Available online at www.ifejost.org

IFE JOURNAL OF SCIENCE AND TECHNOLOGY

Vol 5. No. 1 (2021) 60–65

Investigating Biogeographical Distribution of *Aloe* in Nigeria Based on Herbarium Records for Conservation Purpose

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Abstract
Genus *Aloe* is threatened and therefore needs to be given conservation interventions to prevent its extirpation. This study investigated *Aloe* natural distribution in Nigeria based on herbarium records which is a step towards the conservation of these taxa in Nigeria. Herbarium records of all *Aloe* species in Nigeria were obtained from Forest Research Institute of Nigeria (FRIN) herbarium. A distribution map was constructed to determine the region of high diversity of *Aloe* in Nigeria. This study revealed that *Aloe* natural occurrence was more in the southern part of Nigeria. A pilot survey of *Aloe* populations in the southern part of Nigeria is recommended to determine the current state of the populations of these species in their natural distribution in Nigeria so that a conservation plan for these species in Nigeria can be formulated.

Keywords: Conservation; extinction risk; herbarium records; geographical distribution; threatened species

Introduction

Aloe is a genus of high economic importance (Cousins *et al.*, 2012). Taxa in this genus have been heavily exploited for traditional medicinal uses, cosmetic production, drug manufacturing and horticultural uses (Grace 2011 Cousins *et al.*, 2012). There has been continuous harvesting of taxa in this genus from the wild to satisfy these human demands over a long period of time (Grace *et al.*, 2015).

Aloe is a threatened genus because over 70% of the species that are found in this genus are included in Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and many species in this genus are within the threatened categories of IUCN (International Union of Conservation of Nature) Red List (Mittermeier *et al.*, 2004; Grace, 2011; Bamigboye, 2020). Majority of the species in this genus are threatened due to habitat destruction, invasive species presence, fire occurrences and harvesting of individuals of these species for different purposes including horticultural and industrial uses (Bamigboye,

2020). These factors that are promoting extinction risk of *Aloe* have resulted in significant decline of the population of the species over time across the globe (Klopper and Smith, 2013; Grace *et al.*, 2015). Invariably, the conservation of all species of this genus irrespective of geographical location should be given high priority.

Herbarium records are sources of relevant data that promote recent biological research due to information they contain that include taxonomic information and information on geographical locations of plant species (Pyke and Ehrlich, 2010; Gairola *et al.*, 2013). These records from herbarium are extremely useful in biodiversity conservation studies because they can be used for determining species distribution range and locate regions where we have species of conservation concern in order to formulate proper conservation policies and management for threatened species (MacDougall *et al.*, 1998; Greve *et al.*, 2016; Bamigboye, 2018).

This study examined natural distribution occurrence records of *Aloe* in Nigeria. This was with a view to reveal locations of natural distribution of *Aloe* in the country. This will invariably enable conservationists to conduct thorough survey on the level of extinction of *Aloe* and make informed decision on conservation measures that will prevent further extirpation of *Aloe* natural population.

Materials and Methods

Records of distribution of *Aloe* in Nigeria were obtained from the Forest Research Institute of Nigeria (FRIN) herbarium. The FRIN is located in Ibadan, Oyo-State, Nigeria. This is the oldest and the biggest herbarium with the largest collections in Nigeria. The voucher numbers of these records were obtained alongside the distribution records. The habitat nature of the taxa was also obtained. A geographical map was constructed to show the distribution of these taxa across the country. The coordinates of all the species of *Aloe* were generated based on the locations found on the records of this species in the herbarium. This geo coordinates were used to generate distribution map through the use of GIS (Geographical Information System). Also a chat on the habitat type was constructed to determine the habitat type that is most common with *Aloe* in Nigeria in order to survey this habitat within the region of distribution of *Aloe* in Nigeria. This was with a view to determining other populations of *Aloe* that might not have been discovered.

Results and Discussion

The search of the herbarium revealed that there were only four taxa of *Aloe* that had their natural distribution in Nigeria. These taxa are *Aloe buettneri* A.Berger, *Aloe barbadensis* Miller, *Aloe macrocarpa* Todaro, and *Aloe schweinfurthii* Barker.

