NSW DEPARTMENT OF
PRIMARY INDUSTRIES

**Salvinia control manual - Readers' Note**

This document is part of a larger publication. The remaining parts and full version of the publication can be found at:

http://www.dpi.nsw.gov.au/aboutus/resources/majorpubs/guides/salvinia-control-manual

Updated versions of this document can also be found at the above web address.

NSW DPI

*A single floating plant showing the submerged root-like filaments.*

*An infestation is made up of individual plants floating together.*

Elissa van Oosterhout

# Part 1: The salvinia profile

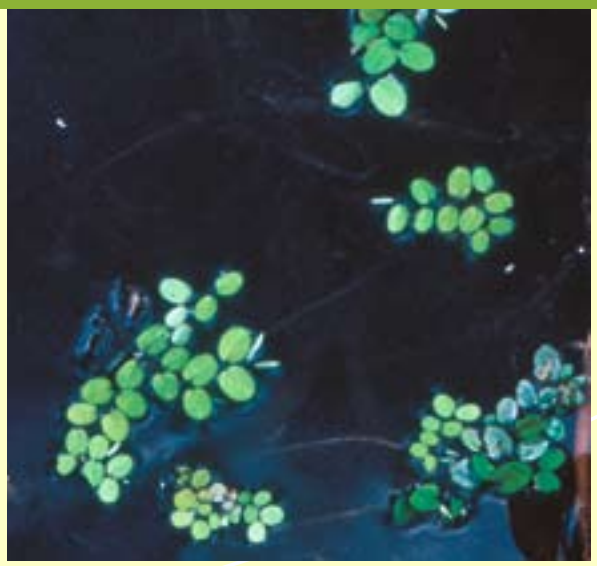
The genus *Salvinia* contains 11 or 12 species, seven or eight of which are native to South America, including *Salvinia molesta*. No salvinia is native to Australia, and all *Salvinia* species are prohibited entry. The only species currently present in Australia is *Salvinia molesta*. The Australian Quarantine Inspection Service (AQIS) identifies a number of other *Salvinia* species that could potentially enter Australia through northern borders. Any unrecognised or unusual plants with salvinia-like characteristics should be promptly identified and reported (contact the relevant State herbarium or weed agency).

## *Salvinia molesta*: physical characteristics

*Salvinia molesta* is a free-floating, mat-forming aquatic fern. Plants have central stems (rhizomes) that lie beneath the water surface, pairs of hairy floating leaves along the stems, and submerged trailing root-like filaments (modified leaves) below the water. The typically wedge-shaped plants rarely exceed 30 cm in length. Salvinia plants are ferns and therefore do not bear flowers.

A single plant, called a phenet, is made up of colonies of ramets (a ramet refers to each pair of leaves and associated bud on the rhizome). There are rarely more than 100 ramets in a phenet.

Plants float together, forming mats over the surface of the water. There are three distinct stages of growth that occur as floating plants become more crowded on the surface.



Mic Julien

*Salvinia in the primary growth stage.*
*Water surface is visible between primary stage plants.*

Anne Ferguson

*Salvinia in the secondary growth stage.*

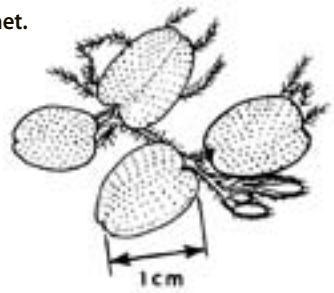
## Primary stage

Primary growth occurs in the early stages of an infestation, when plants are not crowded. The small, flat, oval-shaped leaves lie in direct contact with the water surface and are less than 15 mm wide. The water surface is visible between plants. Salvinia recovering from damage also shows the primary growth form, and regrowth leaves can be as small as 2 mm in width.

