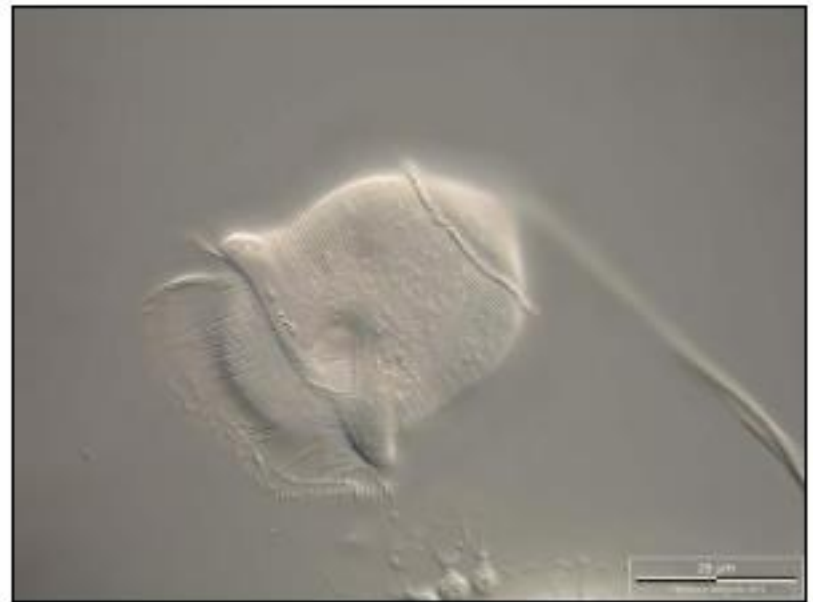


Tracing the evolution and species diversity within the genus *Synura* (Chrysophyceae)

Pavel Škaloud & Magda Škaloudová
Charles University in Prague, Czech Republic
CAUP Culture Collection of Algae

33rd Annual Meeting of the German Society for Protozoology

12-15 February 2014 in Essen



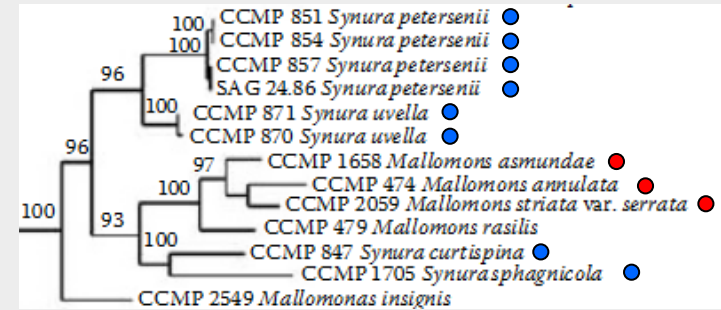
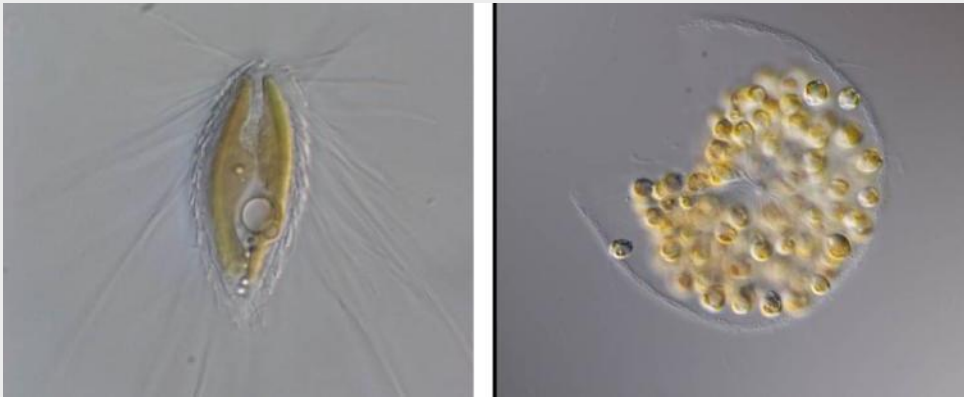
Synura (Synurales, Chrysophyceae)

- A common freshwater genus of silica-scaled chrysophytes
- Colonies of a variable number of cells joined together at their posterior ends
- Cells covered by imbricate silica scales

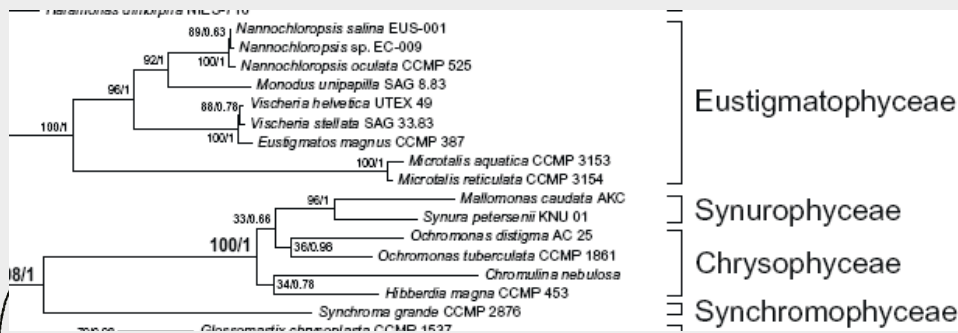


Synura (Synurales, Chrysophyceae)

