Some finds of subaerophytic cyanobacteria on wetted walls of La Palma (Canary Islands)

Nálezy subaerofytních sinic na smáčených stěnách ostrova La Palma (Kanárské ostrovy)

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Abstract

Randomly selected samples of cyanobacterial mats growing on wetted walls of two distinct localities (Barranco de las Augustias, and Los Tilos) in La Palma (the Canary Islands) were collected. The collected samples contained twelve cyanobacteria morphotypes (determined according traditional system). Populations of both localities were dominated by coccoid cyanobacteria (*Aphanothece pallida* and *Aphanothece* cf. *saxicola*) and in some sampling sites by filamentous cyanobacteria *Nostoc* spp. and *Leptolyngbya* spp. In spite of the fact that the Canary Islands are characterized by a high level of species endemism mainly in terrestrial plants, most of the isolated cyanobacteria are considered to be cosmopolitan or widespread. But also some unknown morphotypes, e.g. *Calothrix* sp., were found to be common. Morphological changes in *Calothrix* were studied using light microscope and remarkable morphological changes in the type of branching and filament morphology were found.

Introduction

Community of subaerophytical cyanobacteria on wetted walls has been many time reported to be very diversified in spatial species composition mainly on limestone or basic rocks (NOVÁČEK 1934). Also, many cyanobacterial morphotypes have been described exclusively in materials collected from wetted walls and many of them are supposed to be cosmopolitan in such habitats. Some studies were performed on European main limestone or sandstone mountains ranges (the Alps, Tatra mountains, Mohelno serpentines, Croatia) (NOVÁČEK 1934, JAAG 1945, GOLUBIĆ 1967), but only a few studies were focused on other habitats. We selected two sampling sites in La Palma island (the Canary Islands) to compare the species composition of cyanobacterial mats with the existing data in this field. This short study does not describethe complete species composition in sampling sites, but compares dominant morphotypes in collected mats with data from other geographical parts of the world.

Material and methods

Localities and sampling sites

Eight natural samples in two distinct localities in La Palma (see Fig. 1) were collected in March 2003. Samples were taken in two replicates. Right at the sampling site, one replicate was preserved with 3% formaldehyde, and we added 10 ml of BG11 medium to the second one.

Natural conditions of La Palma island

La Palma, one of the smaller Canary islands (730 km^2), is located off the coast of NW Africa. Like the other Canary Islands, it also has a volcanic origin with a number of eruptions in its recent history (the most recent volcanic eruption was that of Teneguia in 1971). It consists of two main geological units. First, which cover most of the island are Coberta series formed by alkali lava. The Caldera de Taburiente (crater) consists of submarine intrusive and extrusive seamounts and represents a dominant of La Palma island with its height reaching 2426 m above the sea level and 2000 m deep. It is drained to the west by a deep canyon of Barranco de las Augustias.

Barranco de las Augustias:

Barranco de las Augustias is a closed canyon with a surface stream connecting the central crater with the coastal part of the island. The canyon's lower bed is formed by slightly alkali volcanic background (Caldera base). From phytogeografical point of view, it is characterized by humid and semi-arid subtropical scrubs and woods (EMERSON 2003), which bear features of both termophilic scrubs (dominance of *Euphorbia regus-jubae* and *Rumex lunaria*) and pine forests (dominance *Pinus canarensis* and *Cistus symphytifolius*). Wetted walls are supplied by water springs occurring in stone walls. These spatial microhabitats are characterized by the presence of fern *Adiantum capillus-veneris* and microbial mats formed mainly by cyanobateria. Three samples (BA-1 - BA-3) were collected from wetted stone walls in the altitude of app. 300 m above the sea level in a short transect (200 m) of central part of the canyon (see fig.1).

Los Tilos:

Los Tilos is situated in the north-western part of La Palma in Las Nieves Nature Park. It is located in a large geological complex – Taburiente volcano formed also by slightly alkali rocks. Its vegetation is represented by damp forests with rich species composition (dominance of *Persea indica*, *Laurus azorica*, *Erica arborea*, *Ocotea foetens*, *Apollonias barbujana*, *Viburnum tinus* subsp. *rigidum* and *Sambucus nigra* subp. *palmensis*). Five samples (LT-1 - LT-5) were collected from wetted walls in the altitude of app. 600 m above the sea level (see Fig.1).

