Psoralea fascicularis:

A Restoration Project

By
Jeremy Gilmore

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'Psoralea fascicularis: A Restoration Project'

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The author has made every effort to ensure the accuracy of the information within this write-up was correct at the time of publication.

Part 1: *Psoralea fascicularis*

Psoralea fascicularis DC.
(syn. *Psoralea tenuifolia* Thunb., *Psoralea thunbergiana* Eckl. & Zeyh.)

Background:

The genus *Psoralea* L. comprises of over 60 closely related species in the family Fabaceae (pea family). The genus was described by Linnaeus in the 1700's [Kumar *et al*., 2018]. One such species in this genus is *Psoralea fascicularis* DC. This can be abbreviated simply to *P. fascicularis*. The species has two other synonyms: *P. tenuifolia* Thunb. and *P. thunbergiana* Eckl. & Zeyh. In this context, these synonymous names are names that are now considered to be the same species. The generic (genus), specific (species), and infraspecific names of organisms (e.g. subspecies) are always written in italics to make for easier reading in literature.

History & Taxonomy

In taxonomy, the study of the classification of organisms, a species name is followed by the full citation of the person/s that made the first published description of the species. For example, in name "*Psoralea fascicularis* DC.", the "DC." is in reference to Augustin Pyramus de Candolle, a Swiss botanist. de Candolle described the species first and published it in 1825 [IPNI, 2021; GBIF, 2021]. The citation of "L." in the genus name "*Psoralea* L." honours Carl Linnaeus; a Swedish botanist, zoologist, taxonomist, and physician known by most as the "father of modern taxonomy" and binomial nomenclature as we know it today.

The more common species of *Psoralea, P. pinnata* (Fine-leaf Fountainbush), was among the earliest cultivated plants originating in South Africa. This dates as far back as 1690 [Carolus, 2002]. Until now, *P. fascicularis* specifically has thought to have never been propagated before.

- Kingdom Plantae (Plants)
  - Phylum Tracheophyta (Vascular Plants)
    - Subphylum Angiospermae (Flowering Plants)
      - Class Magnoliopsida (Dicotyledons)
        - Order Fabales (Milkworts and Allies)
          - Family Fabaceae (Typical Peas)
            - Subfamily Faboideae (Legumes)
              - Tribe Psoraleeae (Fountainbushes and Allies)
                - Genus *Psoralea* (Fountainbushes)
                  - ***Psoralea fascicularis*** (Large-stipule Fountainbush)

Fig. 1: Diagram representing the taxonomy of *Psoralea fascicularis*

Names & Naming:

In the pronunciation of the generic name, *Psoralea*, the "P" is silent. It is pronounced as follows: *saw-ray-lee-yuh*. The specific epithet, "*fascicularis*", is pronounced as: *fuh-sick-yoo-lahr-riss.*

The generic name (*Psoralea*) is based upon the Greek word "psoraleos", which translates to "warty", referring to the wart-like structures found on the bark of many of the species. The Latin specific epithet (*fascicularis*) translates to either a bundle, tuft, or close cluster [CASABIO, 2021]. Although it does not appear to be specified as to what this is referring to exactly, it most likely has something to do with the impression that the grouped (tufted/bundled/clustered) tri-foliate leaflets give – perhaps specifically the terminal (final) ones. Of the two other synonyms for the species, *P. tenuifolia* Thunb. translates from Latin to mean thin-leaved, referring to the species' thin leaves: tenuis ("thin") + folius ("leaf"/"foliage"). The name was given by Carl Pehr [Peter] Thunberg himself. As the author of *'Flora Capensis'* 1807 (Plants of the Cape) and pupil of Linnaeus, Thunberg has since become known as the "father of South African botany". The second synonym of *P. thunbergiana* Eckl. & Zeyh. honours Thunberg and was given by Christian Friedrich Ecklon and Karl Ludwig Philipp Zehyer who, like Thunberg, also collected at the Cape albeit 50 years later.

Vernacular or common names for this rather uncommon species include: Whine Fountainbush, Fascicled Fountainbush, and Large-stipule Fountainbush. It does not seem to be specified as to what the common name of "Whine" Fountainbush refers to exactly, although it may be a misunderstanding of "wine" in reference to the vast vineyards around Stellenbosch. These have since lead to localised extinctions of the species in the surrounding area. It may otherwise be in reference to the Spier Wine Estate where the species is still supposedly found. However, both of these possibilities are nothing short of conjecture. Nonetheless, "Fascicled" Fountainbush is a direct translation from the specific epithet "*fascicularis*" (meaning bundled). "Large-stipule" Fountainbush evidentially refers to the conspicuously large stipules found on the species [**Fig. 2, pp. 3**]. In this write up, this is the vernacular name that will be used to refer to the species from now on, as there is no controversy surrounding its origin.

Medicinal & Chemical Compounds:

Many *Psoralea* species have been noted for their traditional value and medicinal properties and so pharmaceutical activities are also well documented within the broader scientific community.

Psoralen plus ultraviolet rays (PUVA) has been used to successfully treat various skin diseases, however a myriad of other negative side effects have also been recorded. *Psoralea* has also been known to lead to allergic reactions on the skin following both injection and oral ingestion. In overdose it has been known to cause dizziness, weakness, blurred vision, rapid breathing, and vomiting. Severe cases include vomiting blood and a loss of conciousness – sometimes even coma-inducing. It is therefore no surprised that *P. fascicularis* specifically has been reported as toxic to horses and cattle. It is thus not used as fodder for livestock.

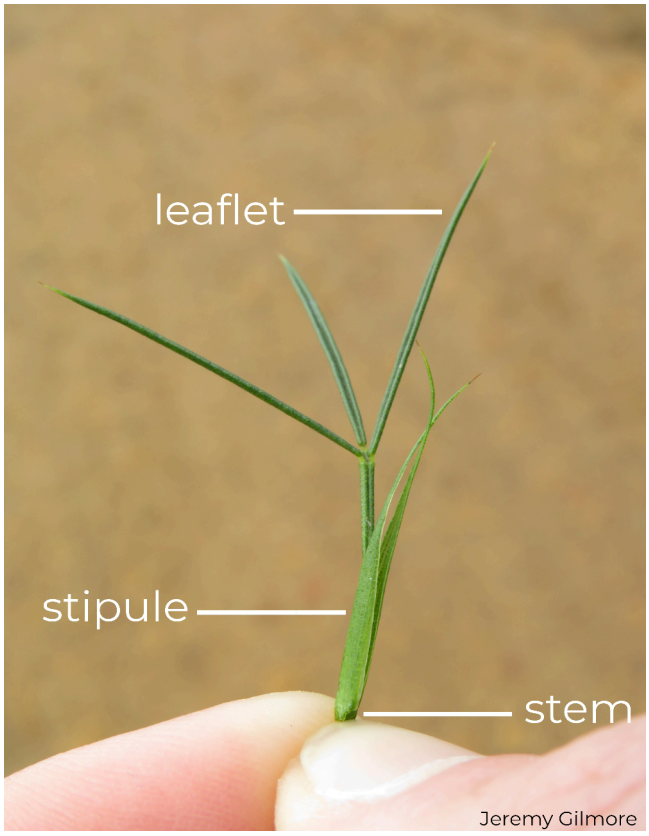
Psoralea fascicularis and its close relative, *P. glaucina*, are both vulnerable to extinction and their bioactive principles and mode of action have not yet been explored. Kumar *et al*. (2018) state: "...their conservation would ensure an alternative source of continuous and sustainable supply of elite bioactive compounds such as bakuchiol, psoralen, angelicin, and psoralidin for the pharmaceutical industry." It is thereafter concluded that *Psoralea* species in general harbour a great potential in acting as panacea to numerous diseases and ailments. As such, even when looking at it from this perspective, it is essential that the conservation of these species takes place before even more excessive exploitation is done.

