Image: *S. quinqueflora*

Samphires

of Greater Adelaide and the Fleurieu Peninsula

This guide covers the samphires of coastal Adelaide, the Northern Adelaide Plains, and the Fleurieu Peninsula. Please take this guide to the plant, not the plant to the guide!

Samphires are the dominant life form in our temperate saltmarshes, and the variety of these amazing plants reaches a peak in southern Australia.

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What are samphires?

Samphires, or glassworts, are saltmarsh plants. They are succulent herbs and small shrubs belonging to the tribe Salicornieae within the family Chenopodiaceae. These unusual-looking plants have jointed (articulated) branches that look like a string of beads. These "articles" provide the structure of the plant and function as both leaf and stem. The succulent articles are the location for photosynthesis, they have a large water-holding capacity and accumulate organic compounds to help them retain water and manage their internal salinity. These adaptations allow samphires to thrive in very dry locations, or in tidally inundated areas that are "physiologically dry" because all the water present is saline.

The name "samphire" is a corruption of "Saint Pierre" or Saint Peter, the patron saint of fishers. It reflects the preference of these plants and their overseas relatives for growing in saline flats near the coast (although in Australia these plants frequently grow inland, adjacent to our extensive salt lakes.) Fishers pickled the low-growing, meadow or 'sward' forming species and samphire pickle is still commonly served in European and British pubs (known as "sampha", "sampkin" or "sea pickle".)

The ash from burnt samphire is very alkaline and was used in glassmaking (hence "glasswort") and soap making in Medieval times. This use continued in less prosperous communities up until the 1800's. Early in South Australia's settlement, a glassworker operated in the saltmarshes south of St Kilda. Small pieces of glass slag can still be found in the saltmarshes between St Kilda and the Little Para today.

Image: *T. halocnemoides*

Where are samphires found?

Samphires are found locally in saltmarshes, a type of tidal wetland. Saltmarshes collect sediment and land-sourced runoff so that water reaching the marine environment is clean. As a result of this sediment accumulation, the marshes act as "living shorelines," growing upward as sea levels rise. These tidal wetlands also contribute to fisheries productivity, as crab and gastropod or sea snail larvae released from the populations living in the saltmarsh provide an excellent food source for juvenile fish (Mazumder *et al*. 2004).

The remarkable water-holding capacity and salinity tolerance of samphires results in them being the dominant plant species in temperate and Mediterranean saltmarshes, and around inland salt lakes and saline scalds.

The southern saltmarshes of Australia have been afforded protection under the *Commonwealth's Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as a vulnerable ecological community (Threatened Species Committee 2013).

Important saltmarsh areas

The greater Adelaide and Fleurieu Peninsula region supports many significant areas of saltmarsh.

In the north, extensive saline clay pans or sabkhas of the Samphire Coast host the nationally vulnerable Fan Samphire. Wide deltas at the River Light and Gawler River contain extensive areas of saltmarshes, strongholds of samphire thornbill birds. Complex waterways, mangrove forests and saltmarshes of the Barker Inlet and Port River estuary, hug the urban area. As its name suggests, Bird Island, off the tip of LeFevre Peninsula, hosts significant seabird and shorebird colonies.

Southward, the saltmarshes of the Onkaparinga estuary support Gahnia sedgelands, historic habitat for yellowish sedge skipper butterflies. These butterflies have been reintroduced to the smaller, but culturally significant, marshes at the Aldinga Washpool and to restored sedgelands of the northern Adelaide Plains.

Image: *T. arbuscula*

Rocky coastlines along much of the Fleurieu limit saltmarshes to tiny pockets in estuaries like the Bungala and Hindmarsh. Further to the south-east, extensive saltmarshes are found in Lake Alexandrina, Hindmarsh and Mundoo Islands, the Goolwa Channel, and the northern tip of the Coorong, between Goolwa and the Murray Mouth.

Saltmarsh wildlife

Saltmarshes host complex food webs that tie together the aquatic, terrestrial and aerial habitats. Birds tend to be the top or “apex” consumers, with an amazing range of microbats, reptiles, fish, insects, and crustaceans further down the food chain.

Iconic saltmarsh bird species include shorebirds of the Adelaide International Bird Sanctuary (Winaityinaityi Pangkara), Neophema parrots (including elegant and rock parrots), samphire thornbills, and other insectivorous birds like white-fronted chats, superb wrens, and grey fantails. In the shrubbery of the high marsh, slow-moving stumpy lizards live. These areas host a range of insects and spiders, such as sedge skippers, blue butterflies and micromoths. Decorative Christmas spiders capture midges and mosquitos in their colonial webs draped across the shrubby samphires.

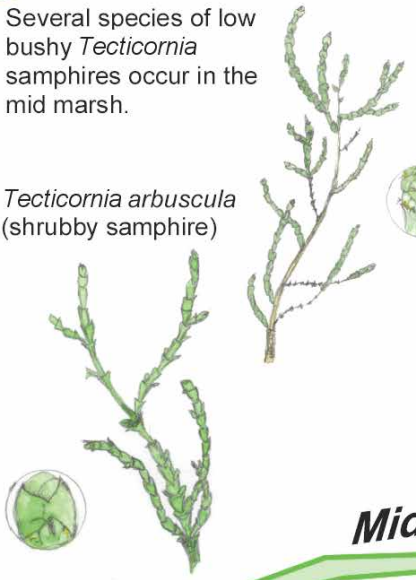
Holes across the low marsh, where the tide comes daily, reveal the presence of the little mud crabs, whose early larvae are a major food source for local fish populations.

Avicennia marina, the grey mangrove, forms open woodlands in the intertidal zone of estuaries. Mangroves are the only trees that grow in the intertidal zone in the Greater Adelaide area.

Mangroves

Several species of low bushy *Tecticornia* samphires occur in the mid marsh.

Tecticornia arbuscula (shrubby samphire)



Mid m

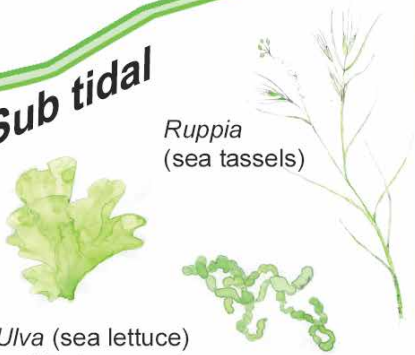
Low marsh

Suaeda australis (sea blite)

Salicornia quinqueflora, a lawn-like, low samphire.