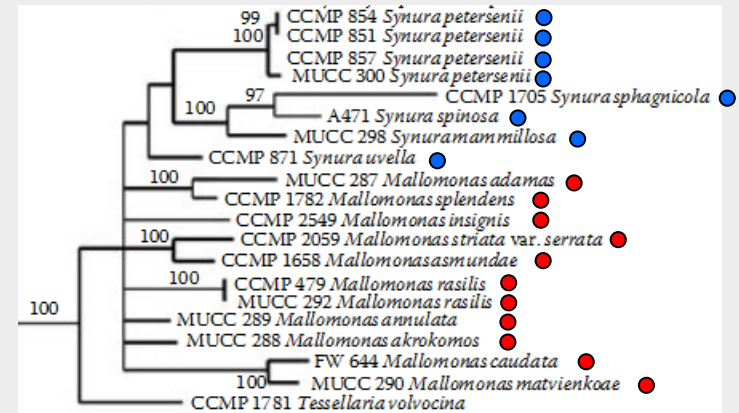
- *Synura* closely related to the genera *Mallomonas* and *Tessellaria* (Synurales)
- Monophyly of *Synura* and *Mallomonas* is still questioned, as well as the phylogenetic position of Synurales (Chrysophyceae/Synurophyceae)
- Evidence of cryptic diversity (*S. petersenii*) - Wee et al. (2001)



Andersen (2007) - *rbcL*



Yang et al. (2012) – five genes



Andersen (2007) – SSU rDNA

Aims

- **I. Phylogenetic analysis of Synurales**

- To better infer the phylogeny and relationship between *Synura* and *Mallomonas* by adding several newly isolated *Synura* species
- To assess the relationships of Chrysophyceae and Synurophyceae, and the validity of the latter class

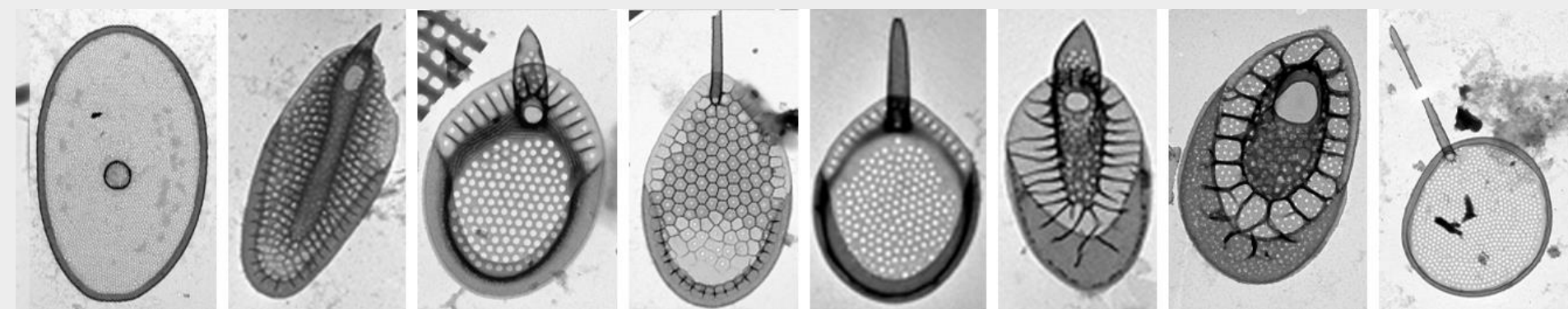
- **II. Hidden diversity within the traditionally defined *Synura petersenii***

- To observe the genetic diversity within *Synura petersenii* isolates by sequencing a large number of isolated strains
- To find the morphological differences among the cryptic species



