Interview with Andrzej Ziemba and Natalia Andrzejewska-Zalewska

Longing for Mars

Natalia Andrzejewska-Zalewska

The tricolor Martian flag, designed by Mars Society members, here flies in the Utah desert. Will it one day be hoisted on the Red Planet?

Academia: The dreams of Jerzy Żuławski, the author of the first science fiction story ever written in Polish, have come true: we have already visited the "Silver Globe" and are now looking to the Red Planet. A trip to Mars seems to pose a much greater challenge than a Moon voyage, including for the human body.

Andrzej Ziemba: *Mankind's conquests of new frontiers and voyages outside its natural environment – e.g. exploration of the Earth's polar regions – have always entailed great risk and involved medical problems. However, space exploration has given medicine and physiology hitherto unknown challenges to tackle, even though modern spaceships are designed to provide conditions for their crews that are approximate to those on Earth. In the past, no one knew how the human body would react to such phenomena as acceleration G-forces, vibration, and noise. It turns out that such unfavorable conditions can indeed be overcome with the right technical safeguards, and with the right training the body can tolerate them well. However, the previously unknown problem of weightlessness was a situation mankind had never before dealt with. Gravity is an inextricable part of our daily existence and of human physiology. The first flights when people experienced weightlessness sparked a sense of euphoria.*

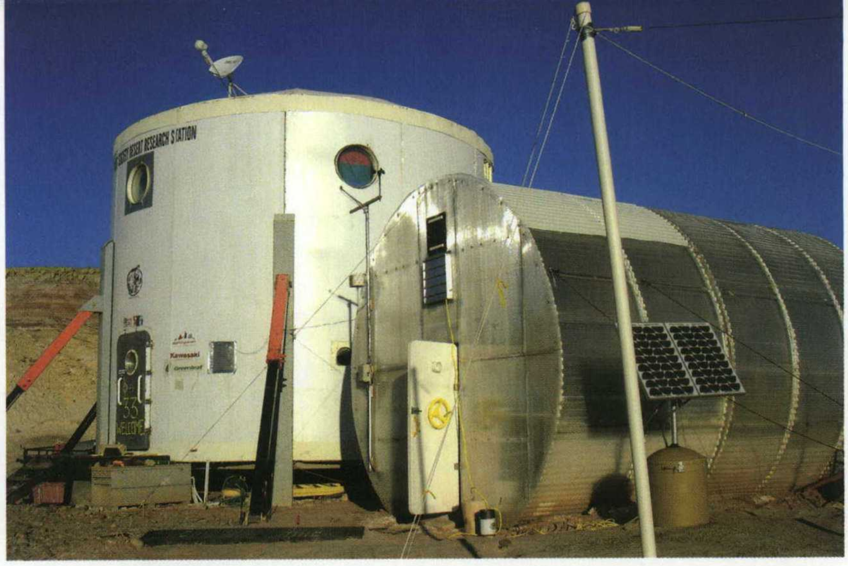
And it's wonder. Who hasn't ever dreamed of flying...?

A.Z.: *The human body does adapt relatively easily to weightlessness. As it turns out, the most important problem might lie not in taking a long voyage itself, but in returning to normal gravity. Only then will most of the changes that occur become manifest in full focus. It was understood quite early on that the pleasure of flying came hand-in-hand with a negative physiological impact. After the first astronauts returned to Earth, they experienced* *difficulty in maintaining their posture or moving around. We used to watch Soviet cosmonauts on TV even getting carried out of their landing capsules. Experience to date shows that bodily changes occur gradually, becoming more profound the longer weightlessness is experienced.*

Which systems of the human body are negatively affected?

A.Z.: Nearly all of them. The problems stem from two factors: hypogravia (the lack of terrestrial gravity) and hypokinesis (limited physical activity). After normal gravity is reinstated, they lead to orthostatic intolerance, as indicated by changes in heart contraction frequency and arterial blood pressure when the body's position is changed to a standing position. Another important aspect is that long bones decalcify and show a slower pace of regeneration. That change especially affects the bones of the legs, most responsible for maintaining the body's upright position under terrestrial gravity. A long period of weightlessness also causes atrophy (disappearance) of the muscles and joint structures, as well as of the bones (leading to osteoporosis), and also changes in the circulatory system (including reduced blood volume, increased blood viscosity, drops in blood pressure when assuming a standing position, and poorer blood circulation in the lower extremities). Not just the strength and power of muscles, but also their overall physical fitness gets reduced. Serious metabolic disturbances occur: lower tolerance of carbohydrates and lower sensitivity of tissues, especially the muscles, to insulin (a state related to reduced physical activity), unfavorable changes in the immunological system, and finally psychophysiological changes.

