The secret underwater world of seagrass sex

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A pair of wire weed (*Amphibolis antarctica*) anthers or pollen sacs (male flower) shedding masses of elongated pollen strands. Photo: Angela Rossen

Flowers are the wonderfully bright and varied reproductive structures that make members of the plant kingdom so unique – designed to lure unsuspecting insects, birds and mammals to disperse pollen – and genes of course!

Bright colourful petals typically attract pollinators, but not all flowers rely on this active assistance.

Our magical underwater meadows of vibrant green seagrasses have a different strategy, one more like their land-based, wind-pollinated relatives, the grasses.

They rely on forces of nature to disperse their pollen – water currents.

Seagrass flowers have adapted to life underwater. Their flowers are small, have no petals and are typically quite cryptic.

Unlike land plants, there is no need for brightly coloured petals and sepals in the marine world.

Sturdy flowering stems, or inflorescences, with mature anthers can be seen emerging from the ribbon weed (*Posidonia australis*) leaf canopy. Photo: Angela Rossen

Another peculiar adaptation to life underwater is seagrass pollen being elongated and sticky, so it can attach to stigmas. Being sticky means pollen can also get trapped in the canopy, sticking to pretty much anything it touches.

In some cases, such as the wire weed (*Amphibolis antarctica*) and ribbon weed (*Posidonia australis*) of cooler, southern Australian waters, the flowers tend to be high up in the leaf canopy, often emerging above it.

This makes it easier for pollen to be carried away in the currents to a neighbouring seagrass meadow.

It's also easier for receptive stigmas to 'trap' pollen already moving in the water from more distant meadows.

Wire weed is dioecious which means male and female flowers are on different plants. Pollen transport is therefore essential for pollination.

The female flowers are rarely seen since they are small and the same colour as surrounding leaves. Once pollinated, the female parts of the flower grow into an entire new seedling, while still remaining attached.

They separate from the mother plant and drift in the water column when the seedlings are large enough to support themselves (usually around 5 – 10 cm long). Eventually they sink to the sea floor and start growing.

We've been taking an especially close look at ribbon weed flowers (*Posidonia spp.*) from Western Australian meadows. All *Posidonia* species have hermaphroditic flowers, male and female organs on the same flower.

Ribbon weed flowers typically have three stamens (male), each with a pair of anthers (pollen sac) and a bract, and a pistil (female) consisting of stigma, style and ovary.

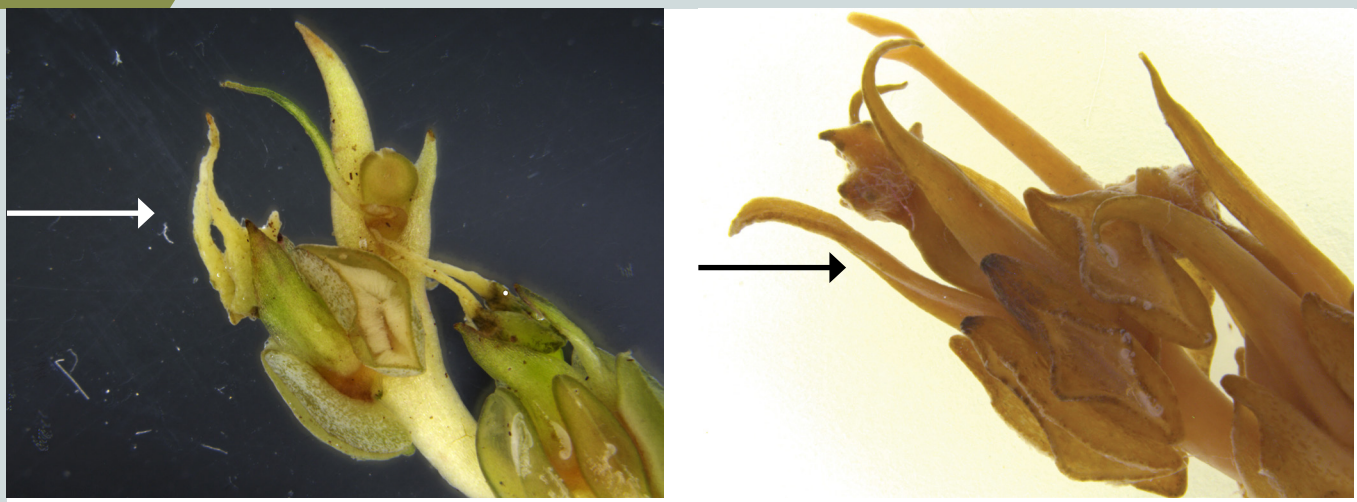
The pollen sacs slowly unzip when mature, releasing the long threads of pollen, which are swirled away by water currents to reach other flowers in the meadow. The pollen sacs on each flower ripen before the stigma is receptive, so there is less chance of being pollinated by the same plant.