Evaluation of cyanobacterial abundance, cultivation and statistical evaluation

Evaluation of cyanobacterial abundance and morphology was performed using a light microscope OLYMPUS CX-40 with a digital camera. Number of cells/filaments in cut of visual field (150x150 μm) was counted in four independent samples and expressed in percents. Semiquantitative scale was selected to visualize the results: + - species rare with abundance up to 5%, ++ - species with abundance varied between 6-50%, and +++ species with abundance over 51%. Natural samples were inoculated each at two Petri dishes with BG11 medium (STANIER et al. 1971) solidified with 1.7% agar and in 50 ml of liquid BG11 medium in 10ml Erlenmeyer's flasks. Samples were cultured under continuous light regime (35 μE photon m^{-2} s^{-1}) and temperature of 20 ± 2°C. The morphology of cyanobacteria was studied 3 times during the cultivation time (2 months) after 5, 20, and 35 days of cultivation. Basic morphological characteristics (cell dimension, morphology of filaments and type of branching) were measured and observed in both liquid and solidified medium.

Species composition of the studied samples was compared by principal component analysis (PCA). We performed the analysis with Canoco for windows 4.0 software.

Results and discussion

Twelve distinct cyanobacterial morphotypes identified according the traditional system (ANAGNOSTIDIS & KOMÁREK 1988, KOMÁREK & ANAGNOSTIDIS 1999) were found in the collected samples. Despite the studied localities differ in habitat conditions, their species composition of cyanobacterial mats does not differ significantly (Table 1 and Fig. 2). In cyanobacterial mats, chroococcoid types were dominant, e.g. *Aphanothece pallida* (Fig. 3/1) (abundance ≥50% of cells in 1 sample from La Palma (BA-3) and in 4 samples from Los Tilos), and *Aphanothece* cf. *saxicola* (Fig. 3/2). Many other cyanobacterial types were associated with these mucilage forming dominant types (for the complete list of species see Table II), such as *Chroococcus spelaeus* (Fig. 1/3,4), *Phormidium autumnale* agg. (Fig. 3/6,10), *Leptolyngbya* spp. and an unknown morphotype of *Calothrix* sp. (Fig. 4). Other six morphotypes were found to be more or less rare (for reference see Fig. 3). In two samples (BA-2 and LT-3), *Nostoc* spp. (Fig. 3/12-14) and *Leptolyngbya* spp. were found as dominant. The populations of these two dominants were not followed by any other cyanobacterial morphotypes.

In comparison to other references, the species composition of the cyanobacterial mat collected in La Palma does not differ significantly (Fig. 2). Dominance of cocal types in such microhabitats has been reported from many distinct geographical parts, such as limestone walls (the_Alps, and Croatia) or serpentines (BAUR et al. 1995, NOVÁČEK 1934, JAAG 1945, GOLUBIĆ 1967). The

Canary Islands are characterized by a high level of species endemism mainly in terrestrial plants (CIFERRI 1962, MACHADO 1976) and have been utilised for evolutionary studies of colonisation and specification (for review see JUAN et al. 2000). However, most of the isolated cyanobacteria are considered cosmopolitan (e.g. *Aphnothece pallida*, and *Aphanothece* cf. *saxicola*), or wide spread in terrestrial or subaerophytical habitats (e.g. *Scytonema hofmanii*, *Nostoc* cf. *calcicola,* and *Phormidium autumnale* agg.). The only specific, that does not correspond to any other described, is *Calothrix* sp. strain (see Fig. 4). Its morphology was studied in fixed natural population and under artificial cultivation condition in liquid and solidified BG-11 N^- mediums. In natural populations, it forms long filaments (up to 100 cells) attenuated towards the ends, surrounded by a thin colorless mucilaginous envelope. In nitrogen free medium, hemispherical terminal heterocytes differentiate at the ends of the filament. In liquid and solidified mediums, the morphology of filaments has changed completely. Filaments became longer (up to 300 cells), irregularly coiled inside the sheet and frequently branched by both Tolypotrichal and Scytonematal types of branching and ended with pointed cells. The morphology of terminal heterocytes was stable in all three samples. This result can indicate that cultivation conditions can change important diacritical morphological features (dividing cyanobacterial families) of an isolated strain even after a short cultivation time.

