1+ B2ab (ii, iii, iv, v)
<i>Telodeinopus</i> sp.	8975km ²	96 km ²	(EN) B1 +B2a b (iii, iv)
<i>Brevitibuis polyptychus</i> (Kraus, 1958)	4307.6km ²	12 km ²	(EN) B1+ B2ab (ii, iii, iv)
<i>Spiropoeus fischeri</i> Brandt, 1833	1712099.3 km ² ,	56 km ²	Least Concern (LC)
<i>Treptogonostreptus intricatus</i> Voges (1878)	11260.880 km ²	24 km ²	(EN) B2ab (ii, iii, iv).
<i>Ophiostreptus</i> sp.	11260.9 km ²	24 km ²	(EN) B2ab (ii, iii, iv, v).
<i>Pelmatojulus excisus</i> (Cook, 1897)	91978 km ²	136 km ²	Least Concern (LC)

This study is the first of its kind in the two prospected areas. It gives a first list of African giant millipede species as well as their habitat preference, distribution, and

conservation status according to IUCN criteria. This is an important step for the consideration of these species in future conservation programs at the national, regional, and global levels.

In regard to the management plan for these target species, some proposals for better conservation actions of giant millipede are:

- Intensify the monitoring of target species in all sectors of the Dja Biosphere Reserve and in the proposed Ebo protected area as well as in adjacent areas to identify all existing populations.
- Encourage the consideration of these species in large projects which generally focus on reptiles, birds, mammals, amphibians, and reptiles.
- Conduct regular missions in collaboration with wildlife conservation officers (MINFOF) to assess the size of populations of target species of giant millipedes with specific conservation needs.
- Initiate urgent measures aiming to reducing the threats to the target species. To this end, it should be noted that the localities prospected during our work, although being key areas for the conservation of biodiversity, are subject to enormous anthropogenic pressures.
- Continue to carry out awareness campaigns both at the level of local populations and of authorities and partners (NGOs) in charge of wildlife conservation aiming at drawing their attention to the place and role of these invertebrate species in natural ecosystems functioning and the need to pay attention to their population assessment during inventory programmes.

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

We did not encounter any major problems during the implementation of this project, whether at the level of the administration in charge of the Dja Biosphere Reserve, which is a fully protected area, or the traditional chiefs of the various villages bordering the study areas. However, we noted some reluctance at the local community level during interviews and surveys on knowledge and perceptions of target species. Indeed, some people approached during questionnaire survey were hostile and refused to participate in our various related activities; they have the right to do that according to the International Society of Ethnobiology (ISE) Code of Ethics about Informed Consent of respondents. However, a favourable outcome was found in most cases after explaining the importance of such studies for local communities.

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

The local communities involved in this project include farmers, local authorities (chiefs of the village and other organisations), students, and field assistants who were people originating from Somalomo, Messamena, Meyomessala, and Djoum close to the Dja Biosphere Reserve. But also, from Iboti, Ndogbaguegue, Bisoue, and Lognanga close to Ebo Forest proposed protected area.

These local communities have been significantly involved both in the planning and final execution of this RSG project. They have been trained in the routine methodology to collect data for conservation activities. Combined with action from local authorities, those persons can now help with long-term monitoring and therefore increase the conservation of these target species.

In the education component, the chiefs of the village and their assistants have helped us to reach people including those who were confused about our study and convinced them to cooperate with us.

Our field research assistants and guides were very active in helping us to collect scientific data and to conduct education campaign of local people using local and national languages.

Ten youths (five per study site) received training on the identification and survey methods of giant millipede species which constitutes an important element for the future monitoring of the populations of these species and consequently for their conservation. Also, educating local populations on the various threats that could be detrimental to the survival of target species in their natural environment represents another income that could minimise human impact on the ecosystem.

To try to compare threats to other localities, we visited other adjacent locations and the Deng Deng National Park, and we recorded important data that will be necessary to be developed in the future.

5. Are there any plans to continue this work?

There is a plan to continue this work. We will pursue our research on behalf of nature conservation in other protected areas in Cameroon. We also plan to:

- Determine the conservation status of all other millipede species occurring in Cameroon and other central African countries.
- Use ecological modelling to predict the distribution and the conservation of the target species giant millipede species in different scenarios in the future and then provide a useful conservation strategy for the species.
- Revise the taxonomic status of the two giant millipede species of the genus "*Spirostreptus*" which no longer belong to the Genus *Spirostreptus* and are actually considered orphans.
- Describe and publish the two new giant millipedes (*Ophiostreptus* sp. and *Telodeinopus* sp.) recorded in this study.
- Continue to survey the population of the letters in adjacent areas of this project in other natural parks such as Deng Deng, Nki, and Lobeke which are all located in the lowland forest of Cameroon, and which could harbour these species and other giant millipedes not yet reveal to Cameroon fauna and for science.
- Continue the conservation education of the local population and train personnel in field surveillance.

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

A manuscript prepared from the main findings of this study is almost ready to be published in an international peer-reviewed journal.

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

A conservation guideline elaborated in collaboration with farmers and local authorities in charge of nature conservation of the two study sites is in progress and will submit to traditional authorities for suggestions and consideration.

