

A close-up photograph of several triggerplants (Stylidium) in bloom. The flowers are white with prominent pink variegation on the petals. They have a characteristic trigger-like shape with a long, curved spur. The background is dark and out of focus, showing some green foliage and brown stems.

Triggerplants

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Photo on cover: *Stylidium eriopdum* one of the boomerang Triggerplants.
Photo: Jean Hort.

This issue compiled by Hazel E. Dempster, life member of the Wildflower Society of Western Australia. Layout by Jim Barrow.

Australian Plants articles

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Introduction

Kevin Thiele

Kevin Thiele is a botanist and the head of the Western Australian Herbarium, in the heart of triggerplant country.

Triggerplants in the genus *Stylidium* are fantastic. I don't often use such an effusive term for a group of plants, but for triggerplants it's appropriate. They are botanically fascinating, most species are visually stunning both overall and up close, many species are important from a conservation perspective, there is an enormous amount of interesting research done (and still to do) on the genus, they are brilliant horticultural specimens, and to top it all off, kids love 'em (and that can't be said for many groups of plants). I can't count the number of times I've drawn children into an appreciation of the bush by saying 'Hey, come and look at this' and shown them what happens when they prod triggerplant flowers with a piece of fine grass. Works every time.

This volume of *Australian Plants* is dedicated to this lovely genus. Its articles cover a wide range of interesting work, understanding and knowledge of the triggerplant genus. It starts with a comprehensive overview of the genus by Australia's principal taxonomic expert on the genus, Juliet Wege. Having recognised over forty new species, Juliet is well-placed to provide this overview of the genus from the perspective of taxonomy, conservation, evolution and pollination. She is also a true triggerplant enthusiast, as I can attest from spending time in the field with her collecting and photographing new and rare species.

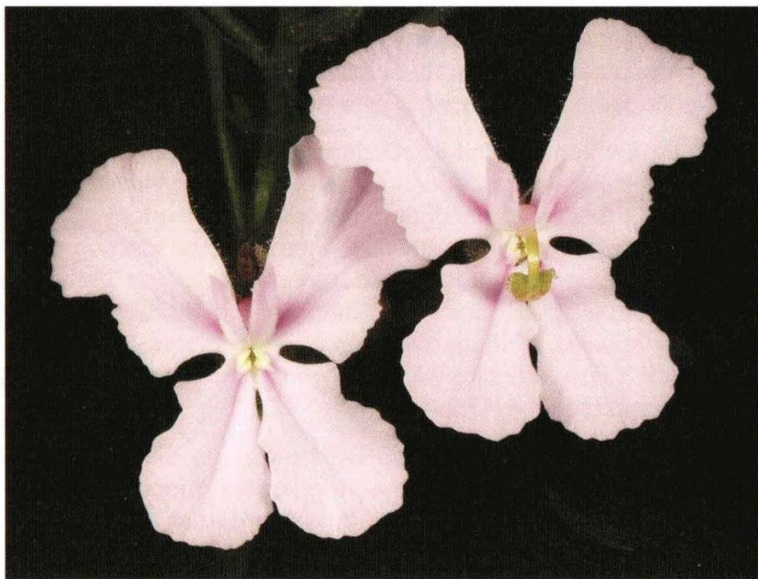
An article on triggerplants of the Kimberleys by Kevin Kenneally, Allen Lowrie and Greg Keighery introduces some of the exotic excitement of the genus. The Kimberley is rich triggerplant country, with many species found in glorious locations, and many new ones still to be discovered in remote gorges and rugged sandstone country and seasonal wetlands. These authors have spent much time hunting for, discovering and describing new species of triggerplants and other plants from these areas, and know them as intimately as anyone can considering how vast and under-explored the Kimberley is.

After these introductory chapters, you will be able in this volume to learn virtually all there is to know about triggerplant propagation and cultivation, from scientists at Kings Park in Western Australia, from the Australian Plants Society Victoria's Richard Davidson, and from the Wildflower Society of Western Australia's Hazel Dempster. Hazel instigated and coordinated this volume, and is a knowledgeable triggerplant

enthusiast and expert of many years standing. Whether you plan to micropropagate in tissue culture or by (surprisingly easy) leaf cuttings, or germinate and grow from seed, these articles provide a wealth of information. The results from propagating stylidiums can be seen in Hazel's garden and planter boxes. They provide a floral and leaf display that will bring both joy and challenge for the keenest enthusiast.

I started this introduction saying that triggerplants are fantastic. Many species are also under severe threat in the wild. Over a third of all known triggerplant species are listed as having high conservation needs. Many are restricted in the wild, either to very specialised habitats or narrow geographic areas. This is especially the case in south-western Western Australia, the epicentre for the genus. Of course, it goes without saying that careful and professional cultivation by skilled horticulturalists can play a significant role in the conservation of rare plants, and triggerplants deserve more attention in this regard.

I hope you all enjoy reading this engaging but scientifically and horticulturally rigorous account of this marvellous genus. Triggerplants deserve more attention. I hope these papers spur on more people to become involved with them throughout Australia, in many and varied ways.



Western Australia's Queen Triggerplant *Stylidium affine*. Photo: K.R. Thiele.

Untangling the taxonomy of the triggerplants

Juliet Wege

Dr Juliet Wege is a Senior Research Scientist at the Western Australian Herbarium who specialises in triggerplant taxonomy, conservation and evolution. She has a small but diverse home garden on the coastal plain in Perth which features 250 native species, including a variety of triggerplants.

The triggerplant genus *Stylidium* is a large and extraordinary group of plants renowned for the cunning way they use insects to transfer pollen between plants. Each flower has a touch-sensitive, catapult-like column (or trigger) which bears the reproductive structures (the male anthers and female stigma) at the tip. When a visiting insect probes for nectar, the column is quick to strike, either dusting it with pollen or, once the stigma has developed, retrieving pollen that the insect is already carrying. The insects, long resigned to their role as pollen couriers, are undeterred by these motile powder puffs and will repeatedly visit different flowers in search of a sweet nectar reward.



Triggerplants know how to pack a punch, often leaving a colourful splotch of pollen on visiting insects. Photos: J. Wege (Left) and Jean Hort (Right).

Triggerplant pollination, which has been clocked at around 10–20 milliseconds, is one of the fastest plant movements known (and also one of the most amusing!). The rapid firing motion is followed by a much slower resetting that returns the column to its original position so that it can be re-triggered (within minutes in hot conditions). Insects will happily move between flowers and, after a short while, a large and often colourful pollen load will become visible to the naked eye. A range of insects visit triggerplants, most commonly bee flies and native bees.

Stylidium is the main genus in the family Stylidiaceae, with a little over 300 taxa currently documented, most of which are confined to Australia. The greatest diversity is found in Western Australia's remarkable south-west region, although a sizable number of species occur across Australia's monsoonal tropics. There are significantly fewer species in the south-east and only a small number outside of Australia, with the genus extending from New Zealand to India.

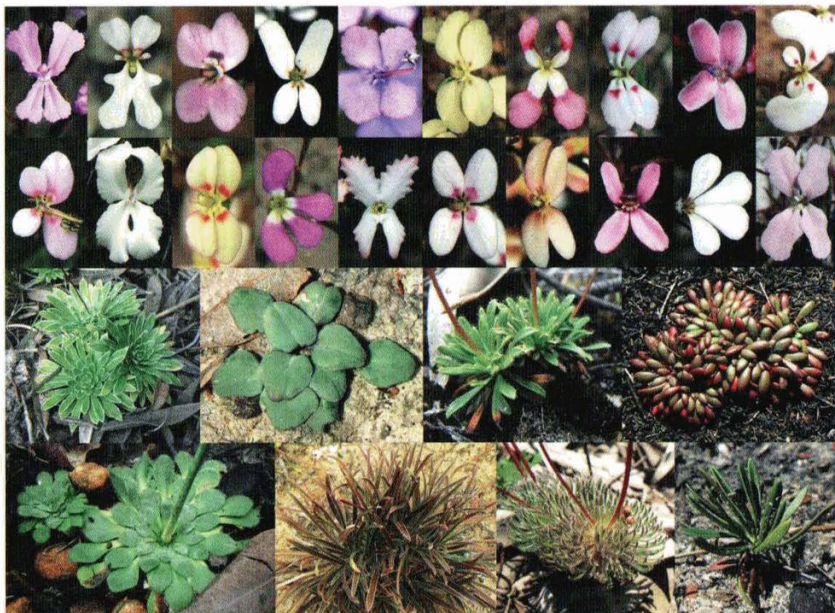
Perth has been an ideal base from which to study triggerplants—not only is the greater metropolitan region a major hotspot of *Stylidium* diversity, but triggerplants grow in the majority of south-west habitats, including forests and mallee woodlands, sandplain heaths, rocky hill slopes and mountain tops, coastal shrublands, granite outcrops, swamps and occasionally even salt lakes. It is common for several different species to grow and flower together, their blooms forming a colourful and iconic part of the region's understorey flora. Flowering times may also be staggered such that repeated visits to an area will be rewarded by a different suite of triggerplants in bloom.

South-west triggerplants encompass an exceptional diversity of growth forms (e.g. rosette, tussock, cushion and creeping plants, climbers and dwarf shrubs) and display a range of different strategies for coping with the region's severe summer drought. For example, there are geophytic species that die back each summer to an underground storage organ, "micro stilt plants" that are elevated above the hot soil surface by fibrous prop roots and annual species that survive the summer months as dormant seed.