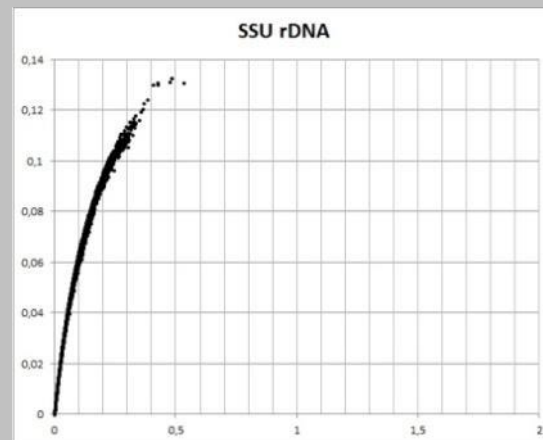
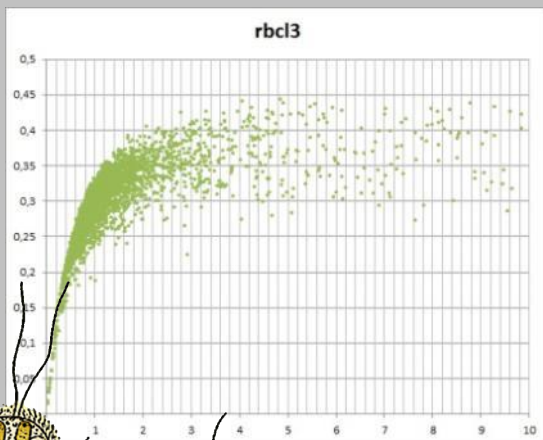
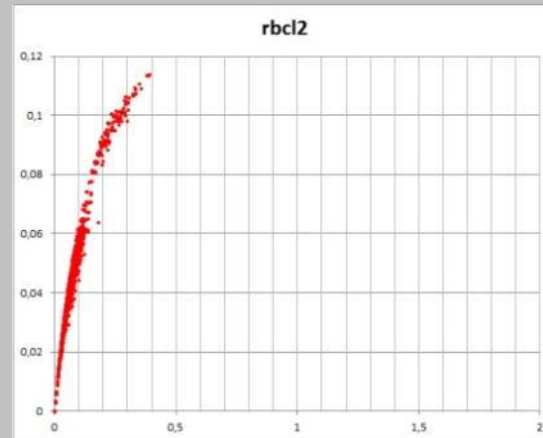
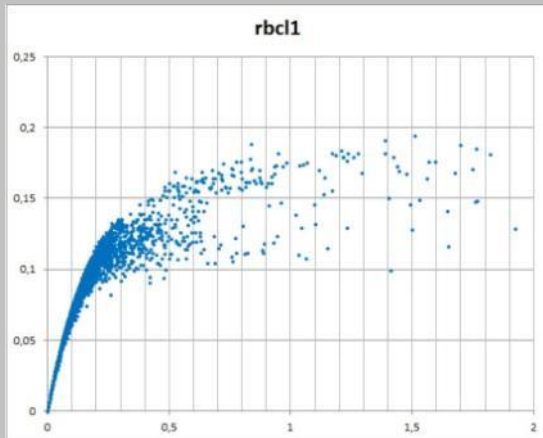
Molecular phylogeny of Synurales

- Newly isolated *Synura* taxa:
 - *S. lapponica*
 - *S. macracantha*
 - *S. mammillosa*
 - *S. mollispina*
 - *S. multidentata*
 - *S. petersenii* f. *asmundiae*
 - *S. petersenii* f. *bjorkkii*
 - *S. splendida*