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

With the experience acquired during this project, it's important to promote and enhance the millipede survey in the Cameroon lowland forest which seems to have a great diversity. According to the importance of forest health and their stability on the survival of millipedes, the most important steps should be: (1) publishing the results and making them available to the local authority in charge of wildlife protection in Cameroon; (2) continuing to share and divulge the obtained results in different scientific events and teaching activities; (3) sustain the educational programme to ensure local population and deciders understand the importance of protecting these fragile invertebrates and create a spirit of conservation throughout the community; and (4) looking additional funding to continue research on millipede conservation in Cameroon.

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?

The Rufford Foundation logo was used in brochures and posters during awareness raising in the communities. It is also acknowledged in the manuscript drafted on giant African millipede assemblage and conservation in two protected areas of the lowland forest of Cameroon. But also, on other taxonomic publication concerning the two new giant African millipedes recorded during this project, The logo was also used at the Myriapodologist virtual meet-up organised by the Marek Lab at Virginia University in March 2023. We also plan to use the logo during the international Congress of Myriapodology that will take place in Colombia. The Rufford Foundation is acknowledged in scientific publications in preparation.

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

Dr. NZOKO FIEMAPONG Armand Richard is the principal investigator and coordinator of this project. He has recently received his Ph.D. in Zoology at the University of Yaoundé. Dr. NZOKO FIEMAPONG A.R. is a taxonomist and invertebrates conservationist focussing his research on the conservation biology of millipedes in Cameroon, especially in the lowland forest hot spot of biodiversity of the Congo Basin Region.

Dr. Jeanne YETCHOM, University of Douala as a Research Assistant, participated in all field activities and report production.

Pr. Tamasse Joseph Lebel, University of Yaoundé 1 help us in some ecological interpretation of our results and in data analysis.

Tsekane Sedrick (MSc) is a trained zoologist and conservationist. Mr. Tsekane is a graduate of Zoology at the University of Douala. In this present study, he assisted in sampling, collection, ecological studies, perception, and awareness-raising campaigns at the Ebo Forest site.

Dr. Wandji Alain Christel has a Ph.D. in Zoology from the University of Yaoundé 1. During this project, Dr. Wandji has applied his skills and experience in analysing the ecological data as well as the data generated from the questionnaire. He has also served as a field assistant.

Mr. Simeu Noutchom Alain is currently a Ph.D. candidate at the University of Yaoundé 1, Cameroon. Mr. Simeu received his Master's and Bachelor's degree at the same university, completing multiple research projects in Entomology. He helped in the coordination of the local team members.

Mr. Tchana (MSc) is a trained zoologist and conservationist. Mr. Tchana is a former graduate of Zoology at the University of Yaoundé I. In this present study, he assisted in sampling, collection, ecological studies, perception, and awareness-raising campaigns at the Dja Biosphere Reserve site.

Mr. N KINGOP DJOPMOU Philippe Hervé (Ph.D. student) holds a Master's in ecology from the University of Yaoundé I. He began his Ph.D. thesis in zoology on forest weavers in southern Cameroon in 2019. Mr. Nkingop has acquired knowledge about the capture and identification of animal species including invertebrates such as millipedes and statistical analyses. In this present study, he assisted in sampling, collection, ecological studies, perception, and awareness-raising campaigns at the Dja Biosphere Reserve site.

Mr. Fokou Oscar (MSc) is a trained zoologist and conservationist. Mr. Fokou is a graduate of Zoology at the University of Yaoundé I. In this present study, he assisted in sampling collection at the Dja Biosphere Reserve site.

Local guides (Dieudonné, Siriki, Nyalingui, Mvoundi, Souley, Njock) have served as excellent facilitators and guides because of their experience of the study site. They have also served as translators during talks with farmers and shepherds.

10. Any other comments?

We are extremely grateful to The Rufford Foundation for granting us such an opportunity to contribute to species conservation in Cameroon without this financial support we could not be able to accomplish what we did on these target species which are particularly neglected in the field of conservation, particularly in the two important ecological zones we prospected. There is a lot of work remaining to be

done on this taxonomic group in Cameroon, and we need to work closely with the local population who are living closely with the target species this is the reason why we are trying to involve more of them in the project under different levels of involvement. However, the challenge has always been to secure funding for research in invertebrate taxonomy and conservation including millipedes. Several scientific publications are in preparation and will be shortly ready to be submitted for publication in international peer-review journals.



Telodeinopus cananiculatus



Spirostreptus pancratius.



Treptogonostreptus intricatus (juvenile).



Pelmatojulus excisus.





Research team camping in the Njuma research station (Ebo Forest).



Research team marking a stop to inspecting illegal wood exploitations.



Principal investigator in the Dja Biosphere Reserve.





Dense tropical lowland forest prospected.



Educational session on the role and importance of millipedes with young people from the locality of Somalomo (DBR) after a football match.



Field survey by some team members in a cacao-based agro-system (DBR).



Research team in the Dja Biosphere Reserve (Bouamir research station entrance).



Research team crossing the Dja River by pirogue.