

## **Carboniferous Fact File**

### **Cycad**

We take a huge step forwards with the cycads; these were the first plants to have seeds and disperse them to form new plants, rather than messing around with separate gametophyte plants, mobile gametes, spores and all the rest. They also had advanced leaves, amazing vascular systems and came to dominate the land for millions of years before other plants superseded them. The dinosaurs grazed happily on them, and they are still a staple food for many people across the world (provided that they are treated to remove the toxins that some of them contain).

### **Adaptations to a tropical life**

Cycads look a bit like a fern on top of a palm tree trunk. They have compound, frond-like leaves that grow in a crown at the top of a trunk. The new leaves slowly uncurl from a scale-covered 'crosier', and old leaves drop off from lower down the trunk to leave their leaf bases behind. These weather and become fibrous; the trunk is actually a slender stem enclosed by the remains of years and years worth of weathered leaf bases, which help to support the crown. They need this because cycads have not yet evolved to the stage where they have woody tissue to give their stems support; much of the stem is filled with a starchy storage material which acts as an emergency food store in hard times. Their roots are fairly advanced too; some species have roots that contain millions of cyanobacteria in nodules close to the surface. These bacteria are able to 'fix' nitrogen from the atmosphere into more useful molecules and so provide their host with extra food and nutrients in return for a comfortable home. This may have helped cycads grow in nutrient-poor soil and so have an advantage over almost all other plants. Other species (and nearly all baby cycads) have contractile roots – as the root dries out, it shrinks and draws the growing tip of the plant underground. This helps to prevent it being food for a grazing animal as well as protecting it from drought and fires. Both of these features are adaptations to a tropical environment; at this time, much of the landmasses had entered into a long hot tropical era that suited the cycads nicely.

### **Reproductive advances**

When it came to making more cycads, these plants showed a fair amount of sophistication too. Cycads are either male or female – no plant carries both male and female parts. Male plants grow cones (strobili) that are long, thin and hang down from their crowns. Female plants have thick, short strobili that stick up high out of their leafy crown. This means, of course, that gametes have to travel from one plant to another – which is good in terms of mixing the genes up, but requires a cycad to come up with some way of doing this. It used to be thought that cycads were wind-pollinated, but recent observations have shown that they have begun the process of co-evolving relationships with certain flies and beetles. The cycad emits pheromones very like those used by the insects to attract mates; at the same time it raises the temperature of the strobili to highlight it to flying bugs.

The gametophyte generation has been reduced entirely to pollen grains in the male plants, and these are carried by the weevils, beetles and flies to female plants. Here the pollen is brushed off onto the scales of the female strobilus (these are again specialised leaves containing and protecting the female eggs (female gametophyte generation)). In front of the egg itself there is a special chamber that the pollen grain falls into. And here is another advanced feature – the pollen grain (it's a gametophyte plant remember) germinates and then begins to dissolve its way through the protective layers around the egg. It reaches the egg eventually and the nuclei fuse to produce a new cycad embryo. And so in cycads, not only has the gametophyte generation been totally dispensed with as a free living plant in its own right, but the female gametophyte is never shed at all; it remains within the sporophyte plant where it is protected, fed and eventually fertilised.

The protective layers around the egg are part of the specialised leaves rather than an ovary surrounding the egg (hence they are classed as ‘naked eggs’) and they thicken slightly after fertilisation to produce ‘seeds’. These are kept in the cone for a while, and then generally removed by animals – rodents, bats, and birds – to be spread far and wide, away from their parent.

No wonder the cycads ruled the plant kingdom for so long.