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Table 1.: Complete list of morphotypes found in sampling sides

	Sample site							
	BA-1	**BA-2**	**BA-3**	**LT-1**	**LT-2**	**LT-3**	**LT-4**	**LT-5**
Apahnothece pallida (Kűtzing) Rabenhorst			+++	+++	+++		++	++
Apahnothece cf.*saxicola* Nägeli	++						+++	++
Cyanosarcina sp.	+							
Chroococcus spelaeus Ercegović.	+		+	+	+		+	+
Pseudocapsa cf. *dubia* Ercegović.				+				+
Leptolyngbya spp.	+	+	++		++	+	++	
Phormidium autumnale agg. (Agardh) Gomont			+	++	+		+	
Pseudophormidium sp.	++			+				
Nostoc cf. *ellipsosporum* Rabenhorst	+	++						
Nostoc cf. *calcicola* Brébisson	+	++			++	+++		
Calothrix sp.	++			++	+		+	++
Scytonema hofmani Agardh			++					+

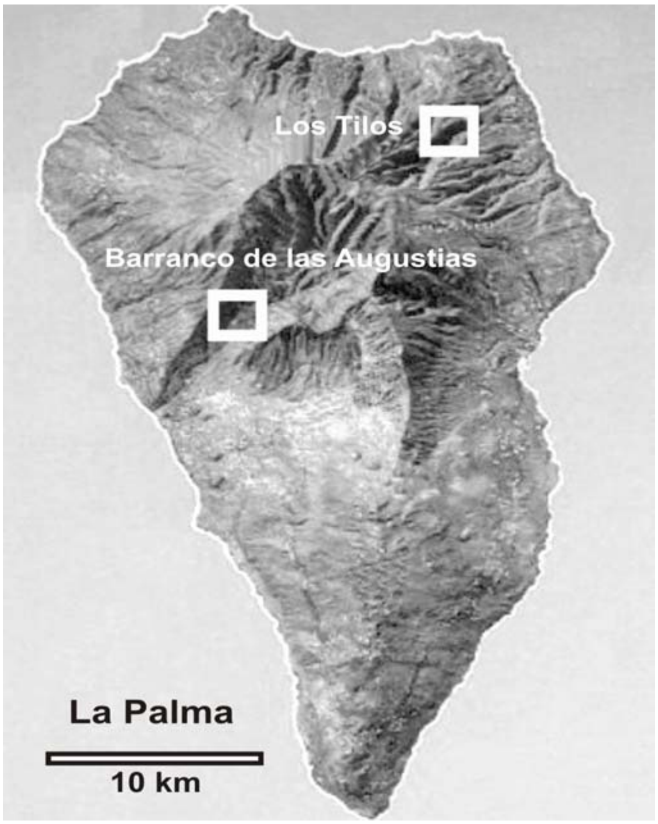

Fig. 1.: La Palma island (Canary Islands) white squares markes sampling sites

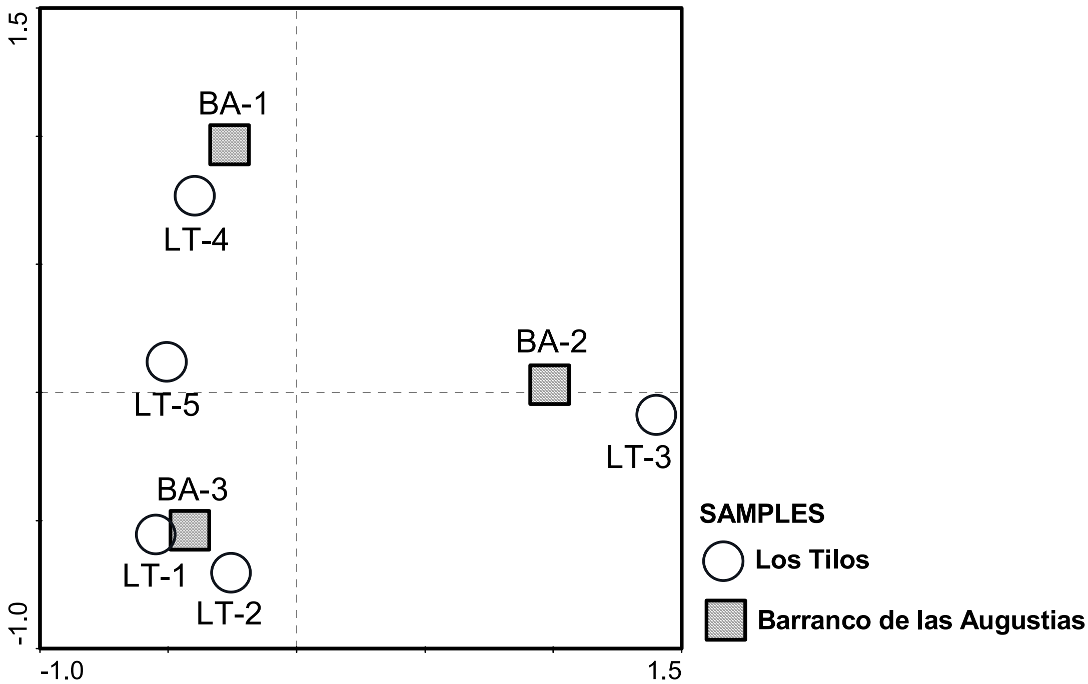

Fig. 2.: Comparison of species composition at eight sampling sites (PCA analysis)