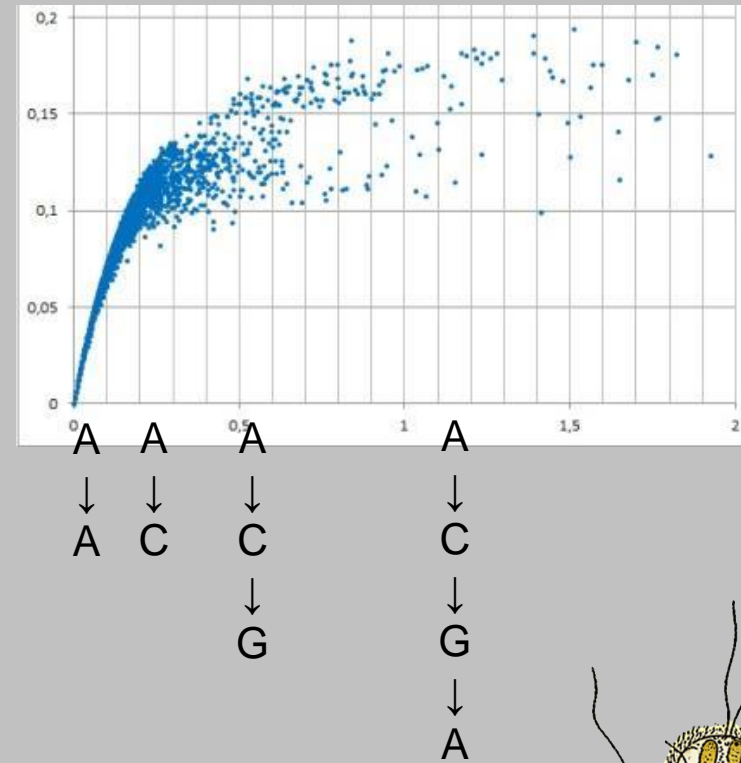


Molecular phylogeny of Synurales

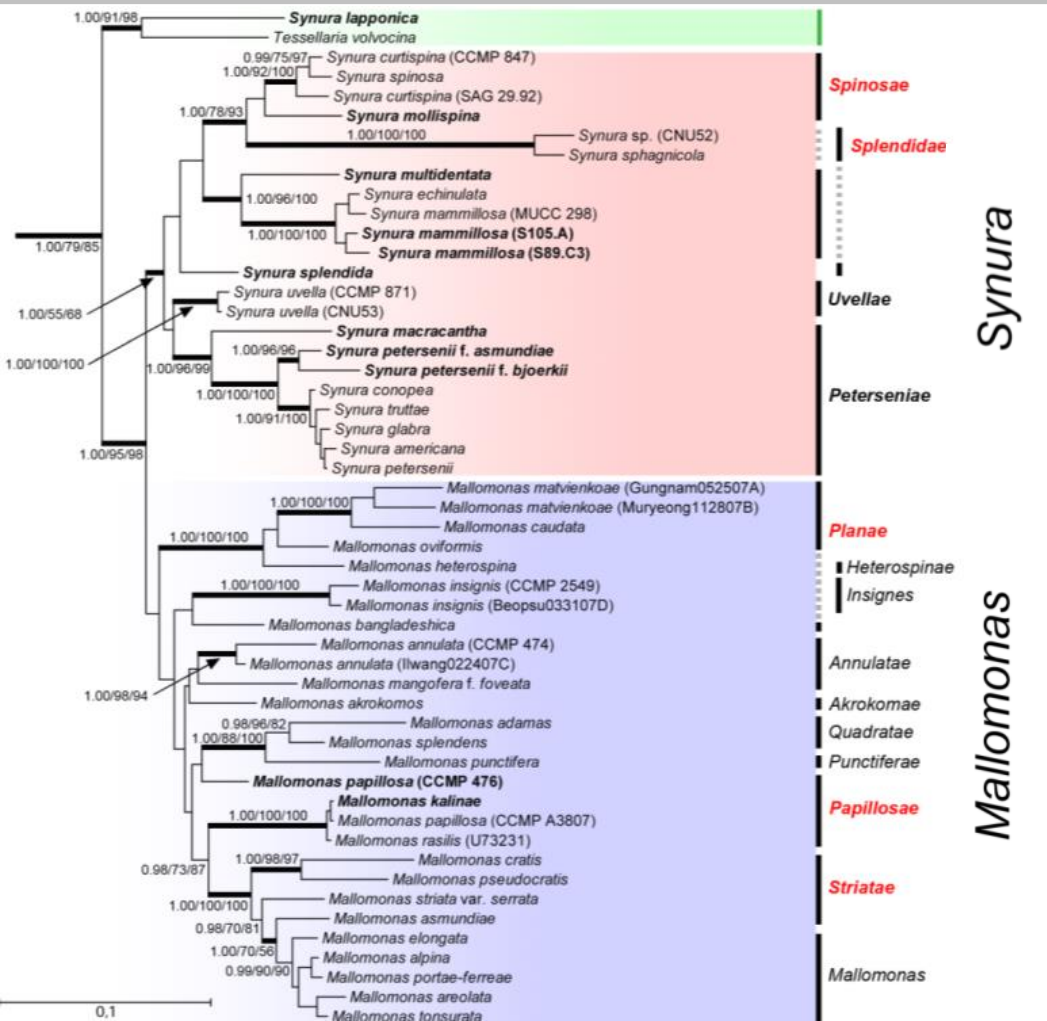
- Incongruence between SSU rDNA and *rbcl* phylogenies
- Significant saturation of 1st and 3rd *rbcl* codon position
- Site stripping – removal of fast sites (saturated nucleotide positions)



Saturation plot



Molecular phylogeny of Synurales



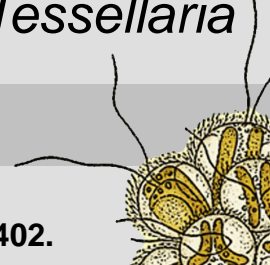
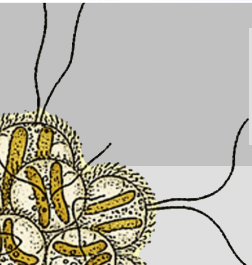
Bayesian analysis based on the combined and partitioned SSU rDNA + stripped *rbcL* dataset.

- SSU + *rbcL* (site-stripped)
 - *Synura* monophyly received the highest BI support (1.00)

- Similarly to the genus *Mallomonas*, the current classification of the genus *Synura* at the section level will require some revision.

- The current species concept requires a revision
 - *S. petersenii* f. *asmundiae*
 - *S. petersenii* f. *bjoerkii*
 - *S. lapponica* = *Tessellaria*

