



# Variation and gene tracking in kūmara

Aotearoa has a long history of growing kūmara since Māori brought them here about 800 years ago. Analysing their DNA can tell us much about where kūmara came from. Mike Stone investigates.

Kūmara varieties, from left - red, gold, orange, kokei, purple dawn, kogenesengan, and orange sunset. My Mirepoix.

## Variation

Sweet potato, *Ipomoea batatas*, known as kūmara in Aotearoa/NZ, is a vine closely related to the weed convulvulus, and a little more distantly related to the potato. It is a very important crop (sixth most common in the world) and is hardy in difficult conditions. Kūmara can grow well with no fertilisers, limited water and just occasional weeding.

Kūmara show variation in size, shape, colour, moisture and nutritional content. There are many varieties; the most common in Aotearoa/NZ today are the orange, red and gold varieties. These three were introduced by Europeans during the 19th century and newer varieties have been developed since.

In the 1950's the kūmara industry was on the verge of collapse as disease decimated the crop. Fay and Joe Gock had developed a disease-resistant red variety (by keeping the best each year) and they gifted stock plants to DSIR to help re-establish the plant.

## Selective breeding

Kūmara can be selectively bred for: resistance to disease and insect pests; yield; root size and uniformity; and nutritional value.

Kūmara is a tropical plant and does not usually flower in Aotearoa/NZ, so we do not breed it here.

Traditionally, Māori selected new varieties in the field based on their traits,

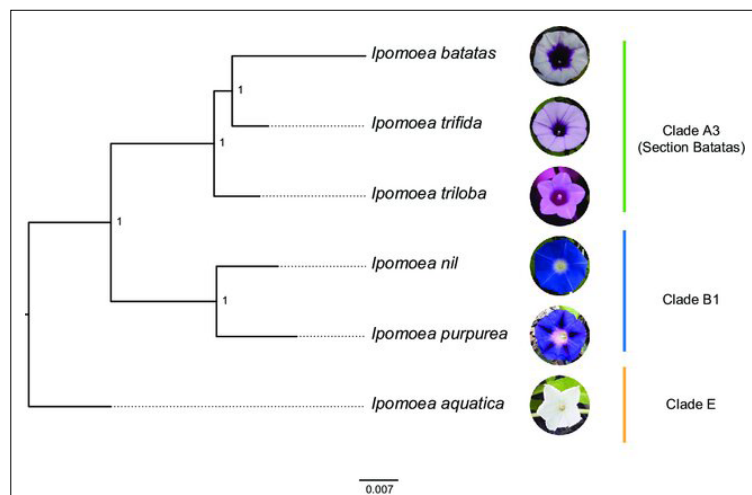
and grew them for a few cycles, with careful observation and evaluation.

Western scientists might call these selections genetic mutations in the first instance and, if the traits persisted, eventually new varieties.

In the Pacific, kūmara are bred by selecting parent plants with desired characteristics and segregating them in a nursery. Flowering is induced and the pollen allowed to spread, pollination and fertilisation forming a new hybrid. The progeny is evaluated and superior seedlings trialled growing in different environments. Once the best kūmara plant is found, stem cuttings are planted, which then grow and form new storage roots.



Three Polynesian varieties brought to Aotearoa in the 1200s. Graham Harris.



A phylogeny of six of the convulvulus family. From top: three sweet potato flowers, Japanese morning glory, purple morning glory, and water spinach.

All production in Aotearoa/NZ is from vegetatively multiplied stock held over from the previous season, ie tipu/cuttings. Although that can allow viral or fungal diseases to be passed on, it is the most appropriate reproduction method for our climate.

## Debated origins

The sweet potato was domesticated in Peru about 8,000 years ago and slowly spread through South and Central America. The similarity in names between South America (cumal), Pacific (kumala) and Aotearoa (kūmara) suggested a South American origin for Polynesian kūmara.

But how it travelled the 5,000km to Polynesia has been the source of endless disagreement. In 1954, Māori anthropologist Sir Peter Buck argued strongly that Polynesians had gone themselves to get kūmara from South America. However, others suggested that the Caribbean or Mexico may have been the sources of kūmara in the Pacific.

## Gene tracking

Then in 2013 a team led by French scientist Caroline Roullier carefully studied kūmara genetics to show how the plant got here.

They needed to source new and old samples from South America, the Pacific and the islands of Southeast Asia. To obtain pre-European plants, they used herbarium specimens, collected by early European explorers and naturalists, which showed the plants present when they arrived.

They extracted DNA from the nucleus and chloroplasts of tissue from both modern and herbarium samples. Specific regions, called gene markers were isolated, six from chloroplast DNA and 11 from nuclear DNA. From analysing this DNA, Roullier and her team were able to solve the puzzle.

The DNA evidence showed definitively that our kūmara came from Peru. It was carried back to the eastern Pacific by Polynesian explorers around 1000-1100 AD, and thence into NZ by the first group of waka in about 1250 AD.

The kūmara genetic signature was distinct from sweet potato varieties that arrived in the western Pacific from Mexico or the Caribbean.

In 2011, biological anthropologist Dr Lisa Matisoo-Smith was part of a scientific team analysing chicken bones found in Chile. Radiocarbon dating showed that these chickens were present in South America in about 1300 AD.

And gene markers in mitochondrial DNA established that this chicken lineage came from Polynesia, probably about then.

