Breakthrough study uncovers origin of plant sperm

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A large international team of researchers has uncovered the origin of an ancient genetic mechanism needed for plant fertility.

The study was led by Professor Takashi Araki of Kyoto University and Professor Frederic Berger of the Gregor Mendel Institute of Molecular Plant Biology in Vienna and involved an international team of 25 researchers. Professor David Twell, from the University of Leicester's Department of Genetics and Genome Biology, headed Leicester's contribution to the project.

The researchers discovered how a gene known to control sperm production inside pollen grains of flowering plants, is also used by primitive land plants to produce free-swimming sperm. The findings are presented in *Nature Communications*, published this month.

A key finding was that the DUO1 gene originated in the stoneworts, an ancient group of aquatic algae that diverged from land plants over 700 million years ago.

The work suggests that it was a simple change in the DUO1 gene sequence that allowed the algal ancestors of land plants to produce small swimming sperm to increase the chances of fertilisation in an aquatic environment.

The DNA sequences of DUO1 were compared in primitive land plants such as liverworts and mosses, with those in freshwater algae. This uncovered quite small genetic changes that allowed the ancestral algal DUO1 protein to recognise a new DNA sequence. This change enabled DUO1 to control a gene network needed to make swimming sperm. The researchers went on to show that liverworts with a mutated DUO1 gene were infertile because they were unable to make active sperm.

Interestingly, the role of DUO1 in plant sperm formation has adapted to the demands of life on land. For example, DUO1 is needed to produce the whiplash flagella used for propulsion of liverwort sperm, but this is not the case in the flowering plant Arabidopsis thaliana (thale cress).

Instead, the sperm of flowering plants do not swim and are transported to the egg by a tube that grows out from each pollen grain. In these sperm, DUO1 has taken control of the specialised network of genes needed for the union of sperm and egg.

Professor David Twell said: "It is heartening that a major event in the evolutionary history of plant sperm has been tracked down through international cooperation and the individual efforts of many researchers. Further team effort to assemble the fertility gene networks of our important crop plants, will uncover new ways to help plant breeders in their quest to maintain food security in the face of environmental change."

The original research paper, "MYB transcription factor neo-functionalization is associated with evolution of sperm differentiation in plants," is available online from *Nature Communications*.

More information: Asuka Higo et al. Transcription factor DUO1 generated by neo-functionalization is associated with evolution of sperm differentiation in plants, *Nature Communications* (2018). DOI: 10.1038/s41467-018-07728-3

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