

Press release

## **New major Danish work: 3000 pages on fungi in Arctic and alpine regions.**

**Danish mycologists are heading an international team of scientists, whom after 45 years now release a new grand work on fungi of the Northern Hemisphere.**

We are talking about the first three volumes of a new mushroom flora (funga), which will be published in seven volumes of 3000 pages and describing 1400 basidiomycetes from the Arctic and Alpine regions of the northern Hemisphere. The three volumes can be downloaded free of charge.

A total of 20.000 collections have been made by the team throughout the period. The material is kept at the Natural History Museum of Denmark, University of Copenhagen, and will be available for other studies in the future.

Each species is treated on two pages, ½ page photo, ½ page description, ½ page map (see below) and ½ page of microscopical features.

The four final volumes will be issued in 2026-27.

### **Extraordinarily comprehensive**

The work is extraordinary in its scope with many species, a large map showing the distribution of the species, often reaching all the way around the North Pole. Comprehensive keys for identification are also given.

Mycologist Henning Knudsen, the former head of the Botanical Museum (today a part of the National History Museum of Denmark), had the leading role with colleagues from Denmark and Greenland, and assisted by colleagues from the Netherlands and Bulgaria. The field work took place over 45 years, during which fungi have been registered in areas stretching from Alaska in the West, to Siberia and Kamchatka in the East, Greenland in the North and the Alps in the South.

### **Unexplored regions**

“These regions of the Northern Hemisphere are largely unexplored for fungi. It is a huge area, so many years were necessary to get the grip on sufficient numbers of collections to be able to make fair conclusions. Many are bound to these cold areas and not to be found elsewhere in the world” says Henning Knudsen.

The purpose of the investigation was to map and identify the species which were found in the area: the common ones, their living conditions in this cold climate, their potential use and the structure of the Arctic ecosystem.

The group found 1400 species of Arctic basidiomycetes, incl. rusts (vol. 2) and smut fungi (vol. 3).

### **New discoveries**

The role of fungi in nature is to decompose and recycle the remnants of the organic material, mainly plants, to benefit themselves and germinating plants. The exploitation of these processes lead to the discovery of novel enzymes, which can be of use in new innovative solutions in biotechnology, biosolutions and pharma.

The fungi were collected by Henning Knudsen, Torbjørn Borgen and Steen A. Elborne, who, since 1980 have collected in Arctic regions in Alaska, Greenland, Iceland, Svalbard, Norway, Sweden, Finland and Siberia, and alpine regions in Switzerland, Germany, France, Austria, Poland, Bulgaria, Romania, Scotland, Japan and the USA (see map for localities below).

“Fungi are often not included in the registration of organisms of the world. They are poorly known, there are many species, fragile and difficult to handle, and they are ephemeral. Due to recent techniques like dna-sequencing, databasing, mobile phones for photography, collections of masses of data from pc and with new repositories like GBIF (Global Biodiversity Information Facility) the road is open for dealing with much larger masses of data. In this way much better knowledge may be achieved in shorter time, and conclusions on the Arctic nature may be made on safer grounds for partners in biotechnical research.” adds Henning Knudsen.

### **Rising temperatures**

The rising temperature of the globe will eventually make the frozen part thaw (40% of the area in Russia is covered by permafrost), and the fungi will start to decay the large masses of organic material, which p.t. is frozen in the underground. This process is expected to exude large masses of methan and carbondioxide to the atmosphere with a potential increase of these essential chemicals on the globe.

-“If we as mycologists one day will hear a minister of environment announce that “this National Park is now opened for the benefit of plants, animal and FUNGI” we will die happy. The fungi is a kingdom in their own right along with plants and animals, but they are strongly underprioritized in public life. In Denmark we know ca. 7600 species of fungi. Many more than plants, but less than the number of animals” says Henning Knudsen.

### **Important for the national product**

For our national product fungi are much more important than both plants and animals. Denmark has an international, strong position in pharma, biotechnology and biosolutions, making products that are often based on fungi. A number of companies like Novo Nordisk, Novonesis and Carlsberg live in a dense understorey of smaller biotech companies, with many more on their way.

When the Japanese wash in cold water, it is partly due to enzymes from e.g. Novonesis, working at low temperatures; when we grow Oyster mushrooms on coffee grains it is a small but imperative sign of the power of fungi to convert a waste product into delicious fungi, and many more options will be open for future entrepreneurs. The new biotechnical methods will only improve the importance of fungi in the decades to come.

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**FAKTA:**

- Volume 1 is an overview of the project and a description of the life of fungi in cold areas. New impressive figures show that 81% of the 950 plants in arctic-alpine regions are parasitized either by rust fungi or by smut fungi; among the remaining 1200 species in vol. 4-7 naturally many will also parasitize plants.
- The smallest willow in Greenland is 5 cm high (*Salix herbacea*), but is symbiotic (a mutually useful and obligatory double life called mycorrhiza) with more than 160 species of basidiomycetes like *Amanitas*, *Russulas*, *Lactarii*, *Cortinarii*, *Hebelomas* and *Inocybes*.
- The author describes a World Wide Web of Willows comprising 66 species in all Arctic and alpine regions, including 5 in Greenland. They have a symbiosis called ecto-mycorrhiza with more than 400 species of ecto-mycorrhiza-demanding fungi, and thereby constitute a substantial prerequisite for life in these areas. The fungal partner decays organic material and with its large cobwebby system of hyphae is much more efficient to gather water than normal roots are. The willow makes photosynthesis and thus sugar for itself and the fungus, and in this way also to the musk ox and other herbivores.
- The project was conducted by Henning Knudsen, curator and associated professor at the Natural History Museum, author and editor of *Funga Nordica* (3000 species) and *Nordic Macromycetes* (1200 pp.), a number of popular mushroom books and scientific papers; Torbjørn Borgen, school teacher in Greenland through 20 years; author of *Pupiit Kalaallit Nunaanni* (Greenlandic fungi), and scientific papers on arctic and alpine waxcaps (*Hygrocybe*) and *Cortinarius*; Steen A. Elborne, cand. scient., working at Hussvamp Laboratoriet (Dry rot fungus Laboratory) for many years, member of the board in the Danish Mushroom Society, co-author of *Nordic Macromycetes* and *Funga Nordica*.
- Two groups of fungi were beyond our expertise and was treated by two Dutch colleagues, A. J. Termorshuizen and C. Swertz, who wrote the volume on the rusts, and similarly two Bulgarian colleagues, T. Denchev and C. Denchev, wrote volume 3 about the smut fungi.
- Aage V. Jensens Fond kindly supported parts of the project.

Homepage: [www.funga-arctica-alpina.dk](http://www.funga-arctica-alpina.dk) from where the three volumes can be downloaded.

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