Sub tidal

Ruppia (sea tassels)



Ulva (sea lettuce) and *Enteromorpha* (green guts).

NB: There are many more species that live above the highest water, these are just a few.

Frankenia pauciflora (sea heath)

arsh

High marsh

Nitraria billardierei (nitre bush)

Dianella brevicaulis (flax lily)

Melaleuca halmaturorum (swamp paperbark tree)

Above high water

Distichlis distichophylla (emu grass)

Atriplex semibaccata (scrambling berry saltbush)

Samolus repens (brookweed)

Triglochin striatum (streaked arrow-grass)

Mimulus repens (monkey flower)

Apium annuum (coast celery)

Disphyma crassifolium (round-leaf pig face)

Spergularia marina (salt sand-spurrey)

Puccinellia stricta (saltmarsh grass)

Wilsonia humilis (silky wilsonia)

Peri Coleman

updated 16/11/2021

Other plants of the saltmarsh

Samphires aren't the only plants that live in saltmarshes, even though they are the most obvious group in South Australian saltmarshes. Everything from grasses to annual flowers, perennial herbs, and tall shrubs live in the marshes. These saltmarsh plants are found in patterns which relate to fresh and marine water inputs, frequency of tidal inundation, and whether the soil is fast draining or a water-holding clay. Some of the samphire species that occur in local saltmarshes, and where they are typically found in the marshes, are illustrated on the previous pages.

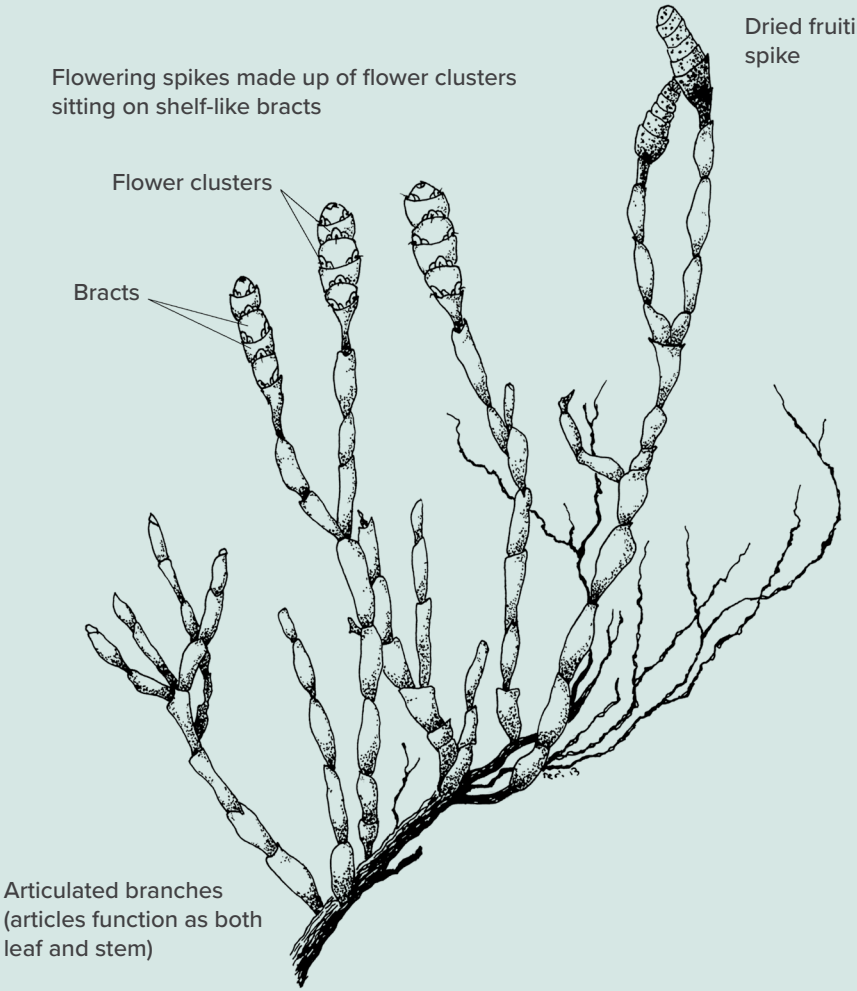
In springtime, local estuarine saltmarshes sparkle with white stars of creeping brookweed, while small sand and shelly ridges, or cheniers, in the marshes ripple as breezes tug the shining flower heads of spear grasses. Insect life of the saltmarshes depends on a wide variety of plant species. Butterflies such as yellowish sedge-skippers need *Gahnia filum* sedges for their larval food, while saltbush blues and bitterbush blues are found on the plants they are named for. There is much yet to learn amount the plants and animals of our saltmarshes.

Threats

The main threat to saltmarshes is draining and filling marshes for industrial or residential land use and dredging for marinas and other developments. More localised impacts include pollution events, dumping, grazing, off-road vehicles, and weed infestation.

Climate change also presents indirect and direct risks to saltmarsh habitats in Australia. Measurable sea level rise over the past half century has seen mangroves colonise saltmarsh areas in South Australia (Coleman 1998) and nationally. As a result, saltmarsh is being squeezed between mangroves and developed areas (Saintilan & Williams 1999). Climate change also impacts saltmarshes directly in southern Australia. The Shrubby Samphire, *Tecticornia arbuscula*, is threatened by sea-level rise and climate-impacted soil salinity increases. This species of samphire provides habitat for samphire thornbills, a species of bird listed as Vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act.

Overall structure



Telling samphires apart

Look closely

If you have a hand lens or a dissecting microscope you can see details that differentiate samphire species. Seed colour, shape, and ornamentation are particularly helpful (the seeds of each species are illustrated in this guide.)

Some samphire species are protected plants under the *National Parks and Wildlife Act 1972*. This includes Bead Samphire (*Tecticornia flabelliformis*) which is listed in this guide. It is also prohibited to "take" native plants that grow on public land (national parks, reserves, marine parks and crown land), without a permit, and on private land you need the owner's consent.

