

Effect of water hyacinth on distribution of sulphate-reducing bacteria in sediments of Lake Victoria

Fredrick J Muyodi^{1*}, Mugassa ST Rubindamayugi², Adelaide K Semesi²

¹ Department of Zoology, Faculty of Science, Makerere University, PO Box 7062, Kampala, Uganda

² Applied Microbiology Unit, Department of Botany, Faculty of Science, University of Dar es Salaam, PO Box 35060, Dar es Salaam, Tanzania

Abstract

The effect of the water hyacinth, *Eichhornia crassipes* (Mart.) Solms-Laub, on the distribution of populations of sulphate-reducing bacteria (SRB) in sediments from various stations on the shores of Lake Victoria around Mwanza Municipality, Tanzania, was studied. Lactate-utilising SRB were observed to be the dominant species in sediments covered by the water hyacinth and at the Mirongo River mouth while acetate-utilising SRB dominated in the offshore open water sediments. Sediments from offshore open waters had the lowest most probable numbers (MPNs) for all the SRB types investigated, more than 100 times less than observed in areas covered by the water hyacinth and the Mirongo River mouth. Lactate-utilising SRB were almost absent in sediments from offshore open waters. A positive correlation between the total populations of SRB and nutrients in sediments was observed. Results showed that sulphate concentration was very high in sediments underneath the water hyacinth at the lakeshore but was minimal in sediments from offshore open waters. It is suggested that water hyacinth decomposition formed lactate, which supported large populations of lactate-utilising SRB.

Keywords: acetate, *Eichhornia crassipes*, formate, hydrogen sulphide, lactate, methanogen, sulphate-reducing bacteria (SRB)

Introduction

Sulphate is used as a terminal electron acceptor under anoxic conditions by a heterogeneous assemblage of bacteria known as the sulphate-reducing bacteria (SRB). These bacteria utilise organic acids, fatty acids, alcohol, and hydrogen as electron donors. SRB have been placed into two broad physiological subgroups (Brock, 1997). The first subgroup consisting of genera *Desulfovibrio*, *Desulfomonas*, *Desulfotomaculum*, and *Desulfobolus*, utilise lactate, pyruvate, ethanol, or certain fatty acids as carbon and energy sources, reducing sulphate to hydrogen sulphide. SRB from the other subgroup consisting of *Desulfobacter*, *Desulfococcus*, *Desulfosarcina* and *Desulfonema*, specialise in oxidation of fatty acids, particularly acetate, reducing sulphate to sulphide. SRB are universally distributed in marine and freshwater sediments (King and Garry, 1999) and are now reported to be distributed in microbial mats including cyanobacterial mats (Van Gemerden, 1993; Teske et al., 1998; Minz et al., 1999). SRB have also been isolated from soil (Iiori et al., 1999). Many of the SRB that have been isolated and described so far are mesophilic, non-spore-forming anaerobes (Widdel and Bak, 1991; *Standard Methods*, 1995). Distribution of SRB in hot water supply systems and hydrothermal vents has also been reported (Rozanova and Entaltseva, 1999).

Competition for electron donors between SRB and methanogens has received considerable attention (Widdel and Bak, 1991). SRB have a higher affinity (lower K_m) for the major precursors, hydro-

gen and acetate than methanogens (Holmer and Kristensen, 1994). The K_m value for hydrogen is about 1 μM for SRB and 6 μM for methanogens, and for acetate the K_m values for SRB and methanogens are 200 μM and 3 mM, respectively (Schonheit et al., 1982). This enables SRB to maintain the pool of these substrates at concentrations too low for methanogens, when sulphate is not limiting. When utilising H_2 as the electron donor, *Desulfovibrio* species have a high maximum growth rate ($m_{\text{max}} = 0.23 \text{ h}^{-1}$) and a low half-saturation constant ($K_s = 3.3 \mu\text{M}$). The m_{max}/K_s value indicates that the effectiveness of substrate utilisation is higher than that of H_2 -consuming methanogenic organisms (Widdel and Bak, 1991). This probably explains why SRB outcompete methanogenic bacteria for substrates even in very low concentrations.

Waters of Lake Victoria are exposed to high organic loading from decaying weed, sewage and municipal waste discharge (Merinyo, 1990; Hecky et al., 1995; Ogutu-Ohwayo et al., 1997; Kansiime and Nalubega, 1999). Due to a lack of complete mixing of the water column by strong waves, especially in areas infested by the alien weed, water hyacinth, *Eichhornia crassipes* (Mart.) Solms-Laub (Pontederiaceae), organic levels increase and are restricted to surface layers of the sediments, where sulphate reduction activity attains exceptionally high rates. Accumulation of substrates, e.g. acetate, for the SRB has been reported to take place under such circumstances despite high mineralisation rates (Holmer and Kristensen, 1994) as the amount of substrates produced cannot all be utilised by micro-organisms. The distribution of different species of SRB in sediment broadly corresponds to the distribution of different substrates needed for the sulphate reduction process and the concentration of substrates present (Parkes et al., 1993). SRB can have a considerable effect on their environment, because their growth is coupled to the production of large amounts of hydrogen sulphide. This activity is important in the removal of

* To whom all correspondence should be addressed.

☎ +256 (041) 531902; fax: +256 (041) 531061;

e-mail: fmuyodi@zoology.mak.ac.ug

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