

## Localization and Distribution of Two Invasive Alien Species *Eichhornia crassipes* and *Echinochloa pyramidalis* in the Pool Malebo Eco-region, Democratic Republic of the Congo

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### Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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### ABSTRACT

**Aim:** To study the distribution of two invasive alien plants and associated plants as well as their distribution in the Malebo Pool eco-region.

**Methodology:** The study was carried out by direct observation by circulating on a motorized canoe. Plant samples were randomly harvested (n=6) in August 2020 depends on the sites. Plant species identification was performed on the field, and those species of which the identification was difficult, were brought to the laboratory for proper identification according to APG III.

**Results:** 19 species, including two Pteridophytes and 17 Angiosperms, belonging to 19 families and 12 orders were identified. The site of Molondo was the most diversified with 15 plant species, followed respectively by the sites of Mipongo (13 species), Japon (12 species) and Kingabwa (07 species). The plant species *Ludwigia abyssinica* A. Rich., *Ipomoea aquatica* Forsk, *Eichhornia crassipes* (Mart), *Pistia stratiotes* L, *Echinochloa pyramidalis* (Lam) and *Salvinia molesta* D.S. Mitchell were present in all four prospected sites. *E. pyramidalis* and *E. crassipes* constitute a serious threat for the environment and are source of erosion/loss of aquatic biodiversity.

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Physiologically, these species form a mono-specific carpet and eliminate native or autochthonous species of aquatic flora.

**Conclusions and Suggestions:** The invasion of alien species is a consequence of human activities and a concern, as it affects all sectors of society. These plants can alter, disrupt, and degrade many ecosystem services like the disturbing of habitats and the alteration of the environmental and biological conditions around them. They can also reduce light and diversity of native aquatic plant species. Controlling invasive alien species is thus a challenge for the Congolese society. Political decision-makers are therefore invited to take appropriate measures for managing and protecting the local aquatic flora and valorize the invasive plants as potential medicinal remedy.

**Keywords:** *Bio-invasion; aquatic ecosystem; native species; invasive plants; Congo basin; The Democratic Republic of the Congo.*

## 1. INTRODUCTION

The invasive behavior of *Eichhornia crassipes* in the edges of Congo River dates back to 1954, prompting the Belgian Colonial Administration to issue ordinance decree on May 4, 1955, which prohibits the possession, transportation, sale, cultivation and multiplication of this plant species, which was considered as alien and invasive by the colonial authorities [1]. Currently, this species is one of the world's most invasive aquatic plants. *E. crassipes* is beautiful and has purple and violet flowers, which makes it a popular ornamental plant for ponds. It should be noted that this species is present in more than 50 countries worldwide. As it fills the surface of ponds or rivers, *E. crassipes* does not allow light and oxygen to penetrate the aquatic ecosystem and this situation decreases the biodiversity of native aquatic ecosystems knowing that light and oxygen are vital ecological factors contributing to the survival of several aquatic living beings. This leads to the disruption of food chains and cycle of nutrients [2]. *E. crassipes* preferentially colonizes fresh waters of the lower courses of the Mainland Rivers as reported by [3]. Invasive alien species are considered the second cause of erosion and the regression of biodiversity just after the destruction and fragmentation of habitats. Worldwide, it is known that socio-environmental impacts associated with plant invasions have increased and are projected to increase significantly due to climate or land-use change [4-7]. Besides their negative or positive impacts on biodiversity [8,9], invasive plants also have positive economic, social, and ecological contributions [10], of which local populations are well aware. Local people assess the impact of invasive plants based on how their socio-economic needs are influenced by these species

[11,12]. In Africa, local people who also know to manage these plants use several invasive plant species for different purposes.

A good management and knowledge of these invasive species could contribute to the improvement of population living conditions [7]. Species and ecosystems constitute the biological diversity of the earth and are so important that their loss and degradation handicap nature. Species other than ours have a right to exist and a place in the world. We are unable to determine which species are essential or redundant to the functioning of a given ecosystem and which will thrive in a changing world [13].

