

# Refreshed, Revived, Resurrected



Grafted GBalds 2019CDE with a total of 15 flowers in early February 2023. 2019C did not completely stop flowering, but 2019D and 2019E more or less stopped growing by late 2022. After repotting in October–November 2022, they now appear to be revived and growing strongly. See the section on the 2019 grafts for the details.

*The following piece is part of a collection of writings published on the [Practical Small Cacti Malaysia site](#).*

## Refreshed, Revived, and Ummm... Resurrected?

The following is a continuation of the previous chapter – Roots of Stalled Growth – and is focused on outcomes and behaviour. In general, news roots are really good for GBalds, but you should not regard it as a 100% foolproof solution. Other *Gymnocalyciums* may respond in different ways. As for the resurrection thing, we will get to that shortly.

## Nicknames for Scientific Names

PMag = *Parodia magnifica*

PClav = *Parodia claviceps*

GBald = *Gymnocalycium baldianum*

MGeo = *Myrtillocactus geometrizans*

This naming scheme is purely for convenience. Just think of them as webchat nicknames. Other nicknames and additional notes can be found in the appendix to the third chapter.

## Some Specimens Will Still Do Funny Things



I don't think this specimen (GBald graft 2021D) is diseased. This is the second time it is doing this. (February 2023.)

All five of my GBald-on-MGeo grafts from 2021 were growing well as of early February 2023. However, one of the five – 2021D – suddenly started to do the corking thing again in late January 2023. It's not shrinking, but sprouting dark bumpy warts all over (see the above picture). It will go a bit soft, then secrete a corky layer. Of the purchased GBalds scions, this is the specimen that look most unlike a GBald. The lack of spines near the apex reminds me of *Gymnocalycium marsoneri*; perhaps it's a hybrid because my older GBald specimens do not behave quite like this.



Here's what it did in 2022. **Left:** 2021D in late April 2022. Large, slightly raised patches can just be seen. **Right:** The patches have darkened four days later. The skin became slightly softer for a while, but is unbroken: the dark stuff appear to be deposited just under the skin of the specimen. (April 2022)



**Left:** Eight days later, corky deposits are appearing on the dark patches. (May 2022)  
**Right:** 2021D a month later in June 2022. There are now more corky deposits than dark patches. Some normal-looking new growth can be seen. Eventually, all the dark bits would disappear, apparently turning into a corky layer.

2021D appears to be really good at extreme corking, giving us a good look into how a dark-coloured precursor is secreted under the skin (epidermis) of the cactus, followed by its conversion into a corky substance. In the above you can see what it did in mid 2022. On the next page, we will resume looking at the behaviour of the scion in early 2023.



**Left:** A week after the dark and soft bumpy warts thing, mid February 2023. The dark bumps are drying up and turning corky. Some patches are grey surrounded by light brown. It looked like the corking started appearing at the edges of the bumps.

**Right:** 2021D about 4 months later, mid June 2023. The corky stuff is now mostly in shades of brown. There is considerable new growth. Everything looks normal... well, maybe the corking is normal too, part of the repertoire of the specimen.

This behaviour overrides growth prompted by new roots, and may have been triggered by hotter weather due to the end of the monsoon season. I've seen some specimens with patches mainly on the side facing the sun<sup>1</sup>. New growth has always looked normal after such corking episodes.

My GBalds do the corking thing but not the “extreme dark patches” thing, as far as I can tell. There is a lot of translucent waxy stuff secreted and the corky stuff starts off as small brown patches. But one purchased commodity cacti GBald has exhibited more intermediate behaviour, see below.



At left is one of two commodity cacti GBald purchased in 2021 and grown on their own roots. Here it is in late February 2023 joining in with a bit of corking during the same period.

While my own GBalds tend to cork up in shades of brown, this purchased specimen corked up in a dark colour like 2021D. But it produced only scattered patches of corking, and nearly all of it is on the side facing the sun.

<sup>1</sup> A discussion and more pictures can be found at the end of the Complications of Shrinking chapter.

## The Rest of the 2021 GBald Grafts

When I later hunted down the pictures of my 2021 GBald grafts for this chapter, I discovered something new: 2021ABC did not exhibit any corking during this period.



