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Perspective

Insufficient collection capacity and facility, bane of plant taxonomic research in Nigeria

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Abstract

This article explores the pivotal role of herbaria in supporting taxonomic research in Nigeria and highlights the need to improve herbarium infrastructure to enhance plant diversity research in the country. Thirteen herbaria are currently recognized in Nigeria on the Index Herbariorum database and collectively house about 260 000 specimens. The Forest Herbarium Ibadan (FHI) is the largest, containing nearly 50% of these specimens. Based on the occurrence data of Nigerian plants on the Global Biodiversity Information Facility (GBIF), the herbaria, namely FHI, ABUH, LUH, NAUH, and UNICAL contributed only 29.9% compared to international herbaria (70.1%). This disparity underscores the need to strengthen the herbarium collection infrastructure in Nigeria. Taxonomic revisionary studies in Nigeria are very scarce as most of the studies have focused on the morpho-anatomical analysis of plant taxa. The poor taxonomic capacity in the country, which is due to insufficiency of collection capacity and trained taxonomists, has been a bane to the compilation of flora of Nigeria and the inability to document the conservation status of threatened plant species, as more than half (66.0%) of Nigeria's plants published on GBIF have not been evaluated. There is an urgent need for capacity building for plant collection, curation, and taxonomic review.

Key words: plant collection, taxonomists, biodiversity, herbaria, Nigeria

Introduction

Nigeria, geographically located in West Africa, is home to a remarkable floristic diversity, boasting approximately 6000 species of vascular plants, including aprroximately 5627 native species (POWO 2023; Bello et al. 2024). Like in other developing countries, the country's plant resources face mounting pressure, such as climate change, deforestation, habitat conversion, invasive species, and urbanization, given that they provide food, medicine, and shelter. It is worth mentioning that the rich flora diversity has been reported by plant taxonomists and ecologists in the country, focusing on different aspects, including endemic species (Borokini 2014), alien species (Borokini et al. 2023), forest tree species (Adeonipekun et al. 2018; Onyekwelu et al. 2022), aquatic species (Uka et al. 2009; Adeonipekun et al. 2019; Oyebanji et al. 2020), and medicinal species (Chukwuma et al. 2015; Ugbogu and Chukwuma 2019; Mukaila and Ajao 2025). Moreover, almost a decade ago, about 146 plant species were listed on the IUCN Red List of Threatened Species (Convention on Biological Diversity (CBD) National Biodiversity Report 2015), while a previous report by Gbile et al. (1981) had put the number of endangered species in Nigeria at 492.

After joining the CBD in 1994, Nigeria launched the National Biodiversity Strategy and Action Plan (NBSAP) in 1995 to provide biodiversity planning for the conservation and preservation of the country's biodiversity. However, despite this foundational effort, critical gaps in implementation and outcomes continue to persist. Notably, the promotion of taxonomic research supported by herbarium collection—a cornerstone of biodiversity conservation—was not incorporated into the national strategic plans. Since the cessation of botanical exploration by Europeans in Nigeria, species description

has significantly reduced, with approximately 20–30 species per year in the last century (Bello et al. 2024). Few species have been described in the country for over three decades, and scanty taxonomic revisionary studies have been carried out. This setback in taxonomic efforts has left many species undocumented, misclassified, or underutilized, impeding conservation planning and obscuring extinction risks (Imarhiagbe et al. 2020). This has consequently affected the development of government policies regarding biodiversity conservation and environmental management (Smith et al. 2008).

Herbaria are huge time series biodiversity data banks that play critical roles in tracking challenges posed by human activities on plant resources by documenting and preserving plant specimens (also Natural History Collections) for reference and posterity. Hence, they serve as valuable repositories for researchers and conservationists to study and protect endangered plant species (Davis 2023). Previous authors have estimated that half of the species not described globally are already housed in herbaria cabinets (Bebber et al. 2010; Gross 2011). They are essential in this process because they offer the platform to authenticate specimens and unlock their other uses by providing reference samples. Despite this relevance, the taxonomic infrastructures in Nigeria—including herbarium facilities and related activities—are still inadequate to address the country's biodiversity crisis. This deficiency threatens the country's ability to monitor, conserve, and sustainably manage its plant resources.

Based on a predictive model, it has been estimated that between 1004 and 2239 new species are expected to be described in the country by 2070 (Bello et al. 2024). Achieving this goal will require significant investment in herbarium collections, infrastructure, and capacity enhancement to support robust taxonomic research efforts. This approach is also helpful in preventing further loss or extinction of plants in Nigeria and providing an adequate inventory of the country's flora (Pyšek et al. 2013). In this article, we aim to identify the factors causing a huge gap in herbaria collections and emphasize the role of herbaria as crucial facilities for supporting taxonomic research and plant biodiversity conservation efforts in Nigeria. Additionally, this assessment will highlight the pressing need to fortify herbarium-based research infrastructure to fill critical gaps in biodiversity knowledge and conservation strategies.