Palisade cells

It may be useful to take a small article cross-section of a common species for educational identification. If you cut a samphire article in cross section, you will see green layers containing the chloroplasts where photosynthesis occurs, located under the surface epidermal (skin) cells. Below this, closer to the centre of the stem, you will see clear water-holding cells surrounding a central stele (vascular bundle). The structure of the green layer (called the palisade) varies in different samphires.

In almost all samphires the palisade is thick, and formed from several layers of similar green cells. Occasional clear "passage cells" can be found in the palisade and a reflection of these clear cells can be glimpsed in the reticulated surface patterning of the epidermis. This palisade arrangement is typical of C3 plants (refer glossary), which have either a temperate distribution or are restricted to very wet habitats in tropical climates.

In one local species, *Tecticornia indica* (Brown-headed Samphire), the palisade comprises two distinct layers. The upper layer contains clusters of green photosynthetic palisade cells. These are located below each stomata and separated by larger clear cylindrical cells. Below this is a layer of tightly packed, dark green, thick-walled, "cuboid" cells. Viewing the articles with a hand lens will reveal the "clusters" of green palisade cells, and a cross-section will show the narrow palisade with a dark green line underneath the palisade. This specialised 2-layer arrangement of the palisade is typical for C4 plants (refer glossary), which often grow in hot climates. Indeed, Brown-headed Samphire is very widespread with related subspecies found across tropical and temperate Australia.

Sclereids

In the two *Salicornia* species you may see sclereids, or stone cells, in the palisade tissue. These hard cells impart a gritty texture to the plant tissue. The sclereids of the two species are different and this can help you determine which species you have in the absence of flowering material. If you examine the palisade of the Thick-headed Glasswort under a microscope you will often see spirally thickened sclereids, while in the Bearded Glasswort the sclereids are thickened and lack the obvious spirals.

Cross-sections of *Tecticornia indica* (top) and another *Tecticornia* species.

Oblique view of *T. indica* showing clustered palisade cells.

Cross section of *T. indica* showing the underlying layer of dark green cubic cells, and the irregular look of the clustered palisade cells above that.

Other things to look for

1.1.1 Growth forms

When you look at a saltmarsh you may see samphires of different growth forms – some are a lawn-like sward and others grow as densely branched small shrubs.

The sward-forming samphires may be *Salicornia quinqueflora* (Bearded, or Beaded Glasswort), *Salicornia blackiana* (Thick-headed Glasswort) or *Tecticornia flabelliformis* (Fan or Bead Samphire). Bearded Glasswort is always decumbent, that is, it puts down roots from stem nodes and grows from "runners" forming a dense mat. Thick-headed Glasswort can grow in a similar manner where it grows in wet conditions, however where it occurs in drier situations it forms a tufted dwarf shrub. Mature Fan Samphire plants are usually dwarf shrubs, but the juvenile plants may grow so closely together that overall they form a sward like *Salicornia*.

1.1.2 Fruiting spikes

Look at the fruiting spikes. Are the seeds held on the bush for a year or so, or do the seeds blow away as soon as they ripen? Are the fruiting spikes hard or soft, light or dark coloured, do they break up or hold together? Do they grow at the end of the branch (terminal) or are they intercalary (the branch soon starts to grow on, past the end of the fruiting spike)? Are the seeds black, reddish brown, creamy or yellow and are they smooth or covered in small bumps?

Salinity tolerance
Low to high

- *Salicornia blackiana*
- *Tecticornia indica bidens*
- *Tecticornia pergranulata*
- *Tecticornia pruinosa*
- *Tecticornia syncarpa*
- *Tecticornia halocnemoides*
- *Tecticornia flabelliformis*
- *Tecticornia arbuscula*
- *Salicornia quinqueflora*

Moisture
Wet to dry

- *Tecticornia arbuscula*
- *Salicornia quinqueflora*
- *Tecticornia flabelliformis*
- *Tecticornia halocnemoides*
- *Tecticornia syncarpa*
- *Tecticornia pergranulata*
- *Tecticornia pruinosa*
- *Salicornia blackiana*
- *Tecticornia indica bidens*

pH
Acidic to alkaline

- *Tecticornia syncarpa*
- *Tecticornia arbuscula*
- *Salicornia quinqueflora*
- *Tecticornia flabelliformis*
- *Salicornia blackiana*
- *Tecticornia indica bidens*
- *Tecticornia halocnemoides*
- *Tecticornia pergranulata*
- *Tecticornia pruinosa*

1.1.3 Location

The overall size and shape of the plant as well as its location in the environment often aids identification. The Shrubby Samphire (*Tecticornia arbuscula*) grows much larger than most of the other samphires and prefers habitats along the edge of tidal creeks just inland from the mangroves. The Bearded Glasswort (*Salicornia quinqueflora*) also likes regular tidal inundation.

Open saline clay pans (sabkhas) are very hostile environments. The low growing samphires found on these pans are usually *Tecticornia halocnemoides* (Grey Samphire) or Fan Samphire, both of which can tolerate hypersalinity (salinity much greater than that of seawater).

Assistive diagrams

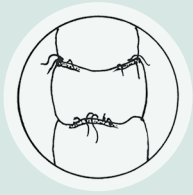
Flowers in 5s or more

Central flower in 2 tiers

Only central flower in triad bisexual

All flowers in triad are bisexual

Flowers exposed Flowers in 3s



Flowers hidden

Bracts separate

Bracts continuous

Styles protruding

Comparing local samphires

This table provides comparative features for the species of samphire found in coastal Adelaide, the Northern Adelaide plains and the Fleurieu Peninsula.

	Flowering spikes							
If you have flowering spikes you can quickly place your specimen into one of the four boxed groups below. The additional columns provide further, or alternate, features to help determine the species.	Flowers in groups of 5 or more	Central flower sometimes 2-tiered	Flowers in triads, but only central flower bisexual	Flowers in triads, all flowers bisexual	Flowers exposed, spike may have undulate outline	Flowers hidden, spike may have smooth outline	Opposite bracts separated	Bracts continuous
S quinqueflora	✔				✔			✔
S blackiana	✔	✔			✔			✔
T arbuscula			✔		✔ ✘			✔
T flabelliformis				✔	✔		✔	
T pergranulata				✔	✔			✔
T halocnemoides complex				✔	✔			✔
T indica subsp *bidens*				✔		✔		✔
T pruinosa				✔		✔		✔
T syncarpa				✔		✔		✔

There is potential for two unrecorded species to be present in the Fleurieu Peninsula, *Tecticornia lepidosperma* (Sea Asparagus) and *Tecticornia triandra* (Desert Glasswort). Locally unrecorded species and species from other regions cannot be identified correctly using only this table.