Commodity cacti GBalds 2021ABC when 2021D was corking up in late February 2023. All had been repotted, and these grew steadily without any hint of corking up throughout 2023. The scar-like patches on 2021A (left specimen) are from the previous corking-up episode around mid-2022. On 2021B and 2021C, the corky bits are hardly visible because they have been crowded out by new growth.



Here is GBald grafts 2021DE on the same day. (Feb 2023)



If you looked closely at 2021E in the picture on the previous page, you may have noticed something a little abnormal. Here is a bigger picture – you can see the skin around the areoles have a darker shade of green.

It turned out 2021E also had a reaction to a stressor, probably hot weather. This is visible as darker shades of green around the areoles. The normal colour of the specimen can be seen in between the ribs of the cactus. A few months later, the skin of the GBald in these areas still had dark bits and is a little uneven (see picture on the next page.) So it appears that 2021E experienced a minor episode of extreme corking. Yet GBald grafts 2021ABC behaved very nicely throughout 2023.

The key difference between 2021ABC and 2021DE is the repotting process. 2021ABC had the roots of the MGeo stocks mostly removed (see the previous chapter), while 2021DE were repotted with their old root balls intact (see picture on the next page.) I think the root system of a cactus controls certain behaviours, including how it reacts to certain stressors.



Commodity cacti GBald graft 2021E about 8 months later, late October 2023. There is new growth and an offset on a young areole. There are still dark bits causing the skin around older areoles to look darker and somewhat uneven.



When they were repotted on September 2022, the root balls were undisturbed.



2021ABC about 13 months after repotting. (October 2023)

