The background of the slide is a photograph of a lichen growing on a light-colored, textured rock surface. The lichen has a complex, branching structure with various shades of green and brown. The overall image is semi-transparent, allowing the text to be clearly visible.

Investigations with the bbe Benthofluor - Fluorescence Patterns of a (terrestrial) Lichen

Anna Maćkowiak

3 VII 2008

Plan

1. Intention

2. Lichens


a. Types

b. Structure

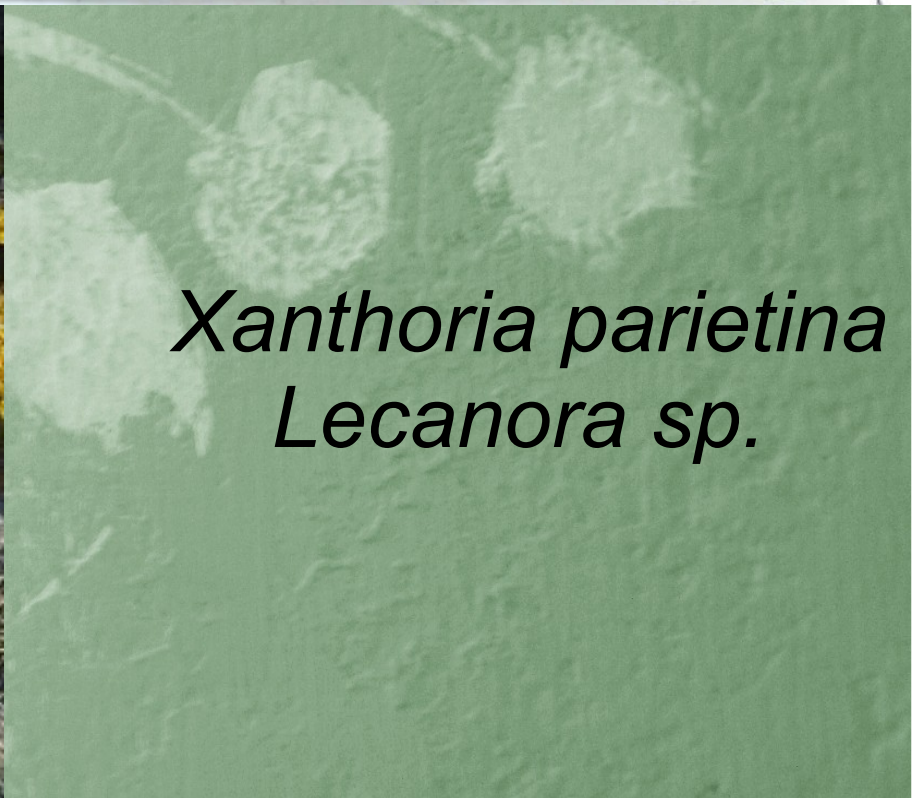
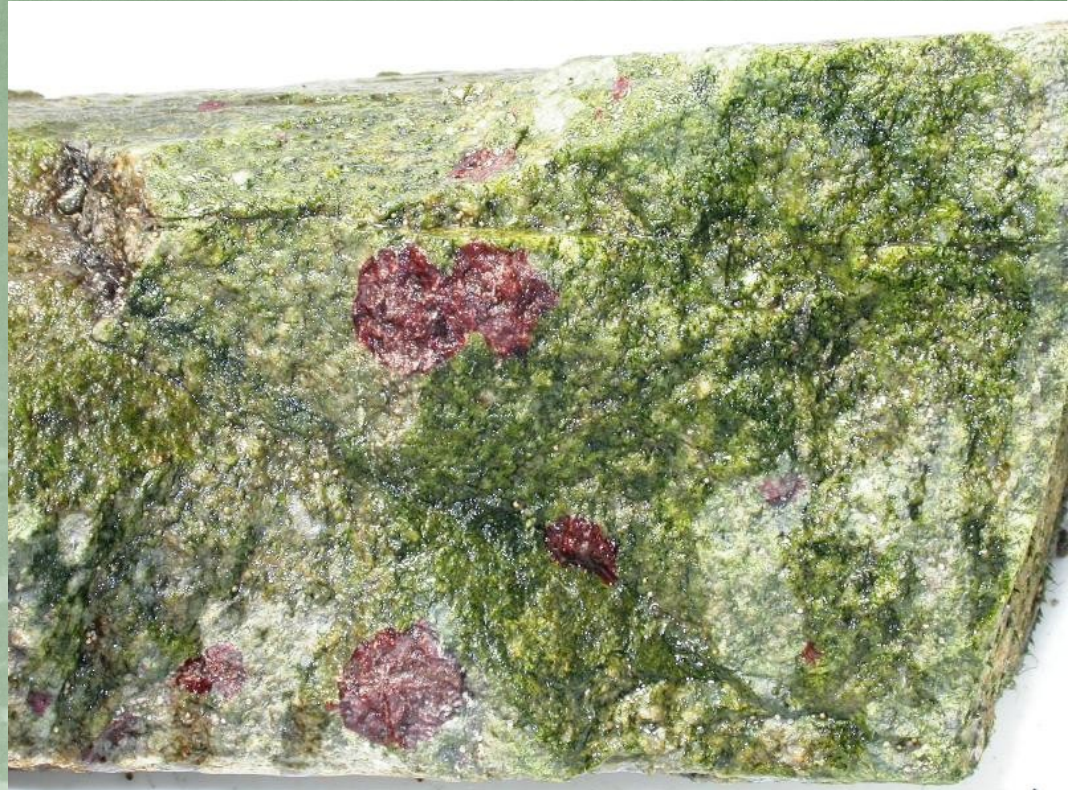
c. Habitat

