Genomes reveal hidden potential of lichens

Among other things, lichens produce substances with biotic effects that are of great interest to the pharmaceutical industry – so-called secondary lichen substances. Researchers of the Bavarian State Collection for Botany (SNSB-BSM), in cooperation with scientists of the LMU Munich, found through genome analyses an unexpectedly high number of previously unknown gene segments responsible for the formation of important secondary lichen substances, the polyketides.

New research findings reveal the great hidden potential of lichens. It is possible that the organisms harbor significantly more active components for drugs such as antibiotics, anti-inflammatories or cytostatics than previously thought.

Lichens are symbiotic communities consisting of a fungal and an algal species. They colonize trees or rocks all over the world. The fungal partner in particular performs amazing things in secret: among other things, it forms substances that are of great interest to the pharmaceutical industry – so-called secondary lichen substances. Among the lichen substances, polyketides form the largest group. They are produced by the lichen-forming fungi in the metabolism of the lichen symbiosis. Polyketides are important both ecologically and pharmaceutically: they protect the lichen from the harmful effects of UV radiation and have anti-inflammatory and antibacterial effects, among other things. However, polyketides also include toxic substances such as the aflatoxin of the mold fungus or conspicuous dyes such as anthraquinones. In the pharmaceutical industry, polyketides are used as antibiotics, among other things.

A team of researchers consisting of Dr. Andreas Beck, curator

and lichen expert at the Bavarian State Collection for Botany (SNSB-BSM), together with colleagues from LMU Munich, analyzed the genomes of lichens or their fungal partners – in search of specific gene segments responsible for the formation of polyketides. The results were astonishing: the researchers found an unexpectedly large number of such gene segments, so-called polyketide synthase genes. Their quantity exceeds the number of known lichen substances from the organisms many times over. In their study, the research group compared more than 600 polyketide synthase genes from the genomes of 23 lichen fungi. The work shows the most comprehensive overview of polyketide synthases to date. The researchers recently published their results in the Journal of Fungi.

The scientists were particularly surprised to find that even the rather inconspicuous reddish rod lichen (*Bacidia rubella*) possesses many more polyketide synthase genes than previously assumed: “Until now, only so-called atranorin has been identified as a polyketide lichen substance for this crustose lichen. However, the genome of the rod lichen harbors a total of 10 polyketide synthase genes, all of which are capable of producing other lichen substances. Consequently, not even 10% of the potential metabolites of the reddish rod lichen are known so far,” explains Julia Gerasimova, from the LMU and the Bavarian State Collection for Botany (SNSB-BSM), and first author of the study.

“This unexpected variety, as well as the diversity of polyketide synthase genes, suggests that we are far from knowing all the lichen substances produced – neither their structure nor their function or mode of action. Among these unknown substances there are likely to be many with very interesting effects – interesting especially for pharmaceutical or biotechnological applications,” says Andreas Beck of the Bavarian State Collection for Botany (SNSB-BSM).

Publication: Gerasimova JV, Beck A, Werth S, Resl P. High Diversity of Type I Polyketide Genes in *Bacidia rubella* as

Revealed by the Comparative Analysis of 23 Lichen Genomes. J Fungi (Basel). 2022 Apr 26;8(5):449. https://doi.org/10.3390/jof8050449

Contact:
Dr. Andreas Beck
SNSB – Botanische Staatssammlung München
Menzinger Str. 67, 80638 München
Tel.: 089 17861 266
E-Mail: beck@snsb.de