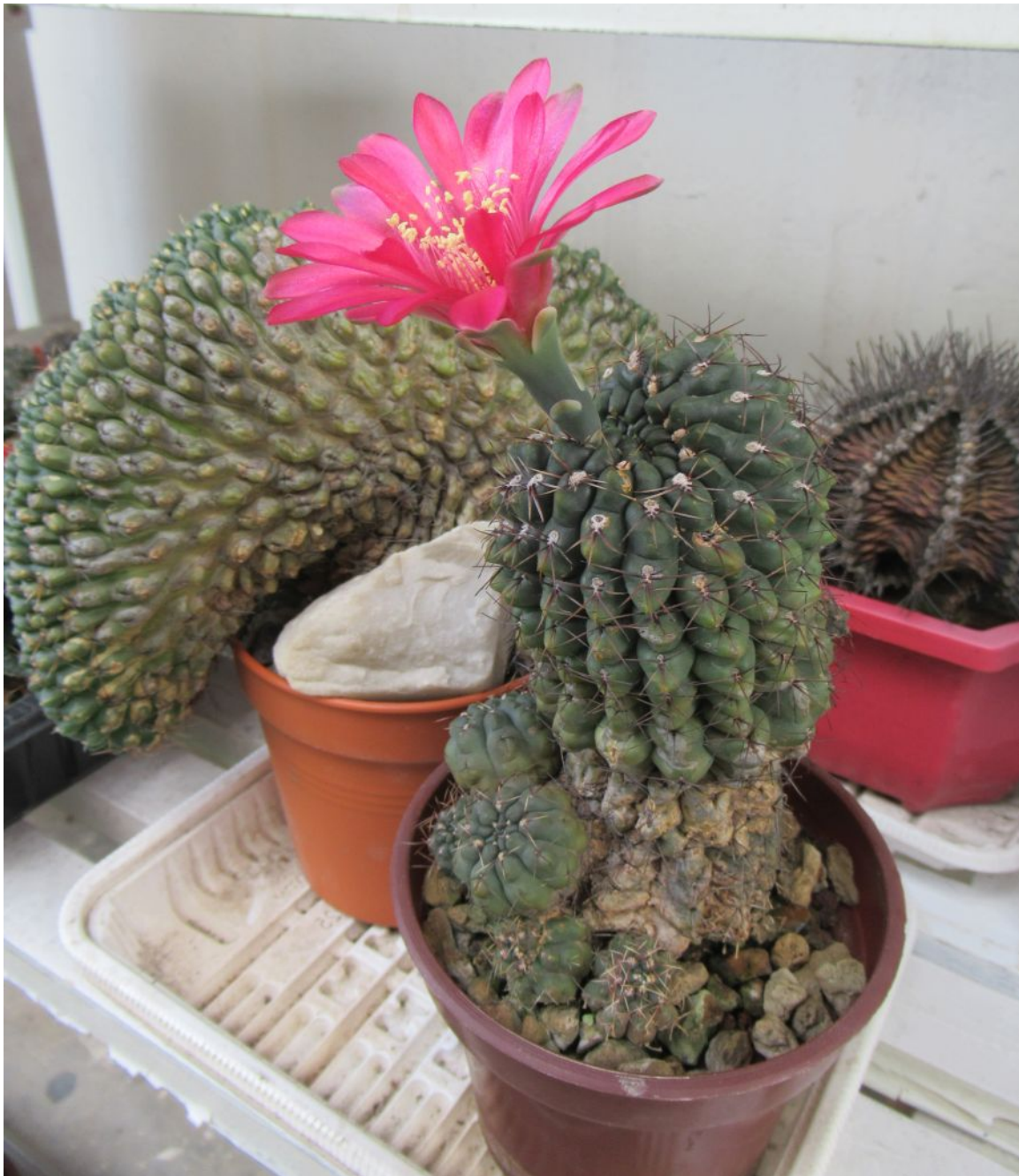


2021DE about 13 months after repotting. 2021D is leaning forward. (October 2023)

Generally, this bunch of grafted commodity cacti GBalds is in good shape. I might decide to repot them after two years, just to keep growth strong. They may not be able to grow much faster, because a couple of the MGeo stocks have sprouted offsets (which I have removed), and I also managed to push 2021E to produce an offset from a young areole. I am pleased that I have a better understanding of how to keep them growing well; maybe some flowers will come in 2024.



## Cactus: Resurrection



Back from the dead. Or it may not have been as dead as I thought it was. Anyway, this is the GBald with many offsets, now looking much better at the end of May 2023. To the left is the crested GBald, which was also revived in the same way and it had just been repotted. To the right is a GSteno horror show (it survived.)

It took about 7½ months for this GBald to go from “nearly dead” to its first flower for more than a year (picture above). No repotting was necessary; all it needed was some new roots.



They looked like this in early October 2022, at the start of the experiment.

Well, after dealing with all the shrinking and corking among GBalds, this is pretty close to a resurrection. It's a miraculous turnaround in 3 months. Another win for new roots, amazing!



Closeup of the offsets. **Left:** After 1 month (November 2022). The offsets have expanded a bit and there is a hint of green. **Right:** In early January 2023, after 3 months of experimentation. Apart from a lack of spines, they look and feel normal.



These two GBalds now look green and feel heavy, after 3 months in usually-wet conditions, early January 2023. *Resurrected in 3 months.*

This is an experiment mentioned in the last chapter. I took the two worst-looking GBald specimens and placed them in a tray with some standing water. The water will evaporate in a few days, and then water is added again. Some of the time they will get fortified water; at other times they got tap water. The dark red offsets of the GBald at right, in particular, felt light and empty – skin and a lot of air. I was certain that the offsets were at death’s door and the main stem was in terminal decline. Without some kind of intervention, it would surely have eventually turned into a dried, dead husk.

This experiment is not without some risk, of course. While the two specimens survived, the threat of fly larvae is always present. But corky roots and a rocky potting mix likely makes the two GBalds harder to kill than small and tender rooted offsets or juvenile plants.

Before, the two pots felt light in the hand. At 3 months, the two GBalds have significantly recovered. The main stems are still slowly returning to their original girth; they have turned green again and looks to be in reasonable health. The pots now feel heavy and the stems are firm to the touch. There is probably a bit of new growth, but without strong spines as yet.

And so, “nearly dead” offsets can actually be revived, if it is connected in some way to new roots and maybe a bigger stem from which it can draw resources. Moist to wet conditions promote the growth of new roots which in turn provides the signal for the offsets to grow. The hormonal signals may also prompt a partial revival of shrunken GBald stems that have not yet turned corky. Thus, nurturing new roots is a powerful tool which can be applied to make your GBalds grow well.