Description:

Simplified: *Psoralea fascicularis* is described as a low, re-sprouting perennial “sub-shrub” - meaning that it is quite small. The tri-foliate leaves are long and narrow with conspicuously large stipules; hence the common name of Large-stipule Fountainbush. Petite indigo flowers are borne in inflorescences that are clustered up the shoot. The upper banner petals show off two white spots in the centre, each adjacent to one another. The flowering season lasts throughout the first few warmer months from September to December. The small seeds are dark brown in colour.

Expanded: *Psoralea fascicularis* is a low and straggling suffrutex that is either a suffruticose, diffuse, or ascending re-sprouting perennial sub-shrub. Branches are long, incurved, subsimple, and densely leafy. The frequent leaves are glabrous and tri-foliate, with the leaflets lanceolate in shape at 3–4cm long and ½–1 line wide; tapering off to an extraordinarily acute tip. Stipules are found at the bases of the petioles and are conspicuously large and adnate for half their length. These are stem-clasping with their points subulate-acuminate, the free-points 3–6 lines long and slender. The inflorescences are loosely capitate. Pedicels are long and axillary with several clustered up the shoot together. Calyx-lobes are acute, ovato-lanceolate to lanceolate-acuminate in shape, with the lowest being subulate and glabrous. The flowers are indigo in colour while the upper banner petals show off two white spots in the centre, each adjacent to one another and on each half of the single banner. Wing petals can be much longer than the keel and standard petals. Flowering lasts from September to December.

It is uncommon for flowers being visited by pollinators to display the androecial column (stamens) against the “flag petal”. Presumably, the mention of a ”flag petal” refers to the banner or standard petals.



- Fig. 2: Photograph diagram distinguishing the stipule

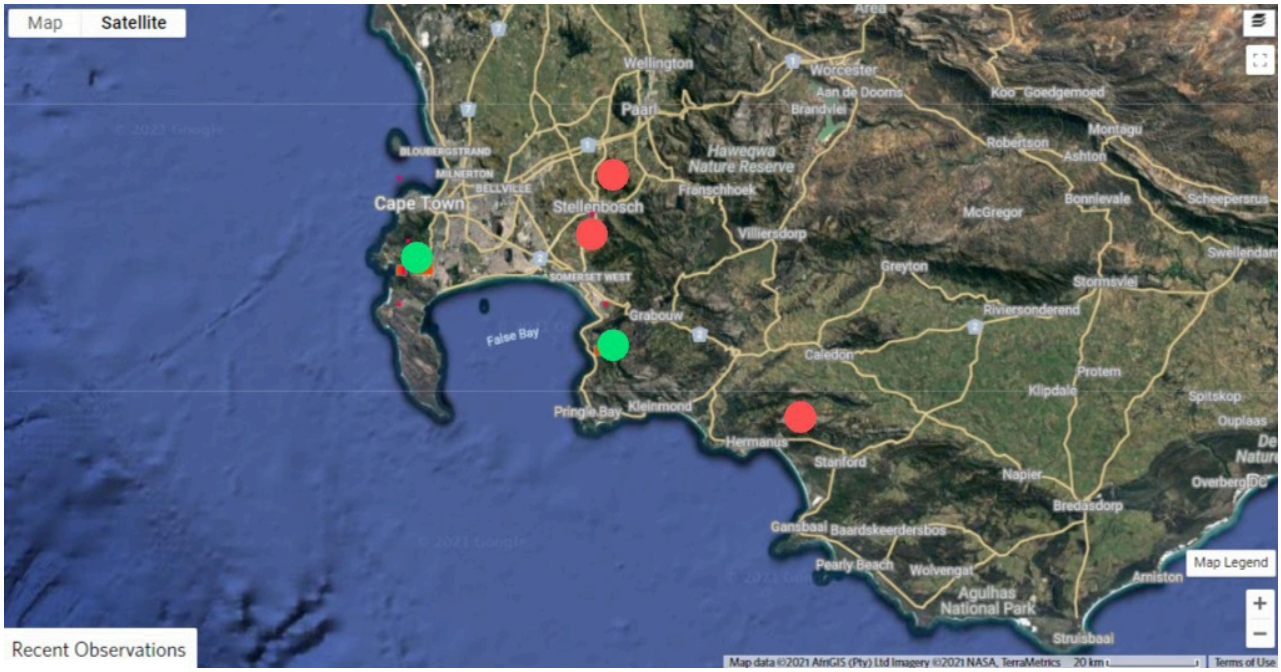
Habitat:

Psoralea fascicularis is found in both mountain and lowland fynbos, such as Peninsula and Boland Granite Fynbos. It has also been found in Western Ruens Shale Renosterveld and Swartland Granite Renosterveld. In these vegetation types it is most often found in moist areas. Although it is said that the ideal habitat for this species is between 100-600m altitude above sea-level [WFO, 2021], the Soetvlei and Grootboschkloof greenbelt sub-populations in the Southern Suburbs of Cape Town are between approximately 15-20m. In addition to this, the Constantiaberg sub-populations push 900m. This will probably mean that a revision of the altitudes is needed.

Distribution Range:

As a rare range-restricted species and Western Cape endemic, *Psoralea fascicularis* is found across the Cape Peninsula, stretching east towards to Hermanus. This includes key localities in the Stellenbosch-Jonkershoek area, Somerset West, and the Hottentots Holland and Shaw's Mountains. Throughout its range, it is restricted to just a few isolated populations. In Cape Town the plant occurs on Constantiaberg, no more than a few hundred metres south-west of the iconic Elephant's Eye Cave (above 600m altitude). It is also found in Lower Tokai Park (compartment block number A10a) and the surrounding greenbelts (below 100m altitude); namely Soetvlei and Grootboschkloof [Fig. 18, pp. 18].

Psoralea fascicularis was recorded on Bergvliet Farm in 1915 by Dr William Frederick Purcell [Rourke, Fairwell, & Snijman; 1981] [Fig. 21, pp. 20]. This was probably not the first time that it was recorded there, and definitely not the last as the species still remains in the area to this day, albeit in the heavily degraded greenbelts. While the sub-populations in Lower Tokai Park also would have fallen just outside of the farms' boundaries, those on the Soetvlei and Grootboschkloof greenbelts [Fig. 18, pp. 18] were much closer and may have even once been a part of those that Purcell saw.



- Fig. 3: Full distribution map where:

(a) green dots indicate the most recent observations,
(b) light red dots indicate where the species has also been recorded, and
(c) tiny dark red squares indicate GBIF records (not all records visible)

Status, Threats, & Assessments:

Although *Psoralea fascicularis* has already lost a significant portion of its habitat around Stellenbosch due to both habitat degradation and destruction, it is perhaps largely the fault of agriculture. This is due to the ever-expanding vineyards. The species has most recently become locally extinct in areas around Stellenbosch, Somerset West, and presumably the Cape Peninsula too due to the rapid urbanisation that has taken place. Alien and invasive plant species have also been noted as detrimental to sub-populations at Shaw's Pass and specific areas around the Cape Peninsula. Unfortunately, this is most likely to be the case in other areas where the plant may still remain.

Historically, *Psoralea fascicularis* has been recorded from a mere ten locations. Between 1920 and the 1980's, at least three of them have been completely wiped out. Intact habitat still exists at two other historical records, but despite these two sites being well surveyed, the species has not been recorded there in over 80 years. A re-assessment of the species done in 2018 concluded that up to 72% of its total habitat has been lost (based on the historical records). As few as five localities may still remain around Stellenbosch and the Cape Peninsula. These are all within an approximate extent of occurrence (EOO) of 1631 km². An estimated 5.3% was lost between 1990 and 2014. The 2018 study deduced that over three generations (100-120 years), a population reduction of 46-50% had occurred. This is in relation to the observed rate of habitat loss. The species was first assessed in 1996 where it was inferred that the species was “insufficiently known” [Hilton-Taylor, 1996]. A later assessment done in 2008-2009 placed the species as “Endangered” (EN) on the International Union for the Conservation of Nature's (IUCN) Red List of Threatened Species™ for the first time [Raimondo *et al*., 2009]. Its latest assessment took place in October 2018, but its conservation status remained as Endangered due to the continuously declining population trend [Stirton, Raimondo, & von Staden; 2018].

- Fig. 4: Dredging posed as a threat on the Soetvlei greenbelt (June 2020)
  (Red circles indicate several plants severely damaged as a result)

Part 2: The Journey

Previous Project Ideas:

Some of my first extremely ambitious thoughts regarding possible project ideas included either (a) Clearing a large portion of land of invasive alien plant species, (b) Setting an urban park on fire, (c) Counting every species on a chosen piece of land, or (d) Documenting every tree fern on the Constantia Valley greenbelts.

My very first idea was to monitor the natural recovery of a piece of open land that had previously been smothered by invasive species once I had cleared them. The second idea had the intention of documenting the effects of fire on a piece of open land that either previously had Fynbos on it or still does in one form or another. This would have had a focus on documenting any underlying seed-banks that might still have remained. The third involved creating a species checklist of every species (within in reason) on a certain piece of land; whether this be a relative's farm, a municipal area below Boyes Drive, or Lower Tokai Park, etc. The checklist would, of course, have a bias towards plants. The fourth and final idea proposed documenting the invasive alien tree ferns of the Constantia Valley greenbelts; namely *Cyathea cooperi*, the Australian tree fern [Fig. 5, pp. 6].

Many issues arose with these ideas, such as questions surrounding the actual legality of some practices that would be carried out. Thus I eventually decided on a Fynbos conservation, restoration, or rehabilitation project involving the Endangered *Psoralea fascicularis* (Large-stipule Fountainbush) on the Grootboschkloof greenbelt. This idea originally revolved around merely cleaning up the wetland home to a population of this species, but it quickly evolved from there.

- Fig. 5: *Cyathea cooperi*, the invasive Australian tree fern

Final Decision:

Psoralea fascicularis is an endangered species. I first encountered it in Lower Tokai Park, after-which I immediately took to iNaturalist to find out more about it. There I saw Prof. Tony Rebelo's recordings of it along the Soetvlei greenbelt where it was threatened by dredging and invasive alien plant species. I became intrigued, trying to find out if there was anyway I could help in preventing this species from edging ever closer to certain doom – locally at least.

Luckily this was right around the time that I needed to start thinking of ideas for our grade 12 projects. I got in touch with Marianne Alexander, warden of the Grootboschkloof greenbelt, who had also observed the species in the greenbelts around Tokai, but this time at Grootboschkloof where it was threatened by municipal grass mowing. After expressing my concerns over the species, she helped me get in contact with several other people who would be able help me further in my quest; whether it was for land permits, harvesting permits, or general expertise regarding the subject. One of those people was Dr Caitlin von Witt from FynbosLIFE, a non-profit Fynbos rehabilitation and restoration organisation based in Cape Town. FynbosLIFE focuses on the conservation of the highly threatened lowland veld types of Cape Town through education, and active restoration through horticulture. Together we decided to propagate cuttings of the species for bulking up the existing population at Grootboschkloof, as well as planting more along the entirety of the greenbelt. Plans later came about to also use some cuttings to replant at the nearby Lower Tokai Park with Prof. Tony Rebelo and the Friends of Tokai Park (FoTP), as well as the Soetvlei and Spaanschemat greenbelts too – or at least in the future sometime perhaps.

- Fig. 6: Brian du Preez examining *Psoralea fascicularis* in situ
  Lower Tokai Park (2019)

Beginning Phase:

Eight months later I found myself in the new FynbosLIFE nursery in Lakeside, on the banks of Zandvlei. Since the nursery was still in the last phase of being set-up, I assisted by helping out with the moving and sorting of plants, as well as any weeding work that needed to be done. I also helped out by planting out some cuttings. This was good practice for my upcoming project. Zide, who had previously worked at Kirstenbosch with the late Anthony Hitchcock, showed me how the different cuttings were prepared. The real challenge by far was constantly dodging the sprinkler irrigation timer, hopping from one corner of the nursery to another in a desperate attempt to avoid getting soaked. This was a never ending challenge. We also fire-smoked some bulb seeds and bulbils to aid with their germination [Fig. 7, pp. 8].
Then the grade 12 plays hit.

- Fig. 7: Zide smoking the bulb seeds

Collecting The Material:

As soon as the grade 12 plays were over, I went out to get some seedling mix, vermiculite, and Dynaroot™ No. 2 rooting hormone powder as per Dr Caitlin von Witt's instructions. Before I knew it I was collecting *Psoralea fascicularis* material with Caitlin on the Grootboschkloof greenbelt [Fig. 8, pp. 9]. Here I met up with Marianne Alexander for the first time. I took the material home in dampened plastic bags where they slept in the fridge overnight to keep fresh, as Caitlin suggested. This would most likely be the first time that anyone has ever propagated the species.

We also collected material of another species growing alongside *Psoralea fascicularis* on the greenbelt. The idea was for this species to be a sort of "companion species" to *P. fascicularis;* to help them grow alongside one another when we plant them out on the greenbelt – and elsewhere – again. This species was a form of *Helichrysum cymosum* (golden carpet everlasting) [Fig. 14, pp. 14]. Although this form is considered to be the nominotypical subspecies of *H. cymosum* (*H. cymosum subsp. cymosum*), it is seemingly quite distinct. Officially, *H. cymosum* has only two subspecies (including the nominotypical)**.** The three unofficial yet distinct forms are (a) The larger Cape Town lowland Fynbos form that is usually found in or around wetland environments, (b) The more grey-leaved dwarf form typically found in coastal Strandveld, and (c) The more montane form with greener foliage.