The current state of biodiversity collection infrastructure in Nigeria

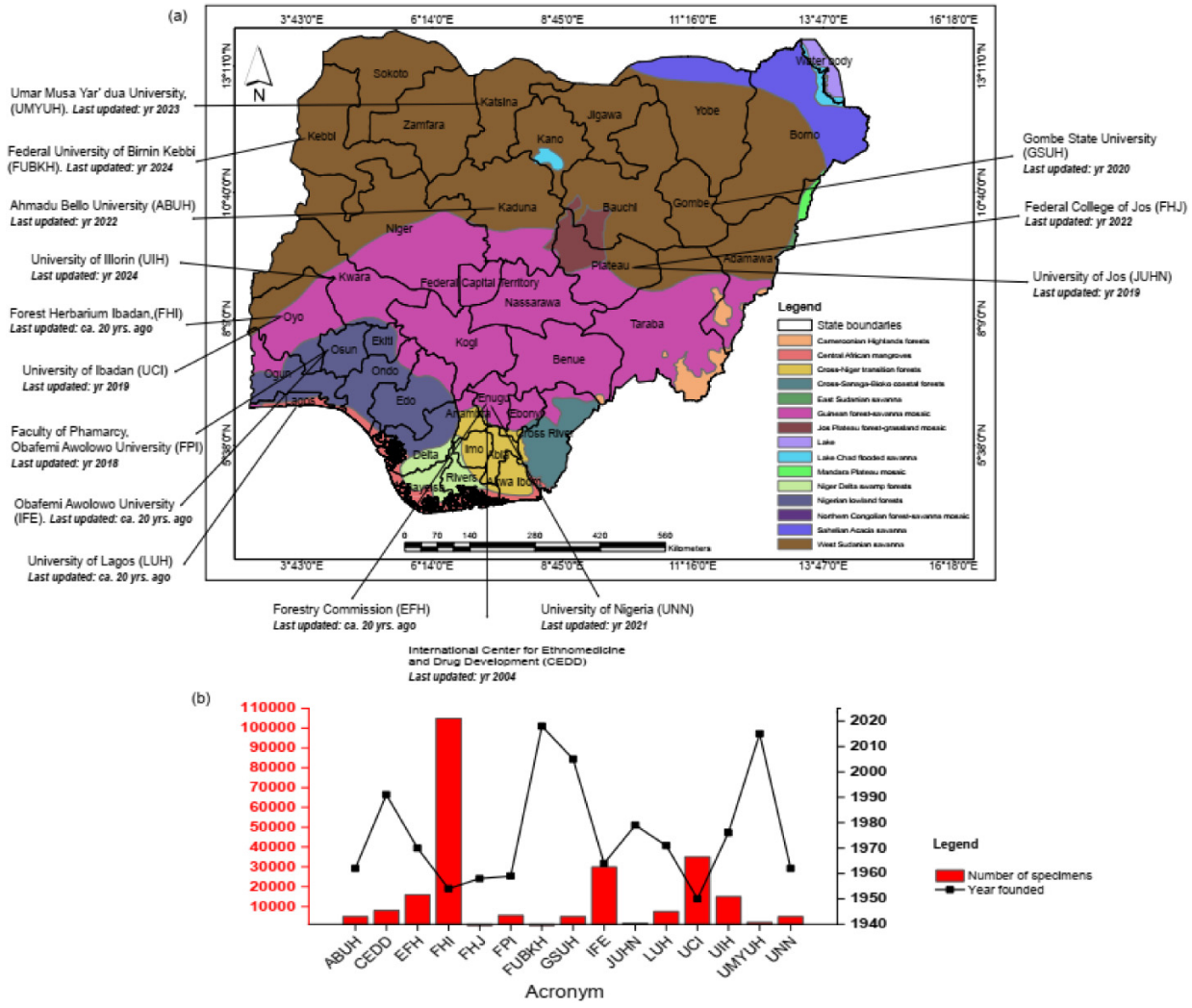
According to Index Herbariorum (https://sweetgum.nybg.org/science/ih/herbarium-list/), 15 herbaria are officially recognized in Nigeria; three are affiliated with research institutions, and the remainder with universities (Fig. 1*a*). Following our observations, this number is likely an underestimation, as many universities offering botany as a major course maintain small herbaria dedicated to teaching and students' research projects, which are yet to be in the global herbarium database.

