

Biological Control of Water Hyacinth on the White Nile, Sudan

M.O. Beshir¹ and F.D. Bennett²

¹University of Khartoum, Shambat, Sudan.

²Commonwealth Institute of Biological Control, Gordon Street, Curepe, Trinidad.

Abstract

First recorded from the Sudan in 1955, water hyacinth rapidly increased to become a major weed. Based on results elsewhere, a biological control program commenced in 1976 with the introduction of *Neochetina eichhorniae*. Under a joint CIBC/ODA/Sudan Government project initiated in 1979, *N. bruchi* and *Sameodes albiguttalis* were introduced and large-scale releases of all species made during 1979-81 resulted in widespread establishment, followed by drastic reduction in the growth rate of water hyacinth. Large floating mats which seasonally covered 113 km² behind the Jebel Aulia Dam and required large-scale herbicidal applications, have not appeared since 1982 and chemical control has ceased. The development of the program, its impact on water hyacinth and the economic benefits are discussed.

Lutte Biologique Contre la Jacinthe d'Eau dans le Nil Blanc, au Soudan

Depuis qu'elle a été relevée pour la première fois au Soudan en 1958, la jacinthe d'eau s'est rapidement multipliée et est devenue une des principales plantes nuisibles du pays. Un programme de lutte biologique, élaboré à partir des résultats obtenus ailleurs, a commencé en 1976 par l'introduction de *Neochetina eichhorniae*. Dans le cadre d'un projet conjoint mis en oeuvre en 1979 par l'Institut du Commonwealth pour la lutte biologique, l'Overseas Development Administration et le gouvernement du Soudan, *N. bruchi* et *Sameodes albiguttalis* ont été libérés. Grâce à toutes les espèces lâchées sur une grande échelle de 1979 à 1981, les insectes se sont établis sur de très grandes étendues, ce qui a entraîné, par la suite, une réduction très marquée du taux de croissance de la jacinthe d'eau. De vastes tapis flottants qui, en saison, couvraient une superficie de 113 km² en amont du barrage de Jebel Aulia et qui nécessitaient l'emploi massif d'herbicides, ne sont pas réapparus depuis 1981, et la lutte chimique a été supprimée. Le rapport traite du déroulement du programme, de ses effets sur la jacinthe d'eau et de ses avantages économiques.

The Problem

The neotropical aquatic weed *Eichhornia crassipes* (Mart.) Solms-Laubach (Pontederiaceae) was recorded from the Sudan in 1955-56 (Heinen and Achmed 1964). First noted as a serious weed in the White Nile system in 1958, it spread rapidly throughout the Sudd region from Juba, over a distance of 1700 km, to the Jebel Aulia 40 km south of Khartoum (Fig. 1). The Jebel Aulia Dam serves as a barrier and with continuous vigilance by the Sudanese authorities, water hyacinth has not established below the dam.

The deleterious effects caused by this weed on the White Nile system are described in detail (Obeid 1975) and include: interference with river transportation including high operational and maintenance costs for ships; blockage of irrigation canals or pumps and access to water for riverine settlements and recreational activities; water loss by evapo-transpiration; fishing losses; and the high cost of chemical control programs. To

cope with the problem the Sudanese-Egyptian Joint Nile Committee initiated a control program; the main thrust was based on herbicidal applications by aircraft and launches. As early as 1963 the Plant Protection Division of the Sudan Ministry of Agriculture controlled a fleet of 42 boats and three aircraft and had set up three stations on the Nile to combat this weed. The main purposes of this operation were to maintain open water access for commercial steamer traffic and to riverside villages. In addition to the high annual costs, problems in application created by bad roads and damage to crops by spray drift imposed limitations to this approach.

