



SWEDISH TAXONOMY INITIATIVE PROJECT REPORT

Project period: 2004–2007

Ellen Larsson
University of Gothenburg,

FUNGI:

Taxonomy and phylogeny of mycorrhiza-forming Agaricales

Inocybe is regarded as one of the larger genera within Agaricales, with an estimated 500 species world-wide (Kirk et al. 2001).

The knowledge about which species occur in Sweden has relied on the surveys by Stig Jacobsson and Leif and Anita Stridvall in Southwest Sweden. Eighty-nine species were then reported (Jacobsson et al 1989).

Several morphological characters have been used for infrageneric classifications of *Inocybe*, most notably spores, cystidia and stipe form. The spores may be ellipsoid, amygdaliform or nodulose/angular. Many species have incrustated thick-walled pleuro- and cheilocystidia (metuloids). Some large groups completely lack the metuloids but then always have numerous thin-walled cheilocystidia. Caulocystidia may be absent or completely cover the stipe.

The stipe may be uniform or have a distinctly bulbous base. A number of classifications combining these and other characters in various ways have been proposed (Heim 1931, Kühner 1980, Kuyper 1986, Singer 1986, Stangl 1989, Kobayashi 2002).

The aim of this project was to: 1) identify the number of species occurring in the Nordic countries, 2) infer phylogenetic relationships among them and, 3) compare the various morphology-based classifications of *Inocybe* with the results from our molecular-based phylogeny.

Collecting was mainly undertaken in boreal forests, arctic/alpine zone and coastal sand dune areas where previous data of species occurrence were insufficient. In total about 900 collections have been preserved and deposited in herbarium GB, University of Gothenburg.

Sequences of three regions were generated, the complete ITS region, 1200 base pairs of the 5' end of the nuclear LSU, and the mitochondrial SSU ribosomal DNA. About 700 specimens were sequenced. Published sequences have been submitted to GenBank (<http://www.ncbi.nlm.nih.gov/genbank/>) and UNITE (http://www2.dpes.gu.se/project/unite/UNITE_intro.htm).

Based on morphology and molecular phylogenetic analyses we have identified about 150 species from Sweden and 160–170 species in the Nordic countries. These species are now included in the key to *Inocybe* in *Funga Nordica* (Jacobsson and Larsson 2012).

In addition, several unidentified clades and sequences on single branches were recovered in the phylogenetic analyses. These terminals may represent new species, either not described or described from another region but not yet identified.

The phylogenetic analyses recovered *Inocybe* as monophyletic. Molecular data also indicate that *Inocybe* should be recognized at the family level.

Four major supported clades were recovered. Two of these conform to subgenus *Inocybe*, which includes all species with incrustated cystidia (metuloids) irrespective of spore shape, and with subgenus *Mallocybe* that includes species with thin-walled cheilocystidia originating from the subhymenium, and dark pigmented basidia.

The other two supported clades cut through the current classification of subgenus *Inosperma* and its two sections *Cervicolores* and *Rimosae*. Section *Rimosae* has traditionally included species with radially fibrillose to rimose (squamulose) caps, ellipsoid to phaseoliform spores, densely packed simple, cylindrical, clavate to pyriform hymenial cheilocystidia. Section *Rimosae* sensu stricto now emerges as a strongly supported sister clade to subgenus *Inocybe* while the rest of *Rimosae* (the *maculata* group) clusters with section *Cervicolores*.

In a revised family Inocybaceae these four clades would correspond to genera as *Inocybe*, *Mallocybe*, *Inosperma* (the *maculata* group + *Cervicolores*), and an as yet unnamed genus covering section *Rimosae* sensu stricto.



Four of the species that were identified as new to Sweden during the project, *Inocybe leucoma*, *I. fulvipes*, *I. dulcamaroides* and *I. bulbosissima*. All were collected from alpine sites in the Abisko mountains. Photo: Ellen Larsson.

PUBLICATIONS AS OUTCOME OF THIS PROJECT

- Ryberg, M, Nilsson, RH., Kristiansson, E., Topel, M., Jacobsson, S., Larsson, E. 2008. Mining metadata from unidentified ITS sequences in GenBank: a case study in *Inocybe* (Basidiomycota). *BMC Evolutionary Biology* 8:50.
- Larsson E, Ryberg M, Moreau P-A, Delcuse Mathiesen Å, Jacobsson S. 2009. Taxonomy and evolutionary relationships within species of section *Rimosae* (*Inocybe*) based on ITS, LSU and mtSSU sequence data. *Persoonia* 23:86-98, doi:10.3767/003158509X475913.
- Jacobsson S, Larsson E. 2009. *Inocybe spuria*, a new species in section *Rimosae* from boreal coniferous forests. *Mycotaxon* 109:210-207
- Ryberg M, Larsson E, Jacobsson S. 2010. An evolutionary perspective on morphology and ecological characters in the mushroom family Inocybaceae (Agaricomycotina, Fungi). *Molecular Phylogenetics and Evolution* 55:431-442, <http://dx.doi.org/10.1016/j.ympev.2010.02.011>
- Cripps C, Larsson E, Horak E. 2010. Subgenus *Mallocybe* (*Inocybe*) in the Rocky Mountain alpine zone with molecular reference to European Arctic-alpine material. *North American Fungi*. 5(5):97-126
- Jacobsson S. 2008. *Inocybe* (Fr.) Fr. In: Knudsen H, Vesterholt J. (Eds.) *Funga Nordica*. Nordsvamp, Copenhagen, pp 868-906.
- Jacobsson S., Larsson E. 2012. *Inocybe* (Fr.) Fr. In: Knudsen H, Vesterholt J. (Eds.) *Funga Nordica*. Agaricoid, boletoid, cyphelloid and gasteroid genera, Nordsvamp, Copenhagen, pp. 981–1021.

Reviewed and approved: 2016-04-04