The contrasting growth forms of the perennial stilt plant *S. crossocephalum* (Left) and the tiny annual herb *S. utricularioides* (Right). Photos: J. Wege.

The foliage of triggerplants is varied and often highly ornamental, but it is their extraordinary flowers that capture the hearts of wildflower enthusiasts—they come in an astonishing assortment of colours, shapes and sizes, are variously arranged and orientated, and are often adorned with hairs and small, intricate appendages. Impressive floral displays are produced by plants with a single, tall flowering stalk bearing hundreds of flowers, or plants with numerous flowering stalks with a more modest number of flowers. Many species produce only one or a few flowers per plant, but spectacular displays can be generated if many thousands of plants grow over a small area.



Stylidium is a highly ornamental genus that displays wonderful floral variation and fabulous foliage forms. Photos: J. Wege.



This stunning carpet of spring wildflowers fringing a granite outcrop in the south-west is dominated by several species of tiny, ephemeral triggerplants. Photo: J. Wege.

Cataloguing the triggerplants of Australia

In the 19th and early 20th centuries, new species of *Stylidium* were described by a raft of botanists from Stockholm, Paris, London, Geneva, Edinburgh, Berlin, Melbourne and beyond, including some very well-known names of Australian botany like Robert Brown, naturalist aboard Flinder's *Investigator* expedition, Jacques Labillardière, French botanist on the expedition commanded by Bruni d'Entrecasteaux, and Ferdinand von Mueller, Victoria's first Government Botanist.

The most recent formal accounts of the genus are those provided by London-based George Benthham, who published on *Stylidium* in 1868 as part of his monumental *Flora Australiensis* series, and Berlin-based Johan Mildbraed, who completed an insightful account early in his career in 1908 only to never work on the Australian flora again. Neither Benthham nor Mildbraed set foot in Australia, basing their revisions on herbarium specimens collected by early explorers and collectors and their accompanying notes.

In the 1950s, Rica Erickson demonstrated the importance of field observations in unravelling the taxonomy of the triggerplants. Her astute research culminated in a delightful field guide, of which my battered copy is amongst my most treasured possessions. Since this time, many scientists from across Australia have made extraordinary leaps forward in the discovery, collection, and description of new species, and the genus has doubled in size. There have been a significant number of finds in south-western and northern Australia, a handful of discoveries in south-eastern Australia, and even an apparent new find in India.



Stylidium ricae, a pretty and uncommon species from Western Australia's northern Avon Wheatbelt, is one of two triggerplants named after Rica Erickson. Photo: J. Wege.

Unlike many other large and iconic Australian plant groups such as *Acacia*, *Eucalyptus* and *Grevillea*, a modern account of *Stylidium* has yet to be completed. A taxonomic revision is, however, well underway and whilst field studies have been essential to this research, it is the natural history collections at Australia's various herbaria, along with those at a number of key international institutions, that have been central to understanding Australia's triggerplant diversity.

Hidden treasures in herbaria

The triggerplant holdings at the Western Australia Herbarium have been a major frontier for species discovery in recent years. This important collection has significantly increased in size over the past two decades, largely as a result of regional botanical surveys and the collection efforts of scientists and volunteers with an express interest in triggerplants. Today, there are over 11,600 pressed specimens held in new, state of the art specimen vaults—a fantastic resource for studying and documenting the State's triggerplants.

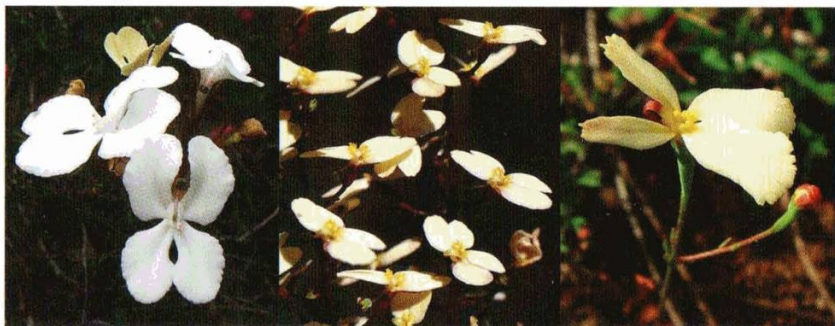


The Western Australian Herbarium, part of the Department of Environment and Conservation (DEC), moved to a new purpose built facility in 2011. Photo: Kevin Thiele.

Sorting and accurately cataloguing this collection has been vital to understanding what species we have, where they grow, when they flower, and how common they are. Unfortunately, triggerplants are notoriously difficult to study once they are pressed since useful features, like the orientation of the flowers and the shape of the corolla lobes and floral appendages, are very difficult to see. The tried and tested technique of

re-hydrating pressed flowers in hot water and detergent is of limited use in *Stylidium* since the flowers are too delicate to withstand such treatment. Sorting the collection has therefore been a major undertaking; however, it has been possible to make progress by applying knowledge and expertise gained from looking at thousands of specimens and from examining plants in the wild.

New discoveries from throughout the south-west region have been made at the Western Australian Herbarium, including: *S. diplotrichum*, a species from the Mt Lesueur region with lovely, large white flowers; *S. validum*, a species from mallee country east of Hyden with unusual blue-green leaves; *S. perplexum*, a remarkable sprawling shrub from near Dardanup; *S. gloeophyllum*, a sticky-leaved species from the south coastal district; *S. ferricola*, a species restricted to ironstone habitats near Busselton that flowers in profusion following fire; and *S. xanthellum*, a tiny geophyte from the Perth Hills.



New species uncovered at the Western Australian Herbarium include (from Left to Right) *S. diplotrichum*, *S. gloeophyllum* and *S. xanthellum*. Photos: J. Wege and Jean Hort (Right).



Western Australian Herbarium Curator Kevin Thiele helps gather reference material of the rare, tangled shrub *S. perplexum* so that it can be formally named. Photo: J. Wege

There are many triggerplants that were collected during the early to mid 19th century but have only recently been formally named and described. One extraordinary example is the beautifully ornate, summer-flowering *S. nymphaeum*, a species distributed in southern Western Australia. *Stylidium nymphaeum* is one of the tallest triggerplants, growing to 2.5 m high in dense vegetation, and is allied to the smaller *S. scandens*. Robert Brown collected both species in 1801 from the Albany region and Ferdinand Bauer, the famous botanical artist who was also part of the *Investigator* expedition, later made an exquisite painting of the taller, more ornate form. Brown went on to describe *S. scandens*, but he was uncertain whether the taller form was a distinct taxon, and it was more than 200 years before this species was named and described.

James Drummond, who collected widely in the south-west from 1835–1851, collected an extremely diverse array of triggerplants, including *S. bellum* and *S. rosulatum*, two gorgeous, rosetted species restricted to the mountains of the Stirling Range. Both species were known only from Drummond's collections (held at herbaria outside of Western Australia) until they were recollected in the early 1990s, and they remained undescribed until 2007.



Collected in the 19th century but only recently described as distinct (Left to Right): *S. nymphaeum*, *S. bellum* (photos J. Wege) and *S. rosulatum* (photo Libby Sandiford).

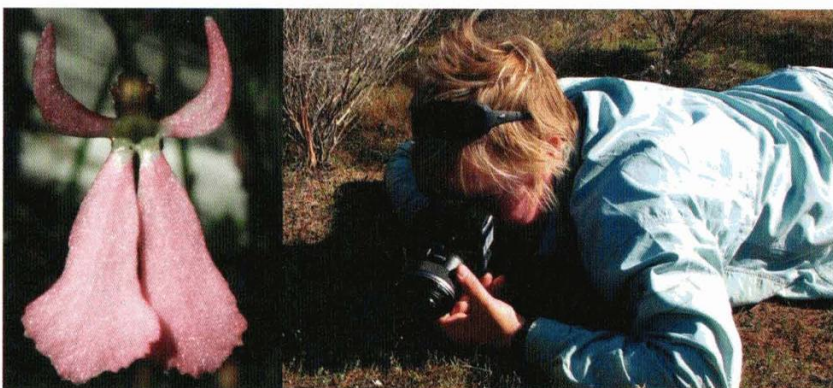
Discoveries in the field

A number of new species have been recently unearthed during botanical surveys by government or industry, including the tiny ephemeral *S. scintillans*. This species was named last year following its discovery during assessments of mining tenements east of Perenjori. This rare species grows in highly localised populations and so its recognition has been an important step towards ensuring its conservation in a region that is under significant pressure from exploration and mining for iron ore.



The rare and threatened triggerplant *S. scintillans*. Photographs: J. Wege.

Stylidium scintillans is one of 14 “microgeophytic” triggerplants, a group of south-western species that die back each summer to a tiny, nutrient-rich corm. Another new find within this enchanting group is *S. cornuatum*, discovered whilst studying another triggerplant near Eneabba. I was struck by how its upper corolla lobes resemble the horns of gnus, hence its common name of the Little Wildebeest.



The Little Wildebeest *S. cornuatum* (Left, photo J. Wege) and the author photographing it in a tick-infested swamp near Eneabba (Right, photo Carol Wilkins).

