

Preliminary observations on the effect of increased concentrations of total dissolved salts on growth and photosynthetic rates in different algal species

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Abstract

The effect of increased Vaal River total dissolved salts (TDS) concentrations was investigated on algal growth and photosynthetic rates of 3 different algal species i.e. *Cyclotella meneghiniana* Kiitz., *Monoraphidium circinale* (Nyg.) Nyg. and *Microcystis aeruginosa* Kutz. The algal species were introduced to different Vaal River salt concentrations in a GBG-11 growth medium for a period of 14 d. The salt concentrations varied between 100 mg·l⁻¹ and 2 000 mg·l⁻¹. Turbidity was used as a measure of growth. On day 8 of the experiment, water samples were taken and chlorophyll-a was measured as well as primary productivity by the ¹⁴C-uptake method (acid-bubbling). With increased TDS concentrations, the growth of *C. meneghiniana* and *M. aeruginosa* was inhibited, but the growth of *M. circinale* was unaffected. With increasing salinity concentrations the chlorophyll-a concentration in *C. meneghiniana*, *M. aeruginosa* and *M. circinale* increased up to salinities of 250 mg·l⁻¹ and then decreased at salinities of between 500 mg·l⁻¹ and 2 000 mg·l⁻¹. The carbon assimilation rate of *C. meneghiniana* and *M. aeruginosa* increased with an increase in TDS concentration, and that of *M. circinale* was very low at salinities of 250 mg·l⁻¹ and above. These results show that if the salt concentration of the river increases with time, algal species that can adapt to a much wider range of salinities may become dominant, e.g. *M. circinale*. *C. meneghiniana* and *M. aeruginosa*, on the other hand, can be expected to be eliminated from the water under conditions of increased salinity.

Introduction

Salinity is a growing problem in freshwater ecosystems in many parts of the world. On a world-wide basis, an area of about 950 m. ha is affected by salt. This is apparently due to dryland salinity as well as salinity in irrigation regions (Hart et al., 1990). According to Hart and co-workers, the main concern is the increase in salinity caused by human disturbances such as agricultural practices, pollution and other human activities. This kind of salinisation is often referred to as secondary salinisation.

Rivers or lotic systems differ from lakes and wetlands in that movement of the water has an effect on plant and animal life. The increase in turbulence increases the input and the breakdown of organic matter which also influences life in the water. In addition, a river is an open system which receives allogenic substances through precipitation and rainfall as well as from streams in its catchment area (Wetzel, 1983). Parts of the Vaal River, which drain densely populated areas, i.e. the Witwatersrand and West Rand mining regions, are also affected by human intervention which contributes to an increase in allogenic substances (Stander et al., 1962).

According to Brock (1985) high salinity conditions could affect autotrophic macrophytic communities in freshwater environments in the following ways. As salinity levels increase, the diversity of macrophyte species declines. At salinities of approximately 4 000 mg·l⁻¹ TDS most freshwater macrophytes will be replaced by halophytic macrophytes which can persist over a much wider range of salinities (Brock, 1981). A similar pattern of change can be expected to occur in algal communities as a result of increased salinity, an aspect that should, at this stage, only be regarded as speculative because there is apparently no information available in the literature on the response of algal communities to

increased salinities in running waters. In this preliminary study the aim was to investigate the effect of an increase in total dissolved salts on freshwater algal species in order to provide specific information in this regard.

The Vaal River is one of the most important rivers in South Africa because of economic activities and the concentration of the human population in its catchment area (Oliveira, 1986). In addition to being eutrophied and polluted, the Vaal River is also salinised and mineralised because of the extensive utilisation of the water through household, mining and industrial activities as well as agricultural practices (Triebel, 1986).

Because of the increased TDS load, the water in the Vaal River will probably become clearer (Grobler et al., 1986; 1987). Clearer water due to salinisation and the high nutrient supply (eutrophication), will probably result in more intensive algal blooms. In some cases the blooms may be by algal species that have not, until now, caused problems (Pieterse, 1986). One possibility is the development of dinoflagellate blooms which could cause phenomena similar to red-tides in the ocean and should be considered as potentially toxic (Pieterse, 1986). However, recently a strategy was developed by the South African Department of Water Affairs and Forestry to control the dissolved salts concentration in the middle reaches of the river by releasing water from the Vaal Dam into the Vaal River Barrage (Van Vliet, 1993).

Temporal changes in phytoplankton composition occur in the Vaal River (Pieterse, 1986). It has been found that a *Sphaerodinium* species (a dinoflagellate) becomes dominant in the Vaal River when TDS concentrations increase to levels above approximately 1 000 mg·l⁻¹ (Pieterse, unpublished information).

Material and methods

Uni-algal cultures from the algal culture collection of the Department of Botany and Genetics, University of the Orange Free State, were used as experimental material, namely *C. meneghiniana*

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