

The Rufford Foundation Final Report

Congratulations on the completion of your project that was supported by The Rufford Foundation.

We ask all grant recipients to complete a Final Report Form that helps us to gauge the success of our grant giving. The Final Report must be sent in **word format** and not PDF format or any other format. We understand that projects often do not follow the predicted course but knowledge of your experiences is valuable to us and others who may be undertaking similar work. Please be as honest as you can in answering the questions – remember that negative experiences are just as valuable as positive ones if they help others to learn from them.

Please complete the form in English and be as clear and concise as you can. Please note that the information may be edited for clarity. We will ask for further information if required. If you have any other materials produced by the project, particularly a few relevant photographs, please send these to us separately.

Please submit your final report to jane@rufford.org.

Thank you for your help.

Josh Cole, Grants Director

Grant Recipient Details	
Your name	Nzoko Fiemapong Armand Richard
Project title	Impact of land use and forest disturbance on millipede diversity and distribution in the forests of the littoral region of Cameroon: conservation implication
RSG reference	20687-1
Reporting period	November 2016-November 2017
Amount of grant	£4980
Your email address	armandnzoko@gmail.com
Date of this report	5/11/2017

1. Please 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>Millipedes diversity, distribution and community structure within the land use system in the littoral region of Cameroon</p>				<p>The survey permitted us to identify a total of 41 species of millipede belonging to 10 families, namely Pachybolidae, Spirostreptidae, Odontopygidae, Chelodesmidae, Trychopolydesmidae, Stemmiulidae, Cryptodesmidae, Pyrgodesmidae, Oxydesmidae and Paradoxosomatidae. Out of these ten families, Spirostreptidae was the most rich (seven species), followed by Oxydesmidae and Chelodesmidae (six species each). Paradoxosomatidae was the less speciose with only two species. <i>Trichocholepus</i> sp. was the most abundant species in the open land (39% of total abundance) followed by <i>Monachodesmus longicaudatus</i> (12.75%) and <i>Urodesmus cornutus</i> (8.23%). In the primary forest of Djawara, the most abundant species were <i>Kartinikus colonus</i> (22%) and <i>Pelmatojulus excisus</i> (19%), respectively. In old secondary forest of Ekite the most abundant species was <i>Coromus vitatus</i> (8%). The highly disturbed forest of Yansoki was dominated by <i>Kyphopyge granulosa</i> (7%). The species richness of millipedes was strongly decreased with environmental degradation, in both forest land and open-habitats (fallow and farmland). This situation led to a marked change in the structure of diplopod communities, with invasive species becoming more dominant at the expense of specialist species, both in terms of species richness and abundance.</p>

			<p><i>Trychochalepuncus</i> sp. was specific to farmland and fallows; <i>Stemmiulus beroni</i>, <i>Laciniogonus</i> sp., <i>Spheroparia integratus</i> and <i>Spirostreptus pancratius</i> to primary forest of Djawara. <i>Coromus vitatus</i>, <i>Coromus barumbi</i> and <i>Telodeinopus cananiculatus</i> were specific to deturbed forest (Yansoki). <i>Paracordyloporus porati</i> and <i>Aporodesmus minimus</i> were found only in the old secondary forest (Ekite). Beside these specific species in the habitat, we have also observed some species whose abundances significantly increase with the destruction of the forest cover (for example, <i>Monachodesmus minutus</i> and <i>Monachodesmus djawara</i>) and others decrease in the size of the population with the opening of the environment (for example, <i>Coenobothrus bipartitus</i>). These observations show that all these species are potential indicators of the anthropogenic pressure in the littoral evergreen forests region of Cameroon.</p>
<p>Characterization and evaluation of human pressure on the forests</p>			<p>During this study we found that the pressure exerted on the natural ecosystems in general and the forests in particular by the riparian populations of the various sites were of several orders. This pressure ranging from the clear-cuts to the anarchic exploitation of the rare and protected forest species as <i>Lophira alata</i>, <i>Pycnanthus angolensis</i>, <i>Termilia superba</i>, <i>Entandrophragma cylindricum</i> and <i>Baillonella toxisperma</i>. A very intensive agricultural activity with destructive practices, such as slash-and-burn was mainly identified at Ekite and Yansoki. This practice have a negative effect on the soil fauna in general and that of the millipede which are generally vulnerable. Indeed during this</p>