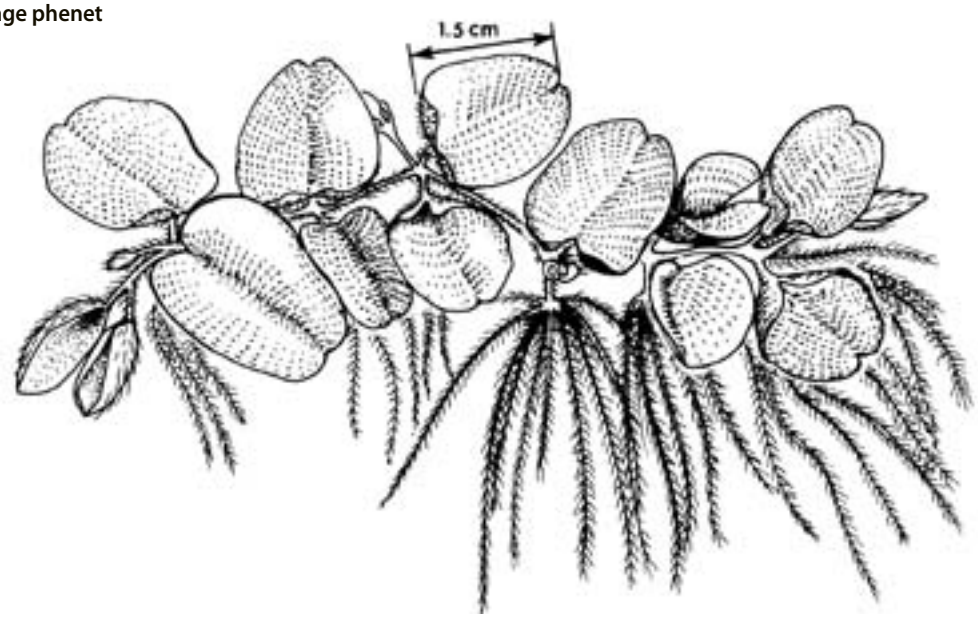
## Secondary stage

Secondary growth occurs when the leaves become slightly cupped, with their lower surface in contact with the water. Leaves are between 20 and 50 mm in width.

**Primary stage phenet.**




**Secondary stage phenet**




Courtesy of the University of Florida

ndrew Petroeschevsky

Mic Julien

*A single salvinia plant in the tertiary growth stage, showing typical wedge shape.*

*Ridge-like thickenings on multilayered tertiary salvinia. At this stage the water surface is not visible and light is prevented from entering the water.*

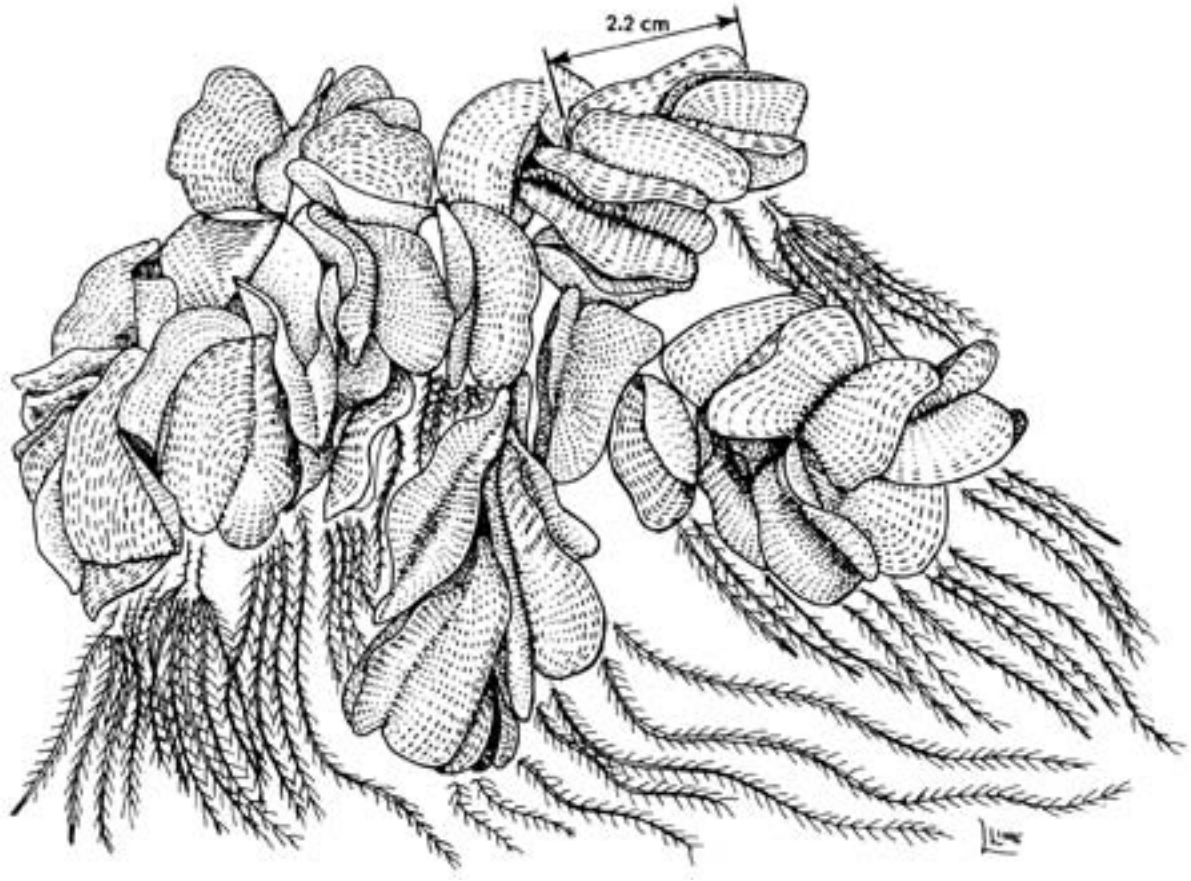
## Tertiary stage

Tertiary growth occurs when plants become crowded in a mature infestation. Leaves become tightly folded and are up to 60 mm in width when forced open. Neighbouring leaves are pressed tightly against each other in an upright fashion, not in direct contact with the water. Leaves are kept wet through capillary action between their surfaces. The water surface is not visible, and light is prevented from entering the water.

