Presentation of two Projects dealing with Microalgae:

1. co-Operation SKD ‘COIN’ (FFG/Applied Research)

2. Metabolomics and Biodiversity of Snow and Ice Phototrophs (FWF/Basic Research)

Netzwerk Algen, Graz, 03.04.2017

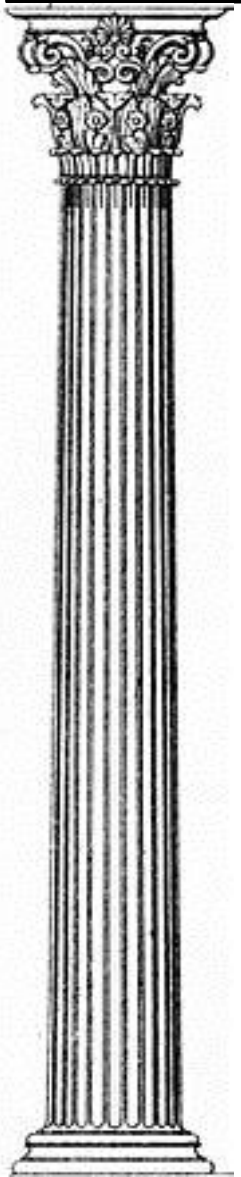
Daniel Remias

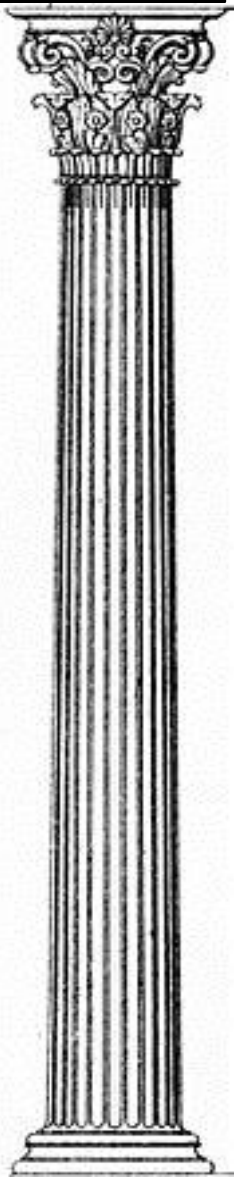
Research Team “Biosciences”

University of Applied Sciences Upper Austria

Wels, Austria, Europe

Research Team Biosciences





Our two fundaments are:

1. “We ***make*** them doing!”

► Molecular Biology: modifying fungi or cyanobacteria to produce valuable biomolecules

2. “We gonna ***find*** those which can do it!”

►(Exotic) microorganisms producing interesting metabolites. Like secondary compounds which they need for survival.