			research, we noted as indicated in one of our intermediate reports, a large number of dead millipede species (<i>Pachybolus tectus</i> , <i>Pelmatojulus excisus</i> , <i>Coenobothrus bipartitus</i> , <i>Telodeinopus canaliculatus</i>) in a large stretch of land after the slash and burn.
Perception and knowledge of people about deforestation and the consequences of this practice on the ecosystems of various study areas			Sensitising local populations and recording their perception of the effect of land use and deforestation on millipedes suggests that the people of the littoral forest of Cameroon know millipede and use them for several purposes. Among the 355 people interviewed during this study, we are observed that certain millipede species are suitable indicators of the degree of transformation of forest ecosystems. Over 80% of those interviewed reported that some of these species seem to dominate farmland and fallow; others reported the empirical use of some millipedes as indicators of season and identified the most common species in the forest, farmland and open habitat in general. The treatment of certain conditions or infections such as haemorrhoids, and certain incurable wounds is done with certain species of millipedes.

2. Please explain any unforeseen difficulties that arose during the project and how these were tackled (if relevant).

We did not encounter any major difficulties except that during the administration of questionnaires about the knowledge and perception of diplopods by the population of the study areas, some of the people did not want to participate in the study. However, after explaining the importance the research we were conducting and the place of the millipede in the functioning of the ecosystem in general and soil fertility, in particular, most of people agreed to participate and responded to the questions.

Furthermore, initially the chief in Ekite was not supportive of the work in the forest. However, the research permits provided to us by the academic authorities and by the Ministry of Research facilitated access to the various sites in the area.

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

- Littoral millipede community has been identified in each of our study sites according to the land use system in the littoral forest of Cameroon. Four land uses were surveyed during our study; primary forest (Djawara), old secondary forest (Ekite), disturbed forest (Yansoki) and open habitat (fallow and farmland) in both locality. A total of 41 species of millipede was identified belonging to ten families, namely Pachybolidae, Spirostreptidae, Odontopygidae, Chelodesmidae, Trychopolydesmidae, Stemmiulidae, Cryptodesmidae, Pyrgodesmidae, Oxydesmidae and Paradoxosomatidae. Out of the ten families, Spirostreptidae was the most dominant family in term of the species number (seven species), followed by Oxydesmidae and Chelodesmidae (six species each). Stemmiulidae and Paradoxosomatidae was the less speciose family with two species only in each. *Trichocholepus* sp. was the most abundant species in the open land (39% of total abundance) followed by *Monachodesmus longicaudatus* (12.75%) and *Urodesmus cornutus* (8.23%). In the near primary forest, the most abundant species were *Kartinikus colonus* (25%) and *Pelmatojulus excisus* (19%), respectively.

Stemmiulus beroni, *Laciniogonus* sp., *Spheroparia integratus* and *Spirostreptus pancratius* are closed to relatively stable and non-degraded forest of Djawara. *Paracordyloporus porati* and *Aporodesmus minimus* were found in the low degraded secondary forests of Ekite only. We have finally noted that *Telodeinopus cananiculatus*, *Coromus vitatus* and *Coromus barumbi* were exclusive to the degraded forests of Yansoki.

The species richness of millipedes is strongly decreased with increasing environmental degradation in both forest and open-land habitats (fallow and farmland). This situation leads to a marked change in the structure of diplopod communities, with invasive species becoming dominant in wildlife at the expense of specialist species, both in terms of species richness and abundance.