The aim of the present research work was to identify the location and distribution of two invasive aquatic species namely *E. crassipes* and *E. pyramidalis* in Pool Malebo in Kinshasa, Democratic Republic of the Congo.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The Pool Malebo (former Stanley Pool: Fig. 1; Latitude: 4°05'- 4°20' S; Longitude: 15° 19'-15° 32' E, average altitude: 272 m above the sea), constitutes the terminal part of the middle course of the Congo River [14]. It is the widening of the Congo River at the border between the Democratic Republic of the Congo and the Republic of Congo. The Pool Malebo constitutes a vast expanse of water between the capitals of the two Congo [15].

It refers to the plant *Borassus aethiopum* Mart (local name: Malebo), which is abundant in the alluvial plain of Kinshasa City [16].

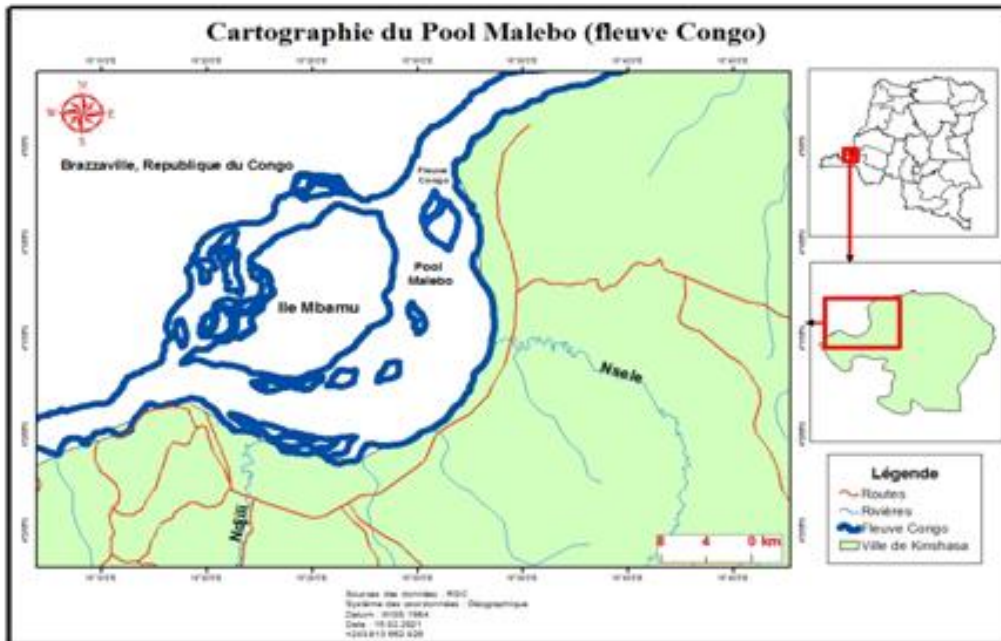


Fig. 1. Localization of Kinshasa City and Pool Malebo

## 2.2 Methods

### 2.2.1 Identification of plant species

Plant species identification was performed by our team on the field, and those species of which the identification was difficult, were brought to the laboratory for proper identification. Definitely, the identification of collected samples was identified by comparison with the herbarium floristic collection of the University of Kinshasa [17,18].

### 2.2.2 Floristic studies

- **Biological types**

The classification of biological types was carried out as previously reported [19-24]. The following types have been recognized in the flora of these rivers:

- **Phanerophytes**

This group is subdivided in Mesophanerophytes (MsPh), Microphanerophytes (McPh), Nanophanerophytes (NPh), Climbing phanerophytes (Phgr).