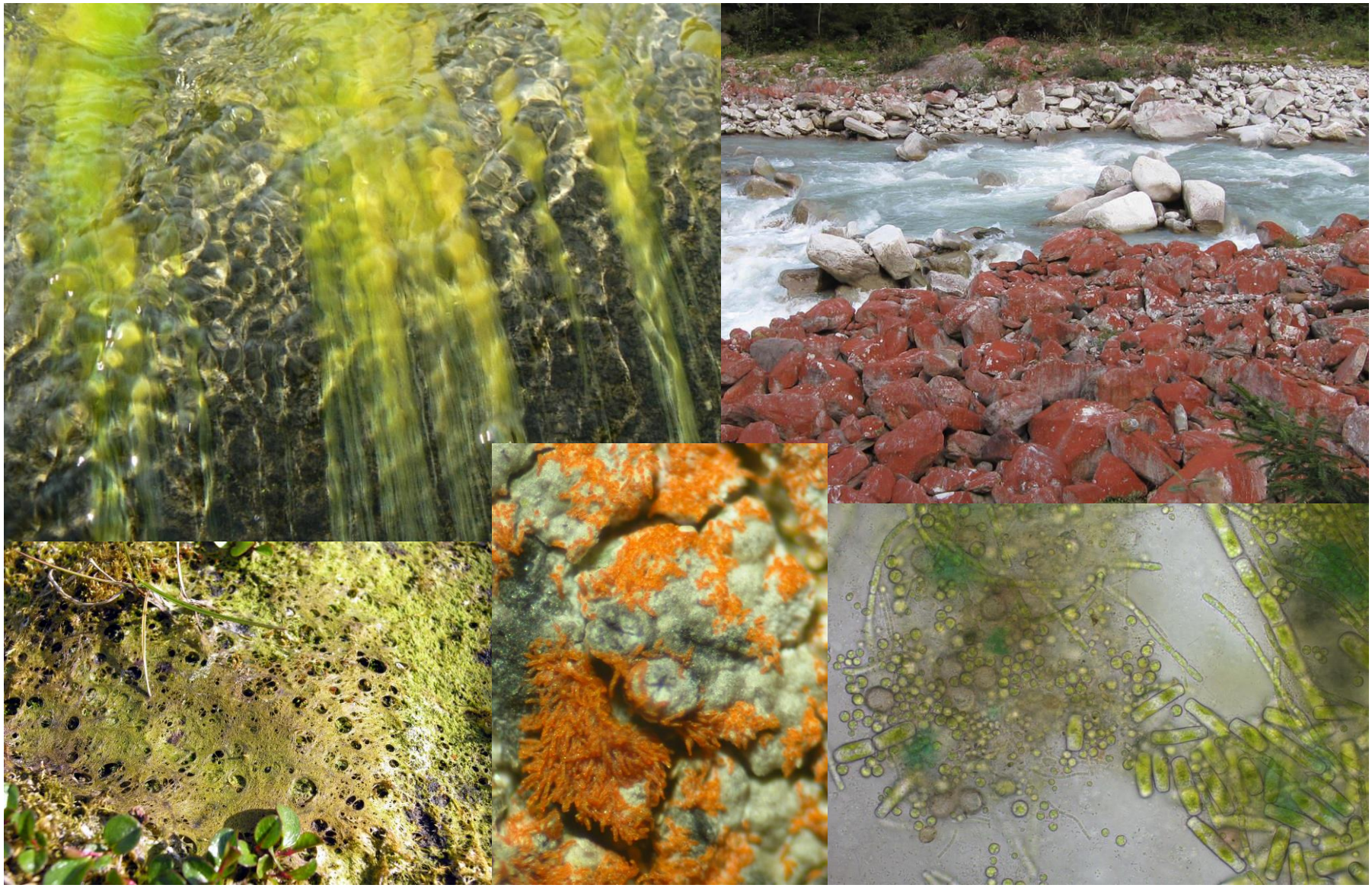
Applied use of Algae

- Food, nutritional supplements
- Pharmaceutic or cosmetic ingredients
- Production of valuable metabolites
  - antioxidants
  - pigments
  - fats (mainly polyunsaturated fatty acids)
  - vitamins etc.
- Biomass usage (e.g. biogas production???)
- Future research: biodiesel made from algae???

Where we can find algae?

- **Habitats**
  - Marine (plankton, seaweed/macroalgae)
  - Freshwater (brooks, lakes, ponds, …)
  - Specialized species also at rocks, tree bark or even at glaciers
  - Lichens: Symbiosis with fungi

Algae: photoautotrophic eukaryotes



1. co-Operation SKD ‘COIN’ (FFG / Applied Research)

Head of Project in Wels: DI (FH) Klaus Krennhuber

- Strain collection of unexplored microalgae isolated from high alpine soils in the 1960/70ies (mainly Tyrolean Alps)

- Gaining competence in culturing strains, analyzing algal compounds and bioactivity assays

- Duration: 2016 - 2019

- Project partners: FH Wels, MCI Innsbruck, ADSI Innsbruck

co-Operation SKD ‘COIN’

Illuminated & aerated
1 litre column bioreactors

Strains are evaluated in these mini-reactors (growth, yield, stress experiments)

Stress in means of e.g. nutrients (nitrogen-limitation), temperature or salinity

Enzymaktivität

5 Kulturen wurden auf potentielle Enzymaktivität vermessen. *Chlorella vulgaris*, *Chlamydomonas culleus*, *Spongiochloris sp.*, *Diplospaera chordatii*, *Chloroidium sp.*

Lipaseaktivität konnte bei *Chlamydomonas culleus*, *Spongiochloris sp.* identifiziert werden (unverifiziert)

Proteaseaktivität konnte bei *Diplospaera chordatii*, *Chloroidium sp.* quantifiziert werden (verifiziert)

