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Morphological and molecular studies of *Neosynechococcus sphagnicola, gen.* et *sp.* nov. (Cyanobacteria, Synechococcales)

PETR DVOŘÁK[1*], FRANTIŠEK HINDÁK[2], PETR HAŠLER[1], ALICA HINDÁKOVÁ[2] & ALOISIE POULÍČKOVÁ[1]
[1] *Department of Botany, Faculty of Sciences, Palacký University, Šlechtitelů 11, CZ-78371 Olomouc, Czech Republic,*
[2] *Institute of Botany, Slovak Academy of Sciences, Dúbravská cesta 9, SK-84523 Bratislava, Slovakia*
[*] *Corresponding author (email: p.dvorak@upol.cz)*

Abstract

The genus *Synechococcus* represents an enigmatic group of cyanobacteria with very simple unicellular morphology and polyphyletic evolutionary origin. Here, we describe a new genus based on strain of *Synechococcus*-like cyanobacterium. The strain was isolated from the peat bog Klin (Slovakia), where it occupies different niches such as hyaline cells of *Sphagnum*, sheaths of cyanobacteria, dead cells of desmids, carapaces of dead crustaceans, and solitary in detritus. We describe this new genus using a combination of molecular, morphological and ecological features. A phylogeny of the 16S rRNA gene, 16S-23S ITS and *rbc*L loci showed a separate position of the investigated strain and its close proximity to filamentous cyanobacteria. Therefore, it is a novel lineage of *Synechococcus*-like cyanobacteria illustrating the polyphyletic nature of the genus *Synechococcus*. Moreover, the strain exhibits unique morphological and ecological features, which allow us to erect the new monospecific genus *Neosynechococcus*.

Key words: new genus, new species, peat bog, Slovakia, 16S rRNA, 16S-23S ITS, *rbc*L

Introduction

The genus *Synechococcus* Nägeli (1849: 56) is a widely distributed group of cyanobacteria exhibiting very simple morphology, which is characterized by unicellular or pseudofilamentous thalli, asymmetric binary fission, and small elongated to cylindrical or rod-like cells (Komárek & Anagnostidis 1998). Its distribution has been extensively investigated in marine environments where, together with *Prochlorococcus* Chisholm *et al.* (1992: 299), it represents the most abundant autotrophs (e.g. Schmidt *et al.* 1991, Li 1994). However, there is important species diversity in other environments, e.g. freshwater planktic, benthic or soil biotopes (see Komárek & Anagnostidis (1998) and John *et al.* (2011) for review). Other taxa include endogloeic species inhabiting mucilage of other cyanobacteria or epiphytic taxa colonizing the surface of colonies. Hindák (1996) described *S. epigloeicus* Hindák (1996: 77) and *S. endogloeicus* Hindák (1996: 78) inhabiting a surface and an interior of mucilage of the cyanobacterium *Microcystis aeruginosa* Kützing (1846: 6) and *Woronichinia naegeliana* (Unger 1854: 195) Elenkin (1933: 30). Another endogloeic species, *S. mucicolus* Joosten (2006: 76), occurs in the mucilage of *Microcystis* spp. and was described by Joosten (2006).

Besides endogloeic species, cyanobacteria often live in association with other organisms including fungi (lichens), corals or ferns. Moreover, cyanobacteria may be partners in symbiosis with mosses (see Solheim & Zielke (2002) and Adams & Duggan (2008) for a review), because of their ability to fix atmospheric nitrogen. Nitrogenase activity, which is indicative of fixation of atmospheric nitrogen, has been documented in the *Sphagnum* Linnaeus (1753: 1106) mosses (Granhall & Hofsten 1976), where diazotrophic cyanobacteria often inhabit *Sphagnum* hyaline cells. This consortium provides nitrogen to the *Sphagnum* while the cyanobacteria benefit from a stable and more favourable environment than acidified peat bog (Solheim & Zielke 2002).

Evolutionary relationships within the cyanobacteria are the most frequently reconstructed using 16S rRNA gene phylogeny. While it is an effective molecular marker for resolution at the genus level (e.g. Komárek 2010), better taxonomical resolution (lower than genus) is achieved using additional molecular markers. For instance, 16S-

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