- **Chamaephytes**

This group is sub divided in: Erect chamaephytes (Chd), Climbing

chamephytes (Chgr), Prostrate chamephytes (Chpr), Creeping chamaephytes (Chrp), Climbing chamephytes (Chgr) and Cespitose chamaephytes (Chces). *Hemicryptophytes* (Hc) & *Hemicryptophytes cespitose* (Hces) are mainly made of Geophytes (G), Therophytes (Th) and Hydrophytes (Hd). Each main group has also specific characteristics. Geophytes (G) are subdivided in Bulbous geophytes (BG), tuberous geophytes (Gt) and rhizomatous geophytes (Grh). While Therophytes (Th) are sub divided in Cespitose Therophytes (Thces), Erect therophytes (Thd), Prostrate therophytes (Thpr) and Climbing therophytes (Thgr) and Hydrophytes (Hd).

- **Types of Diaspores**

This ecological character explains the way of dissemination of different species. Therefore we have: anemochorous plants (pterochores (ptero), pogonochores (pogo), sclerochores (Sclero)), zoochores plants (desmochores (desmo)), autochorous plants (ballochores (Ballo) and barochores (Baro)) and hydrochoric plants (pleochores (Pleo)).

• **Raw spectrum**

The raw spectrum (RS) is defined as the number of species identified in each group in accordance with the ecomorphological criterion considered and is expressed by the following formula:

$$RS = \left[ \frac{\text{Number of species from considered group}}{\text{total number of species in all groups}} \right] \times 100$$

• **Types of Phytogeographic distribution**

The phytogeographic distribution was carried out according to chorological divisions of tropical Africa as reported by [21-23, 25-29].

We have Species with a wide range (Cosmopolitan (Cosm), Pantropical species (Pan), Paleotropical (Pal), Afro-Malagasy (Am)).

• **Species of the low Guinean element**

The plants belonging to this group are distributed in the Guinean-Congolian

region, among them Guinean-Congolian species (GC) and Guinean species (G) which is endemic to the Congo Basin [30].

