

TWO ALIEN INVASIVE AQUATIC PLANTS OF BOTSWANA

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Introduction

There are two important aquatic alien invasive plant species in Botswana *viz.*, Kariba weed, *Salvinia molesta* Mitchell (Family: Salviniaceae) and water lettuce, *Pistia stratiotes* L., (Family: Araceae). Okavango Delta on the northwest and Kwando, Linyanti and Chobe River systems in the northeast of the country have been susceptible to exotic plant invasions due to sub-tropical climate and abundance of aquatic habitats. The native range for these two species is South America, but had been introduced to many parts of the world where they have become problematic. These two “biological pollutants” cause extensive socio-economic and water resource use management problems in Botswana’s wetland systems.

Kariba weed

S. molesta commonly called as salvinia, Kariba weed, African payal and in local language as motshimbaamo, is a free-floating fern that inhabits still and flowing fresh water bodies. The plant’s native range is south eastern Brazil, South America. The plant is sterile and reproduces by vegetative propagation of the rhizomes. Leaves are arranged in a whorl of three: two lateral leaves are floating and the third is dissected into filiform segments covering with hairs, which functions as root. In Southern Africa, salvinia was collected by the botanists firstly at Kazungula island in the eastern Caprivi in 1948.

Impacts of Kariba weed

The negative impacts of salvinia in the country includes: blocking streams and channels, choking of back water bodies, affecting the navigation and recreational activities such as fishing and tourism, elimination of indigenous vegetation, and causing an eye sore to the tourists who visit the wild life areas of the wetland systems. The weed is common in the Moremi Wildlife reserve of the Okavango Delta and Kwando/Linyanti/Chobe Rivers.

Figure 1 – Salvinia weed



Figure 2 Adult weevils feeding on the young leaves



Figure 3 Larva tunneling the rhizome



History of Integrated Control

Use of herbicides

The first effort for the development planning in the weed control in Botswana began in 1972. The Department of Agricultural Research in the country applied the herbicide, paraquat between 1972 and 1976 in Linyanti and Chobe River. These costly operations demonstrated the principal difficulty encountered in applying herbicides to the weed growing under canopy of thick vegetation such as papyrus and reeds. Such inaccessible locations serve as reservoirs for re-infestation by the weed. Booms and earth dykes were erected in the past to control and/or to eradicate *S. molesta* in Botswana. A floating boom was erected in the middle streams of the Kwando River for trapping and clearing the weed manually.

Bunding, Fencing and Drying of Swamps

Bunds constructed in the inflow channels to dry out the weed-infested Xini and Bodumatau Hippo pools and associated wetlands with the use of diesel-powered pumps in 1986 and 1988. The operations yielded substantial control of salvinia augmented by the release of *C. salviniae* transported from Linyanti River. The dense weed mat in Xaxanaka lagoon was removed with the assistance of Department of Wild Life in 1992. Salvinia was sighted in Gomoti River in 1985 and the river became seasonal after 1992. Drying out Xini and Bodumatau areas in the Okavango Delta was an attempt to eradicate the salvinia but its control failed as the primary form of the mat was difficult to find out and it was a futile exercise to pick up a mat to the last among the vegetation. However, the confidence in biological control increased through these operations and subsequent control has been primarily the biological control as a long-term measure to the chemical control.

Early Periods of Biological Control

The entomologists of Agricultural Research in Botswana imported two insects, Curculionid weevil *Cyrtobagous singularis* Hustache (Coleoptera: Curculionidae) and the grasshopper, *Paulinia acuminata* DeGeer. (Orthoptera: Acrididae) recommended by the Commonwealth Institute of Biological Control (CIBC) at Trinidad and were released in Linyanti River and in Chobe River during 1972 –1976 periods. The *P. acuminata* could not control the weed as the winter nights affected the grasshopper significantly. *C. singularis* also failed to control the Salvinia as it feeds only the young leaves not the growing points.

Cyrtobagous salviniae (Calder & Sands)– Australian Success

Wendy Forno from Council of Scientific, Industrial and Research Organization in Australia.(CSIRO, Australia) was the first scientist to collect and confirm *C. salviniae* as the host specific biological control agent for *S. molesta* in its native range, Brazil. The release of *C. salviniae* in Lake Moondara infestation in north-eastern Queensland in Australia was the first real success story in the control of *S. molesta*. Although published in 'Nature Journal' in November 1981 news of the event did not reach Botswana until March 1982. The effectiveness of *C. salviniae* as a control agent is attributed to the fact that its larvae tunnel weed's rhizome causing the plant to collapse while the adults feed more or less exclusively on the critical growth points such as apical buds and young leaves. Thus, *C. salviniae* differs in controlling salvinia weed from its allied species *C. singularis*, which in most cases damage the young leaves only.

Department of Water Affairs, Namibia acted fast and imported the adult *C. salviniae* weevils from Entomology Division of the CSIRO, Australia. A batch of 500 adult weevils arrived in September 1983 and bred successfully in the ponds where salvinia was grown with nutrient solution in Katima Mulelo. By March 1985, over 10,000 insects had been released at various sites of Caprivi and in Kwando River. Thus the weevils made their own way to establish themselves in due course of time in Kwando-Linyanti and Chobe River System with the aid of water currents.