Previous research using genetic markers showed that *P. australis* flowers prefer to be pollinated by pollen from a different plant (outcrossing; see *For People & Plants* issue 110).

A female wireweed plant, *Amphibolis antarctica*, with developing seedlings. Can you spot all the seedlings? Photo: Simone Strydom

A single flower with seedling beginning to emerge. Photo: Angela Rossen

Single ribbon weed (*P. australis*) flower with artificially coloured organs, anthers (yellow, male), bracts (purple) and pistil (blue, female).



Variation in *Posidonia* flowers (left) elongated processes emerge from a *P. australis* stigma; (right) a papillose stigma (multiple small nobs) of *P. coriacea* surrounded by elongated bracts. Photos: Marion Cambridge and Emily Stout

Mass, largely synchronised, flowering occurs in the cool waters every winter. It's generally easy to spot the flowers while snorkelling or SCUBA diving, particularly in Perth metropolitan waters.

The inflorescence or flowering stems are easily visible in ribbon weed although other *Posidonia* species 'hide' their flowers within the long, swaying leaf canopy.

We looked at flowers under the microscope, a mix of fresh and preserved collections. The local *Posidonia* species are all genetically very closely related, but the leaves and flowers help with identification. Some of the floral features are quite unique.

Magnifying the flowers under a microscope, regardless of how old they are, gives us a window into a secret watery underworld of seagrass sex.

From tightly packed flowers and their neatly paired anthers protecting the stigmas, to anthers ripening as the stems elongate to reveal how many flowers they have and eventually ripe, red anthers begin to unzip, releasing pollen into the water.

It is only after the pollen has been released that the female stigmas emerge fully, ready to trap pollen. A neat way to reduce the opportunity of self-pollinating.

A single stem with tightly packed ribbon weed flowers (*P. australis*) with only the brightly coloured red anthers visible (left); expanded stems with mature female flowers visible above the unzipped anthers. Several ovaries are beginning to swell as small green ellipsoid fruit develop (right). Photos: Angela Rossen

Emily looks down a microscope at a *P. coriacea* flower. Photo: Elizabeth Sinclair

My internship experience

Through this internship experience, I have had the opportunity to learn about the exciting world of *Posidonia* seagrass as I got up close and personal with these flowers. Despite their understated appearance, they have a vital function for the environment. Kings Park Science is making remarkable waves by bringing to light the importance of seagrass reproduction, especially in understanding the mystery of the Shark Bay polyploid clone.

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Once pollination occurs, the style and ovary begin to swell with emergent fruit growing towards the light, leaving the darkened pollen sacs to slough off.

The same basic floral structure is shared among *Posidonia* species, but some species have developed unique ways to trap pollen.

Ribbon weed flowers have three elongated processes (or structures) on the stigma creating a tiny vortex that sucks floating pollen onto the stigma surface.

Posidonia coriacea has a rounded stigma, but the anther connectives (or bracts) are extremely long, perhaps serving a similar purpose.

There are few reports of *Posidonia* flowering in Shark Bay and only a couple of meadows were known to even produce mature fruit (see *For People & Plants* issue 110), leading to speculation that what is now known to be a large polyploid clone (plants with more than two sets of chromosomes, see *For People & Plants issue* 119) might be sterile.

So, needless to say, we were a little surprised when divers returned with cuttings for a restoration project in August 2022 (see *For People & Plants* issue 122) that a widespread mass flowering episode was unfolding!

Past flowering events may have gone largely unnoticed, as the flower stems were short and hidden within the leafy canopy.

Stay tuned as we investigate the floral morphology from more than 1000 flowers from the Shark Bay clone. ■

Additional reading

Edgeloe JM, Severn-Ellis AA, Bayer PE, Mehravi S, Breed MF, Krauss SL, Batley J, Kendrick GA, Sinclair EA (2022) Extensive polyploid clonality was a successful strategy for seagrass to expand into a newly submerged environment. *Proceedings of the Royal Society B* 289: 20220538

Sinclair EA, Edgeloe JM, Anthony JM, Statton J, Breed MF, Kendrick GA (2020) Variation in reproductive effort, genetic diversity and mating systems across *Posidonia australis* seagrass meadows in Western Australia. *AoB PLANTS* 12: plaa038

For more information, visit www.seagrassresearch.net