**3. RESULTS**

**3.1 The Floristic Inventory of Aquatic Plants**

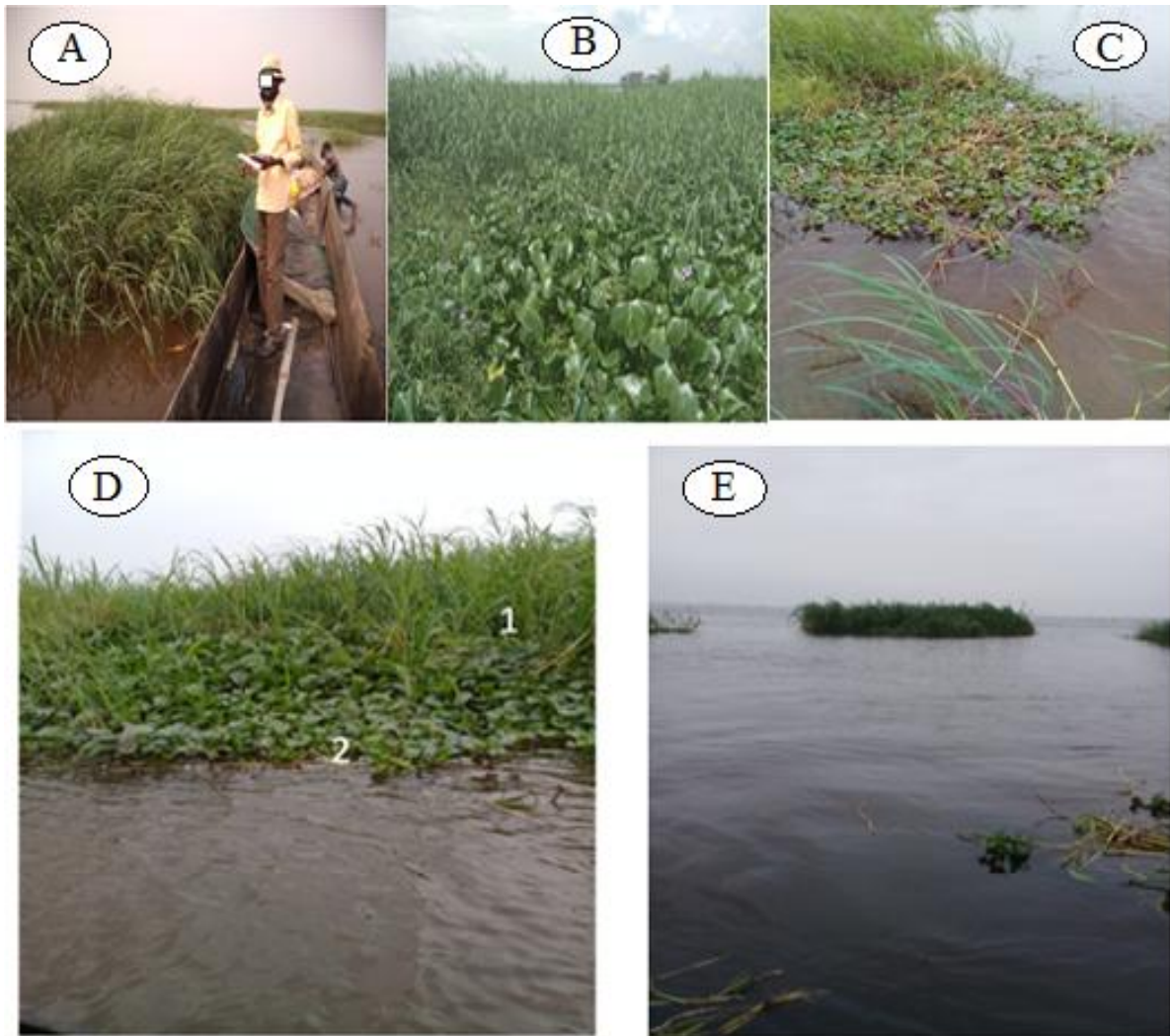
The list of inventoried species of different sites is given in the Table 1. From the prospection of four different sites, 19 species, including two Pteridophytes and 17 Angiosperms, belonging to 19 families were identified. The site of Molondo was the most diversified with 15 plant species, followed respectively by the sites of Mipongo (13 species), Japon (12 species) and Kingabwa (07 species). The plant species *Ludwigia abyssinica* A. Rich., *Ipomoea aquatica* Forsk, *Eichhornia crassipes* (Mart), *Pistia stratiotes* L, *Echinochloa pyramidalis* (Lam) and *Salvinia molesta* D.S. Mitchell were present in all selected sites.

Figs. (2a-e). illustrate different investigated sites with invasive plant species in Pool Malebo eco-region.

**Table 1. Comparison of different species identified in different prospecting sites**

Plant species	Family	Sample harvested sites			
		Molondo	Mipongo	Japon	Kingabwa
<i>Aechinomum sensitiva</i> Swartz	Fabaceae	-	+	+	-
<i>Aeschynomene fluitans</i> L.	Fabaceae	+	-	-	-
<i>Alternanthera sessilis</i> (L) DC	Amaranthaceae	+	+	+	-
<i>Colocasia esculenta</i> (L) Schott	Araceae	+	-	-	-
<i>Commelina diffusa</i> Burm.F	Commelinaceae	+	+	+	-
<i>Cyperus papyrus</i> L	Cyperaceae	-	-	+	-
<i>Echinochloa pyramidalis</i> (Lam)	Poaceae	+	+	+	+
<i>Eichhornia crassipes</i> (Mart)	Pontederiaceae	+	+	+	+
<i>Gysekia pharnaceioides</i> L.	Gisekiaceae	-	+	+	-
<i>Ipomoea aquatica</i> Forsk	Convolvulaceae	+	+	+	+
<i>Leersia hexandra</i> (Sw)	Poaceae	+	-	-	-
<i>Ludwigia abyssinica</i> A. Rich.	Onagraceae	+	+	+	+
<i>Ludwigia leptocarpa</i> (Nutt) Hara	Onagraceae	+	+	-	+
<i>Nymphaea lotus</i> L	Nymphaeaceae	+	-	-	-
<i>Oldenlandia affinis</i> (Roem. &Schult.)	Rubiaceae	-	+	-	-
<i>Pistia stratiotes</i> L	Araceae	+	+	+	+
<i>Polygonum lanigerum</i>	Polygonaceae	+	+	+	-
<i>Salvinia molesta</i> D.S. Mitchell	Salviniaceae	+	+	+	+
<i>Selaginella myosorus</i> (Sw.) Alston.	Selaginellaceae	+	-	-	-

