Lace plants explain programmed cell death

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Programmed cell death (PCD) is a highly regulated process that occurs in all animals and plants as part of normal development and in response to the environment. New research published in BioMed Central's open access journal *BMC Plant Biology* is the first to document the physiological events in the lace plant (*Aponogeton madagascariensis*) which occur via PCD to produce the characteristic holes in its leaves.

The aquatic lace plant, endemic to Madagascar, uses PCD to generate holes in its leaves. Researchers from Dalhousie University, Nova Scotia, used long-term live cell imaging, time-lapse micro-photography and detailed staining to see what actually happens inside individual cells of the lace plant leaves during this process.

PCD always begins in the centre of areoles (areas surrounded by veins) and works its way out, finally stopping four or five cells away from the vein. Within these areoles the stage of PCD can be visually determined by pigmentation. Non-PCD cells contain anthocyanin which is pink. As PCD progresses (early-PCD) the anthocyanin disappears but green chlorophyll remains. By late-PCD, both of these pigments have been lost.

Arunika Gunawardena, who led this research, described what actually happens in more detail, "After the loss of anthocyanin, we saw a reduction in the number and size of chloroplasts concurrent with changes in the actin cytoskeleton, which normally supports the cell from the inside. Actin cables became thicker, but their arrangement became more haphazard (until late-PCD when they began to disappear)."

As PCD progressed chloroplasts and mitochondria (the energy centres of the cell) began to aggregate together and were brought into the acidic vacuole to be degraded - a process that was confirmed using 3D image analysis. Additionally, the researchers found evidence of autophagy (where the cells literally begin to 'eat' themselves from the inside) and discovered organelle-like remnants inside vesicles.

Dr Gunawardena continued, "For each cell we observed, eventually the tonoplast ruptured, and the plasma membrane surrounding the cell collapsed. It only takes 48 hours from the first noticeable loss in chlorophyll until the plasma membrane shrinks, and by 24 hours after this event the cell wall disappears."

This is the first research to use such a variety of visual techniques to look at a process that affects almost every cell type at some stage of an organism's life. These pictures and videos provide a fascinating insight into how the lace plant has high-jacked PCD to produce its quirky, yet beautiful, leaves.

More information: The pathway of cell dismantling during programmed cell death in lace plant (Aponogeton madagascariensis) leaves Jaime Wertman, Christina EN Lord, Adrian N Dauphinee and Arunika HLAN Gunawardena *BMC Plant Biology* (in press)

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