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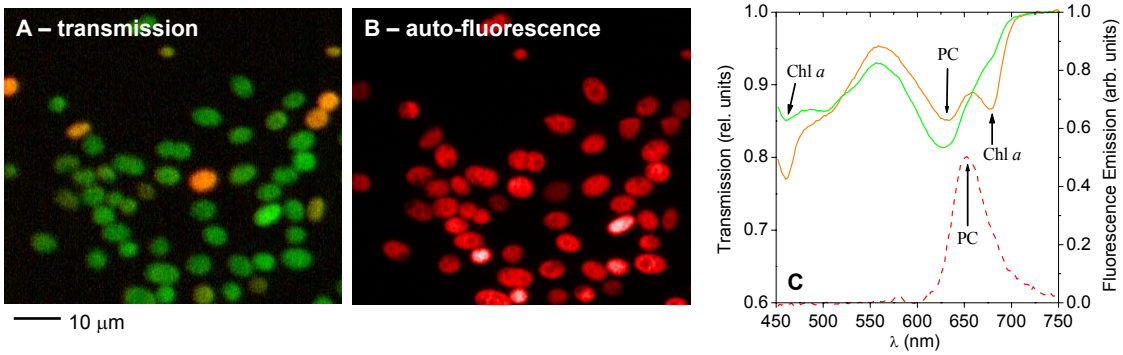
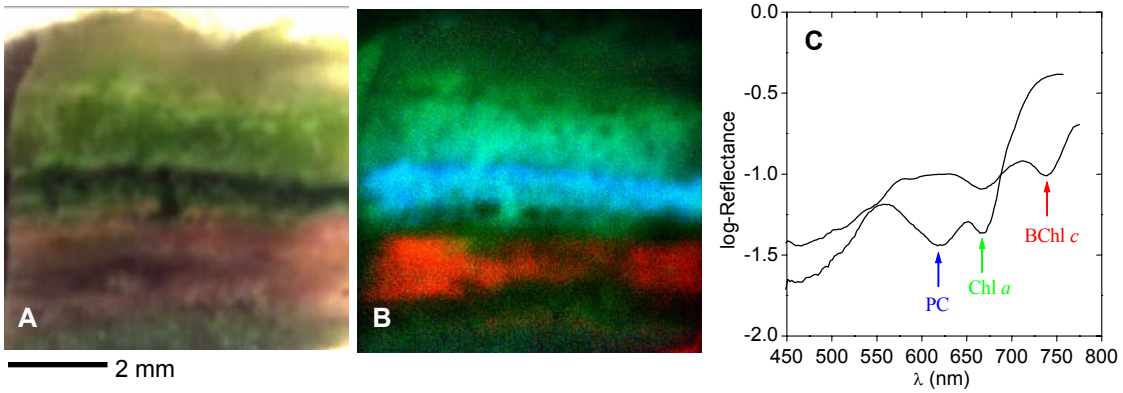
Spectral Imaging for Research on Phototrophic Microbial Communities

Photosynthetic microbial communities are often complex 3-dimensional structures that exhibit complex and dynamic behaviors. To obtain improved experimental tools to study these fascinating microbial systems, a group at the Max Plank Institute in Bremen, Germany, has developed a technique employing a Resonon imaging spectrometer [1-3]. By utilizing modular components, they have obtained high quality hyperspectral images of objects as small as a single cell to as large as tens of cm^2 in size. Additionally, they have developed software for pigment-specific analysis, which is available for other researchers [4]. With this system, they have non-invasively identified pigments in single cells and mapped the spatial organization of phototrophic groups in complex microbial communities. Examples are shown in the following images.



Microscopic spectral imaging of cyanobacterial cells through a 40× objective lens. False-color images were derived from the second derivative of the transmission spectrum at wavelengths corresponding to the absorption maximum of photopigments Chlorophyll *a* and phycocyanin (panel A) and from the magnitude of phycocyanin auto-fluorescence (green excitation at λ_{max} = 550 nm; panel B). Panel C shows the corresponding transmission (solid lines) and auto-fluorescence (dashed line) spectra. Images courtesy of L. Polerecky.



Mesoscopic spectral imaging of a photosynthetic microbial mat. Panel A shows the direct image of the vertical mat section, as it would approximately appear to the naked eye. Panel B shows the distributions of photopigments in the mat, as derived from the second derivative of the log-transferred spectral reflectance at wavelengths corresponding to the absorption maximum of Chlorophyll *a* (green), phycocyanin (blue) and Bacteriochlorophyll *c* (red). Panel C shows examples of log-transferred reflectance spectra. Images courtesy of L. Polerecky.

References

1. L. Polerecky, A. Bissett, M. Al-Najjar, P. Faerber, H. Osmers, P.A. Suci, P. Stoodley, and D. de Beer, “Modular spectral imaging system for discrimination of pigments in cells and microbial communities,” Applied and Environmental Microbiology **75**:3, 758-771, 2009.
2. M. Kühl and L. Polerecky, “Functional and structural imaging of phototrophic microbial communities and symbioses,” Aquatic Microbial Ecology **53**, 99-118, 2008.
3. A. Bachar, L. Polerecky, J.P. Fischer, K. Vamvakopoulos, D. de Beer, and H.M. Jonkers, “Two-dimensional mapping of photopigment distribution and activity of *Chloroflexus*-like bacteria in a hypersaline microbial mat,” FEMS Microbial Ecology **65**, 434-448, 2008.
4. To obtain a copy of the software, please contact Lubos Polerecky at lpolerec@mpi-bremen.de or visit www.microsen-wiki.net.