Final Evaluation Report

Your Details	
Full Name	BADOU Akotchayé Sylvestre
Project Title	Conservation of natural habitats through the establishment of a value chain of edible mushrooms and intensification of reforestation in the Wari-Maro Forest
Application ID	29840-2
Grant Amount	£ 6000
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Date of this Report	21/09/2020

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 train the local populations of the Wari-Maro forest to the cultivation of edible higher mushrooms				
Reforest the degraded natural habitats of edible higher fungi into partner trees, notably Afzelia africana				
To make an analysis of the disparity of ethnomycological knowledge collected by Yorou & De Kesel (2001) and the new ethnomycological knowledge that will be derived from the new ethnomycological surveys of our project to propose new methods of awareness in the Wari-Maro forest.				

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

During the execution of the activities of my project we did not encounter any difficulties. On the contrary, we had the support of the local population and the forestry authorities responsible for the conservation of the Wari-Maro forest reserve. Likewise, the barrier gestures against COVID19 were respected during the execution of our various activities.

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

- **To train the local populations of the Wari-Maro forest to the cultivation of edible higher mushrooms**

This activity took place during from January to June 2020. In total, three villages (Wari-Maro, Abéokouta and Wanou) were included, the same as those selected in our previous project (Project 26916-1) to host the training. 50 volunteers were selected to follow the training on the cultivation of edible mushrooms (photo 1 A B; 2 CD; 3EF and 4). Similarly, the same populations took an active part in the construction of the mushroom farm (photo xxx). The mushroom farm was built with clay-like houses found in the Wari-Maro area and other villages ((photo 1 A B; 2 CD; 3EF and 4)). Theoretical training followed by practical training was offered to our target group (Photo 5; 6; 7 and 8).

Photo 1: (A) and (B) Construction of the edible mushroom field based on rammed earth with the local populations in Wari-Maro.

Photo 2: (C) et (D) Montage des murs de la champignonière avec de la terre battue.

Photo 3: (E) Architectural team for the construction of the mushroom farm (F) The women responsible for drawing water for the construction.

Photo 4: (G) Construction of the mushroom house completed (H) Visit of the project leader (Sylvestre A. BADOU) to see the effectiveness of the finish of the mushroom farm.

Photo 5: Training of local populations in the cultivation of edible mushrooms.

Photo 6: Local people participating in the training on the cultivation of edible mushrooms.

Photo 7: Local people participating in the training on the cultivation of edible mushrooms.

Photo 8: All participants and trainers.

- Reforest the degraded natural habitats of edible higher fungi into partner trees, notably *Afzelia africana*

This activity began March 15, 2020 with the establishment of *Afzelia africana* nurseries. Then, the nursery was maintained for 3 months and transplanted into degraded natural habitats of the Wari-Maro forest reserve during June 2020. The trees planted benefited from 4 months of the rainy season, which will facilitate their development in a real natural environment (Photo 9 and 10).

Photo 9: Embarquement des plants de Afzelia africana pour le reboisement sous la supervision de l'A gent forestier de la zone de Wari-Maro.

Photo 10: Planting of Afzelia africana plants in the natural habitats of the Wari-Maro forest reserve with the local populations and the support of Forest Agents.

- To make a comparative analysis of the disparity of ethnomycological knowledge collected by Yorou & De Kesel (2001) and the new ethnomycological knowledge that will be derived from the new ethnomycological surveys of our project to propose new methods of awareness in the Wari -Maro forest.

The ethnomycological survey took place from 07/01/2020 to 09/10/2020. To this end, four villages (WARI-MARO, KPAWA, TEROU and WANNOU) were investigated. A total of 100 people sampled were interviewed according to the size of their respective population (Photo 11, 12 and 13). Taking into account the size of the respective population of the ethnic groups who stay there in each village, we investigated, 40 people were interviewed in the village WARI-MARO at the rate of one fon, one bariba, six ditamaries, 10 peulhs, seven Biaries, Nago); 10 people in the village KPAWA (one Nago, two peulh, seven lokpa); 25 people in TEROU (four Nago, nine Ditamarie and 12 Wama) and 25 people in the village WANNOU (10 Nago, eight Lokpa and seven Pila-pila).