Legend: (+) presence; (-) absence



**Figs. 2. 2a. Monospecific *Preairi* of *Echinochloa pyramidalis*; 2b. Invasion of two species *Eichhornia crassipes* and *Echinochloa pyramidalis* in Pool Malebo eco-region; 2c. *Echinochloa pyramidalis* and *Eichhornia crassipes*; 2d. *Eichhornia crassipes* and *Echinochloa pyramidalis*; 2e. *Echinochloa pyramidalis***

### 3.2 Study of Ecological Characteristics

#### 3.2.1 Biological types

The weighted biological types of inventoried plants are given in Fig. 3.

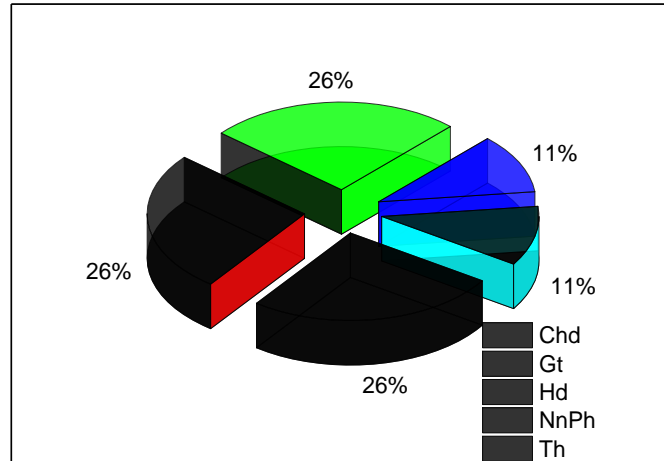
It was observed the predominance of Chamephytes (Chd), Geophytes (Gt), and Hydrophytes (Hd): 26.3% each, followed by Nanophanerophytes (NnPh) and Therophytes (Th) which represent 11% each.

The phytogeographical distribution of different plant species inventoried is given in the Fig. 4.

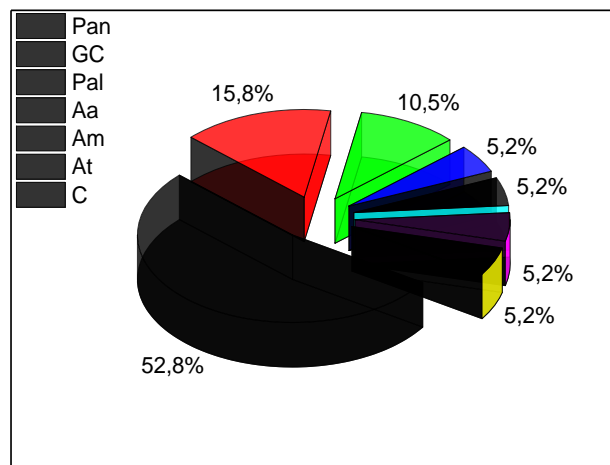
From the figure, it was observed a predominance of Pantropical plant species (52.8%), followed respectively by Guineo-Congolian plant species (15.8%), and Paleotropical plant species (10.5%). The other taxa (Aa, Am, At and C) represented each one 5.2%.

The types of diaspores of different plant species are given in Fig. 5.