- The major threats to the fauna of millipede in the littoral forest of Cameroon are bushfires, agricultural practices, clear-cuts for the production of coal, cocoa plantations and palm oil; but also artisanal timber exploitation and overuse of insecticides.
- Sensitising of local populations and recording their perception about the effect of land use practice and deforestation on millipedes suggests that the peoples of the littoral forest of Cameroon know millipede and use them for several purposes. Villagers used millipede as indicator of season variation and land use systems in the littoral region of Cameroon. Certain millipede species are suitable indicators of the degree of transformation of forest ecosystems. Some millipede species seem to dominate farmland and fallow, while other are common to forest habitat.

4. Briefly describe the involvement of local communities and how they have benefited from the project (if relevant).

The guides and translators who assisted us in the different study areas were native people. The people were trained on the importance of invertebrate and diplopod studies in particular, including empirical methods for collecting survey data, as well as sampling techniques for diplopods and their conservation. Information and sensitisation workshops on the place and importance of the study of soil invertebrates and that of the diplopods in particular were organised in each study locality to enable riparian populations and village authorities to protect their forest and their great diversity. In addition, communities have been monitoring and managing the forest, using indicator species of diplopods associated with particular environments. Furthermore, helped and educated communities about how to use forests sustainably.

5. Are there any plans to continue this work?

Yes, there is plan to continue this work. Based on the data that we collected during this project, several species were new to science and others were recorded in Cameroon for the first time. Within these species, *Pachybolus tectus* Cook, 1897, a giant African millipede was re-discovered 120 years after being recorded in East Africa. *Pachybolus tectus* Cook, 1897, is known only from the original description and the more extensive description by Cook (1899). Cook (1897, 1899) based his description on a specimen labelled "Zanzibar" and deposited in the Zoological Museum of Hamburg, Germany. However, the specimen no longer exists (Weidner 1960). Due to the poor dispersal ability this species is threatened by the land use practice mainly, clear cut and slash burn at Ekite where several specimens of this species were noted in a large band of mangrove forest after bush fire. It is critical to evaluate the size of population of this species in this fragile ecosystem of the littoral region of Cameroon and establish its conservation status in order to prevent extinction and provide long term monitoring program of this species in the habitat.

Furthermore, *Monachodesmus djawara* Golovatch, Nzoko Fiemapong and Vandenspeigel, 2017, *Monachodesmus minutus* Golovatch, Nzoko Fiemapong and Vandenspeigel, 2017 and *Monachodesmus yabassi* Golovatch, Nzoko Fiemapong and Vandenspeigel, 2017 were all new species discovered and described during the present project in a small patch of natural forest in Djawara. The densities of these three species were decreased drastically by increased level of forest destruction. Therefore, it is important to establish their distribution range and verify their status as bioindicator of forest destruction in the littoral evergreen forest of Cameroon.

Given the negative effect of land use practices on millipede it is also important (in the next study) to organise the educational session to sensitise local population about the negative impact of forest destruction on soil invertebrate and millipede in particular and training them to survey their ecosystems using this important taxa as bioindicator. It is also important in the near future to prospect other localities of this

region, mainly those in mangrove site which are particularly vulnerable and speciose.

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

Three scientific manuscripts have been published and one other are in preparation. Certain result of this project were presented during the 24th annual conference of the Cameroon Bioscience Society as mentioned in first report project update. A poster with the title "On main families of millipedes (Myriapoda, Diplopoda) found in south of the 6th parallel North in Cameroon: conservation importance" was presented at the scientific day of the Faculty of Science of the University of Yaoundé I (Cameroon) and during a training session in the Royal Museum of Central Africa (Belgium). The above articles are already published and are available online:

- **Nzoko Fiemapong AR**, Mbenoun Masse PS, Tamesse, JL Golovatch SI and VandenSpiegel D (2017) The millipede genus *Stemmiulus* Gervais, 1844 in Cameroon, with descriptions of three new species (Diplopoda, Stemmiulida, Stemmiulidae). *ZooKeys* 708: 11–23. <https://doi.org/10.3897/zookeys.708.14072>
- Golovatch, S.I, **Nzoko Fiemapong. A.R.**, and VandenSpiegel D. (2017) The first record of the pantropical anthropochore millipede, *Cylindrodesmus hirsutus* Pocock, 1889, from Cameroon (Diplopoda: Polydesmida: Haplodesmidae) *Russian Entomological Journal* 26(3): 281–282
- Golovatch S.I., **Nzoko Fiemapong A.R.**, and VandenSpiegel D. (2017) Notes on Afrotropical Pyrgodesmidae, 3 (Diplopoda: Polydesmida). *Arthropoda Selecta* 26(3): 175–215

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

The Rufford Foundation grant ran from November 2016 to November 2017. Monthly surveys (3 days per month x three localities) were conducted in the evergreen littoral forest of Cameroon. I used the grant throughout the duration of the project. All the plan activities were achieved.

8. Budget: Please 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. 1 £ sterling = 758.357, XAF

Item	Budgeted Amount	Actual Amount	Difference	Comments
GPS (Global Position System)	185	175	+£10	The cost of the GPS (Global Position System) was lower than initially budgeted.
Video camera	£175	£175	0	As initially budgeted

Storage boxes in glass for millipedes conservation	£135	£0	+£135	I received storage box from Dr Didier Vanderspigel during my research visit in November 2016 at Museum for Central Africa, Tervuren, Belgium
Laptop and accessories software	£294	£294	0	As initially budgeted
Dissection kit	£13	£13	0	As initially budgeted
Travel expenses in and out the site studies	£1456	£1456	0	As initially budgeted
Per diem for field assistants and technician	£1248	£1248	0	As initially budgeted
Meals for staff members in the field	£780	£925	-£145	Accommodation and meal were higher than budgeted due to the augmentation rate of the price of food in the sub-region in general
First aid kit	£100	£100	0	As initially budgeted
Supplies: Petri dishes, vials Alcohol 100% (50l) and 70%(50l), ethyl glycol (100l) and winkler setting	£220	£220	0	As initially budgeted
Communications (Internet, phone)	£125	£125	0	As initially budgeted
Miscellaneous	£249	£249	0	As initially budgeted
Totals	£4980	£4980	0	

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

With the experience acquired during this implementation of project, it's important to promote and enhance forest protection in the littoral evergreen forest of Cameroon and the survival of the soil invertebrate in general and millipede in particular. The most important next steps should be:

- 1) Establishing the size of the population and the distribution range of the threatened species recorded during this project, for example, the giant African millipede *Pachybolus tectus* Cook, 1897 in the littoral evergreen forest of Cameroon and propose the main measure to be taken to protect them in their natural ecosystem.
- 2) Investigate the possibility to use the *Monachodesmus* spp. species in this region as a bioindicator of forest degradation as these preliminary results show.
- 3) Conduct educational and training session to ensure that riparian forest people and administrative authority understand the importance of sustainable forest management to protect and prevent the extinction of soil millipedes which are most

habitat specific species due to their less mobility. This will enhance the conservation spirit throughout the community.

4) To survey the locality adjacent our study site during this project mainly those in mangrove the ecosystem, which are particularly vulnerable and speciose and using millipede as indicators of forest degradation and destruction by human activities.

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

Yes, I have used the Rufford Foundation logo in my several official documents and in the materials (produced in this project) such as posters presented during the scientific day at the University of Yaoundé I and during national scientific conferences recently held at the Université des Montagnes, Bangangté, West Region, Cameroon, in December 2016. I have acknowledged the support of the RF in three publications (listed in Section 6).

11. Any other comments?

Millipede constitutes a substantial and functionally significant component of terrestrial biodiversity and are valuable indicators of environmental condition. Although consideration of this important component of fauna has been given, millipedes have historically been neglected in conservation planning and management. Substantial progress with surveys, systematics studies and bio-indication means that it is now feasible and advisable to incorporate them into biodiversity monitoring activities program. However, the challenge has always been to obtain funding for research in invertebrate taxonomy.