A ligand-independent origin of abscisic acid perception

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Necessity is the mother of all invention, the saying goes, and that includes the process of evolution.

Take plant life: Plants get stressed too. Environmental factors such as drought or a high concentration of salt in the soil disrupt their physiology. All land plants, from liverworts to wheat, use a complex

signalling cascade that allows them to survive these, and other, stressful conditions.

But what about existential changes, like putting water-based plants on dry land? How would they cope with the move?

Today, an international research team led by Hebrew University's Dr. Assaf Mosquna has unlocked one of the secrets that enabled plants to do just that, approximately half-a-billion years ago.

In a ground-breaking study published Monday in the prestigious *Proceedings of the National Academy of Sciences* academic journal, the team describes the evolutionary origins of a mechanism used by plants to survive dehydration—a necessary prerequisite for growth on land.

"The move from water to land was one of the most important moments in evolutionary biology," says Dr. Mosquna, an expert in plant responses to environmental stress at The Robert H. Smith Institute of Plant Sciences. "By unlocking one of the secrets of how that process unfolded we shed light on evolution itself, we gain important insight into the challenges facing modern agriculture, climate change and more."

The researchers say the establishment of plant life on dry land was probably an evolutionary "accident": Aquatic algae—typically single-celled or filamentous organisms known popularly as "pond scum"—likely washed up on the shores of ancient freshwater lakes and had to "learn" how to withstand dehydration.

Algae on land accumulate a set of protective proteins and sugars that enable them to survive cycles of dehydration and rehydration. Their descendants went on to dominate terrestrial habitats, and this survival trait was passed on to them, with one important difference: Modern land plants use a stress hormone called abscisic acid (ABA) to trigger the

genetic response that results in the cells accumulating these compounds, but aquatic algae don't.

Although aquatic algae contain ABA, it does not trigger the hormone reaction necessary for survival on dry land. This is because in the true land plants the hormone first has to bind with a specific receptor protein to initiate the dehydration response.

"Until recently, it was thought that algae didn't have this receptor, until a similar protein was discovered in the immediate algal ancestors of land plants. It doesn't bind ABA, but it does interact with the first component of the response pathway resulting in a low-level activation of dehydration tolerance. During the first few million years on land, novel forms of the receptor evolved through mutations that did allow it to bind ABA—and to trigger a much stronger response. This hormonal trigger—coupled with an increase in the number of genes encoding the receptor—enabled plants to diversify and survive in a previously inhospitable environment," says Dr. Andrew Cuming of Leeds University, a senior member of the research team.

More information: Yufei Sun et al. A ligand-independent origin of abscisic acid perception, *Proceedings of the National Academy of Sciences* (2019). DOI: 10.1073/pnas.1914480116

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