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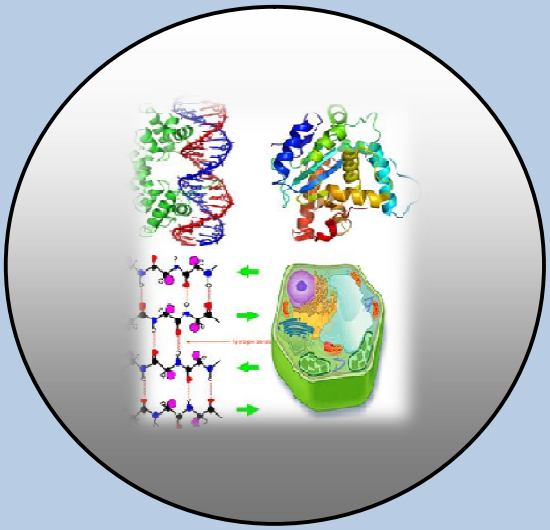

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REVIEW ARTICLE

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Herbarium in the Maintenance of Biodiversity

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ABSTRACT

Biodiversity is the variety of life on earth that includes variation at all levels of biological organization from genes to species to ecosystem. Biodiversity is of direct importance in application such as food, fibre, medicine, and biological control and the indirect importance include: atmospheric regulation, nutrient cycling and pollination. Biodiversity loss can be caused by habitat change, climate invasive species, over exploitation and pollution which result in increased species extinction and loss of biota. This paper established that biodiversity can be maintained using herbarium. Herbaria are plant bank where plants are kept or reserved for future reference or the other scientific studies. It is a databank for the biodiversity. The herbarium allows plant to be preserved for long period with vouchers which allow future researchers to document the authenticity of the material on record. The use of herbarium will help conserve biodiversity are under the threat of extinction. It also preserves information on biodiversity data.

Keywords: Herbarium, Species Preservation, Biodiversity Maintenance and Sustainability.

INTRODUCTION

Herbarium in the simplest form is a collection of pressed and nicely dried preserved specimens usually arranged according to classification system (Gill, 1988). Gill (1998) also maintained that a modern herbarium includes diverse collection of flowering plants, gymnosperms, ferns, mosses, liverworts, lichens, fungi, algae and fossils.

Other resources found in a herbarium are microscope, slides, photographs, photomicrographs, wood specimens, cellulose acetate peels, camera lucid drawing, field notebooks, diaries, letters, unpublished reports, manuscripts list of exsiccates, reprints and botanical illustrations and drawings (Idu and Osawaru, 2008). A herbarium is a growing source of knowledge about the vegetation of an area. Gill (1988) further maintained that utmost care must be taken in the arrangement and maintenance of herbaria specimen to avoid deterioration. A herbarium may contain millions of specimens gradually accumulated by some large institutions and may represents the flora of a continent or it may contain local collections Fish and Steyn (2001). Herbarium plays a vital role in the maintenance of biodiversity. Biodiversity is the variety of life on earth includes variation at all level of biological organization from genes to species to estimate that possibly half or more of all current species could be at risk of extinction in foreseeable future (Myers, 1996; Sax and Gainers, 2003). This loss of biodiversity is of critical concern, given that an increasing amount of research indicates that plays an important role in long-term ecosystem functioning (Groombridge and Jenikins, 2002). For this reason, the importance of biodiversity in nature as an important resource and can be maintained through the use of herbarium. Herbarium is a plant bank where plants are kept or preserved for future reference or other scientific studies. In botany, a herbarium (plural: herbaria) sometimes known by the Anglicized term herbal is a collection of preserved plant specimens. These specimens may be whole plants or plant parts: these are usually in a dried form mounted on a sheet but, depending upon the material, many also are kept in alcohol or other preservatives (Hall, 2001). The some term is often used in mycology to describe an equivalent collection of preserved fungi, otherwise known as a fungarium. A xylarium is a herbarium specializing in specimens of wood. A herbarium (as in the liberty Hyde Bailey Hortarium) is one specializing in preserved specimen of cultivated plants. An attempt has been made here to establish the role of herbarium in the maintenance of biodiversity with a view of establishing more herbarium, and maintaining as well funding existing ones to present floral organisms especially the endangered species. Herbaria serve as biodiversity hotspots. Modern herbaria are utilized as reference centre for identification of plants by botanist doing research work in taxonomy, ecology, agriculture, pharmacy etc (Dewolf, 1968). They are documentation centers because they contain the specimens of new taxa, plants belonging to new discoveries, plants of economic importance, voucher specimens of cytological and cytogenetic studies, photographs of important plants and all documents related with systematic research (Croal, 1978). Modern herbaria are seen as data store house on ecology habitat, distribution of plants for Geneticists chemists, pharmacists etc (Shelter, 1969). Modern herbaria provide training for young undergraduates; solve queries of scientists, environmentalists doctors, public school students thus, work as service institution (Holmgren et al 1981). Herbaria could also be viewed as artificial sacred groves for biodiversity maintenance (Mgumia and Oba, 2003; Shonil and Claudia, 2006).

