Tracing the origin of l

People have been developing new lettuce varieties since 4000 years BCE. It started with wild lettuce in the Caucasus. The prickles on the leaves disappeared in the Middle East, and the big, soft leaves of butterhead lettuce emerged in Europe. Only in America did the crunchy iceberg lettuce appear on the scene, genetic analysis has shown.

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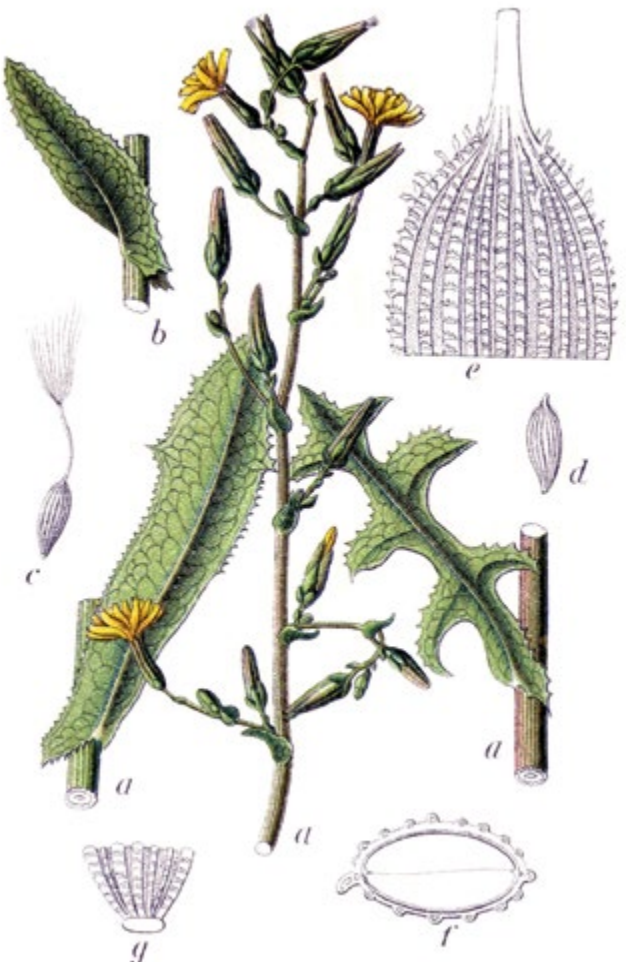

PHOTO ALAMY

Lactuca serriola, the wild lettuce variety which present-day varieties stem from.

From butterhead and oakleaf lettuce to iceberg and romaine: there are hundreds of lettuce varieties nowadays. They all belong to the same plant species, *Lactuca sativa*, which once developed from the wild lettuce species *L. serriola*.

But until recently we had no idea exactly how that process had unfolded. To find that out, Wageningen and Chinese researchers have analysed the genetic diversity of 445 varieties of lettuce from 47 countries, including wild varieties in the Caucuses and the Middle East. They published their research finding in *Nature Genetics* in mid-April. Comparisons of genetic material show that the first cultivated lettuce grew in the Caucasus about 6000 years ago. The main varieties developed later through breeding and selection in the Middle East, then in Egypt, then in ancient Greece and Italy, in Central Europe and finally in North America.

'During the cultivation process, there was strong selection for desirable characteristics such as flavour and ease of growing,' says researcher Rob van Treuren of the Dutch Centre for Genetic Resources CGN, part of Wageningen University & Research. 'But a lot of genetic diversity gets lost that way.' And with it, characteristics that are important to growers, such as robustness and resistance to particular diseases. You can bring those back in the crop through crossbreeding, but to do that you must first find those characteristics.

23,000 SEED SAMPLES

'Wild varieties form an enormous reservoir for that,' says Van Treuren. Sometimes the CGN scientists make trips to collect wild varieties of crops: spinach from Tajikistan, melon seeds from Uzbekistan, leeks from

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> ‘It is as though we found the key to a treasure trove’

Greece – and lettuce from Jordan, Uzbekistan and the Caucasus. But for the lettuce study published in *Nature Genetics* they did not have to leave home. ‘In Wageningen we have a unique collection that includes a wide range of cultivated lettuces and wild relatives,’ says Van Treuren. The CGN gene bank contains more than 23,000 seed samples of 30 different crops, both wild and cultivated, as well as genetic material from farm animals, trees and shrubs.

The first full genetic map of lettuce was created four years ago for iceberg lettuce from California. This produced what is known as a reference genome: the roughly 2.5 billion building blocks that the lettuce genome is made up of. ‘Thanks to the reference genome, we could compare those 445 varieties relatively easily,’ explains Van Treuren. ‘So we looked for genetic variations: places where the genome of one variety is different to the reference genome.’

FAMILY TREE OF VARIETIES

On this basis, you can also compare varieties with one another, such as the different cultivars, or you can compare cultivars with wild lettuces from different geographic regions. That produces a family tree that shows precisely how the varieties are related. The degree of variation in relation to the wild ancestor reflects the length of time that has gone by since that branch of the family tree started. ‘We now know for example that the first cultivation step was taken about 6000 years ago in the Caucasus,’ says Van Treuren. ‘Farmers used selection to stop the plant distributing its seed on the wind, as the related dandelion does. Seeds that stay on the plant are easier to collect.’

With further breeding and selection, farmers in other parts of the world were able to make improvements to the crop too. Prickles on the leaves disappeared somewhere on the way to Egypt. The big, soft leaves of the butterhead lettuce emerged in Europe. And only in America did the crunchy iceberg lettuce appear on the scene.

HELP WITH BREEDING

The researchers found correlations with lettuce characteristics in the DNA data too, including leaf characteristics, flowering time and resistance to diseases. ‘These relations can help with research and breeding,’ says Van Treuren. ‘And they form the basis for what is known as “marker-driven selection”. Genetic markers are short DNA fragments whose position on the genome is known, and which we also know to be associated with a particular characteristic. A breeder can use such markers to see whether even a very young plant has the characteristic in question. This means you don’t have to wait until the plant is fully grown and produces seeds itself to see the seed characteristics. ‘Such markers can speed up the breeding process tremendously,’ says Van Treuren.

The nice thing about the new study, he adds, is that the data are already freely available. Anyone can use them for research and crop improvement. ‘As a gene bank we strive to make information about our material available to the public so that everyone can benefit from it. Thanks to our sequence data, other users can track down characteristics quickly,’ says Van Treuren. ‘It is as though we had found the key to a treasure trove.’ ■

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