

Review of Literature on Biological Control of *Salvinia molesta* in Sri Lanka using the Weevil *Cyrtobagous salviniae*

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ABSTRACT

The floating weed, *Salvinia molesta*, since its accidental introduction several decades ago, has invaded many water bodies in Sri Lanka creating a significant impact on agriculture, aquatic biodiversity, inland fishing and social life in rural areas. Over the years, management of *S. molesta* has been attempted through many different approaches including mechanical, chemical and biological control methods. Biological control of *S. molesta* using the weevil *Cyrtobagous salviniae* has been successful in comparison to other methods of control. The biological control program initiated at the University of Kelaniya in the 1980's, is being continued by the Plant Protection Service at Gannoruwa, Department of Agriculture with main stakeholders. Although biological control of *S. molesta* has been effective in certain water bodies, the weed remains problematic in Sri Lanka, demanding novel control approaches or the improvement of the current bio-control approach. With this objective in mind, the past local literature on *S. molesta* control is reviewed and presented here.

INTRODUCTION

The floating aquatic alien weed, *Salvinia molesta* D.S. Mitchell (Family: Salviniaceae) increases its populations through growth and fragmentation. It is known as a native of South Eastern Brazil and is notorious for its very rapid spread through water flows, wind, by animals and also through human activities such as inadvertent transport. This aquatic invasive weed can take up nutrients when available and grows best in still or slow moving water and forms dense mats. *S. molesta* poses a significant threat to agricultural productivity and livelihoods of farming communities associated with wetland habitats. It has rapidly invaded large extents of water bodies causing problems in water use and creating a wide range of ecological problems. In irrigation tanks and reservoirs of Sri Lanka the storage capacity is reduced as a result of addition of hundred thousand tons of *S. molesta* biomass. It also decreases the flow capacity of irrigation canals, thereby reducing the availability of water to the farmer fields and hampering the use of boats. This aquatic fern, was brought into Sri Lanka in 1939 for research purposes by the Department of Botany, University of Colombo (Williams 1956). Studies were carried out on this species in Colombo and the plant has accidentally escaped into the natural environment and then spread nationally.

S. molesta disrupts the aquatic ecosystem seriously by reducing the surface area of water available for oxygenation. This aquatic weed often reduces the effectiveness of water bodies for fish production too. Further, it decreases the quality of water by causing unpleasant odors.

Dense growth of *S. molesta* may provide ideal habitats for the development of mosquitoes that are vectors of Malaria, Encephalitis and Dengue Fever. Under these circumstances it is essential to manage this aquatic weed population in major and minor water bodies and in unmanaged wetlands including to increase agricultural productivity.

Management of *S. molesta* in Sri Lanka has been tried through many different approaches including mechanical and chemical methods. Many of these strategies are not economically sustainable and do not provide adequate levels of control. A biological control program initiated at the University of Kelaniya in the 1980's, is being continued by the Plant Protection Service at Gannoruwa, Department of Agriculture with its main stakeholders. However, it has been only partially successful in Sri Lanka. It is also reported that in well managed biological control programmes, successful control has been achieved in countries such as Papua New Guinea, and Australia.

Biological control of aquatic weeds is a mandatory activity of the Plant Protection Service of the Department of Agriculture. At present it is carried out on a small scale. However, there is an immediate need to enhance and increase the scale of this program.

OBJECTIVES

The findings of previous bio-control experiments have been reported in numerous research papers, leaflets and technical reports. The information is scattered with many unpublished reports and data. Hence, the objective of this review was to compile available information on the historical invasion of *S. molesta* and the biological control of *S. molesta* using *C.salviniae* in Sri Lanka and to review its status and make suitable recommendations for improvement.

METHODOLOGY

The literature relating to *S. molesta* and its biological control in Sri Lanka was collected by referring published research papers and unpublished reports, technical reports and bulletins. In addition, the researchers who were involved in the published work were consulted to gather further information. The gathered information were screened and compiled.



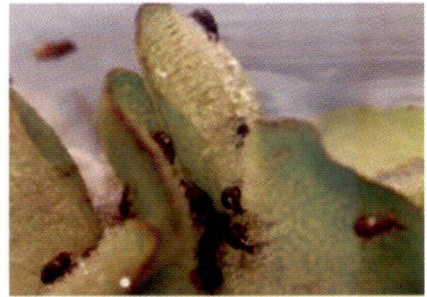
Pangaragammana Wewa with
S. molesta infestation
Figure 1



Adult weevil of *C.salviniae*
Figure 2



Larval feeding of *C. Salviniae*
Figure 3



Adult feeding of *C. salviniae*
Figure 4



Introduction of *C. salviniae* to
Pangaragammana Wewa
Figure 5



Browning of *Salvinia* due
to feeding by *C.salviniae* in
Pangaragammana Wewa
Figure 6