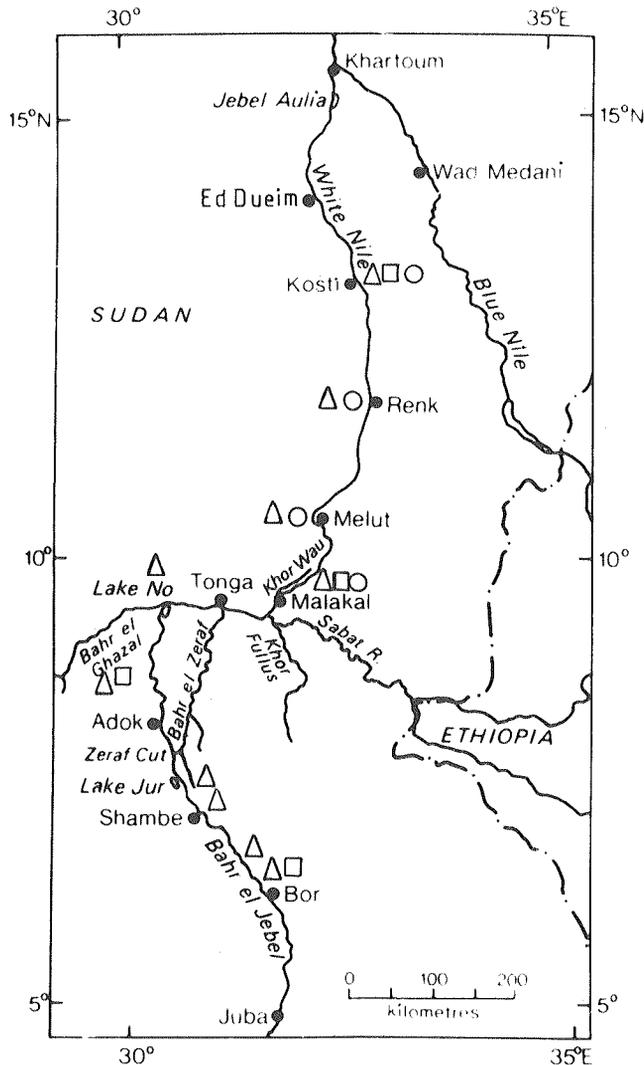


Fig. 1. Map of the White Nile system in southern Sudan infested by water hyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach, showing recovery sites of natural enemies (July 1983). Δ , *Neochetina eichhorniae* Warner; \square , *N. bruchi* Hustache; \circ , *Sameodes albiguttalis* (Warren).

The costs of chemical treatment were calculated to be about Sudanese £1 million per annum (Hamdoun and Tigani 1977). Although Philipp *et al.* (1983) gave a lower figure for the earlier years 1964–74, annual costs since 1975 have exceeded this figure.

Biological Control

Background

In 1967, the UK Ministry of Overseas Development (ODM) provided financial support to the Commonwealth Institute of Biological Control (CIBC) to search for natural enemies of water hyacinth in the Neotropics. The objectives were to ascertain the potential and the feasibility of biological control of this aquatic weed in developing countries in Africa, Asia and the Pacific. During surveys in Trinidad, Guyana, Suriname and the Amazon region of Brazil, potential control agents were encountered. These included the weevils *Neochetina eichhorniae* Warner and *N. bruchi* Hustache (Coleoptera: Curculionidae), the lepidopteran stem-borers *Sameodes albiguttalis* (Warren) and *Acigona infusella* (Walker) (both Lepidoptera: Pyralidae), the grasshopper *Cornops aquaticum* (Bruner) (Orthoptera: Acrididae) and the leaf-mining oribatid mite *Orthogalumna terebrantis* Wallwork (Acari: Galumnidae) (Bennett and Zwölfer 1968). These studies overlapped with similar investigations conducted by USDA scientists and local collaborators in Uruguay and Argentina (DeLoach 1975). As a result of these joint efforts, these organisms have been tested and some have been introduced into several countries (Bennett 1983).

Initiation of a Program in the Sudan

The possibilities of biological control in the Sudan were first given serious consideration during a workshop on management and utilization of aquatic weeds in the Sudan and Nile Basin (Obeid 1975). A project proposal was prepared in 1976 (Bennett 1976) and, funded by the ODM, resulted in a joint ODM/Sudan Government project initiated in 1979. In the interim, a program was initiated under the auspices of the Sudanese National Council for Research and, with the cooperation of the USDA, *N. eichhorniae* was imported in December 1976. After further host-specificity trials at the University of Khartoum, releases commenced during May–July 1978.

Construction of a new laboratory facility at the Faculty of Agriculture, University of Khartoum, commenced in 1978, was completed in March 1979 and, under the joint ODM/Sudan project, CIBC obtained *N. bruchi* and *S. albiguttalis* from Florida, again with USDA assistance, during 1979. After further testing, *N. bruchi* was first released in November 1979, and *S. albiguttalis* in 1980 (Fig. 2). For the initial releases of *N. eichhorniae* first instar larvae and eggs were inoculated into the petioles of water hyacinth plants. In the 1979–80 releases, adults, larvae and infested plants were released in sheltered lagoons and side-channels where fairly stable mats persisted for several months, but would eventually disperse and spread the insects throughout the Nile system.

