

POLLINATION AND FERTILISATION IN THE MAIDENHAIR TREE *GINKGO BILOBA*

BRIAN MOLLOY & BILL SYKES
Landcare Research, PO Box 69, Lincoln

Neil O'Brien (1993) turns the spotlight on to one of the most distinctive trees in existence, *Ginkgo biloba*, truly a living fossil and unique in many ways. We have followed the reproductive cycle of *Ginkgo* in a casual way for several years, and can add a few points of interest regarding the behaviour of trees in Christchurch.

As Neil O'Brien correctly states, *Ginkgo* is a dioecious species, i.e., the male and female sexes are borne on different plants. Other familiar examples include our native conifers totara, rimu, and matai and introduced trees like poplars, casuarinas, and the monkey puzzle. *Ginkgo* also shares a primitive feature with ferns, namely, free-swimming male sperms, but these are released from pollen tubes just before fertilisation occurs. The cycads, also an ancient gymnosperm group, have motile male sperms as well, so the *Ginkgo* is not alone amongst seed plants in this respect.

With *Ginkgo*, as with other seed plants, the distinction between *pollination* and *fertilisation* needs to be made as these processes are often confused. Both can be observed in a general way by following the reproductive behaviour of *Ginkgo* trees in Christchurch, especially those in the Botanic Gardens.

Each year pollen is released from the catkin-like cones of male trees over a period of 2-3 weeks, usually in October. Perhaps because the grains are heavy and lack wings, most of the pollen is shed directly beneath male trees, temporarily staining the ground bright yellow. The male tree planted by Lord Galway in 1938 on the Armstrong Lawn, Botanic Gardens, is a good example. Some of this pollen, as it falls, may be transferred by wind or gravity to the drupe-like ovules borne on female trees, but only if trees of both sexes are close together.

To help capture this pollen, a receptive ovule exudes a bubble of liquid or 'pollination drop' through a tiny aperture or micropyle. Normally the bubble is exuded at night and withdrawn during the day. The buoyant pollen sticks to the bubble and is sucked into the ovule when the bubble is withdrawn, finally coming to rest in the pollen chamber of the ovule, a cavity especially designed for it. At this point pollination is complete, the aperture closes, and the door is shut to any further pollen. The process is all over in a day or two, or even hours, and resembles that seen in many other dioecious species, including our native conifers. The celery pines (*Phyllocladus*) are similar to *Ginkgo* in this respect.

At pollination the ovule is very small but, whether pollinated or not, it develops over the next 4-5 months into a fairly large, green, plum-like and pendulous 'fruit'. Usually there are two ovules on each stalk, rarely three or four, and both may develop. More often only one does.

A female tree that regularly bears good crops of 'fruit' occurs in the border garden between the Avon River and the Pine Mound, Botanic Gardens. Beginning in March the 'fruit' turns a deep yellow, retaining this colour through the autumn and early winter, when the leaves also turn a brilliant yellow and fall to the ground. The 'fruit' are shed irregularly from April to September, by which time they are soft and bluish-grey and give off an unpleasant odour of very rancid butter. The kernels are best extracted about this time, and make a tasty snack if lightly roasted in cooking oil.

While all this is going on, and hidden from view inside the developing ovule, all the necessary steps leading to fertilisation are taking place. For the details of this fascinating story we are indebted to the French scientist Favre-Duchartre (1958), as well as others. This work shows clearly that fertilisation, or the union of the motile male sperm and the female egg cell, begins about 5 months after pollination when the ovule has reached its full size - in Christchurch about March. It is also known that fertilisation may occur over a long period, mostly in ovules still on trees, but also in those that have fallen to the ground.

As the noted American botanist Arthur Eames (1955) observed, "The existence of this condition in a representative of a primitive seed plant is important because it is probably an illustration of the ancient step in seed evolution when fertilization was transferred from the ground to the mother sporophyte".

After fertilisation the female egg cell develops directly into an embryo that continues to grow inside the ovule, whether on the tree or on the ground. By late September in Christchurch these embryos, like tiny clothes pegs, can be seen by cutting the 'fruit' lengthwise. Such fertile ovules or seeds sown at this time show no *fixed* dormancy and germinate readily, though intermittently, and thus have no need for stratification as advocated by Neil O'Brien. This lack of fixed seed dormancy is a recognised feature of *Ginkgo* and the cycads, in contrast to many advanced seed plants. According to Arthur Eames (1955) *Ginkgo* and cycads show *induced* dormancy, i.e., a dormancy brought on by conditions unfavourable to the growth of the embryo, or to germination of the mature embryo. Eames postulates that such induced dormancy may be a step to the fixed dormancy of other plants.

In our experience only one female *Ginkgo* in Christchurch produces fertile ovules or seeds. This tree - in Perry Street, Papanui - has two male trees next to it, and their flowering times overlap. All other female trees we have examined, including those in the Botanic Gardens, produce mature but infertile ovules which lack embryos and therefore are strictly speaking neither fruit nor seed. The reason can only be that most of these trees are isolated from male trees and are not pollinated.

The need for trees of both sexes to be close together for fertile seeds to be produced is demonstrated by the notable pair planted in 1874 in the Chelsea Physic Garden, England (Paterson, 1981). These trees, planted on either side of a main walk, were perfectly matched and about 20 m tall in 1979.

Once looked upon as an 'institution' tree, the attractive *Ginkgo*, with its intense yellow foliage in autumn, continues to find favour with home gardeners. There are several large and impressive trees in Christchurch, as well as many smaller ones. Probably the oldest is the scarred female tree in the Arts Centre. These trees dispel two popular misconceptions about *Ginkgo*, namely, that all male trees are conical in outline and need to be 150 years old before they flower, and all female trees have broad spreading crowns (cf. Mitchell, 1985).

We fully agree with Neil O'Brien that *Ginkgo* is indeed a living treasure, and a species of considerable scientific interest. In a city like Christchurch, renowned for its autumn colours, more use could be made of *Ginkgo* in street and park plantings, including mass planting in suitable areas. Close spacing of male and female trees, propagated from cuttings, should ensure effective pollination and fertilisation and a steady supply of fertile ovules or seeds in the future.

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