We used quota sampling: this technique allowed us to know beforehand the size of our sample based on the information provided by the village chiefs. So, we subjected each person surveyed to pre-established questionnaires in a survey sheet, the results provided are just transcribed on the sheet. The survey was more or less individual because we believe that two people living in the same household may

also have different knowledge. After the survey we can conclude in a global way without the actual analysis of the data, which the nomenclature of the species varies from one ethnic group to another. Likewise, it is essentially based either on the habitat of the species or on the most remarkable morphological character. The names are different depending on the ethnic group.

It can also be deduced from this that the names may be different within an ethnic group, for example among the Fulani: some call the mushrooms "GOMIDJI" and others "GABOUNIÖ". But in general, we can say that it is Fulani, other ethnic groups have a more or less important knowledge of the differentiation of species. In addition, populations in general have little knowledge about mushrooms for medicinal use; but they all use the higher fungi for food. The local populations have a very strong communication network, and the transmission of information is ensured only by the parents. In short, this survey was a success thanks to the help of our local guides that we had in the different villages investigated and also the availability of each village chief.

A manuscript is being written on “The disparity of ethnomycological knowledge between ethnic groups and between the villages bordering the Wari-Maro forest reserve”. It is planned to publish this manuscript in the journal "Tropicultura" or "Journal of Applied Biosciences" in which such articles have already been published.

Photo 11: Local populations surveyed on the disparity in endogenous knowledge about edible fungi.

Photo 12: Semi-structured interview with local populations on the disparity of endogenous knowledge on edible fungi.


Photo 13: Direct group interview with local populations.

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

For the proper execution of project activities, we worked with village groups and other existing actors in the area to carry out the various project activities. These village groups are active women who sell edible mushrooms in the local markets of the study area, from farmers and loggers. Likewise, we have also collaborated with members of the forestry administration and its decentralised structures, ecotourism promotion structures and in particular NGOs specialising in the conservation and sustainable management of biodiversity, with which we have listed the various directives for good sustainable management of natural habitats of wild mushrooms. We also worked in close collaboration with the General Directorate of Water and Forests of Benin, the National Association of Loggers of Benin, the Community Union of Agricultural Producers of Benin the region of our study area.

Some members of village groups served as local field guides in choosing sites for mycological data collection. In the same way, they helped us to carry out our various activities of reforestation of natural habitats in the forest reserve of Wari-Maro.

Some members of village groups served as local field guides for ethnomycological surveys. Likewise, they helped us to mobilise the local people to volunteer to participate in the cultivation of edible mushrooms in the study area.

5. Are there any plans to continue this work?

This work must continue in the years to come. The points that still need to be addressed to strengthen our conservation efforts in the study area are:

- Continue reforestation activities to further enrich the Wari-Maro forest reserve with ectomycorrhizal trees in order to restore the degraded natural habitats of higher fungi.
- Establish a value chain for higher mushrooms in other riparian villages in order to provide income generating activities that contribute to the conservation and sustainable management of natural habitats.

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

A scientific article is on the disparity of ethnomycological knowledge between ethnic groups and between the villages bordering the Wari-Maro forest reserve. This article will be published in the journal "Tropicultura" or "Journal of Applied Biosciences" in which such articles have already been published. The results of our project will also be disseminated during several workshops and symposium, including the conference of the University of Parakou (Benin), the University of Kara (Togo), the University of Lomé (Togo) and the conference of the 'University of Koudougou (Burkina Faso). Likewise, the results of our project will be used to support mycological teaching and research at the Faculty of Agronomy of the University of Parakou in Benin.

Already, I intervene during practical and oriented work in ecology and characterisation of natural habitats of higher fungi. I will effectively transmit the know-how acquired to young students and to my colleagues the results of our project. An important advantage is that I already attend Prof. Nourou S. YOROU (Director of the Research Unit in Tropical Mycology and Plant-Soil-Fungus Interactions) (MyTIPS) during his mycological teaching at the Faculty of Agronomy of the University of Parakou. The scientific seminars and the monthly communication organized by our laboratory will serve to publicise our acquired results; annual scientific conferences and symposia organised by the University of Parakou. In addition, the scientific publications and books that will be generated.