In 1984, a special working group to co-ordinate biological control research in aquatic weeds was set up by SARCUS (Southern African Commission for the Conservation and Utilization of the Soil) comprising representatives from Botswana, Namibia and South Africa. At its first meeting in October 1984, the Namibians reported that a viable breeding colony of the weevils, *C. salviniae* was developed at Katima Mulilo from the stock imported from CSIRO, Australia. Meanwhile the University of Botswana with the help of Australian scientists had drawn up a project to direct a research program for the control of *Salvinia*. Wendy Forno from CSIRO, Australia arrived in Botswana in February 1986 to assist in the implementation of *Salvinia* Biological Control Program in the country. She made seven visits to the country as Aquatic Weed Consultant and her last visit to the country was on 21 July 1999. SARCCUS became defunct in 1998 and merged with Southern African Development Community (SADC)

Current Program of Weed Management-Salvinia

In July 1984, the weed control activities were transferred from Agriculture Research to Hydrology and Water Resources Division in the Department of Water Affairs as the Aquatic Vegetation Control Unit (AVC Unit) at Maun under the aegis of Chief Technical Officer, the late Peter Smith. Currently the AVC Unit has been with Water Quality and Conservation Division in the department since 28 August 2006. AVC Unit offices in Maun and Kasane are the authorized centers to look after the management of wetlands from the danger of alien invasive species in the country. Bio-control monitoring of the weed in Kwando-Linyanti-Chobe system had not been effective from Maun station and hence a new AVC unit office at Kasane was started in January 2000 to monitor Kwando-Linyanti-Chobe river systems. AVC Unit in Maun, as “Head Office” monitors the Okavango Delta as well as offers technical guidance to Kasane Office. The control program had been handled by technical staff until 1996. In spite of some progresses made prior to 1996, lack of profound scientific approach in the aquatic weed control program was discernible. With the appointment of a Senior Botanist, Dr. C. N. Kurugundla from India in August 1997, the matters improved in the aquatic vegetation control management. New strategies were initiated, drafted and implemented. The effectiveness and success of biological control weevil on *salvinia* infestations was really felt under his guidance in all the infested areas of the wetlands. The AVC Unit succeeded in controlling the *Salvinia* in Kwando/Linyanti/Chobe Rivers and currently the Unit’s main task is to control the weed in the Okavango Delta.

Water lettuce

A flowering free floating water lettuce, *P. stratiotes* is distributed in tropical and sub-tropical regions of the world and is a serious weed in south-east Asia, Africa and India. Water lettuce native range is uncertain but it could be possibly the South America. Water lettuce consists of reduced stem modified into rhizome from which a rosette of close spiral leaves develop and posit on the water surface. Roots hang from the base of the rhizome and submerged beneath the floating leaves. Leaves are soft, short stalked, dull green to blue-green, with parallel ridges (veins) and densely covered with hairs. Flowers are inconspicuous and nearly hidden in the axils of the leaves on small stalks. However, seed germination is an important factor in the dynamics of water lettuce populations especially in the seasonal water bodies. Few plants of water lettuce were observed for the first time in Chobe River near Satau village, Zibadianja Lagoon and a large infestation in Selinda canal in Kwando River in the country in 1986.

Impacts of Water Lettuce

The negative impacts of water lettuce in general are similar as those for the other aquatic weeds, where dense mats limit the utilization of rivers and dams. In particular, this weed damaged the seasonal water bodies of Selinda canal and Zibadianja lagoon in Botswana causing uncomfortable situation to the tourists who visit the concession area run by Linyanti Explorations Private Limited.

History of Control

Water lettuce is a minor weed in Botswana because of its limited distribution. The Brazilian weevil, *Neohydronomous affinis* Hustache is the host specific biological control agent for water lettuce. Adult feeding produces characteristic round holes, which penetrate the thinner tissue near the apex of the leaves. The females deposit eggs singly on the upper surface of the leaves and near the margins. Larvae tunnel through the leaf tissues to the basal portion of the leaf damaging the growth points. Development from egg incubation to adult emergence requires *ca.* one month.

In 1987 Botswana Government imported the biological control weevil, *N. affinis* numbering about 437 from Commonwealth Scientific Industrial Research Organization of Australia (CSIRO Australia) through quarantines on 11 September 1987 and raised them on water lettuce plants in above ground porta-pools erected for the purpose in Kasane Water Affairs Campus. The insects were released in Selinda infestations on 3rd November 1987 and in later periods in Zibadianja Lagoon and Chobe River. Selinda canal and Zibadianja Lagoon wetland areas have become seasonal since 1990s and normally dry after September in summer.

Eradication of Water lettuce in Selinda and Zibadianja Lagoon

The AVC Unit conducted research between 1999 and 2003 to determine the source of infestation in the seasonal Selinda canal and Zibadianja lagoon and confirmed that the regeneration of the weed was primarily through seed bank. To arrest the further additions to the seed bank in the infested areas, the weed had been physically removed from 1999 to 2003 before the flower formation. Both localities have been devoid of water lettuce since 2004. The infestation in Chobe had been under control due to the presence of its biological control agent.

Figure 4 Manual removal of water lettuce in Selinda



Figure 5 *Neohydronomous affinis*

