A plant cell recycles its resources in times of scarcity

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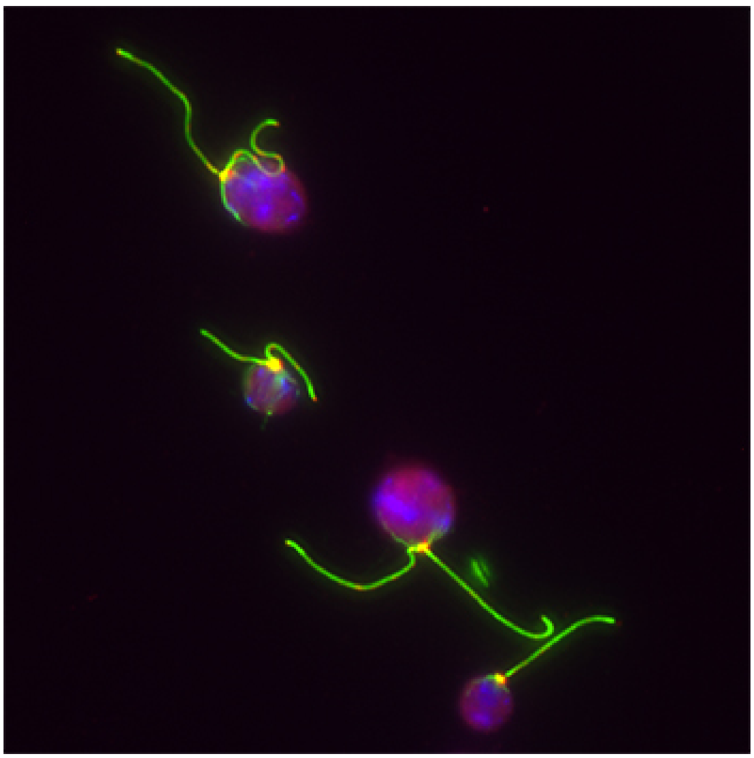

Unicellular algae Chlamydomonas reinhardtii revealed by fluorescent markers. The cell nucleus appears in blue-violet and chlorophyll in burgundy. The flagella are green, with their attachment point in yellow. Credit: Michel Goldschmidt-Clermont, UNIGE

To cope with changes in its aquatic environment and the nutrient deficiencies that may result, Chlamydomonas reinhardtii, a mobile single-cell alga, must adapt its metabolism for subsistence, notably in terms of sugar. The latter is produced by photosynthesis. To this end, plants and algae use internal cell structures called chloroplasts, which are equipped with protein complexes, the photosystems. If certain nutrients are missing, such as iron, the alga temporarily dismantles its photosystems to recycle some of their components. Researchers at the University of Geneva (UNIGE), Switzerland, have identified a protein that plays a distinctive role in this recycling. Their results are described in the journal the *Plant Cell*.

Photosynthesis allows plants to produce their own sugar using sunlight. This process takes place within specific cellular compartments, the chloroplasts. The energy of light is captured by chlorophyll and converted into chemical energy within two protein complexes called photosystems I and II, to produce sugars.

Michel Goldschmidt-Clermont, professor at the Department of Botany and Plant Biology of the Faculty of Science of UNIGE, studies the inner workings of photosynthesis in Chlamydomonas reinhardtii, a swimming single-cell alga used as a model organism. "When this micro-organism is in an environment depleted of the nutrient iron, it must adapt its metabolism to ensure its growth and multiplication. This adaption involves the dismantling of photosystem I, which allows the cell to recover the iron it contains. The alga will then consume other nutrients to overcome the shortage of sugar", says the researcher.

The biologists wanted to find out how exactly the alga responds to iron deficiency and how the dismantling of photosystem I, which is composed of many subunits binding some 200 pigments and cofactors, is performed. "We have identified a protein encoded in the DNA of the nucleus, called Mac1, and demonstrated that it is required for the production of a subunit of photosystem I which, in contrast, is encoded in the chloroplast genome", explains Damien Douchi, researcher from the Geneva group and first author of the study. Indeed, chloroplasts possess their own DNA and synthesize some of their proteins. Iron recycling thus results from a dialogue occurring between genes expressed both in the cell's nucleus and in the chloroplasts.

The protein's alterations reflect the lack

In collaboration with researchers at the Humboldt University in Berlin and the University Pierre et Marie Curie in Paris, the scientists observed that, when iron becomes scarce, the Mac1 protein undergoes biochemical changes, and its quantity decreases. "These changes probably mean that the chloroplast receives a signal. While existing photosystems I are dismantled, the production of new subunits of photosystem I is inhibited because Mac1 is not present in sufficient quantity in the chloroplast", notes Michel Goldschmidt-Clermont. The biologists from UNIGE are now trying to establish how iron deficiency is perceived and relayed to Mac1 during this response that aims at best allocating the available iron.

More information: A Nucleus-Encoded Chloroplast Phosphoprotein Governs Expression of the Photosystem I Subunit PsaC in Chlamydomonas reinhardtii. dx.doi.org/10.1105/tpc.15.00725

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