Repotting the GBald in June 2023. The picture is slightly brightened. There are dead roots, wet roots and wet soil, plus mealybugs.

When the GBald was repotted, it turned out the condition of the root system was quite poor, although there were new roots. Growing cacti in a wet potting mix is risky, no question about it. If I was unlucky, it would have rotted from bottoms up.



Just before potting up, after about a week of resting. (June 2023)



The crested GBald and the GBald with many pups in August 2023, both now repotted. There are a couple of *Zephyranthes* bulbs in the pot as companion plants – Zephys are supposed to be toxic and my Zephy flower beds are never damaged by insects. It's an experiment to use the bulbs to help keep mealybugs away.

Cultivating GBalds in wet conditions is like growing them in rich soil. It's risky, so don't be surprised if you end up killing one or two specimens. Older GBalds with shrunken and corky lower stems are tougher than specimens with soft young stems, so it's a calculated risk to conduct this experiment to revive these two GBalds.

I think the major risk factor with growing cacti in wet potting mixes is bugs in the soil, be it mealybugs or fly larvae. If you can minimize risk from bugs in the soil, I think GBalds have no problems with wet, rich soil. Wet-dry cycling of the potting mix may be beneficial too, see:

Cristiano *et al.* (2016). Propagation Techniques and Agronomic Requirements for the Cultivation of Barbados Aloe (*Aloe vera* (L.) Burm. F.) – A Review. **Frontiers in Plant Science**. 7. 1-14.

This Open Access paper mentions a technique of resting *Aloe vera* suckers to promote root suberization. So even if you want to experiment with wet cultivation of cacti, some dry periods may help strengthen the root system.

## Reviving GBald-on-MGeo Graft 2019D



GBald-on-MGeo 2019D in early February 2023, revived, with 8 flowers partially open due to cloudy and cool weather. This was the day after the front page picture. Note the fat stem of the MGeo stock, rebounded from a shrunken state.

Two GBald-on-MGeo grafts (2019D and 2019E) which had stalled responded with a large flush of flowers a few months after repotting and having their roots trimmed. Unlike 2019E, 2019D did not completely stop growth, but it was down to about one flower per month from August to November 2022. It was potted up in early November 2022, so the big flush of flowers in the picture above came after about 3 months, along with strong renewed growth.



**Left:** The MGeo stock of 2019D starting to shrink, August 2021. Note the misshapen GBald stem, caused by a black patch of fungi; beetles worsened the damage.  
**Middle:** Looks can be misleading. Here is 2019D with 7 flowers in April 2022. The GBald scion still looks great, but the MGeo stock has been steadily shrinking.  
**Right:** In June 2022, 2019D had its last good display. The stock is shrunken. After these flowers, it slowed to about 2 flowers per month, then to one flower per month. The damaged side of the GBald's stem caused it to grow at an angle. The damaged area now has a nice, dark crevice – this will cause big problems later.

The flowers of 2019D were mesmerizing, or rather, misleading through no fault of their own. The flowers overwhelmed any concerns that I had over the health of the GBald scion. By studying my picture archive, I can now see that the MGeo stock started to shrink around August 2021, nearly 2½ years after it was grafted. But flower production was still strong for another year before the growth of scion finally slowed down to a crawl in August 2022.

It's interesting to see that there appears to be two phases to the decline of the GBald scion. So the stock's shrinking action may be an early warning signal of *something*. In my microclimate, 3½ years may be the limit for a GBald-on-MGeo graft grown in a pot.

There was a surprise in store when I repotted 2019D in early November 2022 (see the pictures on the next page.) The specimen did not have a matted root ball and it didn't look pot-bound to me. The root system appears to be in good condition. Yet the specimen did all the shrinking and slowing down. So you see, I think it was a good idea not to automatically blame the crisis on specimens being pot-bound. I'm now more than a little suspicious of old and mature roots: There is a possibility that these roots may be signalling the topside stem to behave in certain ways that is not compatible with what we want the cactus to do.



