

SWEDISH TAXONOMY INITIATIVE RESEARCH REPORT

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LICHENS:

Taxonomy and phylogeny of non-calciferous and non-marine *Verrucaria* in Sweden



Picture 1. Rich Verrucariaceae habitat: shore rocks along a river.
Photo: L. Tibell.

In my continued work on Verrucariaceae, especially *Verrucaria*, two conclusions have emerged as a result of the project:

1. *Verrucaria*, as traditionally defined, is not monophyletic, but its morphological characterization was based on plesiomorphic characters within the family, primarily the non-septate spores.

2. Species recognition in *Verrucaria* has traditionally been based on morphological characters, and naming mostly rests on old type materials. Sequence data do not support these morphospecies as monophyletic, and a characterization of the named species based on available morphological information does not appear to be possible. A number of genetically well-defined species discovered in my investigations cannot be morphologically differentiated from each other and from previously described morphospecies.

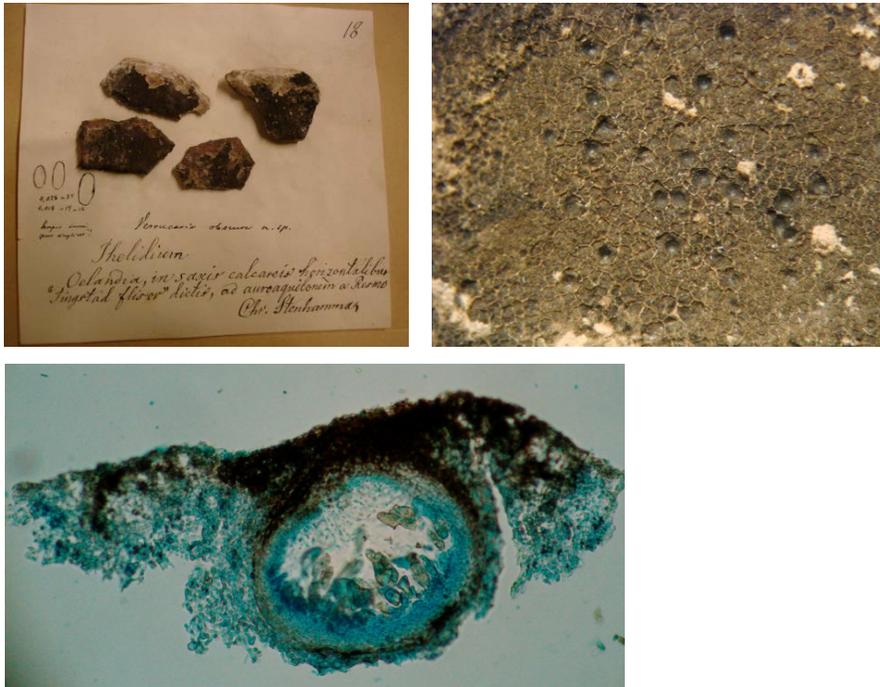


Fig. 2. 'Historic' collection of *Verrucaria obscura*. Photo: S. Tibell.

Fig. 3. Thallus with fruit-bodies of *Verrucaria obscura* Photo: S. Tibell.

Fig. 4. Section of fruit-body of *Verrucaria obscura* Photo: S. Tibell.

Strikingly similar results were also demonstrated in a barcoding project on calciferous *Verrucaria* from Finland, undertaken by Pykälä (2012). Under these circumstances, it seems futile to continue to work with a non-functioning concept under an outdated paradigm. A morphological characterization of species quite simply does not work in *Verrucaria*, where the morphological variation is limited. Thus, future species delimitation and species descriptions have primarily to be based on sequence data. Rather than adding new species to *Verrucaria* and further adding to the confusion, my work has led to this reflection, and to considerable doubt about the validity of the species listed as occurring in Sweden according to Santesson et al. (2004) or any other list based on morphological species recognition in *Verrucaria*.