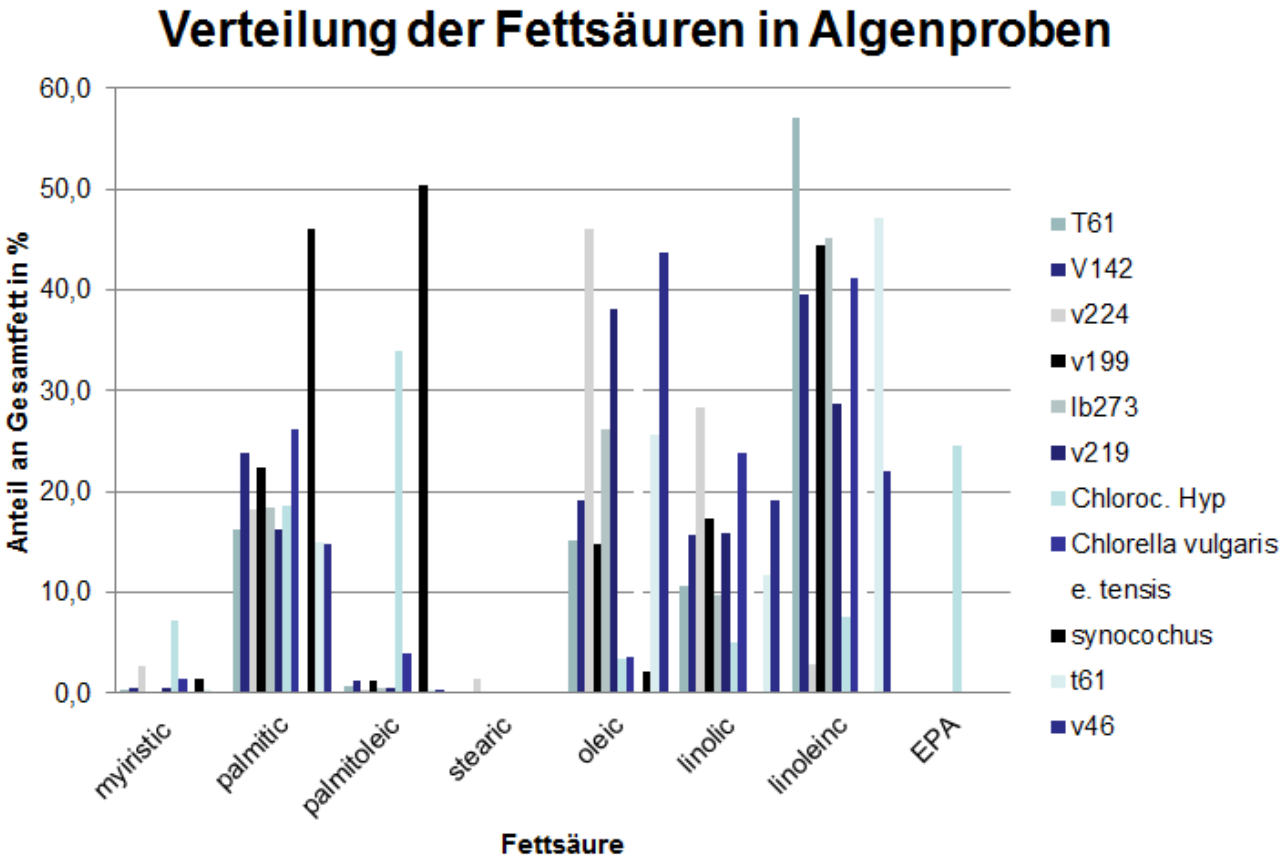
Produktanalytik

- Proteaseassay - Azo Casein-Test
- Azo Farbstoff, gekoppelt an Casein wird durch Protease in lösliche Länge gebracht; Färbung der Probe entspricht Enzym - Aktivität

Tabelle 1: Proteaseaktivität unterschiedlicher Algen bei Azo Casein Test in mU g^{-1} Trockenmasse