Other field-based discoveries include *S. korijekup*, found near Harvey in 2005 during surveys jointly conducted by the Wildflower Society of Western Australia (Inc.) and the WA Department of Environment and Conservation, and *S. coroniforme* subsp. *amblyphyllum*, found on private land near Quairading during surveys conducted in 2002 as part of the World Wildlife Fund Woodland Watch program. The latter has been a fantastic initiative which is helping private landholders understand and manage their remnant bush. The discovery of a new triggerplant in this largely cleared area of the Avon Wheatbelt underpins how important these remaining pockets of vegetation are for biodiversity conservation in Western Australia.



Two exciting finds made during regional surveys, *S. coroniforme* subsp. *amblyphyllum* (L.) and *S. korijekup* (R). Photos J. Wege.

Conservation

Updating the taxonomy of the triggerplants has been of critical importance to conservation efforts in Western Australia, where there are significant numbers of geographically restricted species with very specific habitat requirements. There are 93 taxa listed on the *Threatened and Priority Flora list for Western Australia*, the majority of which need further survey to better document their distribution and abundance, as well as any threats to their survival. More than half of these conservation-listed taxa have been newly named in the last 20 years, underscoring the ongoing importance of taxonomic research in this group, and of baseline botanical surveys.

Poor taxonomy can have negative implications for conservation, as illustrated by tiny microgeophytic triggerplant *S. rubricalyx*. This very distinctive species was discovered by Rica Erickson in 1952 near Williams in Western Australia's Avon Wheatbelt. A taxonomic muddle was subsequently created when *S. rubricalyx* was reduced to a variety of *S. obtusatum* and herbarium specimens of a number of different microgeophytic species were mistakenly identified as this variety. This

meant that *S. rubricalyx*, which was in reality only known from Erickson's original population, was overlooked for direct conservation actions.

In 2007, I fortuitously rediscovered *S. rubricalyx* in the Wandoo National Park, some 150 km north of Erickson's original population. Using my field observations and new collections, I was able to update and expand the description of *S. rubricalyx* and provide more detailed diagnostic information. Since publishing this information last year, targeted survey by DEC staff and Western Australian Herbarium volunteers Fred and Jean Hort has led to the discovery of several new populations. These populations are highly localised and at risk from feral pig diggings and inappropriate off-road vehicle use; however, it is hoped that further survey will unearth additional new populations. Meanwhile, seed of *S. rubricalyx* has been collected for DEC's Threatened Flora Seed Centre.

Triggerplants are challenging to survey because of their small size and narrow flowering windows, and the tendency for several species to occur at any given site. In view of the large number of species in the genus, and the current lack of up-to-date identification guides, conservation personnel and volunteers sometimes struggle to identify the significant triggerplants in their region. Providing helpful information and on-ground training in how to identify significant species is a highly rewarding aspect of my job, especially when great conservation outcomes are achieved, as for *S. rubricalyx*.



Eagle eye Jean Hort (Left, photo Fred Hort) discovers a new population of *S. rubricalyx* (inset, photo J. Wege) in the Wandoo National Park. Andrew Crawford (Right, photo J. Wege) tags flowering plants for subsequent seed collection.



Volunteers are helping improve our understanding of triggerplant diversity in Western Australia. The indefatigable Fred Hort assists with another triggerplant collection at a nature reserve on the outskirts of Perth. He likens pressing plants to the role of a funeral director, laying out each individual so it looks its best for all eternity. Photo: J. Wege.

A new era of understanding

Stylidium remains in a state of taxonomic flux as our natural history collections continue to be sorted and classified, new species are uncovered and formally described, and the scientific names we use are researched and validated. A comprehensive revision of the genus for the *Flora of Australia* is in preparation, and a related project to create an electronic identification guide and web-delivered fact sheets is also ongoing. A team of international researchers are also working together to produce an evolutionary tree of the genus, and to study in more detail the pollinating insects and their behaviour.

This prolific phase of research means that, over the coming years, we will not only have a better appreciation of triggerplant diversity in Australia, but will gain some new evolutionary insights into this most extraordinary group of plants. It is certainly a most exciting time in the world of triggerplants.

Juliet's research has primarily been supported by Western Australia's Department of Environment and Conservation, the Australian Biological Resources Study and Karara Mining

Tropical Triggerplants

Kevin F. Kenneally, Allen Lowrie and Greg Keighery

Kevin Kenneally is an Honorary Research Associate of the West Australian Herbarium and an Adjunct Professor in the School of Earth and Environment at the University of Western Australia; Allen Lowrie is the author of several books about the interaction between plants and insects; Greg Keighery is a botanist in the Department of Environment and Conservation.

Introduction

Triggerplants (*Stylidium* species) are the most widely spread genus in the family Stylidiaceae (Darnowski 2002). *Stylidium* contains more than 230 individual species (more than 300 species exist, but many specimens have not yet been formally described), making it the fifth largest genus in Australia (Good 1925). They are found throughout Australia occurring as far south as Tasmania. A few species extend into New Guinea, China, India, South East Asia and even southern Japan.

In terms of its climate, landscape and biodiversity, the Kimberley is part of northern Australia's tropical savannah biome, so ecological studies and land management lessons from other parts of the savannah bear on its management, especially those from equivalent sub-humid and semi-arid regions in the Northern Territory and Cape York Peninsula – areas where triggerplants flourish.

While the greatest diversity of triggerplants are found in south-west Western Australia, there are smaller secondary areas of diversity in tropical Australia: Western Australia with 29 species (10 endemic), Northern Territory with 36 (15 endemic) and Queensland with 34 (?12 endemic). Many species are widespread throughout tropical Australia. While access and collections have greatly improved over this vast area many species remain poorly known and re-interpretation of current species as well as new discoveries will result in additions to the list.

Habitat

Triggerplants are most diverse in both habit and habitat. In Australia they can be found on grassy plains, open heaths, massive sandstone pavements, desert sand dunes, sand plains, alpine grasslands, forests, perennial swamps and on the margins of creeks and water holes. Nearly all tropical triggerplants are slender annuals growing from 10-30 cm tall with pink, white or orange flowers. Water is the controlling factor in triggerplant distribution. They typically germinate during

the monsoon season (November to March) under water or on recently exposed soils. As the dry season (April to October) commences, they are found edging pools, streams, seepage areas and swampy habitats often dominated by *Eucalyptus* or *Melaleuca* species. At Mitchell Plateau *Stylidium adenophorum* was observed to flower all year in a well-watered lawn outside the mining mess hut. All species favour acid to neutral sands, but may be found on heavier soils during the dry. Plants have been recorded as flowering mostly from March to July.



Herblands along the edge of a creek at Mitchell Plateau. Photo Kevin Kenneally

In her pioneering publication, *Triggerplants*, Rica Erickson (1958) wrote that "The Northern Triggerplants offer a most rewarding field of study. Few have the general appearance of the southern species and most of them present a very different aspect. They are rarely conspicuous but are worthy of scrutiny despite this. They prefer to grow in the shelter of rank grasses and are easily overlooked. The petals are deeply cleft and united into unusual shapes for triggerplants, suggesting that the insect visitors are worthy of observation too. Other characters to study are the throat appendages and position of the labellum, both of which are suspected of varying considerably within the species".

When Erickson published her book over 50 years ago she recorded 30 species of tropical triggerplants. Since that time many new species have been described and currently some 60 species are known from the tropics with new species still awaiting discovery.



Collecting *Stylidium* and other herbaceous species on a sandstone pavement adjacent to a creek at Mitchell Plateau. Photo Kevin Kenneally

The mobile column (or trigger)

In the majority of *Stylidium* species, the mobile column in its set position is bent backwards down below the flower face where it rests on a smooth boss (a landing) called the labellum. The labellum is a modified fifth petal. The boss acts as a brake to stop the trigger column winding further back onto itself when it resets.

Whole trigger columns removed and observed under a microscope actually continue to coil back on themselves like a cork-screw very quickly under the warmth of the microscope lighting. This experiment shows that the labellum (or brake) is very important to the correct functioning of the mobile columns action. The stage is now set for an insect pollinator to be manipulated into performing an out-crossing pollination service for the triggerplant species with the promise and reward of a sweet nectar prize.

When the pollinator arrives, the corolla is orientated in an angled plane where the axis of the corolla is positioned so that one pair of petals (the lowest ones) becomes the pollinator's landing platform. When the pollinator lands the nectar reward is not immediately available. The pollinator must now perform further actions that lead to its reward. The various coloured throat markings and throat appendages are designed for one purpose — that is to direct and corral the pollinator's head into



Stylidium ceratophorum. An annual basally rosetted herb, common in the Darwin region and east towards the Arnhem Land Escarpment. Left: mobile column in set position; centre: column triggered; right: view from back of flower. Photos: Denzel Murfet

one position only where it will receive the nectar. Once the pollinator is in the perfect position as designed by that particular triggerplant species the next stage of the ruse can continue. The very moment the pollinator gets a micro-second sip of nectar, the trigger is fired. The trigger column flies at a speed that is not discernible to the naked human eye and the trigger columns tip either places pollen on the pollinator's body or retrieves pollen from the pollinator. In this action the fired column has now sealed off the top of the corolla nectary tube and nectar is no longer available for the pollinator. The pollinator then flies away.

The nectar supply is cut off sharply so the pollinator flies away to perform this scenario again on yet another flower of the same species for yet another nectar reward. The trigger column in the meantime resets itself back to its set position against the labellum, to arm itself once again to be fired off again by a visit from the another pollinator individual. The trigger resets faster in warmer weather than cooler weather. The trigger column can be fired and reset many times throughout the day.

