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Hygrophytes and Wetland Angiospermic Macrophyte in Gallery Forest of Amurum Forest Reserve, Jos, Plateau State, Nigeria

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Abstract A preliminary study on the hygrophytic composition in the Amurum Forest Reserve, Laminga Jos was undertaken in September to December 2015 using seven (7) different sampling sites. A total number of 57 species belonging to 38 families were recorded as the hygrophytes from the river flowing through Amurum Forest. The division Angiosperms occurred most with 35 species (25 families), followed by Pteridophyta with 19 species (11 families) while Bryophyta had 3 species (3 families). The Hygrophytes occurred in considerable number in all the sampling sites. This report serves as a foot print to the knowledge of hygrophytes' diversity of Amurum Forest Reserve and also serves as a contribution of biodiversity of the region and country at large.

Keywords: *Hygrophytes, Amurum Forest, riparian, biodiversity*

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1. Introduction

In situ preservation through the establishment of a natural reserve as a biodiversity conservation apparatus has shown to be one of the most effective and least expensive means to protect biodiversity [8]. Protected areas, such as Amurum Forest Reserve, often provide habitat and protection for threatened and endangered species in addition to maintaining ecological processes [13].

Although many researches have been carried out in Amurum Forest Reserve, very little information exist on the aquatic and wet land vegetation of the area. Some of the reports related to vegetation in Amurum Forest Reserve includes: [11] on species diversity and abundance of Fig Wasps in *Ficus umbellata* and *Ficus exasperata*, [1] on the important of Figs in conservation efforts, [2] on earthworms, soil nutrients and plant diversity, [4] on factors determining the abundance of *Lantana camara*, [10] on the phyto-diversity of three habitat types in Amurum Forest, [12]on the use of fig *Ficus* species by birds and [14] on assessment of *Ficus* diversity. Nevertheless, Amurum Forest Reserves also harbors many types of aquatic plants and semi aquatics (hygrophytes) that are distributed in the rivers that supports the riparian forest. From the plant biodiversity point of view, the hygrophyte vegetation of Amurum forest still remains unexplored. Studies on the hygrophytes will not only contribute to the knowledge on the biodiversity but will provide the baseline data that will also serve as reference point for monitoring changes. As such, the aim of this study was to present a checklist of hygrophytes and other plant species of the river that sustains the gallery forest. Conservation in marshes and freshwater bodies include the keeping, in so much as possible, of the natural environment in its original conditions including aquatic plants and their respective associated population.

Thus, the present study was undertaken with the objectives to collect and identify the hygrophytes and lowland plants species associated with the gallery Forest in the reserve.

2. Materials and Methods

2. 1. Study Area

The study was carried out in Amurum Forest Reserve, a protected forest reserve covering an area of about 120 hectares. It is located in Laminga Village, 15km northeast of Jos- east on the Jos Plateau in north central Nigeria, at latitude 09° 53N longitude 08° 59E, and at an altitude of 1280m above sea level [25]. It has a mean temperature of 8 to 38°c, and mean annual rainfall of 1411mm [22]. The site holds some of the best remnants of natural vegetation typical to the Jos plateau.

The habitat at the site comprises of gallery forest, savannah wood land and rocky outcrops that differ remarkably in floristic compositions [24]. The savanna woodland is dominated by non-timber forest product species (NTFPS) such as *Khaya senegalensis*, *Daniella oliveri*, *Pakia biglobosa*, *Lophira lanceolata*, *Ficus* spp [16]. It is a key biodiversity hotspot in West Africa and it is recognized internationally as an Important Bird Area (IBA) with at least 278 bird species [15].

Table 1. Description of sampling sites in River Bank in Gallery Forest

Site	Latitude	Longitude	Elevation(m)
1	9.877097	8.979053	1307
2	9.876119	8.977589	1313
3	9.876086	8.97575	1299
4	9.876955	8.973439	1339
5	9.875211	8.9800229	1323
6	9.874267	8.97844	1322
7	9.873344	8.977885	1321

2.2. Methodology

Sampling sites were chosen in August –September for preparing a checklist of hygrophytes. The actual survey is done by Kohler's section mapping method [21] by splitting the length of the watercourse into seven sections. The borders of sections are defined by the changes in the ecological attributes determining the spreading of the macrophytes, so each section can be considered a homogenous habitat. The stratified design incorporated upstream, mid water and downstream sites to provide a representative profile of the ecological attributes that determines the spread of the hygrophyte and to ensure that all plant species were accounted. The position of all sampling sites was recorded with a hand-held GPS unit (Garmin eTrex 64) and documented by using digital photography for later reconstruction as part of any future survey (Figure 1).