2. Fluorescence of lichens

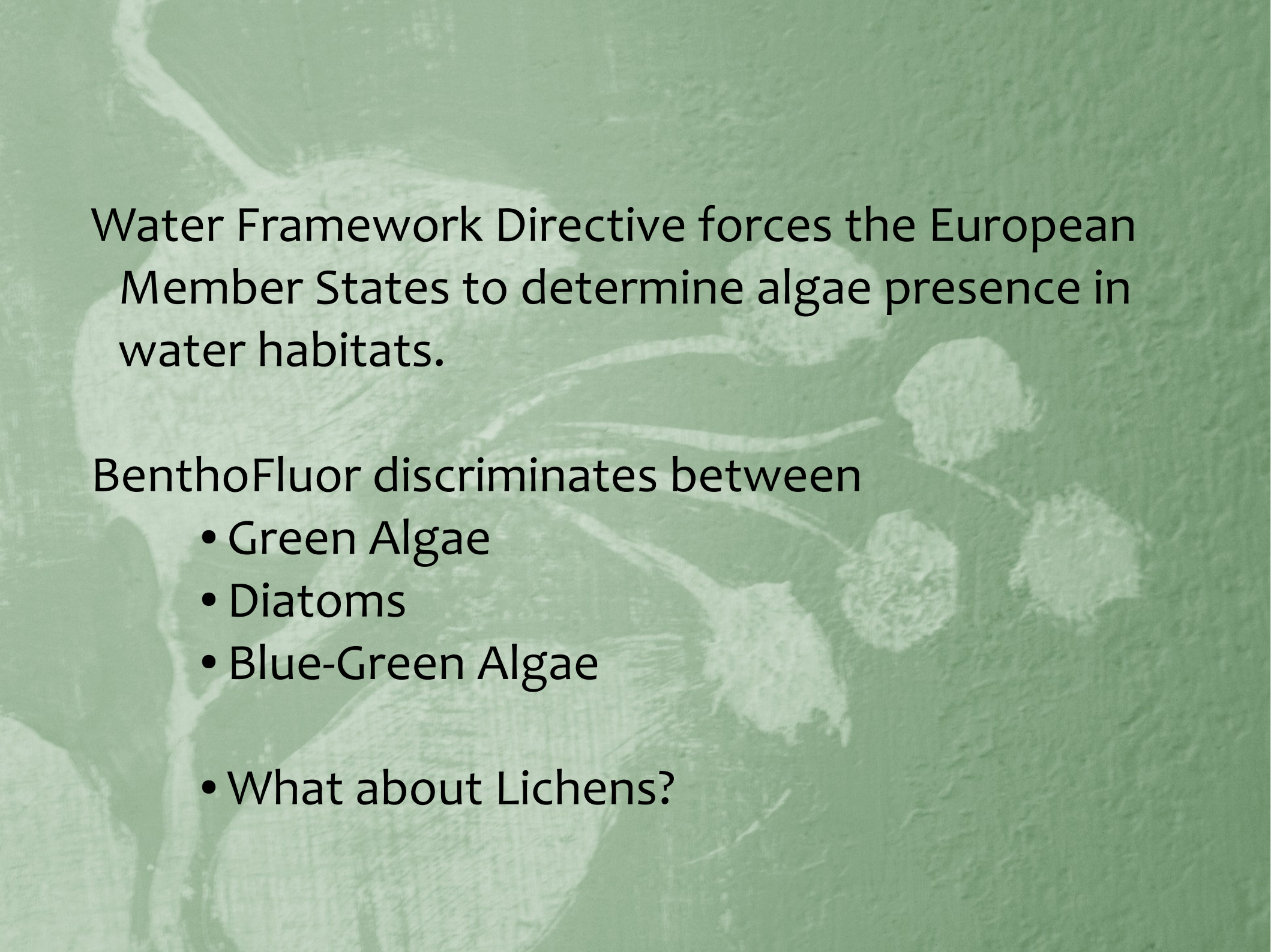
3. Determination of lichens by fluorescence



Algae on stone
surface



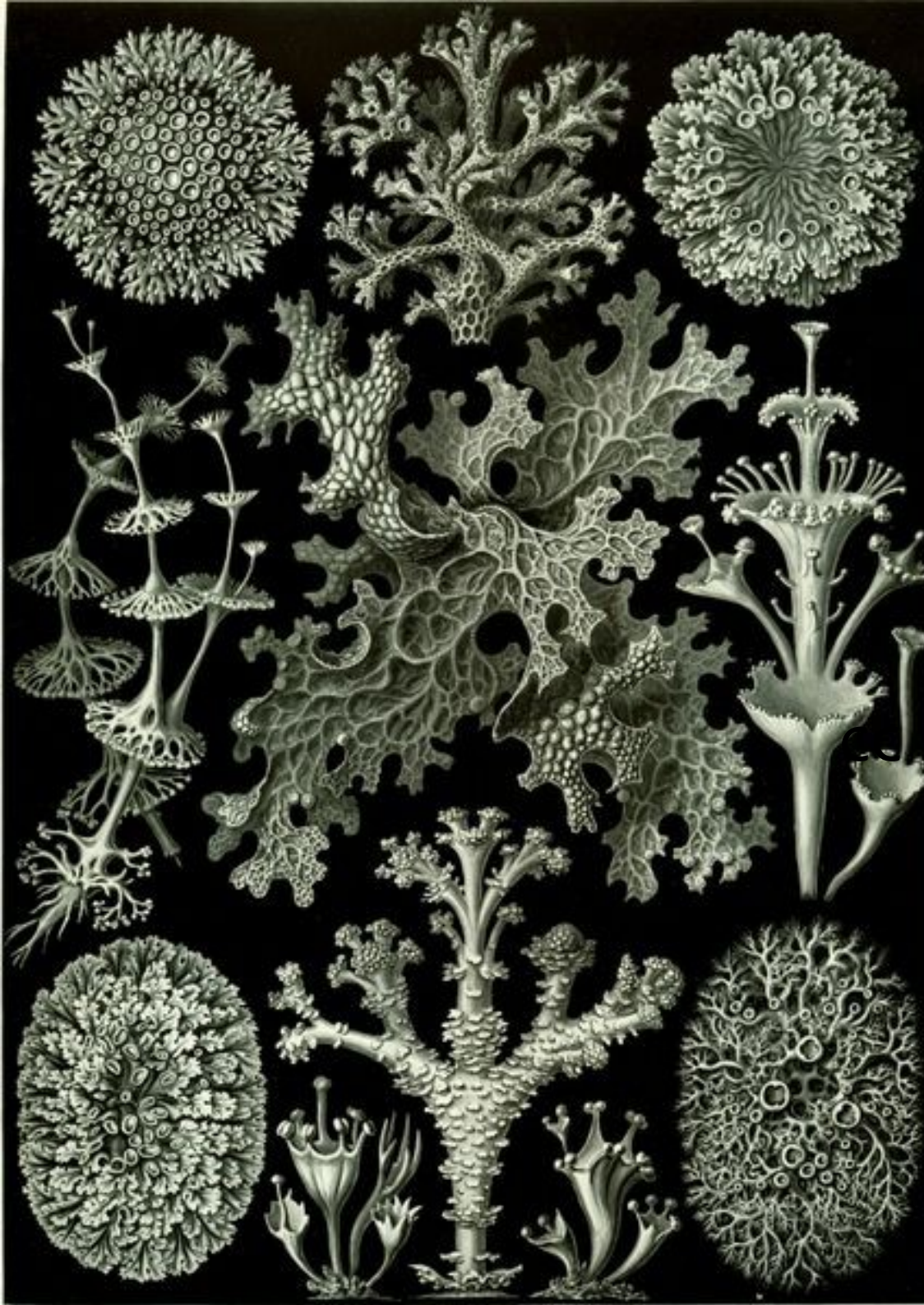
Xanthoria parietina
Lecanora sp.