Establishment

N. eichhorniae was first recovered from one of the release sites near Malakal in January 1980 and was reported to be widespread by 1981, when it was collected at Jebel Aulia 270 km downstream from the nearest (1978) release point at Kosti.

Establishment of *N. bruchi* was confirmed in April–May 1981 by which time *N. eichhorniae* was present throughout the White Nile System from Bor to Jebel Aulia, a distance of 1700 km (Irving and Beshir 1982).

S. albiguttalis, released only in small numbers at three sites, was first recovered in 1982; by July 1983 it was widely established from the Sobat junction to Kosti and Bor (Fig. 2).

Impact of Control Agents

Insufficient time has lapsed since the introductions to assess the full impact of the three control agents. Although *N. eichhorniae* has been widely established since early 1981, and has probably reached its population peak, the other two agents are still extending their area of distribution and are increasing in density.

There has been no accumulation of floating mats of water hyacinth behind the Jebel Aulia since 1982, in contrast to the large accumulations (up to 11,350 ha [27000 feddans]) which have occurred annually since the early 1960s and seasonally required constant herbicide treatment.

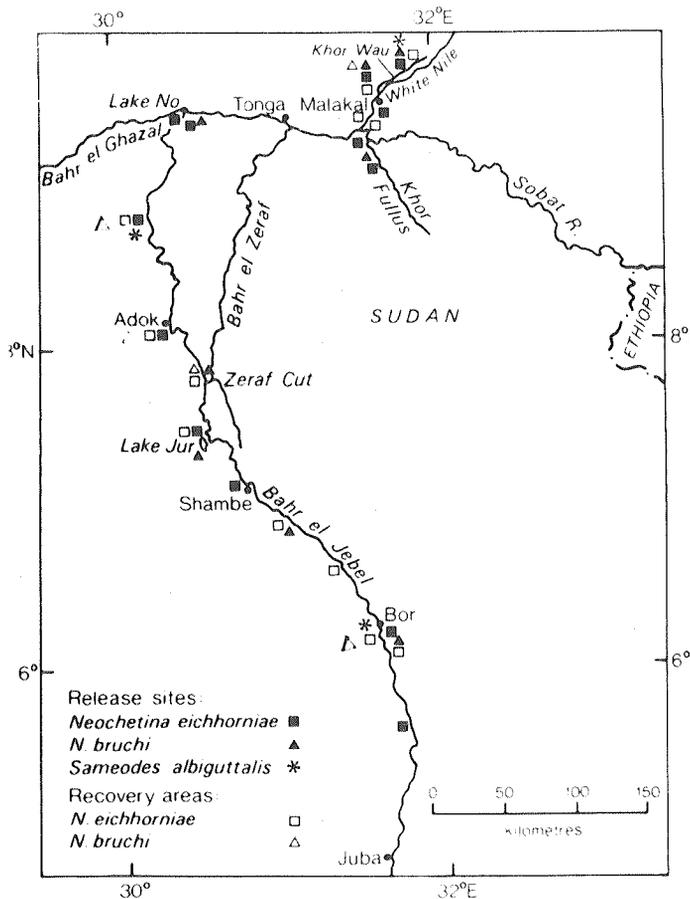


Fig. 2. Release and recovery sites of natural enemies of water hyacinth, *Eichhornia crassipes* (Mart.) Solms-Laubach (1981).

Since 1982, few plants have been spotted even 30 km south of the Dam and the German Sudanese water hyacinth utilization project has had to travel from Taweela to Kosti at regular intervals to collect plants to stock their biogas generators. This contrasts sharply with the pre-1982 situation when during the 'south wind period' from May–October, 4–60 ha/day, and between November and April, 30–140 ha/day, originating from the southern regions and out of the Khor, accumulated along the banks at Taweela (Philipp *et al.* 1983). The Plant Protection Division of the Ministry of Agriculture has relaxed its control campaign and the costs of chemical control have been reduced drastically. The intensity of the chemical control program had already

started to decline because of financial constraints and deterioration of equipment; hence the reduction in annual biomass of water hyacinth following the establishment of natural enemies occurred at a time when the pressure of herbicide control had been relaxed.

Throughout the area the leaves of virtually every water hyacinth plant are scarred by the feeding marks of *Neochetina* adults, plants are much less vigorous, have a lower dry weight, float lower in the water, and no longer form suitable colonization sites for other plants which previously formed substantial islands on the floating platform provided by healthy water hyacinth plants.

Discussion

The rise and decline of water hyacinth on the White Nile has offered a unique opportunity to assess the impact of water hyacinth, and also the effect that control agents may have on a large river system which is only marginally affected by eutrophication as a result of agriculture or industry.

Hydrobiological research in the Sudan commenced in earnest when a Hydrobiological Research Unit was set up at the University of Khartoum in 1953, although a vast amount of hydrological data, some of it dating back to 660 AD and earlier periods, had been accumulated. Although the construction of the Jebel Aulia Dam in 1936 undoubtedly altered the ecology, there was ample opportunity for the system to stabilize. The hydrobiological data, taken from 1954 until the build-up of water hyacinth commenced in earnest c. 1958 (Gay 1958), provided baseline data to permit comparison of data obtained on subsequent surveys.

In preparation for the biological control program, a survey of the fauna and flora associated with water hyacinth on the Sudan was carried out in March 1976. Dr. B. David Perkins, USDA, sponsored by the Sudanese German Water Hyacinth Control Project and one of us (MB) collected data on plant populations, plant size and weight, etc. The Sudanese National Council for Research and the University of Khartoum have obtained similar data on semi-annual survey trips from Juba to Kosti. Similarly, the Sudanese German Water Hyacinth Utilization Project has amassed data on biomass, utilization and control of water hyacinth (Philipp *et al.* 1983).

Hence with the pre-release data and the on-going collection of data, it should be possible in the future to document fully this outstanding example of biological control of an aquatic weed.

It is also too early to evaluate the impact of each of the three introduced control agents. However, the drastic reduction in the amount of water hyacinth accumulating at the Jebel Aulia Dam before *N. bruchi* and *S. albiguttalis* became widespread confirms that *N. eichhorniae* alone, as reported in Australia (Wright 1981), can effect a substantial reduction of growth and cause the collapse of floating masses of water hyacinth.

References

- Bennett, F.D. 1976. Report on a visit to the Sudan to plan a project on biological control of water hyacinth September 1976. Commonw. Inst. Biol. Contr. Rep., 15 p.
- . 1983. Biological control of aquatic weeds. International Conference on Water Hyacinth, 7–11 February 1983, Hyderabad, India, 27 p.
- Bennett, F.D., and Zwölfer, H. 1968. Exploration for natural enemies of water hyacinth in northern South America and Trinidad. *Hyacinth Contr. J.* 7: 44–57.
- DeLoach, C.J. 1975. Evaluation of candidate arthropods for biological control of waterhyacinth: studies in Argentina. *Proc. Symp. Wat. Qual. Manage. Through Biol. Contr. Gainesville, Florida, 1975*, pp. 45–50.
- Gay, P.A. 1958. *Eichhornia crassipes* in the Nile of the Sudan. *Nature* 182: 538–9.
- Hamdoun, A.M., and Tigani, K.B. El. 1977. Weed control problems in the Sudan. *PANS* 23: 190–4.

- Hammerton, D. 1964. Hydrobiological Research in the Sudan. Twelfth Ann. Symp. Sudan Philosoph. Soc., pp. 181-204.
- Heinen, E.T., and Achmed, S.H. 1964. Water hyacinth control on the Nile River, Sudan. Publ. Inf. Prod. Centre, Dept. Agric., Khartoum.
- Irving, N.S., and Beshir, N.O. 1982. Introduction of some natural enemies of water hyacinth to the White Nile, Sudan. *Trop. Pest Manage.* 28: 20-6.
- Obeid, M., (ed.) 1975. Aquatic weeds in the Sudan with special reference to water hyacinth. Nat. Counc. for Res., Khartoum, Sudan, 150 p.
- Philipp, O., Koch, W., and Köser, H. 1983. Utilization and Control of Water Hyacinth in Sudan. *Schriftenreihe der GTZ No. 112*: 224 p.
- Wright, A.D. 1981. Biological control of water hyacinth in Australia. Proc. V Int. Symp. Biol. Contr. Weeds, July 22-27 1980, Brisbane, Australia. Delfosse, E.S. (ed.). CSIRO, Melbourne, pp. 529-35.