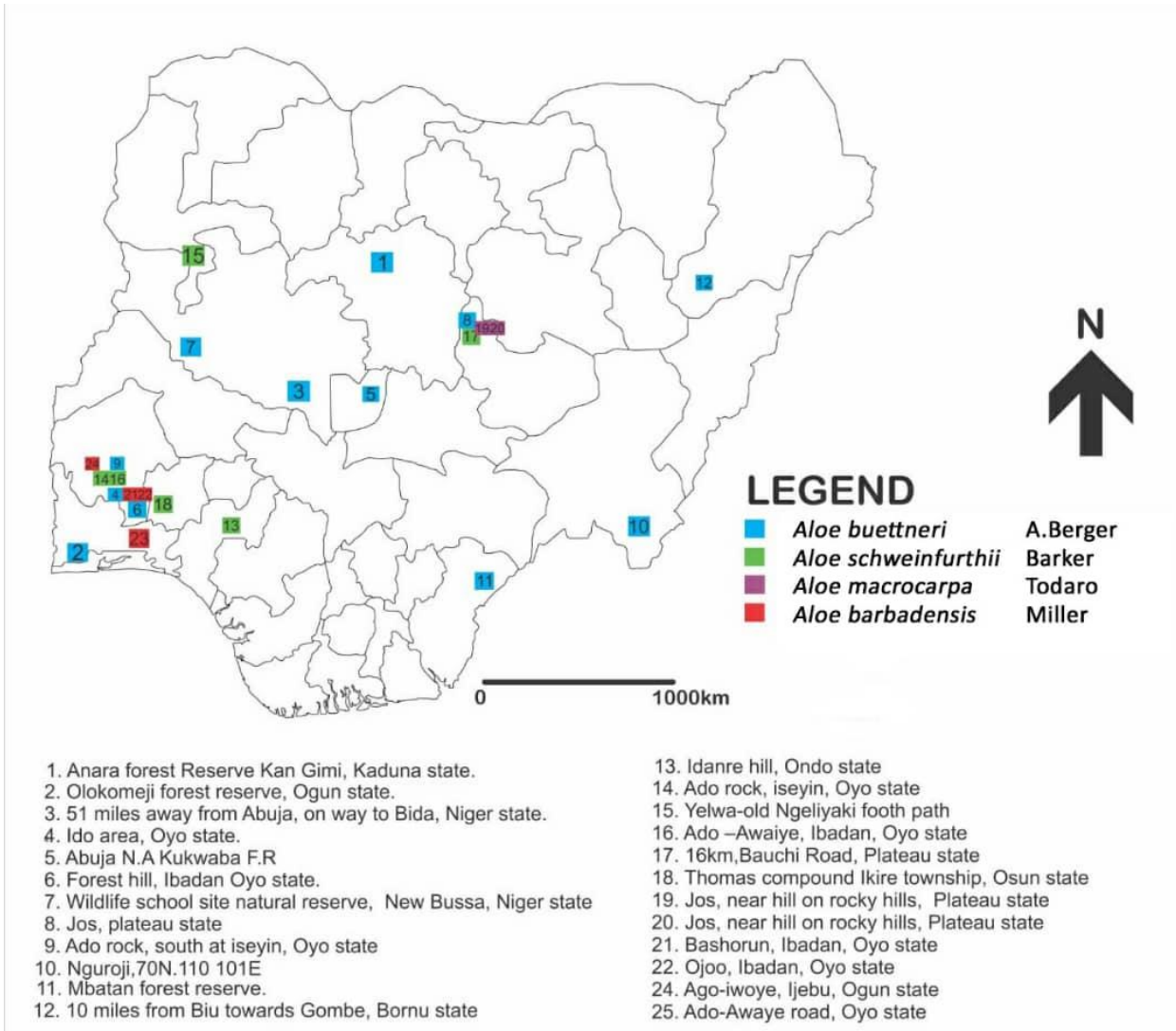

Figure 1: Distribution map of *Aloe* species in Nigeria based on herbarium records