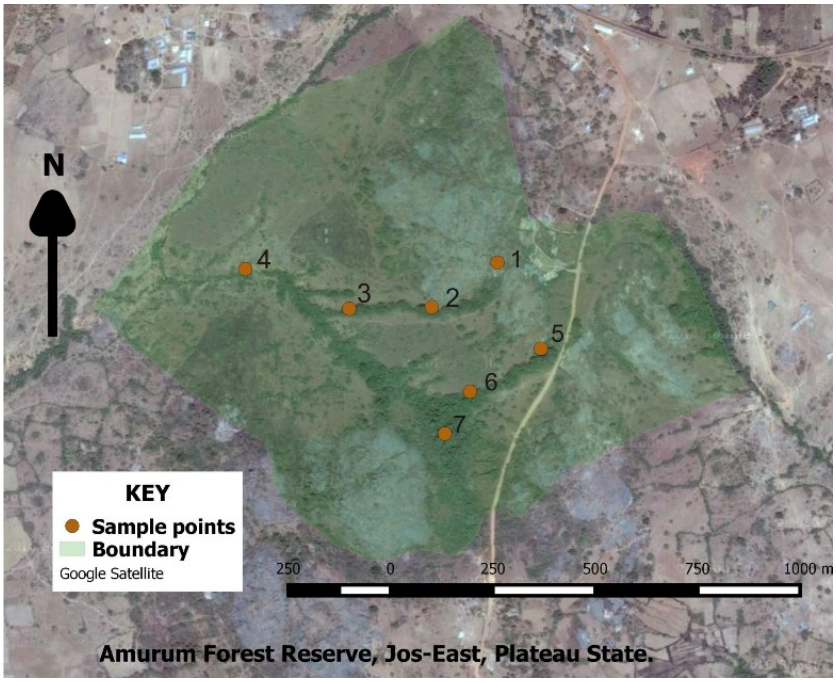


Figure 1. Study area showing sampling sites at Amurum Forest Reserve, Laminga. Plateau State

Collection and analysis of hygrophytes was done in each site by wading or walking along the stream bank while sampling consisted of 1m x 1m quadrats placed at each of the seven selected sites along the river course. Species that were not identified in the field, a representative sample was collected for later identification. A rapid 'sweep up' to record additional species present in the rest of the river course was carried out after the selected plots have been surveyed, so that a comprehensive species list can be compiled for the whole site. The identification of aquatic plants was done with the help of standard books and monographs like [5,6,7,9,18,20]; among others). Correct nomenclature of the plants were established with the help of latest floras, monographs of British Pteridological Society [17] and [23].

Data analysis was designed to determine species composition and relative frequency of occurrence of recorded species.

3. Results and Discussion

A total number of 57 species belonging to 48 genera and 38 families were reported from the present study. The division Angiosperm occurred most with 34 species (25 families), followed by pteridophyte with 20 species (11 families), while bryophyte had 3 species (3 families). The number of hygrophyte species in the site was quite low because of arid conditions with long dry season.

The wide range distribution of *Selaginella, Cheilanthes, Lycopodium, Lantana camara and Biophytum sensitivum* is because of their ability to adapt to a wide range of environmental conditions. A number of species of *Selaginella* are known for their survival in extremely xeric conditions where they cling to the sides of slopes and along the edges of outcrops. One species, *Selaginella lepidophylla*, is so tolerant of drying out that it has been dubbed the "resurrection plant", for it can recover from several months of complete dryness. This is uncommon among vascular plants. Many tropical lycophytes experience xeric conditions as well.