Because each triggerplant species varies in its corolla shape, throat appendages and markings, trigger column length, trigger column travel path from set position to fired position as well as flower size and corolla orientation, the same pollinator can supply its services of pollination to many triggerplant species growing together in the one habitat.

It has been observed that the same pollinator can have a number of different species pollen patches on its body. In every case each species confines its pollen delivery and pick up point to a designated area somewhere away from other *Stylidium* species pollen. Pollen patches have been observed on various parts of the back, abdomen, sides as well as head of the same pollinator.



Left: *Stylidium pachyrrhizum* from the Kimberley. Photo: Allen Lowrie. Right: a lemon yellow form of *Stylidium schizanthum* east of Darwin. Photo: Denzel Murfet



Stylidium quadrifurcatum. An annual herb with a small basal rosette of leaves, flowers pink, white or bicoloured pink and white (right). Grows in wet sandy depressions and is common in the Darwin region and east towards the Arnhem Land Escapement. Photos: Allen Lowrie



Stylidium ericksoniae. Left: close up of flower. Right: habitat. The stalks bring the rosettes above the water level. Photos: Denzel Murfet. *Stylidium ericksoniae* grows in damp sand near sandstone rocks or on swampy drainage channels in lowlands near Darwin from Kakadu National Park.



Stylidium irriguum. A perennial herb, flowers white with yellow throats. Grows in silty sand soils caught between rocks in flowing water of creeks and rivers. Common in the Kimberley region.



Stylidium rubricapum. A perennial herb forming large compact clusters of leaves, flowers pink with red throat markings & red tipped upper petals. Grows in wet sandy grassland depressions and is common in the Kimberley region.



Stylidium costulatum. An annual herb with a tuft of fleshy terete leaves, flowers yellow with orange marks on the upper petals. Grows in wet sand grassland watersheds and flats from the Dampier Peninsula to Beverley Springs region of the Kimberley. In the left picture the trigger has fired. All photos: Allen Lowrie.

Double-action triggers of tropical *Stylidium* species

Another interesting observation in a few species of the tropical trigger-plants is their ability to perform a double-action, all in the one continuous movement of the triggered mobile column. The species that have been identified as having this feature so far are all the many forms of *Stylidium schizanthum*, *S. lobuliferum* and *S. pachyrhizum*.

What happens is truly unbelievable. These double-action trigger species are similar in all their adaptations for harnessing pollinators to perform their out-crossing manoeuvres, except one. That is the action of the trigger column itself.

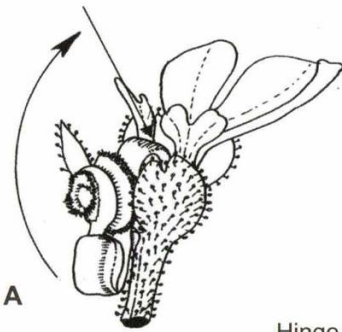
The engineered and architectural design of the double-action species consists of a column that arises from the nectary tube of the corolla, a mobile and sensitive bend (called the torosus) positioned a short distance above the corolla, followed by a straight section of column (which in non double-action triggerplants ends here with the anthers or stigma). In double-action species a floppy hinge is positioned here, followed by another straight section that terminates in the anthers or stigma part of the column (see diagram on opposite page).

When a double-action column is in its set position against the labellum, the floppy hinged portion is positioned against and parallel to this part of the column. When the column is triggered by a pollinator's proboscis taking its first micro sip of nectar, the column flies rapidly forward but comes to an abrupt stop against the throat appendages and the centrifugal force of this abrupt stop action sends the hinged part of the column further forward onto the insects back.

Then in the same continuous unbroken movement, the hinged portion smears its pollen (or retrieves its pollen) as it retracts back onto its column and, without missing a beat, the column returns just as fast backwards as it did forwards, to rest on the labellum once again. This double action is truly an amazing feat as it seems to defy the laws of physics. No one has discovered yet exactly just how triggerplants fire and reset their mobile columns. In the case of these double-action mobile columns it will certainly get the researcher's brains in a twist for sure.

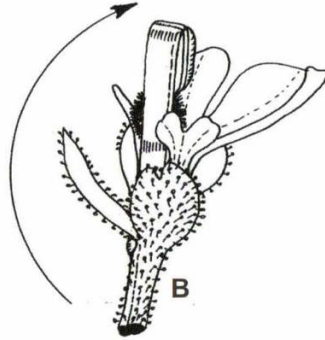
B: First stage of trigger travel to the erect position where it is abruptly stopped by the rim of the corolla tube.

Torosus (mobile bend)



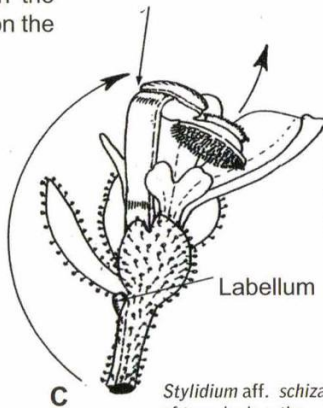
A

A: Trigger column in the set position resting on the labellum



B

Hinge



C

C: Hinged portion of trigger is swung forwards by centrifugal force generated by the sudden stop in figure B

Stylidium aff. *schizanthum* illustration showing the line of travel when the column is triggered. In this species the column returns to its set position all in one forward and backward motion. Drawn by Allen Lowrie Feb. 2013



A population of a white-flowered *Stylidium schizanthum* in the Kimberley.
Photo: Allen Lowrie

Are Tropical *Stylidiums* carnivorous?

A number of *Stylidium* species of tropical northern Australia have been observed to capture small flying insects on the *Drosera*-like glandular trichomes present on their scapes, hypanthium and sepals (Lowrie and Takai 2011). A number of *Stylidium* species from the south-west of Western Australia have also been observed capturing small insect prey. The question that must be asked is — are some *Stylidium* species practising carnivory?

Triggerplants are almost always found in soils that are waterlogged for some months. Nitrogen levels are particularly low in soils that are saturated with water for long periods. It is on these types of soil that carnivorous plants such as *Drosera* and *Utricularia* are found, almost always in association with *Stylidium*.

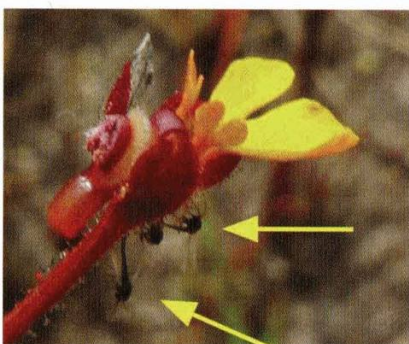
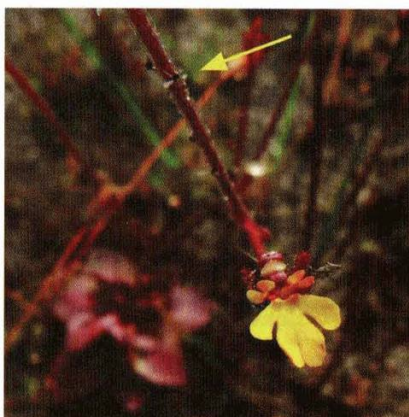
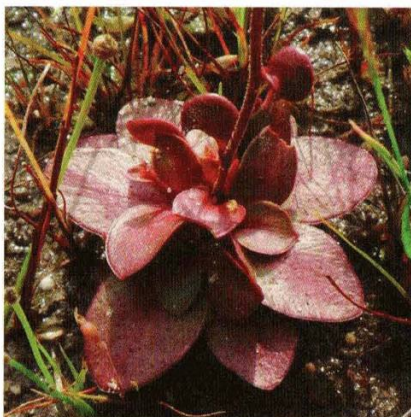
Like sundew species that are proven carnivores, can these glandular triggerplants also process the prey they have captured into beneficial nutrients and are these nutrients then used by these plants as supplementary protein and energy and used to aid in their building blocks of life? Darnowski et al. (2006) have investigated the evidence for proto-carnivory in triggerplants that use mucilage-secreting hairs to trap small insects.

His team concluded that although there was strong evidence for proto-carnivory in *Stylidium*, further experiments were needed to determine nutrient uptake in order to confirm that they were fully carnivorous. We have also noted small fragments of ash attached to the glandular trichomes of *Stylidium lobuliferum* following bushfires. Fire is a natural part of the tropical landscape caused by lightning strikes and human habitation. Thermal-flying, wind-driven ash carries for some distance and is caught on the mucilage-secreting glandular hairs. We speculate if this may also be a source of nutrient to the plants.

Threats

The immediate threat to triggerplants in the tropics comes from feral stock (particularly cattle) and from hot, too frequent fires that burn out of control every year in the Australian tropics (McKenzie et al. 2009). Because triggerplants are dependent on wet areas to survive, climate change could be a risk factor if the climate, as predicted, becomes wetter (but still seasonal) thus promoting the growth of dense grasses.

Cattle are a major problem as they congregate around water to drink and graze. They trample the wet areas fringing swamps and creeks and



Styliidium schizanthum Top left: the red basal leafy rosette of this species. Top right: small flying insects (arrow) adhering to the densely glandular scape branches. Bottom left: small flying insects caught on the hypanthium and sepals. Bottom right: enlarged view. Photos: Denzel Murfet

compact the soil. As waterholes and swamps dry out, the cattle follow the drying apron into the centre of the wetland, eventually destroying the annual herbs. We have witnessed this on Mitchell Plateau (at Airport Swamp) when cattle drifted onto the plateau from Mitchell River Station, rapidly degrading the ecology of this important seasonal wetland.