Culturing of *C. salviniae* at
Plant Protection Service at
Gannoruwa
Figure 7



Community participation in
introduction of
C. salviniae
Figure 8

RESULTS

The literature shows that this aquatic weed was first observed in inland water bodies in 1943 in Colombo area (Senaratna 1943). Subsequently, the plant has spread into other parts of the country invading many of the stagnant or slow moving water bodies. Upon the understanding of the gravity of the problem, the responsible authorities, Minister of Agriculture and Food, took measures in 1952 to include *S. molesta* as a scheduled weed under the Plant Protection Ordinance No. 10 of 1924. According to the gazetted regulations, transport of this weed or any part of it by any person for any purpose was prohibited. The intention was to restrict further spread of the weed. However, by 1954, *S. molesta* had invaded over 8,907 ha of paddy and 810 ha of inland water in Western Province of Sri Lanka (Williams 1956).

Physical control of *S. molesta* such as manual removal of weed from water bodies was initiated under the guidance of the Ministry of Agriculture in 1952 (Dias 1967). However, this type of control had only limited success due to practical reasons, especially due to the high demand for labour involvement. Alternatively, chemical control of *S. molesta* was initiated by the Department of Agrarian Development in 1955 (Williams 1956). Non selective herbicide, Pentachlorophenol was used for this purpose. However, no significant level of control was achieved by 1960, even a few years after initiation of this type of control programme.

In 1960, Department of Agriculture launched a program for eradication of *S. molesta* with community participation (Dias 1967), due to the failure of the programme initiated by Department of Agrarian Development. This approach was continued for several years with limited success. This eradication programme was discontinued in 1964 due to financial constraints (Dias 1967). Subsequently *S. molesta* was found in many water bodies in different climatic zones across the country. Eventually, it became one of the most troublesome aquatic plants in the country demanding a novel approach on control.

Having failed the physical and chemical control approaches, the biological control approach became of interest to local researchers. In this context, the search for suitable biological control agents was launched. *Cyrtobagus salviniae*, (Family: Curculionidae) an insect native to south-eastern Brazil and northern Argentina, was first imported to Sri Lanka as a bio-control agent of *S. molesta*, from Australia in 1986. When introducing a phytophagous exotic insect to local environments the risk involved was high. There was a risk of damage to native plants and locally important plants including major crops. This risk was evaluated through host specificity testing under quarantine conditions conducted using 65 species of plants with economic significance in Sri Lanka including 10 cultivars of rice. This work was jointly carried out by the Natural Resources, Energy and Science Authority of Sri Lanka (NARESA), (currently known as The National Science Foundation), the University of Kelaniya, and the Department of Agriculture in collaboration with Commonwealth Scientific and Industrial Research Organization (CSIRO) Australia with the financial assistance from The Australian Centre for International Agricultural Research (Amarasinghe, 2000).

Upon the successful completion of preliminary tests, *C. salviniae* was identified as a suitable candidate for introduction. Further studies were carried out in 1987 to evaluate the field efficacy in different climatic zones of Sri Lanka. Efficacy tests were done in Battuluoya and Lunuwila tanks in NorthWestern Province, Kadupahara Wewa in the Eastern Province, Mutukandiya in the Uva Province, Kadawatha and Gammanpila in Western Province (Room *et al.*, 1989). These studies showed promising results in management of *S. molesta*. Subsequently the government authorities decided to release these bio-control agents throughout the country. The recommended rate of release was 1000 weevils per square meter.

Following mass rearing, insects were distributed to lowland water bodies. An assessment on success rate of biocontrol of *S. molesta* carried out by Amarasinghe and Ekneligoda (1997) and they reported that the success rate was 80% in the Wet Zone and 60% in the Dry Zone. A follow up study was conducted in 2008 by The Department of Agriculture, Plant Protection Service and the results confirmed the data of the previous study (Bandara, 2010). Another study was conducted to evaluate the distribution and abundance of *C. salviniae* in Medavachchiya Divisional Secretariat (North Central Province) by The Rajarata University of Sri Lanka in 2015 (Chandrasekara *et al.*, 2015). In this study *C. salviniae* was found in all the tanks surveyed. However the abundance is significantly varied among tanks.

All these studies indicated that some factors: water level, temperature and host specificity affect on success of using *C. salviniae* for controlling *S. molesta*, and higher success rate has been found in the wet zone than in dry zone.

At present, some activities to support the biological control programme such as mass culturing and field introduction are being continued by the Plant Protection Service of the Department of Agriculture. However, as the *S. molesta* is still problematic, further improvement of biological control programme or another effective alternate method is necessary.

CONCLUSIONS

Adequate level of control of *S. molesta* could be achieved through integration of all control methods including the use of *C. salviniae* as a biological control method. Further improvements in the introduction technique of *C. salviniae* such as introduction of adequate numbers of biocontrol agents, continuous monitoring and reintroductions of biocontrol agents etc. is required to obtain better control of *S. molesta* in Sri Lanka.

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