GBald-on-MGeo graft 2019D out of its pot in early November 2022. It doesn't really look pot-bound to me. The picture has been slightly brightened.



Closeup of the root system of the MGeo stock after some soil and pumice had been removed. The picture has been slightly brightened. (November 2022)

GBalds just don't want to live long, while PMag and PClav are long-lived and relatively crisis-free. To get long-lived GBalds, we must control their self-destruct mechanisms.





2019D three days later, just before potting up in November 2022. The upper part of the GBald's stem is wet probably because it needed cleaning – in the tropics some kind of webbing can develop after a day or two if the weather is wet. There is now a large patch of white acrylic paint to stop beetles from getting to the black fungi patches – this was added in September and October 2022.



**Left:** Continuing with one flower, early December 2022.  
**Right:** Two flowers were produced at the end of December 2022. The MGeo stock (not visible) has also started to fatten up again.

It turned out that a GBald stem that had been susceptible to black patches of fungi is weak, and it doesn't suddenly recover and turn into a strong, healthy stem. I had seen some sort of scarring at the crevice of the stem (see pictures below) but suddenly in early January 2023 it started spreading and felt soft. While the MGeo stock has fattened a lot, the GBald scion is now in a life-or-death crisis.

The soft brown area looked like Death – moist Death. It may have been some kind of fungi or bacteria, and it kept spreading at a steady pace. For a couple of weeks, I figured that I should let nature take its course. I could tackle dry black fungi patches, but a wet mass of dead cactus tissue seemed like something *very* incurable.

At some point in late February 2023, I decided that since 2019D is as good as dead, I should just try something. By now the brown stuff had grown larger – it looked very, very ugly. Common sense says that the scion will die; throw common sense out of the window. And so I applied a thick coat of white acrylic art paint on the entire mass of dead or dying brown tissue, in order to seal everything off.



**Left:** The soft brown area at the crevice of the GBald stem starting to spread in early January 2023. **Right:** GBald 2019D posing for a picture in late February 2023 after white acrylic paint was liberally spread all over the soft brown area.

And it worked. GBald 2019D didn't die. I had to apply more acrylic paint at least two more times, but the GBald held on. I'll discuss it in detail in a future chapter, but I suspect shutting off gas exchange to the brown mass helped. Overall, the GBald scion didn't slow down much. In fact, it had produced 8 flowers – as seen in the beginning of this section – in early February 2023 with a large patch of damage on its stem (see picture on the next page.)



2021D with seven flowers plus a heavily-damaged stem, early February 2023.

It's quite remarkable how much damage a GBald stem can sustain and still survive – if we help it out a little. Acrylic paint has been very useful to me, and I now see it as an essential tool for stopping fungi from spreading. My GBalds would of course look better if I used green acrylic paint, but it's easier to conduct studies if the paint can be easily differentiated from the cactus stem. If you have old and juicy GBald stems like me, you'd need all your ingenuity and guile<sup>2</sup> to keep them alive.

---

<sup>2</sup> When all appears lost, think of a cunning plan.



GBald-on-MGeo graft 2019D with 10 flowers in early October 2023. The flowers were only half-open because it was a cool and cloudy day.

For the rest of 2023, GBald 2019D plodded on. It does not perform at its peak every month, rather it produces fewer flowers on average and there is more variability. That's not a surprise, since it had suffered considerable damage. But on occasion, it can still put on a really good show, such as having 10 flowers simultaneously open (picture above) and a total of 12 flowers in that flush.

More valuable than flowers is the experience gained in keeping the GBald scion alive. I don't expect my GBalds to live forever, but I am very interested in learning how to keep them healthy and productive.

## Reviving GBald-on-MGeo Graft 2019E



GBald-on-MGeo 2019E with two flowers on Christmas Day, December 2022. This GBald scion also had a large black patch of fungi that attracted beetles, hence the acrylic paint job.

Before it was repotted in early November 2022, 2019E produced its last flower at the end of June 2022. For 4 months, growth had all but stopped. We will now take a look at how this specimen responded to repotting.