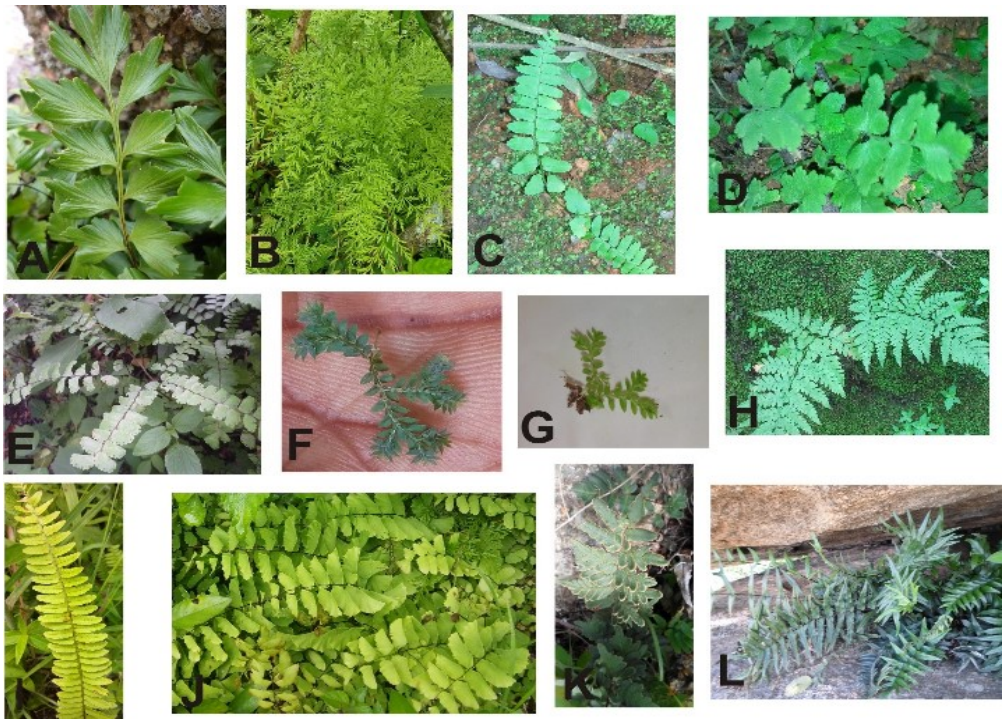
Pteridaceae was the most species-rich family with six species followed by Asteraceae and Euphorbiaceae with four species each, while Aspleniaceae, Polypodiaceae and Rubuaceae had three species each. Nonetheless, most families were represented by only one species. The dominance of pteridaceae in Amurum Forest Reserve may be due to its reproduction by spores which are easily dispersed by wind to different sites.

Table 2. List of plants identified and their respective families in the gallery forest of Amurum Forest Reserve

