PROCHLOROPHYTA: A SUB-CLASS OF CHLOROPHYTA

Prochlorophyta are a photosynthetic prokaryote members of the phytoplankton group Picoplankton. These oligotrophic organisms are abundant in nutrient-poor tropical waters and use a unique photosynthetic pigment, divinyl-chlorophyll, to absorb light and acquire energy. These organisms lack red and blue Phycobilin pigments and have staked thylakoids, both of which make them different from Cyanophyta. Prochlorophyta were initially discovered in 1975 near the Great Barrier Reef and off the coast of Mexico. The following year, Ralph A. Lewin, of the Scripps Institution of Oceanography, assigned them as a new algal sub-class. Prochlorophytes are very small microbes generally between 0.2 and 2 μm (Photosynthetic picoplankton). They morphologically resemble Cyanobacteria, Members of Prochlorophyta have been found as coccoid (spherical) shapes, like Prochlorococcus, and as filaments, like Prochlorothrix.

In addition to Prochlorophyta, other phytoplankton that lack Phycobilin pigments were later found in freshwater lakes in the Netherlands, by Tineke Burger-Wiersma. These organisms were termed Prochlorothrix. *Prochloron* (a marine symbiont) and *Prochlorothrix* (from freshwater plankton) contain chlorophylls *a* and *b*; *Prochlorococcus* (common in marine picoplankton) contains divinyl-chlorophylls *a* and *b*. In 1986, Prochlorococcus was discovered by Sallie W. Chisholm and his colleagues. These organisms might be responsible for a significant portion of the global primary production. Like cyanophytes they are all clearly photosynthetic prokaryotes, but since they contain no blue or red bilin pigment they were assigned to a new algal sub-class, the Prochlorophyta. However, since their possible phylogenetic relationships to ancestral green-plant chloroplasts have not received support from molecular biology, it now seems expedient to consider them as aberrant cyanophytes.

Morphology

Prochlorophytes are very small microbes generally between 0.2 and 2 μm (photosynthetic picoplankton). They morphologically resemble Cyanobacteria. Members of Prochlorophyta have been found as coccoid (spherical) (Coccus) shaped, as in *Prochlorococcus*, and as filaments, as in *Prochlorothrix*. Their association with ascidians from tropical Pacific shores have been reported by various biologists. Such cells found associated with surfaces

of *Didemnum* colonies on the Pacific coast of Mexico, have been shown by electron microscopy to be prokaryotic, which suggests that they are cyanophytes, that is, blue-green algae. Although all known blue-green algae (other than a few apochlorotic types) contain phycoerythrin, phycocyanin, or both, however, these ascidian symbionts are apple green and contain no detectable bilin pigments. Furthermore, like the eukaryotic algae in the divisions Chlorophyta and Euglenophyta, they contain two chlorophyll components, separable by chromatography and provisionally identifiable as chlorophylls *a* and *b*, whereas no cyanophytes are known to contain chlorophyll *b*.

The prochlorophytes are a diverse group of photosynthetic prokaryotes that fall within the cyanobacterial lineage, yet lack phycobilisomes as light harvesting structures. Instead, the prochlorophytes have a light-harvesting apparatus composed of the higher plant pigments chlorophylls a and b. This review discusses the evolutionary relationships among these bacteria, with focus on the structure and function of the photosynthetic apparatus. This analysis yields a consensus from studies both on Prochloron sp. and Prochlorothrix hollandica as to how the thylakoid membrane is organized.

The algal internal structure, resembling that of blue-green algae, consists of two definite zones bounded by a thin (30–50 nm), multilayered cell wall. The outer zone is occupied by the photosynthetic lamellae and the cytoplasm. The central zone is electron-transparent and sometimes contains lamellae of unknown nature. However, unlike single non-appressed thylakoids of the Cyanophyta, the algal photosynthetic lamellae are composed of two-appressed

thylakoids. The central zone undergoes binary division before cytokinesis.


Cells of Prochloron

Taxonomy of Prochlorophytes

Their prokaryotic nature suggests that preference should be given to schemes that comply with the code of nomenclature applied to bacteria, although the type genus Prochloron, when it was first described by Lewin (1976), was validly published under the Botanical Code in the family Prochloraceae, order Prochlorales, division Prochlorophyta. Florenzano et al. (1986) proposed that the order Prochlorales be placed in the class Photobacteria, while Lewin (1989) placed the Prochlorales in a group later named the Oxychlorobacteria (Matthijs et al., 1994) in the class Oxygenic Photosynthetic Bacteria. in formally describing Prochlorothrix hollandica proposed that it be placed in the order Prochlorales, but in the new family Prochlorotrichaceae (on the grounds of its filamentous morphology).

The three known genera of prochlorophytes, *Prochloron*, *Prochlorothrix*, and *Prochlorococcus* form a polyphyletic group within the cyanobacterial radiation on the basis of molecular phylogeny. None of the prochlorophytes appears to be more closely related to plant and green algal chloroplasts than are other cyanobacteria, despite the common presence of a chlorophyll *a/b*. The three prochlorophytes occupy different ecological niches and vary in pigment composition. *Prochlorothrix hollandica*, a filamentous fresh-water species, has a Chl *a/b* ratio of 2.5 to 4, whereas *Prochloron didemni*, an obligate symbiont in

ascidians, has a Chl *a*/*b* ratio of 2.4 and also contains a small amount of a Chl *c*-like pigment. *Prochlorococcus*, an open ocean genus, contains divinyl Chl *a* and *b* and a Chl *c*-like pigment, with the Chl *a/b* ratio of different strains ranging between 0.6 and 13.

The common presence of Chl *b* in chloroplasts and prochlorophytes is difficult to reconcile with the phylogenetic studies, leading to proposals that the ability to use Chl *b* as a light-harvesting pigment evolved independently more than once and discovered that they belong to a completely different family.

Prochlorophyta is a group of photosynthetic bacteria, an important component of picoplankton. These oligotrophic organisms are abundant in nutrient poor tropical waters and use a unique photosynthetic pigment, divinyl-chlorophyll, to absorb light and acquire energy. Prochlorophyta lack red and blue phycobilin pigments and have stacked thylakoids, making them distinctly different from Cyanobacteria**,** but some authors consider them as part of the Cyanobacteria, as the group Prochlorales.

References

Burger-Wiersma T, Veenhuis M, Korthals H J, Van de Wiel C C M, Mur L R. Nature (London) 1986;320:262–264.

Gino Florenzano et al. International journal of systematic bacteriology 36(2):351-353 · April 1986

Lewin R A. Nature (London) 1976;261:697–698.

Matthijs H C P, van der Staay G W M, Mur L R. In: The Molecular Biology of Cyanobacteria. Bryant D A, editor. Dordrecht, The Netherlands: Kluwer; 1995. pp. 49–64.