The herbaria listed currently houses about 260 000 specimens, of which the Forest Herbarium Ibadan (FHI) houses nearly 50%, making it the largest herbarium in the country (Fig. 1*b*). Most of the herbaria were established between 1954 and 1975, with FHI being the oldest in the country, founded in 1954. In the last 32 years, only three herbaria have been established. The University of Ibadan Herbarium (UCI or UIH), followed by Obafemi Awolowo University (IFE), topped the list of university-based herbaria regarding the number of specimens housed. Even though some herbaria, namely Ahmadu Bello University (ABUH), University of Lagos (LUH), Federal College of Forestry Jos (FHJ), and University of Nigeria (UNN), were established around the same time as UCI and IFE, less than 50% of specimens are housed in IFE and UCI. The data reveal a lack of active collection of plants for herbarium specimens in most universities. For instance, numerous ecological-based species distribution studies could have meaningfully contributed to the herbarium collections (as mentioned earlier) if samples had been collected and prepared accordingly. Another evidence of this trend is observed at the Gombe State University herbarium (GSUH), a relatively new herbarium established 20 years ago, which harbours a comparable number of herbarium specimens to UNN and ABUH which were founded more than six decades ago. Among the herbaria established before 1985, the University of Nigeria Herbarium (UNN) recently updated its record, UCI updated in 2019, while others, including LUH and FHI, have not been updated since approximately 20 years ago. This disparity highlights the chronic infrastructure gaps, insufficient support for curators, and disjointed efforts in plant collection and preservation efforts across Nigerian herbaria. Outdated records reveal alarming inactivity, likely due to resource constraints, vacant curator positions, and inactive collections. Ensuring taxonomic relevance and operations sustainability must be prioritized to address these critical challenges.

FHI was recently upgraded as the National Herbarium of Nigeria and remains the only herbarium in Nigeria known for its huge national repository of plants, with collections encompassing a broad representation of the country's flora, including the endemics. Moreover, the extent of sampling biases (spatial, temporal, and collector) within these herbarium collections is largely unknown, an issue well-reported in herbaria worldwide (Daru et al. 2018). This observation reflects limited efforts to update the global herbarium database while embarking on active collection activities. Strengthening these efforts will enhance the scientific utility of herbaria and contribute to a more comprehensive understanding of Nigeria's plant biodiversity.

In an era of global open science practice, the Global Biodiversity Information Facility (GBIF) is the premier platform for open-access biodiversity datasets, enabling large-scale ecological and conservation research. Species occurrence data are indispensable for understanding plant species dynamics, richness, and extinction risks in a country (Peterson et al. 2021; Spear et al. 2023) and at continental scale (Oyebanji et al. 2021; Mambo et al. 2024; Minev-Benzecry and Daru 2024; Gross et al. 2025). An estimated 184 694 occurrence records exist on the GBIF platform for different phyla within the King-

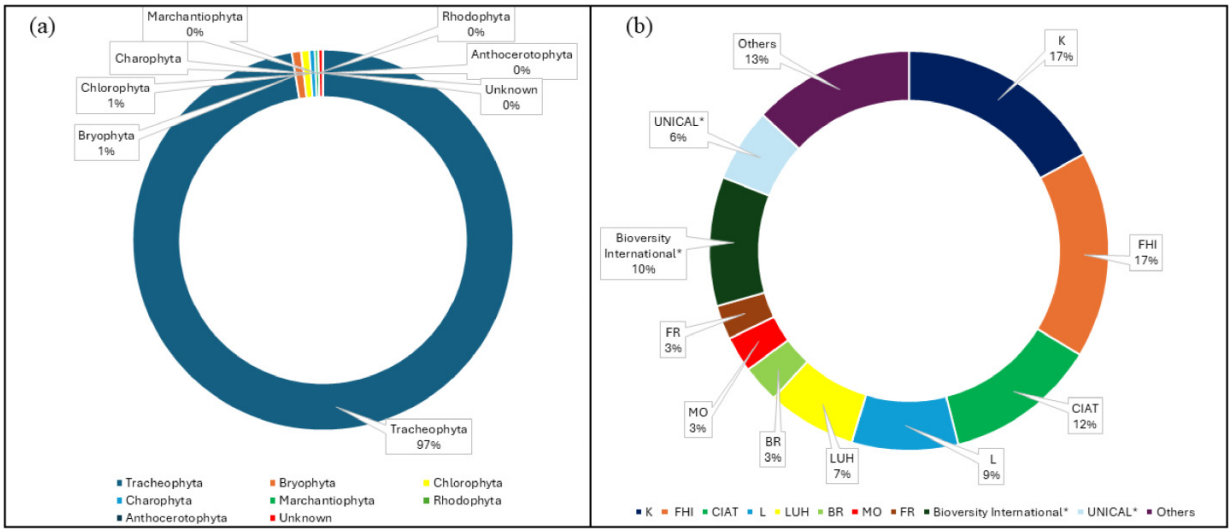
Fig. 1. List of the herbaria in Nigeria according to index herbariorum. (*a*) Distribution of herbaria by state on the vegetation map of Nigeria and (*b*) year of establishment and number of reported specimens. The shapefile was retrieved from https://gadm.org/, map was drawn in ArcGIS v. ArcGIS 10.8 (ESRI, Redlands, CA, USA) while the ecoregions were delimited following Olson et al. (2001). The annotations of the herbaria and the years were extracted from the online database (https://sweetgum.nybg.org/science/ih/herbarium-list/?AddPhysCountry=Nigeria; accessed 15 December 2024).