A microscopic view of various algae, including green algae, diatoms, and blue-green algae, set against a green background. The algae are shown in various forms, some as long, thin filaments and others as more rounded, textured structures.

Water Framework Directive forces the European Member States to determine algae presence in water habitats.

Benthofluor discriminates between

- Green Algae
- Diatoms
- Blue-Green Algae
- What about Lichens?



Lichen:
=
Mycobiont
+
Photobiont

Lichen

Lichen symbiosis is parasitic or mutualistic?

Lichens "provide" the algae with water and minerals that the fungus absorbs from whatever surface the lichen is growing on, i.e. its substrate. As for the alga, it uses the minerals and water to build assimilates for the fungus and itself.

Lichen Types

crustose - paint-like, flat e.g., *Caloplaca flavescens*

filamentous - hair-like, e.g., *Ephebe lanata*

foliose - leafy, e.g., *Hypogymnia physodes*

fruticose - branched, e.g., *Cladonia evansii*, *C. subtenuis*, and
Usnea australis

leprose - powdery, e.g., *Lepraria incana*

squamulose - consisting of small scale-like structures, lacking
a lower cortex, e.g., *Normandina pulchella*

Lichen Thallus

Homeomerous

- no layers can be determined

Heteromerous

- layer structure contains

cortex - consisting of densely packed fungal hyphae

algal layer

medulla - layer of loosely interwoven fungal hyphae without algal cells

lower cortex

NON-STRATIFIED (HOMOEOMEROUS) THALLI

e.g. crustose



Graphis scripta



numerous spp. of the

Arthoniales	Opegraphales
Caliciales	Ostropales
Dothideales	Pertusariales
Graphidales	Pyrenulales
Gyalectales	Teloschistales
Lecanorales	Verrucariales
Leotiales	

a

INTERNALLY STRATIFIED (HETEROMEROUS) THALLI

e.g. foliose (dorsiventrally organized)

with upper cortex only



Peltigera venosa



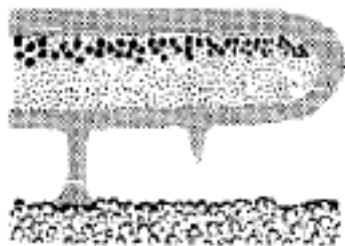
examples: numerous spp. of the genera
Peltigera, *Solorina* (Peltigerales)
Cladonia (Lecanorales)

b

with upper and lower cortex



Parmelia tillacea



examples: numerous spp. of the genera
Parmelia (Lecanorales)
Xanthoria (Teloschistales)
Nephroma, *Sticta*, *Pseudocyphellaria*
(Peltigerales)

c

 substratum  conglutinate zones  aerial hyphae  photobiont cells

Figure 1 Examples illustrating a small part of the morphological and anatomical diversity in the lichen symbiosis.

Structure

Fungi – Algae Relation

Hygroscopic property of lichens

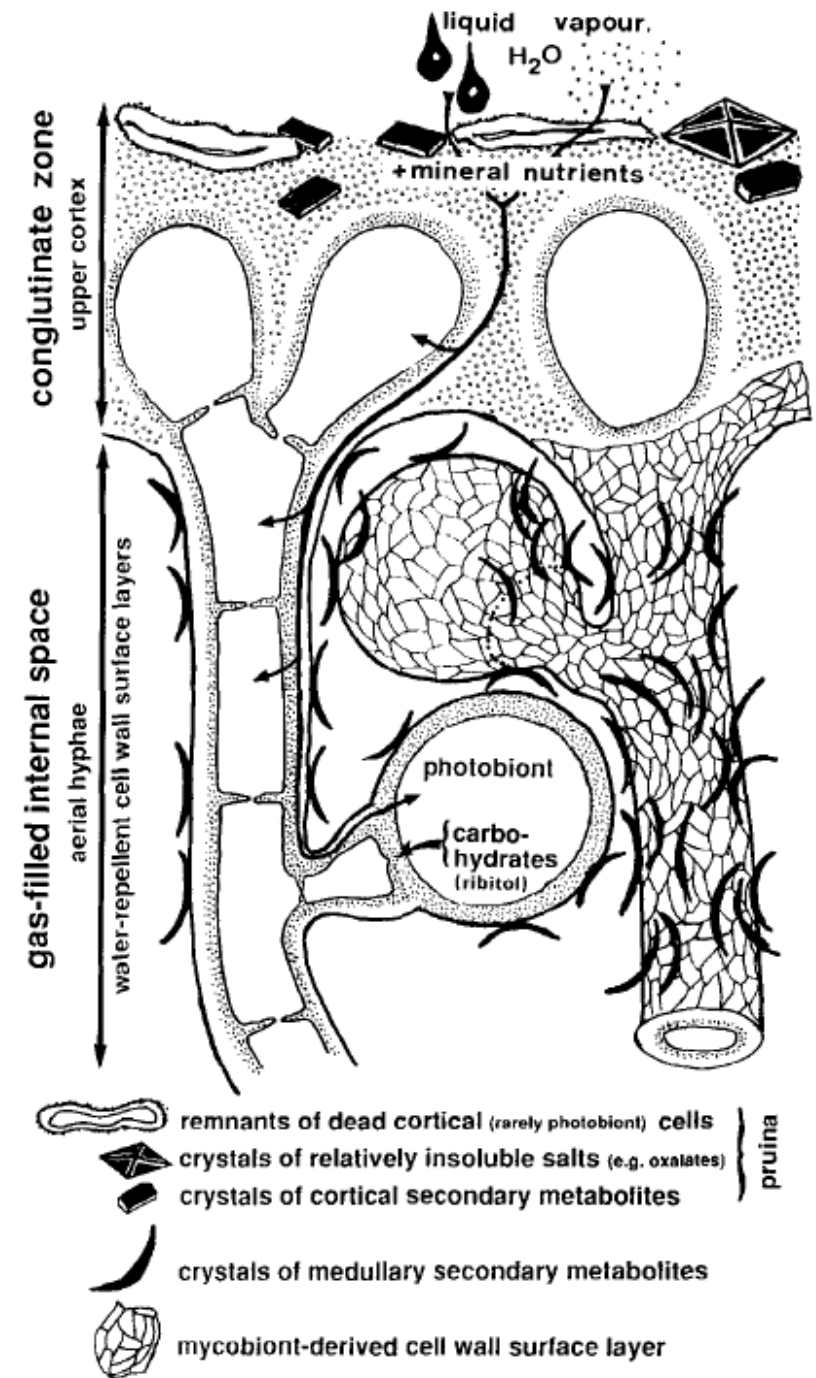
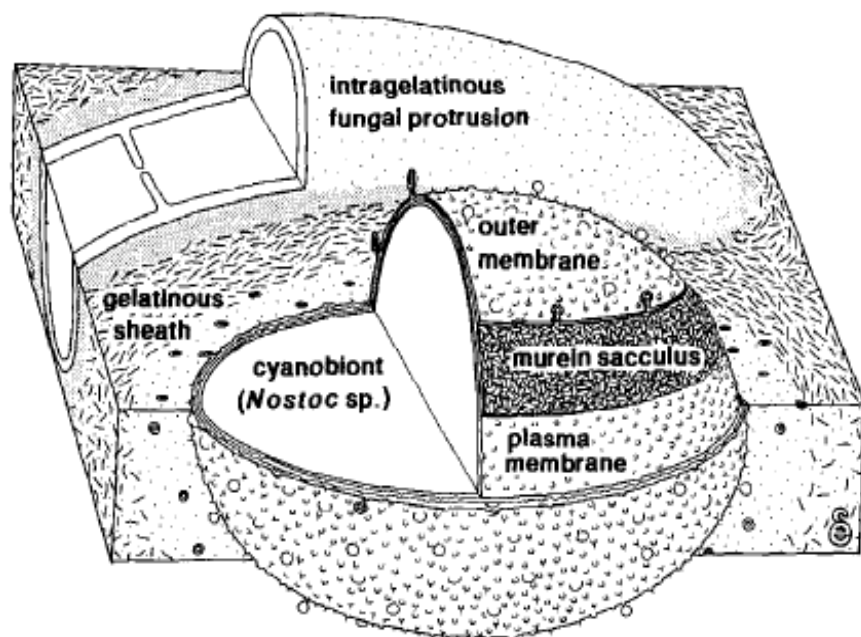
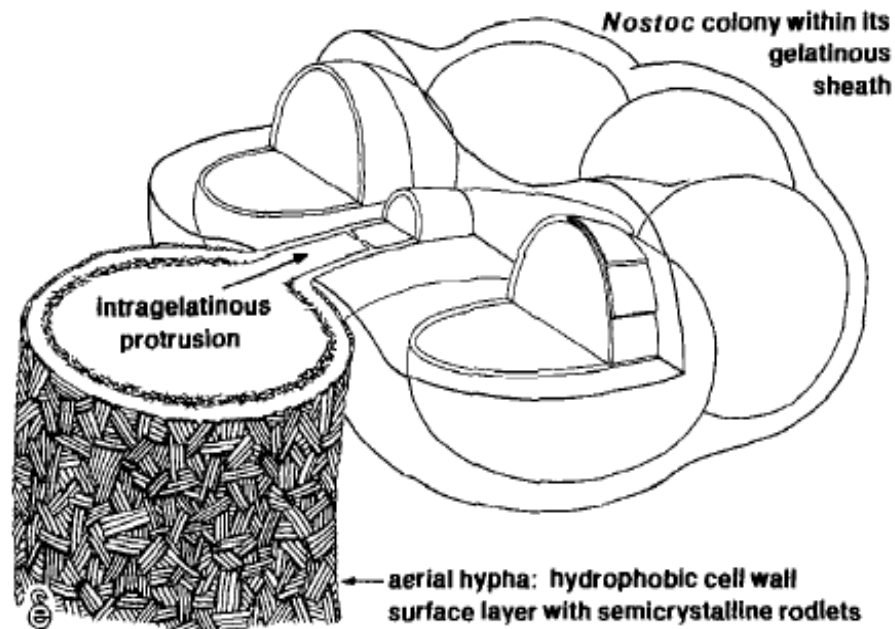