Tertiary weed mats can become multilayered, displaying ridge-like thickenings as layers build up. Up to 30 000 ramets per square metre have been recorded in nutrient-rich water. Biomasses have been recorded at 400 tonnes of fresh wet weight per hectare.

Over time, other vegetation, including sedges, grasses, and small trees, is able to colonise thick multilayered mats, forming a floating island of vegetation referred to as a sudd.

**Tertiary stage phenet**




Courtesy of the University of Florida

Iain Jamieson

*Salvinia will die in sea water.*

Rebecca Coventry

*Dead-looking frost affected salvinia.*

## Growth and reproduction

The salvinia that is currently present in Australia is incapable of sexual reproduction; therefore sporlings ('seedlings' of ferns) do not occur. The spore-bearing sacs (sporocarps) present among the root filaments have no viable spores and all reproduction is vegetative, via bud expansion and breaking of rhizomes.

**The sporocarps present among the root-like filaments contain non-viable spores.**

Courtesy of the University of Florida

### *Salvinia 'seedlings' do not occur*

*'Seedlings' are often mistakenly reported in field observations. New plants that form from a very small piece of stem with one set of small (2 mm) leaves can look like seedlings, particularly when they lodge on the surface of the mud at the edge of an infestation. Young duck weed plants are also mistaken for salvinia 'seedlings'.*

Each ramet can exist independently, and therefore new plants form vegetatively whenever a rhizome breaks. Rhizomes break with age or damage.

Growth occurs at the ends of the rhizomes, where apical buds are present. New rhizome branches can develop from any ramet where axillary buds are present. Each bud can form a new branch of ramets, with the oldest branches eventually rotting and falling away. A growing salvinia plant displays this process in a zigzag pattern, giving rise to the wedge-shaped plants.

The continuing production of new plant material makes salvinia a self-perpetuating perennial under favourable conditions. A new plant can form from a piece of rhizome bearing a bud.

NRME Photo Library

*New green leaves and buds can survive within the dead-looking weed mat.*

Barry Powell

*Yellowed nutrient poor salvinia.*

*Salvinia growth after 10 days at 30 °C.*

Elissa van Oosterhout


## Habitat and conditions for growth

Salvinia grows on still or slow-moving fresh water where nutrients are available, colonising open water or floating among other vegetation. Faster-flowing water is tolerated when other vegetation holds the salvinia in place.

Growth rates decrease by 25% in water that is 10% as salty as seawater. Growth is very slow in water that is 20% as salty as seawater, and plants die after 30 minutes in seawater.

Any depth of water can be colonised. A tertiary mat of salvinia can survive for up to 12 months on mud, as the plants beneath the top layer or next to the moist ground are sustained. In warmer climates very shallow water can reach temperatures above the preferred range for salvinia, making survival less likely.

### Temperature

The ideal temperature for growth is 30 °C (air temperature), but growth can occur between 5 °C and 43 °C. Under laboratory conditions, the highest growth rates occur between 20 °C and 30 °C. Growth starts to increase above 10 °C and declines over 30 °C. Very little growth occurs below 20 °C. Plants die when the buds are exposed to temperatures below –3 °C or above 43 °C.

***Regrowth after frost, drought or heat stress***

*Salvinia can regenerate after being drought stressed, heat stressed or frosted, with new green leaves appearing on a dead-looking brown weed mat. Frost kills exposed leaves and buds, but leaves and buds within the weed mat can survive provided that they do not freeze. Buds will also remain viable in dry or extremely hot conditions if they are protected inside the weed mat.*

### Nutrients

Nutrient levels can affect the appearance of the plant at any growth stage, but they are often difficult to measure. Nutrients are generally optimal when the salvinia is a healthy deep green (not yellowed, brownish or light green) and is growing vigorously as typical wedge-shaped plants. Long, thin, yellowish plants with very long roots and larger leaves are an indicator of low nutrient levels.

Plant health and nutrient levels can affect the success of biological control and some herbicides.

*Temperatures and nutrients*

*There may be a relationship between temperature and nutrient levels. At low temperatures high nutrient levels can have an anti-freeze effect, allowing plants to survive conditions that are colder than normal; at high temperatures lower nutrient levels may lead to better survival.*

## Rates of growth

Growth rates are governed by temperature and nutrients. Nitrogen levels determine how many buds a plant will produce, and also how many buds will break their dormancy to grow into new rhizome branches. Higher levels of nitrogen increase the growth rates of existing branches and the production of new branches.

Under ideal conditions (30 °C with optimal nutrient levels) an infestation can double in size in **less than 3 days**.

Rates of growth vary according to climate zones, starting to increase as temperatures warm up, peaking in late summer, and slowing over the cooler months. Growth rates are therefore seasonal in southern Australia and relatively uniform throughout the year in northern Australia. There are no distinct seasonal periods for stages of plant development.