Specimen preservation

To preserve their form and colour, plants collected in the field are spread flat on sheets of newsprint and dried usually in a plant press, between blotters or absorbent paper. The specimens, which are then mounted on sheets of stiff white paper, are labeled with all essential data, such as data place food, description of the plant, attitude, and special habitat conditions. The sheet is then placed in a protective case. As a precaution against insect attacks, the pressed plant is frozen or poisoned, and in most cases disinfected (Hall, 2003). Certain groups of plant are soft, bulky, or otherwise not amenable to drying and mounting on sheets. For these fruits, other methods of preparation and storage may be used. For example, conifer, cone and palm foods may be stored in labeled boxes. Representative flower or front may be pickled in formaldehyde to preserve their three-dimensional structure. Small specimens, such as mosses and lichens, are often air-dried and packaged in small paper envelopes. No matter the method of preservation, detailed information on where and when the plant was collected, habitat, colour (since it may fade over time), and the name of the collector is usually included (Fish and Steyn, 2001; Hall, 2003).

Storage of reference material and vouchers

Herbarium specimens are dried and stuck to card and then stored in insect-proof cabinet. This allows plant to be preserved for long periods (Hall, 2003). Vouchers allow future researchers to document the authenticity of the material on record. The most important voucher are type specimens-individual specimens designated by the original author when a new taken is described. Other vouchers are used to document specimens used in research. They may also document the record of a plant from a particular locality, or be drawn or photographed to represent a species in a monograph or flora. An efficient referring system allows any specimen to be retrieved quickly (Gill, 1988).

Importance of herbarium

The primary objective of the herbarium is to preserve for all time a series of specimen and notebook that will yield the maximum information about the plant concerned. Specimen in the herbarium are usually collected by field collection and essential items needed are a digger or trowel, a secateur, vasculum or polyethylene bags, a plant press containing old news papers / any other blotting material and a field notebook. Each specimen has a herbarium label. A label has the following data: (a) banner headline to show the region of the collection, (b) botanical name, (c) locality of collection, (d) the habitat, (e) name of the collector, (f) collector's field observations and date of collection and the name of the person who identified the specimen.

Herbaria are essential for the study of plant taxonomy, the study of geographic distributions and the stabilizing of nomenclature. The collections housed in herbaria are primarily used for scientific research. Research that might commonly take place in a herbarium includes.

i. Mapping current and post ecological and geographic distribution of plant to help with land care and bioprospecting.
ii. Evolutionary history of plants
iii. Existing and changing nature of plant communities and their habitats
iv. Inversion biology and need ecology
v. Molecular phylogeneties and
v. Classification and naming of plants

A well arranged herbarium is the fundamental basis of other branches of botany such as plant ecology, palynology, phytogeography, economic botany and biosystematics. Idu and Osawaru (2008) maintained that as a reference center, a herbarium is a functional resource for identification of plants by practicing taxonomists, field ecology and workers with endangered and threatened species, natural heritage employees, conservationists, naturalists and environmentalists.

The document in the herbarium is fundamental reference for basic and applied research in botany, biology, agriculture, medicine, pharmacy and genetics. Herbarium also provides major sources of information on habitat, ecology, distribution and taxonomy of rare species of plants. They provide data centers for all types of research in systematics and herbarium collections provide a foundation for training and research in plant diversity hence regarded as laboratory for much systematic research.

Some other general functions of herbaria are mentioned below:

1. Plant specimens are permanently stored in herbaria, and therefore they are the major sources of information about plants and vegetation.
2. Preserved specimens of herbaria are used in almost all types of taxonomic research.
3. A picture of all species of a genus, or all the genera of a family may be gathered only in the herbarium.
4. The classification of the world's flora is based mainly on the herbarium material.
5. List of the endangered species of any region may be prepared only herbarium specimens.
6. Limited individual collections are identified only with the help of herbaria.
7. Monographs of genera of families are prepared only by the herbarium specimens.
8. Our knowledge of the distribution of plants, evolution, and several taxonomic problems etc is based mainly on the herbarium specimens.
9. Big herbaria provide training to young students in herbarium practices
10. Exact area, region or location of the occurrence of important may be gathered from the herbarium specimens.
11. Herbaria preserve type specimens, and thus serve as a repository of chromosome, chemotaxonomy, and experimental voucher specimens.