Another major threat to tropical triggerplants is introduced invasive savannah grasses. In 2009 the Australian Government listed "Ecosystem degradation, habitat loss and species decline due to invasion of northern Australia by introduced gamba grass (*Andropogon gayanus*), para grass (*Urochloa mutica*), olive hymenachne (*Hymenachne amplexicaulis*), mission grass (*Pennisetum polystachion*) and annual mission grass (*Pennisetum pedicellatum*)" as a key threatening process under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and initiated the development of a threat abatement plan. Several of these species are now also listed as Weeds



Stylidium evolutum. A scrambling annual herb forming branching clusters of stems, flowers pink, dark red or white with red throat markings. Grows in wet sandy grassland depressions. Common in the Darwin region. Left: a pink flowered form. Photo: Allen Lowrie.

Right: a white flowered form with blood red throat markings. Photo: Denzel Murfet.



Stylidium adenophorum. An annual herb with a tuft of fleshy terete leaves, flowers white to various shades of pink with blood red marks on the upper petals. Wet sand flats in open woodland. Common in the Kimberley. Note variation in flower colour. Photos: Allen Lowrie



Stylidium fimbriatum. A perennial herb forming basal rosettes, flowers pink, with a yellow throat. Grows in wet sand beside creek margins and is known from only 2 locations in the Kimberley region.

Photos: Allen Lowrie

of National Significance. These species occupy habitat, out-compete the small triggerplants, change ecosystem processes and can lead to increased frequency and severity of fires throughout their ranges.

A change in current fire management, and feral animal and stock control practices across the entire wet-tropics landscape is required to control erosion, vegetation degradation, weed invasion and fauna declines in savannah ecosystems (Legge et al. 2008). Hot fires burning in the grasslands destroy the herb fields often before seed can be set.

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You can learn more about the beauty, intrigue and novelty of Triggerplants from the internet. All WA species are listed in Florabase maintained by the WA Herbarium. Here you will find a brief description plus, in most cases, pictures of the leaves and of the flowers. If you search the internet for "Stylidium species", you will find a great deal more information including a list of all species in Wikipedia, with detailed descriptions of 100 species. You will also find a link to the Triggerplant journal: see page 95.

Triggerplant Tissue Culture

Eric Bunn and Keran Keys

Both authors work for the Botanic Gardens and Parks Authority. Eric Bunn is a Senior Research Scientist; Keran Keys is a Technical Officer

Arguably, this group of intriguing wildflowers is the most visually stunning and entertaining of all the miniature species of our West Australian flora. There are taller species that stand 30 cm or more but there is no comparison to getting down to earth, literally, and introducing a newcomer to the wonder of Triggerplants. In September 2000, Kings Park and Botanic Garden displayed around twenty species at its then annual Wildflower Festival to raise awareness and expand demand.

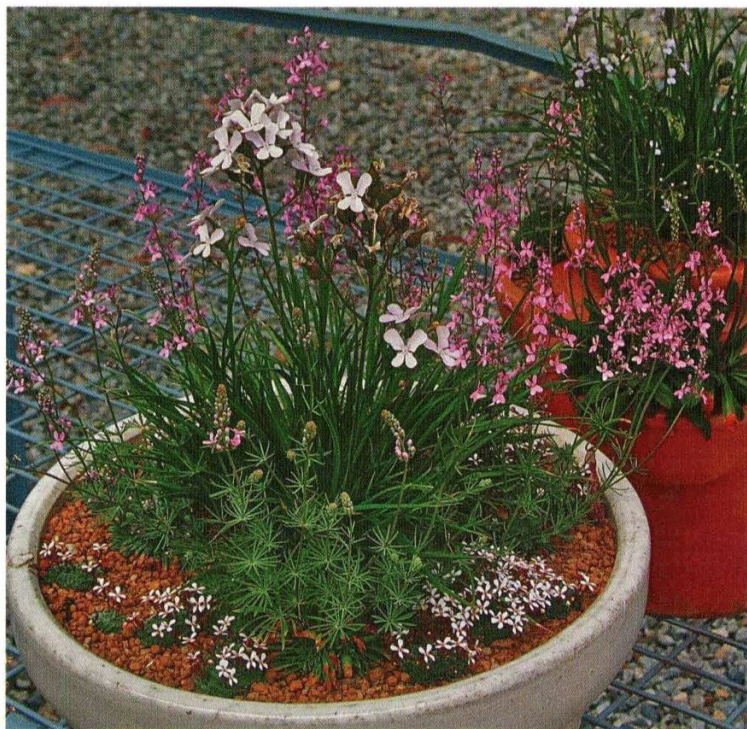
Tissue culture

Material for tissue culture production was sourced from embryo extraction (purchased seed) or cuttings from our Nursery collection. All shoot material was cleaned (disinfected with bleach solution to remove microbes) before introduction to sterilised agar media.

We used a standard tissue culture medium containing macro- and micro mineral nutrients (available in powder formulations from chemical companies such as Sigma® Australia Pty Ltd) with 20 g L⁻¹ sucrose, 8 g L⁻¹ agar, pH 6 and low concentrations of cytokinins (Kinetin + 6-benzylaminopurine) to promote shoot growth and multiplication. Approximately 40 mL of media was put to 250 mL glass containers and sterilised (autoclaved) for 20 minutes before use. Most *Stylidium* species that were trialled grew vigorously on the above medium under standard culture room conditions (16 hour fluorescent lighting and 23-25°C).

To root, explants remained on exhausted media (about 5-6 weeks) or moved to 1/2MS without growth factors to spontaneously root. For a faster rooting response we used 1/4MS with very low dose IBA +NAA (roots within 2 weeks). These media are mostly standard industry media for herbaceous and light woody species.

We de-flasked plants when roots were newly emerged and used an anti-desiccant dip to reduce stress. A minimum of 10% perlite was added to a free draining potting mix for faster root penetration. Small, multiple plants were placed in punnets and larger individuals went to forest pots. Slightly different methods were used depending on the species and its rooting requirements.



Potted micro-propagated Triggerplants; clockwise from bottom: *Stylidium pulviniforme* – a Priority 3 species (small, white flowers), *S. brunonianum* or 'Pink Fountain' triggerplant (tall, dark pink flowers) and *S. affine* or 'Queen Triggerplant' (tall, pale pink flowers). Photo: Eric Bunn

After at least 2 weeks in a shaded glasshouse, pots were moved to full sun. When sufficiently large, plants were potted-up to standard "squares" or made up to display pots (designed, miniature gardens – see photo above). Improved drainage is essential in display pots. Usually, glazed earthenware pots do not have good drainage. Small plastic pots were inverted to create a soak-well at the pot base. It ensured water cleared the pot and roots didn't rot. In larger tubs and heavy, open bowls, polystyrene or expanded clay balls were added to the base, with a sheet of mesh between the lightweight balls and soil mix. Expanded clay can be solarised for re-use.

Nursery propagation.

Species with adventitious or stilt roots produced horizontal growth with new rosettes arising at each node. In autumn, roots emerged under each new rosette. The new plantlets were removed from the parent plant while the roots were white and slightly inserted into a course

potting mix. Potting plantlets with extended red roots was usually not successful. It was akin to burying trunks when potting up – they simply rotted. Red roots are the “stilts” and are sun-hardened.

Most species were easy to grow under nursery conditions. Rooting powder or hormone gels aided root induction.

S. brunonianum rotted if any portion of it was buried when transplanting.

S. bulbiferum is a great species for a beginner. It was easy to propagate from plantlets in autumn, was fast growing, and flowered *en masse* in spring.

S. repens would be an excellent ground cover for unirrigated areas in the hills area, especially on ironstone exposed areas. It can carpet large areas.

S. junceum, from our experience, has a longer pot life than most other species. *S. affine* is another long-lived species. A deep pot and regular fertiliser (when looking less deep green) will keep plants going for about five years (or more if not killed in droughts or loss of irrigation). Plantlets can be taken and propagated-on.

Pot choice

All species succeeded in deep pots with a more stable root environment. Shallow pots required more frequent watering so the plants suffered stress from “dry-to-drown”. We chose pots deeper than they were wide. Narrow pots with mature plants may look great but suffered lack of water as there wasn’t a large enough aperture for overhead water collection. Trickle-irrigation is advisable for larger display pots (miniature gardens).

Slow release and liquid fertilisers were used on all the display plants. Bloom-boosting liquid formulations were particularly good applied 4-6 weeks prior to display – the floral spectacle was stunning.

General Pests

Glossy and firm-leaved species are attractive to scale insects and all species are attacked by mealy bug. The scale is easy to see and often highlighted by feeding ants. Mealy bug tends to suck the roots so it may not be until you notice wilting or brown spots that you realise you have a problem. In cool glasshouses, watch out for fungus gnats. These tiny pests will gnaw away at newly developing root systems.

