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# USING HERBARIUM RECORDS AND IUCN RED LIST TO UNRAVEL THE EXTINCTION RISK PATTERN IN GENUS *GARCINIA* L. IN NIGERIA

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## ABSTRACT
Trees of economic importance are many times vulnerable to extinction due to factors such as anthropogenic pressure, ethnobotanical uses, urbanization, climate change and spread of invasive species. Species in genus *Garcinia* are well known for their ecological and economic importance. In this study, herbarium records from the Forest Research Institute of Nigeria (FRIN) national herbarium were searched to determine the distribution of species of Genus *Garcinia* in Nigeria. The herbarium spreadsheet also contains information regarding their habitat type. These records were used in generating species distribution map and analyzing the habitat type. The IUCN (International Union of Conservation of Nature) Red List web platform was used to determine the conservation status and threats to species of *Garcinia* found in Nigeria. This study revealed that *Garcinia* is highly distributed in Cross River state in Nigeria than other parts of the country. The findings also showed that *Garcinia* is a threatened genus in Nigeria. This implies that many species in this genus needs conservation interventions so that their local extirpations can be prevented hence reducing the extinction risk of the whole genus. Habitat destruction was the main threat to *Garcinia* species in Nigeria as identified in this study. Some species of *Garcinia* have not been evaluated for conservation purpose. The lack of conservation assessments for species of *Garcinia* in Nigeria creates a gap in projecting the risk of extinction of these species in Nigeria in future. This study concludes that *Garcinia* might be at the verge of complete extinction if there are no conservation interventions for the species. It is recommended that species of *Garcinia* in Nigeria be regenerated to prevent their extirpation and also a recent local population assessment of all the species in this genus should be encouraged.

**Keywords:** Biodiversity, biogeography, conservation, ecosystem ecology, taxonomy

## INTRODUCTION
Biological conservation is a global concern in every part of the world (Barnosky *et al.*, 2011; Pacifici *et al.*, 2015). The rate at which species are disappearing from the earth has generated interest in many ways of determining how these extinction patterns are taking place and this has created necessity in designing different unique methods for controlling these trends in extinction risk in relation to peculiarities of the causes of extinction (Chrystal *et al.*, 2015). With factors such as explosive human population growth, increase in reliance on biological resources, expansion in urbanization and climate change, this trend of species extinction might keep going on the increase in a trend that has not been witnessed before (Sala *et al.*, 2000; Mukwevho, 2014). There is a need for designing conservation interventions along taxonomic rankings within geographical context to address the problem of global biodiversity loss(Visconti *et al.*, 2016).
Identifying hotspots of threatened species is one major step in their conservation, protection and sustainability (Moran and Kanemoto, 2017). These hotspots translated into spatial maps can serve as a guide in making sound conservation policies and also assist in conducting other studies like population quantifications of the rest of individuals that have not been wiped out (Thiault *et al.*, 2018). The use of herbarium records in achieving spatial analysis of threatened species has been proven to be effective in the quest to determine threatened species hotspots (Albani *et al.*, 2021).
The genus Garcinia belongs to the family Clusiaceae and contains about 300 species (Kumar et al., 2013). They are trees of ecological and economic importance. They are source of medicine, food and their trunk are used for timber production (Baruah *et al.*, 2021). Some species of this genus produce edible fruits, and some have phytocompounds that have antimicrobial potentials (Kumar *et al.*, 2013). Despite the large numbers of species in this genus studies have revealed that only few of them are found in West Africa including Nigeria (Ajayi *et al.*, 2011). The justification of this study is to unravel the pattern of extinction risk in genus *Garcinia* because many of the species in this genus are heavily exploited for several ecosystem services. It is therefore of great importance to determine the pattern of extinction risk in this genus in Nigeria from biogeographical perspective. The main aim and objectives of this study is to determine the species of *Garcinia* represented in Nigeria using the herbarium spreadsheet, to construct a biogeographical distribution

for *Garcinia* species in Nigeria using the herbarium records and to make conservation interpretations based on the results of this study which can serve as a guide for current and updated population surveys in areas of natural distributions of this genus as revealed in this study.

