Growing Orchids 2 - About Epiphytic Orchids and their Journey (v3) by Jim Brydie

Did you suspect when reading last month's article on soils that it might lead to a discussion on Epiphytes? What better way to explain epiphytes than to explain soil growing plants to provide a background against which epiphytes might be contrasted.

Will all this background really help me learn to grow Epiphytes ?

I have to say yes, ultimately, but I want to change the way you think about learning to grow orchids and to do that I want you to see them first as plants and I have decided to split the topic into a few segments.

My end aim is to steer growers into how to assess each orchid in front of them, and to decide what kind of a grower it is and how they should treat it. For that you will need to know what kind of potting medium you will choose from your bag of tricks, how much light to give the orchid, and how often it might need water and fertiliser. I don't want you to copy some culture procedure given to you by someone else, like following a cake recipe. You should decide yourself, plant by plant, what you are going to do. And that is the same for both epiphytes or soil grown plants.

To be able to do that you need to reach a better understanding of the 'why' for each plant. Knowing the 'WHY' is an integral part of deciding the 'WHAT'. I will get to the practical explanation of potting mixes and growing types in the end, but I hope you can have the patience to follow the process with me.

Evolution of Epiphytes - So what is it that is different about epiphytes? If it is more difficult to grow as they grow, why don't they grow in the soil as other plants do?

The answer is that all orchids were soil growing plants originally, and many still are today, but once plants began to dominate the Earths land surfaces all sorts of other life forms evolved alongside to take advantage. Leaf eaters arise (insects and animals), and new kinds of plants arise to compete with one another. Faced with the pressures of competition for space and prime positions to grow and thrive, evolution creates an increasing development of more and more competitive plants and animals to dominate prime places or to adapt to establish life in new places. Orchids weren't the only ones but plants developed the ability to grow as epiphytes.

So how long ago did plants develop this ability? And for that matter, when did plants start to occupy the land and create that competition that led to epiphytes.

Last month in his presentation on the Atmosphere, Dennys mentioned an wonderful ABC Australia television series called "Earth". It gives an excellent interpretation of the development of our planet and life on the planet. Not all scientists agree on every tiddly aspect of every publication but I have watched Earth and really enjoyed it. As Dennys mentions in his Desk section this month, episode 3 talks about the development of plants and their eventual colonisation of the land. I also recommend your taking the time to check it out.

But as a forerunner, I offer this fascinating but abbreviated Earth time chart from New Scientist to give a time sense of the major stages for the development of plants on the land, and orchids in the trees.

1. Earth forms about 4.5 billion years ago but soon afterwards it is struck by a Mars-sized body dubbed Theia, which vaporises Earth's surface and blasts it into space. This ejected material condenses to form the Moon.
2. Massive bodies continue to strike the Earth, at a declining rate, for the next 1.5 billion years, ending about 3 billion years ago. The impacts reshape the planet surface and may help drive the onset of plate tectonics.
3. Around 4.2 billion years ago the first large oceans may have formed These primordial seas may have been much deeper than today, leaving little or no exposed land.
4. The oldest agreed fossils of single-celled organisms on Earth come from Pilbara in Western Australia, and date to 3.5 billion years ago. They may have lived in freshwater hot springs in a volcanic region on land. The ecosystem is complex and thriving, suggesting life is already well-established. (JB: even today you can go to see living stromatolites in the waters of Shark Bay in Western Australia – it is amazing to see them)
5. By 3.4 billion years ago, Some bacteria are performing photosynthesis: they take in sunlight and carbon dioxide, and obtain energy. However, this is not photosynthesis as we know it today because the bacteria do not release oxygen as a waste product. This anoxygenic photosynthesis remains common for a billion years.
6. By 3.2 billon years ago Fossil microorganisms preserved in rocks from South Africa offer undisputed evidence of life on land.
7. Around 2.5 to 2.2 billion years ago - ***The Great Oxidation Event***. Some cyanobacteria evolve a new form of photosynthesis that releases oxygen. This toxic waste starts to build up in the seas and atmosphere – though concentrations remain below modern levels for over another billion years.
    a. Dissolved oxygen makes the iron in the oceans "rust" and sink to the seafloor, forming striking banded iron formations. Oxygenic photosynthesis may well have evolved earlier, but the resulting oxygen was initially confined to small "oases".
    b. Once oxygen becomes widespread, it may have cause a mass extinction among microbes that are unable to cope with it. It also drives evolutionary innovations. Today almost all animals breathe it.

8. 2.3 billion years ago Earth freezes over in what may have been the first “snowball Earth”, possibly as a result of a lack of volcanic activity.
9. 2.1 billion years and simple multicellular organisms have evolved and are moving.
10. 890 million years ago the first recognisable simple ‘animals’ have evolved.
11. Perhaps 700 million years ago the Earth freezes over again
12. 539 million years ago we have the Cambrian explosion involving massive and rapid evolution and the first ‘animals’ with a true backbone have evolved.
13. 515 million years ago, plants begin to colonise the land. This is believed to have only occurred by a cooperative relationship with other micro-organisms. (Perhaps fungi. Micro fungi may have had the ability to harvest minerals from rock molecules.) *JB : Remember – no plants, no animals = no soils – just mineral sediments.*
14. 410 million years ago plants with elaborate root systems evolve and a few million years later on, plants with woody stems evolve.
15. 125 million years ago flowering plants come into being. (This is the group from which the orchids evolve).

