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Study of specific plant diversity in forest reserves and riparian areas in Benin

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Research Article

Keywords: Sacred forests, Occurrence data, CERF, GBIF, PIFSAP

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Data PAPER

Study of specific plant diversity in forest reserves and riparian areas in Benin

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Abstract

Background

Benin government is committed to the overall strategy for the sacred forests and protected areas conservation through their integration into the national system of protected areas. This is due to the value of biodiversity and the considerable ethno-cultural and religious importance of the forests and protected areas. The project titled “Project for the Integration of Sacred Forests into the System of Protected Areas of Benin (PIFSAP)” was initiated to preserve the biodiversity of the country by protecting and sustainably managing forest resources, biological and cultural heritage of local populations. Thus, all the sacred forests of Benin have been inventoried. The data were collected in 2013 and provided precise information on the sacred forests of Benin. The Center for Forestry Studies, Research and Training (CERF), a social, cultural and scientific institution, has made available the dataset on the species collected during PIFSAP project for publication on GBIF website. After cleaning and removing duplicates, this first dataset of 8,488 georeferenced plant species occurrences was published on GBIF website by GBIF Benin team. The most represented plant families within the dataset are Combretaceae, Sapotaceae and Fabaceae. This dataset will be used by scientists all over the world in various fields and therefore the results generated will inform decisions on biodiversity conservation and sustainable use in Benin and across Africa.

New information

The dataset published on GBIF website contains 8,488 occurrences of species collected in the forests and protected areas of Benin. After cleaning, the dataset was made accessible to the whole world via GBIF website: https://www.gbif.org/dataset/0740c09f-5cf6-48f0-8e94-abaa46f4b87b. This dataset is one of the largest databases published on “Centre d’Etudes et de Recherche sur les Forêts (CERF)” account and can be used for any purpose. The data collected are unique and provides information on species diversity found in the forest reserves of Benin.

Keywords: Sacred forests, Occurrence data, CERF, GBIF, PIFSAP

1. Introduction

Benin is home to a large number of sacred forests which are subject to conservation and distinguished from each other by specific functions: convents of deities, shelters for spirits, gardens of medicinal plants or cemeteries. Benin has about 2940 sacred forests covering an area of 18360 ha (Agbo and Sokpon, 1998). These forest ecosystems are reservoirs of terrestrial biodiversity, both plant and animal (FAO, 2020).

In Benin, forest biodiversity is important for households and exploited by populations in various fields: food, traditional medicine, energy and grazing (Koudokpon et al. 2018). Despite the lack of detailed information on the biological resources of the sacred forests, they contain many medicinal plants and endangered animal and plant species (DGFRN, 2014). In addition, there are other elements of biodiversity such as large trees considered as sacred and used for ceremonies and rituals (Kokou and Sokpon 2006).

However, Benin, like other countries around the world is experiencing a loss of biodiversity. On average, Benin loses fifty thousand hectares of forest per year (FAO, 2020). This is mainly due to the extension of agriculture, overgrazing and the anarchic exploitation of resources (Hadonou-Yovo et al. 2019; Anonymous 2020). Thus, the protection of sacred forests has proven to be an important tool for the sustainable conservation of biodiversity.

Given the importance of the sacred forests for local populations, it is important to define conservation strategies and sustainable use of these resources. This is precisely what the authorities in charge of biodiversity conservation in Benin understood by initiating the project named Project for the Integration of Sacred Forests into the System of Protected Areas of Benin (PIFSAP) carried out from 2011 to 2016 aiming at conserving the biodiversity present in Benin, in particular that existing in the sacred forests and reserves of Benin. Through this project co-financed by the Global Environment Facility (GEF), the beneficiary municipalities, the United Nations Development Program (UNDP) and the Government of Benin, inventories have been carried out in almost all the sacred forests of Benin. Several sacred forests have now become conservatories of biodiversity. This dataset published on the GBIF website constitutes part of the data collected during the project.

2. General description

- **Purpose**

Project for the Integration of Sacred Forests into the System of Protected Areas of Benin (PIFSAP) aims at improving the sustainable use of globally significant areas in and around the country by integrating them into the formal Protected Area (PA) system, strengthening legal and institutional protection and promoting community co-management of sacred forests. The project worked to reforest the degraded sacred forests in Benin. Thus, inventories have been done and the directory of sacred forests of Benin updated. This dataset collected and published later in GBIF website is very useful in guiding decision-making for the conservation and sustainable use of biodiversity in Benin.