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

The activities were carried out according to the periods indicated in the project. Above all, the training of local populations in the cultivation of edible mushrooms during the dry season when they are available. Likewise, ethnomycological surveys were carried out during the period from mid-May to September 2020. Awareness-raising activities were also carried out during June 2020.

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
Room renting	150	150		We rented rooms during our stays in the different villages of the study area

Accommodation and food	397	397		The cost of food is essential for the team in the field. As a result, each project member in the field received a fixed sum per day.
Workshop transport Per diem	150	150		Travel costs for participants in the training course on edible mushroom cultivation.
Conception of pamphlets	213	213		Posters were produced and printed in A0 format to conduct the training on growing edible mushrooms.
Tree nursery, reforestation cost and assistants	1150	1150		We paid for the establishment of the nurseries from March to May 2020. In addition, we also paid the local assistants in the field for the planting of plants in order to restore the ecological balance of the natural habitats of edible fungi.
Local guide for ethnomycological studies	600	600		Cost of local (1 local guide): a local guide and two members of the local population were recruited to help with ethnomycologic al surveys a total of £ 600 has been spent.
Travel to the field	1650	1650		Local travel costs: a prospecting trip= one way + round trip + trip to the study area. A prospecting trip in the Wari-Maro forest reserve. A total of 1650 km is required for the excursions. The trip to Benin costs around £ 1 per kilometer. A total amount of £ 1,650 was spent on the trip.
Internet, telephone	200	200		We have an internet and communication subscription to do documentary research and ensure contacts with other members of the project
Mushrooms farm building	750	750		We built a mushroom farm valued at € 250 for each village. For the 3 villages, we spent 750 € in total.
Equipment for mushrooms cultivation (gloves, fork, barrel,	350	350		We paid for the necessary elements (raw materials) for the cultivation of edible mushrooms

mushrooms seed				
Office supplies (CD, paper, USB key, pen and pencil) and collection sheet for ethnomycological studies	200	200		Office and computer tools, poster prints were made to carry out our data collection and our survey. We paid for the Ram papers of the Paper Line brand.
TOTAL	**6000**	**6000**		

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

The next step after this project is to continue the establishment of an edible mushroom value chain in the other villages bordering the forest reserve area. Across the value chain, we plan to set up mushroom farms to bring local people selling edible mushrooms to local markets to create more income for all involved in the sustainable conservation of natural higher mushroom habitats. These mushroom farms will allow local people to cultivate edible mushrooms locally.

Likewise, we plan to enrich the natural habitats of higher fungi with EcM trees in order to restore the ecological balance of the habitats of the Wari-Maro forest reserve. Likewise, to continue monitoring activities in the various plots of different ages installed during our first Rufford project n ° 26916-1 for another 2 years. With an additional duration, we will be able to record a set of consequent quantitative data to be able to propose the duration of fallow to adopt in order to have a better productivity of edible fungi in the forest reserve in the Wari-Maro.

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?

For the success of the training of local populations on the cultivation of edible mushrooms, we produced posters on which is displayed the logo of The Rufford Foundation. Likewise, during the lectures of Professor Nourou Soulemane, we presented our preliminary results in which the logo of The Rufford Foundation was displayed to undergraduate and graduate students in agronomy of the Faculty of Agronomy of the University of Parakou from Benin. All posters are displayed with the logo of The Rufford Foundation in our Tropical Mycology and Plants-Soils-Mushroom Interaction Unit of the Laboratory of Ecology, Botany and Plant Biology.

11. Please provide a full list of all the members of your team and briefly what was their role in the project.

To achieve the different objectives of our project, we have seen fit to work with people who really have the appropriate skills for the activities of our project:

KPARA Assia, she provided training on the cultivation of edible mushrooms in a controlled environment. She worked with village cooperatives to set up edible mushroom fields for individuals in the study area.

BONI Souleymane, he was responsible for collecting ethnomycological data in the three villages chosen for the project.

DOSSA Asael, he was responsible for the reforestation activities of natural habitats and the establishment of the tree nursery partners of higher fungi people of A. africana.

