Model plant misled scientists about multicellular growth

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Scientists have misunderstood one of the most fundamental processes in the life of plants because *Arabidopsis thaliana*--the dominant model used by plant scientists--is actually quite an unusual organism. Credit: University of Leeds

Scientists have misunderstood one of the most fundamental processes in the life of plants because they have been looking at the wrong flower, according to University of Leeds researchers.

Arabidopsis thaliana—also known as thale cress or mouse-ear

cress—grows abundantly in cracks in pavements all over Europe and Asia, but the small white flower leads a second life as the lab rat of the plant world.

It has become the dominant "model plant" in genetics research because of its simple genetics and ease of use in a research environment. Thousands of trays of the humble weed are cultivated in laboratories across the world, but it turns out they may actually contain a rather oddball plant.

A study by researchers at the University of Leeds found that *Arabidopsis thaliana* was exceptional in not having a "censorship" protein called SMG1.

SMG1 was known to play a vital role in the growth of animals as multicellular organisms, but scientists thought that plants built their complex life fundamentally differently. That conclusion, it turns out, was built on a dummy sold by *Arabidopsis thaliana*.

Professor Brendan Davies from the University of Leeds' School of Biology, who led the study, said: "Everybody thought that this protein was only in animals. They thought that because, basically, most of the world studies one plant: *Arabidopsis thaliana*."

Gene expression—the process by which the information from a genome is converted into the differentiated cells that make up complex life—relies on processes that turn genes on, when their genetic messages are required, and off when they are not.

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"Switching genes on and off is really what life is about. If you can't do that, you can't have life," said Professor Davies. "There are various ways this is done, but one way in more complex life such as animals and plants is through a sort of 'censorship' process. The system looks at the messages that come out of the nucleus and effectively makes a judgement on them. It says 'I am going to destroy that message now' and intervenes to destroy it before it takes effect."

Scientists know that this "censorship" process—called Nonsense Mediated mRNA Decay (NMD)—is used by both plants and animals, but thought the two types of organism did it in different ways.

Because *Arabidopsis thaliana* does not have SMG1, which plays a key role in triggering the censorship system in animals, scientists had concluded that SMG1 was not present in any plant.

However, the Leeds researchers discovered that the plant that has established itself as the standard reference plant for all of biology is in fact an anomaly.

"We have found that SMG1 is in every plant for which we have the genome apart from *Arabidopsis* and we have established that it is being used in NMD. Rather than being just in animals, we are suggesting that the last common ancestor of animals and plants had SMG1," Professor Davies said.

The study also found SMG1 in *Arabidopsis lyrata*, a close relative of *Arabidopsis thaliana*, which suggests that the missing protein has been lost relatively recently in evolutionary time, perhaps in the last 5-10 million years.

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The next key question for researchers is to explain how organisms without SMG1, such has funghi and *Arabiposis thaliana*, work without the protein.

As for *Arabidopsis thaliana*, it may not have met its Waterloo just yet. "It is still a fantastically useful model. We would not be anywhere close to where we are in understanding plant biology without it, but this is a lesson to us all about the dangers of extrapolating from a single model,

however successful that model has been, and the importance of studying processes in a range of models. Evolution does strange and unpredictable things," Professor Davies said.

The flower, which is a member of the mustard family, was first recorded by Johannes Thal in the Harz mountains of northern Germany in the 16th century, but its scientific career really took off at the very end of the 1970s and the early 1980s when molecular geneticists chose it as the ideal model.

Its simple genome, small size, ease of cultivation, and rapid life cycle have since made it an institution in plant genetics with books, web sites and academic conferences devoted to it. In 2008 alone, 3,500 papers on *Arabidopsis thaliana* were added to the PubMed database, which logs important publications in the life sciences.

The plant has a history of leaving scientists scratching their heads. In the 18th century, it was categorised as one of the Arabis genus but had to be renamed "*Arabidopsis*," meaning "resembling Arabis" after the original classification was found to be incorrect.

More information: James P. B. Lloyd, Brendan Davies, 'SMG1 is an ancient nonsense-mediated mRNA decay effector' *The Plant Journal* (2013) DOI: 10.1111/tpj.12329

Provided by University of Leeds

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