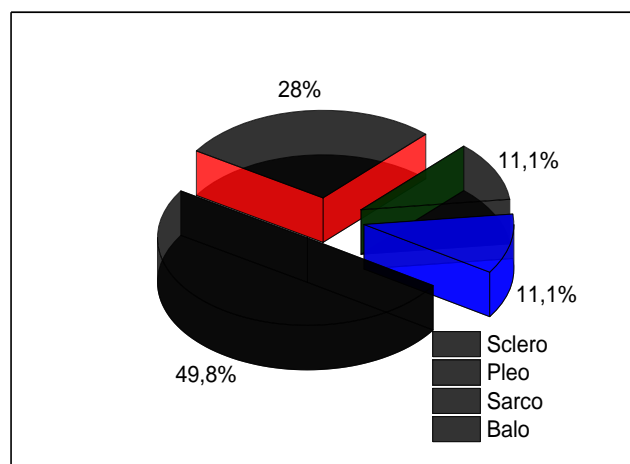
There is a clear predominance of sclerochore species (47.3%), followed respectively by Pleochores (26.6%), sarcochores and ballochores (10.5%, each). While desmochorous species were absente.



**Fig. 3. Weighted biological types of inventoried plant species**



**Fig. 4. Weighted phylogeographic distribution of inventoried plant species**



**Fig. 5. Weighted types of diaspores of inventoried plant species**



#### 4. DISCUSSION

The present study on invasive aquatic alien plants in the Pool Malebo ecosystem reveals 19 plant species, namely 12 exotic species and 2 invasive aliens. These findings revealed that the Kinshasa aquatic flora is polluted by the presence of several exotic plant species (63.16%). This means that the aquatic environment is open, and the hydrochory is one of the most effective modes of dispersion of diaspores. The authors [31] confirmed recently that *E. crassipes* and *E. pyramidalis* are among the most invasive plant species in the Pool Malebo ecosystem as well as the rivers like Lukaya and Funa. Among the 19 plant species inventoried in four prospecting sites, 12 were considered to be exotic while the two others were invasive. It was reported that in Côte d'Ivoire (West Africa), *E. crassipes* and *E. pyramidalis* are considered as exotic and invasive alien species. N'guessa and Pedia reported that the Republic of Côte d'Ivoire contains 3853 plant species, of which 240 species (6.2%) are exotic or introduced species, and 20 species (8.3%) are invasive alien species, and constitutes a major environment concern. Among the 240 exotic inventoried plants, the most representative species are *Eichhornia crassipes*, *Echinochloa pyramidalis*, *Pistia stratiotes*, *Salvinia molesta*, *Nelumbo nucifera*, *Typha australis*, *Polygonum lanigenum* var. *africanum*, *Bacopa crenata*, *Hydrolea glabra*, and *Paspalum vaginatum* [32]. On the other side, the water hyacinth, discovered in 1977 on the Sô River, became ten years later the worst aquatic plant in Benin [33]. This indicates that invasive alien plants constitute an environmental problem in Africa and worldwide. These plants can alter, disrupt, and degrade many ecosystem services like the disturbing of habitats and the alteration of the environmental and biological conditions around them. They can also reduce light and diversity of native aquatic plant species. Controlling invasive alien species is thus a big challenge for the Congolese society.

#### 5. CONCLUSION AND SUGGESTIONS

The present study is a research interesting territory whose vegetation cover is increasingly subject to the impact of hydrological and anthropogenic parameters by the introduction of exotic species. The inventory of the prospected flora reported the presence of 19 species including two Pteridophytes and 17 Angiosperms. This study reveals the presence of two invasive species in the Pool Malebo

ecosystem: *E. crassipes* and *E. pyramidalis*. These two species deserve increased monitoring as they constitute major challenges for the navigability of rivers and the invasion of fishing sites. The predominance of sclerochores and pleochores plants and the presence of species with a broad range distribution is an indication of anthropogenic regressive evolution. It is therefore recommended to broaden the field of prospecting in order to identify and list the exotic and/or invasive aquatic species of the aquatic flora of the Congo. Botanists, defenders of biodiversity, and political decision-makers are therefore invited to take appropriate measures to manage and protect the local aquatic flora and valorize the invasive plants as potential medicinal remedy.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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