Combined with other biological, archaeological and linguistic evidence it seems highly likely that the first chickens in South America were taken there by Polynesian voyagers, who traded them for kūmara, which they brought back to the Pacific.

## References

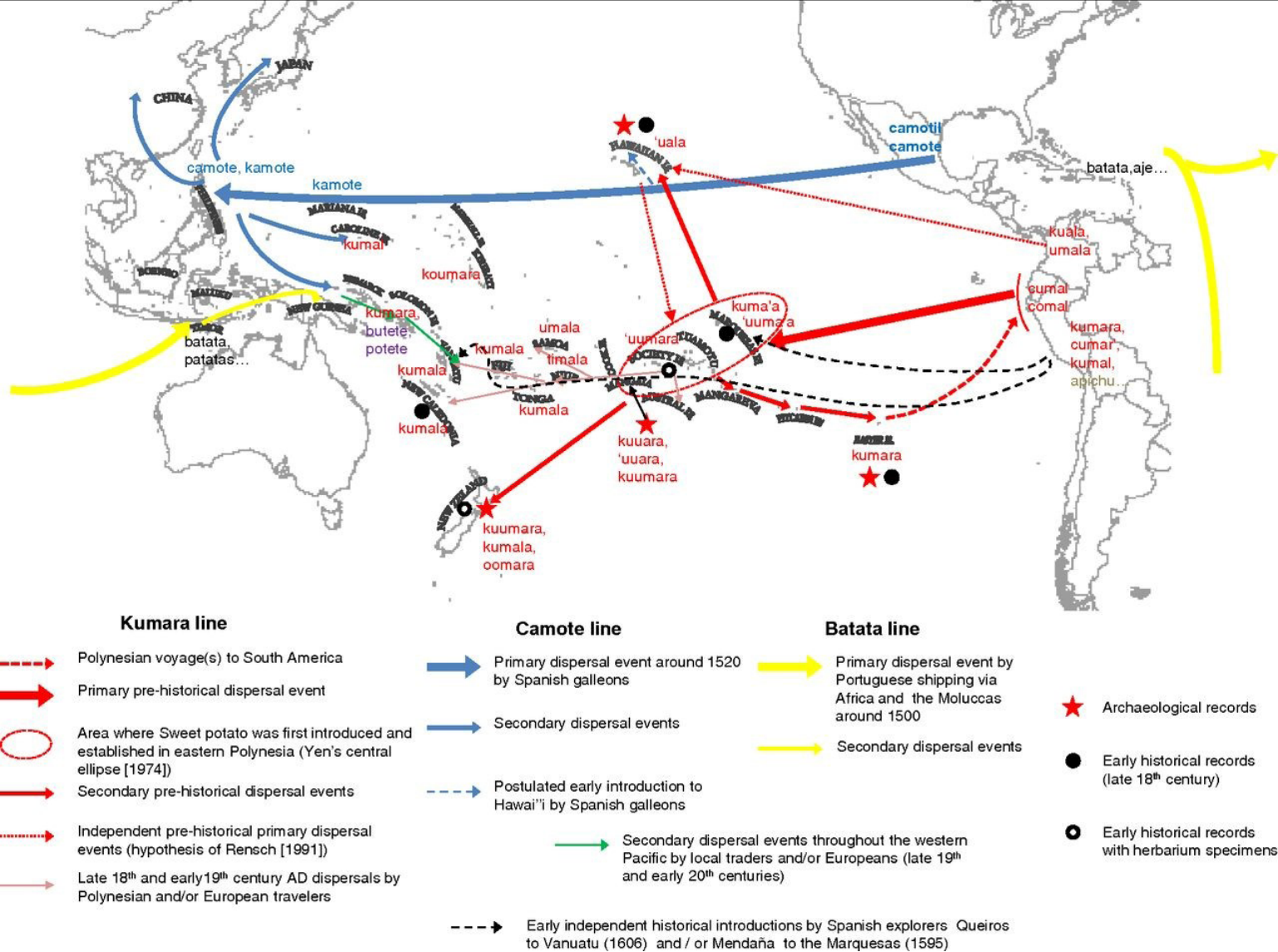
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### Mitochondrial DNA

DNA is found in mitochondria as well as in the nucleus of cells. In mitochondria, DNA is a double-stranded loop rather than a long thread. Mitochondrial DNA is more abundant in cells than nuclear DNA, and can survive in situations where nuclear DNA becomes degraded.

*Right: Feral rooster, Hawaii.  
David Burney.*





## Useful classroom resources

[Whakaotirangi and her kete of kūmara](#), *Connected* 2020, L2. (Traditional story of how a Tainui ancestor brought kūmara to Aotearoa, and how they grew and stored them).

[Growing kūmara](#), 2022, NZASE PDF.

## Video

[Mitochondrial DNA](#), talk by Professor Lisa Matisoo-Smith.

## Questions

- 1A Describe the different traits seen in kūmara.
- B Explain how variation could have occurred in kūmara.

2 There were two gene tracking methods described here. For each:

- A Name the method
- B Say why the method was used
- C Say why the different types of DNA were used.

3A What did the DNA analysis of kūmara tell us?

B What other information supported that evidence?

4 What extra information is in the map?

*The movement of sweet potato species across the Pacific, from Roullier et al, 2013.*

This article benefited from help by Lisa Matisoo-Smith, Professor of Biological Anthropology at the University of Otago; Nick Roskrige, Professor in ethnobotany, Massey University; and teacher Linda Haycock.

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