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Genetic versus phenotypic diversity of planktonic coccoid green algae (Chlorophyceae and Trebouxiophyceae)

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Coccoid green algae evolved in different phylogenetic lineages. To illustrate actual developments in biodiversity research on algae, here we focus on selected clades of the classes Chlorophyceae and Trebouxiophyceae. Experimental strains of members of these algal groups have conquered laboratories of plant physiology, algal mass cultivation and environmental test systems. Like *Chlorella*, the archetypical form of coccoid green algae, they are regarded as some of the best studied autotrophic eukaryotic microorganisms. Coccoid green algae exhibit an extremely high species diversity in phytoplankton of freshwaters of different states and in different climatic regions. However, does the actual species conception meet the requirements for a realistic evaluation of the biodiversity of these important primary producers in limnic ecosystems? The systematics of coccoid green algae is going through a dramatic phase of change. Classical approaches using morphological characters for the circumscription of taxa do not adequately reflect phylogenetic relationships. Molecular data (e.g. 18S rRNA and ITS sequences) provide new insights into the systematics of coccoid Chlorophyta. Here we show the complexity of genus and species conceptions of green algae, and compare strains from different climatic regions.

The polyphyletic origin of picoplanktonic spherical algae is demonstrated. In freshwater habitats, four different clades are reported (*Mychonastes/Pseudodictyosphaerium*-clade, *Choricystis*-clade, *Nanochlorum*-clade and *Chlorella*-clade). These clades which, are differentiated on the basis of molecular phylogenetics exhibit a very similar morphology with a minimal set of organelles: nucleus, chloroplast, mitochon-

drion, some peroxisomes and vacuoles. The multiple origin of this phenotype may be explained by an adaptive advantage in the ecosystem. In extreme saline lakes of Northern America, Asia and Africa, a novel lineage of green picoplankton outside the Chlorophyceae and Trebouxiophyceae was discovered, the *Picocystis*-clade.

On the example of the classical 'green ball' *Chlorella* and related taxa of the Chlorellaceae, it is shown that the clade of the 'true' spherical *Chlorella* species is intermixed with taxa that differ in morphology and were formerly classified in other families e.g. Botryococcaceae, Coelastraceae, Micractiniaceae, Oocystaceae and Scenedesmaceae. Ecophysiological experiments have shown that morphological criteria traditionally used for classification are burdened with a high degree of phenotypic plasticity. Using culture medium of *Brachionus*, spine and coenobia formation in *Micractinium* were induced. The results suggest that these morphological characteristics represent adaptations aimed at reducing grazing pressure in the ecosystem. The discrepance between phenotypic and genotypic criteria complicate a revised systematic conception in these common phytoplanktonts.