dom Plantae from Nigeria, which starkly differs from the records obtained on Index Herbariorum (i.e., lower by 90 000 records). Among the different phyla, however, the tracheophytes (vascular plants) dominate with a remarkable 97%, followed by 1% for bryophytes and green algae (GBIF 2024) (Fig. 2*a*). This dataset also underscores the critical role of GBIF in illuminating patterns of plant biodiversity and guiding efforts to mitigate extinction risks in light of climate change and incessant human activities (Chukwuma et al. 2023; Ajao et al. 2024).

In terms of the contribution of herbaria to Nigeria's plant species occurrence data on GBIF, herbaria, namely FHI, ABUH, LUH, Nnamdi Azikiwe University, and the University of Calabar (Nnabude et al. 2019; Iortsuun et al. 2019; Ugbogu et al. 2019; Onuminya et al. 2022*a*, 2023) contributed only 29.9% to the occurrence data compared to international herbaria (70.1%) (Fig. 2*b*). It is important to note that [Nnamdi Azikiwe University and the University of Calabar Herbarium (UNICAL)] are not listed on the index Herbariorum (https://sweetgum.nybg.org/science/ih/herbarium-list/). Yet, they contributed about 30% to the herbarium-preserved records from Nigeria available on GBIF. This trend is similar to other African countries such as South Africa, Ghana, and Kenya, where local herbaria contributed 36.59%, 24.12%, and 4.93%, respectively, to the occurrence data compared to international herbaria (GBIF 2024). This reflects the lack of adequate capacity of the local herbaria in Africa, especially in Nigeria, since the departure of the foreign collectors after Nigeria's independence that collected plant specimens from Nigeria and deposited them to International herbaria, especially Royal Botanical Gardens, Kew (Bello et al. 2024). Therefore, in this call, we posit that it is essential for the local herbaria to be strengthened in terms of capacity and provision of resources. This will ensure that they are actively engaged in

Fig. 2. Metadata information on Nigeria's plant biodiversity extrapolated from GBIF (https://doi.org/10.15468/dl.e8tnaw). (*a*) Distribution of occurrence records of phylum taxonomic rank and (*b*) contribution of local and international herbaria to species occurrence data. The Kew Botanical Gardens and FHI contributed 17% each, followed by CIAT (12%), Biodiversity International (10%), and L (9%). Abbreviations: BR, Meise Botanic Garden; CIAT, Centro Internacional de Agricultura Tropical Forestry Commission; FHI, Forest Herbarium Ibadan; FR, Senckenberg Herbarium; K, Royal Botanical Gardens Kew; L, Naturalis Biodiversity Center; LUH, University of Lagos; MO, Missouri Botanical Garden; UNICAL, University of Calabar. Others: ABUH, Ahmadu Bello University, Zaria; FPI, Faculty of Pharmacy, Obafemi Awolowo University; CEDD, International Center for Ethnomedicine and Drug Development; EFH; FHJ; Federal College of Forestry Jos; GSUH, Gombe State University; IFE, Obafemi Awolowo University; JUHN, University of Jos; UCI, University of Ibadan; Note: herbaria with asterisk (*) are not listed on the index Herbariorum.



the country's floristic inventory and foster the availability of such collections on GBIF and African plant databases—such as RAINBIO (Dauby et al. 2016), West African Plants (https://africanplants.ac.uk/)—in an attempt to enhance and further clarify the biodiversity status and information about Nigeria.

The GBIF dataset revealed that most of the plant species records from Nigeria are herbarium specimens (109 039), followed by field occurrences (44 300) and human observations (74 366) on the field by either taxonomists or other field workers (Fig. 3*a*). It is noteworthy that the availability of these data are crucial for assessing the extinction risk and suitable conservation intervention for plant species (Ajao 2021; Von Staden et al. 2013; Ely et al. 2017). Based on the occurrence data of Nigeria's plant species on GBIF, it is saddening to realize that more than half of these plants (66.0%) have not been evaluated by IUCN, and a significant number are already on the verge of extinction (GBIF 2024). Table 1 highlights notable taxonomic revisionary studies on Nigerian flora in the last three decades, revealing significant gaps in taxonomic studies involving species description and conservation efforts by the local taxonomists. Bello et al. (2024) noted that international taxonomists did possess a greater capacity to contribute to the conservation of Nigerian plant diversity than local experts—a situation that urgently calls for serious attention. While we note that botanical explorations in Nigeria were started by foreign botanists, who were mostly Europeans, and this has contributed to the larger availability of the country's data from international herbaria, we emphasize the need for the local taxonomists to be strengthened if they are to meet up with the tasks as demanded.