3. Project description

3.1. Title

Project for the Integration of Sacred Forests into the System of Protected Areas of Benin (PIFSAP)

3.2. Personnel

This project was initiated by the Government of Benin in collaboration with UNDP and GEF.

The Global Environment Facility (GEF), established on the eve of the 1992 Rio Earth summit, is a catalyst for action on the environment. Through its strategic investments, the GEF works with partners to tackle the planet's biggest environmental issues.

The United Nations Development Program (UNDP) is a subsidiary body of the Economic and Social Council of the United Nations whose objective is to provide support to developing countries, but also to stimulate and organize the aid brought. Financing and coordination are at the heart of UNDP activities. Its action aims not only at eradicating poverty, but also at reducing inequalities and exclusion.

3.3. Study area description:

The data were collected in Benin, more precisely in the forests and reserves of the country.

Benin is located between 6 º 30' and 12 º 30' N and 1 º and 3 º 40' E (Neuenschwander and Toko, 2011). It is bordered to the North by Niger, to the East by Nigeria, to the West by Togo and to the North-West by Burkina-Faso. Benin covers a total area of 114763 km² with a 125 km long coastline and a straight-line distance of 700 km from the Atlantic to the Niger River in the North (Neuenschwander *et al.*, 2011).

In the south, monthly temperature averages vary between 26°C and 28°C (Neuenschwander *et al.*, 2011) while in the North, monthly maximum averages are above 35°C and can even reach 40 °C in Kandi (Neuenschwander and Toko, 2011). Rainfall is between 900 mm and 1400 mm per year. From South to North, the vegetation presents specific

characteristics to the following climatic formations: shrubby bush, wooded savannah, open forest and shrubby savannah (Azontondé, 1991).

Benin is experiencing strong demographic growth, going from 6769914 inhabitants in 2002 (INSAE, 2004) to an estimate of 9983884 inhabitants (INSAE, 2013) with an average rate of approximately 3.5% annual growth during the last decade (RNCBDB, 2014). Most of the population (70%) practices agriculture, fishing, fish farming, hunting, collecting medicinal plants, etc. (RNCBDB, 2014).

3.4. Design description:

The Study of specific plant diversity in forest reserves and riparian areas in Benin was performed with an integrated approach at both community and species levels. The standard methods of plant systematics and phytogeography were used.

The major stages of this project are documentary research, recruitment and training of field agents, field work, data processing and cartographic drafting. The documentary review was carried out with the projects and technical departments of the DGFRN, IGN and CERF. This made it possible to obtain the directory of sacred forests drawn up by Agbo and Sokpon in 1998, the occupation map of the study area and base maps of the municipalities. A training material has been developed and field agents have been trained on the use of GPS, the data collection method.

Once in the field, the field agents go to the local authorities. They show them to the dignitaries or guarantors of the sacred forests. These dignitaries bring the agents to the sites where they take information such as the geographical coordinates, the characteristic species, the estimate of the surface. Other information is also noted: associated references, basis of record, geographic locality, collection date, collector and person who identified the specimen (identified by). All this information is important for preparing the dataset for publication on the GBIF website.

3.5. Funding

The Project for the Integration of Sacred Forests into the System of Protected Areas of Benin (PIFSAP) was co-financed by the Global Environment Facility (GEF), the United Nations Development Program (UNDP), the Government of Benin and the beneficiary municipalities.

4. Sampling methods

4.1. Study extent

This study was carried out in Benin. More specifically, almost all the sacred forests of Benin have been surveyed and inventoried. This dataset published on the GBIF website constitutes part of the data collected within the framework of the PIFSAP project. The species have been collected in all the forests located on all the department of Benin.

4.2. Sampling description

An inventory of species in the sacred forests and reserves of Benin was carried out. The occurrences of the species have been systematically collected. A sheet has been designed for this purpose and important information have been recorded (scientific name; day, month and year of collection; geographical coordinates; description of the locality and others information deemed important). The field equipment used during the inventories consists of: GPS receivers (Global Positioning System) for geo-referencing (longitude and latitude were taken), compass to take the direction of walk and orient oneself, digital cameras for the shooting.

4.3. Quality control

Herbariums of the species collected in the field were sent to the National Herbarium of Benin (HNB) for identification and validation of scientific names. The information noted on each species was entered into the spreadsheet (Excel sheet containing the standard fields for publishing data

on the GBIF website) in accordance with those set by the Darwin Core (DwC) Standard (Darwin Core Task Group, 2009). Finally, the dataset was cleaned and prepared for publication on the GBIF website.