Vegetative Propagation and Cultivation of Triggerplants

Hazel E Dempster

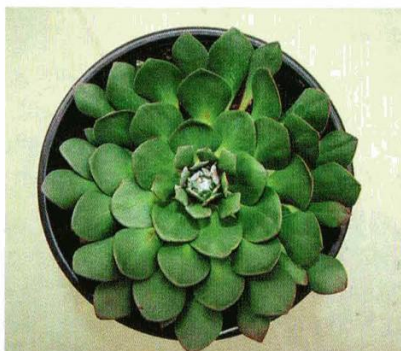
As the daughter of the wonderful Eileen Croxford, Hazel inevitably grew up with a love of wildflowers. Her life-long interest, including 20 years in the nursery industry, have given her an encyclopaedic knowledge of our plants, their cultivation and especially their propagation. She says her main love is the Goodeiaceae family but surely it is no coincidence that, until recently, she lived in Triggerplant Avenue. Truly!

This article is based on my experience of Stylidium propagated and cultivated in Western Australia. Original species material for propagation is collected under DEC Flora license with subsequent material from successful mother plants.

Ornamental appreciation

This fascinating genus of perennial and annual herbs has captured the attention of many a flora lover when they wander through our bushland as they can turn up in the most expected places, many shining out like small colorful jewels or butterflies.

The horticultural potential of the genus is yet to be realised and only a few species are available for the enthusiast and home gardener through normal channels. They are mainly available from a few specialist community plant sales. The passion for this genus can develop into a fascinating and therapeutic pastime. The single rosette or collection of rosettes can be very ornamental, similar to the exotic genus *Saxifraga* and their delightfully colourful flowers are well suited for pot culture, raised beds and small gardens.



Rosettes of *S. ciliatum* (Left) and *S. diversifolium* (Right). Photos: Hazel Dempster



Range of colour forms of *S. dichotomom*. Photo: H. Dempster

Their successful performance in natural gardens is more assured when provided with some shelter from extreme conditions. This will assist them to become established and add more biodiversity to any such garden. Their unique pollination method activated by insects in turn attracts other fauna to the area.

Characteristics of the genus

To understand the different way in which Triggerplants can be propagated vegetatively, we need to understand their different forms and growing processes.

In the wild, the plants become dormant during the dry season. This can last for up to five months with temperatures often averaging above 30°C. They recover and thrive after rains and during the cooler months when temperatures can get down to 0°C.

During the harsh conditions of our dry season the plants survive on their central storage rootstocks or perch on stilt roots away from the ground. After rain or a drop in temperature at the start of the next growing season, the previous season's stem growth comes to life and produces new stems and roots. They continue to produce several new

stem shoots that in turn form the collection of attractive mats, mounds of rosettes or leafy clumps. The colourful flowers with their unique trigger appear from the centre of the new growth. Some species produce new roots from the new growth above ground. These grow down into the soil and anchor the plant above the ground and therefore increase the volume of each plant as well as creating complete new stolons independent of the mother plants. The stilt roots hold the stolons above the soil to allow a cooling airflow around the plants.

Different Groups (Erickson 1988, Lowrie 2010): Each species can be assigned to different groups within the genus and exhibit many forms which can be used to advantage for propagation. Stylidium has the uncommon ability of propagation from almost any vegetative material found on the plants.

Vegetative Propagation

Propagation is best carried out from March to June, making use of the energy in the new season's root growth. Small sharp pointed cutting secateurs are useful for the intricate separation work on the many small species. Stem and leaf cuttings may be taken at any time during the growing season as material presents itself on the plant. All old previous season's stilt roots and damaged leaves are removed from all material ready for propagation.

Stem and leaf cuttings with or without roots are dipped into Clonex purple hormone gel and set into 150 mm pots containing a 50/50 mix of propagating mix/seedling mix plus Perlite, and watered in. Plastic bottles with the bottoms removed make ideal mini-glasshouses (see page 90).

Divided rosettes, stem cuttings or other material with roots is planted directly into seedling mix with slow release native fertiliser into tubes, cell trays or pots. Hormone gel can be used as needed.

Newly set material needs to have the foliage protected from dehydration and watered daily to retain humidity until plants settle, then two or three times a week depending on need.

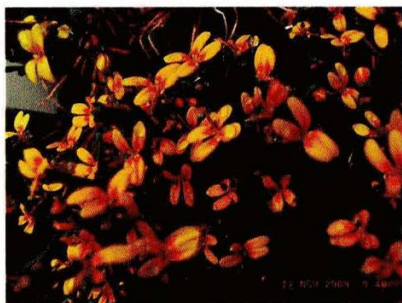
Preparation of propagation material

Stem Cuttings: New shoots from elongated stems produced each season are prepared and treated as normal cuttings. Stem cuttings often produce new rootlets along the stem. These can be put directly into tubes.



Stylidium hispidum: Left: plant rosettes. Right: new roots on stems. Photos: Hazel Dempster

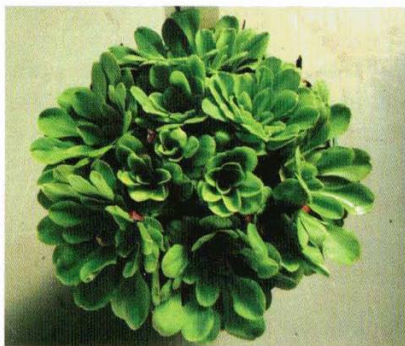
Terminal Stolons: Above ground stolons produced on creeping plants with new roots at their base. They are cut away from the main plant and potted up as seedlings when the new roots are just protruding. These stolons can also be carefully sectioned to produce further plants but treated as cuttings.



Stylidium dichotomum: Left: flowering plants. Right: stolons with new roots. Photos: Hazel Dempster

Seasonal Rosettes: New roots are produced from all rosettes which are divided along with the newly produced root system to form new plants. New stem shoots arising from the old rootstock are cut away and used as cuttings, or the rosettes are pulled apart depending on the species and its form. The new stem cuttings and divisions with roots are then potted directly into tubes or seedling pots. Remaining tuberous fleshy rootstock can be also re-potted to reshoot. Any rosettes that have not developed roots can be treated like cuttings and pressed on to the surface of cutting mix under a plastic cover (Dempster 2011).

Division of Clumps: Some rosette species can be readily divided by pulling apart into individual rosettes. Long scale-leaf species are divided by carefully clipping or breaking apart leafy sections when new roots are appearing.

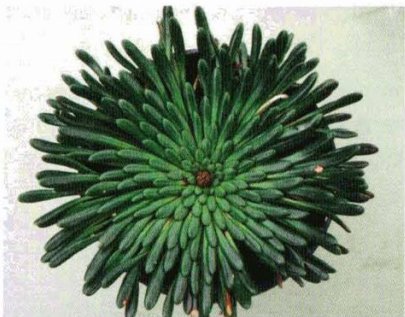


Stylidium spatulatum: Left: mature plant ready for division. Right: divisions with new roots ready for propagating. Photos: Hazel Dempster



Divisions of clumps: Left: *S. maritimum* before preparing for propagation. Right *S. affine* showing new season's roots. Photos: Hazel Dempster

Leaf cuttings: (Dempster 1980). Most species in the *Stylidium* genus, no matter how small, will reproduce from leaf cuttings. Single leaves are pulled away from central rosettes, trimmed to a clean edge and treated as cuttings. No stem attachment is required. Most tested have produced roots within about 3-4 weeks. From those the new plant rosette appears about 3-4 weeks later. Cuttings can then be potted on.



Stylidium assimile: Left: mature rosette. Right: leaf cuttings forming new rosettes. Photos: H. Dempster

Cultivation

Stylidiiums really lend themselves to cultivation in decorative pots, baskets and well drained raised beds or in tanks (Dempster 2010). Fill containers with good quality well drained potting mix containing a good balance of coarse sand to organics. Coarse river sand or small gravel can be added and used as surface mulch.

Raised beds or gardens require an open mix with loam, coarse sand and minimal organic mix.

Landscaping with Stylidiiums: Stylidiiums do best in a well drained soils. They appreciate morning sun and shelter from extreme weather conditions.

Care of growing plants

These plants are definitely seasonal. Their growing phase begins when the new foliage appears. The flowering season starts around June with most species flowering during spring and summer. The flowers are presented on a spike and if fertilised will produce seed so are left on the bush if this is the desired outcome, but be aware that hybridisation may occur (Davidson 2011). At the end of the flowering season flower spikes are removed back to the base of the stem. During the dry season it is important to remove any spent foliage especially when watered from overhead as dense wet foliage may cause the central stocks to rot and die therefore be unable to reproduce the next season.

Watering: In pots or any type of raised bed some moisture needs to be retained in the soil. Trickle irrigation or subsurface irrigation works well in raised beds and small gardens. Excess watering overhead can lead to the rotting of the rosette stocks.

Fertilisers: Slow release native fertiliser in premium potting mixes should last 6-9 months. Trace elements may be needed to treat yellowing in some species.

The future: With interest in Stylidiiums growing locally and internationally, selected species will become a common sight in the future. Meanwhile their conservation in the wild is paramount.

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Acknowledgement

Northern Suburbs Branch Wildflower Society and their volunteer nursery at Landsdale Farmschool in Perth.



Mature divisions of triggerplants growing in the Northern Suburbs Branch of the Wildflower Society of WA nursery. Photo: Hazel Dempster

Seed propagation of Triggerplants

Shane Turner

Dr Shane Turner is currently a seed scientist working for the University of Western Australia and Kings Park on the conservation and restoration of Australia's unique flora.

With well over 200 species spread right across Australia the triggerplants (*Stylidium* spp. and allied genera including *Levenhookia*) are quite a remarkable group of predominantly Australian endemics. Given their diminutive dimensions and highly ornate floral displays they lend themselves readily to pot culture or for the more adventurous to the creation of an Australian version of the classic English cottage garden. Beyond these well appreciated horticultural features however, *Stylidium* spp. also display some interesting seed attributes. This makes them quite an informative model species for probing the inner workings of seeds, in particular, how seeds from our native species respond to smoke and heat and regulate germination to the most opportune time for maximizing the chances of recruitment success.