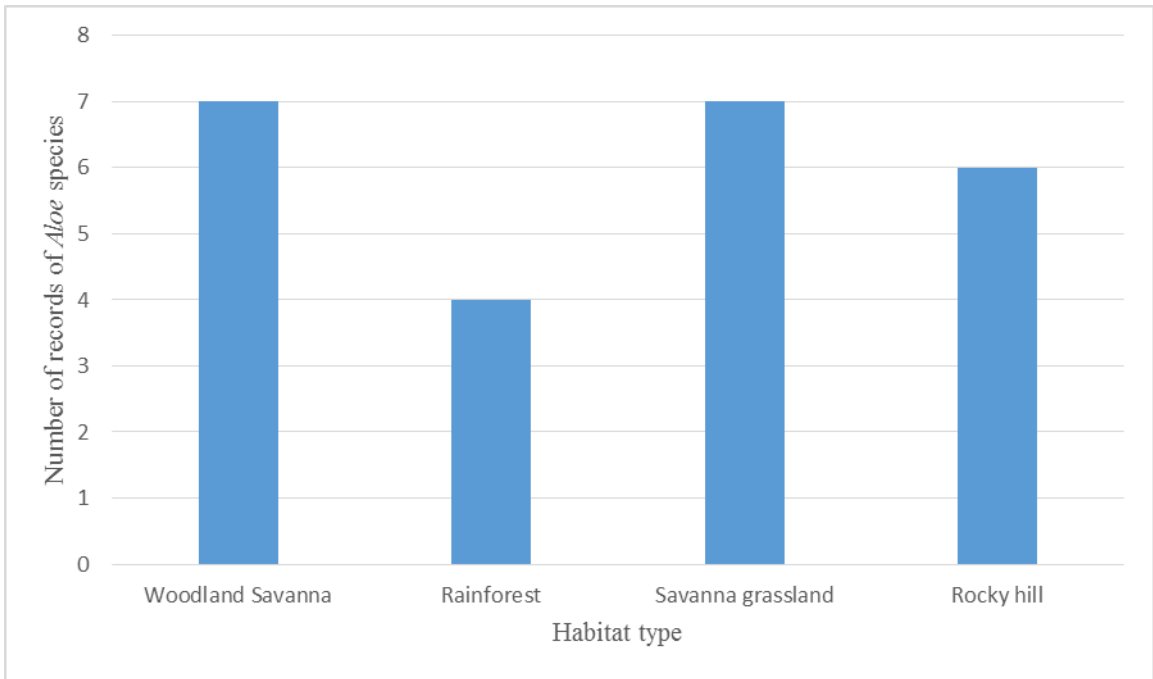

Figure 2: Habitat types of *Aloe* in Nigeria in their natural distribution based on herbarium records.

This study revealed that Nigeria has very few species of *Aloe* among countries that harbor *Aloe* in the world. As a result of extremely few numbers of species, the conservation of these species becomes extremely important. Majority of them are found within the savanna habitat type region (Figure 2). There is a trend of distribution of these *Aloe* taxa being high in the south but decreasing towards the north in Nigeria based on the herbarium records employed in this study (Figure 1). *Aloe* species are heavily explored in traditional medicine and sometimes whole plants are even harvested (Cousins and Witkowski, 2012). A typical example is *Aloe vera* which is sometimes uprooted in order to meet certain medicinal demands (Maundu *et al*., 2006). This has resulted in significant decline of *Aloe* populations in Africa (Cousin and Witkowski, 2012). In Nigeria studies have revealed that there has been high demand of *Aloe* especially Aloe vera for medicinal, cosmetics and soap making purposes in Nigeria (Adibe *et al.,* 2009; Nwafor *et al.,* 2018; Tyowua *et al.,* 2019). This act of placing high demand on Aloe which is a threatened genus, will further aggravate their decline and promote the possibility of their extinction in Nigeria.

Species in threatened genera needs to be highly protected and policies need to be enacted prohibiting their indiscriminate exploitation (Child 2003). In the case of *Aloe* some countries like South Africa and Kenya have moved to protect these species and also criminalized the harvesting of these taxa without the consent of relevant authorities (Wabuyele and Kyalo, 2008). It is important that Nigeria also emulates this kind of policy

on *Aloe* conservation in order to prevent complete eradication of these species in Nigeria in decades to come.

In conserving rare and threatened species, adequate knowledge of their habitat type and natural distribution is very important (Crain *et al.*, 2015). In this study the woodland savanna and the savanna grassland stood out as the prevailing habitat type for *Aloe* in Nigeria (Figure 2). This knowledge will help in seeking out for populations of *Aloe* within these habitat type in their natural distribution range in Nigeria.

Mapping species of conservation concern is important for proper management of the species because mapping reveals regions of natural distribution of the species and also the regions of species richness of the threatened taxonomic group (Bamigboye, 2018). This will serve as a guide for population survey that will determine the current state of the population of the species. The distribution map of *Aloe* generated in this study also revealed that *Aloe* protection should be focused more on the southern part of Nigeria (Figure 1).

Conclusions

Aloe natural distribution in Nigeria is extremely small and scanty based on herbarium records. Such taxa with extremely small distribution within a certain geographical space are always threatened in that region. The limited distribution, which is already a conservation concern and exploitation to meet human demands, put this genus in high risk of extinction in Nigeria. This study recommends a current well updated pilot survey of these species in Nigeria which will support plan and policies on how to protect the taxa.

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