Data cleaning is a process used to improve quality by correcting detected errors and omissions in order to make them fit for use. The data collected were therefore cleaned according to the following steps: define and determine the types of errors; search for and identify occurrences of errors; correct the errors; documenting error cases and typical errors and modifying the data entry process to reduce future errors. Thus, various errors were corrected at the level of the essential attributes on the primary data collected from the biodiversity of Benin: taxonomic, spatial and temporal errors.

4.4. Step description

The information collected from the inventory of species in the sacred forests and reserves of Benin made it possible to properly complete the spreadsheet. The spreadsheet contains Darwin Core fields (Wieczorek *et al.*, 2012) and includes the following: «eventID», «occurrenceID», «institutionID», «basisOfRecord», «eventDate», «year», «month», «day», «kingdom», «phylum», «class», «family», «genus», «subgenus», «specificEpithet», «infraspecificEpithet», «scientificName», «scientificNameAuthorship», «taxonRank», «continent», «waterBody», «countryCode», «country», «strateProvince», «locality», «decimalLatitude», «decimalLongitude», «coordinatePrecision», «geodeticDatum», «minimumElevationInMeters», « maximumElevationInMeters», «minimumDepthInMeters», «maximumDepthInMeters», «habitat», «fieldNumber», «individualCount», «organismQuantityType», «occurrenceStatus », « fieldNumber», «samplingProtocol», «eventRemarks», «recordedBy».

Taxonomic, temporal and spatial data (Ganglo *et al.*, 2017) have been corrected. For taxonomic errors, Catalog of life and Taxonomic Name Resolution Service (TRNS) (Boyle *et al.*, 2013) was used. This online database is very useful to correct spelling errors (badly written name), format errors

(binomial nomenclature) and to replace the names given in synonymy with those accepted. Regarding errors related to spatial data, geographical coordinates (longitude and latitude) were projected on QGIS Desktop software version 2.18.4 (Sutton and Dassau, 2015) and those outside of the study area (outlier) were deleted (Ganglo *et al.*, 2017). Coordinates outside of the desired range as well as coordinates at 0.00 have been removed. *Geolocate* and *Eathexplorer* were used to find geographical coordinates from administrative subdivisions or from the description of the place of collection. Occurrences with no collection location information were removed. In addition, *Canadensys coordinates conversion and species link* were used to convert geographical coordinates (Longitude and latitude) into decimal degrees, an appropriate format for publishing data on the GBIF website. In terms of temporal errors, no consistence dates such as 13-13-2050 (errors made during entry) have been corrected from the field *evenDate*. Feedback was therefore given to the data provider to this effect. Moreover, the field *evenDate* have been formatted under the standard accepted for publication on GBIF website: *Year, month and day*.

Finally, the duplicates occurrences have been removed by considering the fields *scientifcName, decimalLatitude* and *decimalLongitude* (fields relating to essential attributes of primary biodiversity data in order to have unique occurrence).

5. Geographic coverage

5.1. Description

The data collected during this study covers all the departments of Benin. More specifically, the country's forests and reserves were covered. The table 1 shows the departments in which the classified forests and reserves are located as well as the number of occurrences collected. The department with the highest number of occurrences collection is Borgou followed by Alibori.

Table1: Occurrences collected by department

Departments	Occurrences collected

Borgou	4265
Alibori	2300
Collines	992
Atacora	620
Donga	215
Plateau	56
Zou	38
Couffo	2
Atlantique	0
Littoral	0
Mono	0
Oueme	0
Total	**8488**

5.2. Coordinates

9.974 and 10.014 Latitude; 1.397 and 3.651 Longitude

6. Taxonomic coverage

All the species collected were identified at the National Herbarium of Benin (NHB) and all belong to the Tracheophyta phylum and the Magnoliopsida class. The dataset has a total of eight (8) families: Combretaceae (3689 occurrences), Sapotaceae (2060 occurrences), Fabaceae (1775 occurrences), Malvaceae (362 occurrences), Meliaceae (303 occurrences), Moraceae (118 occurrences), Rubiaceae (166 occurrences) and Arecaceae (15 occurrences). The Combretaceae family therefore has the most occurrences collected for this dataset, followed by the Sapotaceae family. In total, nineteen (19) genera have been listed from the dataset. The main genera with the largest number of occurrences collected are respectively *Vitellaria* (2060 occurrences), *Terminalia* (2044 occurrences) and *Anogeissus* (1645 occurrences). Knowing *Vitellaria* as the most represented genus in the dataset, the graph below informs us that the species *Vitellaria paradoxa* is the most abundant (24,27 % of the dataset).

