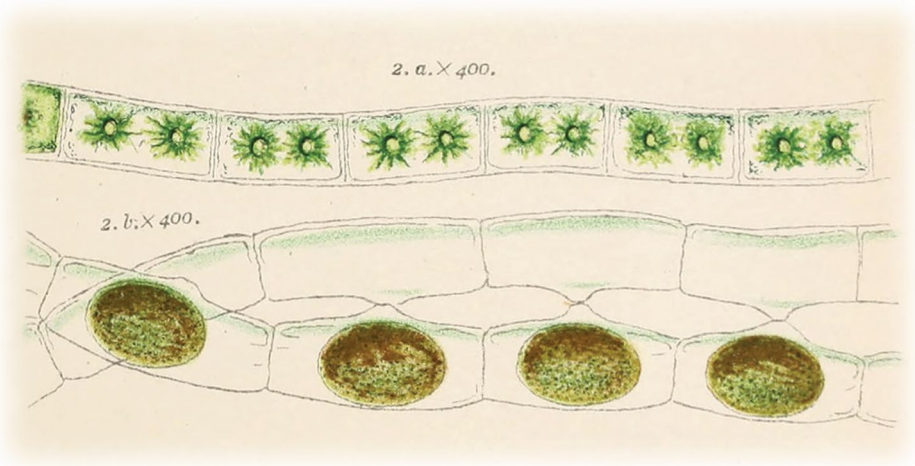
EVOLUTION

A time before ABA signalling

Proc. Natl Acad. Sci. USA http://doi.org/dff8 (2019).



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Around 500 million years ago, something quite extraordinary happened on Earth: a few fearless multicellular algae got out of freshwater and, soon after, newly evolved plants started to colonize land masses. This event radically changed the destiny of our planet by modifying the atmosphere and creating a layer of fertile soil. This made it possible for animals to, in turn, adapt to life on land.

One of the necessary traits for this transition was the ability to survive in dry, temperature-changing and otherwise stressful environments. In today's land plants, abscisic acid (ABA) is the hormone that regulates water loss through stomatal closure. Its core signalling pathway is widely conserved: ABA promotes the interaction between a PYR/PYL receptor and a type 2C protein phosphatase (PP2C), inhibiting the latter, which triggers downstream events to control ion channels and transcription factors. A team led by Assaf Mosquna from the Hebrew University of Jerusalem, Israel, has investigated the evolution of ABA receptors and concluded that the subtle, ABA-controlled regulation of the pathway in modern plants evolved from a cruder on/off ABA-independent version.

The ancestor of all land plants is related to modern Zygnematophyceae freshwater algae. The genome of *Zygnema circumcarinatum* contains one gene encoding for a putative ABA receptor, ZcPYL8. In a series of in vitro assays and in vivo complementation studies, the authors demonstrate that ZcPYL8 has a basal PP2C inhibition activity, but in an ABA-independent manner. On the other hand, receptors from all other land plants tested, including *Marchantia*, *Physcomitrella* and *Arabidopsis*, can be strongly modulated by ABA, and some recently evolved ones have in fact lost their basal activity.

The conclusion is that ZcPYL8 probably represents an ancestral form of the protein, able to modulate a pre-existing pathway but blind to ABA. A quite similar hormone-independent evolutionary scenario has been also proposed for auxin signalling. During evolution, ZcPYL8 has gained ABA interactivity and so has been able to be finely and dynamically tuned by a small endogenous mobile molecule instead of simply by its own abundance. Later on, a major subfamily of the receptor also lost its basal activity, to be regulated only by ABA. The combination of both molecular innovations gave rise to a system with a wide response spectrum to perfectly adapt to a similarly broad range of external conditions — just what was needed not only to survive life on land, but to thrive in this new challenging environment. A fascinating story that started half a billion years ago.

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Published online: 9 December 2019
https://doi.org/10.1038/s41477-019-0571-0