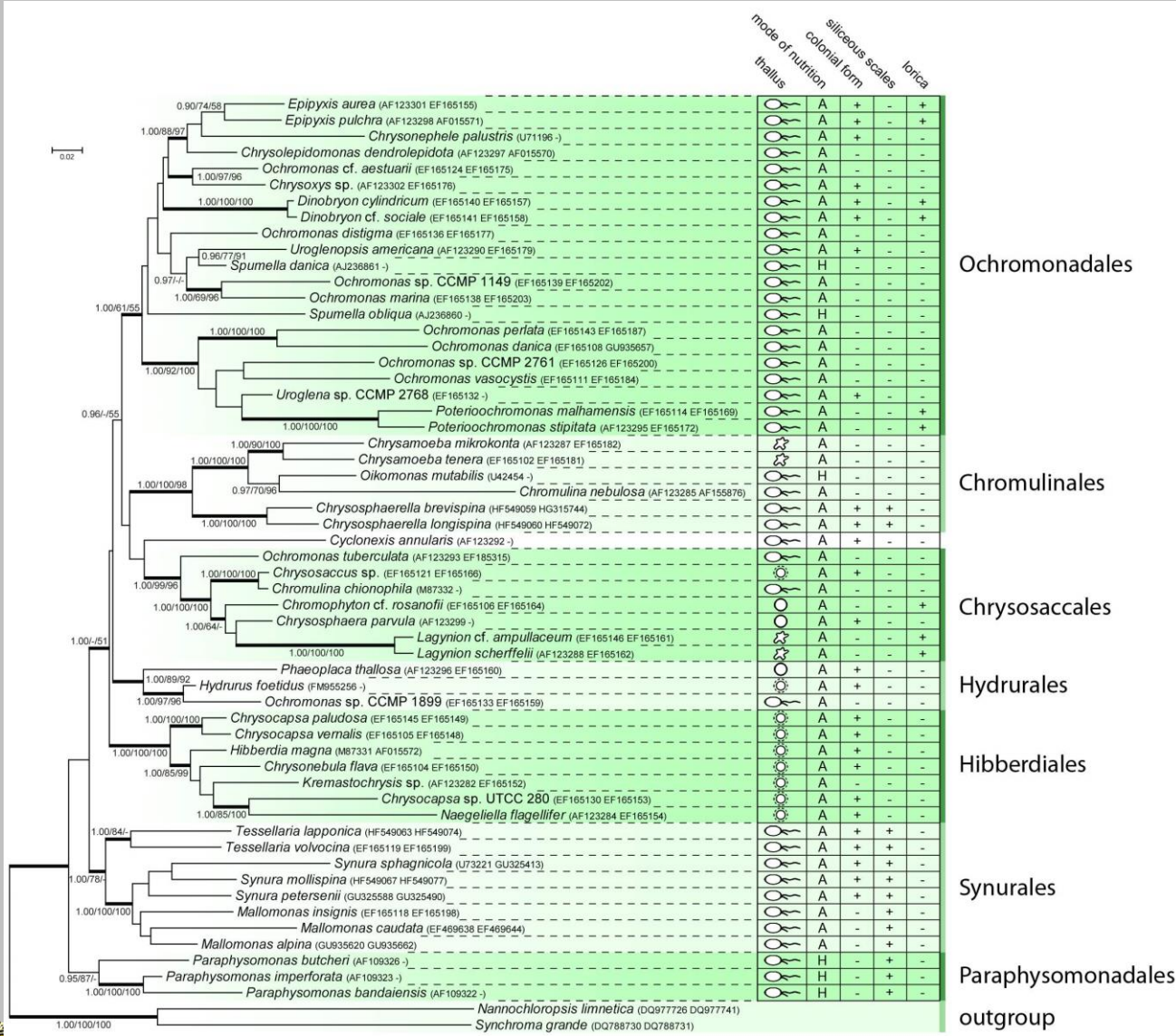
Škaloud P. et al. (2013): Developments in the taxonomy of silica-scaled chrysophytes – from morphological and ultrastructural to molecular approaches (invited review). *Nord. J. Bot.* 31: 385-402.