In addition, I have also been looking for monophyletic groups to be distinguished as genera, but the '*Verrucaria*' species are widely scattered across the family. Although I started a

manuscript to summarize one group, it is not yet ready for publication since a large number of nomenclatural questions require much additional work as well as the question of which species should be included in this genus, as several of its probable members have not yet been sequenced. The work has simply been too extensive for my time horizon.

The project has continued with extensive field work / collection of material, sequencing and analyses. Further contributions have included following-up of my previous work on Verrucariaceae. A partial study of the 'Thelidium group', including several 'Verrucaria' species, has been carried out and shows the need to recognize this as a separate genus - a radical break with the previous tradition (Savić S & Tibell L 2010, IMC9, congress contribution). A detailed revision of *Polyblastia* has been published (2012). Furthermore, a new species of the genus *Atla* (*A. recondita*) has been described from Sweden, and another new *Atla* species (*A. alaskana*) was described from Alaska (Tibell & Tibell 2015).

In the project I have thus introduced a new paradigm for classifying and naming *Verrucaria*, which might not be popular, neither among taxonomists in general nor by ArtDatabanken. However, I think that awareness of a similar situation also in other groups of both lichenized and non-lichenized fungi will grow and necessitate new methods for gathering and communicating information about species. Traditional nomenclature will face major problems, at least until we can reconstruct degenerated DNA and sequence it from old type materials.

Consequences of conclusions 1 and 2 above

My own observations of the difficulty of morphological characterization of species even when molecular data consistently indicate conspecificity was also demonstrated in a barcoding project undertaken by Pykälä (2012), which was presented in poster form at the IAL7 Congress in Bangkok in January 2012. The reported phylogeny showed the same (morphologically characterized) *Verrucaria* species at different locations in the tree. There was thus no congruence between traditional morphological identification of species (undertaken by a leading 'traditional' Verrucariaceae expert, Othmar Breuss) and genetic identification (sequence data, ITS).

Under these circumstances, it seems futile to continue to work with a non-functioning concept under an outdated paradigm. Instead, future species delimitation and species descriptions should primarily be based on sequence data. Morphological characterization seems simply not to work with the data in *Verrucaria*, where the morphological variation is limited. This requires rethinking and radically new concepts and methods for identifying and naming species.

Rather than adding new species to *Verrucaria*, my work has led to this reflection and also to considerable doubt about the validity of the species listed as occurring in Sweden according to Santesson et al. (2004) or any other list based on morphological species recognition. Additional publishing of new *Verrucaria* species based only on morphology is making the situation in the genus even more complicated.

This situation has partly already been described in a publication where I was co-author (Gueidan et al. 2011) and where the phylogeny was based on the analyses from Savić et al. (2008). With support from molecular data, the following genera were recognized: *Bagliettoa*, *Hydropunctaria*, *Parabagliettoa*, *Verrucula*, *Verruculopsis*, *Wahlenbergiella*, all traditionally referred to as *Verrucaria*. In my studies of *Verrucaria* I have been looking for additional

monophyletic groups to be distinguished as genera, but the remaining 'Verrucaria' species are mostly widely scattered within the family.

A group that is a suitable candidate for discernment as a monophyletic genus is the 'Thelidium group', which I identified in an early publication (Savić et al. 2008). In this we find species currently placed in several genera as delimited in the pre-molecular paradigm, namely in addition to *Verrucaria* also *Polyblastia*, *Staurothele* and *Thelidium*. Although I have started writing a manuscript to summarize this group, it is not ready for publication since a large number of nomenclatural questions require much additional and time-consuming work as well as decisions on which species to include in this genus, as several of its potential members have not yet been sequenced.

Actual contributions during the project

The project has continued with extensive field work / collection of materials, sequencing and analyzes. A partial study of the "Thelidium group", including several *Verrucaria* species has been carried out and shows the need to recognize this as a separate genus, a radical break with the previous tradition. Further contributions have included following-up of my previous work with Verrucariaceae. A detailed revision of *Polyblastia* has been published (Savić & Tibell, 2012). A new species of the genus *Atla* (*A. recondita*) has been described from Sweden, and another new *Atla* species from Alaska (Tibell & Tibell 2015) (Figs 6, 7).