***Back to JB again* :** Can you see how quickly the plant story accelerated once it found a way to colonise the land. AND, that momentous leap forward was only 515 million years ago. At least 3 Billion years after we know life existed.

Once they got going, land plants still took 100 million years to develop woody plants (ie trees and shrubs) and then another 285 million years before plants developed what we know today as the flowering plants (the Angiosperms). That is, bisexual flowers with anthers and stigmas. Before that we had grass like plants, and trees more like the ferns and the pines. Ferns propagating by spores that need water to combine, and in the case of pine trees by separate male and female flower bodies and where the dust like pollen is distributed by wind.

Orchids are an even further evolution of flowering plants, with modification of the flower to combine male and female parts in one organ – the column. The actual beginning date for orchids is not quite agreed but it is perhaps 112 million years ago. At this stage however, the orchids are not what you might recognise today and are all terrestrial growers (in soil). The evolution among orchids to lump pollen grains together in a sticky ball (pollinia) was even later and occurred about 65 million years ago. The orchids still didn’t take to the trees as epiphytes until about only 55 or 35 million years ago depending on who you ask. 35 or 55 million years sounds like a long time but it is about ten minutes in the scale of Earth’s history.

The beginnings for Epiphytes

In an article by researchers at Pen State University in the USA, they compared the DNA sequences of 1,450 genes from 610 orchid species, and showed that “epiphytism” — the ability of orchids to grow on other plants — evolved at least 14 separate times. So it took a while to take a strong hold as a growth style.

Curiously, there is still debate about whether epiphytism arose from competition for light, or from the changes that had already occurred to allow plants to survive in dryer environments. It seems to me that it may well have been the combination of both of those pressures.

So what exactly did plants change in able to live an epiphytic lifestyle?

I have discussed the specifics in previous bulletin articles, the most recent just last June (ie 6/23) in an article titled Orchid Epiphytes are Different, so in all conscience I can’t redo it all again here, but to summarise, being an epiphyte needed multiple key changes including :

1. Roots that will hold onto a surface, assist fast water take up, and insulate roots when in dry air.
2. A metabolism process that will work in a dryer environment (a form of photosynthesis called Crassulacean Acid Metabolism, or CAM) – Essentially, this splits the photosynthesis process so that the intake of carbon dioxide and exhale of oxygen occurs at night while the processing of the carbon dioxide occurs in the day via sunlight. To know more check out wikipedia at : https://en.wikipedia.org/wiki/Crassulacean_acid_metabolism
3. Changes to leaf structures, especially where the epiphyte was to grow in a dry airy environment. This includes changes to stomata (pores that open to allow intake of carbon dioxide and exhale of oxygen, but also can close to reduce moisture loss). But also changes to leaf structures such as the creation of fleshy, waxy covered leaves that reduce evaporation.

Many of those physical differences already existed when orchids took to the trees. Changes to leaves, stomata, and metabolism were already being used by soil growing plants adapting to growing in dry environments. Non orchids like succulents, bromeliads, cacti and many others had tough thick leaves and reduced transpiration mechanisms. CAM metabolism was also common in succulents.

In addition, the concept of Velamen, the layer of dead cells on the outside of orchid epiphyte roots, which is the reason they look white when dry, had evolved long before orchids became epiphytes. Most terrestrial orchid roots have velamen and so do many other non-epiphytic, non-orchid plant species. However, the velamen characteristic is pretty much (but not fully) restricted to the Monocotyledon plant families.

To explain, as you probably already know, a seed comes with a store of nutrients to support the initial growth of the embryo in the seed when the seed begins to grow. But the food store in the seed is of no purpose without a baby to use it up to grow. Therefore the seed also comes with the embryo of the growth that will become its first shoot and leaf.

The monocotyledons (abbreviated to 'Monocots'), covers about 70,000 species and are the non woody plants like grasses, lillies, and many others including the orchids. They represent about a quarter of all flowering plants. Monocots have a single embryonic seed leaf. The Dicotyledons (Dicots') have a shoot with two seed leaves.

Now, getting back to the orchids, the evolution to create an epiphyte wasn't such a huge jump. The necessary genetic facilities in plants had already been pretty much invented. They just needed to be combined and deployed in a way that would work effectively and enable an advantage to a pioneer epiphyte. Curious genetic changes pop up all the time but unless the change provides some advantage, like enabling a plant to grow better or at least better than others around them, or to grow where others weren't able to survive, the change dies out and disappears.

All the orchids needed to do was improve on the velamen that already existed, probably at first by just having more layers of dead cells (to create a thicker water absorbing sponge and better insulation), and to create a simple mechanism allowing root cells to cling to a surface. Once that was practical, the epiphyte era was underway with further improvements and more specialist adaptions to follow.

I have decided to break the story at this point. The next episode is titled "Home Culture of Epiphytic Orchids - Introduction and Principles".
