

SPACEWARD BOUND NAMIBIA

FACTSHEET

CYANOBACTERIA AND OUTER SPACE

Spaceward Bound is an innovative programme from NASA, the United States government's National Aeronautical and Space Agency. For more than 50 years, NASA has led humanity's efforts to explore space. NASA rocket engineers helped put the first human being on the Moon in 1969. NASA launched the Skylab space station in the 1970s, which orbited the planet more than 400 kilometres above our heads and broke new records for how long astronauts could stay in space. Today, NASA supports the International Space Station. So what is NASA doing in the Namibian desert, working with researchers and science teachers from South Africa?

The Namibian trip was part of NASA's extraordinary Spaceward Bound programme, which brings together scientists and educators to study life in extreme environments (usually very hot or very cold). These environments are the closest thing we have on this planet to the even harsher environments of other rocky planets in our solar system. So these hot and cold deserts help researchers work out the best ways to look for signs of life in upcoming explorations of Mars, the fourth planet from the Sun. Mars is our planet's neighbour, only 55 to 78 million kilometres away from us depending on our paths around the Sun, so it is easier to reach than some of the planets further away. Just as important, Mars is one of the few planets that seems capable of harbouring some form of life, either now or in its past. It has a thin atmosphere and seems to have water – two things necessary for life to evolve. So what does this have to do with cyanobacteria?

In 2010, teachers from the Namibian fishing port of Walvis Bay met up with their counterparts from Australia, South Africa and the USA at the renowned Gobabeb Desert Research Station about two hours' drive inland from the Atlantic Ocean coast. The teachers helped scientists from around the world scrape up a particular form of cyanobacteria which is so tough that it might be found lurking a few centimetres down in Mars' reddish soil. Some of the teachers ran their own experiments. Other teachers plan to run experiments with their students once they return to the classroom.



Science teacher Edison Haraseb of De Duine Secondary School in Walvis Bay crouches down to watch British researcher Charles Cockell from the Open University sample a saline river in the Namib, watched by educators Mark Gargano, a teacher from Western Australia, and Janine Slocombe from the University of South Australia. Can you see the salt crystals lining the banks of the river, and how it flows through an extraordinarily arid environment?

SCIENTIFIC EXPERIMENTS

Cyanobacteria in space

Several scientific experiments examining how cyanobacteria survive without the Earth's protective atmosphere have travelled strapped inside one of the NASA rocket-powered shuttles to the International Space Station, an outer space research laboratory run by the Americans, Canadians, Europeans, Russians and Japanese, which circles the earth fifteen times a day. If you go to the NASA website and click on the shuttles/stations section and then go to the sightings section, you can find out on what upcoming day – and the precise time and location – that the International Space Station will be visible for a few seconds speeding over South Africa.

The International Space Station can be seen from Earth with the naked eye because it is by far the largest artificial satellite that has ever orbited our planet. Dusk or dawn is the best time to spot the International Space Station because the fast-moving space station is so high above us – anywhere from 350 to 1000 kilometres overhead - that it glows in the rays from the Sun, even when we are shrouded in darkness. Of course, if it is cloudy, you may need to make another date for a viewing!

Check out the International Space Station sightings for Bloemfontein, Cape Town, Durban, East London, Grahamstown, Howick, Johannesburg, Kimberley, Mbabane, Pietermaritzburg, Port Elizabeth, Pretoria, Stellenbosch, Vanderbijlpark and Wilderness here: <http://www.nasa.gov/>

Cyanobacteria are self-sufficient

The word cyan comes from the Greek word for a deep blue colour, but cyan often refers to an aqua colour nowadays. Cyanobacteria are often (not always!) a greenish colour because they use contain chlorophyll, a green pigment found in leaves, grass and all other plants, which is used in photosynthesis. Chlorophyll absorbs the energy of the sun. This makes cyanobacteria self-sufficient: they don't need to go hunting for food. They are solar-powered. Although they're small, there's power in numbers: cyanobacteria account for around a quarter of all the photosynthesis on Earth. A tiny marine cyanobacterium, only discovered in 1986, accounts for more than half of the photosynthesis taking place in the open ocean. Cyanobacteria contribute significantly to global ecology and the planet's oxygen cycle but there is still much we do not know about them. Some researchers are exploring cyanobacteria as biofuel, instead of oil and petrol, and suggest that one day we will be growing farms of cyanobacteria on our rooftops!

Cyanobacteria are successful

Cyanobacteria are among the oldest living things on the planet – they're older than dinosaurs. They have been around for far, far longer than humans! Fossilised rocks in shallow seas off Western Australia are formed of mats of cyanobacteria over hundreds, thousands and millions of years. The bottom layers have died and then by absorbing minerals from the sea water, they have very slowly turned into rock-hard fossils. There are still living cyanobacteria on the top layer of stromatolites. Nobody knows how old the living cyanobacteria colonies are – so the next time you kick over a rock in the desert and discover a green fuzz of living things underneath, treat it with respect: they might be over 100 years old!