Taxonomic changes over the past decades have resulted in all samphire species in Australia being assigned to two genera. *Salicornia* replaces the older name *Sarcocornia*, and the genus *Tecticornia* includes all those species previously within genera *Tecticornia*, *Tegicornia*, *Halosarcia*, *Sclerostegia* and *Pachycornia*.

A glossary of technical terms used can be found after the species descriptions.

Fruits			Seeds				Plant	
Protruding style/s	Fruiting spikes generally terminal (branches do not grow on past fruit)	Branches grow on beyond the fruiting spike	Seeds circular & creamy-white, U-shaped embryo, with hairs or nipples	Seeds relatively smooth and golden	Seeds black, large, mammilate ornamentation	Seeds variously deep gold, reddish or brown, embryo to one side (curved or straight), variously ornamented	C4 anatomy throughout articles	Low growing or tufty, with branches that can set roots at nodes
			✔					✔
			✔					✔
✔	✔			✔				
	✔					✔		
	✔				✔			
	✔					✔		
	✔			✔			✔	
	✔			✔				
		✔				✔		

Species profiles

Salicornia quinqueflora (Bearded, or Beaded Glasswort)

Salicornia quinqueflora (Bearded Glasswort) is usually a decumbent low-growing samphire about 15cm tall that forms extensive swards or meadows, landward of the mangrove fringe. Meadows form when the plants develop roots at the joints along their prostrate branches. In drier conditions, or where the species grows with other bushy samphires, such as *Tecticornia arbuscula*, it may grow more erectly to about 50 cm high or even form a scrambling sub-shrub.

Bearded Glasswort is frequently found in tidally inundated areas that are submerged twice daily, such as estuaries and saltmarsh flats. It is also found further inland around salt lakes, but always in very wet situations.

The extensive swards change colour seasonally and are frequently punctuated with bare “pans” that hold water at low tide. This species is one of the most common coastal samphires in tidal areas.

The flowering spikes can be very long, up to 50 mm, although they are usually shorter. The opposite bracts are united (continuous, forming a cup) and the flowers are arranged in a single-row forming a cymule of 5–9 florets on either side of each bract of the flowering spike. The central floret in each cymule tends to be oblong or wedge shaped. During flowering, the paired stigmas of the ovary that protrude from each floret form an encircling “beard” around the flower spike.

The fruiting spikes are pithy in texture and the almost circular seeds are a little over 1 mm long, with an opaque creamy fawn colour. The seeds are decorated with acutely tapering projections that may have a hooked end. Inside, should the outer testa be stripped away, the embryo can be seen tightly bent into a horseshoe shape.

Salicornia quinqueflora meadows are recognised as providing important habitat for several species of migratory shorebirds and for Neophema parrots. The *Salicornia* zone of coastal saltmarshes is the preferred habitat of the small mud crab, a keystone species for many estuarine fisheries, as the larvae of these crabs provides a major food source for juvenile fish.

A significant threat to bearded glasswort is sea-level rise, which is occurring at a rate higher than the global average in Barker Inlet. Rising sea levels have already resulted in mangroves migrating landward by nearly 1.5km across the wide flats of the estuary of the Little Para, displacing Bearded Glasswort, which migrates landward across other habitats. Other local threats include the impacts of inappropriate use of off-road vehicles, clearance to provide hard stand areas for boats and loss resulting from intensive bait digging.

Autumn

Beard

Cross section

Fruit

Seed

Salicornia blackiana (Thick-headed Glasswort)

Salicornia blackiana (Thick-headed Glasswort) is very similar in its general appearance to *Salicornia quinqueflora*, particularly where the two species grow in proximity in wet conditions, forming dense mats. In drier conditions where the Bearded Glasswort does not occur, the Thick-headed Glasswort tends to grow as a distinct, tufted shrub that may reach 60 cm high, although it still tends to develop adventitious roots along its decumbent branches at the nodes. In these drier conditions the plants usually form thicker articles than when they are found in wet conditions.

If you examine the palisade tissue of the Thick-headed Glasswort under a microscope you will often see spirally thickened "sclereids" (hard cells that impart a gritty texture to the plant tissue). The closely related Bearded Glasswort has thickened sclereids that lack the obvious spirals.

The Thick-headed Glasswort is at its most distinctive in the field when the flowering spike thickens up as the fruit start to ripen. The spike may reach 8 mm in diameter. As with the Bearded Glasswort, the opposite bracts are united (continuous) and the flowers are arranged in opposite linear groups (cymules). The number of florets can be 5–13 on either side of the spike, and the central flowers may appear in two rows (sometimes the lower florets can be so shrunken that this may not be easily observed). This doubling of the central florets is the best aid to identification in the field, for flowering and fruiting specimens.

The fruiting spike is pithy and as the fruits ripen the spike turns a light fawn colour. When the fruitlets have dropped from the spike you may still be able to see evidence of the double tier of the central florets as a double set of dips in the axis of the spike.

The structure of the seeds (observed under magnification) will also separate the two *Salicornia* species. Thick-headed Glasswort seeds are almost circular and an opaque creamy fawn colour, however they are often a little larger than the seeds of the Bearded Glasswort (up to 1.4 mm compared to 1 mm for the latter) and the hairlike projections are papillose, which means that they have a nipple-like or globular end, instead of being acute or hooked as seen in the Bearded Glasswort.

Thick-headed Glasswort is not found as commonly as Bearded Glasswort. It grows in periodically waterlogged soils, but may also be found on limestone platforms that are wet by sea spray.

