

Oscillatoria simplicissima: A taxonomical study

A Venter*, A Jordaan and AJH Pieterse

School of Environmental Sciences and Development: Botany, PU for CHE, Potchefstroom 2520, South Africa

Abstract

Oscillatoria simplicissima is a filamentous blue-green alga that was identified in the Vaal River in South Africa. The magnitude of its blooms causes a decline in water quality as well as problems in extracting and purifying water. This species was classified as *Oscillatoria simplicissima* under the order Nostocales and the family Oscillatoriaceae due to its simple unbranched trichome without heterocysts and akinetes. However, it was reclassified under the species *Microcoleus lyngbyaceus* because of the thick outer walls of its terminal cells. The classification was again changed to *Phormidium simplicissimum*. Therefore, apart from looking at the ultrastructure of this organism this investigation also tried to unravel the classification of this species.

Introduction

Blue-green algae represent only a small proportion of all algal groups in the Vaal River, but they are probably one of the most important, taking into account their potential to be problematic (whether toxin-producing, filter-clogging, scum-forming or discouraging recreational activities). A study done on the development of phytoplankton assemblages in the middle Vaal River (1992 to 1997) showed that *Oscillatoria simplicissima* Gomont, a filamentous blue-green alga, can probably be regarded as the most important bloom-forming blue-green algal species in the Vaal River (Janse van Vuuren, 2001).

Blooms of *O. simplicissima* result in the production of unpleasant odours and tastes in treated water and a general decline of the water quality. Although this blue-green alga is presumably non-toxic in small concentrations, the magnitude of its blooms causes many logistical problems in extracting and purifying water from the Vaal River, leading to increases in purification costs and the loss of large volumes of water.

O. simplicissima was first identified in the Vaal River during 1984 (Pieterse and Steynberg, 1993). Authors such as Geitler (1932) and Desikachary (1959) classified *O. simplicissima* under the order Nostocales and the family Oscillatoriaceae due to its simple unbranched trichome without any heterocysts. Drouet (1968) classified *O. simplicissima* under the species *Microcoleus lyngbyaceus*, grouping organisms of the Oscillatoriaceae that form terminal cells with thick outer walls, together. Anagnostidis and Komárek (1988) introduced other non-traditional features such as the type of cell division, occurrence of aerotopes (groups of gas vesicles), motility and type of trichome disintegration to classify this organism under the order Oscillatoriales, family Phormidiaceae, subfamily Phormidioideae, species *Phormidium simplicissimum*.

The aims of this investigation were to look at the ultrastructure of *O. simplicissima* as part of a study to understand the growth and physiology of this blue-green alga, but also to investigate the different classification systems of *O. simplicissima*. Because of the uncertainty of the correct classification of the organism studied, it will be called *O. simplicissima* for the purpose of this paper.

Materials and methods

O. simplicissima batch cultures were grown in a 50% GBG 11 medium (Krüger, 1978) in 250 ml Erlenmeyer flasks, at 28°C and at a light intensity of 15 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$. Filtered filaments were placed on an agar block (5 x 5 x 5 mm) and prepared for investigations using the transmission electron microscope (Phillips CM10).

For the scanning electron microscope (Phillips XL30 Dxi/4), samples (0.5 to 2.0 ml) were filtered through an 0.5 μm mesh sized Millipore filter.

Preparations for the transmission electron microscope (TEM)

Agar samples were fixated for 2 to 6 h in Todd's solution (Todd, 1986), washed three times for 10 min in cacodylate buffer. Samples were post-fixated in 0.5% OsO_4 for 1 h and washed 3 times for 10 min in distilled water. Samples were dehydrated through 50%, 70%, 90%, 100% and again 100% acetone for 15 min each. Infiltration with resin was initiated with a 3 h soak in a 1:1 mixture of acetone and resin and left for 3 h. Samples were placed in 100% resin for 5 h and placed in fresh 100% resin for another 2 h. The samples were then embedded in 100% resin by keeping it for 8 h at 70°C. Thin sections were cut with an ultramicrotome and were retrieved on a copper specimen grid and post-stained with 0.5% uranyl acetate and 0.4% lead citrate.

Preparations for the scanning electron microscope

The filter papers containing the algal filaments were dehydrated in an ethanol concentration series of 10%, 20%, 40%, 60%, 80%, 90%, 95% and twice in 100%. After dehydration, critical-point drying was done with an EM SCOPE TB500 coater, and the material was coated with carbon and gold palladium for 3 min.

Results and discussion

This investigation found that *O. simplicissima* has typical characteristics as described by Geitler (1932), Desikachary (1959) and Anagnostidis and Komárek (1988). *O. simplicissima* is a filamentous alga with uniseriably arranged cells that are not constricted at the cross walls (Fig. 1). The straight, unbranched, trichome is dark blue-green, covered with a thin hyaline sheath and is not attenuated or capitated at the apice. Terminal cells are

* To whom all correspondence should be addressed.

☎ 018 299 2517; fax 018 299 2503; e-mail: plbaav@puknet.puk.ac.za
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