Barcoding the Rust Fungi of Germany

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The German Barcode of Life (GBOL) project is a large-scale DNA barcoding initiative to assess the biodiversity of animals, fungi, and plants of Germany. Here we introduce the subproject focusing on rust fungi (*Pucciniales, Basidiomycota*). This is the only group of fungi represented in the initial 3.5-year phase of the project.

The goal of the rust project is a complete DNA-barcode sequence library for the roughly 500 rust species reported for Germany. The DNA barcode database will link the extensive information available on morphology, ecology, and host range studies with barcoding data linked to individual specimens. Rust fungi are exceptionally well studied in Central Europe. A significant number of cryptic species may be recovered; alternatively, several species described from different hosts may need to be merged. Further, the full life cycles and host relationships, particularly of some host-alternating species, await elucidation. These data will allow identification of rust specimens in museum collections, which to date could not be identified because of missing discriminatory spore states.

Most DNA samples are extracted from herbarium specimens of the fungus collections preserved at the Natural History Museum Karlsruhe in Karlsruhe Germany, but targeted collecting of additional specimens will also be necessary. In the first phase of the project, primer selection and optimization were found to be essential for successful generation of DNA barcodes. The internal transcribed spacer (ITS) rDNA region and the large subunit of the rDNA are suitable common fungal barcode markers. To facilitate high-throughput barcoding, methods have been developed for semiautomatic DNA extraction from herbarium specimens and polymerase chain reactions in 96 well plates.

Currently the following groups are extensively DNA-barcoded: *Uromyces pisi* s.l., an especially complicated complex of species, and the genera *Melampsora* and *Coleosporium*. An example of an as-yet unidentified *Coleosporium* species on invasive *Solidago* (goldenrod) is presented.

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