LETTER

Upon rehydrating desiccated marine microbial mats, cyanobacterial photosynthesis and migration quickly resume

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ABSTRACT

In the arid regions of the Earth, desiccated cyanobacterial mats constitute the predominant biological characteristic. Desiccated cyanobacteria's reaction to rehydration in terrestrial settings has been extensively studied, but less is known about their behaviour in marine systems. We investigated this reaction in a dehydrated microbial mat from Exmouth Gulf, Australia, using high temporal resolution hyperspectral imaging, liquid chromatography, pulse-amplitude fluorometry, oxygen microsensors, and confocal laser microscopy. Chlorophyll a concentrations increased 2 fold–5 fold over the first 15 minutes after rehydration, and cyanobacterial photosynthesis resumed. We speculate that resynthesis from a precursor stored in dried cyanobacteria is responsible for this sudden surge in chlorophyll a, even if the exact mechanism is still unknown. The reactivated cyanobacteria moved toward the mat surface during the following phase (15 minutes to 48 hours), which coupled with a progressive rise in chlorophyll, caused a further increase in photosynthesis. We come to the conclusion that cyanobacteria from dried mats of both terrestrial and marine origins exhibit the same reaction, which involves an increase in chlorophyll a and a recovery of photosynthetic activity within minutes following rehydration. But the reaction of upward migration and the mechanism that sets it off seem to be mat-specific and probably dependent on other elements. In the arid regions of the Earth, desiccated cyanobacterial mats constitute the predominant biological characteristic. Desiccated cyanobacteria's reaction to rehydration in terrestrial settings has been extensively studied, but less is known about their behaviour in marine systems. We investigated this reaction in a dehydrated microbial mat from Exmouth Gulf, Australia, using high temporal resolution hyperspectral imaging, liquid chromatography, pulse-amplitude fluorometry, oxygen microsensors, and confocal laser microscopy. Chlorophyll a concentrations increased 2 fold–5 fold over the first 15 minutes after rehydration, and cyanobacterial photosynthesis resumed. We speculate that resynthesis from a precursor stored in dried cyanobacteria is responsible for this sudden surge in chlorophyll a, even if the exact mechanism is still

Key Words: *Oxygen microsensors; Cyanobacteria; Confocal laser microscop; Liquid chromatography*

INTRODUCTION

Various kinds of bacteria, archaea, and eukaryotic microalgae are known as microbial mats and are arranged in a sediment matrix. Photosynthetic microbial mats are the predominant biological feature in the arid and mesic zones of the tropical, temperate, and polar climates. *Cyanobacteria* are the predominant primary producers in these settings and exhibit significant rates of carbon and nitrogen fixation while only being active sometimes when water is available.

Microbiological mats are often layered formations having physico-chemical and microbial zonation on a millimetre scale. Microbial mats are characterised by severe vertical gradients of oxygen, pH, and sulphide due to intense attenuation of light and mass transport restrictions in the sediment matrix. Due to the varied light supply, these gradients fluctuate substantially with diel periodicity, and it is generally accepted that these shifts regulate the distribution and structure of the microbial communities in mats. *Cyanobacteria* have evolved sophisticated adaptations in order to survive in microbial mats' dynamically shifting microenvironments. For instance, *cyanobacteria* migrate to improve their position within the extremely fluctuating light field or to prevent the impacts of self-shading, sedimentation, or exposure to powerful UV radiation due to their vital reliance on light for photosynthesis. Although other elements, including salinity gradient and desiccation conditions, have also been proven to play a role, light, oxygen, and sulphide diel fluctuations are typically thought to be the main drivers for the motility of *cyanobacteria* in mats.

The key factor regulating activity and movement in desert crusts, which are an arid home for *cyanobacteria*, is the availability of water. The quick return of photosynthetic activity after rehydration, which results in a "greening" of the surface and can happen in minutes, is one notable illustration of how *cyanobacteria* have adapted to flourish in desert crusts. The buildup of photopigments at the surface of rehydrated desert crusts gives them their green colour. Some research attributes this to the hydrotactic movement of *cyanobacteria*, while other studies attribute it to the recovery of dried pigments.

There is research on the rehydration response of terrestrial desert crusts, but none on dry marine microbial mats, which experience similarly parched conditions of acute drought punctuated by periodic availability of seawater. We predicted that the same reaction as in desert crusts would take place, namely, a quick reactivation of photosynthesis and an upward migration to the mat surface. resistance to desiccation.

On the basis of this concept, we try to incorporate dried marine mats into studies on the desiccation of arid terrestrial systems. We looked at how a dehydrated *cyanobacterial* mat from Giralia Bay in Australia's Exmouth Gulf responded to rehydration in a time range ranging from minutes to days. We employed minimally invasive methods, including microsensors and hyperspectral imaging fluorometry, to detect the rehydration response with great temporal resolution.

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