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Source: Tropical Conservation Science, 4(1) : 103-110

Published By: SAGE Publishing

URL: https://doi.org/10.1177/194008291100400110

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Short communication

Invasive alien plant species in Nigeria and their effects on biodiversity conservation

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Abstract
With very scanty information on invasive alien species (IAS) in Nigeria, this study was conducted to identify the invasive species in the field gene bank of the National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria, on the latitude 7° 22' north of the equator and longitude 3° 50' east of the Greenwich Meridian, and also to assess the level of the species' disturbance to the conserved native plants in the protected area. This study involved sampling of the field gene bank and an on-site assessment and identification of the species and their effects on the indigenous plants established in the field for conservation. Twenty-five invasive plant species were identified, across 16 plant families, of which 14 were herbs, followed by vines, shrubs, and trees, all of which are presently estimated to occupy about 18% of the gene bank. The effects of IAS on the indigenous plants conserved in the field gene bank range from competition for space and nutrients and alteration of the tree canopies (thereby affecting the microclimatic conditions in the lower strata) to obstruction of the plants' reception of sunlight (which could thereby reduce the potential yield of the fruit trees in the gene bank. The paper also discusses the effects of IAS on biodiversity conservation in Nigeria. Human disturbance was observed as the major factor responsible for the spread of these IAS in the gene bank. The paper concludes by advocating stricter screening measures before introducing new plants into the country, capacity building on the early detection and management of IAS in protected areas for the technical staff, biological control, and exchange of technical information among concerned countries.

Keywords: Invasive alien species, Biodiversity conservation, field gene bank, NACGRAB

Received: 21 February 2011; Accepted: 7 March 2011; Published: 28 March 2011.

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Cite this paper as: Borokini T. I. 2011. Invasive Alien Plant Species in Nigeria and their effects on Biodiversity Conservation. *Tropical Conservation Science* Vol. 4 (1):103-110. Available online: www.tropicalconservationscience.org

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Introduction

Biological invasions by alien species are now considered one of the main factors in biodiversity loss and endangered species listings worldwide [1], and almost certainly the worst one on islands [2-3]. This is because the natural biogeographical barriers of oceans, mountains, rivers, and deserts, which provided the isolation essential for unique species and ecosystems to evolve, have lost their effectiveness, due to the increase in economic globalization. This has resulted in an exponential increase in the movement of organisms from one part of the world to another through trade, transport, travel, and tourism, in some cases causing tremendous damage to the natural ecosystems of their new habitats. Invasive alien species (IAS) are found in all taxonomic groups, and they include introduced viruses, fungi, algae, mosses, ferns, higher plants, invertebrates, fish, amphibians, reptiles, birds, and mammals. They have invaded and affected native biota in virtually every ecosystem type, in all regions [4]. In protected areas, as elsewhere, impacts from invasive alien species take the form of impacts on ecosystem function, on ecosystem structure, and at the level of species communities or habitats as well as at the level of species. IAS directly or indirectly impact on livelihoods and poverty alleviation, through affecting ecosystem services and through impinging on cultural and heritage values. The prevalence of IAS has gone beyond free areas and is now being reported in protected areas across the world. De Poorter *et al* [5] in his report was able to identify 487 protected area sites with IAS recorded as an impact or threat; in 106 countries, protected area(s) have been recorded as having IAS as an impact or threat. The report covers all regions, but especially Asia, Africa, South and Central America (including Mexico and the Caribbean), and Europe. It records 326 IAS as an issue for protected areas. Furthermore, the report noted 277 Ramsar sites where IAS are reported as a threat, either from within the site or from within the catchment, as well as 27 World Heritage (WH) sites where invasion by IAS is already taking place [5]. In economic terms, IAS have been estimated globally to cost US$400 million annually due to loss of revenue and expenditures on control measures, while in Africa, an estimate of US$60 million is spent annually on the control of IAS [6].

Virtually all countries in Africa are affected by IAS. In 2004, the IUCN–World Conservation Union identified 81 IAS in South Africa, 49 in Mauritius, 44 IN Swaziland, 37 in Algeria and Madagascar, 35 in Kenya, 28 in Egypt, 26 in Ghana and Zimbabwe, and 22 in Ethiopia [7]. However, very little is known about IAS in Nigeria, with most technical reports and literatures reporting fewer than 10 invasive plants in the country. Aside from plant invaders, *Rattus rattus* and Avian influenza virus were also considered IAS in Nigeria [6]. The initial entry of IAS into Nigeria was mainly through exotic plant introductions by the colonial rulers either for forest tree plantations or for ornamental purposes. The entry of exotic plants into Nigeria during the post-independence era was favored by increasing economic activity, commencement of commercial oil explorations, introduction through ships, and introduction of ornamental plants by commercial floriculturists.

