BIOLOGICAL CONTROL OF *SALVINIA* SPECIES

Jeremiah M. Dye and Kevin M. Heinz, Department of Entomology, Texas A&M University

Abstract

Thick mats of the exotic free-floating ferns *Salvinia molesta* Mitchell and *Salvinia minima* Baker cause severe degradation of slow moving water bodies. *S. molesta* has been controlled using the weevil *Cyrtobagous salviniae* Calder and Sands, and *S. minima* may be made less aggressive by another strain of this weevil. In temperature controlled laboratory experiments, we are studying the effects of cooler temperate conditions on these tropical species to determine the best weevil strain to release against *S. molesta* and *S. minima* infestations in Texas.

Introduction

Salvinia molesta infestation

Members of the genus *Salvinia* (Pterydophyta: Salviniaceae) are aquatic, free floating ferns favoring slow moving water bodies (Mitchell and Thomas 1972). Unchecked *Salvinia* growth can dramatically effect aquatic habitats. The thick mats, often colonized by other plants, can be nearly impassable to boats in addition to preventing the growth of submerged plants and lowering dissolved oxygen and pH levels.

Both of the *Salvinia* species occurring in the US are exotic. Giant salvinia, *Salvinia molesta* Mitchell, has a relatively small native range in southeastern Brazil and northern Argentina, but infestations have been reported around the world including areas of Africa, Australia, Papua New Guinea and India (Oliver 1993) as well as the southern United States (Jacono et al 2002). The native range of common salvinia, *S. minima* Baker, extends from Mexico to Argentina, but it has been naturalized in Florida since the 1930's and now also occurs in South Carolina, Georgia, Mississippi, Missouri, Louisiana and Texas (Jacono et al 2002).

Giant salvinia was first brought under biological control in Australia in the 1980's using the stem-boring weevil *Cyrtobagous salviniae* Calder and Sands. Weevils from Australia have been used to successfully control *S. molesta* throughout the world including in Papua New Guinea, India and Africa (Cilliers 1991, Thomas and Room 1986).

Cyrtobagous salviniae

Weevil damage

Temperature has been found to be a significant factor influencing control. Population growth is highest from 27°C to 31°C due to much shorter immature development times at warmer temperatures and reproduction ceases below 21°C (Sands, Schotz and Bourne 1986). In contrast, *S. molesta* can continue to grow even at 12°C (Room 1986). Thus, though *C. salviniae* has been a very successful biological control agent in tropical regions, there remain questions about its effectiveness in more temperate regions. These questions include regional differences between warmer conditions in southern Texas and cooler conditions in northern Texas.

In addition to temperature questions, biological control efforts against giant salvinia and common salvinia in the US using *C. salviniae* are also complicated by strain differences. In addition to the insects used in Australia and other parts of the world, there is also a population of the same species in Florida that feeds on common salvinia. Currently, weevils descended from the Australian population are being released in Texas against giant salvinia infestations while weevils from the population in Florida are being released in Louisiana against common salvinia infestations. The effectiveness of the Florida strain of *C. salviniae* against both *S. minima* and *S. molesta* is currently unknown, and the effects of temperature have only been studied for the strain used in Australia.

Objective

To identify the conditions of host plant and temperature profile under which each strain of *C. salviniae* can be expected to be most successful in controlling salvinia infestations.

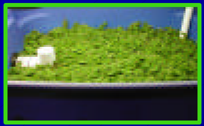
Materials and Methods

The experiment will be conducted with a 2x3x4 full factorial design as outlined in Figure 1, and each treatment combination will be replicated four times. Both *Salvinia* species currently in the US will be used. Both Australian and Floridian weevils will be used, as well as a series of control treatment combinations without weevils. These combinations of weevil and host plant will be studied at four temperature profiles based on temperature measurements during summer and winter for water bodies in North and South Texas.

2x3x4 Factorial Design		*Salvinia* species	Weevils		
			None	Fl.	Au.
Temperature Profile	North Summer	*mol.*	4	4	4
		min.	4	4	4
	North Winter	*mol.*	4	4	4
		min.	4	4	4
	South Summer	*mol.*	4	4	4
		min.	4	4	4
	South Winter	*mol.*	4	4	4
		min.	4	4	4

Figure 1. Experimental design and number of replicates per treatment combination.

Each experimental unit in the experiment consists of one plastic storage bin measuring 62 cm x 44 cm x 40 cm (length x width x height). Each tank is filled with water to a depth of 25 cm, a volume of 45 L. The water temperature in each experimental unit is regulated by recirculating water between each of the experimental units and a temperature-controlled central tank with a turnover rate of once per hour in each experimental unit. A constant water level is maintained using an overflow on the side of each tank at a height of 25 cm. To prevent plant or insect material from clogging the overflow or being transported to the other tanks, the intake of each overflow is located beneath the water surface and screened with a foam filter.



Experimental unit

Temperature-controlled central tank

Bank of experimental units

The temperature profiles are derived from temperatures measured at Hubbard Creek Reservoir near Breckenridge in northern Texas and Lake Charlotte near Anahuac in southern Texas. For each week of the experimental run the water temperature will be subjected to daily temperature fluctuation based on the average high and average low of that week for the desired water body and season. Temperature profiles are run one at a time in the recirculating system.

Sample unit

After placing 200g of plants in each tank, 12 weevils are added to each tank besides the controls. Then, at two week intervals for 12 weeks, three 7.6 cm diameter samples are removed from each tank, weighed and then dried over soapy water to collect adult weevils and larvae from the plants. The plants are then weighed again to determine the dry weight of plant material removed. These procedures allow us to calculate the intrinsic rate of increase of both weevil strains under the different treatment combinations and to assess any negative impact on the plant growth due to weevil feeding.

Preliminary Results and Discussion

In a preliminary study, we compared the wet and dry weights of 38 plant samples collected as described previously. The results are shown in Figure 2. The points shown in green represent samples of *S. minima* while the points shown in red represent samples of *S. molesta*. We observe that *S. minima* samples tend to have a higher wet weight than do *S. molesta* samples with the same amount of dry matter. This is most likely due to the smaller leaf and stem size of *S. minima* which results in this species having a greater surface area for a given amount of dry biomass. Thus water clinging to the plant surface interferes with an accurate measurement of the wet weight. For this reason future research will be based on dry weight rather than wet plant weights.

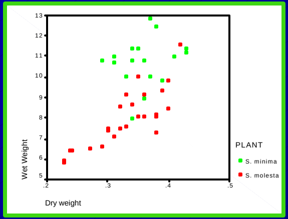


Figure 2. Plant dry weight (g) vs. plant wet weight (g).

As the main experiment is conducted we expect both weevil strains to perform well on their normal host plant, especially at the warmer south Texas conditions. What will happen under the cooler northern conditions and when each strain is not given its normal host plant cannot be anticipated, but this information will be valuable in making recommendations regarding which strain should be released against a given salvinia infestation.

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