Status of plant taxonomic research in Nigeria

The significance of taxonomic revision work in delimiting and estimating the number of species and their distribution cannot be underestimated. However, Nigeria faces significant gaps in plant taxonomic research. Taxonomic revisions on Nigerian plants are limited, and with no complete flora compilation. Consequently, much of the foundational data for taxonomic research are from early works such as *Flora of West Tropical Africa (FWTA)* by Hutchinson and Dalziel (1954, 1958, 1963, 1968, 1972), published in three parts and *Trees of Nigeria* by Keay (1989). These texts provide critical information with nomenclature, taxonomic identification keys, descriptions, distribution, and phenology of Nigerian plants for approximately 7072 species distributed among 1742 genera, and 222 families of vascular plants (dicotyledons, monocotyledons, and Gymnospermae) including 277 species that are imperfectly known (Hepper 1972). Some of these imperfectly known species belong to genera such as *Araliopsis* Engl. (1896:175), *Chytranthus* Hook (1862:403), *Dovyalis* E.Mey. ex Arn (Hooker) (1841:251), *Eugenia* L. (1753:470), *Klainedoxa* Pierre ex Engl. (1896: 227), *Xylopia* L. (1759: 1378), which are yet to receive adequate taxonomic attention. Likewise, *Trees*

Fig. 3. The conservation information and basis of occurrence data on Global Biodiversity Information Facility. (*a*) Basis of occurrence and (*b*) conservation information.

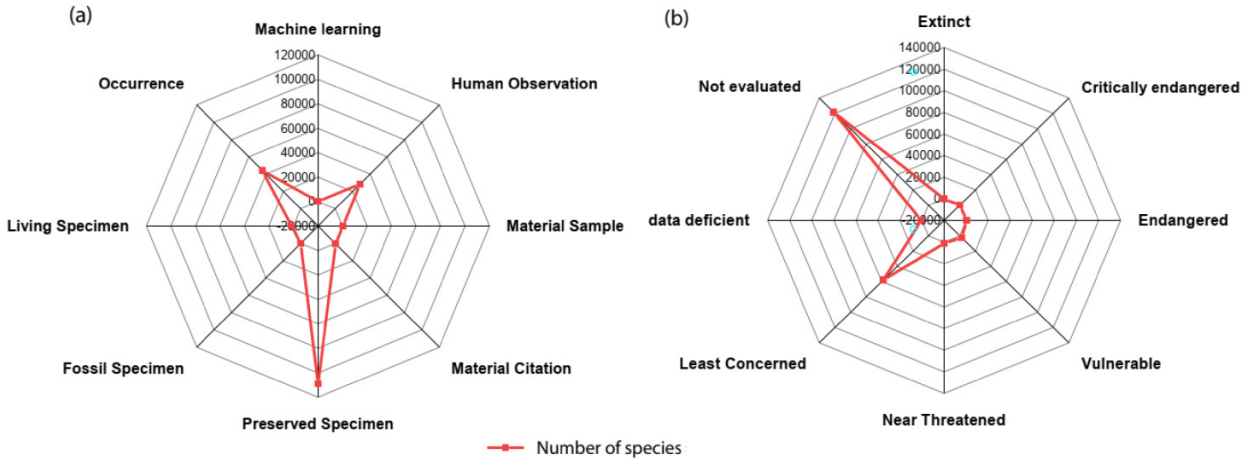


Table 1. Selected taxonomic revision studies on Nigerian flora in the last three decades.

Taxon	Study	Reference
Genus *Baphia* Lodd.; Fabaceae	A revision of the *Baphia* (Leguminosae—Papilionoideae)	Soladoye (1985)
Genus *Baccharoides* Moench; Asteraceae	Taxonomy and new combination in genus *Baccharoides*	Isawumi (1993); Isawumi et al. (1996)
Subtribe Ecliptinae; Asteraceae	Generic revision of the subtribe Ecliptinae	Isawumi (1997)
Tribe Vernonieae; Asteraceae	Generic revision of the Vernonieae	Isawumi (2008)
Genus *Nothovernonia* H.Rob. & V.A.Funk); Asteraceae	Description of new genus *Nothovernonia*	Robinson and Funk (2011)
Stachys aculeolata/*aethiopica*; Lamiaceae	Revision of *Stachys aculeolata*/*aethiopica* complex	Harvey (1996)
Persicaria salicifolia (Brouss. ex Willd.) Assenov; Polygonaceae	Description of new subspecies *Persicaria salicifolia* (Brouss. ex Willd.) Assenov. subspecies *mambillensis* Ayodele	Ayodele and Olowokudejo (2002)
Genus *Psychotria* L; Rubiaceae	Description of new species and subspecies, *P. bilabiata* O. Lachenaud (2019:161), *Psychotria hardyi* O. Lachenaud (2019:236), and *P. potanthera* subsp. *sapobana* O. Lachenaud (2019:319)	Lachenaud (2019)
Genus *Tinnea* Kotschy ex Hook.f.; Lamiaceae	*Tinnea gombea* (Zhigila, Aigbokhan and Muasya (2023:7).	Zhigila et al. (2023)

of Nigeria by Keay (1989) treated 495 species distributed in 417 genera and 86 families of Nigerian trees, including exotic species, vernacular names, and uses, to advance the publication of FWTA. In addition, supplementary works include the inventory of useful plants, *The Useful Plants of West Tropical Africa* (Burkill 1985, 1994, 1995, 1997, 2000, 2004), and Yoruba useful plants (Ajao et al. 2022). The work provided vernacular names, uses, and ecological information, complementing the existing literatures on Nigerian plants.

Furthermore, other taxonomic resources are from the considerable efforts of some researchers focusing on the inventories or checklists of groups of plants from a particular locality (Hopkins 1966; Keay 1971; Hall and Okali 1979; Muoghalu and Isichei 1991), which also form- the basis for local or regional flora checklists in Nigeria. For example, *Trees, Shrubs, and Lianas of West African Dry Zones* (Arbonnier 2004), the *Checklist of Vascular Plants of Southern Nigeria* (Aigbokhan 2013), *Flowering Plants in West Africa* (Steentoft 2008), and many others (Borokini 2014; Nyananyo 2006; Kayode and Ogunleye 2008; Khobe 2011; Edet et al. 2012; Sani et al. 2014; Adeyemi et al. 2015; Oyebanji et al. 2020; Uwalaka et al. 2022). While we also recognize the efforts of a few authors conducting taxonomic revisions of different plant groups (Table 1), these efforts are insufficient given Nigeria's rich biodiversity.

A critical challenge is the limited taxonomic research capacity, which has left many species unexamined and poorly documented. For instance, since the publication of FWTA and *Trees of Nigeria* (Keay 1989), few taxonomic revision papers on Nigerian plant groups with species taxonomic treatments have led to significant advancements or descriptions of new species.

Reviving botanical collections in Nigeria: challenges and the path forward

Advancing botanical collections requires a multi-pronged strategy. Here, we highlight the challenges and the path forward to overcome these obstacles and innovatively re-

establish taxonomic research as an addendum to Bello et al. (2024).

Insufficient taxonomic research capacity

According to the literature, taxonomic research output is low in Nigeria, in stark contrast to many other countries. For example, South Africa described more than 20 new species yearly between 1995 and 2015 (Victor et al. 2015). This distressing deficiency might stem from a dearth of well-trained taxonomists and a pervasive lack of enthusiasm among students. Nigerian taxonomic studies often focus on anatomical aspects rather than comprehensive species-level revisions (Saheed and Illoh 2010; Oladipo and Illoh 2012; Ibrahim and Ayodele 2013; Ajao et al. 2017), while numerical taxonomy publications largely neglect the broader taxonomic implication on the revision of the Nigerian flora (Illoh and Olorode 1990; Bello et al. 2013; Folorunso et al. 2013; Chukwuma et al. 2016; Kolawole et al. 2021). This limited scope not only impedes scientific discovery but also leaves critical gaps in our understanding of the nation's plant diversity, exacerbated by poor specimen documentation and inadequate use of voucher specimens. Bridging this gap necessitates robust capacity-building initiatives designed to cultivate and motivate next-generation taxonomists. We suggest that academic curricula should be revamped to prioritize plant taxonomy, conservation, and collection. Also, national programs, workshops, and scholarships can serve as platforms to ignite student interest and foster a vibrant taxonomic research culture in Nigeria.

Restoring credibility through better practices

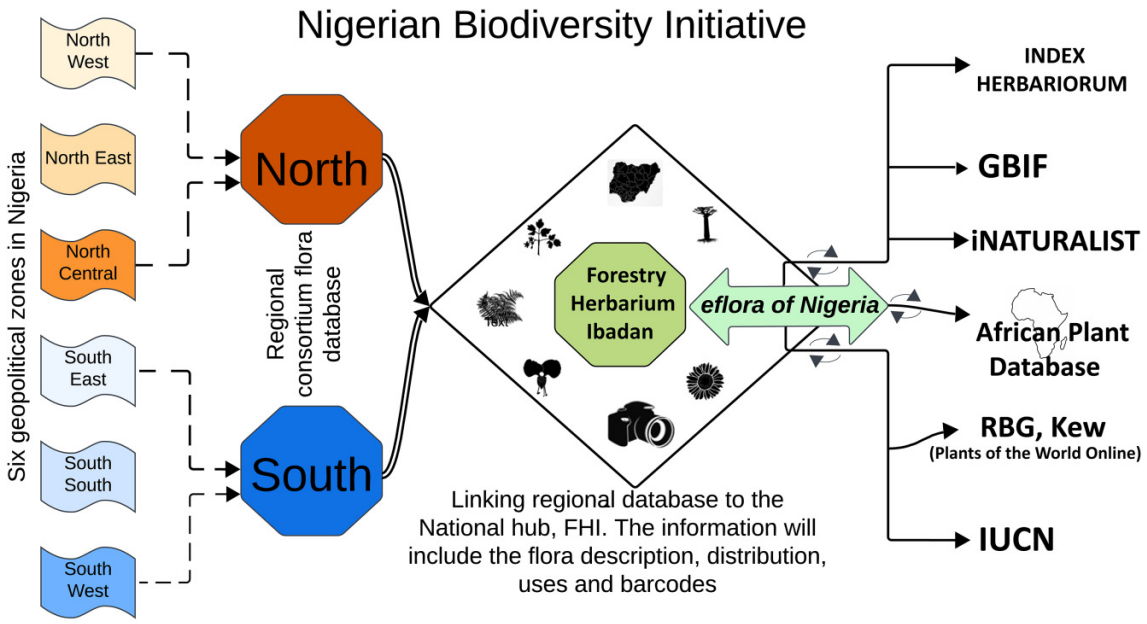
A recurring flaw in Nigerian taxonomic research is the inadequate use of herbarium voucher specimens, which compromises the utilization of these repositories (Cully 2013). In many cases, authors failed to provide the herbarium voucher number of the specimens used in their study, thereby limiting the reliability and update of herbarium records. Another uncommon practice that is essential is the exchange of specimens (or specimen loans) nationally and internationally. This is essential if the taxon has a broader distribution and allows critical assessments of morphological variations along distribution ranges, providing opportunities for identifying or discovering new taxon. Furthermore, deliberate voucher specimen collections should be encouraged to enhance the collections repository and ensure the quality of research and reproducibility.

Increasing the number of herbarium specimens plays a crucial role in restoring biodiversity and advancing taxonomy-oriented global practices. These include fields such as ecology and phytogeography, evolutionary genomics, identification of new species, molecular systematics, traits evolution, and conservation of wild relatives of cultivated plants in Nigeria and beyond, as highlighted by Funk (2003). It will also subsequently increase the number of type specimens of indigenous Nigerian plants that are housed at FHI and made digitally available online (http://plants.jstor.org). We also use this special call to emphasize the improvement of the accompanying herbarium voucher specimens by highlighting information on the phenology, coordinates, abundance, and soil properties of the location where the specimen is collected, in addition to the existing herbarium label. The significance of voucher specimens cannot be underestimated in integrative taxonomic research, as it is essential to validate and identify the locality and progressive taxonomic revisions (i.e., change of names, species placements, synonyms, etc.) of taxa. To enhance this trend, plant taxonomy and systematics researchers must adopt rigorous, internationally recognized standards by conducting taxonomic studies according to ICBN (Engel et al. 2021) and communicate their taxonomic revision findings through publications in relevant journals. Comprehensive specimen collection, consistent meticulous documentation, and updating the global resources are vital. It is worth noting that a study by Lowe and Soladoye (1990) has made some effort to update the species names of Nigerian plants since the publication of the regional flora FWTA. Moreover, fostering cohesive collaborations and embracing digitization initiatives will enrich local datasets and broaden research perspectives, enhancing credibility and taxonomic research impact. To the best of our knowledge, leveraging this concerted effort in biological collections is crucial to developing a comprehensive *Flora of Nigeria* (and promotes *eflora of Nigeria*) and providing essential identification keys (Fig. 4). Following these recommended practices provides valuable resources and fosters credible utilization for large-scale innovative research in phenology, ethnobotany, global change study, and biogeography (Soltis 2017; Heberling et al. 2019).

Digitization for innovation

Currently, we recognize the pioneering initiative and efforts from FHI (jstor.org) and LUH (Onuminya et al. 2022*b*) regarding the digitization of herbarium specimens, but still, this left many collections from other herbaria in Nigeria largely inaccessible. This gap restricts the potential for innovative research while further exacerbating challenges in taxonomic research works in Nigeria. Digitization is not merely an option—it is a necessity for integrating Nigerian collections into the global taxonomic framework and enabling transformative studies that address global challenges such as climate change and biodiversity conservation, all of which rely on taxonomy. To accelerate the digitization of herbarium specimens, strategic investments in digital infrastructure and human capacity are needed, along with fostering partnerships and creating a centralized repository. We believe that implementing these digital strategies will not only improve the data availability but also integrate Nigerian contributions into the global taxonomy community and Cybertaxonomy (Malekmohammadi et al. 2024; Naskar 2024). For instance, digitization of the herbarium collections will enable easy remote extraction of morphometric data during taxonomic revisions using machine learning algorithms. This will complement those from mounted specimens or when physical contact with the sample is unrealistic. With this development, there will be enriched opportunities for student and researcher engagement, fostering a deeper understanding of taxonomy and its application through data interoperability.