Due to overexploitation, the remaining natural ecosystems and primary forests in Nigeria are restricted to the protected areas which include one biosphere reserve, seven national parks, one World Heritage site, 12 Strict Nature Reserves (SNRs), 32 game reserves/wildlife sanctuaries, and hundreds of forest reserves. These are in addition to several ex-situ conservation sites such as arboreta, botanical gardens, zoological gardens, and gene banks managed by several tertiary and research institutions. Therefore, in order to make a reliable assessment of invasive species in Nigeria, such studies should be limited to the protected areas. This pilot survey was conducted to assess the level of invasiveness and the impacts of IAS on the field gene bank of the National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, southwestern Nigeria.

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Methods

Study Area

The field gene bank of the National Centre for Genetic Resources and Biotechnology (NACGRAB) is a protected area earmarked for the conservation of forest trees, fruit, oil, roots, and tuber crops and all other plants whose seeds are recalcitrant and cannot be successfully stored in cold seed gene banks. It is about 12 hectares wide, located within latitude 7° 22' north of the equator and longitude 3° 50' east of the Greenwich Meridian (Fig. 1)



Fig. 1: Map of Nigeria showing the location of the study area, located in Ibadan (red arrow).

The field gene bank was established in 1987, having been previously a natural ecosystem partly occupied by close canopy forest, but mainly with open forests and scattered trees as well as shrubs and herbs. More forest tree crops have been introduced and established on the site over the years. According to a plant diversity assessment carried out and reported by Borokini *et al* [8], members of the family Caesalpiniaceae are the dominant species in the field gene bank. The protected area is surrounded by roads and a rail line with residential buildings within 20 meters distance of the gene bank.

Assessment

A comprehensive field survey involving an on-site assessment and identification and plant collection of IAS were done between Sept. 1 and 5, 2010, on the field gene bank. The level of invasiveness and disturbance of the native plants were recorded and photographs taken. Furthermore, the conserved plants affected were also noted. The plant collections have been deposited in the herbarium at NACGRAB.

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Results

Twenty-five (25) invasive plants were identified during the survey, which extended across 16 plant families (Appendix 1); of these, 14 were herbs, 8 were vines (which include creepers and climbers), 2 were shrubs, and one was a tree (Fig. 2). The Mimosaceae family had the highest number of plant representatives (4) among the invasive plants documented, followed closely by Euphorbiaceae (3), while the remaining plant families had one or two plant representatives on the list (table 1). In most cases, these plant invaders were found in colony/cluster populations and produced fruits/seeds in large quantities to facilitate rapid dispersal and colonization of more lands and spaces. The conserved plants in the field gene bank that were affected included *Mangifera indica, Theobroma cacao, Hura crepitans, Irvingia gabonensis, Cassia* sp*, Terminalia superba*, and many other tree crop seedlings.