Flower

Spiral sclereids

Young fruit

Old fruit

Seed

SPECIES PROFILES

Tecticornia arbuscula (Shrubby Samphire)

The largest of the local samphires, *Tecticornia arbuscula* (Shrubby Samphire) can grow to 2 m high. It is found most commonly in the riparian zone of tidal creeks, just landward of the mangroves where inundation with fresh tidal water is regular, or landward of shelly ridges that allow percolation of seawater. This species decreases in size the further it grows from a water source. The proximity of intertidal Shrubby Samphires to the mangroves means they are amongst the first samphire species to be impacted as mangroves move inland as a result of sea level rise.

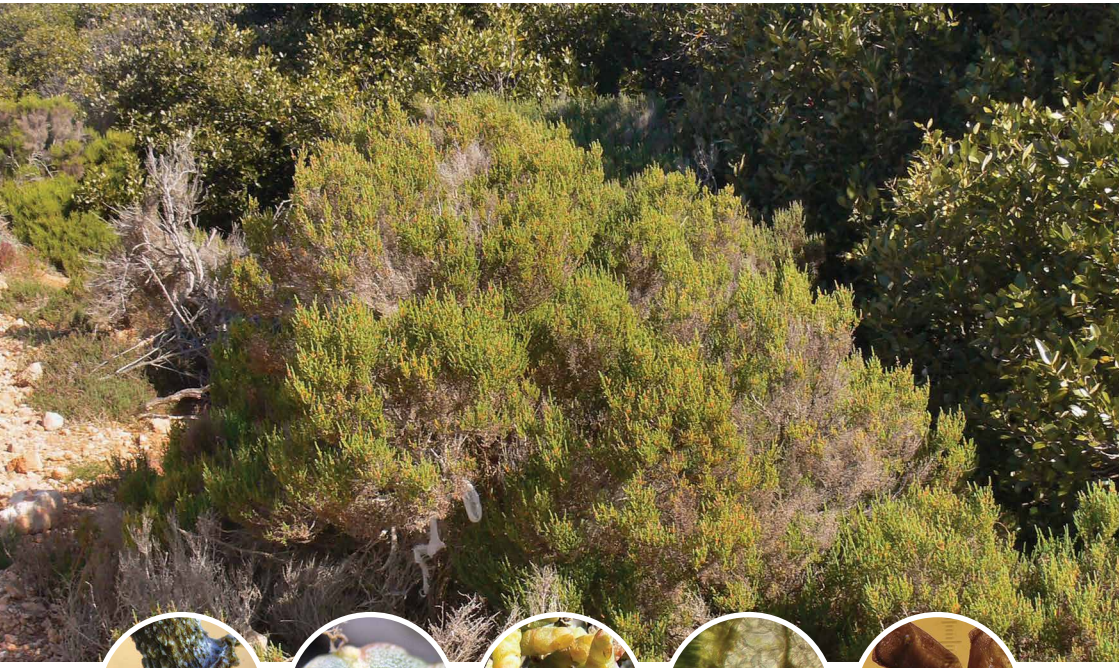
Shrubby Samphires tend to occur in very tidally wet areas and the dense branches and ascending form of this species results in the development of thick shrublands, where bushes grow closely, protecting them from off-road vehicle disturbance and weed invasion. This thick shrubland provides habitat for the slender-billed, or samphire, thornbill (*Acanthiza iredalei rosinae*), which is restricted to the northern shores of Gulf St Vincent and has a State conservation rating of Vulnerable.

The short (only a few articles long) flowering spikes are usually (not always) terminal. They occur on both the main and small lateral branches, so can be oriented in all directions. The supporting bracts of the flowering spikes are continuous and cup-like, almost completely covering the opposite triads of flowers.

Each triad has only one bisexual flower – the central one.

The two flowers on either side of the central flower are male and can only be seen when their pollen anthers push out from between the bracts. The central female flower has a solid style with two stigmas, which can easily be seen protruding on opposite sides of the flowing spike. The style hardens and persists in the fruiting spike and can be seen protruding long after the fruit has shrivelled to dryness. Fruits can be held on the plant for some time although the spike eventually breaks up into separate articles that fall away. A few old fruits can be found on the bushes at all times of the year. The single protruding style in the flowering and fruiting spikes is the most obvious spotting feature of Shrubby Samphires.

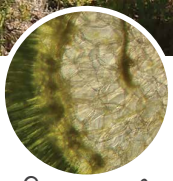
Seeds of the Shrubby Samphire are enclosed in a hard, vaguely pyramid-shaped pericarp which, once cracked, reveals the narrow 1.5 mm long seeds (more than twice as long as they are broad). The seeds are golden brown, transparent and unornamented. The embryo is almost straight and lies next to a large volume of perisperm.



Old fruit

Flower

Early fruit



Cross section

Seed

SPECIES PROFILES

Tecticornia flabelliformis (Fan or Bead Samphire)

In the warmer months of the year, *Tecticornia flabelliformis* (Fan Samphire) is a tufted-looking bright apple-green dwarf shrub that is usually less than 20 cm high. Its branches tend to spring from low on the plant, are not much divided and have large terminal flowering spikes, so the plant does not have a "bushy" look to it, unless it is very old. In fact, when swathes of juveniles are seen the plants can look like a patch of *Salicornia*. This samphire is the only one in the region that is considered to be deciduous, with its fleshy articles turning red and sloughing away in the coldest months of the year, leaving small twisted dry branches. As a result this samphire species is often overlooked in surveys, unless they are undertaken after late October and before early April, when the bright colour of the articles makes the plants readily visible.

The prominent flowering and fruiting spikes seen in summer are commonly 20 mm long and may reach 40 mm in wetter locations. Close examination of the spikes shows that the bracts supporting the exposed triads (groups of three) of bisexual flowers do not continue right around the spike, but instead appear to be separate. This distinctive appearance ensures there is no need to identify the species using a cross section of an article.