Fig. 4. A projected workflow to revitalize and utilize botanical collections to unravel new species and encourage uniform species population from Nigeria on all biodiversity platforms. The silhouette Images were from PhyloPic (https://www.phylopic.org/), and the rest of the silhouettes were from https://freesvg.org/search/.



Bridging the expertise gap

With fewer taxonomists nationwide, Nigeria faces a critical shortage of expertise. This might eventually lead to inadequate training of the taxonomy specialists and curators and a potential decline in next-generation taxonomists in Nigeria (Idu et al. 2023). Lack of awareness of the prospects and significance of taxonomic research could also be responsible for undergraduate and graduate students' lack of interest in the field and preferring other research areas in botany. This cycle may perpetuate itself, leaving the botanists uninspired to pursue careers in taxonomy, further exacerbating the expertise gap to persistently uncover new species in the country. A robust national framework to attract, nurture, and advance taxonomic expertise is urgently required. Local universities and herbarium institutions in the country must prioritize taking the lead in inspiring students and professionals by launching public awareness campaigns that emphasize the importance of taxonomy in biodiversity conservation and sustainable development. These campaigns should also highlight the diverse career options available in this field. From our point of view, plant taxonomy can be revitalized by introducing innovative niches such as bioinformatics, cybertaxonomy, digitization (virtual herbarium), fieldwork, machine learning molecular systematics, and photography (imaging technology). These modern tools can complement the traditional morphological and anatomical assessment of plant taxa using leaf, stem, and wood samples for classification purposes, either from fresh or herbarium or silica-gel samples, to enhance classification accuracy and high-quality material for molecular studies. We propose these strategies as a path to bridge expertise gaps at both local and international levels, paving the way for achieving the ambitious goal of describing ~1000 new species by 2070 (Bello et al. 2024).

Funding: the lifeblood of botanical collections

Funding has been mentioned as one of the major taxonomic challenges of this era (Britz et al. 2020). Generally, lack of research funding is one of the problems responsible for low research productivity at Nigerian universities and research institutions, regardless of the field, owing to a lack of interest by the government (Ibeh 2022). Taxonomic research is not left out of this problem as FHI, which serves as the National Herbarium in the country, and other relevant institutions do not receive any major funding from the government for taxonomic research or for field collections of plants to expand the number of herbarium collections in their repositories. This neglect undermines efforts to document and actualize the recommendations in this article.

Moving forward, it is essential for the government to take an active role in providing dedicated funding to significantly support local efforts. As an illustration, creating competitive grant proposals tailored towards taxonomic studies can encourage researchers to pursue innovative approaches, from comprehensive plant collection efforts to cutting-edge studies, e.g., cybertaxonomy. Complementing this, partnerships with private organizations and international bodies for plant taxonomy studies/collections can open up additional funding opportunities, fostering collaborative and impactful research. Such initiatives will not only improve the quality of research but also position the nation as one of the key players in global biodiversity studies.

Conclusion and recommendations

This article highlights the critical deficiencies in the botanical collection capacity, which not only obstruct taxonomic

research but also negatively impact the management and utilization of the Nigerian biodiversity. Here, we identified the current efforts from all stakeholders (governments and professionals) and propose some impactful best practices for the reconstruction of botanical research and collections in Nigeria to meet the mandates of the CBD. Therefore, we recommend that a Nigerian Biodiversity Initiative (NBI) be established to coordinate biodiversity collection activities from the six known geopolitical zones in Nigeria and the global biodiversity archives (see Fig. 4). Utilizing this scheme will allow the use of local people to discover new species (citizen science) alongside ethnobotany to reduce bias sampling and promote plant conservation. It would also serve as a central platform for planning, monitoring, and disseminating biodiversity information while advising stakeholders and NGOs such as the Botanical Society of Nigeria (BOSON), Nigerian Conservation Foundation (NCF), and Nigerian Field Society (NFS) to collaborate with the scientific community to lobby for policies that recognize botanical collections which is fundamental to plant taxonomy, conservation, and management of species invasion. Furthermore, the stakeholders should declare a state of emergency with a 20-year strategic plan to modernize taxonomic infrastructure. This plan should prioritize the establishment of the *eflora* of Nigeria, facilitate the upgrade of the existing herbaria, and create capacity-building programs for curators, researchers, and students. It will involve commissioning strategic projects and initiatives promoting and enhancing taxonomic information in the country, such as Nigeria Flora 2035. These collaborative efforts among all the stakeholders will facilitate the integration of these projects into academic curricula, engaging students and fostering a new generation of skilled taxonomists. Finally, there should be a dedicated and sustainable funding allocated to support frequent fieldwork and best practices, as mentioned in this article (i.e., integrative taxonomy and cybertaxonomy. These efforts will enhance practical relevance, making the practice of plant taxonomy more appealing, which will not only bolster taxonomic research but also create interdisciplinary employment opportunities for aspiring taxonomists while fulfilling local and global commitments.

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Data availability

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