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Polyphasic characterization of *Kastovskya adunca gen. nov. et comb. nov.* (Cyanobacteria: Oscillatoriales), from desert soils of the Atacama Desert, Chile

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Abstract

Recent taxonomic revisions within the cyanobacteria have shown that the traditional simple filamentous genera often represent large polyphyletic clusters of not-so-closely-related taxa. In this study, the new cyanobacterial genus *Kastovskya* is described based on a combination of morphological, molecular, and ecological evidence. *Kastovskya* was first described as *Schizothrix adunca*, a morphospecies discovered in the Atacama Desert, Chile more than 50 years ago. This species has been transferred to *Kastovskya* and serves as the generitype. *Kastovskya adunca* currently represents a unique and probably endemic taxon for the soils of the Atacama Desert region. Description of this new genus contributes to the revision of the Phormidiaceae by providing a clear taxonomic definition to one of the clades within the *Schizothrix/Microcoleus/Phormidium* cluster.

Introduction

Deserts provide harsh habitats (saline lakes, arid soils) habitable only by extremophiles, such as Cyanobacteria. However, species-level diversity is poorly known for this group. In particular, arid deserts such as the Atacama Desert are greatly understudied.

The Atacama Desert forms a narrow but long strip of arid land along the Pacific coast in South America. It extends from La Serena, Chile in the south to the Peruvian-Chilean border in the north (Rundel *et al*. 1991). Two main regions can be distinguished in this desert. First is the hyperarid core, located in the vicinity of Yungay, Chile. This part is considered to be one of the driest places of the world with soil water potential reaching as low as -166 Mpa, and thus has soils posing similar challenges to conditions found on Mars (McKay *et al*. 2003, Navarro-González *et al*. 2003). Some studies have shown that parts of this Atacama core may be even too dry for microbes to survive (Navarro-González *et al*. 2003, Lester *et al*. 2007). The second region is the coastal zone adjacent to the Pacific Ocean. In comparison with the hyperarid core, the climate is milder here, and is characterized by the presence of microorganisms and higher plants. The crucial factor influencing the environmental conditions is regular formation of fog (called "camanchaca" in Chile) which serves mostly as the only source of water (Rundel *et al*. 1991, Cereceda *et al*. 2008). A remarkable number of endemic plants have been discovered in the fog oases (Rundel *et al*. 1991, Larrain *et al*. 2002, Cereceda *et al*. 2008); however, much less is known about the potential endemism of microorganisms living in this desert.

Research focusing on cyanobacteria inhabiting soils of the Atacama Desert started more than 50 years ago near the cities of Antofagasta and Caldera, Chile. The author of the very first study confirmed the presence of living blue-green algae by finding four cyanobacterial species: *Calothrix desertica* Schwabe (1960: 282), *Schizothrix adunca* Schwabe (1960: 293), *S. atacamensis* Schwabe (1960: 296), and *Plectonema polymorphum* var. *viridis* Schwabe (1960: 291). All of them except *P. polymorphum* were species new to science (Schwabe 1960). Six years later, Forest & Weston (1966) reported three additional species of cyanobacteria from the Atacama Desert. Nevertheless, due to their use of the oversimplified classification system of Drouet (1968), it is difficult to determine which species were actually present (Büdel 2001).

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As can be seen in the example of the re-investigated phylogeny of strains from Boyer *et al*. (2002), morphology in the order Oscillatoriales is insufficient for descrimination of the different lineages. In fact, strains falling within the morphological description given by Boyer *et al*. (2002) for *M. steenstrupii* are distributed in the 16S rRNA tree among taxa with clearly different morphology (e.g. *Wilmottia*, *Kastovskya*). However, morphology in the original study was not investigated throughout the whole life cycle, so it is possible that some morphological variability within the *M. steenstrupii* morphotype exists. The polyphyletic nature of this group highlights the need for using large datasets for phylogenetic studies. Today, 11 years after Boyer *et al*. (2002), many more cyanobacterial sequences are available in databases. Consequently, much more reliable results in terms of phylogenetic position of strain groups can be obtained.

Recent investigations have shown that the Atacama Desert possesses an interesting cyanobacterial flora, which definitely deserves more attention (Osorio-Santos 2011, Baldarelli 2012). *Kastovskya adunca* studied in this work represents a stable morphotype unique for this desert. Since the description of this cyanobacterium more than 50 years ago (Schwabe 1960) it has not been recorded from any other location. This suggests that the Atacama Desert contains endemic cyanobacterial species. By thorough investigation of cyanobacteria from different parts of the world, not only will microfloristics be better understood, but cyanobacterial diversification will be better characterized. The simple filamentous cyanobacteria need further revision and many new genera and species probably will need to be described and defined in order to obtain a taxonomic system comprised only of monophyletic taxa.

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