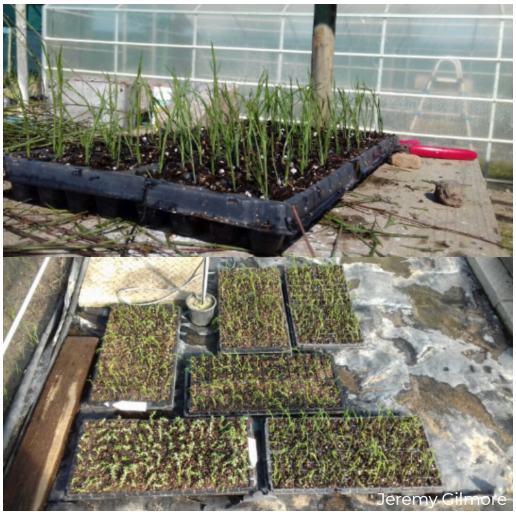
- Fig. 8: Dr von Witt and myself collecting cutting material at Grootboschkloof

Planting Phase:

It wasn't until I had already started on planting the cuttings out into my seedling mix-vermiculite concoction at the nursery the next day [Fig. 9, pp. 10] that I realised just how many cuttings I could make out of the material that we had gathered. What started as three trays (of 128 plugs each), soon became three and a half, four, and then eventually a solid five. This amounted to 640 *Psoralea fascicularis* cuttings in total. I only stopped because the rest of the material had begun to get a bit droopy and was drying out. Since I was (incorrectly) expecting a very low propagation success rate, I wasn't too concerned about the overwhelming amount of cuttings. Re-sprouting Fynbos plants are generally notoriously difficult to root and often have a success rate of less than 5%. In addition to the five trays of *P. fascicularis*, I did one tray of *Helichrysum cymosum* cuttings. In total, five trays of *P. fascicularis* cuttings (640 cuttings) and one tray of 128 *H. cymosum* cuttings were completed that day [Fig. 10, pp. 10]. This amounted to a total of 768 cuttings in six trays.

It was time for an Easter break to Beaverlac for the weekend.

- Fig. 9: (above) Preparing cuttings and soil



- Fig. 10: (second photo) All cuttings completed

Rooting Phase:

In less than a month the cuttings had already begun to root [Fig. 11, pp. 11; Fig. 14, pp. 14]. Now all I could do was play the waiting game. In doing so I helped out with odd jobs around the nursery again such as weeding, re-potting, and sorting and organising other potted plants. I was introduced to Lloyd who works at the nursery, and also soon-to-be-named Houdini, the angulate tortoise (*Chersina angulata*) who keeps on disappearing.

- Fig. 11: Typical rooted cutting of *P. fascicularis.*

Transplanting The Cuttings (1/4):

After two cold winter months I began planting out the *Psoralea fascicularis* cuttings into larger trays of 20 plugs each [Fig. 12, pp. 12; Fig. 13, pp. 13]. I mixed the soil using one part reddish loamy soil, one part white coastal sand, and half a part an alluvial soil. The one part reddish loam came from Newlands. The one part white coastal sand was Cape Flats Sand Fynbos sand excavated from Parkwood. The half part alluvial soil was Table Mountain Sandstone from the recently developed Chapman's Bay Estate on Ou Kaapse Weg near Noordhoek. When taking into account the preferred habitat of the species, this was quite a good mix. Unfortunately not much in the way of experimenting with different soils was done.

The process of mixing the soil was a lot more strenuous on my back than I had anticipated. Another factor was clearing out all the small stones and rocks. “Volcanoing” was the best strategy for mixing these three soil types (just add water). On this first day of planting the rooted cuttings out in the larger trays I almost completed planting out one full small tray of 128 rooted cuttings. This was equal to about six of the larger trays. In total I had planted out 118 cuttings that day. Of the 128 in the first tray, 125 had survived, which amounted to a whopping 97% success rate! This was amazing considering my rather low preconceived estimations. Three cuttings were still alive, but had not yet rooted sufficiently.

- Fig. 12: Mixing soil for cuttings to be transplanted into larger trays

Transplanting Cuttings (2/4):

On the second day, two weeks later, I mixed up more soil following the same protocols and continued planting. After finishing the first tray I began on the second. That day I planted out another four large trays (80 cuttings). This time, 118 out of the 128 for the second tray had survived – a 92% success rate.

I continued planting the next day, using my leftover soil. I finished the second tray and began on the third; planting out three trays, or 60 cuttings. The success rate of this third tray was a bit lower – 111 of the cuttings in this tray had survived. Still, the success rate was at 86%. By the end of the following week the fourth tray had been completed. This fourth small tray amounted to a total of ten large trays (200 cuttings). Approximately 123 cuttings in this tray had survived, which amounted to a 97% propagation success rate yet again.

- Fig. 13: The Three Stooges

Cuttings reacted in many different ways

Transplanting Cuttings (3/4):

The fifth and final small tray saw the survival of 121 cuttings – a 95% success rate. However, there was one other cutting missing, neither dead nor alive. The single small tray of *Helichrysum cymosum* had rooted with 100% success. [Fig. 14, pp. 14]. They were therefore planted out into the larger trays too. In total I had done 26 ¾ large trays of *P. fascicularis* and 6 ¼ large trays of *H. cymosum*. Once I had run out of what soil I had previously mixed, I finished the rest of the cuttings using a new wetland soil that had been dug up from just up the road north of the railway line between Main Rd and Promenade Rd, opposite Zandvlei. I also met some other volunteers that regularly help out in the nursery.

- Fig. 14: Typical rooted cutting of *H. cymosum*

Transplanting Cuttings (4/4):

The cuttings needed a few weeks to adapt to the transplanting before they could be planted out into the Grootboschkloof greenbelt and FynbosLIFE Mandala. Ideally it would have been best for them to have a much longer time period to adapt, but I was rather pressed for time in terms of the project deadline and so waiting any longer was not feasible. In the meantime I reached out to Prof. Tony Rebelo and got a copy of Purcell's List in print [Fig. 17, pp. 17], after which I contacted the Compton Herbarium at the Kirstenbosch Research Centre to view Purcell's specimen and others in-person [Fig. 19, 20, & 21; pp. 20]. A few days later I hiked up to the mast and Elephant's Eye Cave in search of the Constantiaberg population of *Psoralea fascicularis*, but the search was unsuccessful as the plants were not in flower and very difficult to spot in and amongst the fynbos.

Final Planting Phase (1/2):

Less than a week later I met up with Caitlin and Marianne on the Grootboschkloof greenbelt once more where I planted out just under half of my cuttings in the Fynbos Circle, as well as elsewhere up the greenbelt. The Fynbos Circle is a planted display of local fynbos species that would have naturally occurred in the area before urbanisation took place. Caitlin showed me how and where to plant the *Psoralea fascicularis* and *Helichrysum cymosum* cuttings together. Some were planted in the two beds (or petals) of the flower-shaped mandala [Fig 15, pp. 15] closest to the river as they were the dampest – the preferred habitat for *P. fascicularis*. More cuttings were planted all up the greenbelt in four other spots with more to come in the following weeks. I used water from the river to water them, sticks to mark the individual plants, and dead branches to protect them by placing them on top of the cuttings and covering them a bit. I also met Martin who helped me plant a few of the cuttings in the mandala that he maintains. Due to time constraints we decided to plant the rest of the cuttings at the top of the greenbelt another day.

While working, I took geo-tagged photos of all the groups of cuttings that I planted so that they could be found again for check-ups. The next day I potted up four *P. fascicularis* plants and one *H. cymosum* plant into small pots for the project presentation display.

- Fig. 15: Grootboschkloof Fynbos Circle

Final Planting Phase (2/2):

Over the next couple of weeks I continued to plant the cuttings out at Grootboschkloof by myself and in my own time. During this time I planted cuttings all along the greenbelt from Spaanschemat River Rd to the Neva Cl-Airlie Pl bridge. More cuttings were planted below the bridge, connecting the previous weeks work to the work before that; effectively completing my planting work on the Grootboschkloof greenbelt. Before visiting Dreyersdal Farm and the Die Oog Wetland and Bird Sanctuary in Bergvliet [Fig. 23, pp. 22], I re-visited the Soetvlei sub-population to take comparison photos of the recovery [Fig. 25, pp. 24] following the previous years' dredging [Fig. 4, pp. 5]; as well as scouting out the area to see where it might be best to plant some more of the cuttings. Unfortunately when I checked up on the Grootboschkloof cuttings, many of them planted above the Neva Cl-Airlie Pl bridge had been chewed off by vlei rats, field mice, or the likes thereof. Still, some may survive. The other plants planted below the San Juan Rd existing population and in the FynbosLIFE Mandala were doing excellently.

