Newsletter

Issue 1, April 2010

Undoing the Damage:
How Biotechnology can Spare our Water

Water is essential for life of all forms and is therefore a precious resource. A person can only survive a few days without clean and safe drinking water, making it the most critical element of basic human needs. Water is also needed in every industry. It is key to each of the three pillars of sustainable development - economic, social and environmental. Yet, fresh water is a scarce, limited resource which needs particular care and attention to preserve and sustain.

The shortage of water has the potential to be a global crisis. The United Nations (UN) estimates that 2.7 billion people will experience water shortages by the year 2025. The impact will be felt particularly in developing countries in Africa. Water shortages will affect food supplies, health, and social and economic development. The UN has named the years 2005 to 2015 as the “Water for Life” International Decade for Action. They aim to ensure long-term sustainable management of water resources, in terms of both quantity and quality.

South Africa is rapidly approaching a water crisis. It is estimated that the quantity and quality of water will become a limiting resource in South Africa within the next decade. Various factors reduce the quality of our water, ranging from industrial waste, sewage, littering, intense use of fertilizers in agriculture and mining activities that cause heavy metal pollution and acid mine drainage (AMD). Each of these factors must be minimised in order to address the impending water shortages in the country.

Yellow residue of AMD in polluted water

Recently, more attention has been given to acid mine drainage due to its impact on the Witwatersrand area. In March this year it was announced that the Department of Water Affairs has made R6.9 million available to assist mines with treatment of AMD. It is estimated that up to 60 million litres of polluted water from acid mine drainage could pour into Johannesburg by 2011 if nothing is done to address the problem.

AMD is produced when sulphides in the mining rock are exposed to oxygen and water. Although this process also occurs naturally, mining can promote AMD simply because it increases the exposure of sulphide minerals to the atmosphere. Once exposed to the elements, the sulphides form highly corrosive sulphuric acid, which leads to potentially toxic metals such as copper, nickel, lead, mercury, arsenic, aluminium and manganese dissolving into ground- or surface water.

An African proverb says that “dirty water cannot be washed” but through the work of the Metagenomics Platform of the University of the Free State, this may soon change. This Platform is funded by BioPAD, now the Technology Innovation Agency or TIA, and is managed by Prof Esta van Heerden. Her team is offering bioremediation services to the mining industry to assist in the treatment of AMD.

Prof Esta van Heerden collecting samples

Bioremediation is the use of living organisms, primarily microorganisms, to degrade environmental contaminants to less toxic forms. Research has demonstrated that there are very few environments where microbes have not been able to survive, adapt, and indeed, thrive. We cannot yet put a figure on the number of different and specialised microorganisms. Microbes adapt by specialised ways of driving their metabolism and of detoxifying their environment. Bioremediation uses these principles to select a suitable combination of microbes to treat a targeted pollutant using the natural processes of the specialised microbes.

Bioremediation strategies are often more beneficial than traditional strategies because bioremediation can be implemented directly on site with no need to transport the contaminated material. This provides a simpler, less intrusive, and cheaper method than conventional ‘pump and treat’ systems that often use hazardous chemicals and create an additional environmental risk. Although it is not complex technology, considerable expertise is required to design and implement a successful bioremediation program, due to the need to thoroughly assess the site for suitability and to optimise conditions to achieve a satisfactory result.

In the treatment of acid mine drainage, specialised bacteria called sulphate-reducing bacteria are utilised. These bacteria can reverse the damage caused by acid mine drainage and improve the quality of the water. They are able to “breathe” sulphate, converting it to sulphide which in turn binds to dissolved metals, removing them from the water. Bicarbonate is also formed in the reaction, which

neutralises the acidity of the water. These specialised bacteria are called extremophiles because they live in such extreme conditions.

The Metagenomics platform specialises in extremophiles. In fact, they go deep underground and to other extreme environments in order to find them and study them. Their focus is on bioprospecting in order to find unique genes and specialised functions which may be useful to us for bioremediation and also to improve industrial processes and products. Organisms living under extreme conditions have adapted specifically to be able to cope with that harsh environment and therefore have a unique genetic makeup. Extreme environments in South Africa may contain many hidden treasures of unique biological and genetic material which must be preserved. This is one of the aims of the platform.

The Metagenomics platform is studying a variety of extreme environments, and through their work and understanding of the life in the environment, they are able to offer solutions to the mining industry for bioremediation of contaminated water. This plays an important role in preserving South Africa's precious water supplies.

More information about the Metagenomics platform can be obtained from Dr Bongi Gumede at bongi@biopad.org.za or Prof Esta van Heerden at VHeerdE@ufs.ac.za.

Joanne Riley
TIA

With special thanks to Dr Elsabe Botes for her input. Elsabe is a Post Doctoral Student in Prof van Heerden's lab whose focus and interest is in the various Bioremediation projects. Elsabe firmly believes that we can make a positive change - someone just has to initiate the process and realise that each of us can make a difference.