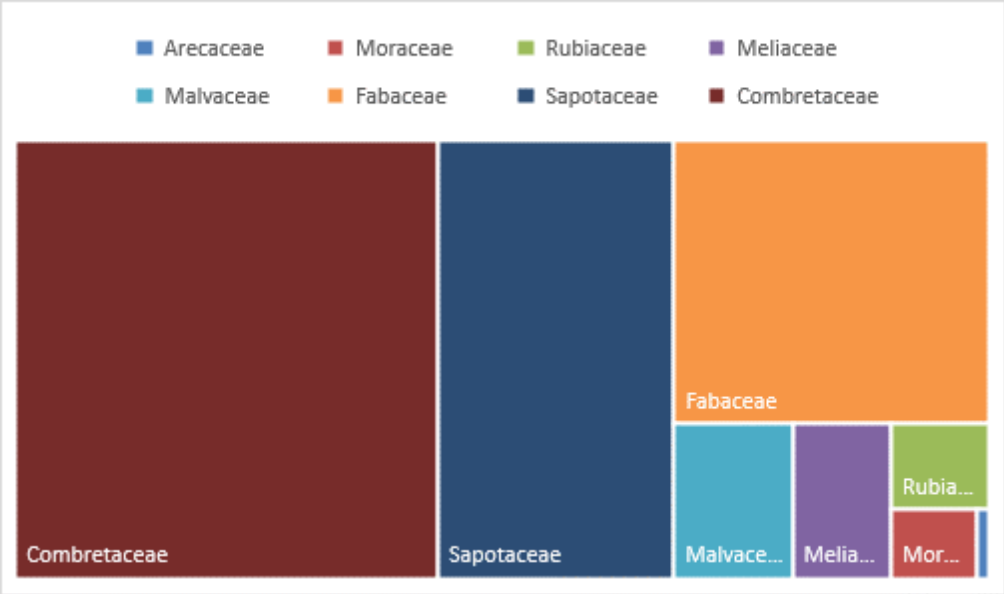

Figure 1: Record by family

7. Temporal coverage

7.1. Data range:

2013 01 01 – 2013 12 29

7.2. Notes

This dataset has been collected all the months of 2013 (Figure 1). The number of occurrences collected varies by month. We still observe a peak in the month of July followed by the month of August (Figure 2).