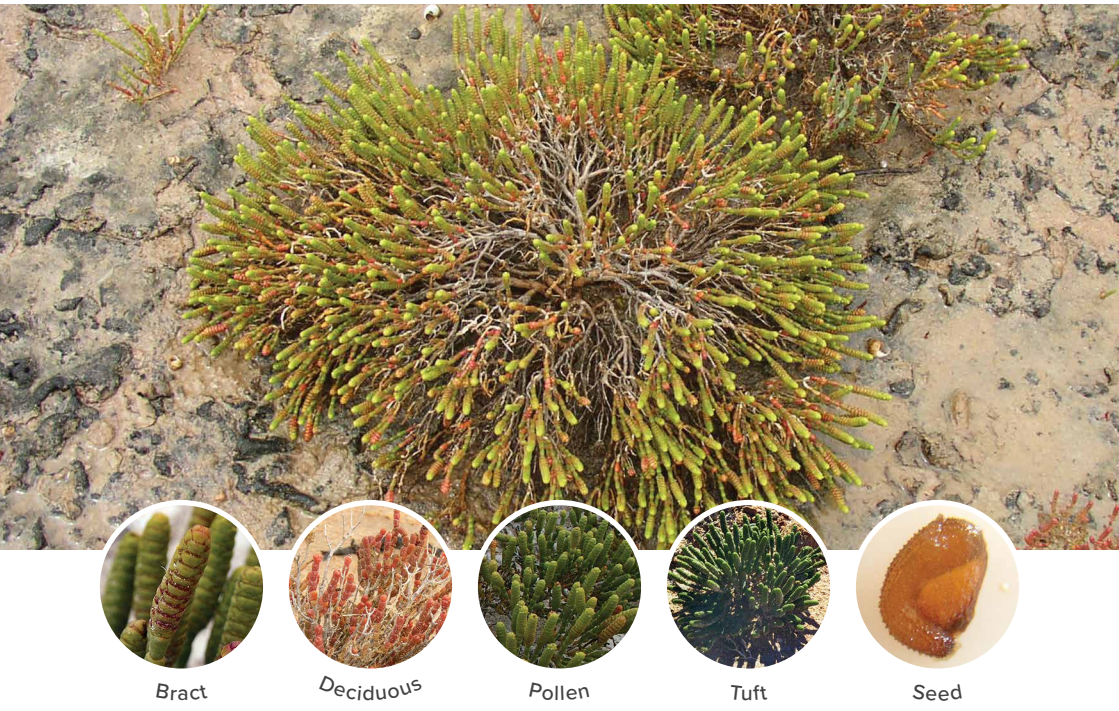
Seeds of this species are a little less than 2 mm long and are translucent yellow to brown in colour, with minute pointed protrusions round the outer edge of the seed (over the curved

embryo) but smooth over the sides where the white perisperm can be seen.

Fan Samphires are listed as a Vulnerable species under the EPBC Act and the state's National Parks and Wildlife Act, as they have a very restricted range and require distinct soil conditions that are not common. They are found on small parts of the extensive network of sabkhas (salt clay pans) located along the edge of Gulf St Vincent north of Adelaide. The plants are gypsophiles and grow on the clay pans where there is wet saline clay above hardened layers of soil impregnated with gypsum (fragipans). The salt concentration in these soils is very high.

These specific soil conditions provide a habitat that precludes other species. Small changes to the soil moisture or salinity result in Fan Samphires being outcompeted by other samphires. For example, additional tidal inundation sees the Fan Samphire replaced with *Salicornia* species, while additional drying allows *Tecticornia halocnemoides* (Grey Samphire) to invade the Fan Samphire niche.

Threats to Fan Samphires include grazing (the flowering and fruiting spikes taste sweetish and the plants appear to be preferentially grazed), off-road vehicle use and alterations to the hydrology of the sabkhas by road building, dredging, and extraction of the underlying salt water.



SPECIES PROFILES

Tecticornia pergranulata subsp. *pergranulata* (Blackseed Samphire)

Tecticornia pergranulata (Blackseed Samphire) is a low shrub that can reach half a metre in height when it grows in an upright manner. It sometimes grows in a lower, more spreading form. Blackseed Samphire have articles that tend to be dull and the colour varies widely from a dusty blue-green through green to pinkish purple. The size of the articles varies considerably.

Flowering and fruiting spikes of Blackseed Samphire are terminal on the branches and upward facing lateral branchlets. The spikes may reach 5 cm long. Blackseed Samphire have continuous bracts that circle the spike and are partially obscured by the opposite triads of flowers, producing a "bow-tie" appearance. The silhouette of the fruiting spike tends to be undulating, reflecting the orientation of the flowers in the alternating bulges of the bracts.

The seeds of Blackseed Samphire are retained in the fruiting spikes on the plant for a considerable time. The spikes tend to become softly corky and hang down from the branch tips, so that for much of the year the bushes appear to be covered with lambs' tails. Hidden in the corky spikes are the seeds, which are round to oval, black (sometimes reddish-black) and opaque. The seeds are a little less to a bit more than 1 mm long. Simply rubbing the grey fruiting spike between your fingers allows the

black seeds to fall out into your palm, where they are very visible amongst the light grey detritus of the fruiting spike. This is the most obvious spotting feature for Blackseed Samphire.

The distinctive black seeds are ornamented with nipple-like or 'mammilate' projections that are packed tightly into concentric ribs. In most plants these ribs extend over the entirety of the seed, however there are some varieties where the seeds are reddish black and the ribbing does not extend to the centre of the seed faces.

Blackseed Samphire is less tolerant of salinity than many other species, and is the dominant samphire along the higher, inland edges of estuarine saltmarshes and in brackish wetlands. It also occurs on slightly elevated shelly sand ridges that are rain leached, in saltmarshes dominated by other species of samphire. The habitat preferred by Blackseed Samphire is often characterised as "high marsh" and this habitat is frequently used for grazing. In many areas high marsh has been cleared to allow planting of salt tolerant (mostly exotic) pastures.

Crushed fruit

Flower

Flowering

Fruit spike

Seed

Tecticornia halocnemoides subsp. *halocnemoides* (Grey Samphire)

Tecticornia halonemoides subsp. *halocnemoides* (Grey Samphire) is not always grey. The rather small articles (3-5 mm long) can be green or red and may be glossy or dull. Grey Samphires are very variable, but the two most commonly observed varieties of this subspecies in the vicinity of Adelaide and Fleurieu Peninsula are both low growing. On the pans of salt lakes the smallest type grows to about 10 cm tall and has small twisted grey branches with just a few gem-like, translucent, ruby articles. Somewhat upslope grows a form that is highly branched but very low, forming a shrub generally between 15–25 cm high, usually with a contorted grey woody trunk. The articles along branchlets of this form also soon fall away, and only a few short dull articles remain evident at the ends of the dry branchlets.