But here we should mention that Ms. Andrzejewska has already been to Mars...?



Natalia Andrzejewska-Zalewska

The experimental station building is a cylinder 8.4 m high and 8.6 m in diameter. Alongside lies an experimental greenhouse

Natalia Andrzejewska-Zalewska: Well, I have served as "mission geologist" for the 33rd crew of the simulated Martian expedition at the Planetary Society's desert base in Utah. These Martian missions are organized by the Mars Society - an association whose statutory goal is to promote the concept of exploring the Red Planet, and especially sending a manned mission to Mars as soon as possible. At the base's experimental stations, crews that rotate every two weeks live the kind of lives that await future Martian researchers. Each crew includes at least one geologist, one biologist, one engineer, one psychologist, and one individual with medical training. The Mars Society is an NGO which has no affiliation with government agencies, including in terms of funding - the stations are successfully supported by contributions from sponsors. Cooperation with NASA is therefore not something routine, although its staff members do quite frequently draw upon the experience of the Martian missions.

Man on Mars

The prevailing conditions on Mars, although very harsh, do not rule out a manned mission to the planet. The average temperature on the surface is -60°C, but there are places where it reaches 20°C at noon in the summer. The thin Martian atmosphere consists almost exclusively of carbon dioxide. The main threats that Martian mission crews will have to cope with stem from the presence of fine dust in the atmosphere, which settles on solar panels even in good weather, reducing the amount of power generated, and penetrates every nook and cranny that is not properly safeguarded. Frequent dust storms, during which the wind reaches speeds in the hundreds of km per hour, reduce visibility nearly to nil. Dust particles can scrape away at helmet visors, clog engines, and cause space suits to become unsealed. Corrosive substances contained in the dust can destroy any equipment exposed to them, including the seals that protect them. If dust is not successfully eliminated from the air inside the station, members of Martian missions will suffer from lung disease (pneumoconiosis). Another problem is that the Martian atmosphere does not shield against harmful solar radiation - the intensity of ultraviolet radiation on Mars is 800 times greater than values typical for moderate geographical latitudes on Earth. The thin atmosphere, which has not quite 1% of the normal pressure on Earth and is equivalent to the pressure 35 km above the Earth's surface, also complicates radio communications since it does not reflect radio waves like our ionosphere (the upper later of the Earth's atmosphere). Communications at distances beyond the Martian horizon, around 7 km, will therefore need to be transmitted by satellite.

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While participating in the study, members of successive crews simulate the day-to-day life of future Martian explorers. The role of mission geologist involves seeking out geological formations similar to those that have been discovered on Mars

During my stay at the base, two NASA engineers came to test a system for monitoring astronauts.

And what is such monitoring for?

A.Z.: By comparing the already extensive data obtained from telemetric monitoring of astronauts' physiological readings during space flights to the results of studies carried out on Earth with immobilized healthy individuals, we can develop an approximate model of the changes in bodily functions that occur in both situations. In cooperation with NASA, such research has also been carried out at the Applied Physiology Department, Medical Research Center, Polish Academy of Sciences in Warsaw. Besides, such research is not just of import for space applications, it also has clinical significance and helps us get patients forced to lie immobile for various medical reasons back in motion.

Getting back to the station: what were the responsibilities of a geologist there?

N.A.Z.: Comparing the geological conditions of the station's environs to Martian conditions. I was therefore an exceptionally mobile member of the crew, going out on extended research trips nearly every day, taking pictures and collecting samples. All of that study was harder than I had planned, as I had to do everything like a true Martian explorer, wearing more than 15 kg of gear: a space suit, thick awkward gloves, and a helmet that limited visibility. Even going outside the station involved a complex procedure: after entering the lock, one had to make sure that the fan pumping air into one's helmet had its batteries charged. Outside the station, we talked to one another by radio.

Back in your normal life, you work on processing the data obtained from remote probes observing Mars.