## MATERIALS AND METHODS

A thorough herbarium search was conducted at the national herbarium of the Forest Research Institute of Nigeria (FRIN) in Ibadan, Oyo State Nigeria. The records of genus *Garcinia* in Nigeria were obtained from this herbarium. We documented all the records of genus *Garcinia* in Nigeria with the assistance of herbarium specialist in FRIN. The records of the habitat type were extracted along with the occurrence data in the herbarium. Records from the Forest Research Institute of Nigeria herbarium were examined to determine the natural distribution and habitat type of genus *Garcinia* in Nigeria. A geographical distribution map was constructed based on the herbarium records to show areas of natural distribution of genus *Garcinia* in Nigeria. Chart showing the habitat types of genus *Garcinia* was constructed to show prominent habitat types of this species in Nigeria. Using the IUCN Red List, the conservation status and threats of each species of *Garcinia* that was discovered in the herbarium were extrapolated from the IUCN web page and presented in a tabular form.

## RESULTS AND DISCUSSION

The herbarium search revealed that only 7 species of *Garcinia* are represented in Nigeria. The results of this study revealed that species of *Garcinia* are more in the Southern region of Nigeria, with many distributions of the species found in the Cross-river state (Figure 1). This depicts that the species thrives close to the riverine areas (Figure 1). The few occurrences in the middle belt region with lesser rainfall and water availability might be as a result of adaptation of these species. Except for *Garcinia polyantha* Oliv. and *Garcinia afzelii* Engl. that are prominent in the grassland savanna, all other species seems to occur better in the high forest where there is high rainfall and water availability (Figure 2). The result on the IUCN Red List revealed that two species of *Garcinia* in Nigeria (*Garcinia afzelii* Engl. and *Garcinia brevipedicellata* (Baker F.) Hutch & Dalziel) are threatened, two species of *Garcinia* (*Garcinia gnetiodes* Hutch. & Dalziel and *Garcinia polyantha* Oliv.) have not been evaluated by IUCN Red List (Table 1). Two species of *Garcinia* (*Garcinia punctata* Oliv.and *Garcinia tinctonia*(Choisy) W.Wight) are not threatened because their status is least concern, but the IUCN Red List still revealed that one of them (*Garcinia tinctonia*) is facing threat due to deforestation and habitat destruction (Table 1). With all this evidences this study concludes that genus *Garcinia* is a threatened genus in Nigeria.

