How did higher life evolve? Scientists determine the complete genome sequence of brown alga

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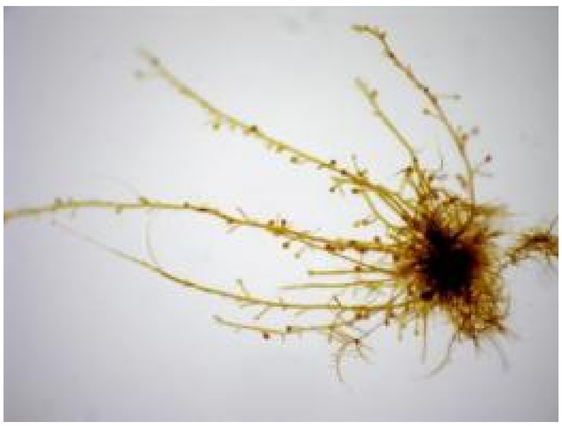

This is the brown alga, *Ectocarpus siliculosus*, in culture. Credit: Delphine Scornet, Station Biologique Roscoff

With the world's first complete sequencing of a brown algal genome, an international research team has made a big leap towards understanding the evolution of two key prerequisites for higher life on Earth - multicellularity and photosynthesis. As the internationally renowned science magazine *Nature* reported in its latest issue, about 100 scientists and technicians, during a five-year research project, successfully decoded all hereditary information - commonly known as the "genome" - of *Ectocarpus siliculosus*, an up to 20 cm large brown seaweed, which occurs mainly along coastlines in temperate latitudes. They have analyzed approximately 214 million base pairs and assigned these to about 16,000 genes.

The biologists, Dr. Klaus Valentin and Dr. Bank Beszteri of the Alfred Wegener Institute for Polar and Marine Research in the Helmholtz-Community have been involved in this global project since the planning phase in 2005.

"As evolutionary scientists we are particularly interested in why the world has developed as we know it today" said Klaus Valentin about this project. "During earth's history, complex multicellular life has evolved from unicellular organisms along five independent paths, which are: animals, plants, fungi, red algae and brown algae." Evolutionary scientists have therefore set themselves the goal to decode a complete genome from a representative of each of these lines and to look for comparable genetic information. "This goal has now been achieved for the brown algal genome. The decoding of a red algal genome has already been completed, and we are currently evaluating the data" says Valentin on the future prospects of comparative genomics. "And indeed, in the brown alga, we found many genes for so called kinases, transporter and transcription factors. Such genes are also commonly found in land plants, and we suspect that they also play a key role in the origin of multicellular organisms".

The sequencing of the brown algal genome is also a milestone in the efforts to reconstruct the evolution of photosynthesis. "We now know that oxygen-producing photosynthesis was „invented" before about 3.8 billion years ago, by cyanobacteria, sometimes erroneously called 'blue-green algae'", says Valentin about the elemental capability of plants to convert sunlight into biologically usable energy, whilst releasing oxygen. "Green and red algae have developed this ability after their ancestors scavenged living cyanobacteria, and thus more or less captured photosynthesis, to the benefit of both sides, since this symbiosis resulted in tremendous competitive advantages in the primordial ocean".

Brown algae were assumed to have arisen from the fusion of photosynthetically inactive colourless cells with a unicellular red alga. However, as discovered in a previous research project on single-celled diatoms, AWI researchers showed that brown algae also arose from the fusion of a green alga with a red alga and thus refuted a widespread theory among experts. "Interestingly", says Klaus Valentin, "In the brown alga we discovered, a high proportion of genes that are characteristic of green algae, including the kinases and transporters typical for multicellular land plants, as mentioned above. To which extent we have traced common origins of multicellular life, will have to be determined in future investigations".

From an ecological point of view, however, brown algae are also an exciting study object. On the rocky shores of polar and temperate latitudes, their role in the ecosystem is similar to that of trees on the mainland. Some species can reach lengths of up to 160 meters. These "submarine forests" are not only an important habitat for marine animals, but in areas with strong tides, they often fall dry for several hours and reveal an incredible stress tolerance. "In the context of climate change, we have now become interested in how brown algae have adapted to UV light and increasing temperatures. How they adjust to changing living conditions," mentions Klaus Valentin, is one of the aspects of research on ocean forests at the Alfred Wegener Institute. "In addition, brown algae are evolutionary speaking much older than terrestrial plants. They have multiple metabolic properties, but these have barely been studied. A better understanding of the properties locked up in the genes could also be a foundation for the development of new products and technologies".

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