A further extensive work has been initiated during the period, namely the production of a first Verrucariaceae volume of the Nordic Lichens Flora (in prep.). The text of my contribution has been submitted, but with the photographic images partly missing. Here I am the author of *Atla*, *Henrica*, *Polyblastia*, and *Sporodictyon*.

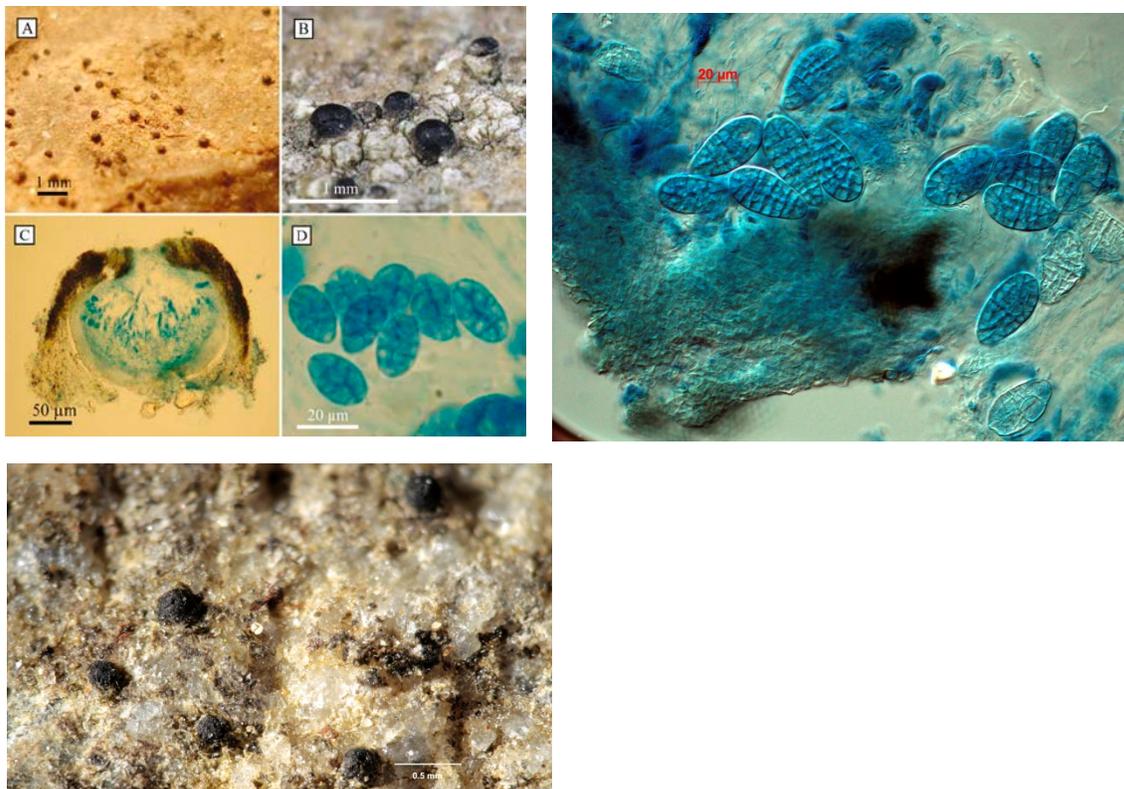


Fig. 5 (top left). Thallus, detail of thallus, section of fruit-body and spores in *Polyblastia borealis* Savić & Tibell, new to science described from Torne Lappmark, Sweden. Photo: S. Tibell).

Fig. 6 (top right). *Atla recondita* Tibell & Tibell. A species new to science described from Härjedalen, Sweden. Scale: 0.5 mm. Photo: G. Hillman.

Fig. 7 (bottom left). *Atla recondita*. Spores. Scale: 20 µm Photo: S. Tibell.

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