**Tardigrades: from genestealers to space marines**

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**Abstract**

Tardigrades, also known as water bears, are microorganisms of the invertebrate phylum and are related to arthropods. It is one of the most interesting organisms, especially because of their high stress-tolerance. Their ability to survive in conditions that lead to death of many other organisms potentially is a key to understanding advanced mechanisms in biological systems and evolutionary processes.

**Introduction**

Tardigrades are able to withstand the most hostile conditions we know. They have highly extensive areas of habitat from up from 6000 meters in Himalayas and down to 4000 meters in sea troughs. Tardigrades are 0,1-1,5 mm in length and their small size is the one of the reasons of their ability to survive. They can get over low temperature conditions, using anhydrobiosis [1]. It is a variant of anabiosis, a process of suspended animation, that is accompanied by water exclusion from cell [2]. Also their high stress-tolerance is explained by existence of highly effective DNA reparation system. Genome of tardigrades has more than 200 million base pairs. It is longer than an average genome of their phylum. Nowadays is considered that tardigrades could obtain some stress-response genes by horizontal gene transfer [3]. After sequencing tardigrades genome we can find out the reasons of their endurance.

**Materials and methods**

In this article we present results obtained after BLAST search on UniProtKB/Swiss-Prot database with default parameters, localisation prediction by WoLF PSORT and TargetP-2.0 with parameters tuned to search on animals sequences and domain prediction by Pfam and HMMER.

**Results**

More information about our results are available in table in our notebook [4].

As we can see the most similar protein from our sequences are damage suppressor protein which is responsible for DNA repair and could be the reason of tardigrades ability to survive.

**Discussion**

We have discovered a unique protein Dsup (Damage suppressor protein) (accession P0DOW4.1). It forms stable complexes with DNA, causing its aggregation in the nucleus. Apparently it is responsible for the protective function against radiation damage [5]. Also the results of our study prove the fact that tardigrades have many genes that are horizontally transferred from other organisms. Usually in the tardigrades genome several copies of the MRE11 gene are found, which is responsible for repairing double-stranded breaks. Moreover, these animals lack key components of the most important intracellular signaling pathway, mTORC1, which responds to hypoxia, genotoxic and oxidative stress. At the same time, the components responsible for the recognition of amino acids and energy deficiency remained intact.

**References**

1. Tsujimoto M, Imura S, Kanda H. 2016. Recovery and reproduction of an Antarctic tardigrade retrieved from a moss sample frozen for over 30 years. Cryobiology 72, 78–81. (10.1016/j.cryobiol.2015.12.003)
2. Asfar P, Calzia E, Radermacher P. Is pharmacological, H₂S-induced 'suspended animation' feasible in the ICU?. *Crit Care*. 2014;18(2):215. Published 2014 Mar 18. doi:10.1186/cc13782
3. Extensive horizontal gene transfer in a tardigrade Thomas C. Boothby, Jennifer R. Tenlen, Frank W. Smith, Jeremy R. Wang, Kiera A. Patanella, Erin Osborne Nishimura, Sophia C. Tintori, Qing Li, Corbin D. Jones, Mark Yandell, David N. Messina, Jarret Glasscock, Bob Goldstein. Proceedings of the National Academy of Sciences Dec 2015, 112 (52) 15976-15981; DOI: 10.1073/pnas.1510461112
4. Project log <https://github.com/alexmorphine/bioinformatics_workshops/blob/master/Project4/project4_log.ipynb>
5. Hashimoto T. et al. Extremotolerant tardigrade genome and improved radiotolerance of human cultured cells by tardigrade-unique protein //Nature communications. – 2016. – Т. 7. – С. 12808.