Biological Control of Aquatic Weeds in South Africa - An Interim Report

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Abstract
At the end of 1985 the curculionids Neochetina eichhorniae, Cylindrosozous salviniae and Neohydronomus pulchellus were brought into South Africa and released for the biological control of Eichhornia crassipes, Salvinia molesta and Pistia stratiotes. The main water hyacinth problem in South Africa is in a high-elevation area (approximately 1500 m) on the Vaal River, where low temperatures and frost are common in winter. N. eichhorniae readily established in this problem area and in subtropical and temperate areas where it had been released, but populations have not yet increased to a point where an evaluation of the effect of these beetles on water hyacinth can be done. Because of detailed basic work done on S. molesta and C. salviniae, especially in Australia, some results are implemented in South Africa, with monitoring of beetle population growth and spread and, on the plants, the number of beetle damaged growth tips, plant nitrogen and dry weight. From initial results on nursery dams and other S. molesta infestations still being monitored, C. salviniae is again proving its value for biological control of S. molesta. N. pulchellus adults were first released onto a dense infestation of water lettuce on an isolated pan (shallow lake occasionally drying up). Within 10 months, the P. stratiotes at this site was under biological control as reflected in plant size, plants/m² and plant dry weight. The three projects discussed in this paper emphasised the value of implementing research results obtained elsewhere in the world, but also the importance of monitoring progress in biological control programmes.

Introduction
The common problems experienced elsewhere in the world with infestations of aquatic weeds (e.g., impediment of water used for agricultural, domestic or recreational purposes, increased danger of floods, breeding sites for vectors of disease organisms, the high cost of control and the change in stream ecology), are also valid for the alien aquatic weeds in South Africa (Beshir and Bennett 1985, Edwards and Thomas 1977, Goyer and Stark 1984, Manning 1979, Room et al. 1979, 1981, Scott et al. 1979, Thomas and Room 1985).

Three alien aquatic weeds in South Africa, Eichhornia crassipes (Martius) Solms-Laubach (Pontederiaceae; water hyacinth), Salvinia molesta D.S. Mitchell (Salviniaceae; salvinia), and Pistia stratiotes L. (Araceae; water lettuce), have become troublesome to varying degrees. Of these, E. crassipes is most important, and it occurs in inland and coastal subtropical lowlying areas, temperate coastal and high-elevation inland areas. The biggest infestation occurs for 300 km on the Vaal River (altitude approximately 1500 m), where the winters are cold and frost generally occurs from May to September (Department of Environmental Affairs 1986).

Biological control of E. crassipes has previously been investigated in South Africa. In 1974, a small number of the beetle Neochetina eichhorniae Warner (Coleoptera: Curculionidae) was introduced from the USA into South Africa. After breeding in a glasshouse and outdoor pools, releases were made at five localities from 1974-6 (Julien 1982, Kluge, R.L., pers. comm., 1987). The project was terminated in 1976 because of manpower shortage, interdepartmental policies, flooding and extensive chemical control of water hyacinth (Kluge, R. L., pers, comm., 1987). Trying to assess in 1985 what had happened since 1976 proved difficult, but there is some evidence that N. eichhorniae did spread, because it has been recorded at localities far away from the original release sites.
On the Vaal River, water hyacinth was controlled chemically in 1972 and some of the remaining water hyacinth was thereafter removed mechanically. Extensive floods in 1974-5 left only scattered plants, but vigorous growth of the plants soon necessitated chemical control. Extensive spraying of water hyacinth, with glyphosate (N-(phosphonomethyl) glycine), for 2 yrs prior to 1984, again reduced the infestation to reasonably low levels. The chemical programme to clear the river in 1972 and again in 1982-4 cost in excess of R 5 million (US $ 2.5 million), and follow-up operations have been calculated to cost approximately R 25 000 (US $ 12 500) annually. Several reasons, including ecological considerations and cost, brought a halt to chemical control, and within 2 yrs after the last campaign, the Vaal River was again heavily-infested with water hyacinth (Reid, P.C. and W. Liebenberg, pers. comm., 1986). Therefore, in 1985 the Department of Water Affairs started looking at the possibilities of alternative control methods. The present programme on biological control was started following good results obtained elsewhere (e.g., Center 1981, Cofrancesco et al. 1985, Delfosse 1978, De Loach and Cordo 1976, Forno 1981, Stark and Goyer 1983, Harley and Wright 1984, Wright 1981). At the same time it was decided to also initiate biological control of the less troublesome S. molesta and P. stratiotes following good results in Australia, Papua New Guinea and the eastern Capri (e.g., Forno 1985, Forno and Bourne 1983, 1984, 1985, 1986, Room 1985, Room et al. 1981, 1985, Thomas and Room 1985, 1986, Schlettwein, C.H., pers. comm., 1985).

Interim Results

Waterhyacinth

_N. eichhorniae_ was re-introduced from Australia during the 1985-6 summer. After screening in quarantine the beetles were released in the following different habitats: subtropical coastal (Swartrips River), inland subtropical (Crocodile River, eastern Transvaal, and also on a small farm dam in this area), inland temperate (Crocodile River, western Transvaal) and the high-elevation area (Vaal River). Study sites were chosen along the Vaal River and Crocodile River West to monitor beetle populations and to evaluate the effect of the beetles on water hyacinth. They would also serve as safe nursery sites from where beetles could disperse. The beetles established readily and have increased appreciably since the 1985-6 summer. On the Nseleni River, beetle activity, as estimated by adult feeding scars on _E. crassipes_ leaves, was common by December 1986, one year after release. By January 1988, the majority of older leaves had 5 to 15 feeding scars/leaf. On the Crocodile River East, the beetle population persists and has spread at least 5 km from the release site. The beetle population remains low at this site because many plants had been washed away during the past summer. On the small farm dam in the eastern Transvaal, the water hyacinth is under stress from the beetles and the fungus _Cercospora piaropi_ Tharp. (Hyphomycetes) (Morris, M.J., per. comm., 1987). On the Crocodile River West, beetle populations increased during the 1987-8 summer at two sites heavily-infested with the weed. At the first site, beetle density was approximately three adults/plant and at the second site, one adult/plant has been recorded.

On the Vaal River at one site in a bay (back water) not disturbed by floods, beetle numbers are increasing. The water hyacinth population was again drastically reduced by high river flows in late 1987, and washed into the Bloemhof Dam lower down on the Vaal River, where the plants are being sprayed to prevent them from infesting the river further downstream.

Mechanical control is only done on a limited scale on the Vaal River at Orkney by Vaal Reefs Mining Company, by removing water hyacinth at the rate of 150 t/day. This mechanical control has limited effect during the growing season, but is more marked in winter (Brits, C.J., pers. comm., 1987).

Salvinia

_S. molesta_ occurs in the Transvaal, Natal and the southern and south-western Cape Province. This distribution is within inland and coastal subtropical and temperate coastal areas,
generally from sea level to 500 m elevation. Until 1986, this noxious weed was controlled chemically, but this practice has been discontinued because of biological control by the beetle *Cystobagous salviniae* Calder & Sands (Coleoptera: Curculionidae).

Breeding colonies of *C. salviniae* were obtained from the eastern Capriv in September 1985. These colonies were released onto *S. molesta* on three water storage dams on farms in the north-eastern Transvaal. These dams served as nursery sites, where the beetles were allowed to increase. The size of two of these dams, Van Veijeren and Thalwitzer were 0.2 and 0.3 ha; the third dam, Barnard, was 3 ha. In keeping with the results of studies on *S. molesta* and *C. salviniae*, especially in Australia, feeding damage to the plant’s growth tips, the number of adult beetles/m², the dry mass of plants per m³ and the percent tissue nitrogen of *S. molesta*, were determined at intervals of approximately 6 wks. At the Van Veijeren nursery dam the mean nitrogen content was 1.7% and seven months after introducing 1000 beetles, the dry weight of *S. molesta* was still high at 500 g/m³, the number of adult beetles 474, and 88% of the growth tips damaged/m². Twelve months after release, the dry weight of *S. molesta* was 203.8 g, number of adult beetles 423, and 92% growth tips damaged/m². This dam was clear of *S. molesta* in October 1986, 13 months after introducing beetles onto the dense salvinia mat (Cillicers 1987a). A practical way of distributing beetles from the nursery dam to new release areas was to use beetle-infested plant material. It was estimated that at least 200 beetles were necessary to start a new colony (Forno, I.W., pers. commun., 1985). In April 1986 it was determined that a plastic bag, 80 x 52 cm, filled with beetle-infested plant material, yielded about 200 adult beetles. Such bags of infested plant material were used to distribute beetles to other *S. molesta*-infested areas. For areas far away (e.g., Natal and the Cape Province), beetles were extracted from the plant material using Berlese funnels and then sent by air.