➤ *"Tessellaria lapponica"*

Molecular phylogeny of Synurales

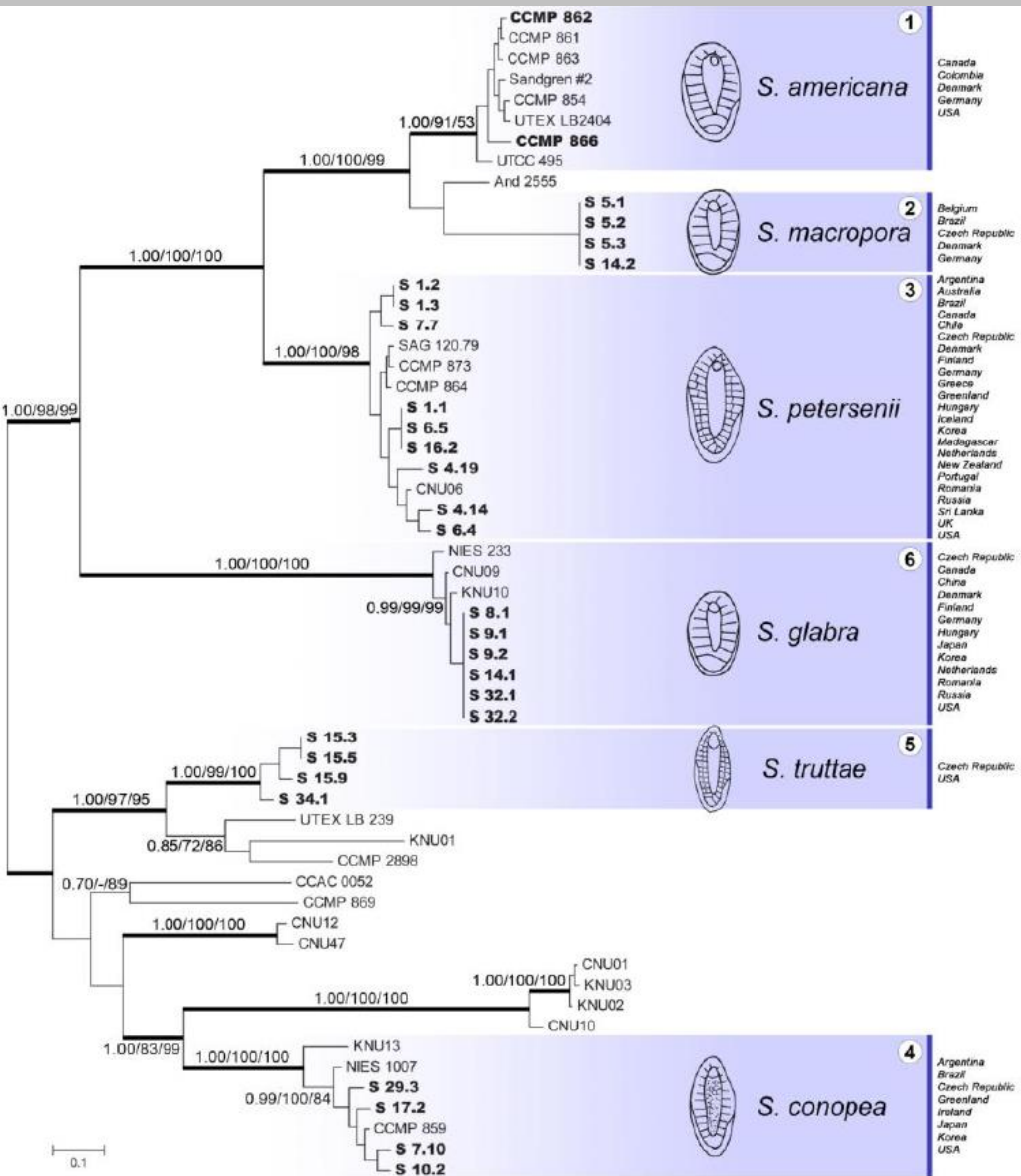


- Synurophyceae nested within the paraphyletic Chrysophyceae
- Synurophyte algae should be rather classified as members of a single order within Chrysophyceae, Synurales.

Bayesian analysis of the combined and partitioned SSU rDNA + rbcL dataset.



Hidden diversity in *Synura petersenii*



- Distinction of six cryptic lineages, which were redefined or described as new species in accordance with molecular and morphological evidence

- *S. petersenii*
- *S. glabra*
- *S. truttiae* comb. et stat. nov.
- *S. americana* sp. nov.
- *S. macropora* sp. nov.
- *S. conopea* sp. nov.

Bayesian analysis based on the combined ITS rDNA, *psaA*, *rbcL* and *cox1* dataset.

Škaloud P. et al. (2012): Toward a revision of the genus *Synura*, section Petersenianae (Synurophyceae, Heterokontophyta): morphological characterization of six pseudo-cryptic species. *Phycologia* 51: 303-329.

Hidden diversity in *Synura petersenii*



- What is the real hidden diversity within *Synura petersenii* sensu lato?

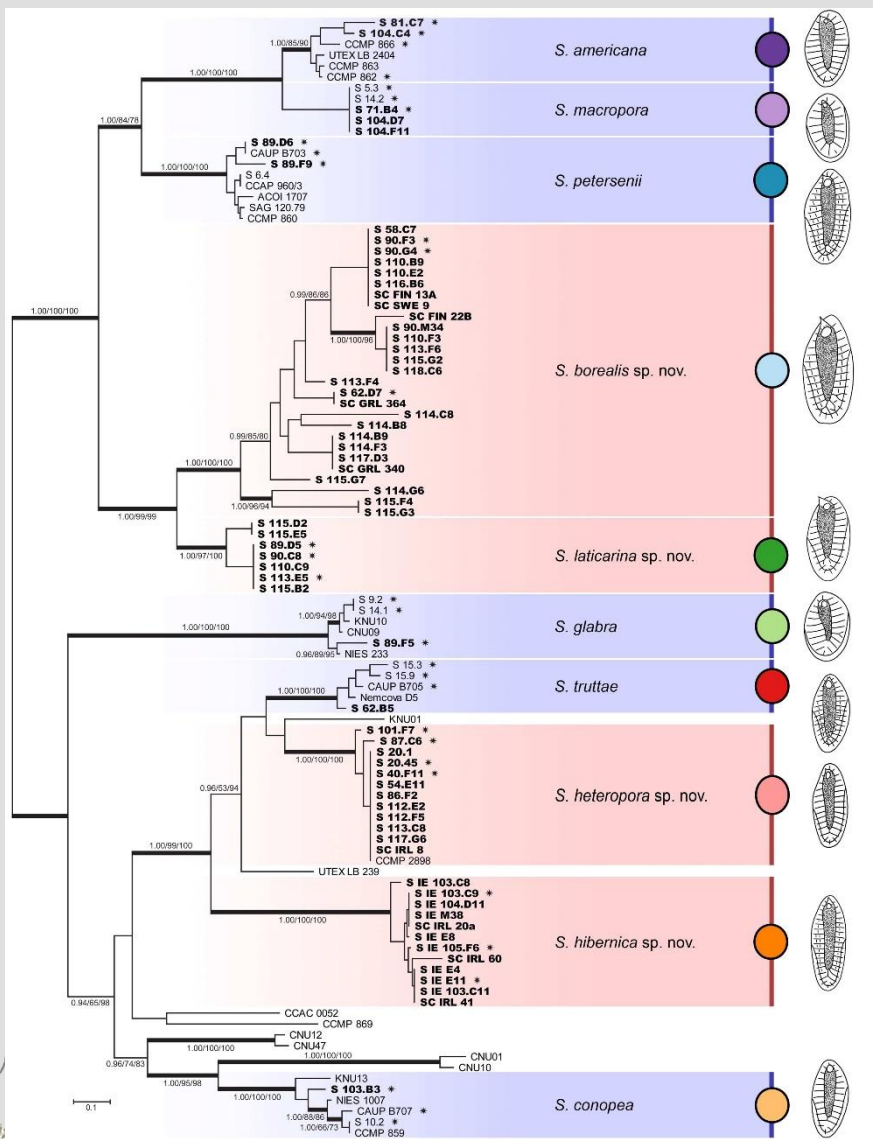
- Extensive sampling in 15 European countries, including Greenland



