



*Creating the Nation's first BioPark*

National Zoological Park · Smithsonian Institution · Washington, D.C. 20008-2598

Letter from the Desk of David Challinor  
August 1992

The Viking Lander has been sitting inoperable on the surface of Mars for the past ten years. This self-propelled vehicle was designed to take soil samples which would aid in our search for life on our neighboring planet. From its arrival on the surface of Mars in 1976 until it ceased operating in 1982 (a period equal to 6-1/2 Martian years), the Lander sent back photos and information to Earth. The few soil samples it took and analyzed *in situ* revealed no evidence of organic compounds that are commonly present in Earth soil. We thus have reasonable evidence that no life exists at the landing site. Under an agreement between the Smithsonian and NASA, equipment which is no longer needed by the latter is transferred to the Smithsonian's Air and Space Museum for addition to its collections. The Viking Lander was transferred in 1984, but understandably the Institution has not yet been able to attach its inventory number sticker to it.

I have related this anecdote to illustrate that the human search for life, especially in extremely harsh environments, is never ending. The Martian surface, at cursory inspection, seems too forbidding to sustain life of any form. The Viking Lander's short-lived and geographically narrow investigation found no evidence of life in the soil samples it took on the surrounding Martian desert. Visitors from other planets might also judge the Earth to be lifeless if soil samples were taken in some of its climatic extremes such as the Namibian Desert, the deepest part of the Pacific Ocean, and the dry valleys of the Antarctic.

Close examination of these inhospitable environments indicates, however, that life does exist on Earth even under the most extreme conditions. For example, in the Namibian desert in southern Africa, when daytime temperatures on the sand's surface reach 116°F (46.5°C), Silver ants come out of their desert holes to scavenge for insects that have died from the heat. At 116° on the sand, the lizards that normally prey on the ants have retreated to their holes. Rüdiger Wehner, a Swiss zoologist, has been studying these fascinating ants and has learned that they have adapted to survive a body temperature of 138°F (or 53.6°C), which is the highest temperature ever recorded for any terrestrial animal. The ants emerge from their burrows in an explosive pattern during the hottest part of the day. They have to find their food before the ambient temperature cools off enough for the lizards to come out of their holes to prey on

them. However, for the ant to survive while it is out foraging, it must climb up blades of grass periodically to cool off. If it cannot cool itself during its search for food, it dies.

Professor Wehner and his colleagues have also learned that the ants use patterns of polarization in the diurnal sky to find their way back to their holes before the lizards emerge from theirs.

A scorching terrestrial environment creates different problems than exist in extremely cold or extremely hot aquatic ones. Certain bacteria can live and reproduce in thermal springs where the water temperature is above boiling because their cellular fluid contains heat resistant proteins. At the other end of the aquatic temperature spectrum are the Antarctic blennies, small fish seldom more than a foot long and weighing just over a pound which live in Antarctic salt water registering about 28°F. They have adapted to these conditions by having no red blood cells and producing a form of antifreeze (glycopeptide molecules) which keeps their body fluids from forming ice crystals. Large fish, such as the giant Blue fin tuna, can actually maintain a body temperature considerably higher (more than 10°F) than the water in which they swim due to the heat generated by the use of their swimming muscles. Small fish do not have sufficient muscle mass to generate such heat, and like the Antarctic blennies have had to evolve other strategies to stay alive in such cold water. Marine mammals thrive in very cold water by insulating their bodies with a layer of blubber.

Another creature which exists in an extreme environment is the tube worm discovered by scientists in the research submersible Alvin. This marine invertebrate lives near the geothermal vents just east of the Galapagos more than two miles below the ocean surface. Measuring six or more feet long and 3" in diameter, its body cavity was filled with black "gunk" which, upon closer inspection, turned out to be millions and millions of a highly specialized bacterium that provides the life giving energy to this worm species. The bacteria in the body cavity are able to convert hydrogen sulphide that escapes from the vent into proteins on which the worm survives. We still know little about these vent creatures other than that they live completely independent of solar energy, which we once thought was crucial for all life on earth. Vents are relatively transitory and shut down or open up along thousands of miles of the collision zone of adjacent tectonic plates. How do these worms reproduce and how do their larvae (if they have any) find a new vent on which to settle when their once active vent stops producing heat and nutrients? It is unlikely that we will have answers to such questions soon because of the difficulty in observing these organisms.

Another obscure organic structure surviving on the edge of extreme environmental conditions is the lichen that grows among the interstices of sand grains in the sandstone of the harsh dry valleys of Antarctica. These plants are easier to study than the vent worms as long as you can get to these remote valleys. A lichen is a combination of an alga and a fungus, and the algal component needs sunlight for photosynthesis. It is estimated that the sun is bright enough to trigger photosynthesis only about 80 hours a year in this area of Antarctica, and thus the climate is marginal for any kind of plant growth. Yet the lichens do live and grow -- how, we do not yet fully understand.

Given these few remarkable examples of organisms exploiting extreme habitats and living on the edge of existence on Earth, it is not surprising that some biologists speculate that other forms of life could have evolved to exist on other planets in our solar system. I emphasize that such thoughts are pure speculation now, and we must wait until well into the next century when planetary exploration will enable us to investigate new habitats to confirm whether or not life exists elsewhere.

David Challinor  
202/673-4705