Figure 5 Diagram illustrating functional aspects in Parmeliaceae with *Trebouxia* photobionts. Comparable, horizontally dissected thallus fragments were used in inhibition-technique experiments (94). There is an apoplastic continuum between the fungal partner and the *Trebouxia* cells. After 59.

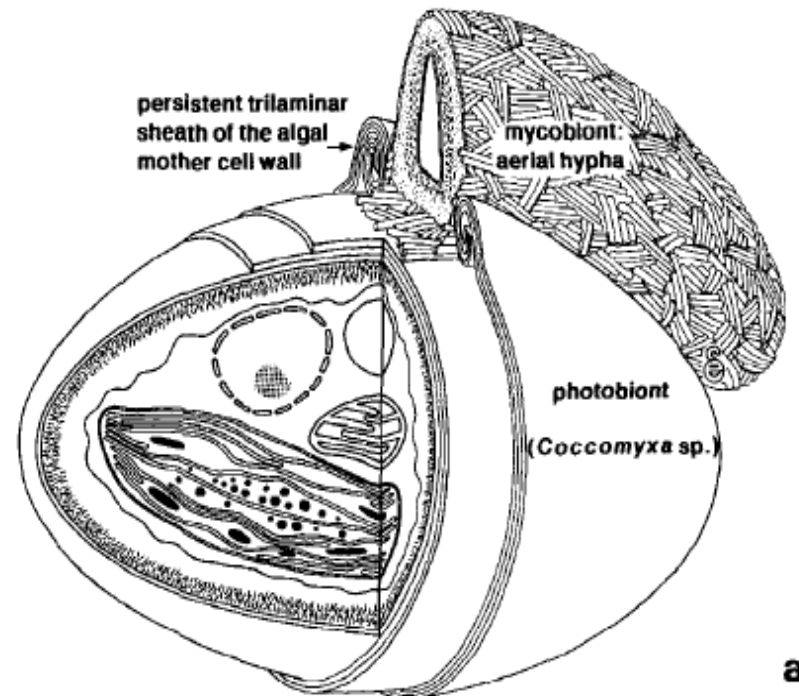
Peltigera - *Nostoc* symbiosis: intragelatinous fungal protrusions



a

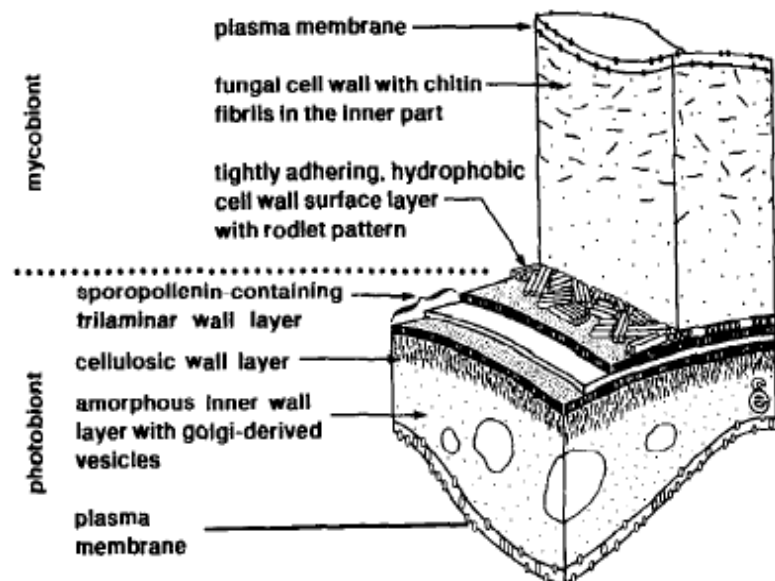
b

Peltigera - *Coccomyxa* symbiosis: wall-to-wall apposition



a

Detail of the mycobiont-photobiont interface:



b

Figure 2 Diagrams illustrating the mycobiont-photobiont interface in *Peltigera* spp. with *Nostoc* cyanobiont. Ultrastructural data from 6, 42, 51; diagrams designed by Sybille Erni.