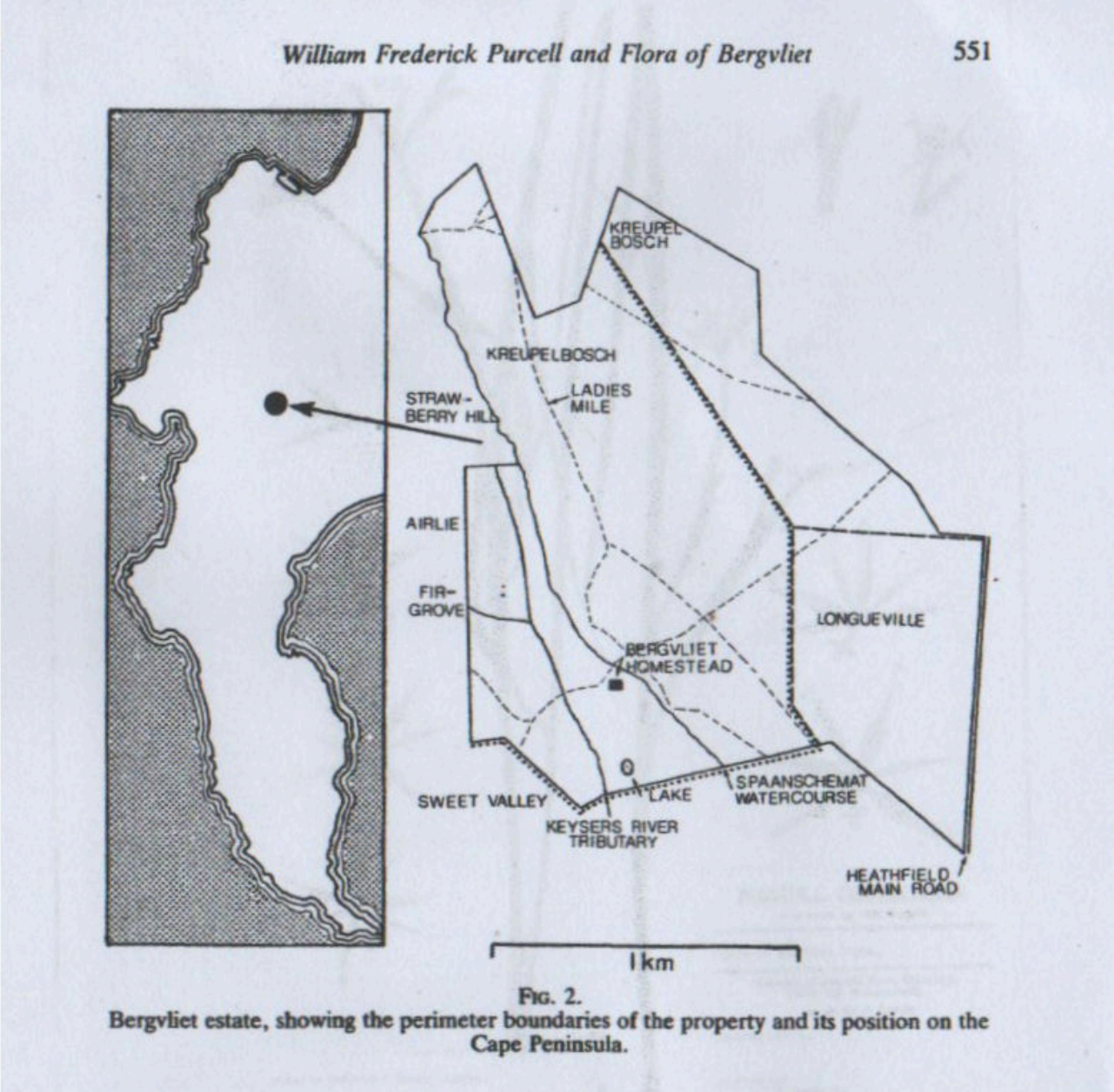
More cuttings could be planted on the Soetvlei and Spaanschemat greenbelts, as well as in Lower Tokai Park. At Tokai, the best places to plant *P. fascicularis* are the Prinkasteel Wetland (compartment block A9), the Restoration Trail (A22), the existing population (A10a), or the wetland in block A16. A map indicating where each block is situated can be found online on iNaturalist.

- Fig. 16: Cuttings planted at Grootboschkloof

Part 3: Further Research

Bergvliet Farm:

To put Purcell's Bergvliet Farm into the perceptive of the changed world around us today, I created an digital map [Fig. 18, pp. 18] by using the printed, physical copy of the map [Fig. 17, pp. 17] sourced from the 'Journal of South African Botany' – *William Frederick Purcell and the Flora of Bergvliet*. This I got from Prof. Tony Rebelo. The digital version, created with Google Maps, puts the context of the Bergvliet Farm into what Cape Town has since become following the rapid urbanisation that has taken place post-1900; specifically since Purcell documented *Psoralea fascicularis* there in 1915.

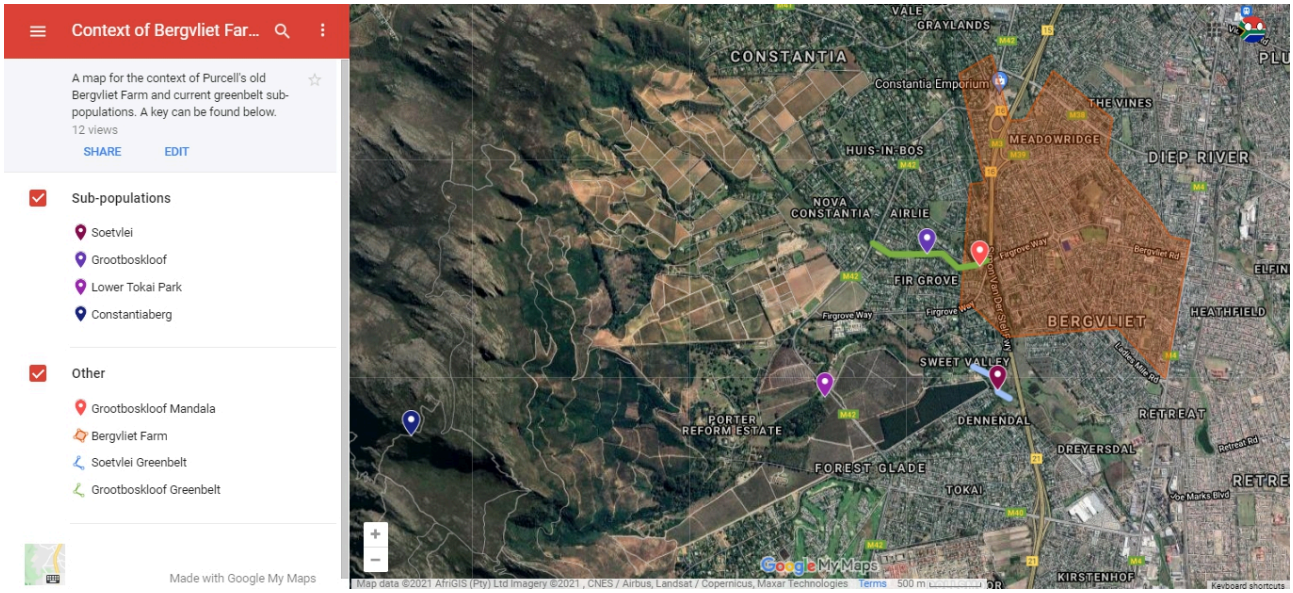


- Fig. 17: Purcell's map used to create the digital version

Digital Map in Perspective:

The digital map puts the existing sub-populations of *Psoralea fascicularis* on the greenbelts into the context of Bergvliet Farm. The four pin-points located outside of the farm's boundaries each represent a known sub-population. As per the colour-coded key to the left of the map, they have all been named according to the greenbelt or immediate area in which they occur.