Names of macrophyte plant species	Family	Frequency (%)
Bryophyte		
***Aulacomnium androgynum* (Hedw.)**	Aulacomniaceae	14.29
***Lunularia cruciata* (L.) Dumort**	Lunulariaceae	42.86
***Porella platyphylla* (L.)**	Porellaceae	14.29
Pteridophyte		
***Adiantum capillus veneris* L.**	Pteridaceae	42.86
***Adiantum raddianum* C. presl**	Pteridaceae	42.86
***Asplenium aethiopicum* (Burm. F.) Bech**	Aspleniaceae	14.29
Asplenium bulbiferum G. Forst	Aspleniaceae	42.86
***Asplenium* sp.**	Aspleniaceae	42.86
***Bommeria hispida* (Mett.ex kuhn) underw.**	Pteridaceae	42.86
***Cheilanthes farinose* (Forsk.) Kaulf.**	Pteridaceae	14.29
***Cheilanthes formosana* Hayata**	Pteridaceae	57.14
***Cyathea australis* (R.Br.) domin**	Cyatheacea	14.29
***Dryopteris affinis* (Lowe.) fraser-Jenk.**	Dryopteridaceae	28.57
***Egeria densa* (Planch.) vict**	Hydrocharitaceae	14.29
***Hydrilla verticillata* (L.) F. Royle**	Hydrocharitaceae	28.57
***Hygrophila africana* (T. Anderson) Heine**	Acanthaceae	28.57
***Lycopodium clavatum* L.**	Lycopodiaceae	57.14
***Nephrolepis exaltata* (L.) Schott**	Lomariopsidaceae	28.57
***Pollinia distachya* (L.) Spreng**	Polypodiaceae	14.29
***Polygonum cambricum* L.**	Polypodiaceae	14.29
***Pteridium aquilinum* (L.) Kuhn**	Dennstaedtiaceae	42.86
***Selaginella caudate* (Desv.) Spring**	Selaginellaceae	28.57
***Selaginella* sp**	Selaginellaceae	85.71
Angiosperm		
Acacia ataxacantha DC.	Mimosoideae	14.29
***Agrocharis melanantha* Hochist**	Apiaceae	14.29
***Albizia zygia* (DC.) JF macbride**	Mimosoideae	14.29
***Aspilia africana* (Pers.) C.D. Adams**	Asteraceae	14.29
Bidens pilosa L.	Asteraceae	42.86
***Biophytum sensitivum* (L.) DC.**	Oxalidaceae	57.14
***Chamaesyce hirta* L.**	Euphorbiaceae	14.29
***Cissus* sp**	Vitaceae	14.29
***Commelina diffusa* Burm F.**	Commelinaceae	14.29
***Costus spectabilis* (Fenzi) schumann**	Costaceae	14.29
***Dichrostachys cinerea* Wight et Arn**	Mimosoideae	14.29
***Dioscorea* sp**	Dioscoreaeceae	14.29
***Diospyros* sp**	Ebenaceae	42.86
***Dissotis* sp**	Melastomatacea	42.86
***Emilia fosbergii* Nicolson**	Asteraceae	14.29
***Euphorbia sp1* (purple flower)**	Euphorbiaceae	14.29
***Euphorbia Kamerunica* Pax**	Euphorbiaceae	28.57
***Euphorbia* sp2**	Euphorbiaceae	28.57
***Ficus cordata* Thunb**	Moraceae	14.29
***Ipomoea involucrata* L.**	Convolvulaceae	14.29
***Jasminum dichotomum* Vahl.**	Oleaceae	14.29
***Lantana camara* L.**	Verbenaceae	57.14
***Macrosphyra longistyla* (DC.) Hiern**	Rubiaceae	14.29
***Manilkara multinervis* (Bak.) Dubard**	Sapotaceae	28.57
***Maranthes corymbosa* Blume.**	Chrysobalanaceae	14.29
***Nabalus albus* (L.) Hook**	Asteraceae	14.29
***Pachystela pobeguiniana* Pierre ex Lecomte**	Sapotaceae	14.29
***Paullinia pinnata* L.**	Sapindaceae	14.29
***Psychotria psychotrioides* (DC.) Roberty**	Rubiaceae	14.29
***Psychotria* sp**	Rubiaceae	14.29
***Saba comorensis* (Boj. ex. DC.) Pichon**	Apocynaceae	14.29
***Santaloides afzelii* (R.Br.) Schellen B.**	Connacraceae	28.57
***Setaria barbata* (Lam.) Kunth**	Poaceae	14.29
***Solenostemon monostachyus* (P. Beau V.) Briq**	Lamiaceae	28.57

Upstream stations showed weeds like *Commelina*, *Cissus*, *Euphorbia*, *Jasminum* and *Agrocharis* as plants commonly growing at the river bank that is more exposed. The upstream station also showed plant like *Aulacomium androgynum* which are mosses. This agrees with [19] and [3], who reported that mosses are more typical for upstream reaches of rivers with higher flow velocity. It may also be as a result of their resistance to desiccation. This agrees with [2224], who reported that mosses can lose water in the dry season, become dormant and imbibe water or spring back to life when it rains.

In the Midstream sites where the river is most shaded, these plants were replaced by slow growing amphibious species of the hydrophytes such as *Hygrophila*, and *Egeria densa*, while Midstream and downstream also showed plants like *Porella* and *Lunularia* which are true hygrophytes and so are characteristic of such a microclimate.



A. *Asplenium aethiopicum* (Burm. F.) Bech **B.** *Asplenium bulbiferum G. Forst* **C.** *Nephrolepis cordifolia* **D.** *Cheilanthes farinose* (forsk.) Kaulf. **E.** *Adiantum capillus veneris* (L.) **F.** *Selaginella caudate* (Desv.) spring **G.** *Selaginella Sp.* **H.** *Dryopteris affinis* (Lowe.) fraser-Jenk.**I.** *Nephrolepis exaltata* (L.) Schott **J.** *Adiantum capillus* (L.) **K.** *Bommeria hispida* (Mett.ex kuhn) underw.**L.** *Cheilanthes formosana* Hayata.

