

S-face

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The Mysterious “Ultimate Survivor” Revealing the Ecology of **Tardigrades** Megumu Tsujimoto



VOL.

031

/100

2019.Oct ISSUE

Japanese Color: KARAKURENAI-tro

Adorable and Intriguing The Fascinating Tardigrades

Tardigrades have become popular for their incredible ability to withstand the extreme environments such as the radiation exposure, the vacuum of space, and the extreme low temperature.

However, much of the ecology of this tiny “ultimate survivor,” which does not even reach one millimeter in length has been left unrevealed. Assistant Professor Megumu Tsujimoto, who specializes in Polar Ecology, has devoted herself to working on the ecology of the Antarctic tardigrades.

She has participated twice in the summer party of the Japanese Antarctic Research Expedition (JARE), to conduct field surveys in order to understand the ecology of tardigrades living in the extreme environments.

Furthermore, she broke the record by decades of long-term survival of tardigrades in a study in which tardigrades frozen in moss for over 30 years were successfully revived and then reproduced.

The 56th Antarctic Research Expedition



The 56th Japanese Antarctic Research Expedition (JARE 56) was the first to carry out the in-depth survey of tardigrades living around Syowa Station. In the right photo, Tsujimoto (front) and Associate Professor Suzuki are observing the samples collected in the field under the microscopes in a hut built on an ice-free area away from Syowa Station. The JARE 56 terrestrial research team carried out sampling at an ice-free area where the terrestrial research teams had never visited before for the vegetation and tardigrades survey and also in the intertidal zones for the marine tardigrade survey in order to deepen understanding of the ecology of the Antarctic tardigrades.

Research with Students



In the laboratory, Tsujimoto works with students on the Antarctic terrestrial organisms including tardigrades as well as flowering plants growing on the Antarctic Peninsula. “I’ve always worked on my research alone, so I’m really looking forward to working with the SFC students.” (Tsujimoto). There are many international collaborations carrying out in the Antarctic, and she engages with many researchers in foreign countries. She would like to take the students to the international science conferences and workshops so that they will gain experiences in international collaborations.

Fundamental Ecology of Tardigrades is Left Unrevealed Research Leads to the Numerous New Discoveries

Tardigrade are animals that belong to the phylum Tardigrada. Tardigrade earned the moniker of “water bear” due to its slow, lumbering walk. Tardigrades live in a variety of environments on earth, and can be found in patches of moss and soil, as well as extreme environments like the deep sea and the Himalayas.

In particular, I have been working on the ecology of a tardigrade species *Acutuncus antarcticus*. This species is endemic to Antarctica and is widespread throughout the Antarctic region. Today, over 1,200 species of tardigrade have been recorded on earth with many regions still not yet explored. Thus, we expect many more species to be found.

I was so much fascinated by the tardigrades described by Dr. Atsushi Suzuki (Associate Professor, Keio University School of Medicine) in the book “Tardigrada?!—the Little Monster” (2006, Iwanami Shoten) that I decided to start studying tardigrades by my own. Associate Professor Suzuki succeeded in rearing the tardigrade species *Milnesium tardigradum* and conducted daily observations on this species from hatching to death. He became the first researcher to report the life history of tardigrades in detail. The book included many adorable pictures of the tardigrades taken by Associate Professor Suzuki, and their cute appearances and fascinating ecology sparked my interests in the animals. In 2012, I started my own research on the tardigrades living in Antarctica. Most of the research on tardigrades has long focused on the strength and mechanisms of their outstanding survival capability, and we still have very limited knowledge on their fundamental ecology. As we progress in conducting the researches, we gain new understandings of their ecology, and then come up with more questions. This process is just a joy, and gives the greatest satisfaction as a researcher.

Succeeded in Resuscitating Tardigrades Frozen for Over 30 Years

Tardigrades have the ability to temporarily shut down their metabolic activities, which is called cryptobiosis. In 2014, my research group extracted adult tardigrades and an egg from a moss sample which had been frozen for over 30 years, and succeeded in recording the process of their resuscitation and hatching of the egg and their reproduction after the revival. The previous longest records of the long-term survival of tardigrades were eight years in adult under the frozen condition and nine years in eggs at desiccated state preserved at room temperature. Therefore, we were able to break the records of the long-term survival of tardigrades by decades.

In the study, the moss sample was collected near Syowa Station in Antarctica in November 1983, and stored frozen at -20°C at National Institute of Polar Research

in Tokyo. We thawed the sample and soaked in water, then picked up two resuscitated adult tardigrades and an egg and reared them in the lab. While an adult did not recover completely and died a while later, another adult sufficiently recovered. The fully resuscitated adult and the hatchling of the resuscitated egg went on to successful reproduction and laid eggs multiple times.

The long recovery time required for the resuscitated animals, and the longer time required for the first egg laid after the revival to hatch indicated possible damage accumulated over the long period of storage, and also suggested that the resuscitated individual and egg possibly recovered from the damage. A key aspect of our research was that we documented and reported the recovery conditions and reproduction following the revival of the tardigrades in detail, and not just simply reported their resuscitation. Our research was the first to present such detailed conditions, and with further experiments and investigation we will be able to develop better understanding of the mechanisms underlying the long-term survival of these organisms in cryptobiosis.

Leading Young Researchers to Antarctica “I Want to Bring Excitement to Antarctic Science Together”

There are still few researchers who work on the microscopic animals that live in the Southern Ocean. Those animals include tardigrades, nematodes and kinorhynch, and our knowledge on their ecology is scarce. Under such circumstance, I launched a project with young taxonomic

researchers in Japan to investigate the diversity and speciation of the marine benthic microorganisms^(*) of the Southern Ocean. In this project which I am leading, we are planning to carry out diving operations for two consecutive summer seasons in 2020/21 and 21/22 with JARE. I am also planning to participate in the JARE operation, and this time I would like to give lectures at SFC from Syowa Station in Antarctica through satellite. Just like many other fields of research, the impact of climate change on the wildlife in Antarctica is quite a hot topic. It is essential to obtain the very fundamental data such as diversity and distribution of species in order to build up the research as to understand the impact of climate change. With the taxonomists specializing in various animal groups, I would like to further investigate the process of the speciation and evolution of the microorganisms living in the Southern Ocean, and develop our understanding of the Antarctic ecology in much larger scale.

In my career, I have been engaged with many international collaborative projects and worked with researchers in other countries. At the same time I admire the high productivity and strength in logical thinking of researchers in foreign countries. I always appreciate the quality of the data Japanese researchers often can produce from their steady efforts and careful works. While working with talented researchers in Japan including the staff and students of SFC, I would like to build upon this strength of the Japanese researchers, and increase our presence in the Antarctic Science.

* Microscopic animals such as tardigrades that live in the sand on the bottom of the sea.

Profile Megumu Tsujimoto

Assistant professor, Faculty of Environment and Information Studies, Keio University. Completed the five-year Doctoral Program at Department of Polar Sciences at School of Multidisciplinary Sciences at Graduate University for Advanced Studies (SOKENDAI). Specializes in Polar Ecology. Ph.D. (Philosophy).



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There are more articles and
video of Megumu Tsujimoto.

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