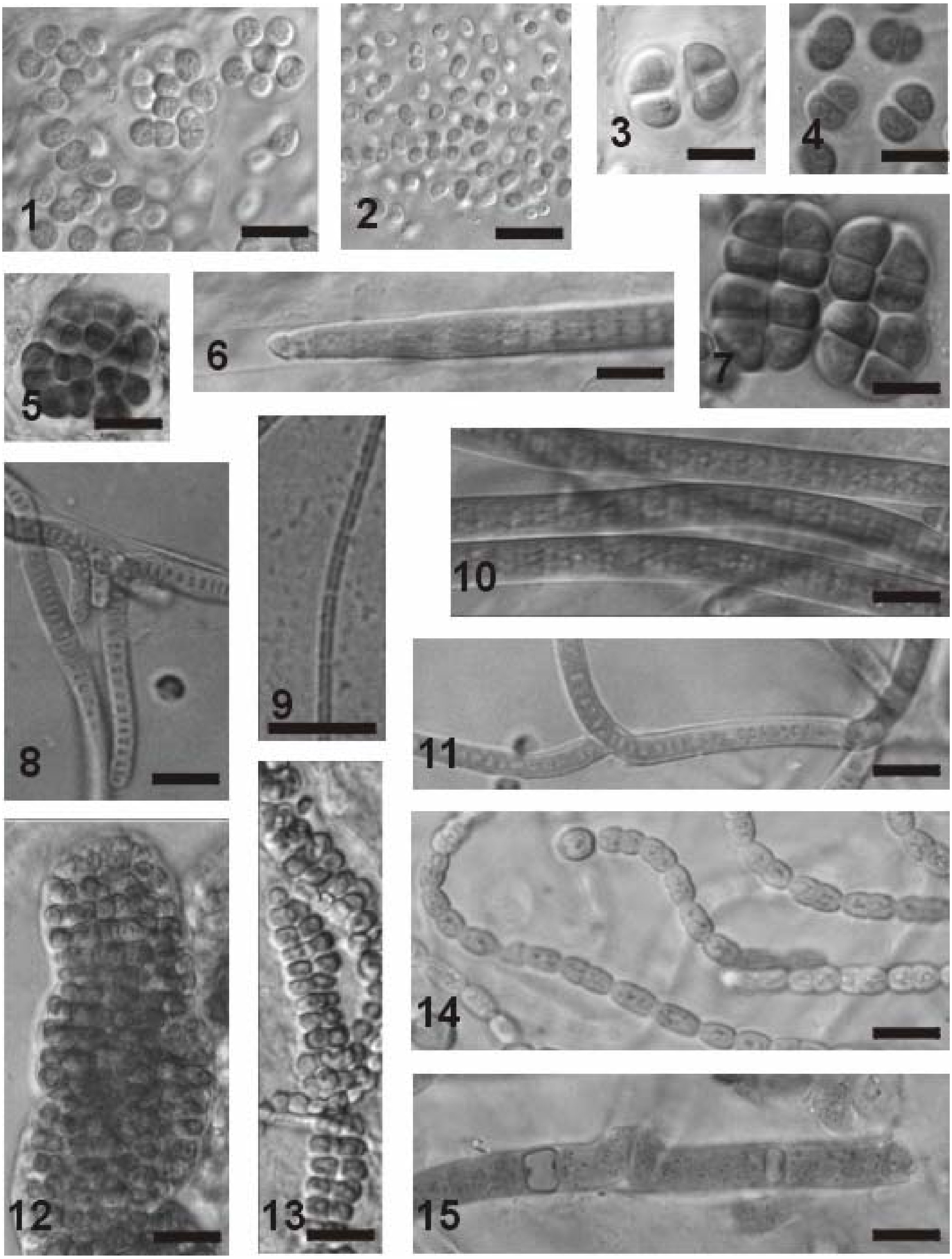

Fig. 3.: 1 – *Aphanothece pallida*, 2 – *Aphanothece* cf. *saxicola*, 3-4 – *Chroococcus spelaeus*, 5 – *Pseudocapsa* cf. *dubia*, 6 and 10 – *Phormidium autumnale* agg., 7 – Cyanosarcina sp., 8 and 11 – *Pseudophormidium* sp., 9 – *Leptolyngbya* sp., 12 – *Nostoc* sp., 13 – *Nostoc calcicola* agg., 14 – *Nostoc ellipsosporum* agg., 15 – *Scytonema hofmanii* (barr 10 µm)