Figure 3 Diagrams illustrating the mycobiont-photobiont interface in *Peltigera* and *Solorina* p. with *Coccomyxa* photobiont. Note: algal cell wall dimensions in Figure 3a are not to scale. Data from 10, 11, 49-51, 58, 63; diagrams designed by Sibylle Erni.

Habitat – Surfaces

1. stone surfaces

limestone

silicate

2. wooden surfaces

dead wood

live wood

e.g. bark



Habitat

1. aquatic (submersed)

water-tolerant, no direct contact with air

2. terrestrial

desiccation-tolerant

Fluorescenc of Lichens

Fluorescence of dominant algae in lichens:

Blue-green algae

Green algae

Fluorescence of secondary fungal substances

“Fingerprints” of Algae

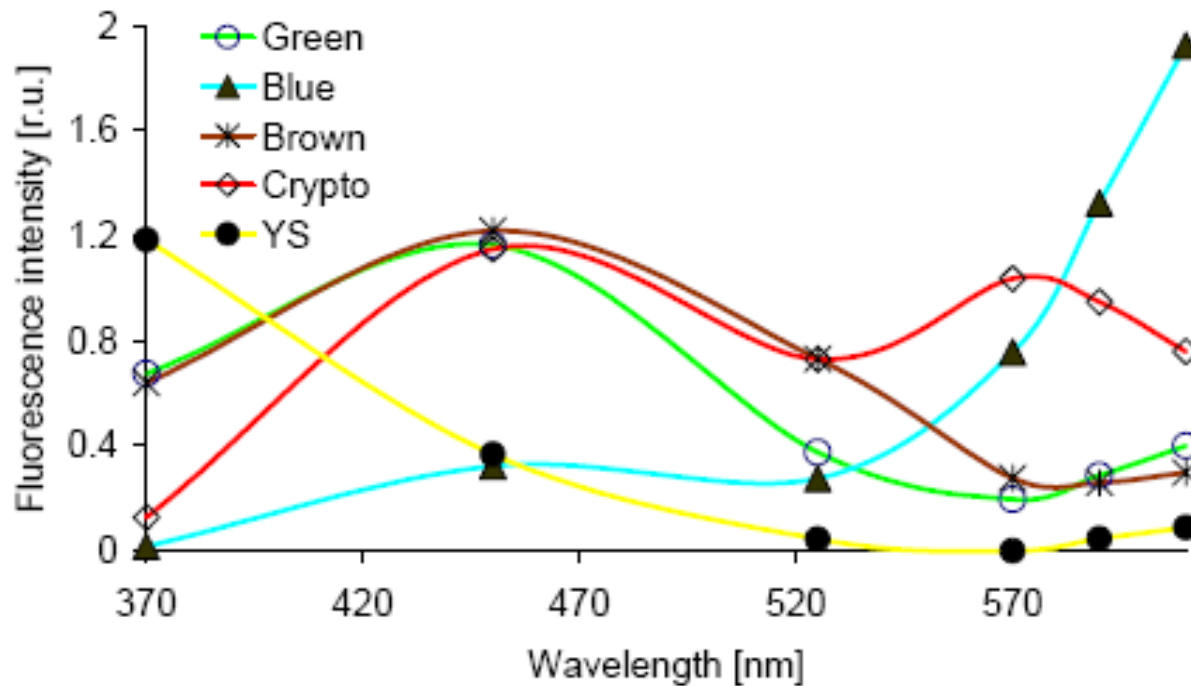
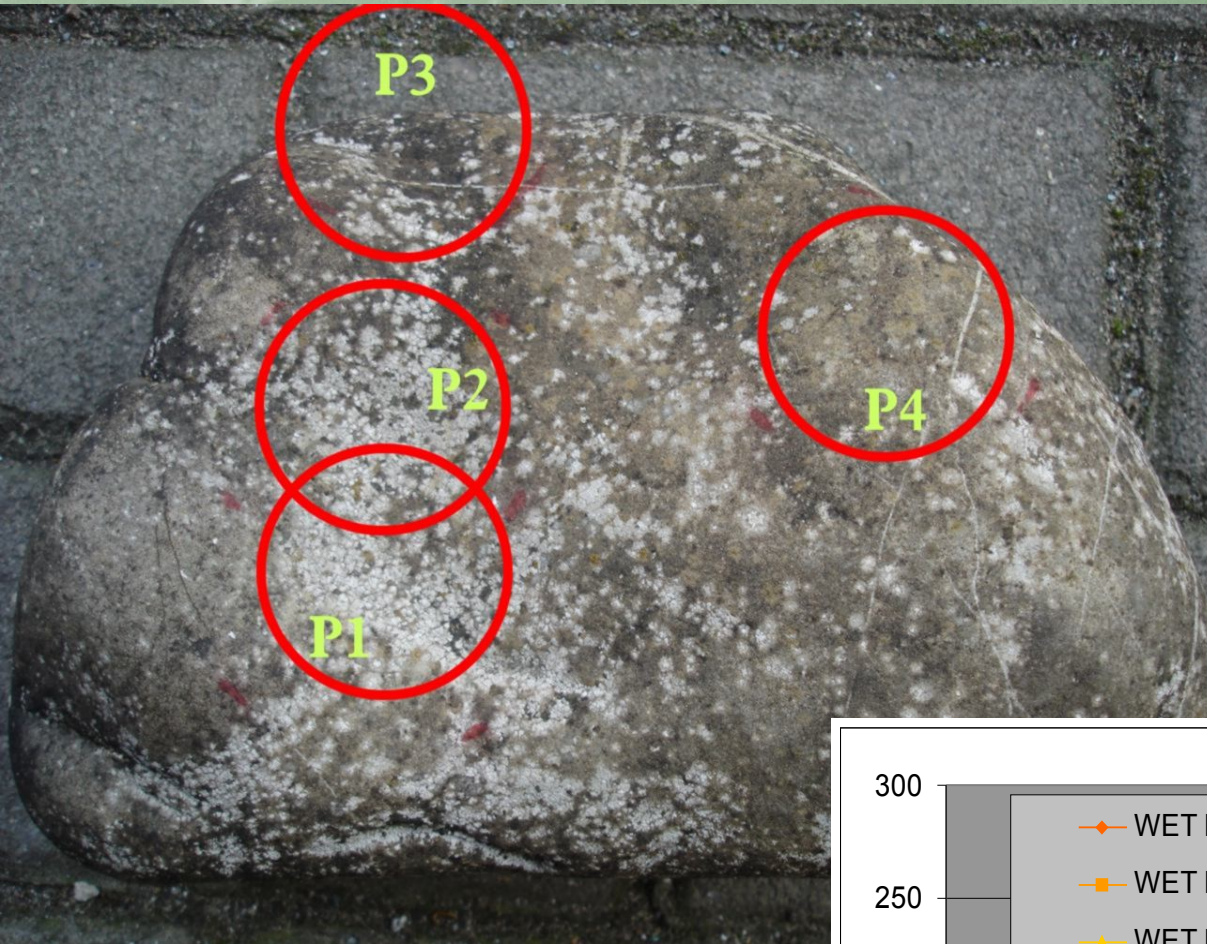
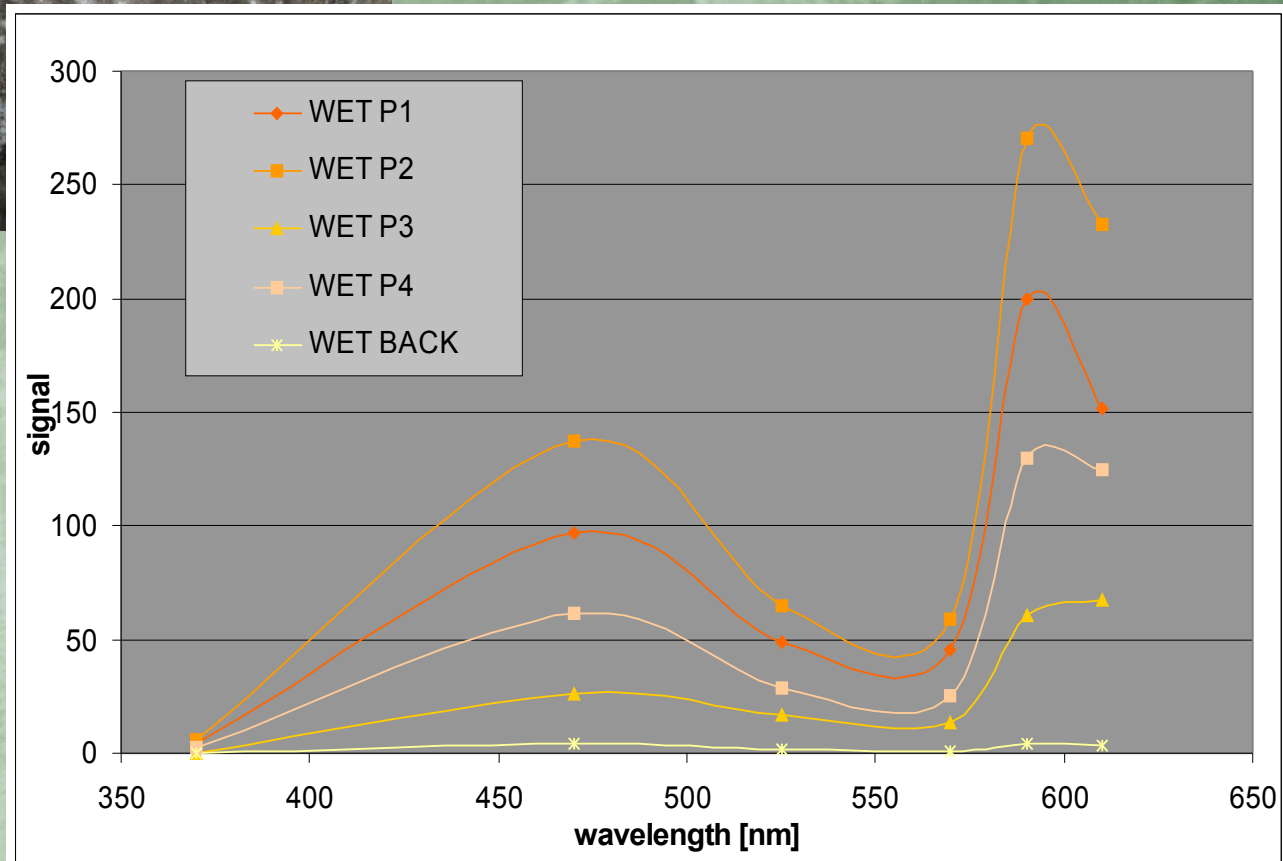