The flowering and fruiting spikes are terminal (at the ends of the branches) and can be up 2.5 cm long, comprising more than a dozen articles. Although the bracts are continuous around the spike, the triad clusters of flowers are large and obscure much of each bract, giving the bract a “bow-tie” appearance. The bracts bulge where there are no flower clusters, so the outline of the spike tends to have an undulating silhouette.

All three flowers in each triad are fertile, and the seeds are held for only a short time on the plants. Each fruitlet is like

a papery bag, formed by the drying perianth (flower) and holds a small (1 mm) reddish-brown opaque seed that is ornamented with tiny raised bumps over the outer edge of the seed and that has a slightly rippled surface overlying the sides. In late autumn the papery fruitlets with ripe seeds blow away from the plant, leaving the empty bracts remaining on the plants. These empty remains look like small Japanese pagodas standing on the tips of the branches, until the winter storms knock them from the bushes.

This samphire is very common. It tolerates a wide range of tidally and seasonally waterlogged saline habitats and can tolerate extended periods of dryness and very high salinity. Saltmarshes that receive only occasional tidal inundation are often dominated by this species, which is also found on salt lakes or edging the huge network of sabkhas that occur along the northern parts of Gulf St Vincent, where it is found on slightly drier and higher land than *Tecticornia flabelliformis*.

Threats to this species include off-road vehicle use, and "reclamation" of its habitat by filling, usually for coastal residential or industrial lands. Placement of roads across saltmarshes often results in the hydrological "stranding" of large areas of this species. While the adult plants rarely die outright in this situation, new recruitment ceases and the old plants become less resilient.


Fruit spikes


Flowering


Pagoda shapes


Pollen


Seed

Tecticornia indica subsp. *bidens* (Brown-headed Samphire)

Tecticornia indica subsp. *bidens* (Brown-headed Samphire) prefers well drained soils of only moderate salinity. Locally it can be found in sandy elevated areas above the "beaches" edging the sabkhas of northern Gulf St Vincent. It is fairly common in the coastal reserves north and south of Thompson Beach.

Brown-headed Samphire is a sturdy blue-green to yellowy-green shrub that can reach 2 m high, although it is usually shorter than this. The large, stout articles can reach 1 cm long, and have "keels" on their lobes, as do the flower spikes. The keels may be clear or coloured, and sometimes have a reddish hue.

The epidermis (skin) of the articles, when examined with a hand lens, shows an unusual clustered arrangement of the green palisade cells, as it is a C4 species. Cross-sections of the articles reveal a single layer of palisade cells underlain by a narrow band of tightly packed, dark green cuboid cells (see "Telling samphires apart").

The flowering and fruiting spikes of Brown-headed Samphire have a smooth outline, with even cup-like bracts that almost conceal the triads of bisexual flowers. The lowest bract of each spike is larger and more deeply lobed than the slightly smaller bracts above. The mature fruiting spike is corky to feel and remains on the plant for much

of the year, gradually changing colour from straw to grey. Small nodules, hardly noticeable on the newer fruiting spikes, gradually darken and form small black spots across the surface of the older spikes. Wet spikes swell and soften and eventually fall apart.

Extracting the seed is tricky, as it is surrounded by a very hard pericarp. Cracking the fruitlets open tends to result in bits of fruitlet and seed flying off in all different directions. If you manage to obtain some seeds you will observe that the golden brown seed is a little less than 1 mm long, smooth, unornamented and translucent. The straight to slightly curved embryo may be visible through the seed's testa as a darker area along the seed's outer edge, with a large light coloured perisperm adjacent to it.

While Brown-headed Samphire is considered to be widespread in Australia, it is not particularly common, probably because it occurs on land that has potential for other uses. South of the Gawler River much of this species' habitat has been converted to agriculture.

Epidermis

Small nodules

Keel

Fruit spike

Seed

Tecticornia pruinosa
(Waxy Samphire or Bluish Glasswort)

Tecticornia pruinosa (Waxy Samphire or Bluish Glasswort) is another species that prefers well drained soils of moderate salinity. It is often found where alluvial soils have washed into the edge of a saltmarsh forming a “fan” of soil that may be a distinctly different colour to the rest of the soils in the saltmarsh.

This species is very common, occurring in the high marsh where saltmarsh intergrades with saltbush and coastal dune habitats, along embankments in saltmarshes and edging sabkhas along the coast. It also occurs inland, where it grows in depressions and adjacent to salt lakes. The drier nature of the soils utilised by this samphire makes the species vulnerable to damage from off-road vehicles and other forms of trampling.

Waxy samphire is a solid looking low shrub that may reach a metre high but is more usually around 40 cm tall. The bush is generally a dull (waxy looking) blue-green in colour and has medium sized articles, usually between 5–8 mm long. The older articles often become flushed with pink or purple in winter.

The flowering spikes are terminal on the branches and laterals. The flowering spikes of the waxy samphire are usually less than 3.5 cm long and have a smooth outline, with overlapping bracts. These bracts continue right around the spikes in smooth rings that totally conceal the opposite triads of flowers.

The bracts remain swollen in the fruiting spike, which is spongy or corky to feel. Fruiting spikes remain on the plant for much of the year, gradually changing colour from light to dark brown as they mature. The mature fruiting spikes break easily into rings that reveal the opposite triads of fruitlets in a star shaped pattern. The breaking up of the fruiting spikes prevents the branches from “growing on” beyond the fruits.

The fruitlets are fibrous pyramids that easily separate from each other. The perianth can be split apart to reveal the seed, which is covered in a thin, membranous dark brown pericarp. The golden brown translucent seed is small (about 0.7 mm) and smooth, although it sometimes has a slightly grainy appearance over the outer edge where the almost straight embryo is located. The lighter coloured, abundant perisperm forms an obvious lateral bulge next to the embryo.

In the field the dark brown, smooth fruiting spikes break apart easily revealing the star pattern of fruitlets. This is fairly distinctive, and provides a helpful aid to identification.

