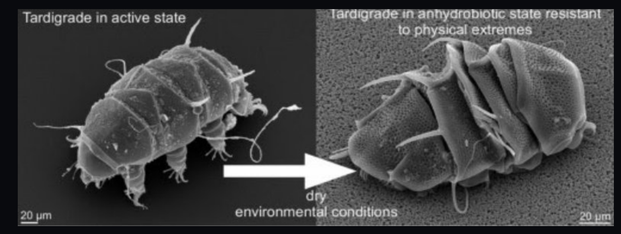
Looking to the past to predict the future: Tardigrades - a model example

Andrea Francesca BELLIA*[1], Maria AQUILINA[2], Sandro LANFRANCO[1], Joseph BORG[3], Josef BORG[4], Kristian ZARB ADAMI[4]

[1]Department of Biology, University of Malta, Msida, MSD2080, Malta; [2]Faculty of Science, University of Malta, Msida, MSD2080, Malta; [3]Department of Applied Biomedical Science, University of Malta, Msida, MSD2080, Malta; [4] Institute of Space Science and Astronomy, University of Malta, Msida, MSD2080, Malta

***Corresponding author: andrea-francesca.bellia.17@um.edu.mt**

European Astrobiology Network Association (EANA) Virtual Meeting 2020, 27-28 August, 2020



Why Tardigrades?

The **extremotolerant** invertebrate phylum Tardigrada comprises approximately 1300 extant species. They have a long **evolutionary history**, with their origin probably dating to the Cambrian. Species in this phylum exhibit some of the highest known ranges of tolerance to abiotic conditions, including tolerance to conditions potentially found on the surfaces of the Moon, of Mars and in interplanetary space. These peculiar physiological properties have attracted the attention of astrobiologists, consequently resulting in these organisms' use in space-survival research. The use of Tardigrada in space-related research is also facilitated by their cosmopolitan distribution, high abundance in nature, and relatively large size (*ca* .0.5mm). This therefore makes them easier to isolate and use for experimentation. From the point of view of genetic investigation, their relatively smaller genomes also facilitate experimentation, as these are easier, quicker and cheaper to sequence.

Driving Force: What do we aim to answer?

This study aims to determine which extremotolerant genes were inherited and retained throughout Tardigrade evolution. In doing so, we hope to identify when the extremotolerant genes originated, and why tolerance to so many extreme conditions was required for such an organism. Therefore, the main scope is to trace where and when tardigrades got their extremotolerant genes, and whether extremotolerance is increasing or decreasing with time.

Workflow

The overall plan of work for this project will be to determine:

1. Which genes confer **tolerance** to which extreme conditions;
2. At what point in the tardigrade's **evolutionary history** such genes for extremotolerance originated, and **why;**
3. Whether resistance to such extreme conditions increased or decreased with the **evolution** of tardigrades, and why;
4. Which of the genes for extremotolerance were **inherited** from ancestral DNA.

Proposed work

1. Observation and identification of gene responses (using genetic analysis) to gradual and sudden shock exposure to extreme conditions.
2. Use DNA sequencing to:
   - 2.1. identify genes for extreme resistance and compare with other known extremophiles and extremotolerant organisms;
   - 2.2. compare extremotolerant genes with tardigrade ancestors and descendants;
   - 2.3. identify which genes were inherited from tardigrade ancestors, and try and postulate as to why other genes for extreme resistance arose;
   - 2.4. determine which extremotolerant genes were retained by tardigrade descendants, and whether extremotolerance is increasing or decreasing with time.
3. Isolation and use of extremotolerant genes for resistance as knock-in genes using CRISPR/CAS9 for crops, medicines, and a plethora of other uses.