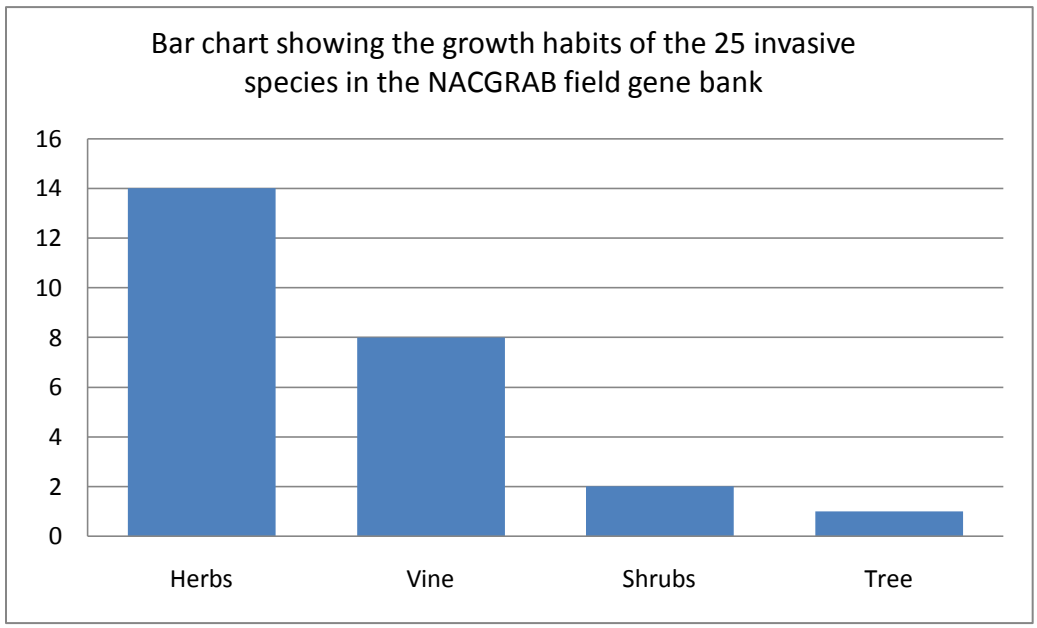


Fig. 2. Bar Chart showing the growth habits of the 25 invasive species in the NACGRAB field gene bank

Discussion

This study involves a comprehensive field survey of the field gene bank of the National Centre for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Nigeria, for identification of IAS and an assessment of their disturbance on the native species. As comparatively small as the gene bank is, 25 plant invaders were identified, indicating a severe level of plant invasion in the site. It can be estimated that the land cover by the IAS on the field gene bank is up to 18% of the total land of the gene bank. Similarly, in South Africa, alien plant species are reported to now cover more than 10.1 million hectares (ha), threatening the indigenous plants [6]. Impacts of the shrubs, herbs, and tree species of the IAS identified include competition for land, space, and nutrients as well as sunlight receptivity. The most aggressive species are the climbers that spread both horizontally and vertically along wide perimeters, colonizing every area within their reach. In addition, these vines find their way to the canopy of the trees and extend their vegetation to cover part or all the canopy of such trees, thereby reducing the receptivity of those plants to the sunlight needed for photosynthesis. In addition, the extensive growth of these climbers over the canopy can affect the canopy structure and formation of these trees, thereby affecting the microclimate of the land lying below. An alteration of the microclimatic conditions can

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affect the diversity, density, and survival of plants and animals that are already adapted to the existing microclimatic conditions in the forest lower layers. Particular mention must be made of *Chromolaena odorata*, which is considered a problem in Benin, Central African Republic, Congo, Cote d'Ivoire, Democratic Republic of Congo, Liberia, Mauritius, Nigeria, Senegal, South Africa, Swaziland, and Togo [6].

Human activities also contribute immensely to the introduction and spread of IAS in the gene bank. These human activities are in form of land clearing and farming activities and field characterization of orthodox crops. In addition, major roads and footpaths bisect various portions of the field gene bank that are accessible to everybody, giving wanted and unwanted visitors unrestricted access to the protected area, all of which could possibly promote the introduction and spread of invasive species.

Most invasive species, once established, becomes permanent. Eradication is possible in a few instances, but only at great expense and effort [9]. Most others require control, which may be said to be successful when the plant no longer exceeds a threshold level determined by the objectives of the managers [10]. Controlling the invasive alien species poses a great challenge, since it must be done without affecting the native plants conserved in the field gene bank. Biological control still offers the best method of controlling IAS. However, the importation, breeding, and release of the leaf-feeding moth *Pareuchaetes pseudoinsulata* and seed-feeding weevil *Apion brunneonigrum* in Ghana and Nigeria in the early 1970s to control *Chromolaena odorata* have not been successful because the insects did not establish [11-12]. Controlling water hyacinth by using a phytophagus weevil, *Neochetina eichhornia*, has not been very successful, though it was successful in South Africa. This calls for more intensive studies on biological control of IAS so as to improve its effectiveness.

Implications for Conservation

The impacts and contributions of IAS to global biodiversity loss have reached levels that attract the attention of all scientists concerned. The threat posed to biodiversity by IAS is considered second only to that of habitat loss [13]. Baillie *et al* [14] reported in the 2004 IUCN Red List of Threatened Species that IAS contributed to 50% of freshwater fish species extinctions and contributed to the threat to the survival of 67% of oceanic islands birds. Nigeria is highly susceptible to invasion by alien species and unfortunately similar studies on the presence and impacts of IAS have not been carried out in other protected areas in Nigeria. Invasive alien species may threaten native species as direct predators or competitors, as vectors of disease, or by modifying the habitat or altering native species dynamics [15]. Invasive species may out-compete native species, repressing or excluding them, and therefore fundamentally changsing the ecosystem. They may transform the structure and species composition of the ecosystem by changing the way by which nutrients are cycled through the ecosystem [16]. Furthermore, IAS may cause changes in environmental services, such as flood control, water supply, water assimilation, nutrient recycling, conservation, and regeneration of soils [17]. The colonization of fruit tree canopies, as observed in the field gene bank, can reduce the fruiting potentials of the trees, and this can adversely affect the population of frugivorous animals and birds that depend on the fruits for food. There is also risk in the gene bank of habitat degradation and changes in the species composition.