Algenstamm	Aktivität
V199	337
V142	193
T61	766
V219	361
C. vulgaris	388

Fettsäurezusammensetzung



2. Metabolomics and Biodiversity of Snow and Ice Phototrophs (FWF/Basic Research)

Head of project: Dr. Daniel Remias

Coastal Antarctica

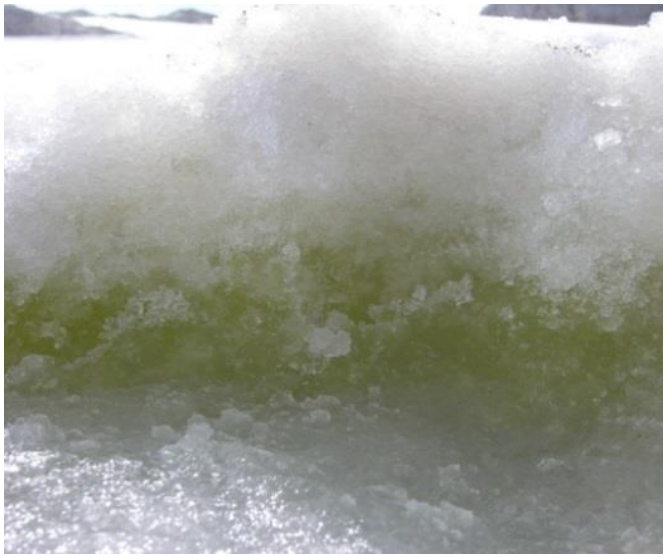
Preliminary publications about physiology and ecology of snow and ice algae

- Procházková, L., Remias, D., Řezanka T., Nedbalová, L. (2017) *Chloromonas nivalis* subsp. *tatrae*, subsp. nov. (Chlamydomonadales, Chlorophyta): re-examination of a snow alga from the High Tatra Mountains (Slovakia). *Fottea*, *accepted*
- Remias, D., Pichrtová, M., Pangratz, M., Lütz, C., Holzinger, A. (2016) Ecophysiology, secondary pigments and ultrastructure of *Chlainomonas* sp. (Chlorophyta) from the European Alps compared to *Chlamydomonas nivalis* forming red snow. *FEMS Microbiology Ecology*, *early online*, DOI: 10.1093/femsec/fiw030
- Remias, D., Jost, S., Boenigk, J., Wastian, J., Lütz, C. (2013) *Hydrurus*-related golden algae (Chrysophyceae) cause yellow snow in polar summer snowfields. *Phycological Research* 61: 277-285. DOI: 10.1111/pre.12025.
- Aigner, S., Remias, D., Karsten, U., Holzinger, A. (2013) Unusual phenolic compounds contribute to ecophysiological performance in the purple-colored green alga *Zygogonium ericetorum* (Zygnematophyceae, Streptophyta) from a high alpine habitat. *Journal of Phycology* 49: 648-660. DOI: 10.1111/jpy.12075.
- Remias, D., Wastian, H., Lütz, C., Leya, T. (2013) Insights into the biology and phylogeny of *Chloromonas polyptera* (Chlorophyta), an alga causing orange snow in Maritime Antarctica. *Antarctic Science* 25: 648-656. DOI: 10.1017/S0954102013000060
- Remias, D. (2012) Cell structure and physiology of alpine snow and ice algae. In: Lütz, C. (Editor) Plants in alpine regions. Cell physiology of adaption and survival strategies. Springer Wien, 202 p., pp. 175-186. ISBN 978-3-7091-0135-3
- Remias, D., Schwaiger, S., Aigner, S., Leya, T., Stuppner, H., Lütz, C. (2012) Characterization of an UV- and VIS-absorbing, purpurogallin-derived secondary pigment new to algae and highly abundant in *Mesotaenium berggrenii* (*Zygnematophyceae*, Chlorophyta), an extremophyte living on glaciers. *FEMS Microbiology Ecology* 79: 638-648.
- Remias, D., Holzinger, A., Aigner, S., Lütz, C. (2012) Ecophysiology and ultrastructure of *Ancylonema nordenskiöldii* (Zygnematales, Streptophyta), causing brown ice on glaciers in Svalbard (high arctic). *Polar Biology* 35: 899-908.
- Sattler, B., Post, B., Remias, D., Lütz, C., Lettner, H., Psenner, R. (2012) Cold Alpine Regions. In: Bell, E.M.: Life at extremes. Environments, Organisms and Strategies for Survival. Wallingford CAB International Publishing, pp. 138-154. ISBN 978-1-84593-814-7
- Remias, D., Albert, A., Lütz, C. (2010) Effects of realistically simulated, elevated UV irradiation o photosynthesis and pigment composition of the alpine snow alga *Chlamydomonas nivalis* and the arctic soil alga *Tetracystis* sp. (Chlorophyceae). *Photosynthetica* 48: 269-277.
- Remias, D., Karsten, U., Lütz, C., Leya, T. (2010) Physiological and morphological processes in the Alpine snow alga *Chloromonas nivalis* (Chlorophyceae) during cyst formation. *Protoplasma* 243: 73-86.
- Leya, T., Rahn, A., Lütz, C., Remias, D. (2009) Response of arctic snow and permafrost algae to high light and nitrogen stress by changes in pigment composition and applied aspects for biotechnology. *FEMS Microbiology Ecolology* 67: 432-443.
- Remias, D., Lütz, C. (2007) Characterisation of esterified secondary carotenoids and of their isomers in green algae: a HPLC approach. *Algological Studies* 124: 85-94.
- Remias, D., Lütz-Meindl, U., Lütz, C. (2005) Photosynthesis, pigments and ultrastructure of the alpine snow alga *Chlamydomonas nivalis*. *European Journal of Phycology* 40: 259-268