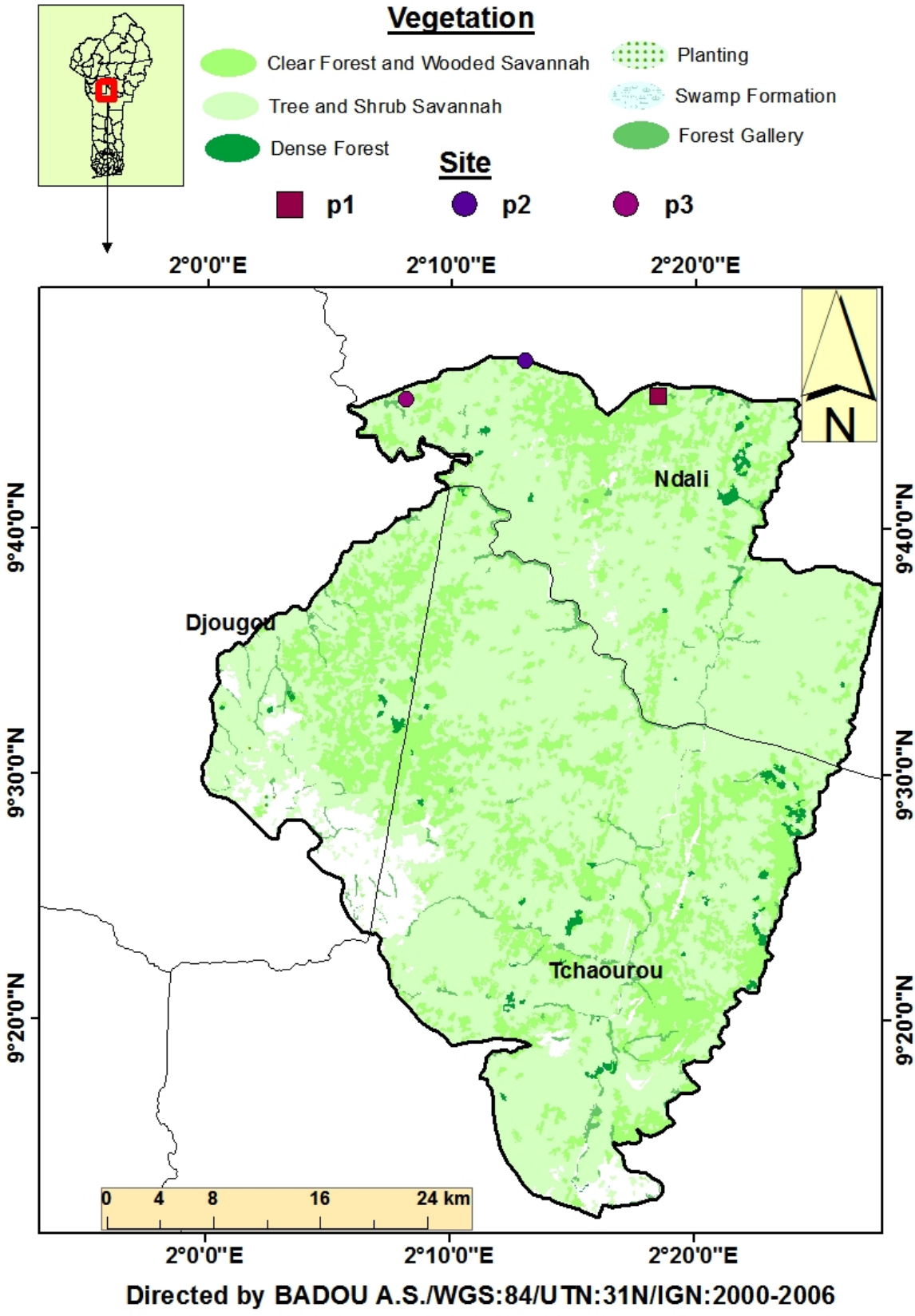


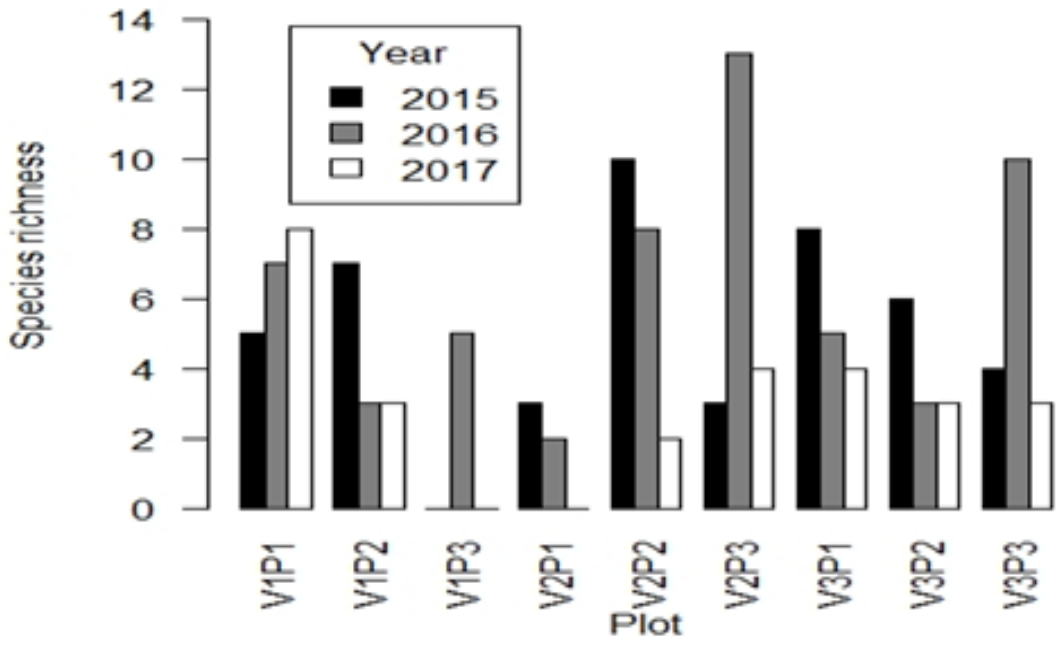
Fig.1: Vegetation map of the Ouémé Supérieur Forest Reserve

Table.1: Geo-location of the different plots

Sites	Tree species	Plots (Acronyme)	Geographic coordinates
	Isoberlinia doka	V1P1 = Plot *I. doka* Angaradebou	N09°45''16.4'' E002°08'26.3''
Angaradebou	*Isoberlinia tomentosa*	V2P1 = Plot *I. tomentosa* Angaradebou	N 09°45'24.4'' E 002°18'24.3''
	Uapaca togoensis	V3P1 = Plot *U. togoensis* Angaradebou	N 09°46'50.0'' E 002°12'58.7''
	Isoberlinia doka	V1P2 = Plot *I. doka* Gando	N09°45'16.7'' E002°08'31.0''
Gando	*Isoberlinia tomentosa*	V2P2 = Plot *I. tomentosa* Gando	N 09°45'51.2'' E 002°18'39.1'
	Uapaca togoensis	V3P2 = Plot *U. togoensis* Gando	N 09°46'.09.5'' E 002°18'39.1''
	Isoberlinia doka	V1P3 = Plot *I. doka* Sonnonmon	N 09°45'15.7'' E 002°08'08.3''
Sonnonmon	*Isoberlinia tomentosa*	V2P3 = Plot *I. tomentosa* Sonnonmon	N 09°45'15.7'' E 002°08'08.3''
	Uapaca togoensis	V3P3 = Plot *U. togoensis* Sonnonmon	N 09°46'49.6'' E 002°14'48.9''