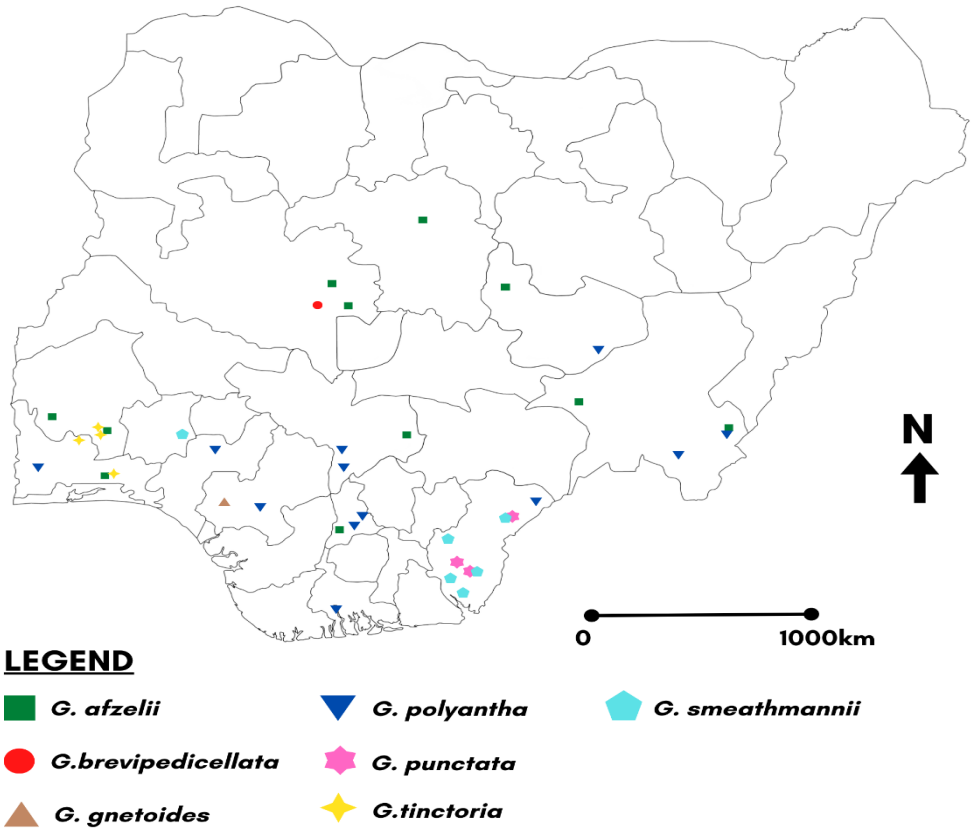


**Figure 1: Biogeographical distribution of species of *Garcinia* in Nigeria based on their herbarium records**

**Table 1: List of *Garcinia* species in FRIN herbarium records, their conservation status and the threats they are facing**

| S/N | Species | IUCN Red List | Threat |
|---|---|---|---|
| 1 | *Garcinia afzelii* Engl. | Vulnerable | Harvest for human uses |
| 2 | *Garcinia polyantha* Oliv. | NE | |
| 3 | *Garcinia smeathmannii* (Planch. & Triana) Oliv. | LC | No threat |
| 4 | *Garcinia brevipedicellata* (Baker F.) Hutch. & Dalziel | Vulnerable | Deforestation |
| 5 | *Garcinia punctata* Oliv. | LC | No threat |
| 6 | *Garcinia gnetoides* Hutch. & Dalziel | NE | |
| 7 | *Garcinia tinctonia* (Choisy) W. Wight | LC | Deforestation, habitat destruction |