This is why I had to cover up the black patches of fungi. This beetle (blue arrow) and others kept making tunnels in the dried-out black patch areas. The beetles were easy to squash because they were slow to jump away. (March 2022)



A closeup of 2019E just before it was repotted, late October 2023. Due to the many black patches and the poor colour of the stem as a whole, I would regard this GBald scion as weakened.

Since it is also a fat and juicy stem, I wouldn't be too surprised if it succumbed to an aggressive fungi attack at some point. At the lower right corner is 2019F, which is in a somewhat similar predicament.



The root ball of 2019E, late October 2022. 2019F is in the background.



The root system of 2019E after removal of the soil mix, late October 2022. 2019F is in the background and it had even less roots.

When the specimen was removed from its pot at the end of October 2022, the root ball did not have a mat of roots (like many PMag or PClav root balls) and the roots did not appear jammed up. Like 2019D, it did not appear to be pot-bound. 2019F which was repotted at the same time as 2019E had even less roots. Yet for some reason they all went into a sort of nose-dive after mid-2022.



Resting on a plastic pot saucer five days later, early November 2022. 2019E has a larger root system than 2019F. Both root systems do not look like normal MGeo root systems because of the GBald scions' hormonal influence.



Potting up 2019E and 2019F two days later. 2019F is shown in the picture. A few Zephy bulbs were added to both pots as an experiment to test whether Zephy bulbs can act as a mealybugs repellent. (November 2022)



About seven weeks after repotting, 2019E produced two flowers in late December 2022. The next flush of flowers was a big one – a total of seven in early February 2023, as seen on the front page.

2019E sprouting flower buds around mid-January 2023. Note the dark green parts of the stem associated with the flower buds – those parts are growing or getting healthier. The lower stem however, still sports a lighter green colour and does not really look all that healthy.

The scion has a big problem: Beetles have worsened damage caused by the black patches and the GBald's growing point at the apex has been damaged. As such, it will have to sprout offsets from somewhere.



GBald-on-MGeo graft 2019E about 2 weeks later, at the beginning of February 2023.

Like 2019D, this GBald responded well to repotting. While both root systems did not appear to be truly pot-bound, repotting changed the root systems enough to restart growth and flower production.