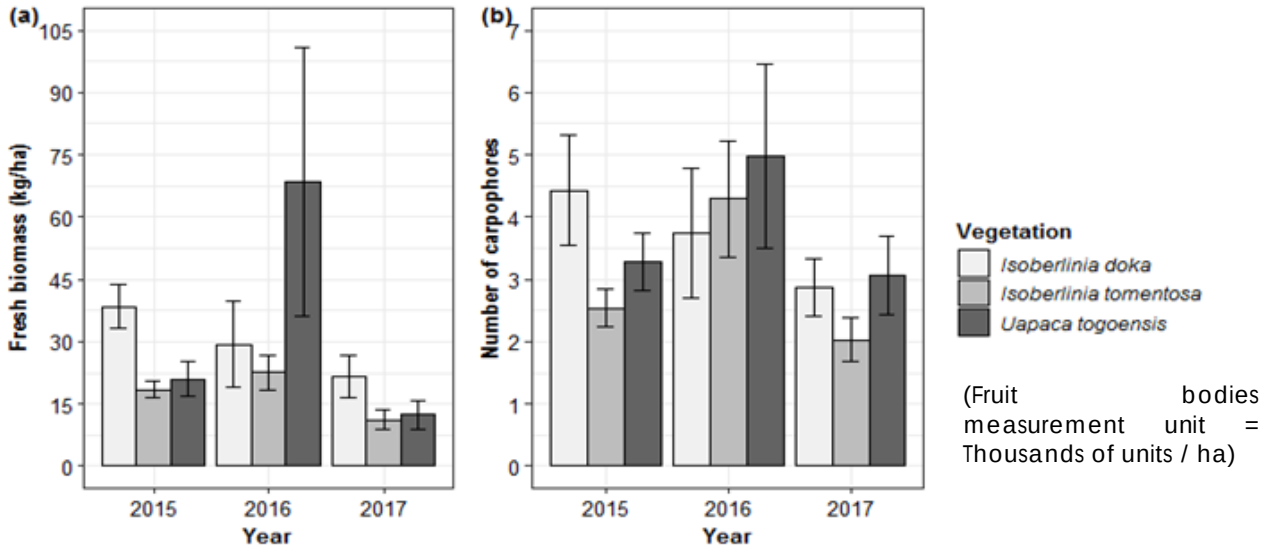
Table. 2: List of boletes collected from 2015 to 2017

Vouchers	**Species name**	**Sequence access numbers**				**References**
		atp6	tef1	rpb2	*LSU*	
BADOU 258	*Boletus sp1*	-	-	-	-	
BADOU 248	*Boletus sp2*	-	-	-	-	-
KIT 0295	*Boletus acidulus nom. prov.*		-	-	MK908838	This study
LAG-0101	*Boletus pseudolosii* nom. Prov.	-	-	-	MK908839	This study
HLA-0100	*Gyrodon sp A1*		-	-	MK908837	This study
HLA-0036	*Gyroporus viridoodorata* nom. prov.	-	-	-	-	-
HLA-0043	*Phlebopus sudanicus*	-				
HLA-0026	*Phylloporus tubipedes*	-				
FOG0504	*Porphyrellus sp*	-				
SAB0629	*Pulveroboletus sokponianus*	MH983001	MH983002	MH983003	-	Badou *et al.*, 2018
BADOU-0009	*Tylopilus sp*	-				
HLA-0100	*Xerocomus luteovelutipes* nom prov.		-	-	-	-
LAG 0101	*Xerocomus sp*	-	-	-	-	-
HDR 0029	*Xerocomus sp1*	-	-	-	-	-
LAG-0141	*Xerocomus subspinulosus*	-	-	-	-	-



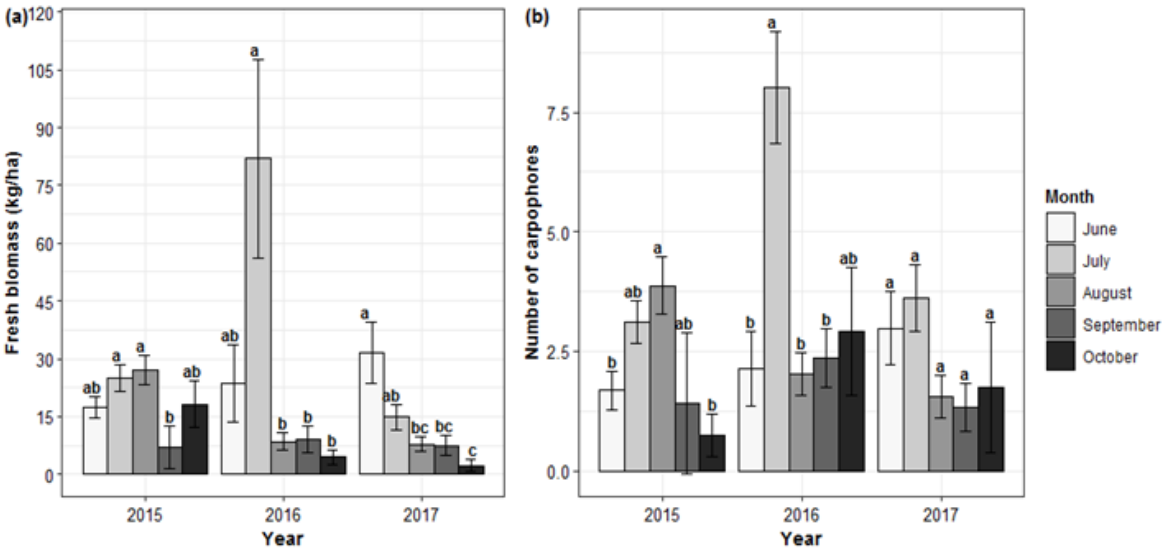
V1P1 = Plot *I. doka* Angaradebou
V1P2 = Plot *I. doka* Gando
V2P1 = Plot *I. tomentosa* Angaradebou
V2P2 = Plot *I. tomentosa* Gando
V3P1 = Plot *U. togoensis* Angaradebou
V3P2 = Plot *U. togoensis* Gando
V1P3 = Plot *I. doka* Sonnonmon
V2P3 = Plot *I. tomentosa* Sonnonmon
V3P3 = Plot *U. togoensis* Sonnonmon