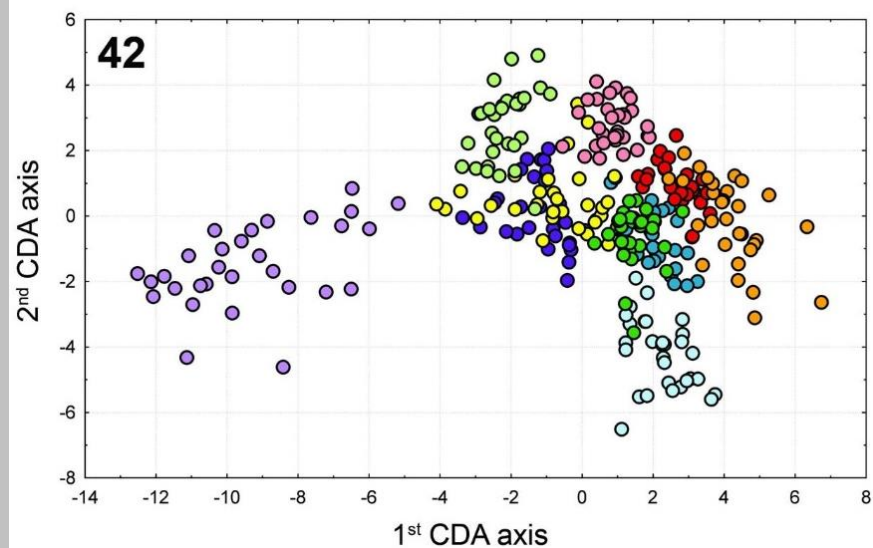
Skaloud P. et al. (2014): Morphological delineation and distribution patterns of four newly described species within the *Synura petersenii* species complex (Chrysophyceae, Stramenopiles). *Eur. J. Phycol.* (in press)



Hidden diversity in *Synura petersenii*



- 4 novel lineages recognized, resulting in a total of 10 well-defined species
- All species were shown to be distinguishable by the siliceous scale morphology



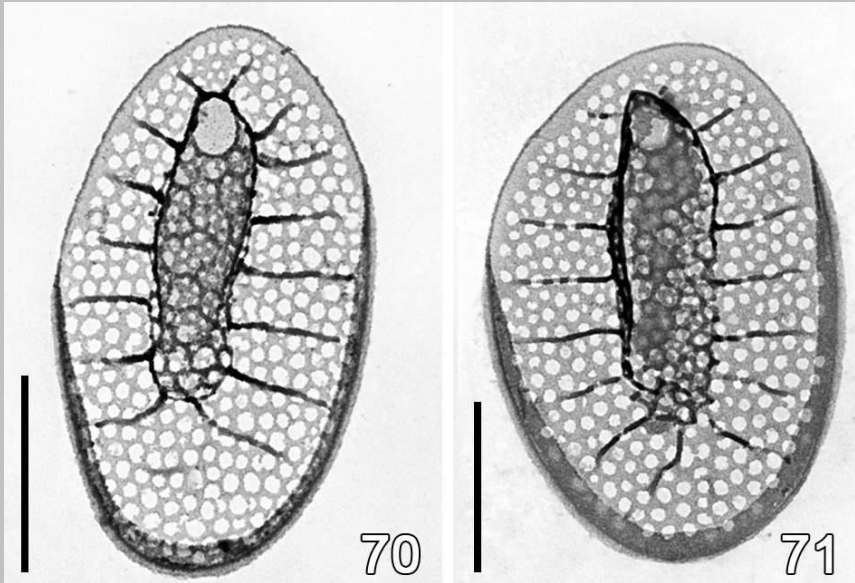
Bayesian analysis based on the combined ITS rDNA, rbcL and cox1 dataset.

Canonical diskriminant analysis (CDA) of morphological data

Skaloud P. et al. (2014): Morphological delineation and distribution patterns of four newly described species within the *Synura petersenii* species complex (Chrysophyceae, Stramenopiles). *Eur. J. Phycol.* (in press)

Hidden diversity in *Synura petersenii*

- Although they are evolutionary young, peculiar species obviously underwent some degree of morphological differentiation
- *Morphological adaptation?*