The field gene bank was established and is expected to be a back-up conservation site for the in-situ conservation sites in case of loss of these biologically diverse resources. Therefore, the following recommendations are made regarding the prevention and management of IAS in Nigeria:

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1. Risk assessment, prevention, early detection, and rapid response to the incidence of IAS can help stop the threats of biological invasion at an early stage, and reduce environmental, livelihood, and financial costs.
2. There is a need for capacity building for the control and management of invasive species in Nigeria. There are hardly any technical officers in Nigeria who are trained in IAS.
3. There is a need for effective implementation of existing laws that bar people from farming in protected areas. In many of the protected areas in Nigeria, including the field gene bank of NACGRAB, the major factor that supports the growth, spread, and survival of invasive species is human disturbance including land clearing for farming. The management of invasive species should be mainstreamed into the policy formulation of laws and policies pertinent to environmental matters in Nigeria.
4. Awareness of invasive species is poor. Most Nigerians know very little about this, and yet they contribute to the spread of invasive species without knowing it. Nigerians should be given orientation on exotic plant introduction, while extensive studies should be carried out on species to be introduced into the country. They should be certified environmentally safe before being approved for entry.
5. Some of the invasive species are already "naturalized" to Nigeria and this could make their eradication and control difficult. Therefore, the best way to manage them is to control their spread. One of the ways by which this can be achieved is by utilizing these plants as fodder crops, for medicinal purposes, and for any other relevant use.
6. Also, there may be the need to globally review the status and definition of IAS, because some native species are also assuming the role of invasive species as a result of disturbance of the natural ecosystem. Therefore, the management of invasive species should not be limited to IAS, but attention should also be given to invasive native species (INS).

Acknowledgments

The author is highly indebted to the research officers at Forestry Herbarium, Ibadan (FHI), of the Forestry Research Institute of Nigeria (FRIN) for the identification of some of the species. Sincere gratitude goes to all the reviewers for their constructive criticism and significant improvement of this paper.

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Appendix 1. Invasive species found in the field Gene bank of NACGRAB, Ibadan

S/N	Plant name	Family	Growth habit
1	*Acalypha indica* Linn.	Euphorbiaceae	Herb
2	*Adenia cissampeloides* (Planch ex. Benth) Hams	Passifloraceae	Vine
3	*Ageratum conyzoides* L.	Asteraceae	Herb
4	*Alternanthera brasiliensis* Hort ex. Vilmorin	Amaranthaceae	Herb
5	*Alternanthera sessilis* (Lin.) DC.	Amaranthaceae	Herb
6	*Antigonum leptopus* Hook. & Arn.	Polygonaceae	Vine
7	*Chromolaena odorata* (L.)	Asteraceae	Herb
8	*Cissus arguta* Hook. f.	Vitaceae	Vine
9	*Commelina benghalensis* L.	Commelinaceae	Vine
10	*Dissotis rotundifolia (Sin.) Triana.*	Melatomataceae	Herb
11	*Euphorbia graminea* Jacq.	Euphorbiaceae	Herb
12	*Euphorbia heterophylla* L.	Euphorbiaceae	Herb
13	*Lantana camara* L.	Verbenaceae	Shrub
14	*Leucaena leucocephala* (Lam.) de Wit	Mimosaceae	Tree
15	*Merremia kentrocaulos* (C.B Clarke) Hallier f.	Convovulaceae	Vine
16	*Mimosa invisa* Mart	Mimosaceae	Herb
17	*Mimosa pudica* L.	Mimosaceae	Herb
18	*Mucuna pruriens* (L.) DC	Fabaceae	Vine
19	*Passiflora foetida* L.	Passifloraceae	Herb
20	*Platostoma africanum P. Beauv.*	Labiatae	Herb
21	*Ruthalicia eglandulosa* (Hook. f.) C. Jeffrey	Cucurbitaceae	Vine
22	*Schrankia leptocarpa* DC	Mimosaceae	Herb
23	*Setaria barbata (Lam.) Kunth*	Poaceae	Herb
24	*Tithonia diversifolia* Hemsl.	Asteraceae	Shrub
25	*Triumfetta rhomboidea* Jacq.	Malvaceae	Vine

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