TARDIGRADES

SUPERHEROES AND SLEEPING BEAUTIES

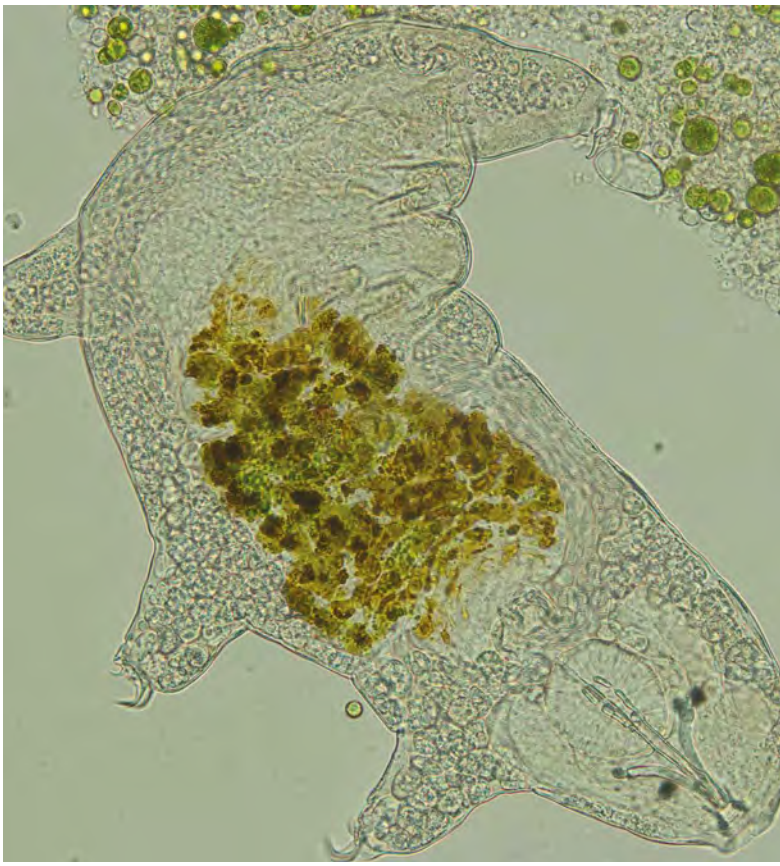
Tardigrades (popularly known as water bears or moss piglets) are often referred to as indestructible animals that can withstand very high and extremely low temperatures, prolonged droughts, and even exposure to cosmic radiation. What is behind this remarkable resistance, and is there really nothing that could harm them?

Photo: iStock

***Paramacrobiotus experimentalis* female immediately before laying eggs**
Photo: Assoc. Prof. Izabela Poprawa

"The fact that tardigrades are frequently referred to as water bears is probably due to their body shape and their way of movement. When they move around, they are quite clumsy and evoke some feeling of sympathy," says Dr. Izabela Poprawa from the Faculty of Natural Sciences at the University of Silesia, who has been studying these unusual invertebrates for years.

Tardigrades are the subject of intense scientific inquiries. Their body structure and extraordinary ability to survive in the most difficult, extreme conditions arouse great interest.



Herbivore tardigrade *Dactylobiotus dispar* on the prowl
Photo: Assoc. Prof. Izabela Poprawa

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EVERY SUPERHERO HAS WEAKNESSES

It is true that tardigrades survive excellently in extreme environmental conditions. They can overcome temperatures close to absolute zero, i.e. on the order of -270°C, as well as those as high as 150°C. They managed to survive a journey into space. Although they prefer humid environments, such as moss-covered habitats, we can find them in subpolar areas as well as in a nearby sandbox or home garden. Can we perceive them with naked eyes? The largest specimens are about 1.2 mm long, but there are not many of them. The vast majority of tardigrade species are only about 0.5 mm long.

Active animals are exposed to the same dangers as other organisms on Earth, and there are no exceptions. However, when something disturbing is happening, the body of tardigrades goes into a state of cryptobiosis, i.e. latent life. Depending on the conditions, it can be e.g. a state of anhydrobiosis caused by too little water, cryobiosis – due to too low a temperature in the environment, osmobiosis – due to a change in salinity, or anoxybiosis occurring as a result of insufficient oxygen levels.

In the state of anhydrobiosis, metabolic processes are so low that they are practically difficult to detect. In addition, as a result of dehydration, tardigrades form a so-called tun. Because their body constricts, the evaporation surface is reduced, and excess water is removed from the body etc. All this is done in order to survive.

We do not know how many years they can survive in this state, so far documented experimental research has shown that at least... thirty. And here we come to another paradox. Tardigrades are like sleeping beauties. Studies have shown that their bodies do not age during their state of cryptobiosis. In practical terms, this means that if a forty-year-old person fell into such a state and woke up, say, a hundred years later, their body would still be forty years old. Therefore, it is not surprising that scientists want to know the secrets of tardigrades.

Although they are able to manage extreme conditions, recent studies show that tardigrades can be harmed by the effects of... global warming.

"In a state of cryptobiosis, they can survive in a really challenging environment, but may not in time acclimatize to the slightly higher temperatures which have increasingly become the norm today. It is worth mentioning that this study was conducted on only one species of tardigrades, which should of course be taken into consideration, but the results should – and do – give us food for thought," the biologist says.

AND WHAT IF A HUMAN BEING GAINED THE POWER OF A TARDIGRADE?

Tardigrades were first sent into space in 2007 – in a state of anhydrobiosis. Most of them woke up after their return, but among the four traveling species, *Milnesium tardigradum* turned out to be the greatest superhero. After being rehydrated, they recommenced all basic life functions, including reproduction.

The remarkable abilities of these small organisms fire the imagination of people. What if we traveled to Mars, for example, in a state of cryptobiosis, without experiencing the negative effects of a long journey, without aging? As of today, such considerations are obviously mere fantasy, but since there are organisms on Earth that have certain capabilities, it means that some potentially interesting solutions are not alien to nature.

Of course, there is still a long way to go to discover all the secrets of tardigrades. Scientists discovered several proteins and other substances responsible e.g. for protecting the DNA of these invertebrates from damage caused by various extreme conditions or for influencing the process of water crystallization in the body, which is of particular importance in the state of cryobiosis, since due to the change in its state of aggregation, water could tear the cells of their tiny bodies apart.

Research shows that the range of solutions is huge and specific to a given species. A better or worse adaptation to difficult conditions is also influenced by the stage of development of the given individual. This topic is one of the main scientific interests of Prof. Izabela Poprawa. The analyses are conducted in cooperation with a team of scientists from the Adam Mickiewicz University in Poznań. Researchers study e.g. at which stage of development the survival rate in the state of anhydrobiosis in certain species of tardigrades is the highest. This is experimental research. First, selected specimens are dried, then watered and observed, and all relevant parameters are recorded. In the next stage, genetic tests are planned.

"My main interests also concern the reproductive system of tardigrades, which is of great importance in taxonomy and phylogenesis," says Prof. Izabela Poprawa.

Tardigrades are positioned between arthropods and *Onychophora*. Therefore, our researcher looks for features to better understand their classification. Modern tools support scientists on this quest. Thanks to advanced technologies, it is possible to reconstruct a three-dimensional image of various elements of the reproductive system and then compare it with reconstructed parts of the organisms of the two sister types we are interested in. These results have made a great impression in the scientific world and bring us closer to a better understanding of invertebrates.