



Taming wild limes

Most Australians would be surprised to learn that we have six native tree species that are true citrus, closely related to conventional oranges, lemons, limes and mandarins.

These native limes, long collected in the wild by Aboriginal people, early settlers and, more recently, by a burgeoning native food industry, have given rise to colourful new citrus varieties, and their commercial production is on the horizon.

How did this transformation – from untamed desert and rainforest denizens to neatly aligned commercial orchard trees – come about? And what taste sensations and culinary delights can we anticipate?

Horticultural scientist and plant breeder at CSIRO Plant Industry, Dr Steve Sykes, says CSIRO researchers first took an interest in native limes to see if their special characteristics, such as salt tolerance, disease resistance and novel colours, could be bred into conventional citrus fruits.

Desert and rainforest origins

Sykes, who is based at Merbein in north-western Victoria, says the desert lime (*Citrus glauca*) is a good example. It grows mostly in the semi-arid inland regions of Queensland, New South Wales and South Australia and is the only known citrus

species that is xerophytic, or naturally adapted to withstand drought.

Seedlings develop an extensive root system before making vigorous above ground shoot growth. During extreme drought, the plant's leaves simply fall off (to avoid water loss) while it is thought that the leafless twigs carry on some photosynthesis.

The desert lime can tolerate temperature extremes of 45 to -24°C, without injury, and is also salt and boron tolerant. It seems to be highly resistant to Phytophthora root rot. Its yellow-green lime-like fruit matures in just 10-12 weeks, the shortest flowering to fruiting period of any citrus species. Little wonder the desert lime has attracted the attention of citrus breeders worldwide.

Five other citrus species, previously classified as *Microcitrus* species, occur in Australian rainforests, from Cape York to northern New South Wales, and they produce a range of fruit types with a pleasant but acidic juice. The small fruits can be round or finger-shaped and vary in colour, one variant being a striking burgundy hue. The dwarf, shrubby habits of these species suggest they could be a useful source of genes for breeding dwarf varieties.

'We were initially drawn to these native limes because we saw them as a source of

The three new citrus fruits, the Outback, Sunrise and Blood limes, introduce an appealing range of colour, size and shape to the market.

valuable genetic characteristics for improving existing citrus varieties,' Sykes says. 'We have used them as an additional germplasm resource in our citrus breeding program.

'But more recently, encouraged by the expansion of the Australian native foods industry, and working in partnership with people involved in that industry, we have been taking a different tack.

'For the past decade or so, we have been investigating the potential for developing new crop plants from these wonderful native limes, and their hybrids, using traditional breeding methods of cross-pollination and selection.

'At Merbein, starting with native trees from our arboretum, we have now bred lime varieties that can be considered distinct citrus fruits in their own right. It is an exciting development, and very timely, given the unprecedented consumer interest in native Australian foods.'

Well-bred limes

Three of these varieties – the Blood Lime, the Sunrise Lime and the Outback Lime – are being evaluated in commercial orchards in Australia by Australian Native Produce Industries (ANPI). Andrew Beal of ANPI was one of the first people to recognise the potential of Sykes's research into native limes, some 10 years ago.

'Using the CSIRO-bred varieties, we have, over several years, established more than 16 000 lime trees throughout the citrus-growing areas of Australia,' Beal says.

These trees will supply the fruit for ANPI's manufactured food products which are proving popular both here and overseas. Growers, under contract, made their first commercial harvest last year and the company intends to treble the number of trees under cultivation to meet the expected demand.

Sykes says that despite the three new limes having a lemon-like acidity, each has its own unique flavour. They make good sauces, preserves, marmalades, chutneys, syrups, garnishes, confectioneries and beverages.

The Outback Lime is an improved variety of desert lime that Sykes selected for its large fruit (for a desert lime), high yield, lack

of thorns, upright habitat and uniform ripening time. Its natural tendency to drop ripe fruit suggests it may also be suitable for mechanical harvesting. The green spherical fruits, each up to 20 mm across, have a thin skin and turn yellow as they ripen in early summer.