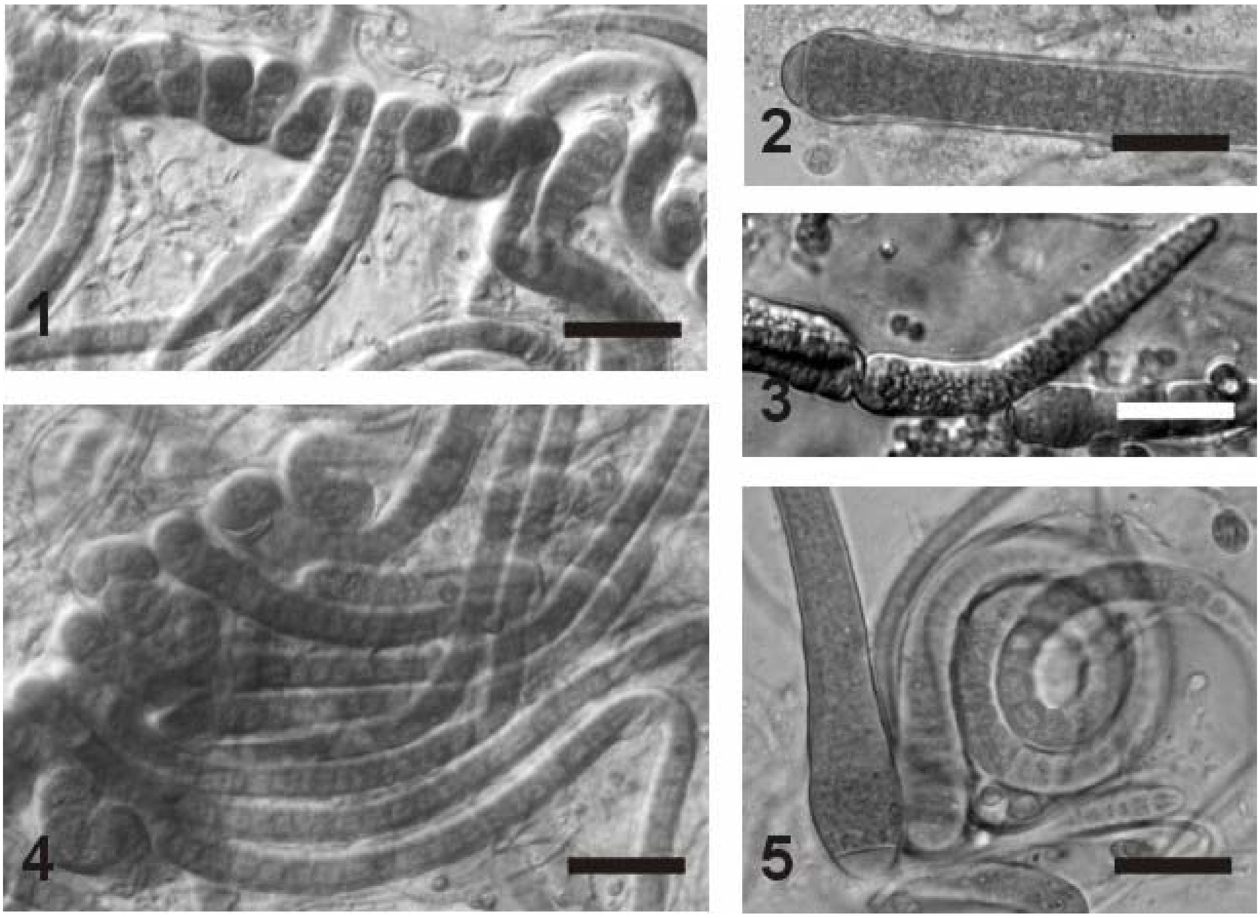

Fig. 4.: 1-5 *Calotrix* sp., 1-4 morphology of filaments under cultivation conditions, 5 – morphology of filaments in fixed natural sample
(barr 10 μm)