12. Herbarium material is used in studying the palynology, anatomy, and chemical aspects of desired plants.
13. Herbaria provide loan of specimens for study at other institutions.
14. Herbaria preserve the national plant wealth, and provide scientific information to the public regarding the plants.

Public outreach

The staff of the herbarium often provides information about poisonous plants, medicinal plants, needs, ornamentals, and species at risk and so on. Doctors, farmers, government officials, horticulturists, landscape architects, environmental consultants, foresters, landowners, students and teachers are among the many people who may make use of the herbarium.

Biodiversity

Biodiversity is the variety of life on earth that includes variation at all level of biological organization from genes to species to ecosystem (Agbogidi and Okonta, 2011). Genetic, organization and ecological diversity are all elements of biodiversity with each including a number of components.

Genetic diversity

Every individual in a species differ widely from other individuals in its genetic make up due to large number of combinations possible in the genes. This genetic variability is essential for healthy breeding population of a species (Olele and Agbogidi, 1999). The reduction of genetic diversity will result in-breeding in species. This leads to genetic anomalies and eventually extinction of that particular species. The variety of nature's bounty can be explored if domestic plant and animal varieties with their wild varieties are bred to make them more productive and disease resistant. Modern biotechnology also manipulate gene to develop better types of seeds, medicines and other industrial raw materials (Agbogidi and Okonta 2011).

Organism diversity

Every natural and manmade ecosystem is made up of a variety of animal and plant species. Some ecosystems such as tropical rainforests are very rich in the number of species as compared to other ecosystems such as the desert ecosystem. At present the scientists have been able to identify 1.8million species on the earth. However, this may only be a fraction of what really exists.

Ecosystem diversity

There are a large variety of different ecosystems on the earth. Distinctive ecosystems include natural landscapes like forests, grass lands, deserts, mountains etc as well as aquatic ecosystem like rivers, lakes, and sea. Each of these also has man-modified areas such as farmlands, grazing lands, urban land etc. Any ecosystem that is overused or misused loses its productivity and got degrade (Agbogidi and Okonta, 2011).

Table 1. Elements of biodiversity.

Genetic diversity	Organizational diversity	Ecological diversity
Nucleotides	Individuals	Population
Genes	Populations	Niches
Chromosomes	Subspecies	Ecosystem
Individual	Species	Landscapes
Population	Genera	Bioregions
	Families	Biomes
	Order	
	Classes	
	Phyla	
	Kingdoms	

Source: Gaston and Spicer (2004).

Biodiversity and its importance

Many people want to know "why is biodiversity important?" Firstly, it is important because it represent the almost variety of plant and animal life, and the variety of the types of earth's ecosystem that support life as we know it. It enables human to survive in what would otherwise result in adverse conditions (Sax and Gaines, 2003). Biodiversity is the very stuff that supports the evolution and differentiation among the varying species. It is why cats are cats and horses are horses and humans are humans. Further, it is responsible for the differences among groups within the large species (Olele and Agbogidi, 1999). Look at how many seemingly different types of humans there are or jungle cats or birds. Water, wind, and sunlight generate much of the energy we use and the action of the planet on various substances over the course of centuries create and provide things like coal, which is use to generate heat and more energy. Energy from wind, water, sunlight, and coal heats our home and power all our applicants decaying animal matter has, over the centuries created the fossil fuel we use on a daily basis to power the vehicles that make transportation relatively easy and convenient.

Without biodiversity we could be (if we existed at all) a homogeneous population, with each of us having the same vulnerabilities (Olele and Agbogidi, 1999). This would mean that in case of an epidemic, we could all be killed since there would be no biologic differences that would enable some of us to survive and adapt. Much of our modern medicine is based on combinations of biologically diverse substances isolated from various plants (which we, therefore, label medicinal). Even before the rise of modern medicine, ayorveda and unani systems of medicine used various plants to achieve various results. Without those plants, and the great variety of insects that are vulnerable to disease. The biodiversity contained in the ecosystem provides forest dwellers with their daily need-food, building materials, fodder, medicines and a variety of other products (Agbogidi and Eshegbeyi, 2008).

Biodiversity also provides us with lumber, granite, and marble to name a few of the building materials much human habitation depends upon we would largely be without shelter. While humans are omnivorous, without biodiversity there would be virtually no variety in our diets. One reason to ask "why is biodiversity important?" is because biodiversity provides a literal treasure trove of foods, things as common as wheat or corn to things as exotic as some of the sea food used in sushi. Further, not all the nutrients we need are in any particular food, so without a diverse base of foods to make combinations from, our general health would suffer. Biodiversity sustains the bodies we live in, and affects the live we lead, and the societies we form (Agbogidi and Okonta, 2011).