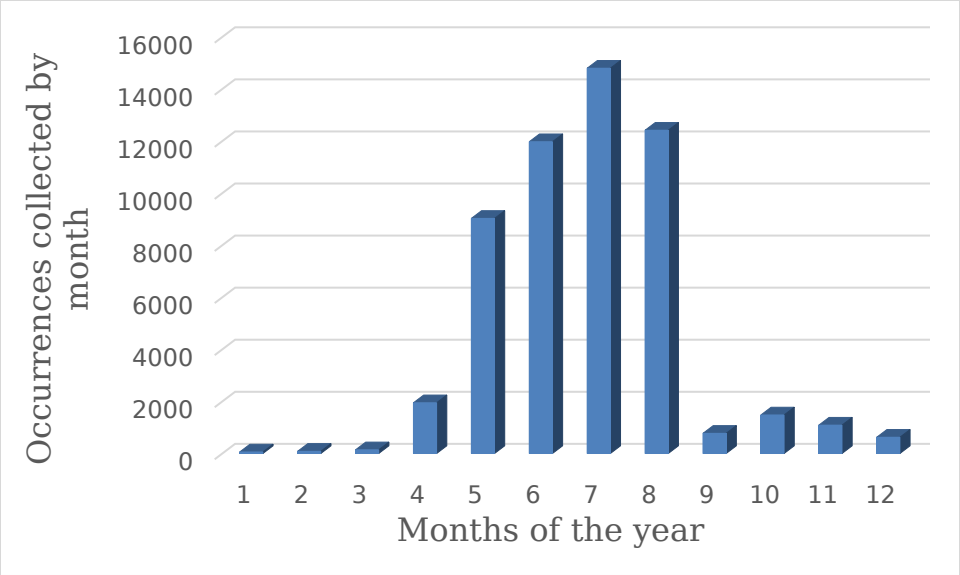

Figure 2: Histogram by month

8. Usage right

8.1. Use licence

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8.2. IP rights notes

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9. Data resources

9.1. Data package title

Study of specific plant diversity in forest reserves and riparian areas in Benin

9.2. Resource link

https://doi.org/10.15468/dl.9xgpx8

9.3. Number of data sets

1

9.4. Data set

Data format is DarwinCore

9.4.1 Number of columns

The number of columns is 30

9.4.2. Download URL

https://www.gbif.org/dataset/0740c09f-5cf6-48f0-8e94-abaa46f4b87b

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Figures

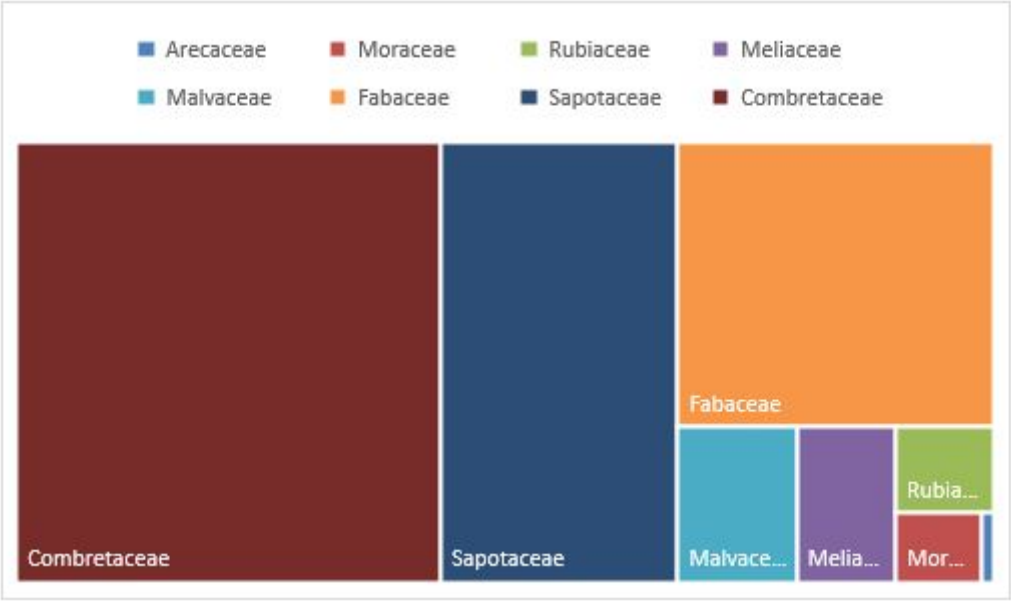

Figure 1

Record by family

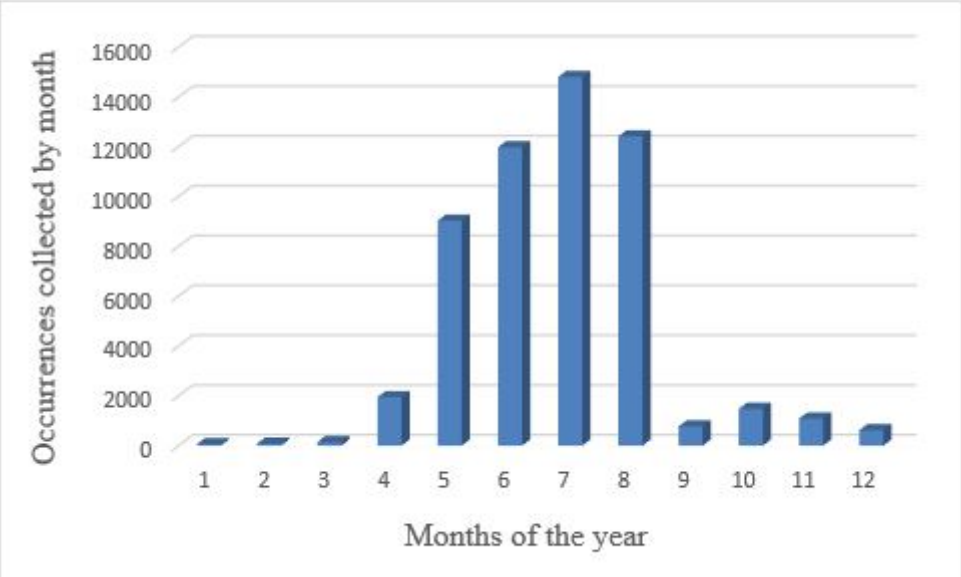

Figure 2

Histogram by month