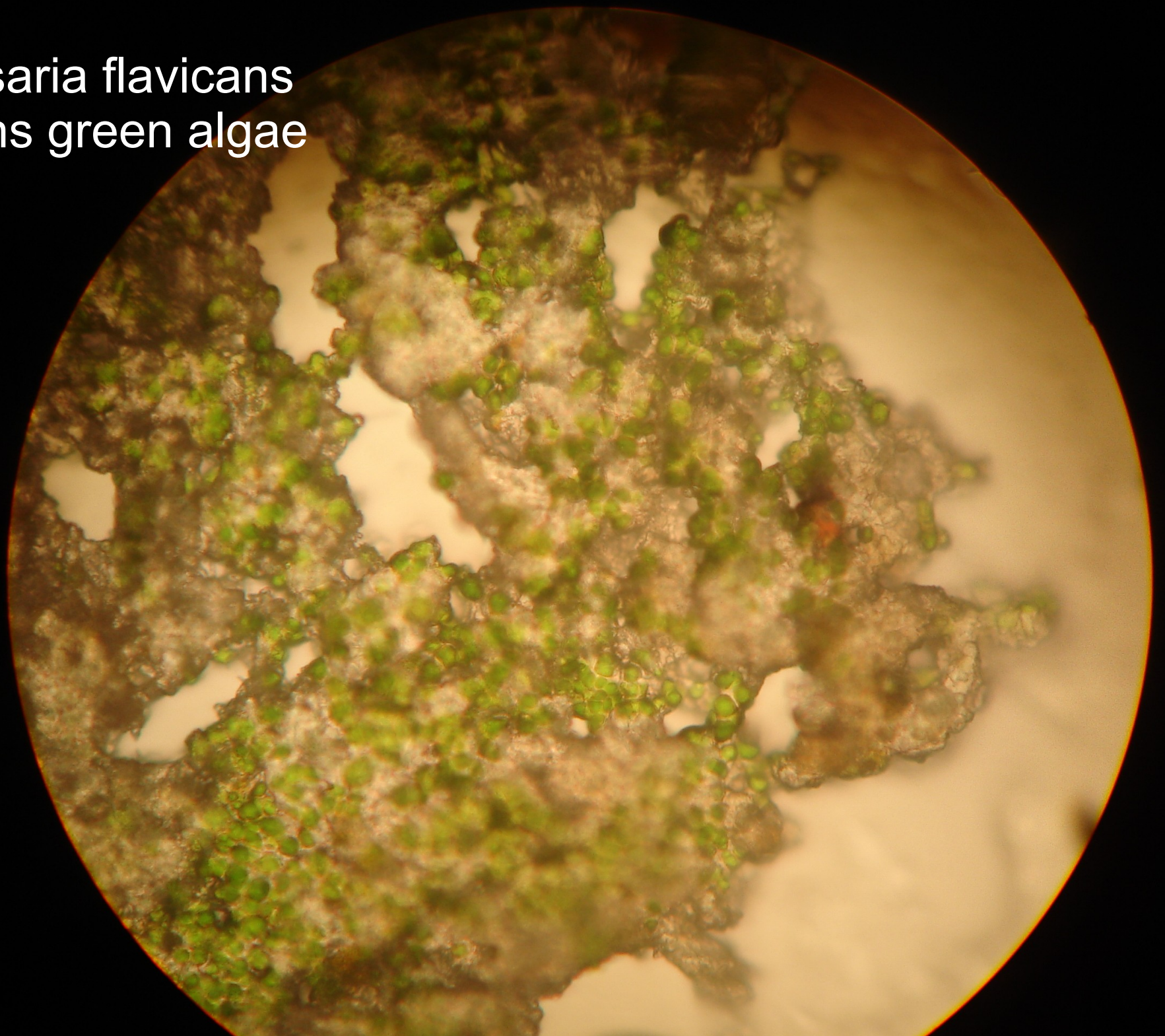
Figure 3.1. Norm spectra of spectral algal groups and YS. Mean fluorescence intensity of four spectral algal groups and YS at six excitation wavelengths in digits (photovoltage at the photomultiplier) normalised to Chl *a* concentration ($\mu\text{g l}^{-1}$) for spectral algal groups.