Fig.2: Species richness according to the plots and the year (2015, 2016 and 2017)



(Fruit bodies measurement unit = Thousands of units / ha)

Fig.3. Mean of **(a)** the fresh biomass (Kg/ha) and **(b)** the number of fruit bodies for each vegetation per year of study



Number of fruit bodies measurement unit = Thousands of units / ha

Fig.4: Temporal variation of fresh biomass from one year to another. Letters (a and b) represent the results of multiple comparisons; the bars with the same letters do not differ significantly (α = 5%) and the opposite conclusion holds for different letters.

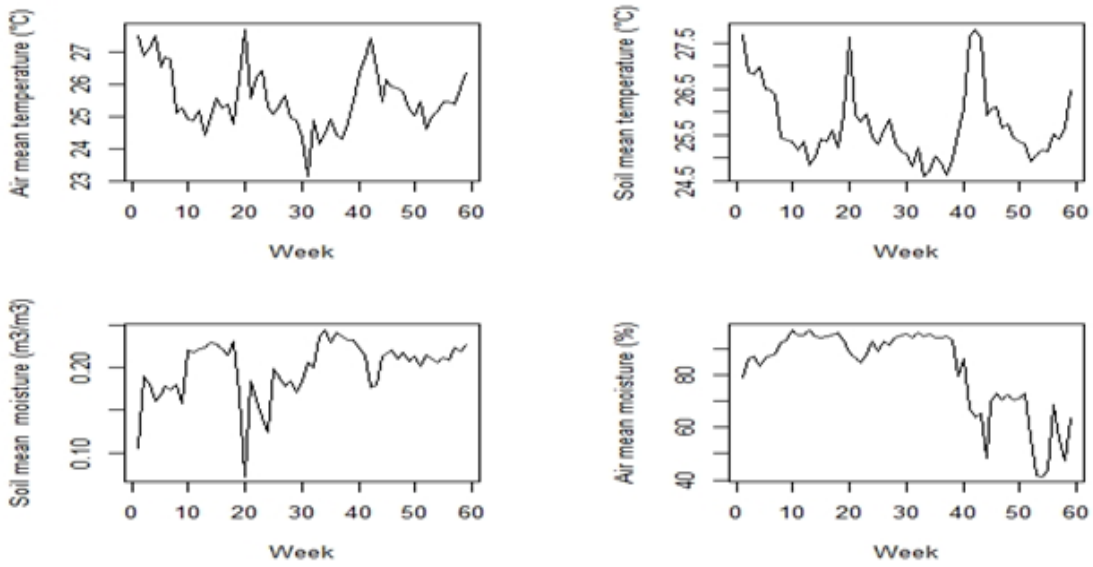


Fig. 5: Temporal variation of the weekly mean of the microclimatic parameters to 2015 to 2017.

From top to bottom, left to right: Gyroporus virido-odorata nom. prov., Xerocomus subspinulosus, Gyroporus virido-odorata nom. Prov, Xerocomus luteovelutipes nom prov., Pulveroboletus sokponianus, Boletus pseudolosii nom. prov., Phylloporus tubipedes, Porphyrellus sp

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