My cuttings were originally sourced from the Grootboschkloof greenbelt sub-population [Fig, 8, pp. 9] represented by the indigo pin, after-which they were planted up along the rest of the Grootboschkloof greenbelt as well (light-green line). The single beige pin that is located inside the farm's boundaries (orange) shows the Fynbos Circle [Fig. 15, pp. 15] where my cuttings where also planted, for “display”. The maroon pin shows the Soetvlei sub-population that inspired my project after it was nearly destroyed by dredging in preparation for the winter rains [Fig. 4, pp. 5]. This is accompanied by the light-blue line that depicts the extent of the Soetvlei greenbelt. The mauve pin represents the Lower Tokai Park sub-population – the first one that I saw, sparking my initial interest in the species in October 2019. The remaining dark-blue pin shows the Constantiaberg populations. It is the closest to Bergvliet Farm that is at the highest altitude above sea-level (600-900m).



- Fig. 18: Context of greenbelt sub-populations and Bergvliet Farm
  (Key to the left of the map)

Compton Herbarium:

On Monday the 12th of July I visited the Kirstenbosch Research Centre as per my appointment. My goal was to find Purcell's specimen of *Psoralea fascicularis* from Bergvliet Farm, as well as any specimens that may be held there.

Purcell collected hundreds of physical specimens consisting of hundreds of different plant species. These were mostly from around his home on Bergvliet Farm where they were preserved by being carefully pressed and dried. By collecting these specimens, he inadvertently created a comprehensive list of all plant species occurring on the 3.43 km² farm [Fig. 17 & 18, pp. 17 & 18] in a collection that has since become known as "Purcell's List". Purcell's List is still used as a reference for many conservation, rehabilitation, and restoration projects in the area today. Following his death in 1919, all of Purcell's specimens were donated to the South African Museum Herbarium (SAM) in 1921 by his widowed wife, Anna Purcell [Rourke, Fairwell, & Snijman; 1981]. In 1956 the SAM herbarium was transferred to Kirstenbosch where it was soon after incorporated into the Compton Herbarium in 1957 where Purcell's specimens are still preserved to this day.

At the Compton Herbarium I met up with Kholiwe Dubula and Pieter Winter, who led me around the herbarium, but Pieter and I could not find the two supposed specimens being held there. It could have been that they were being loaned out to someone conducting related research at the time. Pieter and I then went upstairs to where the historical SAM Herbarium records were now kept. In these records we found three specimens that I photographed. One of these was Purcell's specimen [Fig. 21, pp. 20], collected on the 20th of October in 1915 on Bergvliet Farm: "...[near the] rose garden in clay, by water." Although I cannot be certain as where this might have been exactly – even with the help of the map of Bergvliet Farm provided by Rourke, Fairwell, & Snijman (1981) [Fig. 17, pp. 17] – it may very well have been near or around where the Die Oog Bird Sanctuary is today [Fig. 23, pp. 22] (namely between that and Homestead Ave – the old farm's Homestead). The remaining two specimens in the herbarium were collected in 1986 in the Hottentots Holland Mountains near Somerset West [Fig. 19 & 20, pp. 20].

Interestingly, all three of the specimens held in the herbarium had pencil markings of "*Psoralea tenuifolia* L." written on them as a synonym. Although the true synonym that this should rather be is "*Psoralea tenuifolia* Thunb.", Pieter suggested that it could very well have been meant to represent Thunberg's interpretation of Linnaeus' concept; in opposition to his own independent name. It could be that in the past someone had thought of combining *P. fascicularis* DC. (or *P. tenuifolia* Thunb.) under *P. tenuifolia L.*, therefore annotating them as such – as the two species are quite similar morphologically. Presumably, these pencil markings can therefore be ignored as they were not official herbarium determination slips (det. slips). It should generally be noted that although a mistake regarding the citations may seem minor, a different citation can refer to a completely different species, as in this case, even if the scientific names are exactly the same (e.g. *P. tenuifolia* Thunb. vs. *P. tenuifolia* L.) This still applies even when the one name is no longer in use (i.e. a synonym).

The Specimens:

- Fig. 19 & 20: (above) Two specimens collected near Somerset West, 1986 (isotypes)

- Fig. 21: Purcell's specimen from Bergvliet Farm, 1915

BODATSA Records:

By checking the online Botanical Database of Southern Africa (BODATSA) records, I found fourteen other herbarium specimens for the species listed, but four were either mislabelled or duplicates. This left ten remaining, most at the National Herbarium in Pretoria (PRE). Summarised, these were:

1. Collector: Acocks, J.P.H.
   Date: 00/08/1936
   Locality: Cape Peninsula District; Hout Bay; [by the] golf course.

2. Collector: Dorse, C.
   Date: 10/10/2005
   Locality: Stellenbosch; Spier Wine Estate; [at the] base of [the] Slangkop granite dome.

3. Collector: Forbes, H.M.L.
   Date: 10/28/1924
   Locality: Kirstenbosch National Botanical Gardens. [Specimens likely kept at].

4. Collector: Gillett, M.C.
   Date: 27/09/1938
   Locality: Caledon District; Shaw's Mountains; [in the] valley South of Shaw's Mountain.

5. Collector: Grobbelaar, N. *[Locality notes translated from Afrikaans]*.
   Date: 21/10/1970
   Locality: [[Stellenbosch; Jonkershoek; at [the] upper road-bridge over [the] Eersterivier]].

6. Collectors: Oberdieck, H.D.; Werdermann
   Date: 01/10/1958
   Locality: East Jonkershoek District.

7. Collector: Smith, C.A.
   Date: 12/11/1927
   Locality: Stellenbosch; Van Der Stel; [in] damp places near the station.

8. Collector: Taylor, H.C.
   Date: 23/10/1963
   Locality: Stellenbosch District; Jonkershoek; Jakkalsvlei, [at] the eastern segment of the cut-off belt 13, northern side of [the] valley with [a] steepish South West slope.

9. Collector: Van Rensburg, W.L.J.
   Date: 17/10/1960
   Locality: Stellenbosch District; Swartboskloof.

10. Collector: Verdoorn, I.C. *[No date visible]*.
    Locality: Kirstenbosch Botanical Garden. [Specimens likely kept at].

Note: All specimens were collected in the Western Cape province of South Africa.
Additional information available in the BODATSA records not included.

- Fig. 22: List of additional specimens

Finishing Up:

While finishing up the last phase of the planting, I decided to create a Wikipedia page for *Psoralea fascicularis*. At first when I submitted the article it consisted of just a few core sentences, however since the article was approved on the same night that I had submitted it, I went on to piece together a full article covering all of the most important aspects of the species. In the future myself or others may add more to it, but it is more than substantial for now. I also edited the current page for *Psoralea*; updating the species list as per Plants of the World Online (POWO – Facilitated by the Royal Botanic Gardens, Kew), as well as the two other existing pages on two other *Psoralea* species. These edits were very minor.