Many traditional societies have played an important role in preserving their biodiversity. They value biodiversity as a part of their livelihood as well as through cultural and religious sentiments. Traditional agricultural societies have been growing a great variety of crop which acts as an insurance against the failure of one crop. Modern agricultural practices on the other hand, depend largely a monoculture with little of importance given to cash crops for national and international markets. This has resulted in local food shortage, unemployment, landlessness and increased vulnerability to drought Agbogidi (2011). Dependence on irrigation facilities, fertilizers and pesticides has also increased. Besides, all forms of life have a right to exist on the earth. Apart from the economic importance of conserving biodiversity, there are several cultural, moral and ethical values which are associated with the sanctity of all forms of life. Biodiversity also makes irreplaceable contribution to our aesthetics, imagination and creativity. It forms an integral part of tourism in the world. People all over the world visit national parks, sanctuaries, and resort to recreate them. It not only helps them to de-stress but also help them to feel one with nature (Myers, 2001).

Threats to biodiversity

Biodiversity is a fragile thing, susceptible to all sorts of threats. Even as it supports all life on earth, it is constantly facing threats and damage that are almost impossible for our multiple ecosystems to recover from. Threats to biodiversity looms human greed. Historically, humans have always taken what they needed from the earth itself and from its plant and animal species, with no regard as to whether the resources beings consumed were finite or not (Agbogidi, 2012). It has only been since the middle of the 1980s, as species started becoming extinct at a record rate, that threats to biodiversity became recognized as a major concern. Deforestation has left areas of former forest bare and inhospitable to the animals and plants that depended on them for food and substance (Agbogidi, 2002; Agbogidi and Uzokwe, 2012). Some bodies of water, such as the Aral Sea, have had their Sabine levels change so radically that they are inhabitable by the marine life that use to be plentiful. These and other threats to biodiversity, again mostly caused by humans, have created situations where support for the human life of some regions is imperiled by the changes to the area (Agbogidi, 2011).

For example, when a body of water is no longer habitable, the fish become extinct or migrate elsewhere, contributing to hunger of the local land species that used to feed on them.
Engineering projects such as dams and irrigation channels which change the flow of water to a region, and can create either flood basins or deserts, depending an which made threats to biodiversity. They render vast amounts of land unusable for growing food, although to be fair an irrigation project is usually implemented to bring water to land that is more either arid or far more populous than the land used for the project.

Other threats to biodiversity

The millennium ecosystem assessment identifies habitat change, climate change, invasive species, over-exploitation and pollution as the primary drivers leading to loss of biodiversity. Humans have had an effect on every habitat on earth particularly due to conversion of land for agriculture. Cultivated systems (areas where at least 30% of the landscape is in be plants, shifting cultivation, confined livestock production, or freshwater aquaculture) now cover one quarter of earth's terrestrial surface. Habitat loss also occurs in coastal and marine systems, though these changes are loss well documented. Trawling of the seabed, for instance, can significantly reduce the diversity of been thin habitats (Agbogidi, 2011).

Herbarium and biodiversity maintenance

Addressing the question, "what can be done to actively preserve, maintain and promote that diversity? Become crucial. Herbarium play a role of recognize ecosystem and capable of supporting considerable amount of biodiversity and have a basic understanding of the pattern and processes that affect biodiversity. In the following ways herbarium can help in maintaining biodiversity:

i. Databank for biodiversity: Loss of biodiversity has been named as the major crises facing the world today. Specimens stored in herbaria provide documentation of biodiversity and historical record over 100 of years.
ii. Herbarium records: Is used in creating range maps and plots historic and correct species distributions.
iii. Plant identification: Researchers, members of the public, and people with specific interests such as vets, herbicide companies, and consultant being vegetation surveys, may all approach the herbarium to have plants identified knowing fully well that identification is a basic essential service provided by herbaria, the flora of an area.
iv. Teaching: The materials in a herbarium may be used to teach many subjects such as plant taxonomy, ecology, biogeography, history, biochemistry and ethno botany concerning the importance of biodiversity.

CONCLUSION

This study attempted to establish the role of herbarium in the maintenance of biodiversity and maintained that herbarium is a biodiversity hotspot. Herbarium commonly referred to as a collection of pressed and dried specimens usually arranged according to classification system. It is seen as a plant bank where plants are kept for future reference or for other scientific studies. Biodiversity is the variety of life on earth which includes variation at all levels of biological organization from genes to species to ecosystem. It is of direct importance in application such as food, medicine and environmental functions, like carbon sequestration, nutrient cycling and pollination. The paper established that herbarium assists greatly in the maintenances of biodiversity by creating a data bank, plant identification, teaching and herbarium records used in creating range maps, plots historic and correct species distributions.

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