2002 TAIWAN INTERNATIONAL SCIENCE FAIR

CATEGORY：Environmental Science

PROJECT TITLE：The Solution to Global Water Pollution?

AWARD：First Award

SCHOOL：Namib High School

FINALISTS：Helgo Rainer Horsthemke

COUNTRY：Namibia

Abstract of Project

Category of project: Environmental Science
Title of project: The Solution to Global Water Pollution?
Name of exhibitor: Helgo Rainer Horsthemke
Country: Namibia

The Solution to Global Water Pollution?

Hydrogen Sulphide Along Namibia's Coast and the magnificent occurrence of the Giant Sulphur-Eating Microbe in its waters

The waters of the Benguela, the Atlantic Ocean off South Western African shorelines, are amongst the most productive in the world, supporting prolific marine life. However despite the abundance of animals, survival in this marine ecosystem is not always easy. Oxygen-deficient bottom water, often containing toxic hydrogen sulphide, is a feature of the northern Benguela coastal upwelling system. Here, superfluous cells from excess phytoplankton production, decay and sink to the bottom to form the oozy diatomaceous mud belt sediment off the Namibian coastline. Within this diatomaceous mud further intensified decay takes place to form toxic hydrogen sulphide in the sediment. Sporadically large amounts of the hydrogen sulphide are released into the water column, causing the deadly annual "sulphur" events, as they are locally known in Namibia, to take place. Sulphur eruptions result in the deaths of thousands of marine animals.

This marine system off the Namibian coast, with its harsh natural conditions of hydrogen sulphide and low oxygen, is similar to an ecosystem suffering intensive marine pollution. These natural conditions of the Benguelan waters are closely related to the conditions of many coastal areas suffering from the global marine pollution problem, created by man all over the world, through the discharge and disposal of wastes, such as nitrate fertilisers, sewage and biological decay material.

A specialised group of bacteria known as sulphur bacteria occur within the sulphidic conditions of the diatomaceous mud belt. They form conspicuous white patches on the surfaces of the sediments. Sulphur bacteria actually use some of the produced toxic hydrogen sulphide in the sediments, converting it to harmless elemental sulphur micro granules in their cytoplasm. Where no other life occurs, due to the harsh conditions unfriendly to most marine life, sulphur bacteria thrive. Sulphur bacteria control and decrease the amount of hydrogen sulphide, which goes from the sediment into the water, through their complex metabolic systems. The biggest and most effective sulphur bacteria, only found off the Namibian coast, were dubbed Thiomargarita namibiensis. *Thio* means sulphur and *namibiensis* refers to its occurrence in Namibia. This giant sulphur-eating microbe is the earth's biggest known bacterium, visible to the naked eye.

I conclude with a personal hypothesis to suggest a solution to global water pollution by utilising this magnificent bacterium. Through bacterial cultivation and processing

Thiomargarita namibiensis could be employed in tackling the extent of global marine pollution. The bacteria use toxic hydrogen sulphide as "fuel" for their metabolism and nitrate as an oxidizing agent, to produce harmless sulphur granules. This explains the bacteria's effectivity in removing nitrate and hydrogen sulphide wastes, the forms most biological wastes eventually occur in, from the water. This spectacular process, as it occurs within these magnificent "sulphur pearl strings", could be the sensational answer to the regeneration of polluted marine waters on a worldwide scale. This absolutely natural treatment of the water would not bear any harmful consequences such as those artificial treatment leaves behind. Sewage treatment or denitrifying treatments applied by man on polluted water leaves chemical discharge and damage to affected ecosystems. Especially Thiomargarita could be used in the regeneration of rural and urban waters (should those survive in fresh water) and sewage schemes as well as most marine waters, due to its high effectivity in removing hydrogen sulphide from affected water. It is not *the solution to global water pollution* to fight chemicals with chemicals. Nature has provided an excellent and valuable resource that could enable absolute natural recovery within polluted marine ecosystems. We should dedicate ourselves towards such magnificent discoveries and help nature help itself.

Research on these Sulphur bacteria (especially Thiomargarita namibiensis) is very recent and ongoing. I recently enjoyed the privilege of a 24 hour marine research ship cruise off the Namibian coast with marine biologists from the Namibian Ministry for Fisheries and Marine Resources, to obtain mud cores holding Thiomargarita namibiensis bacteria. Several chemical tests are done and biological reactions are studied to collect the necessary data concerning Thiomargarita namibiensis.

The discovery of Thiomargarita namibiensis awoke worldwide scientific excitement and interest. Its application to solve the problem of global water pollution would be a spectacular scientific breakthrough for the human race.

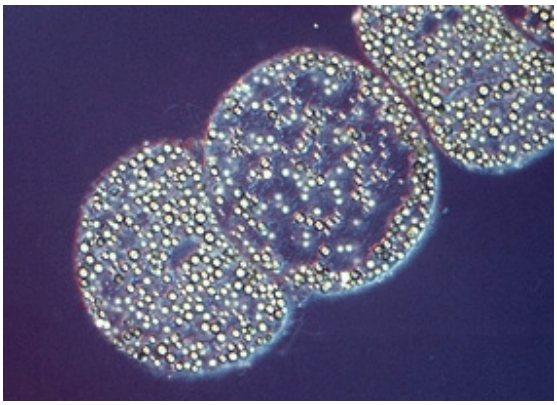

Figure*:* *Light-photomicrograph of three cells of Thiomargarita with polarized light. The internal sulphur globules shine white.*
Picture Source: Max Planck Society (Research News Release)

Figure: *A single cell of Thiomargarita photographed next to a fruit fly. The head of the fly and the white cell have about the same diameter (0.5 mm).*
Picture Source: Max Planck Society (Research News Release)

評　　語

本研究探討 Namibia 海岸底層所釋出 H_2S 問題，在底層缺氧之情形下將造成海洋生態之浩劫，而在硫化物之環境中會有一群特殊硫細菌，作者利用大型團隊研究之機會於 Namibia 海岸底層找到世界上最大、最有效力之硫細菌 Thiomargrita Namibiensis，探討其可在硝酸鹽存在之情況下淨化硫化物，可解決 H_2S 污染之問題，深具學術創新及科技應用特點。