Fraunhofer
IBP

FRAUNHOFER INSTITUTE FOR BUILDING PHYSICS IBP

IBP REPORT 532

41 (2014) NEW RESEARCH RESULTS IN BRIEF

UNEXPECTED DIVERSITY IN MOSSES ON WALLS OF MODERN BUILDINGS

Wolfgang Hofbauer, Laura L. Forrest*, Michelle L. Hollingsworth*, Thorsten Rennebarth, Klaus Breuer

Fraunhofer Institute for Building Physics IBP

Nobelstrasse 12, 70569 Stuttgart, Germany
Phone +49 711 970-00
info@ibp.fraunhofer.de

Holzkirchen Branch
Fraunhoferstr. 10, 83626 Valley, Germany
Phone +49 8024 643-0

Kassel Branch
Gottschalkstr. 28a, 34127 Kassel, Germany
Phone +49 561 804-1870

www.ibp.fraunhofer.de

**Royal Botanic Garden Edinburgh (RBGE), 20A Inverleith Row, Edinburgh EH3 5LR, United Kingdom, www.rbge.org.uk*

Literature *– [1] Hofbauer W. 2007. Aerophytic organisms on building surfaces (Aerophytische Organismen an Bauteiloberflächen), Ph.D. Thesis, Innsbruck University (Austria) – [2] Blom H.H. 1996. A revision of the Schistidium apocarpum complex in Norway and Sweden. Bryophytorum Bibliotheca 49 – [3] Milyutina, I.A., Goryunov, D.V., Ignatov, M.S., Ignatova, E.A., and Troitsky, A.V. 2010. The phylogeny of Schistidium (Bryophyta, Grimmiaceae) based on the primary and secondary structure of nuclear DNA Internal Transcribes Spacer. Molecular Biology 44(6): 883-897 – [4] Ignatova, E.A., Blom, H.H., Goryunov, D.V., and Milyutina, I.A. 2009. On the Genus Schistidium (Grimmiaceae, Musci) in Russia. Arctoa 19: 195-233 – [5] Bell, D., Long, D.G., Forrest, A.D., Hollingsworth, M.L., Blom, H.H., and Hollingsworth, P.M. 2012. DNA bar coding of European Herbertus (Marchantiopsida, Herbertaceae) and the discovery and description of a new species. Mol Ecol Resour. 12(1):36-47 – [6] Frahm, J.-P. 2008. Naturpatent Moos. Umwelt & Gesundheit 1(2008): 13-6*

INTRODUCTION

Previous investigations of the first colonizers of modern building surfaces, especially of external thermal insulation compound systems (ETICS), revealed that after a certain while certain mosses may be found amongst them [1]. Usually fungal and algal colonizers are faster, but after only a few years, moss growth may start if conditions are favorable. Grimmias (*Schistidium* spp.) are prominent colonizers amongst primary biological growth on modern building surfaces. In the past, almost all *Schistidium* growth on man-made surfaces was attributed to a very broad species group called "*Schistidium apocarpum s.l.*". The taxonomy of this critical genus has advanced considerably in recent years and it has been shown that a narrow species concept is most appropriate (e.g. [2], [3]) Furthermore a narrow morphological species concept better fits patterns of DNA sequence variation [3], [4].

METHODS

The growth of *Schistidium* on buildings is slow and its development is often incomplete. The presence of morphological characters required for species identification is therefore often limited and, as a consequence, these building colonizers are still often assigned to *Schistidium apocarpum s.l.*

In recent years, DNA barcoding has been extensively used in studies of species complexes, to aid species assignments for morphologically cryptic species and the identification of new species (e. g. [5]). The application of DNA barcoding to obtain a genetic signature for well-identified "reference" material is a powerful tool, allowing subsequent species identification from environmental samples.

To utilize these facts, a common project between the "Royal Botanic Garden Edinburgh (RBGE)" and the main author from the Fraunhofer-Institute for Building Physics IBP was undertaken, with the main author awarded with a SYNTHESIS grant (GB-TAF-3881). The primary aim of this project was to obtain DNA barcodes of samples that are involved in the primary colonization of building surfaces (masonry), with special emphasis on the genus *Schistidium*. The herbarium at RBGE holds over 600 specimens of *Schistidium* from collections made worldwide. From these, specimens of *Schistidium* species thought to be involved in the colonization of European buildings were examined morphologically and sampled for DNA analysis. In light of this preliminary study, recently collected material was examined and grouped according to morphological characters (where present). A subset of these samples (representative of the different types) was DNA barcoded using up to four loci (rbcL, matK, psbA-trnH and ITS). A comparison of DNA barcodes from samples collected from masonry to those of previously identified material

and specimens collected from the surroundings of the building sites gives a first insight into the taxonomy of *Schistidium* species inhabiting modern building structures. Preliminary results are presented below.