In addition to this, I visited Dreyersdal Farm [Fig. 26 & 25, pp. 27 & 26] and the Die Oog Wetland and Bird Sanctuary [Fig. 23, pp. 22] before re-visiting the Soetvlei sub-population [Fig. 25, pp. 24].

- Fig. 23: (top to bottom) Die Oog Wetland and Bird Sanctuary

Part 4: My Findings

Propagation:

This is believed to be the first time that *Psoralea fascicularis* has ever been propagated. Although the very high propagation success rate should not necessary come as a surprise, it is still quite remarkable. It was interesting to note the different ways that the cuttings grew [Fig. 13, pp. 13]. Some re-sprouted from completely below the soil surface, showing off their tough re-sprouting capabilities. Others grew just as I had planted them; from the tips. These tip cuttings grew the best. Cuttings that were even just bare sticks (but with at least one node) grew. Some trays had much better rooting than others, with the 86% success tray being the lower-end anomaly. Perhaps some trays got drier than others during the planting, or maybe did not get as much water if they were further away from the sprinklers in the rooting greenhouse. The trays done first were probably those that did better due to the fresher material – and they had less time to dry out throughout the day. I learned a lot from this project, such as the propagation techniques for different species – but most importantly *Psoralea fascicularis*, of course, and how it responds to these different propagation techniques, as mentioned above. This learning also includes information about the species in general, all of which I have gathered together in this project write-up.

As Prof. Charles H. Stirton from the University of Cape Town (UCT) suggested there might be, I found tiny root nodules on the roots of one cutting that I checked on [Fig. 24, pp 23]. On this particular cutting there were about three, each approximately 1.5mm in diameter. Some plant species – such as *Psoralea fascicularis* – develop these root nodules in symbiosis with certain nitrogen-fixing bacteria [Küster, 2013]. In this case the soil bacterium is most probably in the Rhizobiaceae family (rhizobacteria). This causes no harm to the plant since the bacteria helps produce nitrogen compounds that aid the plant in growing and competing against other species. This nitrogen is released back into the soil when the plant dies and it thereafter becomes available to other plants – effectively fertilizing the soil. Many species, especially those in the pea or Fabaceae family, use this symbiotic method to their advantage.

- Fig. 24: Rhizobiaceae root nodules on a *Psoralea fascicularis* cutting

Greenbelt Populations:

How did *Psoralea fascicularis* get to the greenbelts in the first place? The most likely answer would be that it has simply survived there in fragmented sub-populations since the post World War II urban development boom of the Bergvliet area. This could mean that the plants were most likely much more common in the surrounding area as well, before development took place and wiped many of them out. A similar case would be that of the species' decline in and around Stellenbosch.

Alternatively, perhaps there has been seed dispersal from other existing plants nearby such as those in Lower Tokai Park – as this is surely the least disturbed sub-population. Or maybe rather from plants that existed closer to where Purcell recorded them on Bergvliet Farm in 1915 [Rourke, Fairwell, & Snijman; 1981] – plants that have since spread to where they are today, narrowly escaping complete extinction in the lowland Southern Suburbs. Seed dispersal could have happened in many different ways; either via animals, the rivers and streams that make up the greenbelts, or even people. For example, people could accidentally have introduced the greenbelt sub-populations by moving and dumping soil when dredging the rivers and streams there. This scenario would be extremely unlikely – even if accidentally so – and either way, the source for the greenbelt sub-populations would still be very local anyway. There are no known records to say how long these specific sub-populations might have occurred on the greenbelts for. That is, to say, except for Purcell's very nearby record of the species. To reiterate how just how nearby these sub-populations could have been to Purcell's, my digital depiction for the boundaries of Bergvliet Farm [Fig. 18, pp. 18] put both of the current greenbelt sub-populations at less than 500m away.

Wild plants in the nearby Lower Tokai Park may back up all of the aforementioned possibilities to some degree. However, the fact that the plant is not known in cultivation, and rather rare and not very well-known in general makes it extremely unlikely for someone to have planted them – no matter the context; whether as active restoration or just for aesthetics (“gardening”). This could be another factor to show us just how tough these plants might be, as re-sprouters, surviving being cut down during the annual dredging at Soetvlei [Fig. 25, pp. 24], mowing at Grootboschkloof, and severe habitat degradation from aliens, pollution, and disturbance at both – yet still persevering in nothing but *once assumed* less-than desirable circumstances despite severe physical damage.

- Fig. 25: *P. fascicularis* quickly recovered from dredging at Soetvlei (August 2021)

Dreyersdal Farm & Die Oog

I found that the Die Oog Wetland was much too transformed from previous restoration work for there to be any wild plants still growing there [Fig. 23, pp. 22]. However, it did appear to be a great spot for possible future planting/s of the species to take place. The northern-most side of the Die Oog Bird Sanctuary also looked promising in this regard. Both of these areas were damp and consisted of clay – as close as can be to the original habit description presented by Purcell on his *P. fascicularis* specimen from Bergvliet Farm in 1915 [Fig. 21, pp. 20].

Before visiting Dreyersdal Farm I scouted out the Keysers River wetland between the Blueroute mall and Zwaanswyk High School. Unfortunately the area was largely out of bounds to the general public as a part of Dreyersdal Farm and proposed private nature reserve. Nevertheless the area still looked quite suitable for possible future plantings of *Psoralea fascicularis*.

Dreyersdal Farm is in close proximately to Purcell's Bergvliet Farm and so the two farms and their homesteads should not be confused. In fact, Dreyersdal Farm may have even once been a part of Bergvliet Farm under the ownership of Petrus Michel Eksteen in 1769; long before Purcell began to manage the estate in 1902 [BMRA, 2018]. Dreyersdal Farm is largely comprised of wetland around the vlei where the Keysers River runs through it [Fig. 26 & 25, pp. 27 & 26], creating the ideal habitat for *Psoralea fascicularis*. In addition to this, it is also in close proximity to both the existing *P. fascicularis* greenbelt sub-populations and Purcell's recording of it (supposedly the Die Oog-Homestead area).

- Fig. 26: Dreyersdal Farm Homestead east of the vlei

Ending Lines:

Historically, not much information has been recorded about this species; its pollinators, attempts to introduce it into cultivation, etc. In fact it has been rather difficult to dig up most information and research regarding the species, even with the Internet readily at hand. In the process of gathering this much-needed information, the research that I have come across has taught me a great deal about this species and even helped me in understanding various issues when applying thought to the conservation of other taxonomically unrelated species too.

My journey has connected me to many people with similar interests and goals, whether they be professionals or just share common goals or views. I learned a lot from this project, such as the propagation techniques for different species – but most importantly *Psoralea fascicularis*, of course, and how it responds to different propagation techniques, as I before. This learning also includes information about the species in general, all of which I have gathered together in this project write-up.

- Fig. 27: Dreyersdal Farm with the Keysers River to the left and the vlei to the right

Part 5: The Future

The Future:

The leftover *Psoralea fascicularis* cuttings will remain at the nursery to be used in future restoration projects by FynbosLIFE. The cuttings that have been planted in the greenbelts will be monitored throughout the hotter and drier summer months for at least one year in order to both monitor their maturation and ensure their survival. The cuttings will most probably will need some care for at least the first year or two through these regular check-ups. This "care" will largely revolve around a very small amount of watering when absolutely necessary and making sure that they are not all totally destroyed by animals and/or humans – or anything else too for that matter.