On the second dam (Thalwitzer) the mean nitrogen was 1.4%, and eight months after the introduction of 1680 adult beetles, the number of beetles recorded was 184/m². Therefore, in this case, two full bags of infested plant material were required to start a new colony elsewhere. This dam was clear of salvinia 19 months after *C. salviniae* was released. The third dam (Barnard), where the mean nitrogen content was 1.6%, was cleared of salvinia 14 months after introducing 1000 *C. salviniae*. Two larger dams, on the farms La Motte and on Letaba Estates in the Leisieke area in north eastern Transvaal, were chosen to monitor the progress of *C. salviniae*. These dams have been monitored since September 1985 and May 1986 respectively. The La Motte dam was covered in thick salvinia sward, and since January 1986, *Typha capensis* (Rho.) N.E. Br. (common bulrush; Typhaceae) rooted in the shallow water along the edges of the dam, started growing on this mat. The *T. capensis* and also grass growing on the salvinia covered more than half the dam by the end of 1986. An initial colony of 750 beetles was released on this dam in September 1985 with material brought from the nursery dams in May, September and November 1986, during which time a further 5000 beetles were introduced at new fronts. The mean tissue nitrogen for *S. molesta* in this dam is 1.1%, fluctuating to very low levels of 0.8% and 0.5% nitrogen from May to October 1987 during the then-experienced drought. The beetles have steadily increased in the release sites along the 300 m wall, and by November 1986 had spread along the entire length of the wall and 30 m upstream. Open patches of water started to appear in September 1986 where the initial releases of beetles were made one year previously. The open water increased as the salvinia sunk, and by September 1987 the thick *T. capensis* stand started to collapse along the edges where the salvinia had already sunk. By December 1987 nearly half the dam was clear of salvinia. It remains to be seen when the *T. capensis* and grass will disappear, as the water is too deep for these normally-rooted plants away from the periphery of the dam. The dry mass of one m² of salvinia declined from 673 g in April 1987 to 218 g in December 1987, and the percent growth tips damaged in the release areas had increased slowly from 4% in October 1986 to 62% in December 1987. The number of adult beetles over the same period increased from 6 to 47.

On the second dam at Letaba Estates, beetles were introduced for the first time in May 1986. This dam is still being monitored but is following a similar trend as the La Motte dam.

*C. salviniae*, introduced into the Hoëkraal and Karatra Rivers in the south-eastern Cape Province, a temperate coastal area, has become established and will hopefully control *S. molesta*. Along the subtropical Natal coastal belt, *C. salviniae* readily established at Happy
Valley Swamp, and significant control has been achieved within one year. At two other localities, Richards Bay and Umlalazi Nature Reserve, the beetles were released in early December 1987, and by the end of January 1988 establishment was confirmed. At all the sites mentioned the tissue nitrogen of *S. molesta* is not excessively high: the mean value for all sites being 1.3% (Cilliers, unpubl. data).

**Water lettuce**

*P. stratiotes* is of minor importance in south Africa, but is a declared weed mainly to prevent the sale and distribution of the plant. The first attempt at biological control of water lettuce in South Africa is described by Cilliers (1987b) and summarised here. *Neohydronomus pulchellus* Hustache (Coleoptera: Curculionidae) was obtained from CSIRO, Australia, ex South America. Five hundred beetle were released onto a pan (shallow lake occasionally drying up) heavily infested with *P. stratiotes* (757 plants/m², mean rosette dia 11.97 cm) in December 1985. The pan, Nhlangalawe, is in the northern Transvaal in the Kruger National Park where the mean daily maximum and minimum temperatures are 28.9 and 16.7°C, respectively. Subsequent visits were made in February, June and September 1986. By September 1986 the number of plants/m² had declined to 692, mean rosette diameter to 3.03 cm, and the number of beetle damaged plants was 662. *P. stratiotes* was controlled by *N. pulchellus* within 10 months of release. *N. pulchellus* was also introduced to a nearby pan, DaKamila, in June 1986, and by March 1987 a patch 20 x 5 m started to rot and sink. Both the Nhlangalawe and DaKamila pans had dried up completely by May 1987 because of severe drought. The first good rain fell in February 1988. At this stage it is not known if any seedlings have germinated or if the pans have been re-infested from the Limpopo River. The beetles were introduced into the Stabile River, further south in the Kruger National Park, and this release is still being monitored.

**Future Prospects**

*N. eichhorniae* did not survive extensive spray programmes, soon after initial releases, on the Hartebeespoort Dam and the Vaal River, but persisted at and even spread from other release sites started in 1974-6. The increase of beetles and their resultant damage to water hyacinth since the 1985-6 releases are encouraging. It is not necessary to repeat basic work done in the USA and Australia on water hyacinth biological control agents, but it will be necessary to assess the effect of these agents on water hyacinth in South Africa. This information is essential in order to decide whether a biological or an integrated programme (chemical/biological) has to be followed in future. Dr. M.J. Morris (Plant Pathologist, Weeds Unit, Plant protection Research Institute, Stellenbosch), is also investigating the use of pathogens on this weed and has already identified *C. pisiformis* in South Africa. From basic work done in Australia, it is known that plant nitrogen and temperature are key factors in the biological control of *S. molesta*. This as well as other work done in Australia, in particular simplified monitoring, is being conducted in South Africa.

The rapid results achieved by the first attempt of biological control of *P. stratiotes* hardly allowed time for data collection! At present it is not necessary to consider other biological control agents for salvinia and water lettuce. On the other hand, all available natural enemies for water hyacinth will be obtained, and we hope that in time results comparable to those in other countries will be achieved.

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References