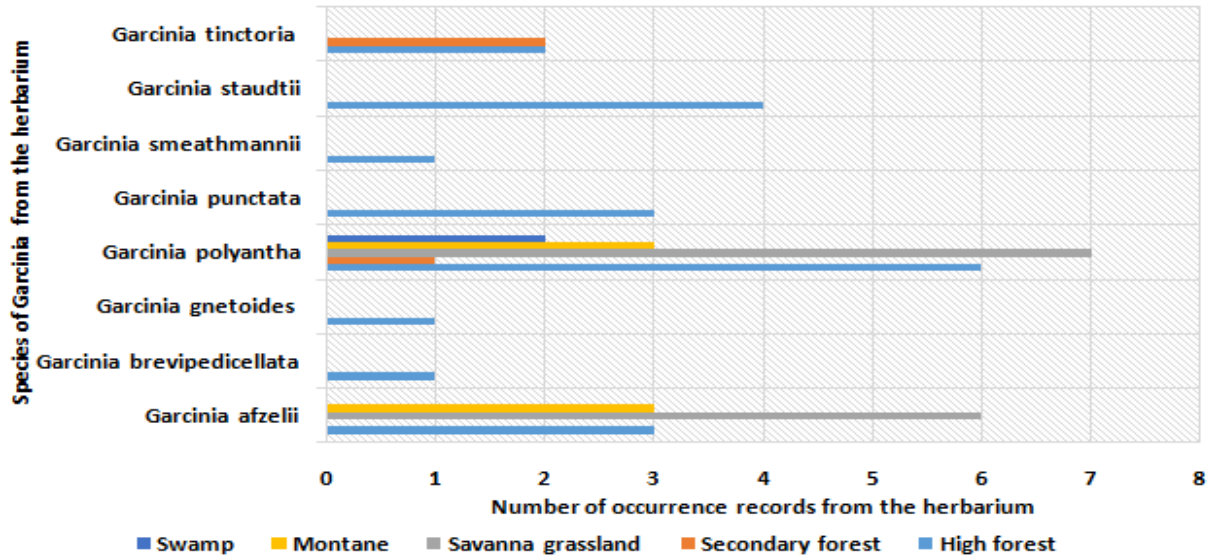


**Figure 2: Occurrence of species of *Garcinia* in different habitat types**

Human anthropogenic activities is one major ecological force still driving plant extinction risk, and crave of plant resources to satisfy human needs has made many tree taxa in the wild highly vulnerable to extinction (Jimoh *et al.*, 2012; Gagneux, 2021). The forest ecosystems have been degraded by intense utilization of forest resources especially trees and this will keep declining ecosystem services and promoting loss of genetic diversity (Beech *et al.*, 2017). This study revealed that *Garcinia* species which are heavily exploited for several uses have been listed as a threatened genus in Nigeria (Table 1). Since this species are well represented in the high forest in Nigeria (Figure 2), the current heavy forest degradation might keep affecting this species and might wipe out this genus in decades to come. The IUCN Red List also identified deforestation as the main threat to species in this genus (Table 1). The individuals of this species might have been taken out for several human uses from the forest ecosystem indiscriminately and this will keep increasing the population decline of this species.

Habitat destruction of tree taxa due to agricultural activities, urbanization and exploitation of tree species for timber and wood production are factors that has been detected to be threat to global tree taxa (Shaltout and Bedair, 2022). Habitat destruction was identified in this study as threat to *Garcinia* species in Nigeria (Table 1). Recent evidence on how this factor might currently affects the populations of these threatened species in Nigeria is extremely important and this can be revealed in current population ecology of these species. Controlling factors such as habitat destruction demands that the distribution of these species be well understood. This makes the biogeographical map constructed in this study extremely important to identify hotspots of Garcinia species that needs conservation interventions to reduce habitat destruction (Figure 1).

Ethnobotanical uses of *Garcinia* in Nigeria is a contributing factor in decline of its population and increase in its risk of extinction (Baruah *et al.*, 2021). The uses of species of *Garcinia* which includes source of food, medicine and also a symbol of culture in African ceremonies will promote continuous harvest of these species to satisfy human demands hence declining their population leading to extirpation of some of their local distribution in Nigeria (Ajayi *et al.*, 2011). A current population survey for reassessment of this species for conservation purpose will reveal how these species are thriving in the face of several ecological factors pushing them to extinction. This why the biogeographical map constructed in this study can serve as a guide to regions of high distributions of this species for current population survey (Figure 1). Ethnobotanical uses couple with lack of regeneration of this species have made these species scarce in the wild. It is of importance for many of these species to be regenerated to keep their demands for ecosystem services.

This study discovered that some species of *Garcinia* (*Garcinia polyantha* and *Garcinia punctata*) that herbarium records showed they occur in Nigeria have no conservation assessment by IUCN hence their status could not be determined (Table 1). This leaves a wide gap in determining the current conservation status of this genus in Nigeria. Effort should be made by local conservation authorities to assess these species as some might be currently extinct due to lack of early assessment. All these evidences point to the fact that this genus is at the verge of extinction in Nigeria.

## CONCLUSION

This study provides information about the biogeography of *Garcinia* species in Nigeria and their conservation status. It was discovered that species in this genus are of conservation concern in Nigeria. The biogeography of this genus in Nigeria revealed the species in genus *Garcinia* are well distributed in the Southern part of Nigeria but has poor distributions in other regions in Nigeria. The genus is seen to have better distribution towards the riverine areas as there are more records found in Cross River in Nigeria than other states of the country. Conservation of species in this genus have to be intensified in areas where they are well distributed in Nigeria as revealed in the biogeography results in this study.

**Recommendations**

i This study recommends an up to date and thorough population survey of all the species in genus *Garcinia* in Nigeria.

ii There is need for sustainable utilization of the species of *Garcinia* in all the habitats identified in this study, in other to prevent their complete extirpation.

iii This study recommends that conservation authorities should enact plans and policies that will protect the species of *Garcinia* in Nigeria.

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