Cyanobacteria are tough

They are found in some of the harshest terrains on the planet, including the Namib desert in Namibia, where they hide under quartz rocks and use the light filtering through the semi-transparent rock to conduct photosynthesis, just like grasses and bushes and trees do in easier climates. Cyanobacteria are also found living in parts of Antarctica. In fact, cyanobacteria can be found almost everywhere.



Clockwise from left: Cyanobacteria are found living in communities of other microbes in translucent rocks like this one from the Namib desert. In the USA, in Yellowstone national park; the brilliant colors come from microbes that have evolved to thrive in this extreme environment of boiling acid. Researchers have sampled these waters to try to help unlock their secrets; cyanobacteria are found around the world. Here in Western Australia, biofilms of microorganisms, dominated by cyanobacteria, trap sand grains floating in the shallow waters. Gradually the bacteria cement the sand grains into these rocks, known as thrombolites; could you live in this environment in Namibia? Cyanobacteria can. And that's why scientists investigating the possibility of life out in space - known as astrobiologists - come to Southern Africa to turn over stones and take samples and monitor the little-known dull green "fuzz" indicating that a community of microbes, including cyanobacteria, is clinging to life at the bottom of transparent rocks like the ones in the foreground. The NASA photographer who took this picture says this part of Namibia looks a lot like the photos sent from Mars by the Pathfinder, a remote-controlled roving robot.



An evening view of the Gobabeb Desert Research Station in Namibia, showing how we are just a planet spinning among the stars. Could microbial life - maybe even cyanobacteria - be found not just in the desert sand and rocks but also out there somewhere in the universe?

CURIOSITY AND CYANOBACTERIA

In 2011, a NASA rocket is due to send up the roving Mars Science Laboratory, known as Curiosity, to assess whether Mars ever supported microbial life in the past and if so, whether it still does. The Curiosity rover will scoop up samples from the soil and drill into rocks before analysing them with its own equipment (including a tiny but powerful laser chemical sampler that can shine on a rock thirteen metres away and work out what that rock is made of). Then the robot rover will communicate the results of its experiments to us. Check out the Mars Science Laboratory here at the Jet Propulsion Laboratory: <http://www.jpl.nasa.gov/>

THE INTERNATIONAL HUNT FOR CYANOBACTERIA

In 2018 the European Space Agency plans to launch its first Mars rover, which will be able to drill holes two metres deep into the soil in search of organic living molecules like cyanobacteria. This exploration, done with NASA, will include another rover which will be able to store selected samples. The idea is that scientists will send out another orbiter which will send down a “fetch” rover which will collect the soil samples, return to the orbiter and come back to Earth, some time between 2020 and 2022. Researchers would examine the samples in sterile laboratory conditions to find out if it contains living or dead life forms such as cyanobacteria.

SENDING HUMANS IN PURSUIT OF LIFE ON MARS

Engineers at NASA and the American military company Lockheed Martin have already begun work on the Orion spacecraft to send humans back to our Moon by 2020 as part of their preparations for sending people to Mars by 2037, when they will also be looking for evidence of life on Mars. The European Space Agency hopes to land humans on Mars in our lifetime, between 2030 and 2035, and their expedition will certainly try to find out if cyanobacteria live in Martian soil. Future colonists on the Moon might be able to use cyanobacteria to extract resources from the soil to make rocket fuel and fertilizer for crops. Check out the latest on the European Space Agency here: <http://www.esa.int>.

DID YOU KNOW?

Not all microbes are cyanobacteria, but all cyanobacteria are microbes

Cyanobacteria - also known as blue-green algae – are a particular type of microbe, or micro-organism. These are primitive and ancient bacteria. Cyanobacteria are visible as a group of hundreds, even thousands, of microorganisms living in colonies. However, a single cyanobacteria is too small to be seen by the human eye without the help of a microscope. Cyanobacteria can live with more than just one type of bacteria: they may exist as colonies, or communities, of several different types of microbes.

Food for thought

Cyanobacteria are an important link in the food chain here on planet Earth. Humans even eat one form of cyanobacteria: check out the vitamin shelf at your local shop and see if you can find anything called Spirulina, which is a high-protein cyanobacteria found in sport drinks or health drinks.



NASA staff and researchers from around the world took time out from the desert to speak to Namibian students, hoping to inspire them to embark on their own voyages of scientific discovery.



Find out more at the web site of the Institute for Microbial Biotechnology and Metagenomics at the University of Western Cape – see <http://imbm.co.za>