Cycads

Ancient Gymnosperms

Recently I walked through bushland with a large population of *Macrozamia communis*. The Jurassic-like understorey inspired me to write this article. *Macrozamia communis* belongs to a group of plants known as **cycads,** a truly remarkable group of plants. From ancient origins to modern day chemical factories, cycads have a lot of stories to tell.

A grove of *Macrozamia communis*. Photo: Hayden Wardell

In spite of their appearance, cycads are **NOT** *palms*, nor are they closely related. They are *gymnosperm*s and are more closely related to *conifers* than to flowering plants. They are slow growing, and once mature, produce male and female cones but on separate plants; they are *dioecious*. As plants with ancient origins, they are known as *living fossils*, however this term is a little problematic, I'll explain later. The earliest fossil record is indeed around 280 million years ago, even older than dinosaurs! And to survive depredation by dinosaurs, good defences were essential, so many cycads still retain defensive traits such as an abundance of gnarly spines on leaves and cones.

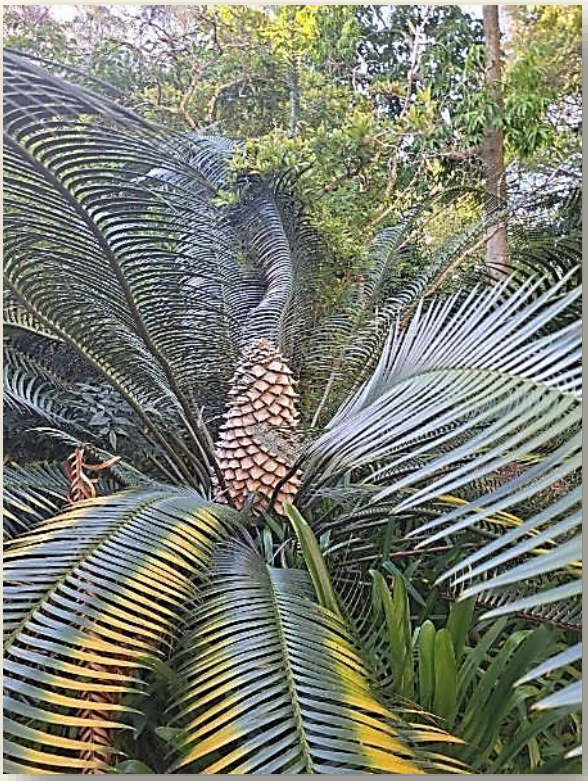
Encephalartos horridus is an extreme example of defensive spines on cycads.
Photo: Flavio Agrosi

Cycads also produce some extremely potent toxins. Colonies of *cyanobacteria* (blue-green algae) live in specialised root structures called coralloid roots, that lie at, or close to, the soil surface. The cyanobacteria have a symbiotic relationship with the host plant and fix nitrogen for the cycad in return for sugars. Thus, they are the only gymnosperm known to form a symbiosis capable of fixing nitrogen! However, cyanobacteria also produce a neurotoxin, an amino acid known as BMAA, (beta-N-methylamino-L-alanine), which is distributed throughout the cycad. This toxin has been linked to some neurodegenerative diseases in humans when released from *blue-green* algal blooms in our waterways.

Some cycad species, such as *Cycas panzhihuaensis* from south-western China, have acquired genes from microbial organisms through a fascinating process known as *horizontal gene transfer*, in which genes from the bacterium *Pseudomonas fluorescens* encode the production of an insecticidal toxin known as ‘fitD’. This *direct toxicity* mechanism contrasts with another toxin from the bacterium *Photorhabdus*, known by the creative name, *Make caterpillars floppy* or ‘Mcf’ toxin. Mcf toxin works by enabling *Escherichia coli* bacteria to persist within caterpillars, with the infection overwhelming and killing the insect. Just when you thought it couldn’t get worse for any would-be cycad munchers!

Cycads are often referred to as *living fossils* probably through association with the heyday of the age of dinosaurs ~ 199.6 to 65.5 million years ago. Unsurprisingly, the diversity of cycads decreased over time because they were outcompeted by the more successful flowering plants (angiosperms), leaving our modern-day cycad species as little more than relicts. However, phylogenies are rarely simply resolved: in 2011 botanist Nathalie Nagalingam and colleagues

published a paper detailing how most present-day cycad species are **actually** very young and most extant species diversified recently within the past ~12 million years. Strangely, worldwide, the new species appeared at about the same time, coinciding with a shift to a generally cooler, seasonal climate.



Some native species, such as *Macrozamia communis* and *Lepidozamia peroffskyana*, can be found on campus. This piece is but a slice of the amazing world of cycads. I hope this article has inspired an appreciation for these curious and precious local plants.

Lepidozamia peroffskyana with a large female cone on Macquarie University campus.
Photo: Hayden Wardell

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