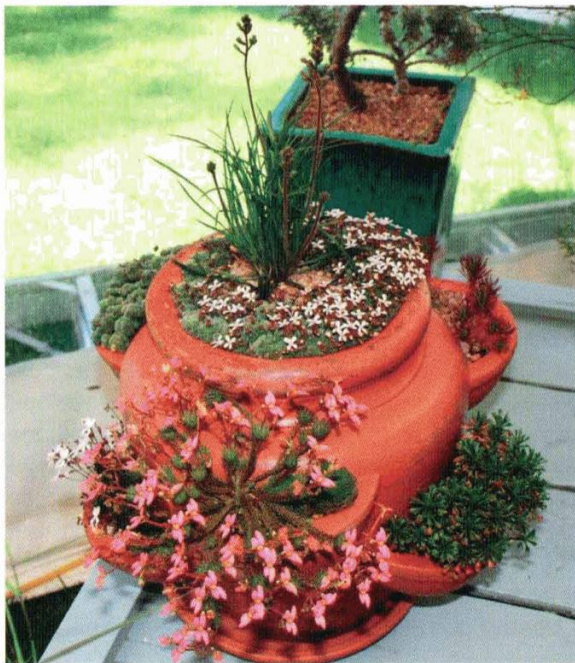
For many years now researchers at Kings Park and Botanic Garden have been investigating various species of Western Australian *Stylidium* such as *Stylidium affine* (Queen Triggerplant), *Stylidium amoenum* (Lovely Triggerplant), *Stylidium brunonianum* (Pink Fountain Triggerplant), *Stylidium bulbiferum* (Circus Triggerplant), *Stylidium crosssocephalum* (Posy Triggerplant), *Stylidium hispidum* (White Butterfly Triggerplant), *Stylidium junceum* (Reed Triggerplant), *Stylidium maritimum* and *Stylidium schoenoides* (Cow Kicks) to determine what initiates germination. Prior to this research it had been known that *Stylidium* generally produce large numbers of highly viable seeds but more often than not when collected fresh and sown, germination is sporadic and erratic at best, a trait commonly observed for many other native species as well. Pioneering work in the early 1990s demonstrated that smoke was key to stimulating numerous native species to germinate including many that had proven time and time again to be highly problematic. One of the key outcomes from the initial smoke research was that *Stylidium* were shown to be highly smoke responsive whether the smoke was applied in an aerosol form (pumped into a sealed tent or shed for one hour) or liquid form (10% v/v smoke water which the seeds are soaked in for 24 hours prior to sowing). More recently (since 2004) one of the active components (now called Karrikinolide) in smoke that promotes the germination of many Australian native seeds – including different species of *Stylidium* has not only been identified but has now been

synthesised by chemists at the University of Western Australia. In its pure form Karrikinolide is highly active showing a significant ability to promote germination at concentrations as low as 1 parts per billion (ppb). As with treating seeds with smoke water, seeds treated with Karrikinolide are soaked for 24 hours in a 100 ppb Karrikinolide solution then sown as normal and if all goes according to plan these should begin showing the first signs of germination within 2 to 4 weeks.

Is this all there is to germinating *Stylidium* seeds? – well not quite. In addition to many requiring smoke to germinate (though not all – for example the eastern species *Stylidium graminifolium* (grass trigger-plant) has been reported to be readily germinable under some conditions without any form of stimulant) another factor that can still play havoc with germinating *Stylidium* seeds is dormancy. In this case, if the seeds from a particular species are known to be smoke responsive but are nevertheless dormant (ie fresh) it will not matter how well you treat them with smoke as they will still not likely germinate. In these cases seeds can require a period of dry after-ripening to promote dormancy loss. As the name suggests dry after-ripening is simply the dry storage of seeds at room temperatures (~30°C is ideal though 20 – 30°C will also work just as well though it may take a little longer) for several weeks for up to 3+ years. As seeds age under these conditions seeds gradually lose dormancy and start to become smoke responsive. The time required for dry after-ripening varies between species (for *Stylidium graminifolium* 24 weeks was found to be optimal) and in one extreme case which we discovered several years ago seeds from *Stylidium affine* do not readily germinate until they have been stored at 30°C for 3 years which is a very long time to wait and requires an unusually high level of patience. Luckily this is still not quite the end of the story as we have discovered several short cuts to side step this sizable hurdle. These are rapid, easy to administer and in many cases highly effective.

In addition to after-ripening, seeds from *Stylidium affine* and *Stylidium maritimum* have also been shown to become highly smoke responsive when dry heated to 80 – 100°C for approximately 10 minutes. To apply this treatment air-dried seeds are simply placed into a paper envelope and then into a domestic oven set at the required temperature. Once the seeds are removed and cooled these can then be soaked for 24 hours in 10 % v/v smoke water and sown as required. No one is exactly sure what is going on with the dry heat treatment but one idea is that the heat replaces the requirement for dry after-ripening so rather than waiting up to 3 years for seeds to become germinable it is all over within 10 or so minutes when treated correctly at a suitable temperature.

The last trick to encouraging *Stylidium* seeds to germinate is probably the easiest one to apply and coincidentally one of the most effective as well (at least in the species where it has been tested). In addition to *Stylidium* seeds responding to smoke products it has also been observed that the seeds of several *Stylidium* species readily respond to gibberellic acid solutions and in many cases will germinate to the same level as smoke treated seeds. Treatment with gibberellic acid also appears to circumvent the requirement for after-ripening and dry heat if seeds are still dormant so it is particularly effective when seeds have been freshly collected. A solution of gibberellic acid can be prepared using commercially available Progibb (used in horticulture for grape production) which is prepared as a 100 ppm (ie 1 mL in 1 L of water) to 1000 ppm (ie 10 mL in 1 L of water) GA3 solution. As with smoke water, seeds are soaked for 24 hours in this solution then removed and sown as required. It must be said that we have barely scratched the surface in truly appreciating and indeed understanding the germination requirements of most species of *Stylidium*, so a little patience and perhaps some novel combinations of the treatments described above may unlock some of the more challenging species of *Stylidium* that are almost certainly lurking amongst our flora.



Triggerplants growing in a strawberry pot at the Kings Park Exhibition, featuring *S. bulbiferum* (orange-pink) and *S. pulviniformis* (white)
Photo H Dempster.

Growing Stylidiums in Southern Victoria

Richard Davidson, Melton South, Vic.

Richard is a retired research scientist who was captivated by Stylidiums during a short holiday in WA in 1973. His interest was rekindled when on a long holiday in WA in 2005, resulting in the study that follows.

Introduction

In 1977 I started the Stylidium Study Group (then ASGAP, now ANSPA) and ran it until 1986, with encouragement and support from the late Eileen Croxford of Albany. We learned much about propagation but had little success with horticulture. Some twenty years on, in 2005, my wife and I visited WA and renewed our acquaintance with Hazel Dempster, who in her inimitable fashion, rekindled my interest in Stylidiums and encouraged me to have another go at them. Some of the results of that “gentle persuasion” are the subject of this article. The general idea was to try to broaden the knowledge of horticulture of Stylidiums away from their normal habitat and to encourage others to grow them.

I needed stock plants and I was impressed by the bottle technique used by Hazel and her colleagues for cuttings. The smoked water method for seed germination was just becoming popular as a result of the work by Kings Park staff, and smoked water was commercially available. Hazel also introduced me to propagation by leaf cuttings, a technique that she has used for many years. I recall that John Philp of the Study Group had been successful with bottom heat and “Growool” medium back in 1982 but I had not tried it. By January 2006 I had *S. graminifolium* leaves under plastic bottles and a 6 x 3 m shade house under construction. The latter was equipped with an automatic misting system to cope with a large number of pots and allow me to take holidays from time to time. I have included a brief description of propagation for those who wish to increase their plants for the garden.

Procedures

All material was supplied by Hazel Dempster from plants propagated at the Wildflower Society of Western Australia, Northern Suburbs nursery.

Cuttings: all cuttings were dipped in Clonex purple rooting hormone gel. The medium was a mixture of 30 L of Debco propagation mix with five litres of Perlite. The cuttings were set in 125 mm or 150 mm pots, watered in and a 1.5 L or 2 L plastic bottle with the bottom removed was placed upright over the cuttings. The pots were sheltered from

the wind, allowed filtered morning sun and watered once or twice daily depending on weather conditions. Cuttings taken from late autumn to early spring were generally ready to pot on after three months but leaf cuttings took up to six months.

Leafy stemmed species such as *S. repens*, *S. dichotomum*, *S. bulbiferum* and *S. asciculatum* strike readily from tip cuttings of new season growth 3-5cm long, and are generally more successful than offsets with new aerial roots, especially when the material has been

transported. Removal of the stem leaves is sometimes not needed and damage to the stems avoided. Species with whorled stems such as *S. scandens* and *S. nymphaeum* also strike from stem cuttings, and roots may form at the nodes both above and below the surface, depending on the time of year they are taken.



"Bottle" propagation, 31/1/2006



Stylidium assimile from a leaf cutting



Stylidium assimile seedling

Rosetted and tufted species tend to multiply by production each season of multiple new tufts or rosettes which can be separated from each other and set as cuttings, even though there will be very little plant below the surface.