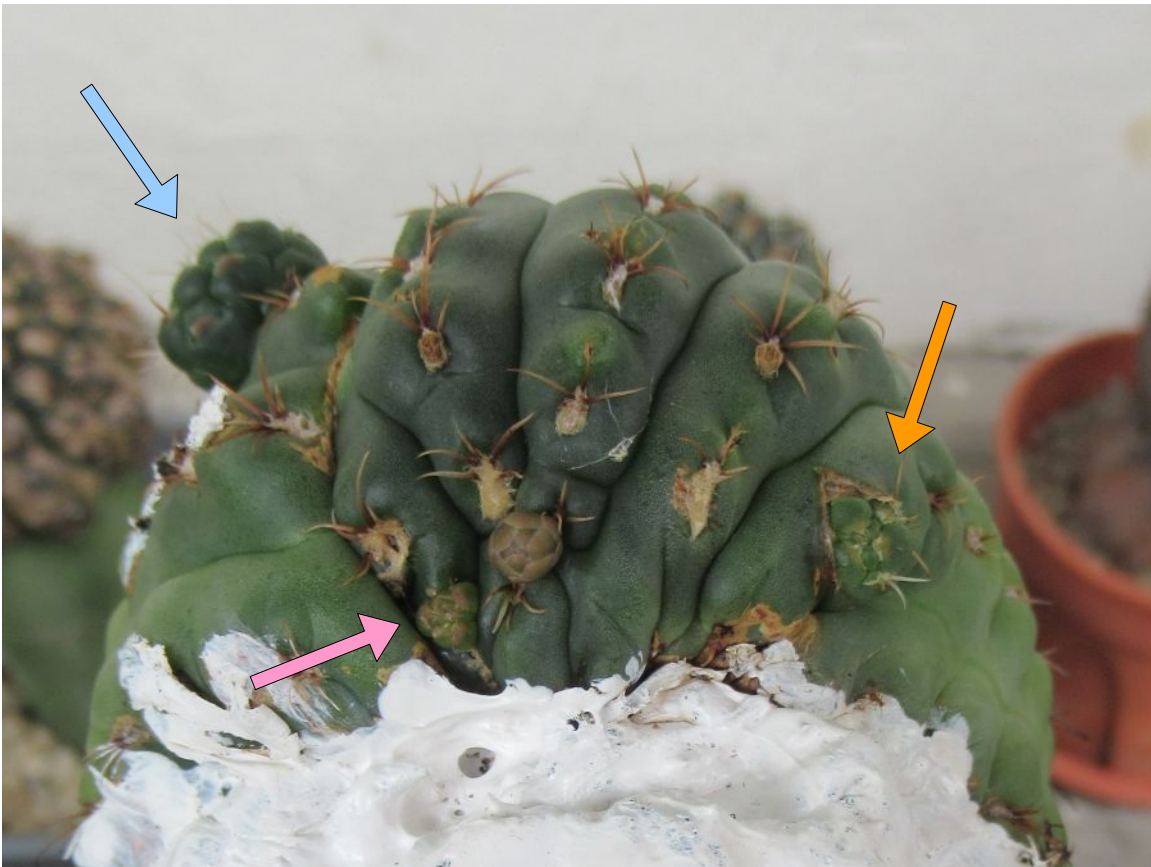


**Left:** 2019E with 4 flowers in March 2023. The healthy side of the stem has grown higher than the damaged side. **Right:** About a week later, a weird-looking offset was detected (blue arrow). This offset is sporting scales reminiscent of a GBald flower bud. The bits of white paint on the dark green part of the stem were originally close together; they were spread out by the growth of the healthy portion of the upper stem. (March 2023)

After the flush of 7 flowers in February, the damaged stem of 2019E still tried to grow its apex area, but it did not have a proper growing point anymore. The GBald produced 4 flowers in March 2023, and then it transitioned to producing offsets near the apex area.

This GBald scion did not suddenly switch over to producing offsets. Instead, the offsets had some soft scales so they looked a bit like flower buds in the beginning. As they grew larger, they started growing more normal areoles and looked more like a normal offset. Flower buds that sprouted around this time were all aborted. There were three offsets in total, and you can see their development on the next page.

Since GBalds are slow CAM plants, it turns out that transitioning from producing flowers to producing offsets is slow, and during the transition period, intermediate forms can appear. All of this may be due to hormonal signals that do not change very fast.



Closeup of 2019E's apex area at the end of March 2023. The first offset (blue arrow) grew very fast and it now looks like a proper offset with areoles and spines. A second offset (orange arrow) has erupted from another areole, growing so fast that it's tearing the skin of the stem. Finally, a third weird-looking offset (pink arrow) can just be seen. The normal-looking flower bud near the centre would later be aborted.



The three offsets of 2019E in mid-April 2023. Initial growth speed was very fast.



After the initial burst of growth, the oldest offset started sprouting flower buds. This led to a total of 5 flowers for 2019E in May 2023. Small offsets near the base of a GBald stem are normally incapable of producing flowers, but this offset is near the apex and is experiencing different signals.



The offsets' flowering capability mostly disappeared after that burst of 5 flowers in May 2023, but the specimen still managed a total of 3 flowers from June to November 2023. Here is 2019E with one flower each on two offsets at the end of July 2023.

In general, 2019E is a large stem and it still has considerable resources. However, resources do not automatically translate into growth and flowers. The behaviour of the GBald scion (and the MGeo stock) depends a lot on hormonal signals.

First, the specimen ground to a halt. Then it started growing again after being repotted. Root system signalling is to blame for that. Next, due to a damaged growing point, it could not continue to grow its apex. The loss of the growing point means loss of apical dominance – normally the growing point inhibits or stops areoles further down from sprouting offsets. So the GBald now sprouted offsets, but they initially looked like a mashup of a normal offset and a flower bud. The intermediate character of the offsets may have been caused by hormonal signals changing too slowly – perhaps a new “make offset” signal adding to an older “make flower” signal that hasn't been metabolized yet.

