PLANT GENOMICS

Under the sea flowering plants adapt and thrive

P. Morgan/NPG

On three known independent occasions, the ancestors of the seagrasses left the land to colonize the coastal seabeds with widespread success. To survive in such a different ecological niche requires extensive adaptation to the pressures of a marine environment. Now, Olsen *et al.* present the fully sequenced genome of *Zostera marina*, a marine angiosperm also known as eelgrass, and the genetic losses and gains that enable it to thrive under the sea.

The authors used a combination of fosmid-ends and whole-genome shotgun techniques to sequence a *Z. marina* clone from Finland's Archipelago Sea. Genome annotation revealed that this seagrass organizes its protein-coding genes into dense clusters separated by stretches of repetitive elements, with evidence of transposable elements helping to shape genic adaptation. The team identified 36 conserved microRNAs and their predicted targets, with only one microRNA being ancestral to all monocots (that is, flowering plants whose

seeds contain one embryonic leaf). This finding suggests that *Z. marina* diverged from other monocot plants before the expansion of microRNA genes. Phylogenetic dating suggested a whole-genome duplication event occurred 72 to 64 million years ago during the Cretaceous–Palaeogene extinction event — a period of diversification when ecological niches were opened up.

Turning to the gain and loss of gene families, the team identified several adaptations specific to the marine environment. *Z. marina* has lost stomatal differentiation genes, the ability to produce and sense volatile compounds, and has a reduction in infection resistance genes. The authors hypothesize that these adaptations are linked, as land plants release volatiles through stomata for defence and communication.

The spectra of light shifts in the marine coastal environment because UV, red and infrared wavelengths poorly penetrate water. In adaptation to reduced light, the seagrass has lost UV resistance genes, along with

the red and far-red phytochrome receptors, while the light-harvesting complex B family has expanded in number. A preference for sucrose storage and the re-gain of sulphated polysaccharides in the cell wall has helped the plant adapt to changing osmotic conditions associated with seawater. Unlike other flowering plants, *Z. marina* reproduces entirely under water, which may explain why it has lost the genes responsible for complex flowers and exine-coated pollen (a measure to prevent decay in land plants).

As the proportion of the world population living by the coast increases, the authors note that understanding the biology of *Z. marina* will help to monitor its physiological and ecological status in an environment that is amongst Earth's most threatened.

Ross Cloney, Associate Editor,
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