Bracts

Flower spikes

Fruit spikes

Seed

Seed arrangement

SPECIES PROFILES

Tecticornia syncarpa
(Bracelet Samphire or Fused Glasswort)

Tecticornia syncarpa (Bracelet Samphire or Fused Glasswort) is a low shrub commonly growing to a maximum of around 0.5m, although it is recorded in other parts of Australia as growing somewhat taller than this. It tends to either form a low erect bush about as wide as it is tall, or it may sprawl, forming a ground hugging low mound.

Bracelet Samphires are generally found on the higher beaches around the edges of salt lakes inland and around coastal playa lakes. Locally they are not common. They can be found along the embankments of the Dry Creek Saltfields, near St Kilda and at Port Prime. It is possible this species was once more widely spread in this region, however little is known about its historic distribution locally, so while the species may have been reduced through clearance, it may just as easily have always had a restricted distribution across the local landscape.

The vegetative articles of Bracelet Samphire have “apiculate” lobes that are almost miniature keels. As a result, the articles are often described as “heart shaped”. In colour the articles are mid to bright green and are often suffused with a red blush.

The flowering spikes, between 1–7 articles long, tend to be a lighter green and initially form at the ends of the branches, however the branch tips quickly grow on past the flowers and later the fruits. These intercalary fruit

spikes look like sets of bracelets on the branchlets, hence the common name of Bracelet Samphire.

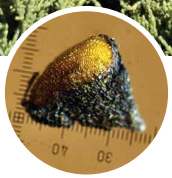
The bracts of the flowering spikes are continuous, completely encircling the spike and almost entirely obscuring the triads of flowers. Only the very tip of each flower is visible. The outline of the flowering spike may be smooth or undulate, depending on how "bulgy" the bracts are.

In each triad of flowers the individuals are joined together and the triads are also joined to the bract above, leading to the second common name, Fused Glasswort. As the fruiting spike matures the intervening bracts shrink a little, so that the triads of fruits become obvious and the fruiting spike tends to have an undulate outline.

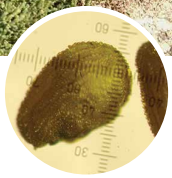
The fruitlets are quite leathery, so extracting the seeds can be a challenge as the pericarp obstinately sticks to the seed. Once free of the perianth, the seeds can be seen to be covered with a crusty dark brown pericarp that is usually torn at the base, revealing the relatively large (a little more than 1 mm long) golden brown seed. The seed is opaque with a distinct granulation of concentric lines over its longer edge.


Bracelet


Flower


Pericarp


Section


Seed

Glossary

Apiculate – ending abruptly in a short point

Article – jointed organ that functions as leaf/stem of the plant

Bract – small leaf-like structure that forms a “shelf” under the flower clusters

C3/C4/CAM plants – photosynthesis and respiration in plants varies according to the environment they find themselves in. The names reflect the carbon pathways in the plants, but essentially C3 plants are the most common, they open their stomata in the day and live in temperate conditions, C4 and CAM plants have evolved ways to utilise higher light intensities and temperature and conserve water used in respiration. C4 plants are usually tropical or are summer annuals, CAM plants live in arid areas

Cortical – relating to the outer fleshy material between the stem and the epidermis

Cymule – smaller form of the “cymose” flowering arrangement where the main axis of the flowering arrangement ends in a flower

Decumbent – branches lie on the ground but turn up at the ends

Gypsophiles – plants that live in gypsum-rich environments

Intercalary – where the branch continues to grow on after flowering, leaving fruits inserted along the stem

Keels – projecting ridge along the middle of a flat or convex surface (similar to a boat)

Ornamentation – patterns of ridges and lumps found on seeds

Palisade cells – long cells filled with chlorophyll, aligned perpendicular to the upper leaf surface

Papillose – covered with papillae (small nipple-shaped structures)

Perianth – floral envelope, comprises the calyx (sepals) and corolla (petals)

Pericarp – the fruit wall (around the seed)

Perisperm – nutritive material next to the embryo, found inside the seed

Sabkhas – supratidal salt flats or playas, forming along arid coastlines that are characterised by salt, gypsum and carbonate within a mineral clay matrix

Sclereids – strongly thickened cell, also called a stone-cell

Spike – flowers and fruits of samphires have a simple spike-shaped arrangement

Stele – the central core of the stem, root or fruits of a vascular plant

Stigma – point or head of the style of the female reproductive apparatus

Stomata – minute pores on leaf used in respiration

Style – narrow upper part of the female reproductive apparatus, that sits atop the ovary and below the stigma/s

Sward – an area of densely growing low plants that creates the impression of a "lawn"

Testa – seed coat

Triad – group of three flowers

Tribe – in biology, a tribe is a taxonomic rank above genus, but below family and subfamily

Image: ***S. blackiana*** **flower**

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Acknowledgements

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Image: *T. arbuscula*

Blue carbon futures

Our saltmarsh, mangrove and seagrasses are vital for a healthy coast. These habitats can help provide living, growing protection from storms and rising sea levels. They are also invaluable in storing carbon, both in the plants themselves, and sediments below. Coastal wetlands have high carbon storage potential relative to their area. This carbon stored in coastal and marine ecosystems is called “blue carbon”.

Protecting and restoring blue carbon is important not only for carbon storage, but also because these habitats can become sources of greenhouse gas emissions if they are degraded or cleared.

Both nationally and globally, blue carbon is recognised as playing a key role in reducing emissions, and as a nature-based solution to help meet climate change commitments under the international Paris Agreement, a legally binding international treaty on climate change.

In 2019, the State Government launched the blue carbon strategy for South Australia 2020–2025, which sets a path to establish a state-wide, evidence-based program of projects and research geared towards blue carbon ecosystem protection and restoration.

Green Adelaide is committed to conserve and restore blue carbon habitats that can be used to sequester blue carbon through its Regional Landscape Plan.

Green Adelaide’s Blue Carbon Futures project helps research and implement blue carbon initiatives in the region to enhance climate resilience and adaptation and increase environmental and social benefits.

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Green Adelaide was established by the South Australian Government to help manage urban densification and climate change impacts on metropolitan Adelaide. Green Adelaide will work to create a cooler, greener, wilder and climate-resilient city by partnering, funding and supporting aligned organisations and communities, as well as delivering on-ground iconic projects to establish Adelaide as Australia's first National Park City.

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