Metabolomics and Biodiversity of Snow and Ice Phototrophs

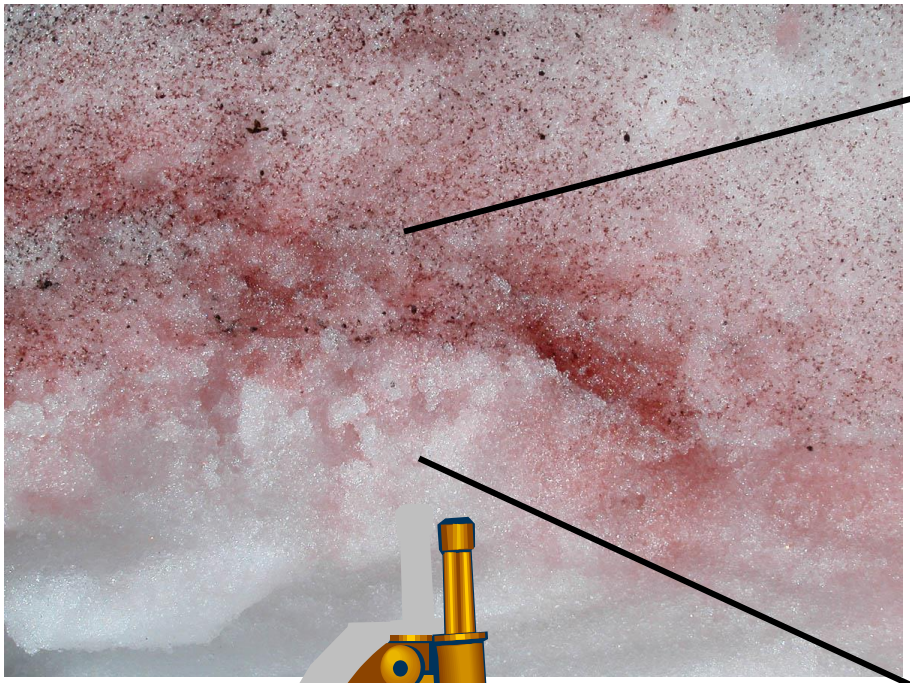
- Project start: April 2016
- Duration: 3.5 years
- Project sum: 350.000 €
- People at Wels: post-doc, technician, master students
- Project partners: Helmholtz Zentrum Potsdam (DE), Universities of Innsbruck (AT) and Prague (CZ)
- Project aims:
  - Biodiversity evaluation (molecular Polar-Alpine comparison)
  - Metabolomics of field samples (GC-MS)
  - Screening for interesting (secondary) compounds (LC, GC)
  - Establishing new strains for biotechnology

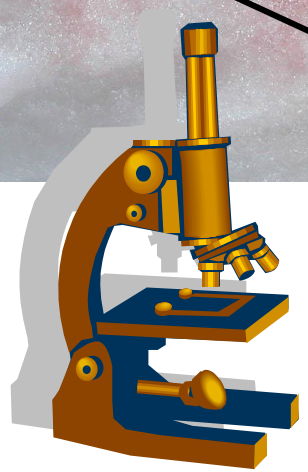
What are your associations looking at these snow colors?