Leaf cuttings: many species can be propagated from leaf cuttings, using the same basic method as for stem cuttings. In general leaves with basal tissue are more successful than those without; the new leaves grow from the base of the original leaf. I am indebted to Hazel Dempster for alerting me to the potential of leaf cutting propagation,



Stylidium graminifolium Left: roots on leaf cuttings' Right: new growth on leaf cutting

both for *Stylidium*s and other genera such as *Goodeniaceae*.

Species with small leaves such as some of the rosetted types can be handled as bunches of leaves with success. Although the best results from cuttings are with material in active growth, *Stylidium*s tend to shut down in summer, even if they retain some leaves and it would be useful to know whether leaves collected in summer would strike. Accordingly, I set leaf cuttings of several forms of *S. graminifolium* taken in January. All were successful, and healthy leaf cuttings of several WA species taken in December also struck.

At first I used 'Richgro' commercial native potting mix, but in 2008 I noticed that some *S. dichotomum* cuttings that I had potted on had become yellow within a few days of potting on. I suspected the new bag of potting mix and tested the theory by transferring some plants to a new mix consisting of 30 L each of Debco propagating- and seed-raising mix with 10 L of Brunnings propagating sand and a little Osmocote slow release native fertiliser. On August 25th I repotted half the affected *S. dichotomum* cuttings into this mix and within a few days they had begun to recover the original green colour; those left in Richgro had become worse.



S. dichotomum cuttings in original Richgro



S. dichotomum cuttings repotted into 'New Mix'

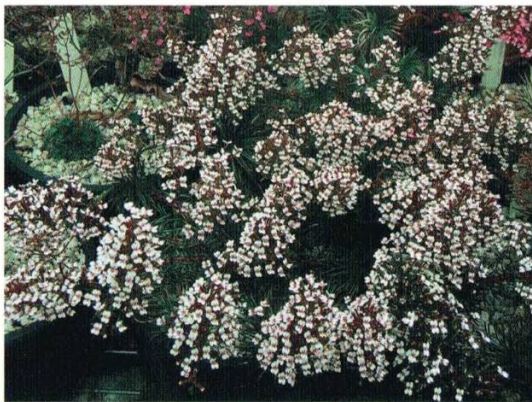
Although this may have been a bad bag or a bad batch, I wasn't prepared to persevere with Richgro and have used the above mixture ever since.

Seeds: Seeds were sown on to a suitable seed raising mix and treated with smoked water once a day for three days, followed by regular normal watering. Germination of fresh seed (up to four years) usually occurs within 4-6 weeks. Older seed often fails to germinate, but whether this is because the seed is dead or dormant is not clear. I use the three-day treatment because I feel exposure to the active chemical in smoke would be very short in nature. Soaking for 24 hours may help to break dormancy of older seeds.

Pot Culture

At first I used the Richgro potting mix for my stock plants in 200 mm round or 230 mm square self-watering pots, but after the problem with Richgro I used the Debco mixture described above. I also abandoned the self-watering pots as I thought they remained too wet for the plants. The choice of potting mix is one for the grower, but I found that any mix that contains composted material eventually produces liverworts that can cover the surface and prevent water ingress. I use a layer of 6 mm screenings to minimise liverwort growth.

Rosetted species allied to *S. spathulatum* grow rapidly and need to be renewed every 2-3 years. Those in the *S. piliferum* group multiply more slowly and are smaller so will last 5-6 years before renewal. Leafy



S. dichotomum 26/12/2012

stemmed species tend to become straggly after 2-3 years and need renewal or trimming, this includes those that produce aerial roots in autumn such as *S. dichotomum* and *S. repens*. The floral display from *S. dichotomum* is best in the second year, and the colours range from white through yellow and orange to pink.

Species that have given good displays include *S. affine*, *S. articulatum*, *S. assimile*, *S. bulbiferum*, *S. caespitosum*, *S. ciliatum*, *S. corymbosum* var *proliferum*, *S. fasciculatum*, *S. hispidum*, *S. ireneae*, *S. lateriticola*,

S. megacarpum, *S. piliferum*, *S. pritzelianum*, *S. pulviniforme*, *S. scandens* (bushy form), *S. spathulatum* and *S. uniflorum* but this list is by no means exhaustive. Climbers such as *S. scandens* and *S. nymphaeum* need support and I have found that they become very straggly. *S. scariosum* has very short leaves for the first year then the long flowering stems take over photosynthesis and the basal leaves die off. If the old stems are removed, the plants grow new basal leaves. The flower stems are long and tend to flop about so need support.

Some notable failures in long term survival are *S. tenue*, *S. amoenum*, *S. affine* and *S. brunonianum*. The first two grow over laterite so may need special treatment, and the other two grow in sand and may be unhappy in mixes with organic matter. Or maybe not, it's too early to say.

Stylidiums in the garden

Melton is in the middle of the Western Volcanic Plain and has a long term average rainfall of 375-450 mm. The average for 2000-2009 was 320 mm but the last two years have been wet, 550 and 620 mm, though a significant amount fell in Summer. It is windy and the evaporation rate is high, temperatures are generally several degrees higher in Summer than in Melbourne and correspondingly lower at night in Winter. The soil in our garden is a brown clay loam of pH 7.5-8 that is very hydrophobic. When dry it is very fine and impossible to wet out without a great deal of effort; wetting agents are only marginally effective. The topsoil is about 150 mm deep and overlays a similar depth of a light coloured clay subsoil. Below that is 1-1.2 m of red or yellow clay on top of basalt. There is no water table. The shallow soil does not encourage large shrubs and trees to put their roots well down so any garden bed that is regularly watered is very quickly invaded by roots. I have added coarse sand to some beds to improve drainage but I have not used gypsum as a soil conditioner.

In general Stylidiums in the garden have been disappointing, with the exception of *S. adnatum*, which was first planted in 1980. It survived and multiplied as seedlings until the middle of the recent 15 year drought. Fortunately I had maintained a stock pot — or rather it maintained itself by producing seedlings every year — so I was able to restock the garden in 2006; there are now more self-sown seedlings than I need. Most of the other WA species that I have seem to need consistent rain in winter and a reserve of moisture in the soil to carry them through the flowering season. Plants grow and often flower in the first season but then decline and die within two years. Some of last

year's *S. dichotomums* are not showing good new growth, but at least they survived the summer. Three plants of *S. affine* on a raised bed of the local red soil have looked healthy but did not flower well. It may be that the alkaline soil does not suit many of the WA species as they grow well enough in pots. Deep soil may be needed for success in the garden as I have noted that stock plants in pots can produce very large root systems. In the wild such roots may grow very deep to maintain the plants over summer. Those with gardens in the sand belt may have more success with *Stylidium*s, as may those in the moister areas to the east and in Gippsland. The garden horticulture evaluation is ongoing.

A note about seeds.

Quite early on I was pleased to find seed capsules on many of my plants and made a good collection of them. Seeds from this collection sown in April 2008 produced a prodigious crop of seedlings and, while most of them appeared to be 'true to label', there was one that didn't. As the seedlings of *S. ireneae* developed they became less and less like those of the parent plant and more like those of *S. spathulatum*. In due course the plants flowered and looked for all the world like pink-flowered *S. spathulatum*. Unfortunately some of my surplus '*S. ireneae*' seedlings were distributed by Barbara and David Pye of 'Suntuff' nursery before I realised their hybrid nature. It is very important that we do not distribute such hybrids without clear designation of their hybrid origin (or preferably not at all).

Species that came true include *S. assimile*, *S. spinulosum*, *S. rigidulum*, *S. dichotomum*, *S. caespitosum*, *S. ciliatum*. Unfortunately, there is no guarantee that those species will be true next time as there may be compatible species nearby that were absent the first time. Such are the hazards of a plant collection.

Overall, propagation and pot culture is reasonably well established but the garden remains to be conquered. For the future I am considering a variation on the 'tank bed' described by Hazel recently (reference). Rather than use metal tanks I propose to try timber boxes made from treated pine, to seal the bottom to exclude invasive roots, and to use a slightly acid, sand-based medium.

I am grateful to Hazel Dempster for providing plant material for this study, and for her encouragement and advice along the way. I also thank Maureen Schaumann, Faye Candy and Christine Wadey for their interest and enthusiasm in nurturing some of my plants under difficult conditions.

Triggerplants International

You can learn more about triggerplants at the web site of the International Triggerplant Society (<http://www.triggerplants.org>). There are now about 111 members in 19 countries from five continents. They produce a journal (*Triggerplants International*). It was commenced in 2009 by Greg Bourke and Doug Darnowski. It includes scholarly articles on trigger plants and their relatives such as: Allen Lowrie & John G. Conran *An overview of the Australian Levenhookia (Stylidiaceae) complex, including a new species (L. murfetii) and observations on the triggering methods employed for pollination and outcrossing*. Volume 1 2011.

Did you know that Levenhookia plants are so tiny they were named by the botanist Robert Brown in honour of Leeuwenhoek the inventor of the microscope? Did he simplify his name or mis-spell it? The common name "styleworts" was given to the genus by Rica Erickson.



Left: *Levenhookia leptantha*

Right: *L. pauciflora*



Left: *L. stipata*.

Photos: Allen Lowrie

Right: *L. stipata* really is tiny, as this "thumbnail" shows.

Photo: Jim Barrow

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