Since there were still signals pushing for flower bud production, there was a burst of flowers from the largest offset. Signalling for flowers then tapered off, so only three more flowers were produced in the following months. 2019E has not produced a flower since August 2023. Most likely, the growing points of the three offsets are geared towards stem growth, so the specimen is not getting any more signals for flower production.

For now, I think there is nothing that I can do except to let the three offsets grow until they transition from a juvenile stem to a mature stem. Then it may be possible to get flowers on more than one stem of the now multi-headed grafted GBald, 2019E.

## Root Systems, Hormones, and Climate Complications

After reviving many GBald specimens by repotting them, I now prefer to de-emphasize “pot-bound” when dealing with stalled growth among GBalds. Even for PMags and PClavs that end up with thickly-matted root balls, it is better for me to think about root system health. Thus:

**Keep the root system of the cactus running in a suitable way, and the root system will in turn keep the stem growing. It’s about sending the correct signals to the stem apex.**

In practice, this means keeping an eye on how your GBalds are faring, and repotting them every 2 years to 3 years. But you can always break the rules set by such recipes, if you understand that the focus is on the root systems of C&S and not the pot that they are in.



A few GBalds posing for a picture, mid-February 2021. Enjoy the flowers, but don't forget to collect all kinds of visual data. Often, one can learn a lot when things go wrong and you engage in some problem solving.



GBald-on-MGeo grafts 2019BCD in bloom, November 2023. With a better understanding of how GBalds behave, we can keep them going for a long time. In the upper-left corner, the old GBald ex-graft is being subjected to a new experiment.

All of this was accomplished without any added horticultural hormones, and generally no fungicides or pesticides were used. I substituted acrylic paint in place of fungicides, while the mild mosquito spray that I normally use was ineffectual against the beetles. If we understand what is going on with our C&S, it's possible to keep them productive and healthy without high-tech solutions.

In their natural habitat in South America, GBalds experience a climate that has two phases. It's cold and dry around the middle of the year. In the other half of the year, it's warmer and wetter. GBalds in their natural habitat gets this cold-dry and warm-wet cycle each year. This cycling may be just what the root systems of GBalds need (or expect): each year some roots die and some new roots appear. That may be important to maintain normal behaviour for the topside stem of the GBald.

In Klang Valley, Malaysia, the annual weather cycle that GBalds are used to has been short-circuited. The grower also helps, by trying to keep the cactus in its growing phase throughout the year. But it's not like growers like me have much of a choice – it's impossible to give them the “cold and dry” treatment because it's hot, humid and rainy for most of the year. The microclimate is also probably a little hot for GBalds. In addition, heat waves may strike in urban Klang Valley at any time.

It's no surprise that my GBalds are more than a little messed up. But in recent years, I have made a lot of progress in understanding PMags, PClavs and GBalds and for the most part, I am in a much better position to maintain healthy and productive specimens for many years. ♦

## Version Information

This is the December 2023 Edition of this document.

Every released PDF can be found at: <https://www.mysmallcacti.net/>

## Author & Copyright

This work is licensed by **slime\_mold\_b** under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License.

Here is a human-readable summary of the license:

<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Here is the actual legalese:

<https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode>

**Note that the CC license does not restrict your Fair Use rights.** The key rules (Attribution-NonCommercial-NoDerivatives) is somewhat similar in spirit to the case where an out-of-print work is put on the Internet for everyone to read by an author who holds copyright over the material. It is meant to preserve the integrity of the work in its intended form. You can freely read it, print it out, criticize it, discuss it, etc. However, copying the material and claiming it as your own work would be a violation of the license. Extracting pictures and using them for a website with monetary return would also violate the license.

## Colophon

Written on LibreOffice. Most images were produced using GIMP and IrfanView. PDF tested using SumatraPDF. Fonts used include Liberation Serif, Arimo and Liberation Mono. The document is sized for A4 or Letter printing with enough whitespace for comfortable reading.

All pictures used to produce the images in the document were taken by the author unless otherwise stated. Images are not meant to be of art print quality. The pictures were taken by unsteady hands without a tripod, then they are cut or resized and finally resampled to about 150 DPI and a JPEG quality of 80 for screen reading and also to keep file sizes manageable.