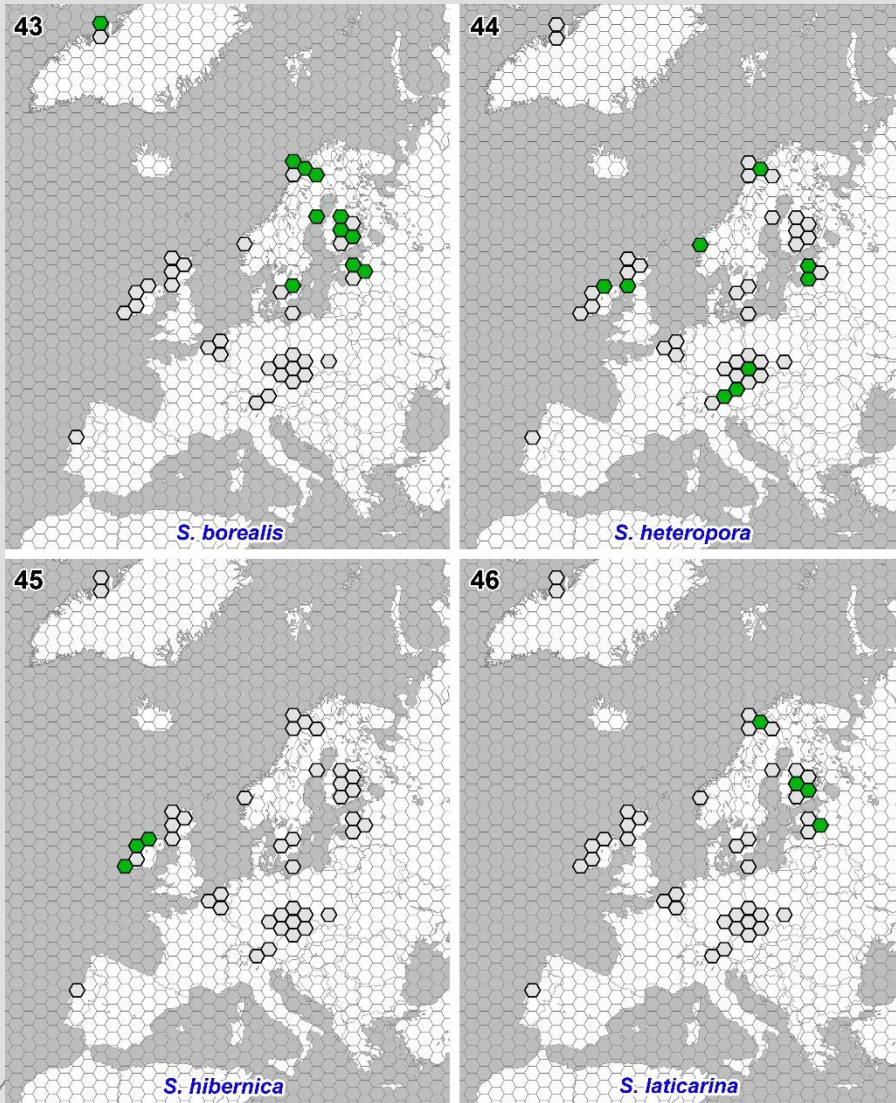


S. macropora: adaptation to eutrophic conditions (less availability of silica could cause a shift from heavily to less silicified scales)

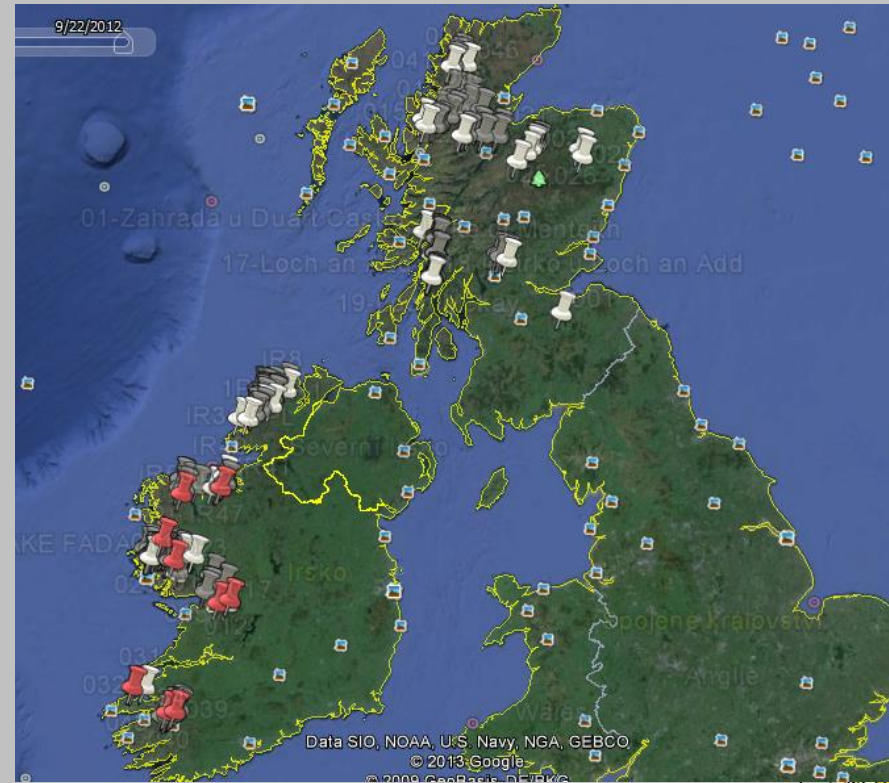
S. hibernica: adaptation to oligotrophic conditions (less availability of nutrients could cause cell elongation - to achieve a high surface-to-volume ratio)

Skaloud P. et al. (2014): Morphological delineation and distribution patterns of four newly described species within the *Synura petersenii* species complex (Chrysophyceae, Stramenopiles). ***Eur. J. Phycol.* (in press)**

Hidden diversity in *Synura petersenii*



- Different distribution patterns can be recognized in four newly described species
- *S. hibernica* restricted in its distribution to western Ireland



Skaloud P. et al. (2014): Morphological delineation and distribution patterns of four newly described species within the *Synura petersenii* species complex (Chrysophyceae, Stramenopiles). ***Eur. J. Phycol.* (in press)**

Acknowledgements

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