The Sunrise Lime arose from a seedling selected from a hybrid of the native finger lime and a calamondin (which is itself a mandarin-cumquat hybrid). It boasts dark glossy-green leaves, short spines and golden pear-shaped fruit.

The Blood Lime also has its ancestral origins in coastal rainforest, being selected from a cross between a sour-mandarin hybrid and a seedling of the pigmented variant of the finger lime (*C. australasica*). As the name implies, it has eye-catching blood-red fruit, which are oval-shaped. They ripen in winter.

Sykes and Beal are confident that these Australian newcomers to the citrus industry will fill an important niche, catering for the growing interest in so-called bush foods. By domesticating the native limes they believe harvesting pressure on wild trees will be eased and patchiness in the quality and availability of fruit for processing will be smoothed out as the area of native lime orchards expands.

Contact: Dr Steve Sykes, (03) 5051 3100, Stephen.Sykes@pi.csiro.au.

Steve Davidson



Plant breeder, Dr Steve Sykes, with one of the new citrus varieties, the Outback Lime, a tree with upright growth habit, no thorns at maturity, and berry-like fruit.

What's happening to India's vultures?

A DRAMATIC decline in India's vulture populations has sparked an international investigation into its cause.

According to the Bombay Natural History Society (BNHS), a recent survey found that more than 90% of Indian white-backed and long-billed vultures have been wiped out in at least 17 key locations. In some areas none remain.

Dr Andrew Cunningham, a veterinary pathologist at the Zoological Society of London, is working with the BNHS, the UK Royal Society for the Protection of Birds, and the Poultry Diagnostic and Research Centre, Pune, to help coordinate the investigation.

Cunningham says that in areas where declines are marked, abnormally high rates of nesting failure and adult, juvenile and nestling mortality have been observed.

'Also, vultures with obvious signs of clinical illness – lethargy and intermittent, but often prolonged periods of neck drooping – have been seen,' he says. 'It has been reported by the BNHS that birds exhibiting these clinical signs invariably die after a period of 30–32 days of illness.'

While there may be several reasons for localised declines, the BNHS has shown that normal ecological factors such as food supply and habitat availability are not constraining the vulture populations.

Initial investigations suggest a pathogen, such as a virus, could be the cause. To find out, Cunningham and Indian authorities have turned to CSIRO's Australian Animal Health Laboratory at Geelong in Victoria.

'The laboratory has a proven track record in detecting new and emerging diseases, particularly those with the potential to infect livestock,' laboratory director, Dr Mike Rickard, says.

'And it is one a handful of facilities anywhere in the world where research can be safely carried out on foreign animal diseases and pathogens.'



Initial investigations suggest a pathogen, such as a virus, could be the cause of declining vulture populations in India.

While investigations continue, human and animal carcasses in India are creating a new problem.

'The decline of vultures is worrying from a biodiversity viewpoint, but also because a great number of carcasses are being left uneaten,' Cunningham says.

Vultures play an important role in scavenging human and animal carcasses. For example, India's 76 000-strong Parsees community does not bury its dead; bodies are placed in 'towers of silence', for the bones to be picked clean by vultures.

'Another concern is the increase in number of feral dogs indulging in the now abundant food supply. These animals can carry diseases such as rabies, which further threaten public health,' Cunningham says.

Researchers are also concerned that any infectious pathogen in the vultures has the potential to spread.

'The ranges of species in the genus *Gyps* overlap from India through central Asia and the Middle East to South Africa and Western Europe, and birds travel widely,' says Dr Debbie Pain, head of international research at the Royal Society for the Protection of Birds.

'Should an infectious pathogen spread, the ecological impacts could be even more devastating.'

This work is supported by the Royal Society for the Protection of Birds.

Contact: Andrew Cunningham, Andrew.Cunningham@ioz.ac.uk, or Judith Maunders (03) 5227 5426, Judith.Maunders@li.csiro.au

Judith Maunders