N.A.Z.: Martian minerals are the same as terrestrial ones; that fact has also been confirmed by Martian rovers. The surface of Mars is chiefly composed of basalt; only in certain places does that basalt form weathered forms, i.e. containing clay minerals. Aside from that, there are also various types of sulfates and carbonates on the surface of the Red Planet, although the presence of the latter is not yet completely certain. Another mineral that is encountered is hematite, or iron oxide.

My own research describes the mineralogical composition of Mars, in particular the Hellas crater. That is a very difficult area to study, since the atmosphere in this area is very dusty and the surface is covered in a layer of dust. I derive the underlying mineralogical composition by looking at infrared spectra from the shortwave OMEGA spectrometer and longwave spectra from the PFS (Planetary Fourier Spectrometer). Both spectrometers are carried aboard the Mars Express probe.

Is there some kind of geological research activity which automatic probes or rovers are not capable of performing? In other words: do we really need human researchers on Mars?

N.A.Z.: A robot cannot accomplish the same things a human can. Humans can verify and choose interesting sites and specimens to investigate, while a robot will study everything automatically. Remotely controlling and programming robots yields some results, but so far remote site selection has been more like speculation. Besides that, there remains the problem of selecting and bringing back the most interesting specimens to Earth. Of course, robots would always be sent out to especially dangerous locations. But it would definitely be easier for humans to travel greater distances than rovers, which have only managed to cover thousands of kilometers over the course of several years.

What did your stay in Utah teach you? Did it force you to rethink some of your opinions?

N.A.Z.: While in Utah I realized the difficulties involved in working in a spacesuit, i.e. the visual, mobile, and physiological limitations it imposes. The spacesuits used by astronauts are definitely much better suited to human needs than those in Utah, but working in gloves alone poses considerable problems, such as manipulating equipment or just simply taking notes. Wearing a helmet limits one's field of view, especially when traveling by vehicle.
Of course, those are limitations well-known to astronauts, and spacesuits are constantly being refined and devices for space use being developed. Engineers have to do their best to ensure that a Mars voyage can proceed as safely as possible. One does hear about equipment shortcomings which largely stem from neglect. But I am a great advocate of manned voyages to Mars and eventually to other planets - a challenge that will inevitably be tackled.

Before reaching Mars, a mission will have to spend a long time in space. What does that entail for the human body?

A.Z.: Based on our existing knowledge we cannot say with full certainty how traveling to Mars will affect the human body, as the voyage duration exceeds all of our existing experience and ability to predict negative effects. We can anticipate the health impact of spaceflight, but not over as long a time as the planned trip to Mars. It is also worth noting that on the way astronauts will be exposed to harmful cosmic radiation and only partially protected from it by the design of their ship. However, that does not mean that man is completely defenseless against the negative consequences of being in space. Special sets of muscle exercises have been developed, and spaceships are even fitted with stationary track machines so that astronauts can prevent or reduce their loss of fitness. But we can hope that when more ambitious space exploration challenges are taken on, the human body will manifest new extraordinary adaptive abilities.

Interviewed by:
Weronika Śliwa
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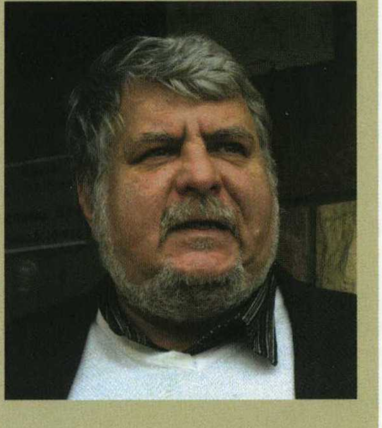
Natalia Andrzejewska-Zalewska, geologist, is finishing her doctorate at the Space Research Center, Polish Academy of Sciences. In January/February 2005 she took part in a simulated Martian mission at the Planetary Society's base in the Utah desert. Apart from her scientific interests, she plays the violin and is a theater aficionado (one of the founders of the "Divadlo" theater). During the 2006 Warsaw Science Festival she played the role of Niels Bohr's wife in the play *Copenhagen*.



Assoc. Prof. Andrzej Ziemba MD is head of the Applied Physiology Department, Medical Research Center, Polish Academy of Sciences. In 1982-1984 he worked at the Gerontology Research Center, NIH in the United States. He currently studies issues related to the human metabolism and physical effort.