The pattern of lichen fluorescence looks like a mixture of blue-green and green algae, but...

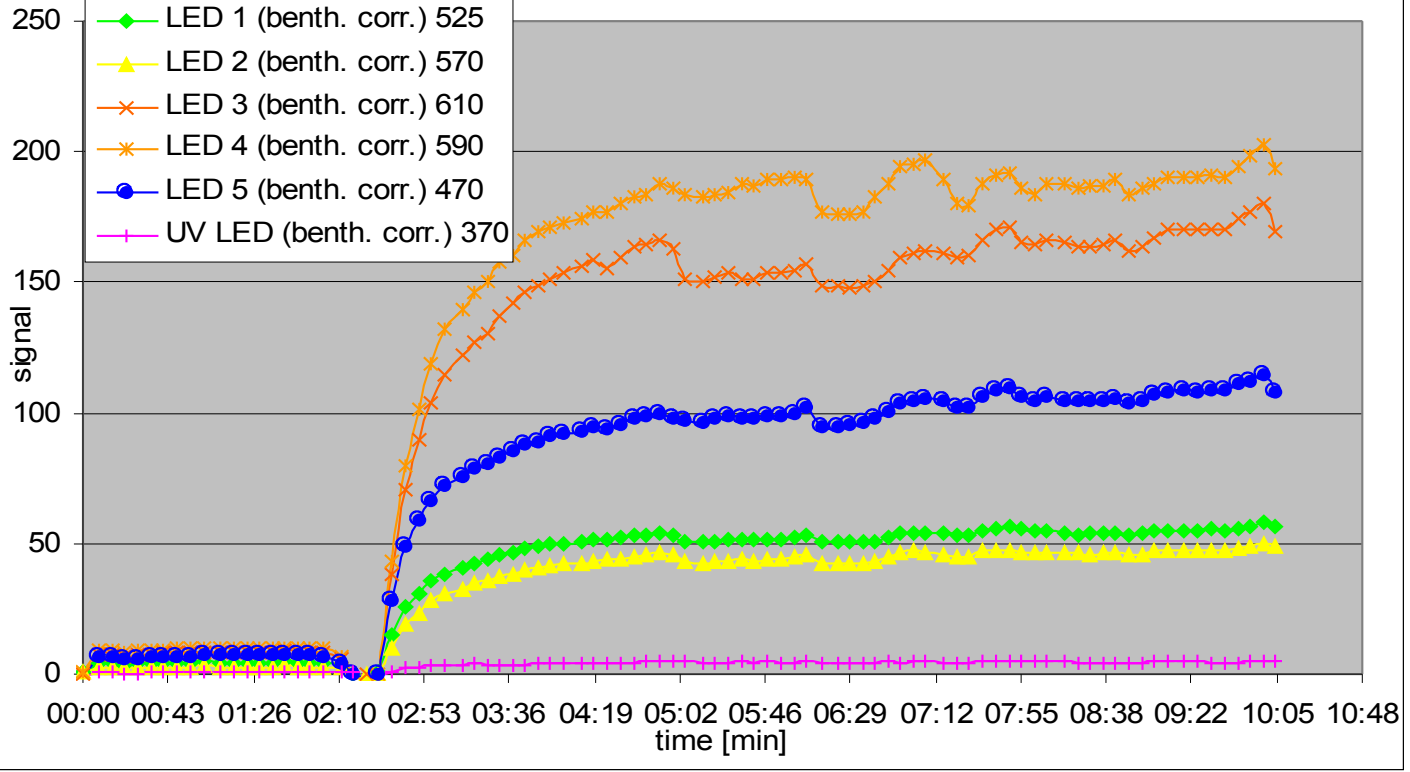


Pertusaria flavicans
contains green algae

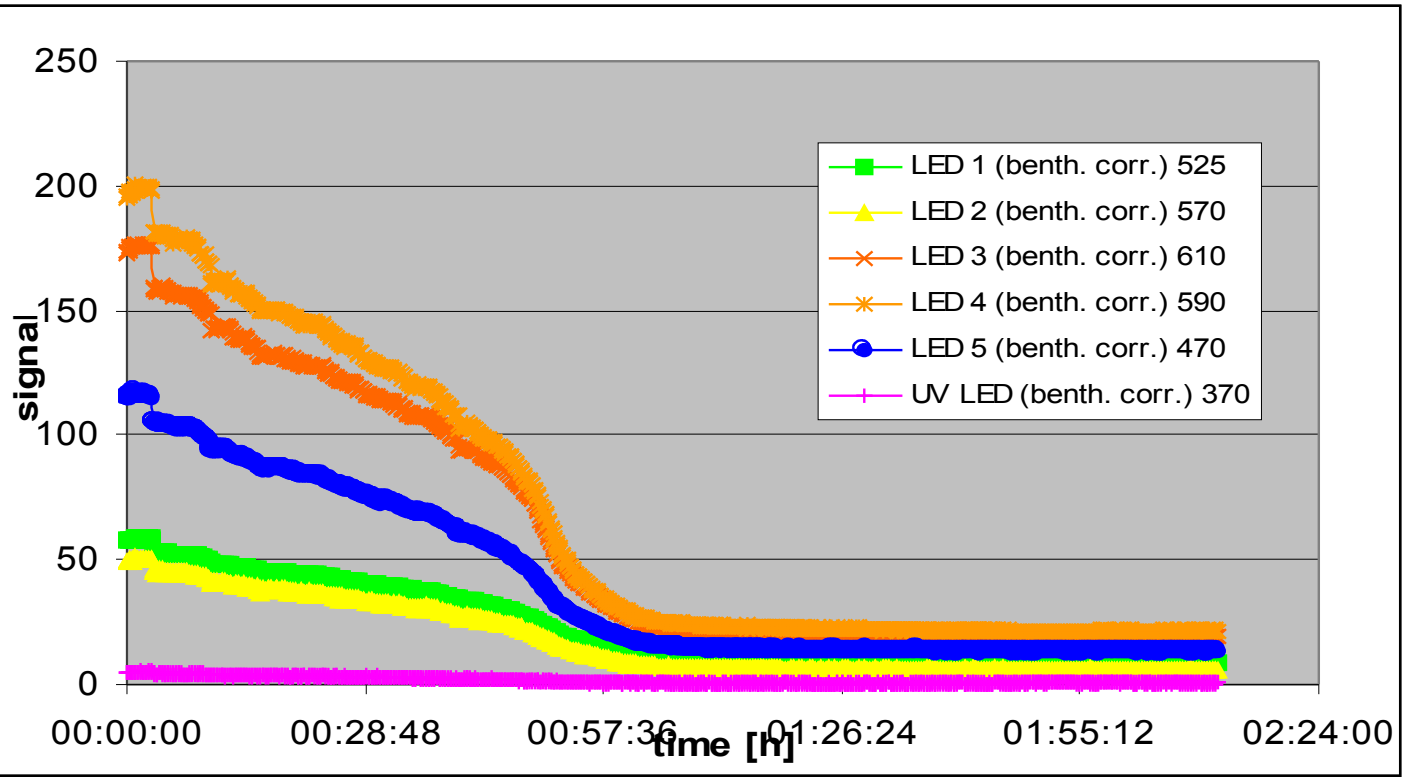


Conclusion and Theory 1

In our first approach with terrestrial lichens we face problems in identification. We need a more sophisticated model to estimate the right sort of photobiont



Change of fluorescence while hydrating and drying algae.

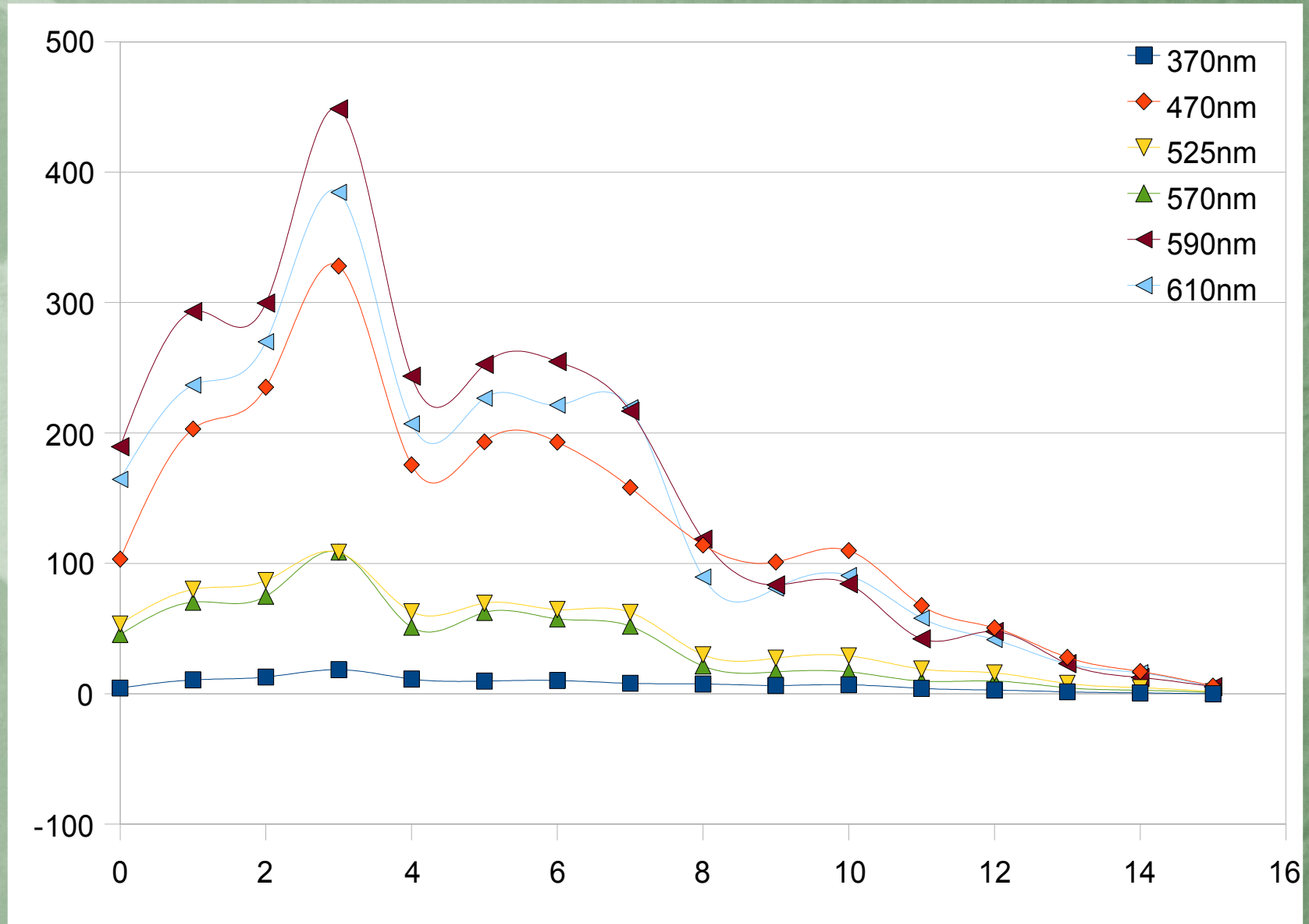


Conclusion and Theory 2

Desiccation and re-hydration changes the fluorescence response of the wavelengths of all excitation LEDs.

Because all changes appear to occur in parallel, in this special case we can apply a specific fingerprint.

Fluorescence Profile Through Layers



The profile was done by measuring the fluorescence of a lichen. After every measurement a thin layer of a lichen was scratched off. This diagram shows the change in fluorescence across the thallus of the lichen.



Thank you for your attention!