This is a break-through in research for the propagation of this species. As I have mentioned before, I have learned a lot from this project and I hope that my research project will be both beneficial to and inspire others as it has with me, ensuring the long-term conservation of this species. Perhaps in the not too distant future *Psoralea fascicularis* can eventually be enjoyed in many gardens across Cape Town, or even elsewhere too.

- *Psoralea fascicularis* cuttings planted on the Grootboschkloof greenbelt

In Hindsight...

First and foremost it would have been ideal to have more time for this project in general, however it was still possible to work around these time constraints. It would also have been slightly more convenient if the vlei rats had chosen to rather not eat some my cuttings. This is not particularly rare in active fynbos restoration, though, and these plants do have to survive in the natural ecosystems. In the wild, the plants would usually regenerate after a fire when the rodent populations have been reduced to some extent – avoiding complete annihilation.

Looking back, it would have been far better to have had a wider range of genetic diversity among the cuttings; for example collecting material not just at Grootboschkloof, but also at Soetvlei and maybe even Lower Tokai Park. Of course harvesting permission would be trickier to get a hold of for these areas, but it would still have been very much possible in the end. Another less important aspect that would have been fun to play around with would have been experimenting with different soils and recording how the *Psoralea fascicularis* cuttings reacted to the different soils, and which one/s they preferred. Still, this is a very minor aspect and probably would not have yielded much in the way of additional research. It would also have been great to experiment in propagating the species from seed, but the timing and duration of the project made this impossible due to the specific flowering season. In addition to this, harvesting the seeds from this species would not be easy and requires either the bagging of flower-heads or daily visits over weeks to ensure that the seed is not lost. Perhaps this can still be done in the near future though. Propagating cuttings is generally more difficult for re-sprouting shrubs and so seeds are still the only way to propagate many of these species. However, in this case the cuttings proved to be very easy and are, in fact, almost certainly far easier to propagate than seeds.

- Fig. 28: (left to right) Zide, Lloyd, and Caitlin in the FynbosLIFE greenhouse

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Details regarding donations to FynbosLIFE or their nursery can be accessed via their website at: https://www.fynboslife.com/support-our-work/

FynbosLIFE
Locally Indigenous Flora Education

FRIENDS OF TOKAI PARK

iNaturalist

- Fig. 29: FynbosLIFE, Friends of Tokai Park, and iNaturalist logos

Glossary

Letters A-K:

active restoration – ecological restoration through direct intervention.
acuminate – tapering off to a point.
acute (of angles) – less than 90°; a sharp point.
adjacent – alongside; next to.
adnate – grown or joined together.
alluvial – soil derived from silt.
androecial column – grouped stamens in a flower.
angelicin – organic compound used in many medications.
ascending (of branches) – first spreading horizontally and then directly upward.
axillary (in botany) – growing on the axil, from the stem.
bakuchiol – chemical compound used in many medications.
banner (of petals) – top petal in a pea flower (also see: standard).
bioactive compound – compound that affects living organisms.
bioactive principles – plant derived compounds that cause reactions in humans and animals.
binomial nomenclature – taxonomic system using two-part names derived from Latin or Greek.
bulbil – small reproductive bulb-like appendage.
calyx-lobes – sepals or "bracts".
Cape Flats Sand Fynbos – vegetation type found on the Cape Flats.
capitate (in botany) – distinct compact head [of flowers].
chemical compound – chemical substance.
companion species – species that grow alongside one another.
conjecture – opinion based on incomplete information.
diffuse – widely spread out.
dredging – process of scooping mud, rubbish, and plant matter from a river.
endangered (of species) – specific conservation status where a species is threatened by extinction.
endemic – occurs in one place only and nowhere else.
fascicled – in a close bundle, tuft, or cluster.
"flag petal" – the banner or standard petals at the top of a pea flower.
GBIF – Global Biodiversity Information Facility.
generic name – genus name; first name preluding the species name (specific epithet).
geo-tag – digital photograph with GPS attached in metadata.
glabrous – devoid of hairs; smooth.
habitat degradation – process of a natural habitat losing its value or richness due to humans.
herbarium – collection of pressed plant specimens.
herbarium determination slip (abb. det. slip) – annotated label on a herbarium specimen containing identification by a specialist.
horticulture – practice of growing plants extensively.
iNaturalist – social network of naturalists, citizen scientists, and biologists.
incurved (of branches) – with an inward curve.
inflorescence – branch consisting of a cluster of flowers.
infraspecific – taxonomic rank below species (e.g. subspecies/subsp.).
in situ – on site; in its natural habitat.
isotype – duplicate of a holotype.
> *HOLOTYPE* – specimen upon which the first published description of the species is based.
keel (of petals) – basal petal situated between the two wing petals in a pea flower.

Letters L-Z (W):

lanceolate – shaped like a lance; narrow oval pointed at both ends.
lanceolate-acuminate – between lanceolate and acuminate in shape.
leaflet (in botany) – the smaller leaf of a divided compound leaf.
loam – soil containing equal parts of sand, silt, and clay.
lowland (of veld) – vegetation types found at lower altitudes.
mandala – geometric configuration of symbols and shapes.
material (in botany) – pieces of a plant gathered for any use.
mode of action – described change of an organism in reaction to a substance.
montane – from the mountain.
myriad – large number.
nitrogen – chemical element also used by plants.
node – the point where leaves, branches, and roots grow out of the stem.
nominotypical – infraspecific name (e.g. subspecies) which is the same as the species name.
ovato-lanceolate – between ovate and lanceolate in shape.
panacea – cure-all for diseases.
pedicels – stem on which a single flower is borne.
perennial (in botany) – living for many years.
petiole – stalk connecting the leaf to the stem.
pharmaceutical activities – the roles of certain medications.
psoralen – light-sensitive drug that absorbs ultraviolet.
psoralen plus ultraviolet rays (abb. 'PUVA') – used in photochemotherapy treatment.
> *PHOTOCHEMOTHERAPY* – treatment method against various skin diseases.
psoralidin – chemical compound found in some *Psoralea* species.
renosterveld – vegetation type found in the south-western Cape.
re-sprouter – shrub that re-sprouts from the base if cut down or burned.
root nodules – nodules found on the roots of some plants.
stamens – pollen-producing organs of a flower.
standard (of petals) – top petal in a pea flower (also see: banner).
stipule – small appendage found at the base of a leaf-stalk.
strandveld – coastal vegetation type found in the south-western Cape.
specific epithet – species name; second name following the generic (genus) name.
subsimple – with few branches.
subspecies (abb. 'subsp.') – taxonomic rank below species (see: infraspecific).
subulate – slender with a tapering point.
subulate-acuminate – slender and tapering off to a point.
suffrutex – dwarfed or small shrub.
suffruticose – with a woody base.
symbiotic – mutually beneficial interaction or relationship between two organisms.
synonym (abb. 'syn.') (in taxonomy) – taxonomic name that is no longer used.
Table Mountain Sandstone – rock type found in the extreme Cape.
taxonomy – study of classifying, naming, and ranking organisms.
terminal leaf – final or tip leaflet in a leaf.
tri-foliate (leaf) – leaf which divides into three parts.
urbanisation – process in which the increase of housing or development takes place.
vermiculite – mineral used in potting soil.
vernacular – common, everyday; not complex.
"volcanoing" – process of piling soil into the shape of a volcano.
wing (of petals) – side petals in a pea flower.

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