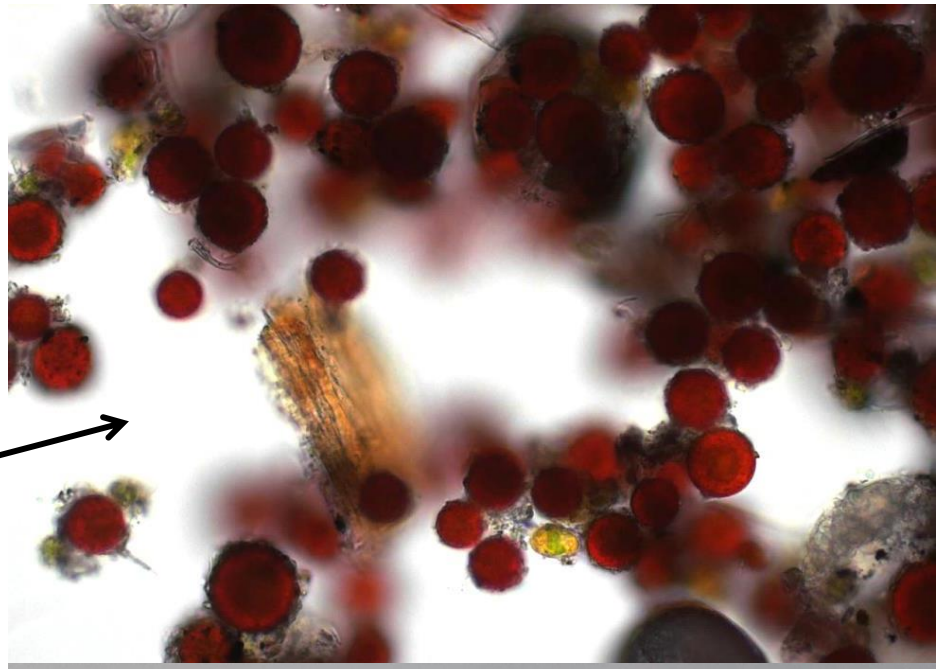



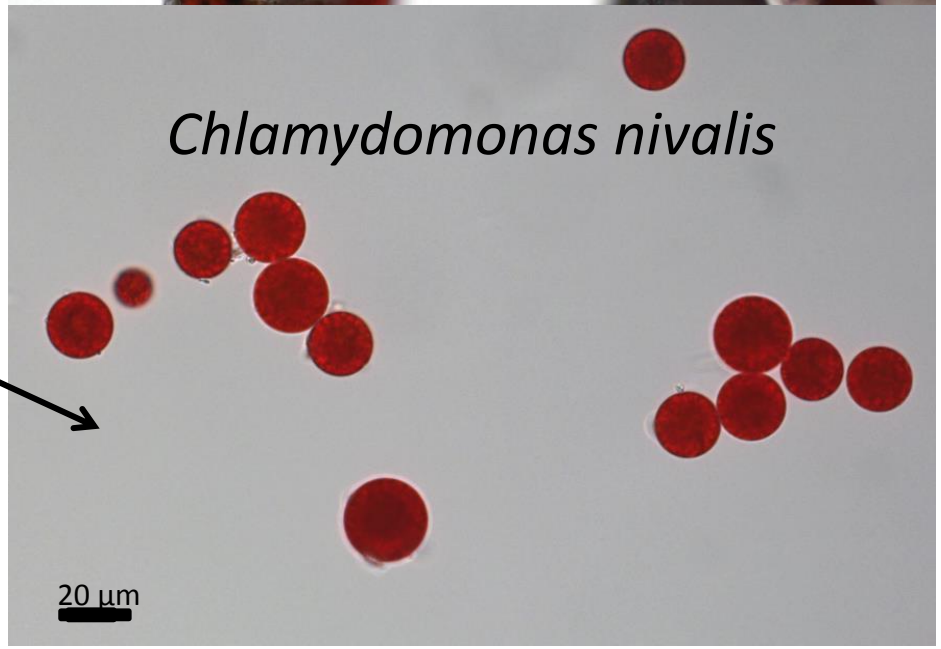


Tinted snow is caused by microalgae



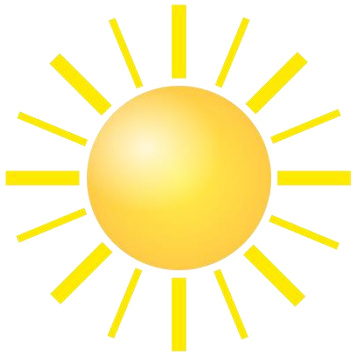






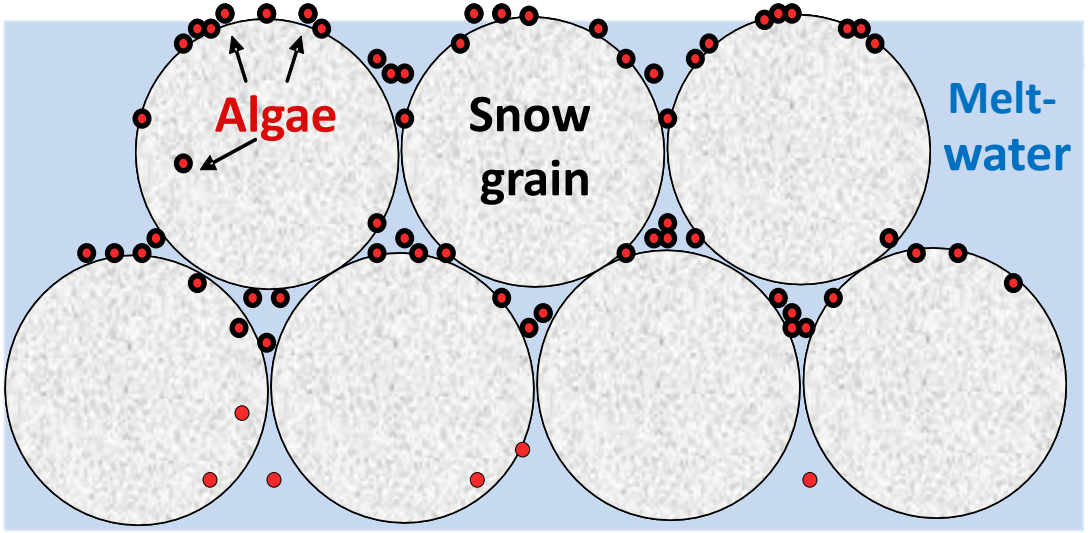
Snow algae have to cope with a lot of stresses

Excessive irradiation
(visible & UV)



Freeze-thaw cycles
(day / night)

Short season
(weeks/year)



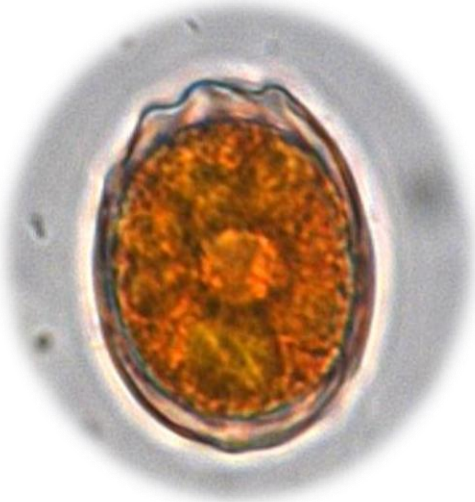
Limited nutrients
(e.g. N, P)

Why to work with snow algae?

Explore biodiversity of polar and high alpine cold ecosystems

Special metabolites could be beneficial for biotechnology/applied fields

Understand fundamental strategies of stress response



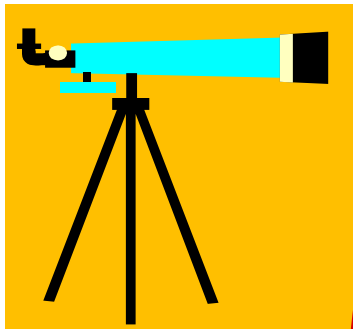
UV screening compounds, anti-freezing metabolites (compatible solutes) unsaturated fatty acids anti-stress proteins

Global warming supports algae reducing the albedo of Greenland's ice cap: faster melt → rising sea-level

No strains available to work with? Harvest of field material!

Special equipment: low temperature climate chamber (Perceval LT-36VL)

- Stable down to -10°C (± 0.5) while illuminated!
- Needed for cultivation of psychrophilic strains



Main methodical approaches

Arctic-alpine comparison of cryoflora

- High Throughput Sequencing (18S, *rbc*L, ITS2 genes)

  Evaluate presence of all eukaryotes like algae and fungi, but also bacteria and archaea. Look for geographical patterns (Helmholtz Potsdam)

- Metabolomics (GC/MS)

  Gives ‘snapshot’ of the physiology of the cell. Cellular processes cause biochemical fingerprints (Innsbruck University)

Thank you for your attention!

University of Applied Sciences Upper Austria
Stelzhamerstr. 23
4600 Wels/Austria
Tel.: +43 5 0804 44479
Mobil: +43 677 61352386
E-Mail: daniel.remias@fh-wels.at
Web: www.fh-ooe.at/campus-wels/biosciences