RESULTS AND DISCUSSION

Although several species are mentioned in literature as growing on old man-made surfaces [2], [3], [4]. Thickpoint Grimmia (*Schistidium crassipilum*) seems to be prevalent on concrete and the like. It was expected that either a restricted number of specialist taxa would be prevalent on modern building surfaces, or that the species would be recruited by chance from the nearby vicinity. In our recent survey of *Schistidium* populations from man-made structures in Europe, several different taxa have been identified, with far more diversity than expected; similar taxa occur on man-made structures in geographically distinct regions. At least two major groups, although morphologically rather similar, can be identified in the molecular analysis of the first 23 samples.

Diagram 1 shows a genetic distance tree generated using DNA sequences from the nuclear ITS region of these samples. Apart from control samples of species usually growing on rocks in the wild, the other samples are mainly recruited from man-made substrates like masonry and concrete: these are divided clearly into two major groups. In the final project, far more samples and more genetic regions are under progress; it will be interesting to see how the picture resolves. Very preliminary results from the wider analysis have already shown that the two main groups may have internal structure. However in order to identify all the involved groups, more extensive sampling is necessary.

Overall it is clear that there are many different systems, designs and materials used in modern construction and these are obviously also mirrored by the different species/subspecies of *Schistidium* that are part of the primary colonization.

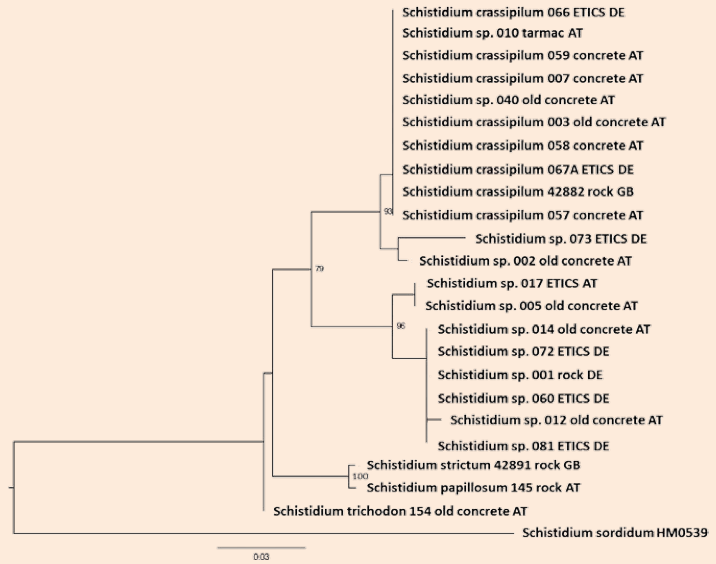
To resolve this pattern may offer the following advantages: On one hand, this research may lead to better control of moss growth on building surfaces, not only by tailor-made chemical or physical measures, but also by exclusive biocontrol of dominant species. In contrast, the gained knowledge can also be utilized to allow deliberate induction of moss growth on masonry, which can be beneficial for insulation, aesthetics and carbon sequestration. It has already been shown that mosses can bind and break down particulate matter and pollution from the air [6].

Further results of the current project include:

- a reference library of DNA barcodes,
- a review of genetic characters on herbarium and recent collections of *Schistidium* that were previously classified by morphological characters and
- the proof that, in the investigated moss genus, DNA barcoding can be successfully used to identify otherwise indistinguishable samples.

Concurrently, further planning involves work identified by DNA barcoding, for deliberate cultivation on building surfaces. The already existing experience of moss cultivation, in both institutions, on varied artificial surfaces, and RBGE's expertise in growing a broad range of organisms, means that there is potential for much useful knowledge exchange.

Diagram 1: Preliminary grouping of the first 23 samples according to genetic distance (scale bar and confidence level given) of the ITS region. Samples which could not yet be delimited to species level according to morphological characters are marked with "sp.". Additional the record numbers, the substrates and the international state codes are given. *Schistidium sordidum* is used as an out-group.



1 *Thickpoint Grimmia (Schistidium crassipilum) growing on a concrete wall, detail.*

2 *Specimen wall with early growth of moss (Grimmia) on it.*

3 *Beginning moss growth at the surface of a modern building.*