M. *Hydrilla verticillata* (L.F) Royle **N.** *Egeria densa* (planch.) Vict **O.** *Lunularia & Aulacomnium* (L.) Dumort **P.** *Aulacomnium androgynum* (Hedw.) **Q.** *Aulacomnium androgynum* (Hedw.) **R.** *Hygrophila africana (*T. Anderson) Heine **S.** *Lunularia cruciata* (L.) Dumort.

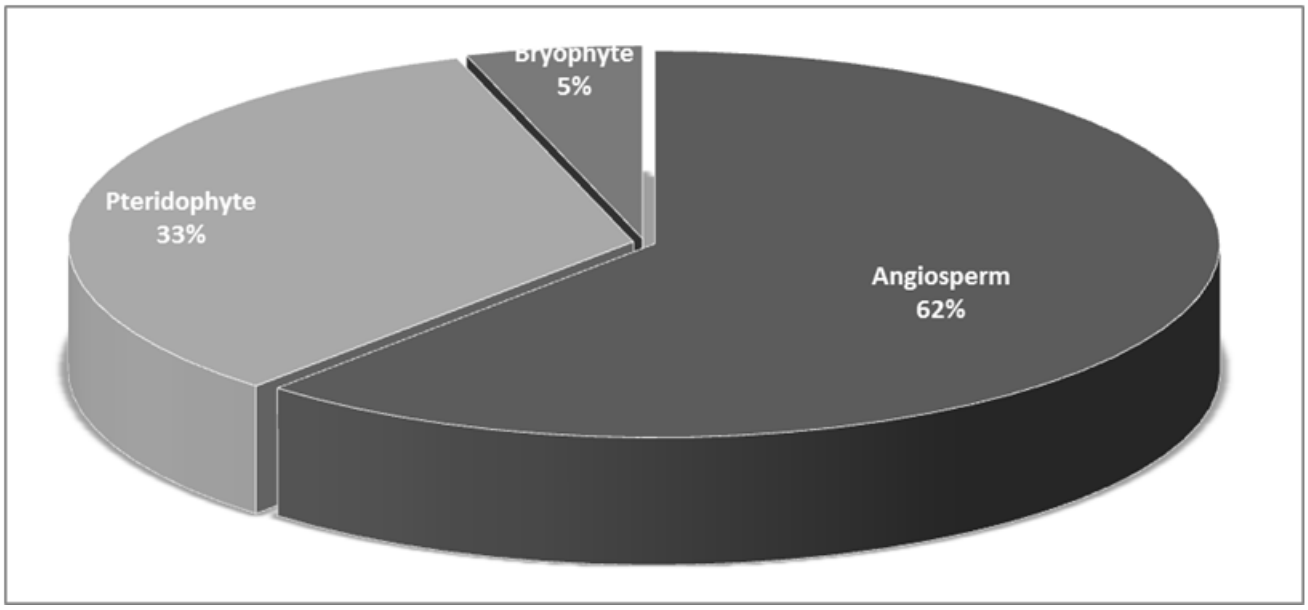


Figure 2. Number of species Identified for Different division at the sampling site in the Gallery Forest of Amurum Forest Reserve

4. Conclusion

Numerical analysis of the species distribution revealed out of the 57 species recorded, 35 species belong to Angiosperms (25 families), 19 species to Pteridophyta (11 families) and 3 species to Bryophyta (3 families). This report serves as a contribution to the knowledge of hygrophytes' diversity of Amurum Forest Reserve. This Study has provided a checklist of hygrophytes and other plant species of the river that sustains the gallery forest. As such, it also serves as a contribution of biodiversity of the region and country at large. The baseline data that will also serve as reference point for future research and other conservation efforts. Therefore, considering the importance of hygrophytes and wetland plants, measures should be taken for proper maintenance and conservation of riparian habitats as well as its plant wealth.

5. Recommendation

Whereas, the section mapping method by Kohler is cost effectiveness and its possibilities for evaluation and determining the basic state of watercourses are suitable, a more detailed study is recommended. Future efforts towards broadening and repetition of previous unit mapping surveys over seasons will contribute to better body of knowledge about indicating relations between species and changes in their environment. This will also highlights the connections between vegetation changes and environmental parameters in the areas as well.

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