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Polyphasic characterization of *Stigonema dinghuense*, *sp. nov.* (Cyanophyceae, Nostocophycidae, Stigonemaceae), from Dinghu Mountain, south China

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Abstract

Polyphasic taxonomic studies have been largely conducted at genus/species levels in cyanobacteria, leading to the description of numerous cyanobacterial genera and species. The present study describes a new cyanobacterial species *Stigonema dinghuense*, *sp. nov*. Song *et* Li based on the combination of morphological, genetic, and ecological evidences. This new species was collected from a wet rocky wall in Dinghu Mountain, Guangdong Province, China. *Stigonema dinghuense* was morphologically similar to *Stigonema mamillosum*, the type species of the genus, however, *Stigonema dinghuense* grew on the rocky wall in subtropical region and the type species *Stigonema mamillosum* inhabited in subfrigid and frigid zones, reflecting a relatively large difference in ecology. 16S rRNA sequences based phylogeny revealed that all the *Stigonema* species/strains reported so far, including *S. dinghuense*, grouped into a monophyletic cluster. Phylogenetic analyses based on 16S rRNA, *nif*H and *rbc*LX gene sequences yielded the congruent support for the monophyly of heterocytous cyanobacteria. The true branching cyanobacteria (formerly Stigonematales) were separated into four major groups, three of which intermixed with Scytonemataceae.

Key words: Cyanobacteria, Morphology, Phylogeny, Taxonomy, Stigonematales, Nostocales

Introduction

The taxonomic system of cyanobacteria has been continuously revised over the past decades due to the development of modern and integrated approaches (Hoffmann *et al*. 2005, Komárek 2006, 2010, 2013, 2014). In earlier cyanobacterial classification systems, the heterocytous cyanobacteria had been divided into two orders as Nostocales and Stigonematales, the former representing non- or pseudo-branching species and the latter true-branching ones (Desikachary 1959, Anagnostidis & Komárek 1990). However, molecular phylogenies based on 16S rRNA gene and *nif*D sequences demonstrated that the true branching cyanobacteria (formerly Stigonematales) is polyphyletic since Stigonematales was shown to mix with Nostocales, leading to the conclusion of the monophyly of the heterocytous cyanobacteria (Zehr *et al*. 1997, 1998, 2000, Henson *et al*. 2004). Consequently, Hoffman *et al*. (2005) proposed a taxonomic system of cyanobacteria with four sub-classes, in which Nostocophycidae contained only one order Nostocales covering all heterocytous cyanobacteria, including branching and non-branching ones, and this treatment for the true branching cyanobacteria was accepted by Komárek (2013) and Komárek *et al*. (2014).

The true branching cyanobacteria comprise 46 genera, a number of these taxa are rarely found in nature and reported only once (Komárek 2013). Generally, true branching cyanobacteria are characterized by the heterotrichous filaments, which are composed from creeping filaments or combined with creeping and erect filaments, indicating the highest degree of morphological complexity within the cyanobacteria. However, the true branching cyanobacteria are known to be the least studied group due to their lack of dominant ecological role, rare distribution and complicated life cycle (Anagnostidis & Komárek 1990), and one of the most important reason comes from the fact that these organisms are difficult to cultivate in laboratories. Taxonomic studies on the true branching cyanobacteria based on cultivated strains are mostly restricted to genera from particular biotopes, *e.g. Fischerella* (Kützing ex Bornet & Flahault 1886: